Engineering

SAN/0499-82
MDC G9705

10 MWe Solar Thermal Central Receiver Pilot Plant

SOLAR FACILITIES DESIGN INTEGRATION

PLANT MAINTENANCE/TRAINING MANUAL (RADL ITEM 2-37)
SECTION 1 — ROTATING APPARATUS (BOOK 3 OF 3)

Revised September 1982
July 1981

WORK PERFORMED UNDER CONTRACT
DE-AC03-79SF10499

MCDONNELL DOUGLAS ASTRONAUTICS COMPANY
5301 BOLSA AVENUE
HUNTINGTON BEACH, CA 92647

U.S. Department of Energy

MCDONNELL DOUGLAS CORPORATION | Rockwell International Rocketdyne Division | Stearns-Roger | Solar Energy

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10 MWe Solar Thermal
Central Receiver Pilot Plant
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UNDER CONTRACT DE-AC03-79SF10499

UPDATE FOR
PLANT MAINTENANCE/TRAINING MANUAL
(RADL ITEM 2-37)
SECTION 1 - ROTATING APPARATUS

INSTRUCTIONS:

1. This update is issued to incorporate corrections and additions to the preface, table of contents, index pages of the original July 1981 document and to incorporate additional information in paragraph 1.2, Pumps. This update has resulted in the addition of several books for this section (for paragraph 1.2) due to the large volume of data. Accordingly, Section 1 has been completely revised and reprinted in its entirety. Therefore you can destroy the original July 1981 issue.

2. For information, the following items were changed in the original issue:

   - Revised index pages 1.2-3, 1.3-1, 1.4-1 and 1.5-1

3. The following new data was incorporated in paragraph 1.2, Pumps:

Book 1

- Oil Circulating Pump - Pages 1.2.1-45 thru 1.2.1-49.
- Fluid Makeup Pump - Pages 1.2.3-1 thru 1.2.3-16.
- Flash Tank Drain Pump - Pages 1.2.4-1 thru 1.2.4-36.
- Raw/Service Water Pumps - Pages 1.2.6-1 thru 1.2.6-28.
- Primary and Secondary Fire Water Pumps - Pages 1.2.7-1 thru 1.2.7-441.

Book 2

- Fire Maintenance Jockey Pump - Pages 1.2.8-1 thru 1.2.8-51.
- Demin. Water Transfer Pump - Pages 1.2.9-1 thru 1.2.9-23.
- Separator Waste Water Pump - Pages 1.2.10-1 thru 1.2.10-24.
- Oil Sump Pump - Pages 1.2.11-1 thru 1.2.11-27.
- Raw/Service Water Sump Pump - Pages 1.2.12-1 thru 1.2.12-20.
- Oil Sludge Pump - Pages 1.2.13-1 thru 1.2.13-14.
- TSU Area Sump Pump - Pages 1.2.14-1 thru 1.2.14-13.

Book 3

- Receiver Feedwater Pump - Pages 1.2.23-1 thru 1.2.23-563.
- BCS Fluid Receiver Pump - Pages 1.2.36-1 thru 1.2.36-17.

PREFACE

This document is provided by the McDonnell Douglas Astronautics Company (MDAC) in accordance with Department of Energy Contract Number DE-AC03-79SF10499, Reports and Deliverables List Item 2-37. The material presented here is intended for training and maintenance usage by Southern California Edison Operations Personnel.

Specific notes on the organization and content of the document are as follows:

1. This document is organized in major sections that reflect the top level breakdown of the Master Equipment List as defined in RADL Item 2-19. This is in contrast to the subsystem approach used in designing the plant, however, is consistent with the Southern California Edison operating plant equipment lists.

Section 1 - Rotating Apparatus
Section 2 - Stationary Apparatus
Section 3 - Electrical Apparatus
Section 4 - Valves
Section 5 - Instrumentation
Section 6 - Control and Data Systems
Section 7 - Collector System
Section 8 - Special Heliostat Instrumentation and Meteorological Measurements Equipment
Section 9 - Heating Ventilating and Air Conditioning
Section 10 - Facilities

2. Assignments to categories are made on the basis of the lowest level tag numbers. For example, maintenance information for the thermal storage extraction pump skid assembly (SA-309) is not listed in the stationary apparatus section, but broken down to the generic categories as defined by the tag number; i.e., pumps (Section 1.2), air operated stop valves (Section 4.2), pressure transmitter (Section 5.2), etc.

3. The Process Instrumentation Section (Section 5.0) is organized on the basis of sensor type as defined by the first letter of the designating tag number. It contains sensor-related information only. Signal conditioning equipment is treated in Section 6.0.

4. The information on the Collector System, which was provided by the Martin Marietta Corp. (MMC) and the major items of the Electrical Power Generation System equipment, provided by Southern California Edison is not provided herein. However, the various sections were structured for their inclusion where applicable.

Technical questions concerning this RADL Item should be directed to Mr. R. G. Riedesel at (714) 896-3357 or Mr. R. J. Perkins at (714) 896-3073.

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1.2.23 Receiver Feedwater Pump

1.2.23.1 Identification

Tag Number	Description
P917	Receiver Feedwater Pump with pressure controller tag number PC1105 and Lube oil pump (tag P942)

1.2.23.2 Description

Pump

Manufacturer:
Bingham-Willamette Co.
P.O. Box 1085
Denver, CO 80201

Pump type: CP-1080, 4 x 6 x 9E

Stuffing Box

Manufacturer: Bingham-Willamette Co.

Type: Injection system, temperature control

Bearings

Manufacturer:
Kingsbury, Inc.
Philadelphia, PA 19154

Type: JHJ-5

Driver

Manufacturer:
Reliance Electric Co.
Cleveland, Ohio 44117

Frame No: E5810S

Coupling

Manufacturer:
Thomas
Warren, PA 16365

Frame No.: DBZ-C

Gyrol Fluid Drive

Manufacturer:	American Standard Dearborn, Michigan 48121
Type:	VS Class 6

Controller

Manufacturer:	Leslie Co. Parsippany, N.J. 07054
Type:	Series 2310

1.2.23.3 Vendor

Bingham-Willamette Co.

1.2.23.4 Procurement Specification

Stearns-Roger Spec No. D46.1 (DOE Spec 40M700-27S)

1.2.23.5 Operation/Maintenance

See attached Bingham-Willamette manual, Serial No. 1A995

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BINGHAM-WILLAMETTE INFORMATION

NOTE: SEE SUPPLEMENTS DATED 10-27-81 AND 11-25-81
FOLLOWING PAGE 1.2.23-443.

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VENDOR INFORMATION

BEARING DRAWING	KINGSBURY	NO. 163866 ✓
INSTRUCTIONS	KINGSBURY	271-H-66
COUPLING INSTRUCTIONS	THOMAS	DBZ-C ✓
DRIVER	RELIANCE	B-3628-4 ✓
ROUTINE TESTS	RELIANCE	RE 1293VV3
DIMENSION PRINT	RELIANCE	608991-360
DATA TRANSMITTAL	RELIANCE	RE 1805ST1
GYROL FLUID DRIVE INSTRUCTIONS	AMERICAN STANDARD	SEC. 1, pp1-25 SEC. 2, pp1-3.1
ORDER BILL OF MATERIAL	AMERICAN STANDARD	78-AD-6271
CROSS SECTION	AMERICAN STANDARD	78-C293
OUTLINE	AMERICAN STANDARD	78-CD-6266
BILL OF MATERIAL	AMERICAN STANDARD	78-146D-6-104CCW 7 SHEETS
INSTALLATION NOTES	AMERICAN STANDARD	78-AD-6270
SPARE PARTS	AMERICAN STANDARD	ONE SHEET
INTERNAL PIPING	AMERICAN STANDARD	78-CD-6273
OIL COOLER	AMERICAN STANDARD	78-CD-6563
CP EXCHANGER PARTS	AMERICAN STANDARD	5-046-08-042-009
CP EXCHANGER DRAWING	AMERICAN STANDARD	5-046-08-042-009
CP EXCHANGER INSTRUCTIONS	AMERICAN STANDARD	PAGE 101
THERMOMETER (ASHCROFT)	AMERICAN STANDARD	SEC. 250-999-H
PROCESS COMMAND CONTROLLER	AMERICAN STANDARD	78-DD-5694
200/400 CONTROL INST.	AMERICAN STANDARD	D-3490
ACTUATOR (JORDAN)	AMERICAN STANDARD	SEC. IM-0422-A
MAG PICKUP (AIRPAX)	AMERICAN STANDARD	SEC. 78-BD-6267
OIL FILTER	HILLIARD	BLTN. HF-11 DWG.DD-431
LUBE SYSTEM INFORMATION	DELAVAL IMO	C3E-A
LUBE PUMP DRIVER	GENERAL ELECTRIC	GEC-1241D

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VENDOR INFORMATION CONTINUED

INSTALLATION
OPERATION
MAINTENANCE

CP
CPA
CP-DS
CPA-DS

Bingham-Willamette
MULTISTAGE
HORIZONTAL PUMPS

CAUTION
BEFORE OPERATION, AUXILIARY EQUIPMENT SETTINGS MUST BE CHECKED/RESET

CONTENTS

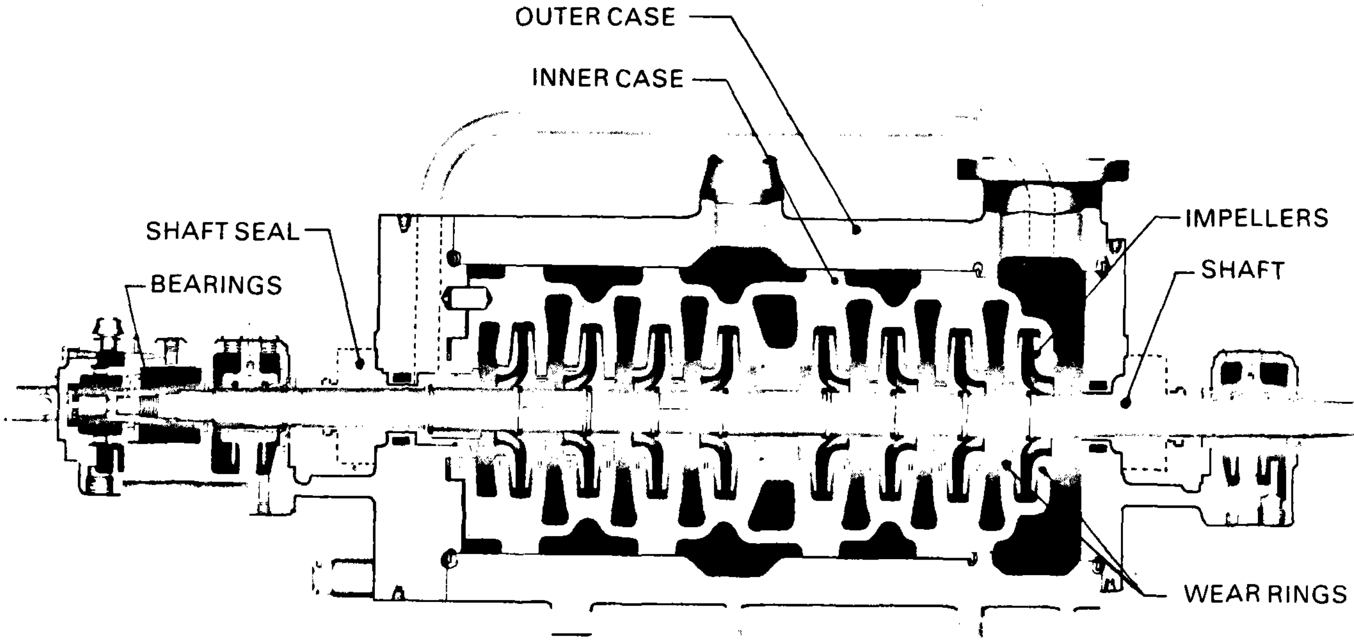


Fig. 1 Typical 9-stage CP

INTRODUCTION

SCOPE

This manual provides installation, operation and maintenance instructions for the Bingham-Willamette type CP, CP-DS, CPA, and CPA-DS multistage double case horizontal pumps. Instructions are developed by engineering and field service personnel who are involved in design, manufacture and service. This manual is prepared for operation and maintenance personnel.

Read instructions carefully before operating system.

Use this manual with a cross section drawing, parts list and outline drawing (see specific manual). Instructions on vendor equipment is included in the specific manual.

DESCRIPTION

CP, CP-DS, CPA, CPA-DS The Bingham-Willamette type CP, CP-DS, CPA, and CPA-DS are double case, opposed impeller, multistage pumps. The CP and CPA has a double volute and single suction first stage impeller. The CP-DS and CPA-DS is a double volute, double suction first stage design.

The CPA and CPA-DS utilize compohents, such as impellers, common to the MSD line. The CP and CP-DS are designed and built to answer "high specification" requirements.

MAJOR COMPONENTS

OUTER CASE Suction and discharge nozzles are provided to match customer requirements. Nozzles are welded to the outer case and are typically attached at the case top centerline.

INNER CASE The inner case halves are cast with an alloy to suit application.

SHAFT Machining provides proper impeller fit for each stage.

IMPELLERS The impellers are key driven and positioned axially with split thrust rings.

WEAR RINGS Replaceable case and impeller rings provide a close running clearance to reduce quantity of liquid leaking from high pressure side to low pressure side.

SHAFT SEAL Shaft sealing is provided by either a cartridge type mechanical seal, a packed type stuffingbox or a packingless stuffingbox. Refer to outline drawing for arrangement furnished.

BEARINGS Choice of three standard bearing configurations depend on size, speed and service requirements:

1. Double row ball thrust bearing and single row radial bearing.
2. Duplex angular contact ball thrust bearing and sleeve journal radial bearing.
3. Pivot shoe thrust bearing and sleeve journal radial bearing.

COUPLING The coupling is selected to suit operating conditions and service requirements for a specific application.

PERFORMANCE FACTORS

Pump performance may be affected by changes in pumpage, specific gravity, viscosity, pump operating speed, and NPSH (Net Positive Suction Head). Centrifugal pumps are designed for specific services and may not be suited for any other service without loss of performance or damage.

IMPORTANT NOTE: Do not change operating conditions from original design parameters without contacting a Bingham-Willamette representative.

INSTALLATION

INSPECTION

INSPECT UPON ARRIVAL Equipment is inspected prior to shipment. Check for shipping damage upon receipt. Report damage or shortage immediately to the carrier and to a representative of Bingham-Willamette.

STORAGE

NOTE: The following storage instructions apply only to the pump and may not be appropriate to driver units, switches, etc. Follow vendor instructions for all other components of the pump system.

REQUIREMENTS Prior to shipment, the pump and its components are adequately prepared for outside storage with the following additional requirements:

1. Store off ground on skids or cribbing so that no water will accumulate around unit.
2. Protect pump and attachments with a vinyl coated nylon tarpaulin. Lash tarp down evenly to provide drainage that does not form pools. Maintain sufficient air circulation with a 3 in. (8 cm) minimum clearance between tarp and pump.
3. Locate in an area which is free from blowing sand and dirt.
4. Maintain desiccant effectiveness.
5. Do not stack on top of this equipment.
6. Prevent animal entry by keeping connections sealed.
7. Maintain bearing lubricant or rust preventive protection.
8. Periodically rotate shaft to prevent set, and lubricate bearings.

APPROVED STORAGE MATERIAL The following materials shall be used for maintenance:

1. Use packages of VPI crystals or a desiccant. Desiccant will be non-halogenated, non-deliquescent, chemically inert silica gel (or equivalent) to meet MIL-D-3464-D, type 11.
2. Vinyl-coated nylon tarpaulin.
3. OVER-COAT (Certified Laboratories, Fort Worth, Texas) or equivalent, rust preventive.
4. Lubriplate No. 4, or equivalent.

INSPECTION AND MAINTENANCE Inspect every four weeks:

1. Remove protective tarpaulin.
2. Remove nozzle cover(s). Desiccant is attached to cover.
3. Change desiccant as-necessary and re-attach to cover. Change desiccant every 6 months.
4. Recoat surfaces requiring protection with approved rust preventive.

5. Wipe up spilled or excess rust preventive.
6. Recoat bearings with approved lubricant every 6 months. Drain bearing housing and replace plugs.

NOTE: Bearings should be disassembled and inspected before operation.

7. Hand rotate shaft for ten correct-direction revolutions. Leave shaft at least 90 degrees from original.
8. Replace and reseal protective cover(s).
9. Replace and lash protective tarpaulin.

RECORDS Keep an inspection record with equipment:

1. Date of inspection
2. Signature of person performing inspection and/or maintenance.
3. Results of inspection.
4. Date of maintenance.
5. Description of maintenance performed.
6. Amount and type of desiccant replaced.

NOTE: Requirements of a job specific Bingham-Willamette Storage Procedure supersede the aforementioned instructions.

CLEANING

RUST PREVENTIVE External nonpainted machined surfaces may be protected with a rust preventive. This external coating can be removed with kerosene or safety solvents.

Any internal parts of the pump that are vulnerable to rust are protected with a film of rust inhibitor.

NOTE: Rust inhibitors are not normally used on corrosion resistant materials. Flushing is unnecessary.

FLUSH AND CLEAN Before installation, thoroughly flush to remove rust inhibitor and any foreign material that may have accumulated during shipping or storage. Use a mild alkali solution at 180° F(82° C), or a safety petroleum solvent. Flushing step may be eliminated if the pumpage is a petroleum product compatible with the rust preventive.

NOTE: Before cleaning, be sure to remove any desiccant.

WARNING: The cleaning solution or solvent accumulates within impeller cavities. If subject to freezing temperature. evacuate pump by draining or air pressure. A hot air purge is required to completely dry the interior.

FOUNDATION

DESIGN The foundation must be sufficiently rigid to inhibit pump vibration. The most satisfactory foundation is made of reinforced concrete. The foundation design will depend on the specific system support and external piping requirements. Pour foundation well in advance of installation to allow time for drying and curing.

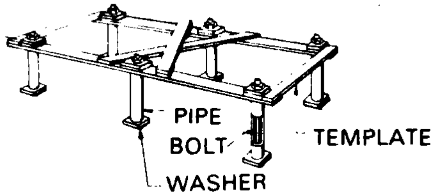


Fig. 2 Template

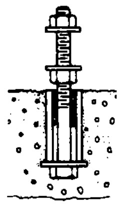


Fig. 3 Foundation bolt

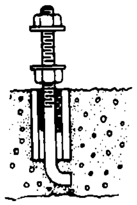


Fig. 4 Hooked foundation bolt

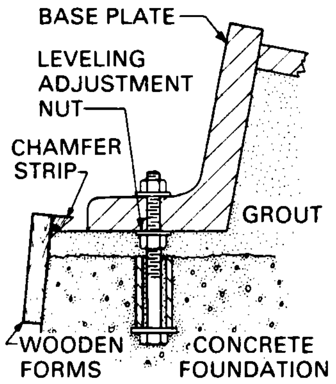


Fig. 5 Leveling adjustment nuts, angle base

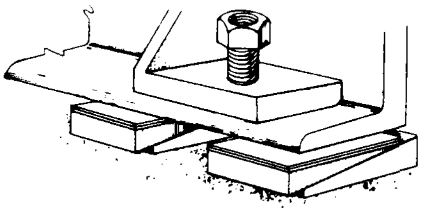


Fig. 6 Leveling adjustment wedges, angle base

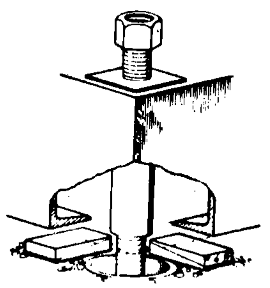


Fig. 7 Leveling adjustment wedges, channel base

When unit is to be mounted on steel work or a similar structure it should be set directly over or as near as possible to supporting beams or walls. It must be supported securely to prevent distortion and misalignment caused by yielding or springing of either structure or base.

SITE Install as close as possible to source of pumpage. Allow adequate space for operation, maintenance, and inspection. The outline drawing provides dimensions necessary for site design. Motor-driven pumps should not be located in damp locations unless equipped with moisture proof motors.

BASE PLATE-FOUNDATION CONSTRUCTION Construct a template to dimensions of base plate. The template holds foundation bolts in place during foundation pour (Fig. 2).

Each foundation bolt should be surrounded by a pipe with an inside diameter about three times bolt diameter. In this way, the pipe is held solidly in place while allowing some later minor adjustment of the bolt (Fig. 3 & 4).

The bolts should extend above the top of the pipe sleeves enough to allow one to two inches (2.5 - 5.1 cm) of grouting between base plate bottom and foundation. Provision for leveling the base plate is by use of support and leveling nuts and washers placed on the foundation bolts (Fig. 5) or shims, wedges or leveling screws (Fig. 6).

The bolt, washer, and pipe are tack-welded together before placement into the template. Pack rags or stuffing around bolt to center it within the sleeve.

A hooked foundation bolt is useful for installation on existing construction, or where height of pier is limited. This type of bolt has greater mechanical hold and is less sensitive to vibration.

Pour the foundation. After the foundation is cured, remove any water from foundation bolt sleeves and dry entire foundation.

It is essential that the concrete foundation be fully cured before mounting the unit. Prepare the foundation surface for grout by scarfing with a chipping hammer. Remove one inch minimum of foundation material. This recommended removal is intended to remove low strength, high porosity concrete.

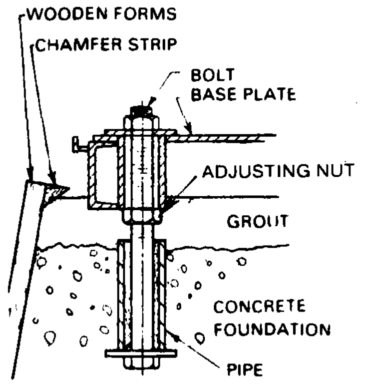


Fig. 8 Leveling adjustment nuts, channel base

If grout must be applied to damp concrete, thoroughly coat with a penetrating sealer at least four hours before pouring grout. Inspect for and remove any loose particles, dirt or oil-soaked concrete.

BASE PLATE INSTALLATION

The pump is shipped mounted on its base plate. To satisfactorily install base plate, it may be necessary to disconnect auxiliary piping or remove pump entirely. Lift pump by sling placed around pump feet.

All base plate surfaces which will be in contact with grouting must be clean. Remove rust, oil, paint or other foreign substances.

NOTE: Do not use oil-base solvents for base plate cleaning. The residue may prevent adherence.

Attach wire rope slings to base plate lifting lugs and lift base plate into position over foundation bolts.

LEVELING Before lowering the base plate, check that leveling adjustment nuts have been run down to the foundation (Fig. 5).

WEDGE LEVELING Use wedges or shims 4 to 6 inches (10 - 15 cm) long, 2 to 3 inches (5.1 - 7.6 cm) wide, and thick enough to allow proper grouting clearance (Fig. 6).

To level base plate, place a machinist's level on mounting pads. Adjust as necessary and begin to tighten nuts of foundation bolts. Continue to check level, re-adjust as required, until all nuts are completely tightened and base plate is level.

GROUT Build a dam around base plate perimeter. Forms must be of sufficient strength to withstand pressure of grout, and must be sealed and rendered watertight by caulking between forms and foundation. Attach a chamfer strip on inside of forms at grout grade elevation, to provide a neat beveled edge.

If forms are placed on rough concrete surface, seal bottom with a stiff sand and cement mortar, flush with form inside face. This should be done immediately prior to placing grout because shrinkage of mortar may result in leakage.

Apply two heavy coats of good quality paste wax, or one coat of shellac and one heavy coat of wax to the forms. Plastic sheeting is acceptable, but must be stretched tightly to prevent wrinkling.

Cover wedges with caulk or plastic tape, if later removal is desired. Mark wedge positions on mounting flange, to locate after grout pour.

Select a non-shrinking grout, resistant to damage by any chemicals that may be spilled in the vicinity, and compatible with the highest temperature that may be encountered.

After grout has thoroughly hardened, remove forms and any supporting wedges. If wedges are removed, fill holes with grout.

GROUT CONDITIONS

REFERENCES:

1. Annual book of ASTM STANDARDS, Part 13, ASTM C-109. "Cement; Lime; Ceilings and Walls"
2. Corp or Engineers; CRD-C79-77; Dec. 1, 1977; "Test Methods for Flow Grout Mixtures,
3. CRD-C588-78; March 1, 1978; "Corp of Engineers Specification for Non-Shrink Grout".

CHARACTERISTICS:

1. Shall be non-bleeding (no water run-off) while being transported or placed,
2. Shall be non-shrink in nature as defined by CRD-C588-78,
3. Shall require minimum strengths as specified in CRD-C588-78 (minimum 5,000 psi at 28 days).

TYPES:

1. High fluidity grouts as defined in CRD C-588 and C-79 shall be in the range of 20-30 second efflux from a standard flow cone,
2. Flowable grout, as defined per ASTM C-109, Shall fall within the range of 124-145 percent with five drops,
3. Standard dry pack grout uses moist sand and cementitious materials.

PLACEMENT:

1. High fluidity grouts shall be placed by pouring down an inclined plane into grout holes on the base plate. Sufficient materials should be poured in to overflow the forms. In difficult to reach locations placement with steel strapping is recommended. Where special placement requirements must be met, pumping of high fluidity grouts can also provide acceptable placement. The use of vibrators to aid placement can cause water and grout to separate and therefore should be discouraged.
2. Flowable grouts normally require movement into position. The use of steel straps or a well and plunger is recommended. Placement with a chain is not recommended due to air entrainment in the links. The use of vibrators to aid placement can cause water and grout to separate and therefore should be discouraged.
3. Dry packing requires manual placement followed by compaction using a round-end rod. Care should be taken to avoid excessive packing and subsequent buckling of the baseplate.

Tapping with a steel rod or chisel (not hammer) will detect a void (usually one square inch or more) by making a dull sound rather than a ringing sound. Epoxy grout may be used to fill voids.

Before void filling epoxy grout is applied, a full 28 day cure of the previously poured grout is recommended. Epoxy grout is usually hand pumped through high pressure threaded fittings installed in the base plate at the void locations. Extreme care should be taken to avoid excessive pressures and resultant base plate buckling. At least one vent hole should be drilled into each void to help prevent excessive pressure.

Seal grout by covering exposed grout with a quality oil base paint.

DRIVER INSTALLATION

ORDER OF INSTALLATION Driver components may be mounted separate from pump. Heavier driver components are generally mounted before the pump but space and service requirements will dictate which unit is positioned first. Refer to outline drawing and manufacturer's instructions.

DRIVER SHAFT RUNOUT It is important to check shaft runout on all drivers. Distortion can occur whether driver is mounted or not during shipment.

Driver shaft runout should be checked with dial indicators (Fig. 9), not to exceed .001 inch (.0254 mm) angular, and .002 inch (.0508 mm) concentric TIR (Total Indicator Reading). This data will also be used during pump to driver alignment. In the case of an apparent out of tolerance driver, consult a Bingham-Willamette representative or the driver manufacturer.

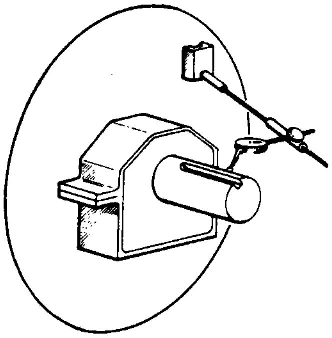


Fig. 9 Driver shaft runout

DRIVER POSITIONING When a driver shaft runout has been checked, lift driver onto base. Refer to manufacturer's instructions for correct handling of unit(s). See pump outline drawing for driver mounting dimensions. Use suggested dimensions for first approximation only.

NOTE: Do not drill driver mounting base plate holes before determining driver shaft placement and mounting hole size.

A nominal distance between shafts is usually noted on pump outline drawing. Use the outline drawing dimension for reference only. Use the coupling drawing and instructions (see vendor section of specific manual) for final determination of distance between shafts. When a limited end float coupling is used, be certain driver shaft is in correct running position or magnetic center.

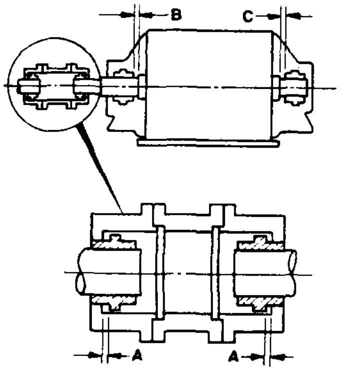
PUMP INSTALLATION

INSTALLATION After an appropriate concrete curing period, mount the units. Refer to outline drawing for possible use of alignment guide key blocks (mounted on pedestal ties), for high temperature applications.

CAUTION: When it is necessary to weld around system be certain the ground connection is located very close to the weld area. Keep electrical currents from passing through any unit.

A nominal distance between shafts is usually noted on pump outline drawing. Use the outline drawing dimension for reference only. Use the coupling drawing and instructions for final determination of distance between shafts. When a limited end float coupling is used, be certain driver shaft is in correct running position or magnetic center.

COUPLING



A + A = total coupling end float
example: .094 in. + .094 in. = .188 in.
(2.381 mm + 2.381 mm = 4.762 mm)

B + C = total motor end float
example: .156 in. + .344 in. = .500 in.
(3.969 mm + 8.731 mm = 12.700 mm)

Fig. 10 Coupling and motor measurements

LIMITED END FLOAT COUPLING A motor not equipped with a thrust bearing uses a limited end float (LEF) coupling. This coupling limits axial movement of one shaft relative to the other.

End float is restricted to protect motor bearings from shaft shoulder damage. Because limiting end float determines driver shaft position in its bearing, distance between pump and driver is critical.

NOTE: The shaft of a motor without a thrust bearing must be in proper running position before distance between shafts is established. The correct running position can either be center of axial travel, or magnetic center. Refer to manufacturer's instructions.

GEAR COUPLING Measure four dimensions illustrated in Fig. 12. Use these measurements, along with coupling and driver manufacturer instructions, to correctly position the limited end float coupling.

DISC OR DIAPHRAGM Measure dimensions B and C, Fig. 12. Use these measurements, along with coupling and driver manufacturer's instructions, to correctly position the disc type coupling.

ALIGNMENT

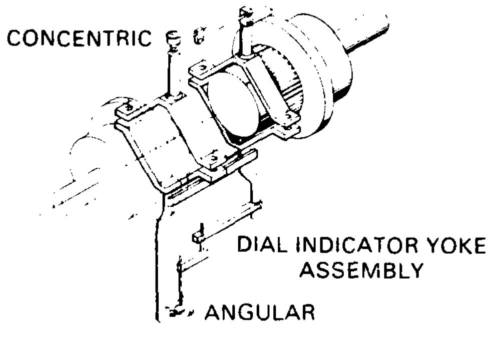


Fig. 11 Yoke assembly on coupling hub

ALIGNMENT PROCEDURE Precise alignment is mandatory for correct system performance. Accurate alignment is required each time a unit is removed and remounted:

1. *MOUNT INDICATORS* Mount two dial indicators. When possible, use a yoke assembly to provide greater ease in obtaining accurate readings. A yoke assembly permits both shafts to be turned in unison (Fig. 10).
2. *READINGS* Rotate shafts to four readings, 90 degrees apart. Place shims under driver mounting lugs to bring angular and concentric TIR within tolerance (Fig. 11). All measurements are made with mounting bolts properly tightened. Some situations may require shims under the pump.

3a. *DRIVER EXPANSION* Allow for driver thermal expansion shaft rise.

3b. *DRIVE GEAR EXPANSION* A drive gear requires allowance for vertical offset and some horizontal offset. Exact amount is specified by gear manufacturer. Fasten and pin (with dowel pins) a drive gear to base plate directly below output shaft. All horizontal expansion will then be realized on input shaft.

OPERATING SPEED rpm	TIR max	
	concentric	angular
1800 and slower	0.006 in. (0.152 mm)	0.004 in. (0.102 mm)
1800 to 4000	0.003 (0.076)	0.002 (0.051)
over 4000	0.002 (0.051)	0.001 (0.025)

Fig. 12 Operating speed - maximum TIR

4. *MOUNTING HOLES* Carefully scribe mounting hole locations on base plate, taking care that drilled holes will be exactly centered below mounting lug holes. The driver must be removed during drilling operation.

   The mounting bolt diameter should be ⅛ inch smaller than driver mounting hole diameter.

   Drill and tap driver mounting base plate holes, then remount driver. Return shaft to correct position and realign.

5. *RECHECK* Tighten mounting bolts and recheck alignment.
6. *MOTOR ROTATION* Connect motor wiring according to motor manufacturer's instructions. Before coupling installation, momentarily start driver and verify correct rotation.
7. *INSTALL SPACER* After pump and driver are correctly aligned, coupling spacer can be installed.

NOTE: Final or "hot" alignment is done only after the system is brought to normal operating temperature. Do not make permanent attachments until this is done, preferably after a week of operation within normal API vibration limits. If system is out of vibration limits, shut it down immediately and realign. See OPERATION.

STUFFINGBOX

MECHANICAL SEAL POSITIONING Methods of establishing seal setting dimensions vary with manufacturer and type of seal. In every case a specific seal drawing must be consulted. Generally the seal setting dimension is given as a relationship of a component of the seal to the pump stuffingbox face.

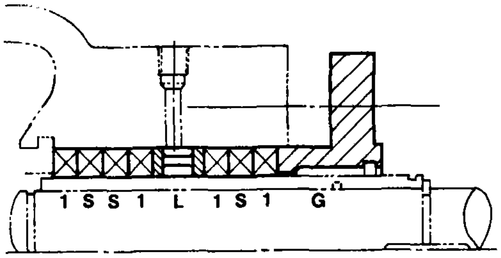
A seal manufacturer's seal assembly drawing provides seal setting dimensions. Seal drawing and instructions are located in the vendor section of a specific pump manual.

MECHANICAL SEAL INSTALLATION The sealing surfaces of a mechanical seal must be protected from nicks or scratches. Imperfections of any kind on mechanical seal faces will cause leakage. Care must be used to keep these surfaces clean and free of substances that would mar seal faces.

Remove all burrs and sharp edges from the shaft or shaft sleeve, including edges of keyways and threads. Inspect stuffingbox bore and face for cleanliness and freedom from burrs.

A lubricant is recommended for installation, but match compatibility of lubricant to materials of the seal and pumpage. See manufacturer's instructions. A light coating of oil on the shaft or sleeve will allow the seal parts to move freely. A clean finger method of applying oil will avoid leaving lint.

Install mechanical seal. Bolt gland flange to stuffingbox after coupling is installed. To determine correct seal setting, refer to seal manufacturer's drawing. Be sure to follow seal manufacturer's instructions for installation and maintenance.



1 & S - Packing
L - Lantern ring
G - Gland

Fig. 13 Typical packing ring sequence

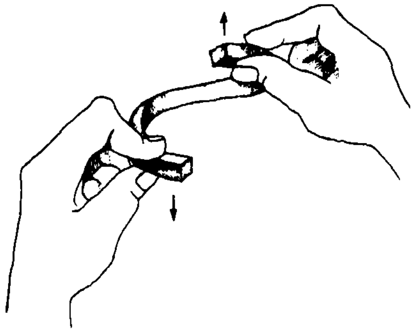


Fig. 14 Spiral twist is correct

Some units have special mechanical seals or auxiliary seal equipment, such as heat exchangers or cyclone separators. Refer to the manufacturer's instructions for general maintenance.

PACKING Packing rings are not preinstalled and are now inserted into the stuffingbox. They prevent leakage by compressing against shaft and gland.

Success of packing depends upon even compression of rings by the gland along with a slight amount of leakage required to cool and lubricate the packing.

Insert rings in sequence indicated on outline drawing (left to right is inside to outside). Begin with inner ring:

1. Remove gland ring halves. Use a hooked wire to slide lantern ring out of stuffingbox. Clean stuffingbox of any debris.
2. Note location of sealing liquid passages. Lantern ring openings line up with inlet and outlet.
3. Begin with inner ring. Correct ring sequence is noted on outline drawing.

   Insert rings one at a time, seating each ring before installing next. Stagger joints of successive rings by 90 degrees.

   To fit packing rings around shaft, pull into a spiral. Attempting to expand radially results in breakage.

   WARNING: It is imperative that the lantern ring be aligned with liquid passageways.
4. When last ring is in place, install and assemble gland halves. Tighten gland nuts evenly until barely snug. Then back off nuts and retighten finger-tight. Do not tighten to compress packing rings against shaft sleeve.

See OPERATION, START-UP CHECKS. At start-up packing rings may leak substantially. A minimum leakage rate of 2 drops each second is required to cool and lubricate packing rings.

At start-up excessive packing ring leakage is adjusted by tightening gland nuts one flat or one-sixth of a turn. Wait several minutes for leakage to stabilize, then check new leakage rate.

PACKINGLESS STUFFINGBOX This design uses a shaft throttle sleeve and a surrounding throttle bushing. A packingless stuffingbox is fully factory assembled and no field assembly is required. Piping connections are required.

PIPING

SUCTION AND DISCHARGE PIPING Use special care to prevent dirt, pipe scale, or welding residue from entering pump during installation. Thoroughly flush suction system before piping is connected.

It is suggested that a suction screen be in place for at least the first 24 hours of operation. Install strainer into a spool piece and insert pressure gauges so that screen pressure drop can be monitored.

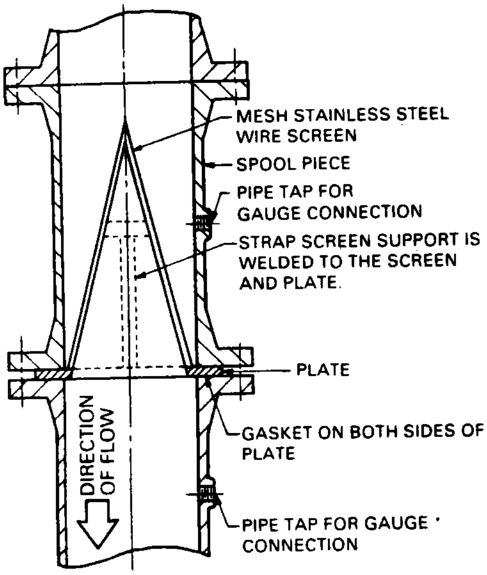


Fig. 15 Suction strainer example

Install piping so that no piping loads are imposed. Allowable piping forces and moments are operational only and should not be used as justification for imposing excessive loads. Piping loads can adversely affect component life.

BYPASS PIPING If pump is to be operated at reduced discharge, it will be necessary to install a bypass pipe from discharge back to suction source. This protects against damage caused by heat generated within pumpage, created by throttling the discharge line.

CAUTION: Pump should not be operated below minimum flow.

Install a minimum-flow orifice in bypass line to regulate flow and thus control amount of recirculation.

AUXILIARY PIPING Auxiliary piping may be required for bearing lubrication, oil cooling, gland cooling, seal injection, stuffingbox drain, bearing bracket drain, or case drain. This piping is normally factory installed. Required connections are noted on the outline drawing.

CAUTION: It is mandatory that piping from drain connections create no back pressure. Refer to piping drawing(s) for specific water flow rate information.

FINAL ALIGNMENT

ALIGN AT OPERATING TEMPERATURE Final "hot" alignment is done only after pump system is brought to normal operating temperature. Do not make final attachments until this is done. See OPERATION.

Perform a hot run and alignment check.

MISALIGNMENT If realignment is required after hot run, loosen hold down bolts and adjust pump and/or driver as necessary. Recheck alignment.

1.2 PUMPS
(CONTINUED)

BEARING LUBRICATION

DESCRIPTION

STD BEARING CONFIGURATIONS:
1. Single row ball with double row ball
2. Sleeve journal with ball
3. Sleeve journal with pivot shoe

OIL RING: Rotating ring used to carry oil from reservoir to bearing.

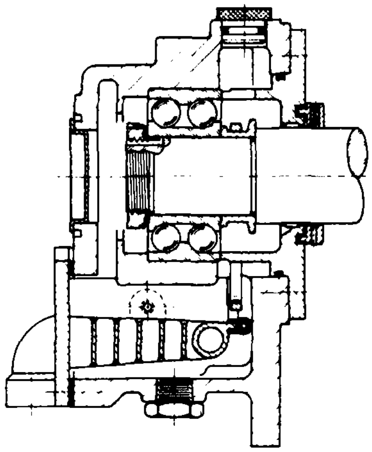


Fig. 16 Submerged oil cooler

LUBE SYSTEMS A number of bearings and lubrication systems are employed to suit application. Lubrication system variations are available for each bearing configuration. Choice depends on size, speed and service requirements. An integral oil ring lubrication system is standard. Refer to pump outline drawing for arrangement furnished.

Oil rings are employed on every unit. A pressure lubrication system is added as required. Pivot shoe bearings necessarily have pressure oil delivery.

Supplemental cooling can be added by placement of a submerged cooler into bearing oil reservoir and/or an outboard heat exchanger of a pressurized lubrication system.

Coolant can be applied to seal circulation, stuffingbox and pedestal cooling. Additional equipment such as isolating valves, strainers, heat exchangers, controllers, alarms, and gauges may be supplied. See outline drawing and any referenced specific piping drawing.

SUBMERGED COOLER The submerged cooler is a hollow, finned casting tapped for water flow. It is placed into the oil reservoir beneath the bearing. Oil rings maintain oil circulation over the fins of the submerged cooler and deliver oil to bearings.

HEAT EXCHANGER A pressurized lubrication system employs a heat exchanger. A variety of size combinations are available for specific heat transfer requirements.

LUBRICATION HEATERS Some applications call for lubrication heating. Heaters may be added to the external reservoir of a pressure lubrication system or to the bearing oil reservoir.

PRESSURE LUBE SYSTEM The main components of any pressurized lubrication system generally include:

1. Oil pump
2. External reservoir
3. Filter
4. Pressure regulating valve
5. Heat exchanger
6. Pressure gauge
7. Thermometer

General pressure lubrication system requirements:

1. Supply bearings at 8 - 12 psi (55.2 - 82.7 kPa),
2. Use appropriate viscosity turbine-type neutral mineral oil,
3. Maintain oil inlet temperature between 60° F and 170° F (15.6° - 76.7° C).

A typical two oil pump pressure lubrication system normally includes switching controls. A reservoir-mounted motor-driven auxiliary oil pump provides pressure before the main pump is started and also acts as backup to the main pump shaft-driven oil pump.

NOTE: This illustration is for reference only and may differ from a special application. See specific outline drawing and piping drawings.

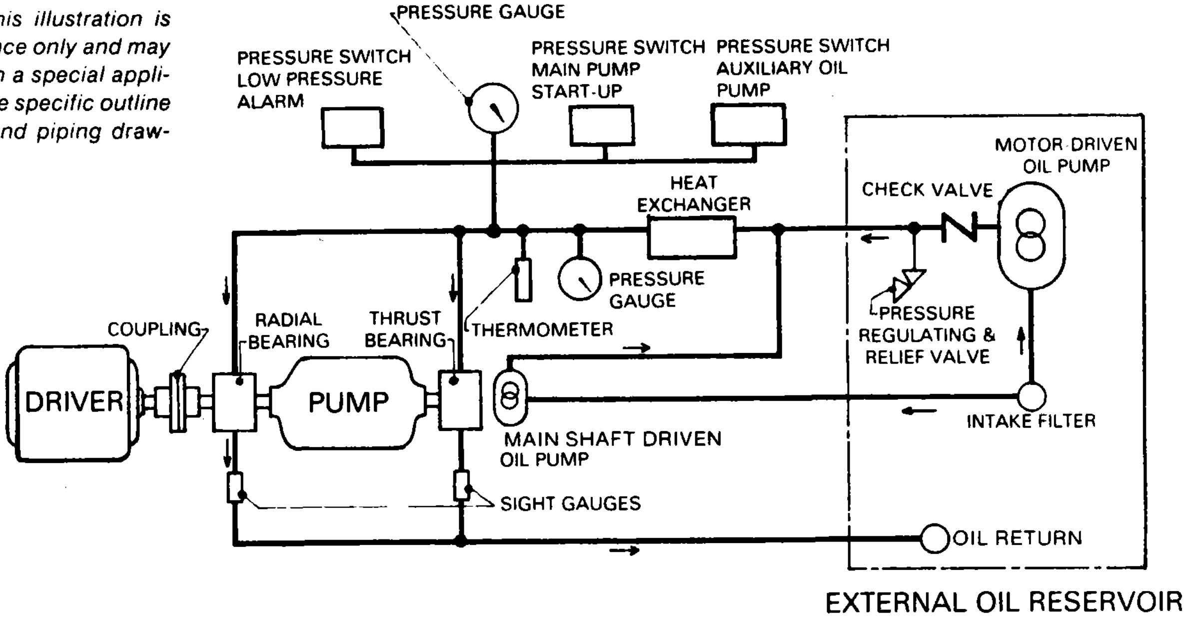


Fig. 17 Typical pressure lube system with primary and auxiliary oil pumps

The pressure switch controls of a tyical application provide the customer with capability of:

1. Sounding low oil pressure alarms,
2. Delay of main pump start until lubrication system is operating,
3. Shut off of motor-driven auxiliary oil pump after main pump shaft-driven oil pump is operating,
4. Switch on of motor-driven auxiliary oil pump upon failure of main pump shaft-driven oil pump.

NOTE: Controls provided are switches only. Customer must provide appropriate interface wiring with motor starter controls to obtain desired functions.

MOTOR-GEAR DRIVEN LUBE SYSTEM Pressurized oil delivery to motor-gear driven pump bearings is typically provided by an integral lubrication system of the gear unit. See pump outline drawing.

INSPECT AND CLEAN

REMOVE BEARINGS Prior to shipment bearings were coated with an oil soluble rust preventive.

Remove pump bearings before flushing the lubrication system. Bearing removal is required to prevent dirt from lodging in the bearings during a flush and subsequent damage at start-up.

Handle bearing components with clean dry hands and with clean rags. Lay bearings on clean paper and keep covered or wrapped with plastic film or oil-proof paper.

BALL BEARINGS Don't wash a new ball bearing - it is already clean and the coating should not be removed. Bearings should be washed only when necessary.

SLEEVE BEARINGS Note match marks on sleeve bearings before removal. This will aid replacement to original position after flush operation is complete.

FLUSH SYSTEM Flush entire lubrication system before adding lubricant.

NOTE: Remove pump bearings before flush operation. Lodged dirt can seriously damage bearings upon start-up.

Flushing is done with kerosene or a safety solvent. Flush the bearing housings, piping, cooler and reservoir by operating the auxiliary lube oil pump. Remove cleaning fluid before filling with oil.

INSTALL BEARINGS Wipe up with clean rags any residue of cleaning fluid from bearing housings before bearing reassembly. Observe clean conditions while installing bearings. Give bearings a generous coating of recommended lubricant at time of installation. This will assure protection during the first moments of start-up.

OIL FILL, NONPRESSURIZED SYSTEMS

Fig. 18 Oil level plate

CONSTANT LEVEL OILER Refer to oil level plate mounted on bearing housing. The plate calls out oil level in inches below shaft centerline. Oil level of constant level oiler is compared to this oil fill level.

Fill bottle of constant level oiler, insert onto lower reservoir of oiler and allow oil to flow into bearing reservoir. Several fillings of bottle may be required before oil level of bearing reservoir is equal to level for which oiler is adjusted.

NOTE: Never fill bearing reservoir through lower reservoir of oiler.

Correct oil level, as noted on oil level plate, brings oil level to just above inside diameter of oil ring.

As an alternative to oiler-only filling, the greater volume of oil can be introduced directly into the bearing housing. Finish by filling the oiler bottle until oil level of bearing reservoir is equal to level for which oiler is adjusted.

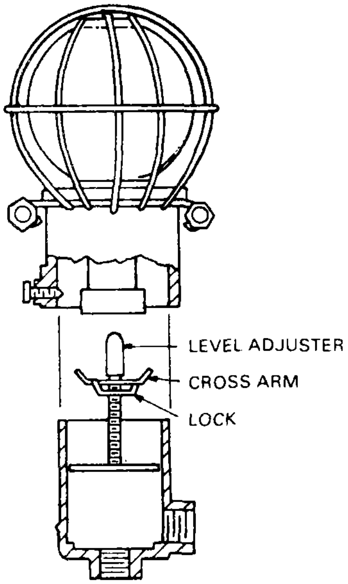


Fig. 19 Level adjuster

BEARING HOUSING OIL CAPACITY

housing[1]		w/cooler[2] [4]	w/o cooler[4]	oil level[3]
#1	drive	16.0 oz (.47 L)	20.0 oz (.59 L)	2 15/16 in.
	thrust	32.0 (.95)	40.0 (1.18)	
#2	drive	20.8 (.62)	25.6 (.76)	4
	thrust	51.2 (1.51)	60.8 (1.80)	
#3	drive	44.8 (1.32)	49.9 (1.48)	5⅛
	thrust	86.4 (2.56)	96.0 (2.84)	

Notes: [1] Drive and thrust housings.
[2] With submerged cooler.
[3] Distance from shaft centerline to oil level.
[4] U.S. fluid ounce (litre).

A constant level oiler is adjusted at factory prior to shipping but should be checked before use. If it becomes necessary to adjust oil level, remove bottle from oiler and lift level adjuster from lower reservoir. Slightly raise the crossarm, secure with the lock, then replace adjuster and bottle. Check new level and readjust as required.

PRIME OIL PUMP

PRESSURIZED SYSTEMS The main shaft driven oil pump requires priming before operation of the pressure lubrication system. Loosen vent of oil pump and tighten when emitted oil runs clear.

RECOMMENDED LUBRICANT/ALARM SETTINGS

GENERAL To ensure maximum bearing life, use a turbine-type neutral mineral oil. The oil must not contain any free acid, chlorine, sulphur, or more than a trace of free alkali. Viscosity choice depends on operating temperature.

VISCOSITY, NORMAL TEMP OPERATION Under normal operating conditions, with oil temperatures between 120 and 150° F (49 - 65.6° C), choose ISO/ASTM viscosity grade 32 (SUS viscosity grade 150 @ 100° F).

ALARM SETTINGS, NORMAL TEMP OPERATION When ISO VG 32 is used, the maximum oil temperature (shutdown setting) is 160° F (71.1° C). If a high *oil* temperature alarm is used, set it at 155° F (68.3° C). If a high *bearing* (sleeve type) temperature alarm is used, set it at 190° F (87.7° C). Pump must be shut down when bearing temperature exceeds 200° F (93.3° C).

VISCOSITY, HIGH TEMPERATURE OPERATION Choose ISO/ASTM viscosity 68 (SUS viscosity grade of at least 235, 300 recommended @ 100° F) when oil temperature is between 160 and 170° F (71.1 - 76.7° C).

ALARM SETTINGS, HIGH TEMP OPERATION When ISO VG 68 is used the maximum oil temperature (shutdown setting) is 180° F (82.2° C). If a high *oil* temperature alarm is used, set it at 170° F (76.7° C). If a high *bearing* (sleeve type) temperature alarm is used, set it at 230° F (110° C). Pump must be shut down when bearing temperature exceeds 240° F (115.6° C).

INTERCHANGEABLE LUBRICANTS

LUBRICANT CHOICE Listing of a product does not indicate quality of lubricant nor what performance can be expected under a particular set of operating conditions. Further information should be sought from a Bingham-Willamette representative or oil company application engineer.

INTERCHANGEABLE LUBRICANT CHART Two ISO/ ASTM viscosity grade listings are given: (1) Products with nominal ISO VG 32 @ 40° C, application 120 to 150° F (49 -65.6° C); and (2) Products with nominal ISO VG 68 @ 40° C, application 160 to 170° F (71.1 -76.6° C).

Previous product notations, generally SUS viscosity grade, are indicated by parenthesis enclosure.

SUPPLIER	ISO/ASTM VISCOSITY GRADE 32 VISCOSITY: 28.8 - 35.2 cSt @ 104°F (140 - 182 SUS @ 100°F)	ISO/ASTM VISCOSITY GRADE 68 VISCOSITY: 61.2 - 74.8 cSt @ 104°F (317 - 380 SUS @ 100°F)
AMERICAN OIL AND SUPPLY CO.	*PQ ISO VG 32 (PQ LUBE C-102)	*PQ ISO VG 68 (PQ LUBE C-105)
ASHLAND VALVOLINE	ETC (R&O) 15 *AW 15	ETC (R&O) 30 *AW 30
ATLANTIC RICHFIELD	DURO S-150 *DURO AWS-150	DURO S-315 *DURO AWS-315
BP OIL CORP	ENERGOL HL-C32 *ENERGOL HL-65* *ENERGOL HLP-C32	ENERGOL HL-C68 *ENERGOL HL-100* *ENERGOL HLP-C68
CITIES SERVICE	PACEMAKER 15 *A/W HYDRAULIC 15 *PACEMAKER XD-15	PACEMAKER 30 *A/W HYDRAULIC 30 *PACEMAKER XD-30 PACEMAKER T-30
COOK'S INDUSTRIAL LUBRICANTS	*ALBAVIS 8	*ALBAVIS 20
EXXON	TERESSTIC 32(43) NUTO 32(43) *NUTO H-32(44)	TERESSTIC 68(52) NUTO 68(53) *NUTO H-68(54)
FISKE BROS. REFINING	*LUBRIPLATE HYDRAULIC #0	*LUBRIPLATE HYDRAULIC #2
GULF OIL	HARMONY 44 *SECURITY 43AW *HARMONY 32AW (43AW)	HARMONY 53 *SECURITY 54AW *HARMONY 68AW (54AW)
E.F. HOUGHTON CO.	*HYDRO-DRIVE HP-150 HYDRO-DRIVE MIH LIGHT COSMOLUBRIC 515	*HYDRO-DRIVE HP-300 HYDRO-DRIVE MIH - 20 COSMOLUBRIC 530
A. MARGOLIS & SONS	*T.I.P. 100-15-7	*T.I.P. 100-30-7
MOBIL	DTE LIGHT DTE 797 *DTE 24 *ETNA 24*	DTE HEAVY MEDIUM *DTE 26 ETNA 26
SHELL	TURBO 32(25) *TELLUS 32(25)	TURBO 68(33) *TELLUS 68(33)
STEWART WARNER ALEMITE DIVISION	*HYDRAULIC HD #0	*HYDRAULIC HD #2
SUN	SUNVIS 916 SUN R&O 150 *SUNVIS 706	SUNVIS 931 SUN R&O 300 *SUNVIS 754
TEXACO	RANDO 32(A) *RANDO HD 32 (HD A)	RANDO 68(C) *RANDO HD 68 (HD C)
WHITE & BAGLEY	SUPER HYDRAULIC 150 *EP HYDRAULIC 150	SUPER HYDRAULIC 300 *EP HYDRAULIC 300

Antiwear products are noted with an asterisk (*).

Products listed are designated as hydraulic and general purpose oil, rust and oxidation inhibited.

Fig. 20 Lubricant suppliers

MAINTENANCE

ADD OIL Monitor oil level and refill oiler or reservoir as required. A sudden drop of oil level may indicate a leak. Stop operation and inspect unit.

OIL CHANGES Oil is subject to gradual deterioration from dirt and moisture. Accumulated sludge is harmful to bearings. Moisture caused by condensation contributes to accelerated bearing wear.

Periodically, remove plug and drain used oil. Then flush lubrication system and refill with new oil. Oil change intervals vary according to actual operating conditions. Under normal conditions oil should be changed after twelve months of operation.

Change oil of non-filtered systems 24 hours after initial start-up.

FILTER ELEMENTS Replaceable filter elements are replaced when differential pressure indicates that the filter element is clogged. Refer to filter manufacturer's recommendations for change point pressure drop.

OPERATION

PRE-START

Also see INSTALLATION.

1. Clean the unit. Be certain to remove any drying agents.
2. Determine tightness of bolted flange connections. Review external connections and function.
3. Inspect piping for correct installation.
4. Verify shaft freely rotates.
5. Be certain driver and coupling is installed according to manufacturer's instructions.
6. Provide adequate lubrication. See BEARING LUBRICATION.

STARTING PROCEDURE

HOT SERVICE When pumpage is hot over 300° F (149° C), the pump case should be heated before start-up. Circulate a small amount of hot liquid (induced pumpage is preferable) through pump until within 100° F (38° C) of product temperature.

PRIME OIL PUMP The main pump shaft driven oil pump requires priming before operation of the pressure lubrication system. Loosen vent of oil pump and tighten when emitted oil runs clear.

COOLANT AND LUBE SERVICES Activate coolant and lubrication systems. Follow manufacturer's instructions.

PRIME Before starting any centrifugal pump the case and suction piping must be *completely* filled with liquid. The liquid lubricates rotating parts within the pump. *Damage can be caused if operated dry.*

With discharge valve closed, slowly open pump suction valve to allow pumpage to enter pump.

1. When pump is located below suction level source, open vents to release trapped air or vapor, and pump will prime itself. Full prime is indicated when vented liquid no longer contains bubbles.
2. When pump is located above liquid level of pumpage, an ejector or other means must be provided to evacuate air or vapor from pump case.

NOTE: Bleed air from any seal circulation piping. Damage to seals may be caused by absence of liquid.

3. Once suction valve is fully open, set discharge valve to approximately 10 percent open. A minimum flow bypass line may be used for start-up purposes.

NOTE: When pump is located above suction source, the discharge valve cannot be opened until driver has been started, since this would cause loss of prime.

START-UP Start pump and bring immediately to operating speed. As soon as pump begins to develop discharge pressure, start slowly opening discharge valve. Avoid making any abrupt change in discharge velocity in order to prevent surging within piping. *Surging can cause serious damage.*

CAUTION: Turbine driven pump systems must be brought to immediate operating speed. Damage may occur at less than 1,500 rpm due to lubrication failure.

NOTE: Pump should produce pressure at discharge as soon as rated operating speed is reached. If not, shut down immediately.

As soon as pump stops, open vent valves and reprime.

CAUTION: Do not operate against closed discharge valve, unless pump is equipped with bypass piping.

CAUTION: Never attempt to control pump output by throttling suction valve. Use of suction valve as a throttle causes cavitation damage.

BYPASS If pump is required to operate at less than design output it is necessary to utilize a bypass line. Consult with a Bingham-Willamette representative.

START-UP CHECKS

LEAKAGE Periodically check for leakage at stuffingbox. Excessive mechanical seal leakage indicates wear or damage.

Watch for any signs of leakage at suction and discharge lines and auxiliary piping.

PACKING RING LEAKAGE At start-up packing rings may leak substantially. A minimum leakage rate of 2 drops each second is required to cool and lubricate packing rings.

Correct excessive packing ring leakage by evenly tightening gland nuts one flat, one-sixth of a turn. Wait several minutes for leakage to stabilize, then check new leakage rate.

OIL TEMP/LEVEL Monitor bearing oil temperature and level. See BEARING LUBRICATION. *If oil temperature exceeds maximum allowable, shut unit down immediately.*

OIL PRESSURE Monitor oil pressure on units so equipped. Adjust pressure relief valve as necessary.

SUCTION STRAINER Observe pressure drop across suction strainer. Some drop is normal, even when screen is clean. Watch for any increase in pressure drop that indicates accumulation of debris. Strainer must be cleaned if there is an increase of 5 psi (34.5 KPa) pressure drop. Leave strainer in line for at least first 24 hours of operation, then remove if system is clean.

SHUTDOWN The pump should be shut down rapidly to prevent internal parts from running dry and seizing. Turbine-driven units in particular must be shut down rapidly. If possible, it is recommended that the overspeed trip switch be manually tripped.

ALIGNMENT Final alignment is done only after all components *are brought to normal operating temperature. See* INSTALLATION.

EXTENDED SHUTDOWN

PERIODIC RESTART If possible, a standby lube system should be started once every two weeks and run for 20 minutes. This will prevent condensation from accumulating.

STANDBY SERVICE When pump is on standby for instant start-up service, it should be kept ready by circulating pumpage. Maintain any coolant services.

FREEZE DAMAGE Exposure to freezing temperatures requires care to prevent liquid from freezing within pump. Drain all cooling jackets to prevent freeze damage.

NOTE: The inner case cannot be completely drained.

LUBRICATION A pump shut down for more than 30 days must have bearings relubricated before start-up. Apply oil directly to shaft and bearings.

CAUTION: Failure to relubricate bearings before start-up may result in scored bearings!

MAINTENANCE

MECHANICAL SEAL

A mechanical seal may be removed for inspection and replacement wihout disturbing the pump and driver. This may be done without disturbing the case. Removal of any necessary auxiliary piping, bearings, bearing housings, and spacer coupling is required. See DISASSEMBLY.

Be sure to follow seal manufacturer's instructions for installation and maintenance. See the seal manufacturer's drawing for correct assembly and seal setting. New O-rings, springs and faces should be installed.

DISASSEMBLY, GENERAL

PRELIMINARY Be certain pump has been isolated. Close suction, discharge and auxiliary piping valves.

Lock power breakers to off position.

Drain pump case and bearing housings.

If rotating element will be removed, disconnect all piping, instrumentation or leads from bearing housings and case ends.

If furnished, remove the constant level oiler to prevent breakage.

Disconnect pump-to-driver coupling and remove any coupling spacer. (Limited thrust bearing maintenance can be performed with coupling in place).

It is not necessary to disconnect suction and discharge lines or any auxiliary piping that is connected to the outer case. It is not necessary to disturb position of driver or outer case.

TOOLS AND PROCEDURES A variety of equipment is required to remove the pump. Specific requirements differ according to location, physical surroundings and size of each pump. Review entire removal procedure in advance to determine what equipment and disassembly procedures are necessary.

INNER CASE REMOVAL Removal of inner case requires special tools and equipment. Each pump receives a kit of a dismantling fixture, crossbars, spacers, eyebolts, and jackscrews.

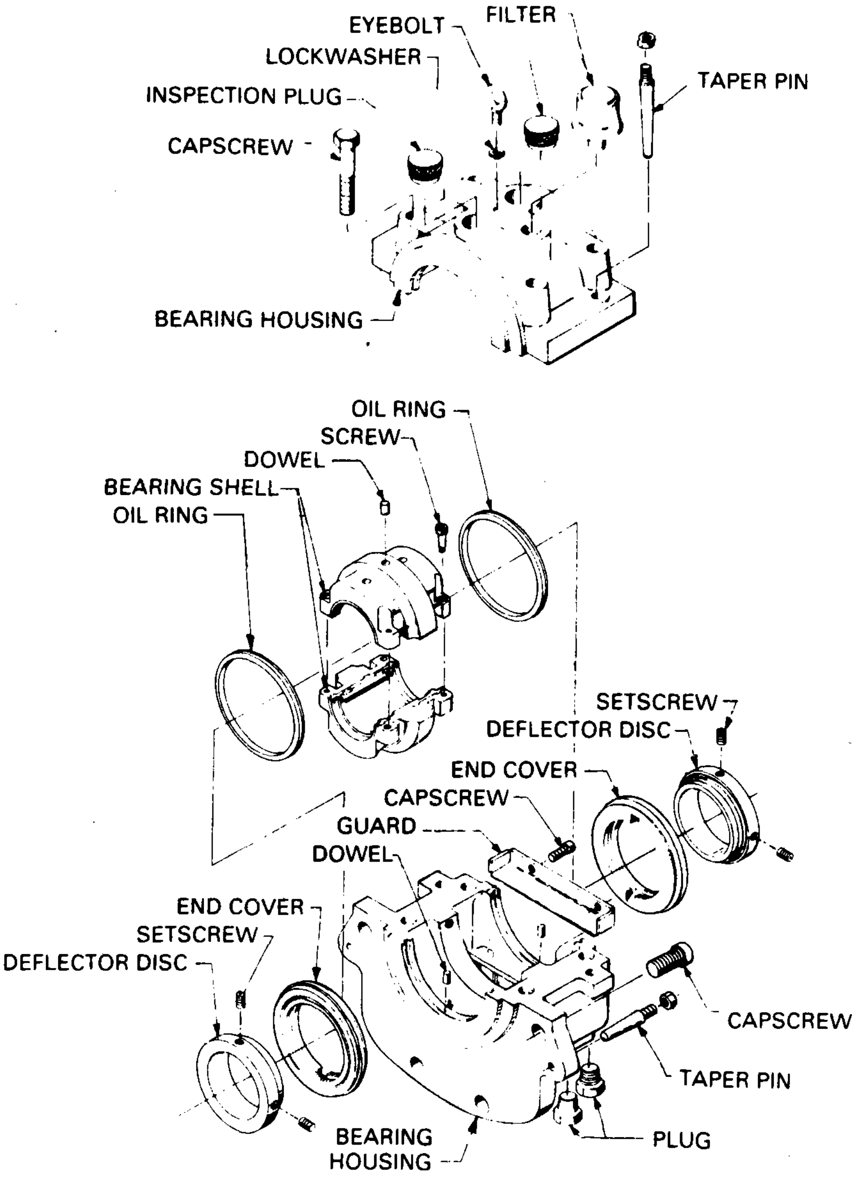
Refer to specific pump cross section drawing and parts list.

WARNING: Check rotation of pump. Note that threaded components of shaft are normally tightened against rotation, removed with rotation.

All parts should be protected. Larger parts should be placed in a protected area and wrapped in cloth or plastic. Smaller parts should be placed in bags or boxes.

PACKINGLESS STUFFINGBOX

DISMANTLING Refer to pump cross section drawing and parts list. Throttle bushing and shaft sleeves are removed after rotating element has been pulled from case.



DRIVE END

NOTE: This illustration is for reference only and may differ from specific application.

Fig. 21 Typical pivot shoe thrust and sleeve journal bearing, drive end

PACKING

REMOVE PACKING Remove gland nuts and gland ring halves. Use a hooked wire to pull packing and lantern rings from the stuffingboxes.

DISASSEMBLY, PIVOT SHOE THRUST BEARING & MECHANICAL SEALS

1. Carefully remove and store any vibration probes, keyphasor probes, or bearing temperature detectors.

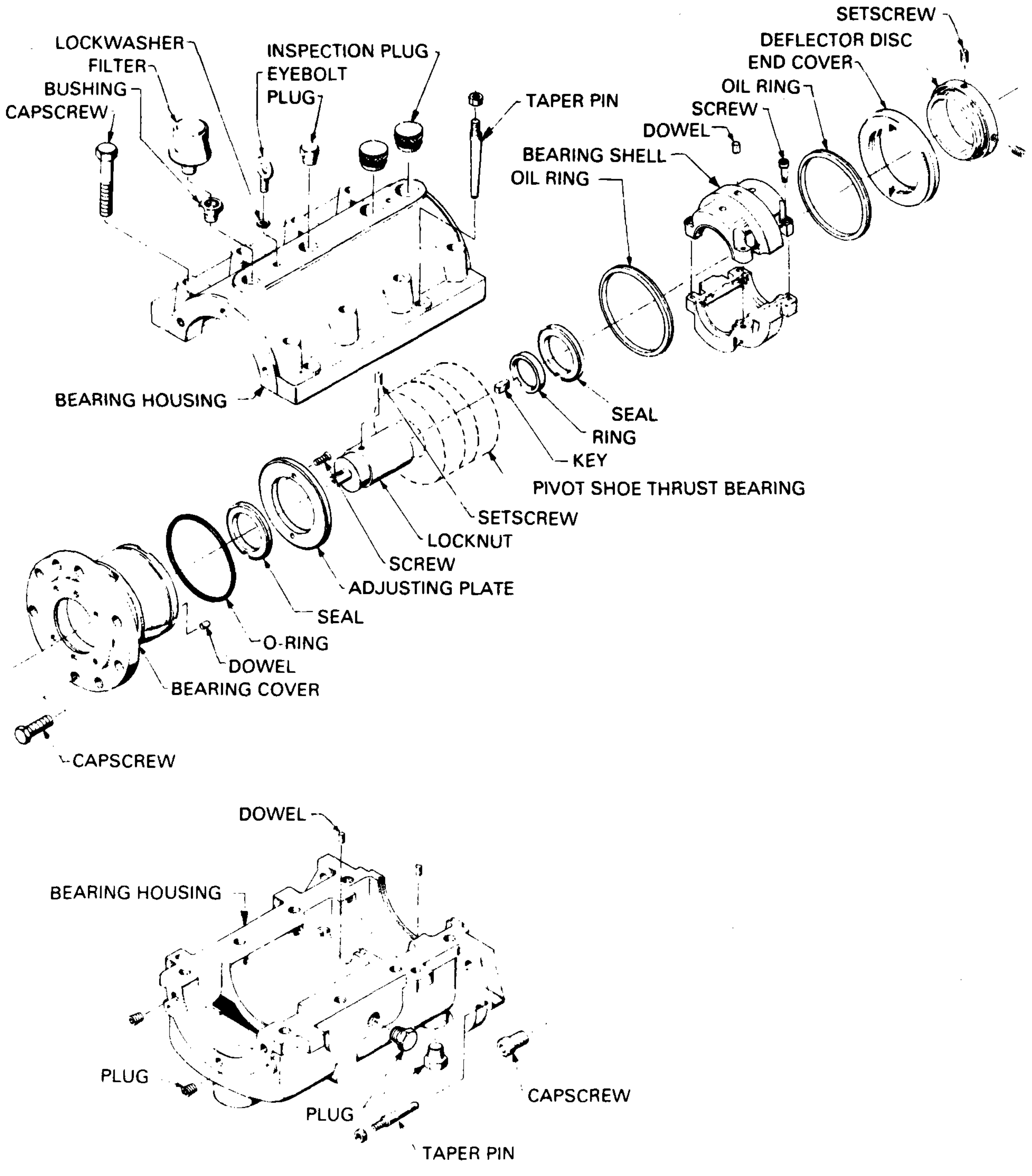
DRIVE END:

2. Remove coupling spacer.
3. Remove coupling by loosening socket head setscrew in shaft extension nut and remove nut.
4. Remove coupling hub with use of a puller. Some moderate heating of hub may be required. Avoid damage to sealing ring.
5. Loosen setscrews of inboard and outboard deflector discs.
6. Remove outboard deflector disc.
7. Insert a seal setting spacer between seal drive collar and seal gland. See seal manufacturer's instructions for seal setting dimension.
8. Loosen socket head setscrews of seal drive collar.

THRUST END:

9. Loosen setscrew of inboard deflector disc and move away from bearing housing.
10. Insert a seal setting spacer between seal drive collar and seal gland.
11. Loosen socket head setscrews of seal drive collar.
12. Loosen capscrews of thrust bearing cover and remove only the capscrews which go into upper half housing.
13. Remove two taper pins located at split line of top and bottom of bearing housing.
14. Remove capscrews holding bearing housing halves together.
15. Using eyebolts, lift off bearing housing upper half. Lower onto a flat surface, padded with cloth to protect the flange surface.
16. Remove all exposed thrust bearing shoes. Rotate base rings, lifting drive keys out of their slots in the bearing housing to expose another set of shoes. Remove these shoes. Now rotate base rings back so split lines of rings align with housing flange, then lift off top halves of base rings.
17. Rotate bottom halves of base rings out of the housing, removing thrust shoes as exposed until base rings can be removed. Be sure to keep matched halves together.

NOTE: Wrap each shoe individually in soft material to protect the babbit face. Shoes should be kept in order so that they can be replaced in the same slots.



THRUST END

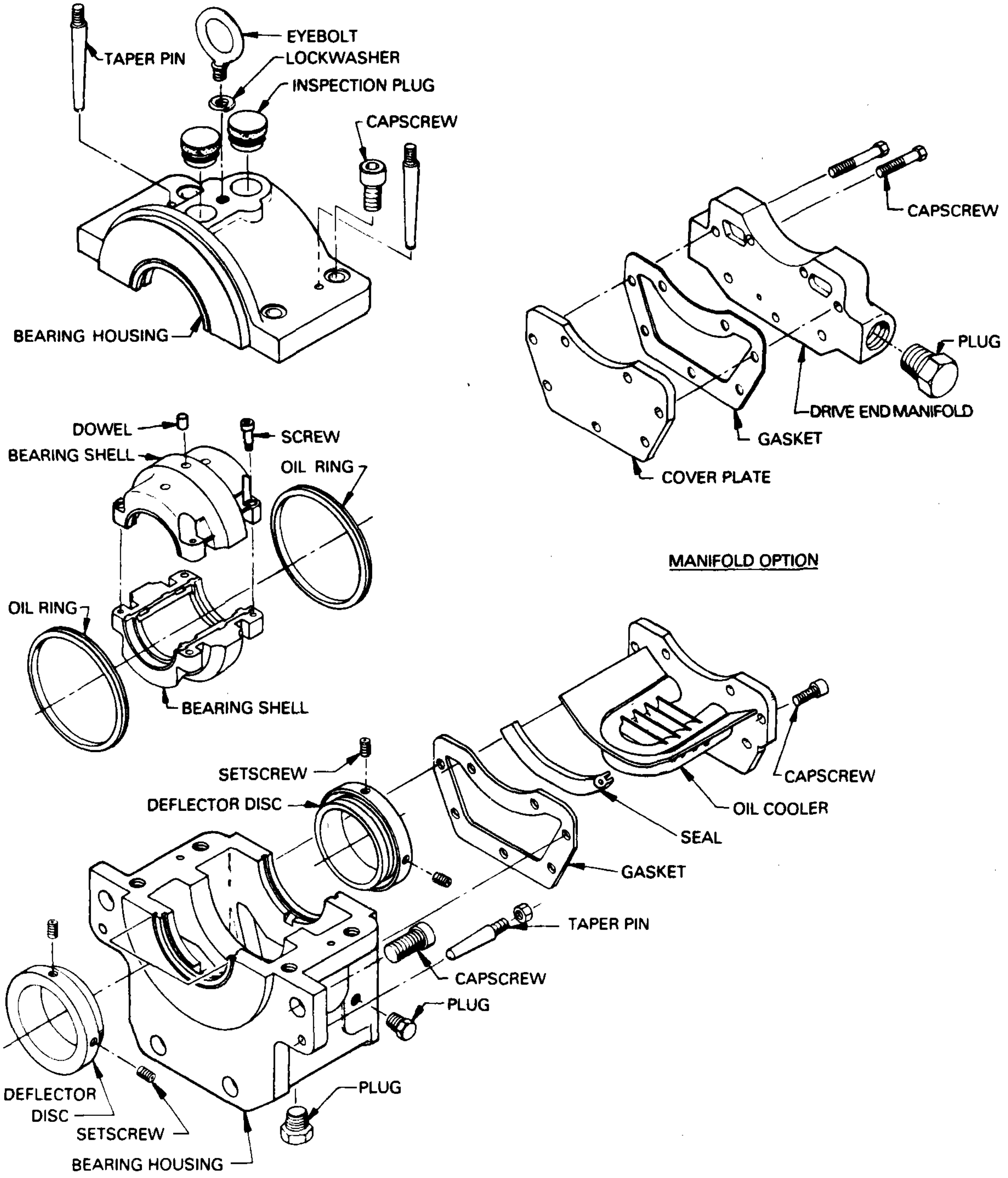
NOTE: This illustration is for reference only and may differ from specific application.

Fig. 22 Typical pivot shoe thrust and sleeve journal bearing, thrust end

18. Remove remaining capscrews of thrust bearing cover and remove end cover along with any attached oil pump or speed transmitter.
19. Loosen setscrews of thrust bearing locknut and remove locknut.
20. Remove thrust bearing collar.
21. Remove thrust bearing drive key.
22. Remove adjusting plate.
23. Remove socket head capscrews and dowels of bearing shells. Lift off top half.
24. Move oil rings from bearing and rest on shaft.
25. Lift shaft slightly and remove lower bearing shell half.
26. Remove taper pins from lower bearing housing to pump bracket.
27. Remove capscrews of bottom thrust bearing housing half. Lower housing and remove.
28. Remove seal ring.
29. Remove oil rings.
30. Remove inboard bearing cover.
31. Remove inboard deflector disc.
32. Loosen and remove 4 hex head nuts and washers from mechanical seal gland.
33. Check that spacers are in place between seal drive collar and gland, then remove mechanical seal.

DRIVE END:

34. Remove two taper pins located at split line of top and bottom of bearing housing.
35. Remove capscrews holding bearing housing halves together.
36. Using eyebolt, lift off bearing housing upper half. Lower onto a flat surface, padded with cloth to protect the flange surface.
37. Remove socket head capscrews and dowels of bearing shells. Lift off top half.
38. Move oil rings from bearing and rest on shaft.
39. Lift shaft slightly and remove lower bearing shell half.
40. Remove two taper pins of lower bearing housing to pump bracket.
41. Remove capscrews of bottom thrust bearing housing half. Lower housing and remove.
42. Remove outboard end cover.
43. Remove oil rings.
44. Remove inboard end cover.
45. Remove inboard deflector disc.
46. Loosen and remove 4 hex head nuts and washers from mechanical seal gland.



MANIFOLD OPTION

DRIVE END

NOTE: This illustration is for reference only and may differ from specific application.

Fig. 23 Typical ball thrust and sleeve journal bearing, drive end

47. Check that spacers are in place between seal drive collar and gland, then remove mechanical seal.

See INNER CASE REMOVAL.

DISASSEMBLY, BALL THRUST AND SLEEVE JOURNAL BEARINGS & MECHANICAL SEALS

1. Carefully remove and store any vibration probes, keyphasor probes, or bearing temperature detectors.

DRIVE END:

2. Remove coupling spacer.
3. Remove coupling by loosening socket head setscrew in shaft extension nut and remove nut.
4. Remove coupling hub with use of a puller. Some moderate heating of hub may be required. Avoid damage to sealing ring.
5. Loosen setscrews of inboard and outboard deflector discs.
6. Remove outboard deflector disc.
7. Insert a seal setting spacer between seal drive collar and seal gland. See seal manufacturer's instructions for seal setting dimension.
8. Loosen socket head setscrews of seal drive collar.

THRUST END:

9. Loosen setscrew of inboard deflector disc and move away from bearing housing.
10. Insert a seal setting spacer between seal drive collar and seal gland.
11. Loosen socket head setscrews of seal drive collar.
12. Loosen capscrews of thrust bearing cover and remove only the capscrews which go into upper half housing.
13. Remove two taper pins located at split line of top and bottom of bearing housing.
14. Remove capscrews holding bearing housing halves together.
15. Using eyebolt, lift off bearing housing upper half. Lower onto a flat surface, padded with cloth to protect the flange surface.
16. Remove remaining capscrews of bearing cover. Remove cover and shim set along with any attached oil pump or speed transmitter.
17. Bend tab of lockwasher out of bearing mounting sleeve. Remove capscrew and lockwasher.
18. Slip oil ring sleeve and oil ring off shaft.
19. Remove bearing and retainer ring. Apply even pressure to inner race.

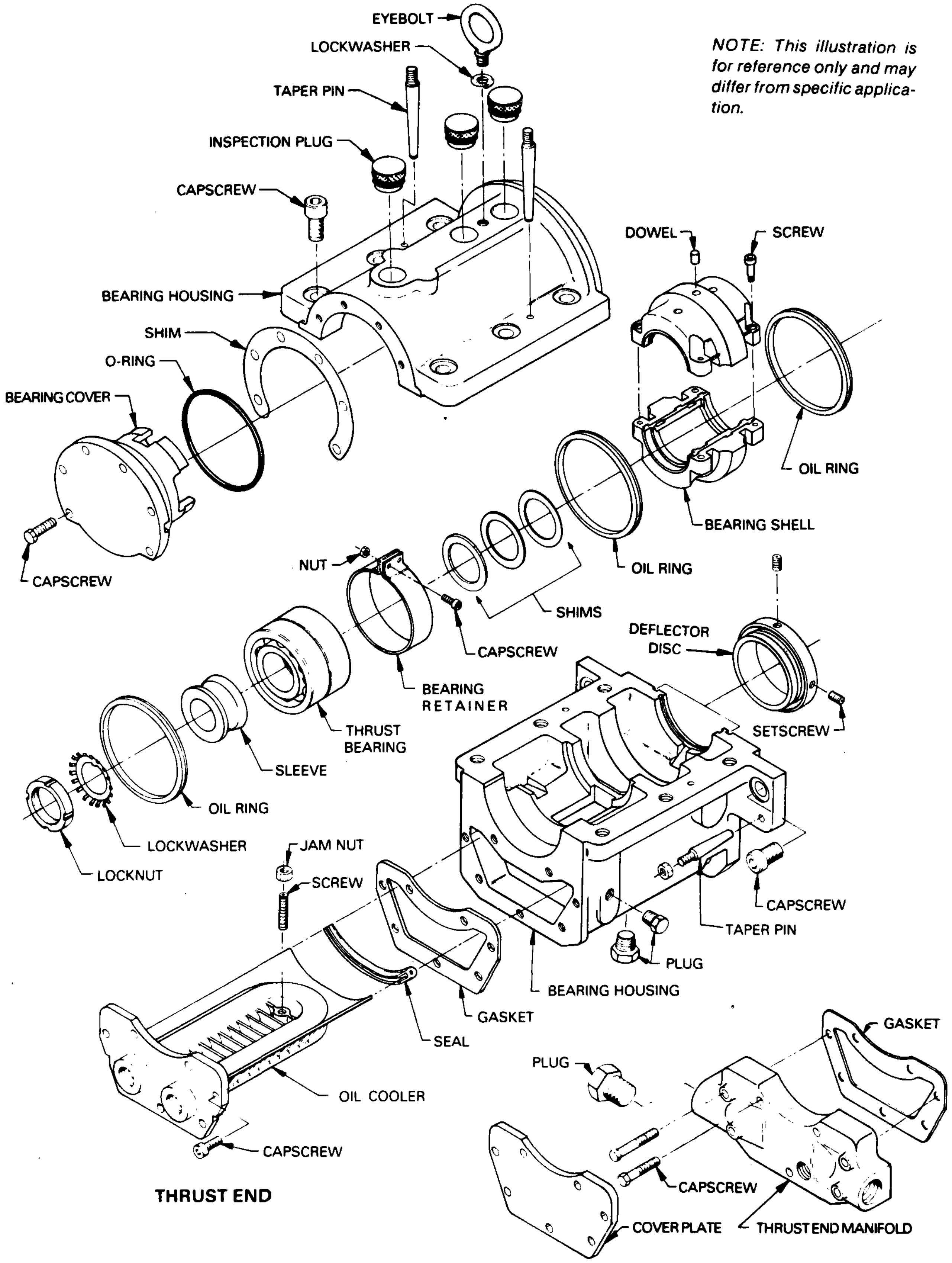


Fig. 24 Typical ball thrust and sleeve journal bearing, thrust end

20. Remove bearing shim set, noting position for reassembly.
21. Remove socket head capscrews and dowels of bearing shells. Lift off top half.
22. Move oil rings from bearing and rest on shaft.
23. Lift shaft slightly and remove lower bearing shell half.
24. Remove taper pins from lower bearing housing to pump bracket.
25. Remove capscrews of bottom thrust bearing housing half. Lower housing and remove.
26. Remove oil rings.
27. Remove inboard end cover.
28. Remove inboard deflector disc.
29. Loosen and remove 4 hex head nuts and washers from mechanical seal gland.
30. Check that spacers are in place between seal drive collar and gland, then remove mechanical seal.

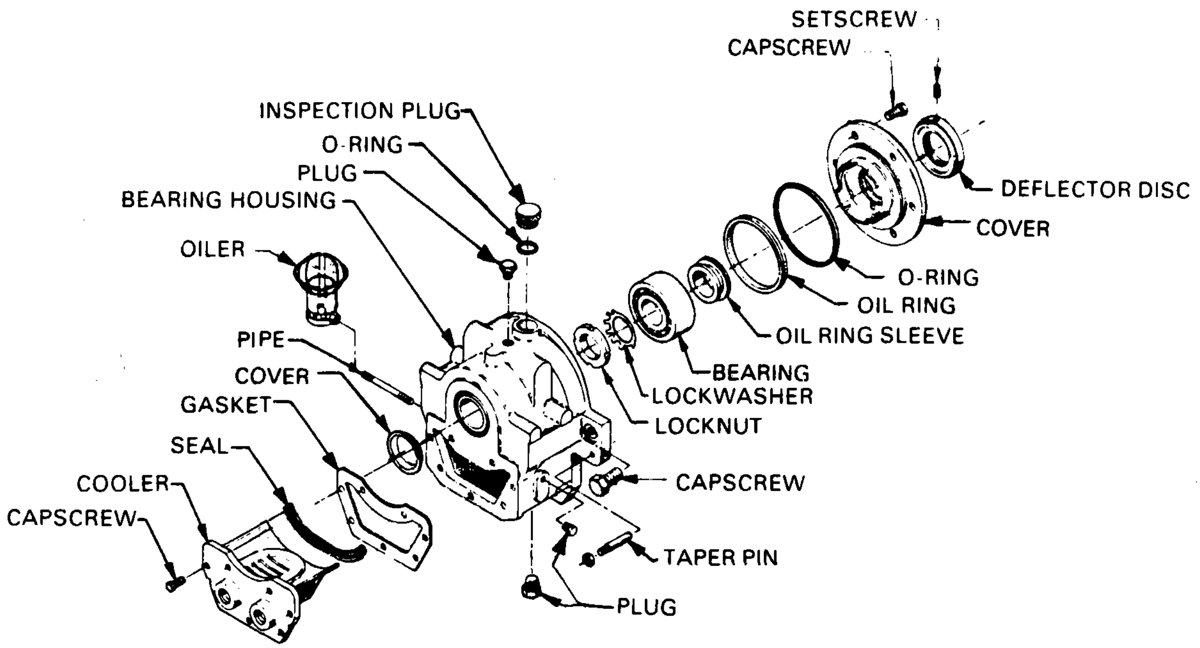
DRIVE END:

31. Remove two taper pins located at split line of top and bottom of bearing housing.
32. Remove capscrews holding bearing housing halves together.
33. Using eyebolt, lift off bearing housing upper half. Lower onto a flat surface, padded with cloth to protect the flange surface.
34. Remove socket head capscrews and dowels of bearing shells. Lift off top half.
35. Move oil rings from bearing and rest on shaft.
36. Lift shaft slightly and remove lower bearing shell half.
37. Remove two taper pins of lower bearing housing to pump bracket.
38. Remove capscrews of bottom thrust bearing housing half. Lower housing and remove.
29. Remove outboard end cover.
40. Remove oil rings.
41. Remove inboard end cover.
42. Remove inboard deflector disc.
43. Loosen and remove 4 hex head nuts and washers from mechanical seal gland.
44. Check that spacers are in place between seal drive collar and gland, then remove mechanical seal.

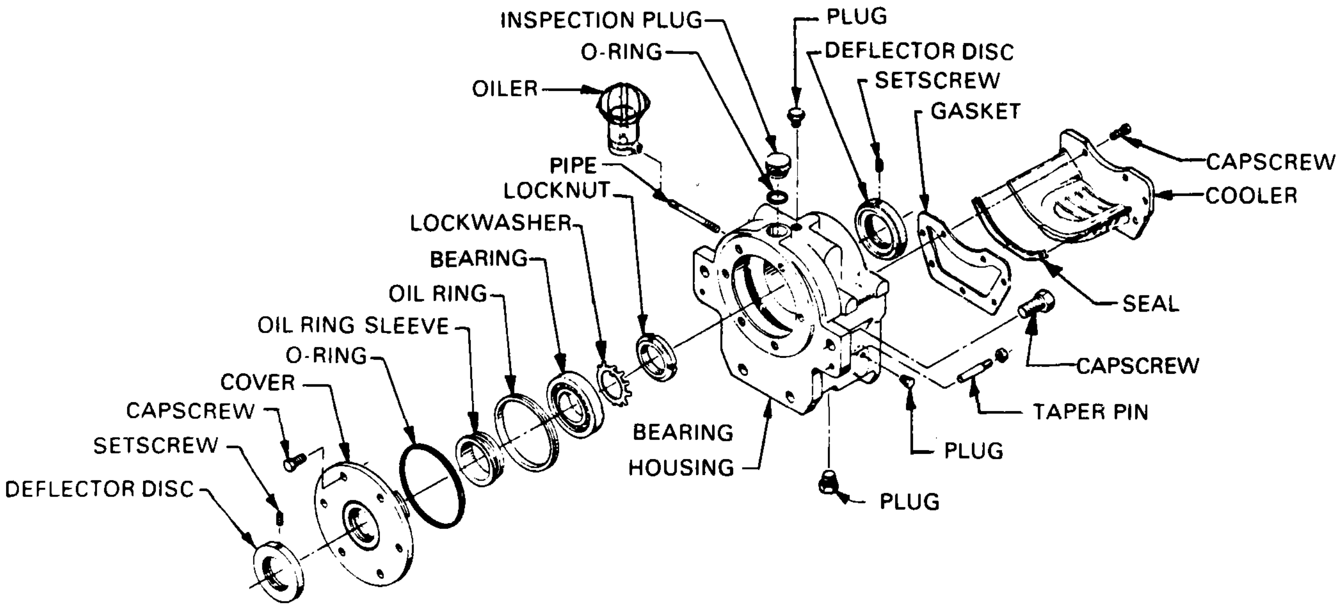
See INNER CASE REMOVAL.

DISASSEMBLY, BALL THRUST AND BALL RADIAL BEARINGS & MECHANICAL SEALS

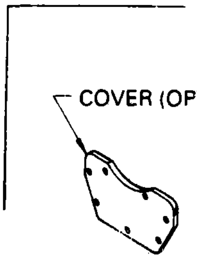
1. Carefully remove and store any vibration probes, keyphasor probes, or bearing temperature detectors.



THRUST END



DRIVE END



NOTE: This illustration is for reference only and may differ from specific application.

Fig. 25 Typical ball thrust and ball radial bearing

DRIVE END:

2. Remove coupling spacer.
3. Remove coupling by loosening socket head setscrew in shaft extension nut and remove nut.
4. Remove coupling hub with use of a puller. Some moderate heating of hub may be required. Avoid damage to sealing ring.
5. Loosen setscrews of inboard and outboard deflector discs.
6. Remove outboard deflector disc.
7. Remove capscrews holding inboard end cover to housing.
8. Move aside inboard deflector disc and inboard end cover.
9. Engage oil ring with a wire hook inserted through oil inspection hole. Lift oil ring onto bearing cover projections. This will prevent oil rings from hanging up and resultant damage during bearing housing removal.
10. Carefully remove bearing housing.
11. Remove locknut and washer.
12. Pull bearing with suitable puller, applying pressure to inner race.
13. Remove oil ring.
14. Remove oil ring sleeve.
15. Remove end cover.
16. Remove deflector disc.

THRUST END:

17. Repeat bearing removal steps given for driver end.

See INNER CASE REMOVAL.

INNER CASE REMOVAL

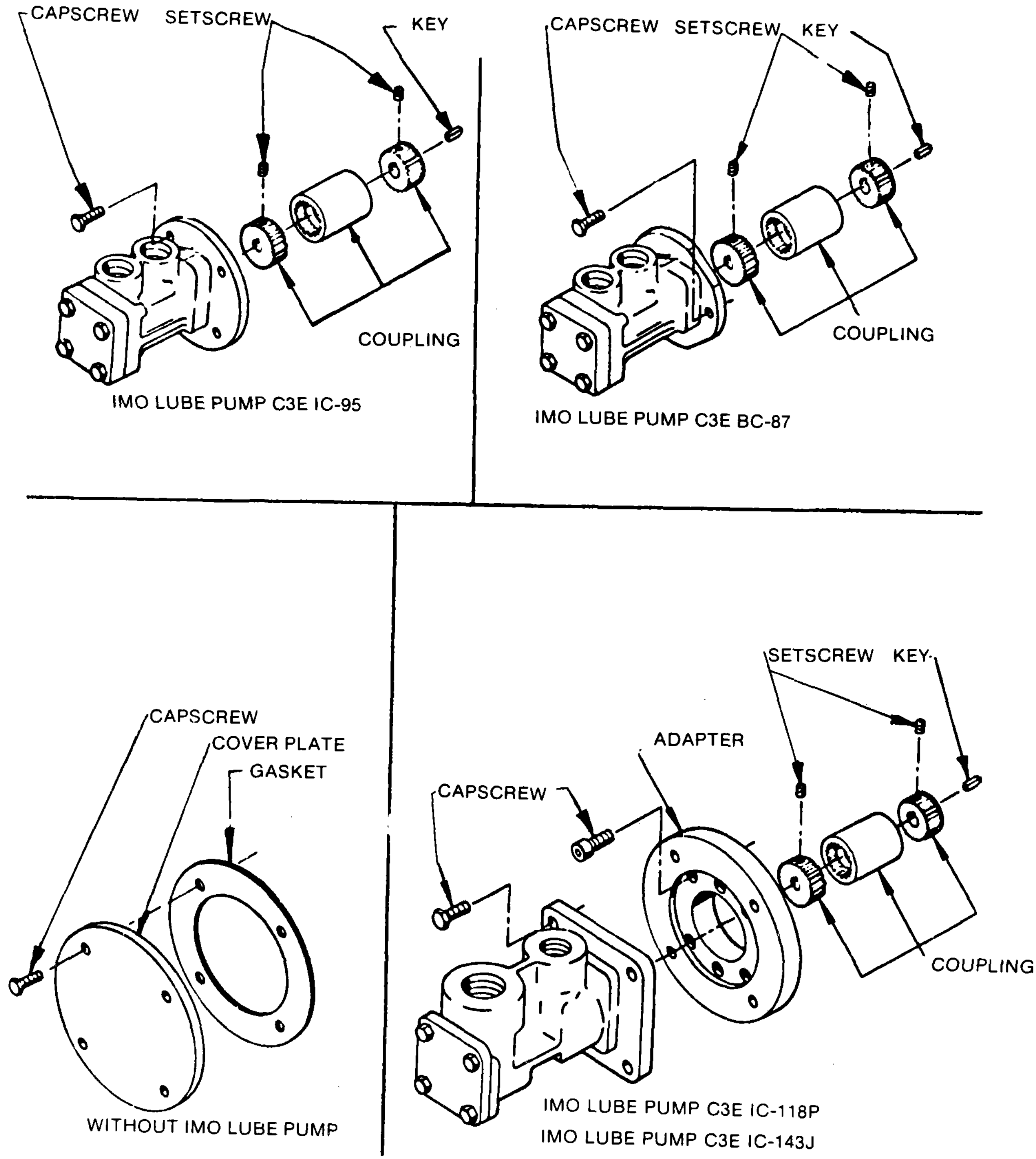
PRELIMINARY Bearings and bearing housings must be removed before inner case is removed. See disassembly instruction section appropriate to specific configuration.

The inner case is pulled from the thrust end of the outer case. The drive end outer case cover need not be removed until pump reassembly.

NOTE: Protect shaft bearing surfaces.

THRUST END:

1. Remove nuts from outer case thrust end cover.
2. Attach a hoist to eyebolt of outer case thrust end cover.
3. Equally tighten jackscrews to break joint.
4. Carefully pull end cover away from outer case, supporting end cover by hoist.
5. Remove antirotation pin and end cover to inner case shims, noting position for reassembly.
6. Install eyebolts in tapped holes of inner casing.



NOTE: This illustration is for reference only and may differ from specific application.

Fig. 26 IMO lube pump options

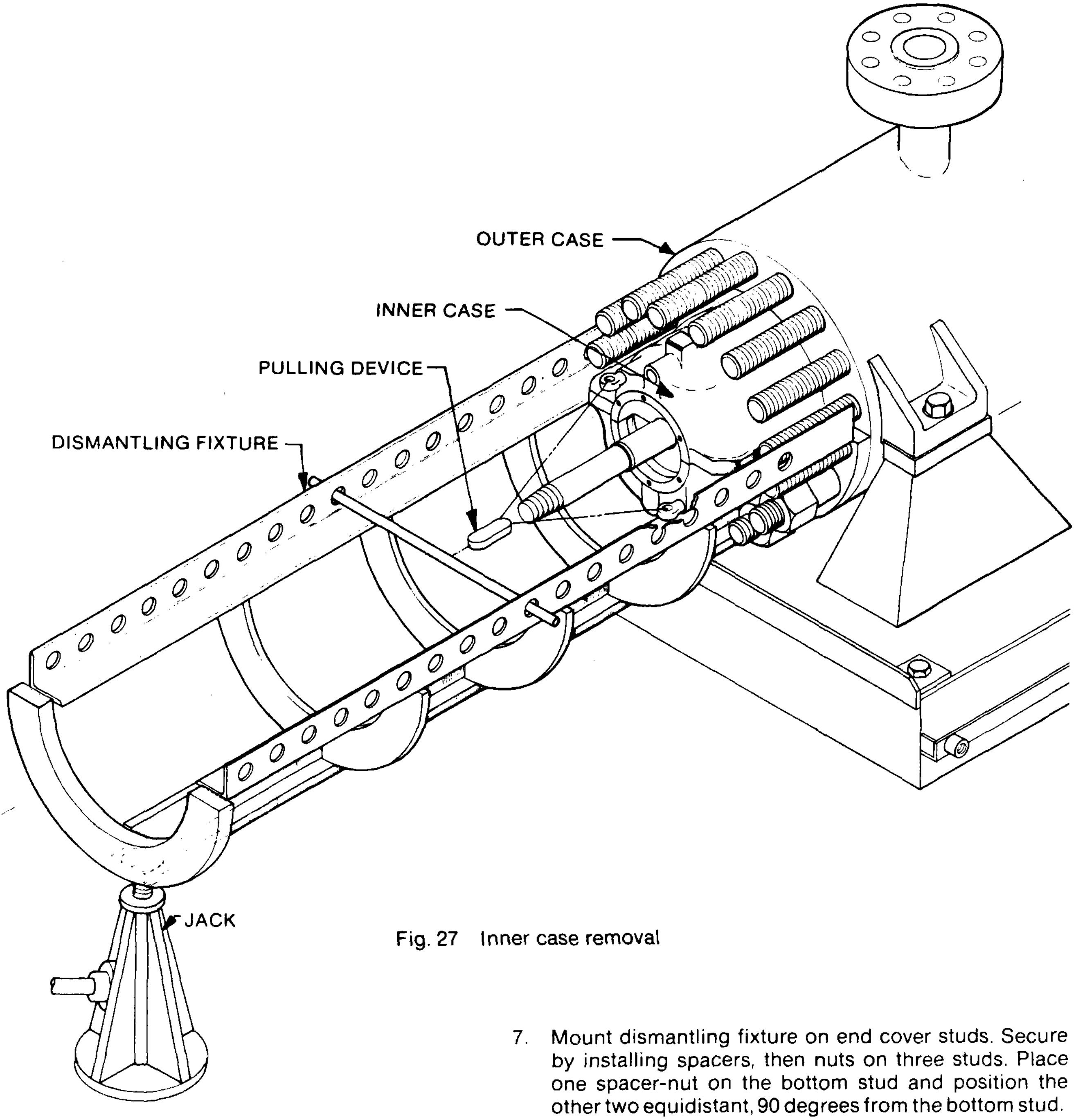
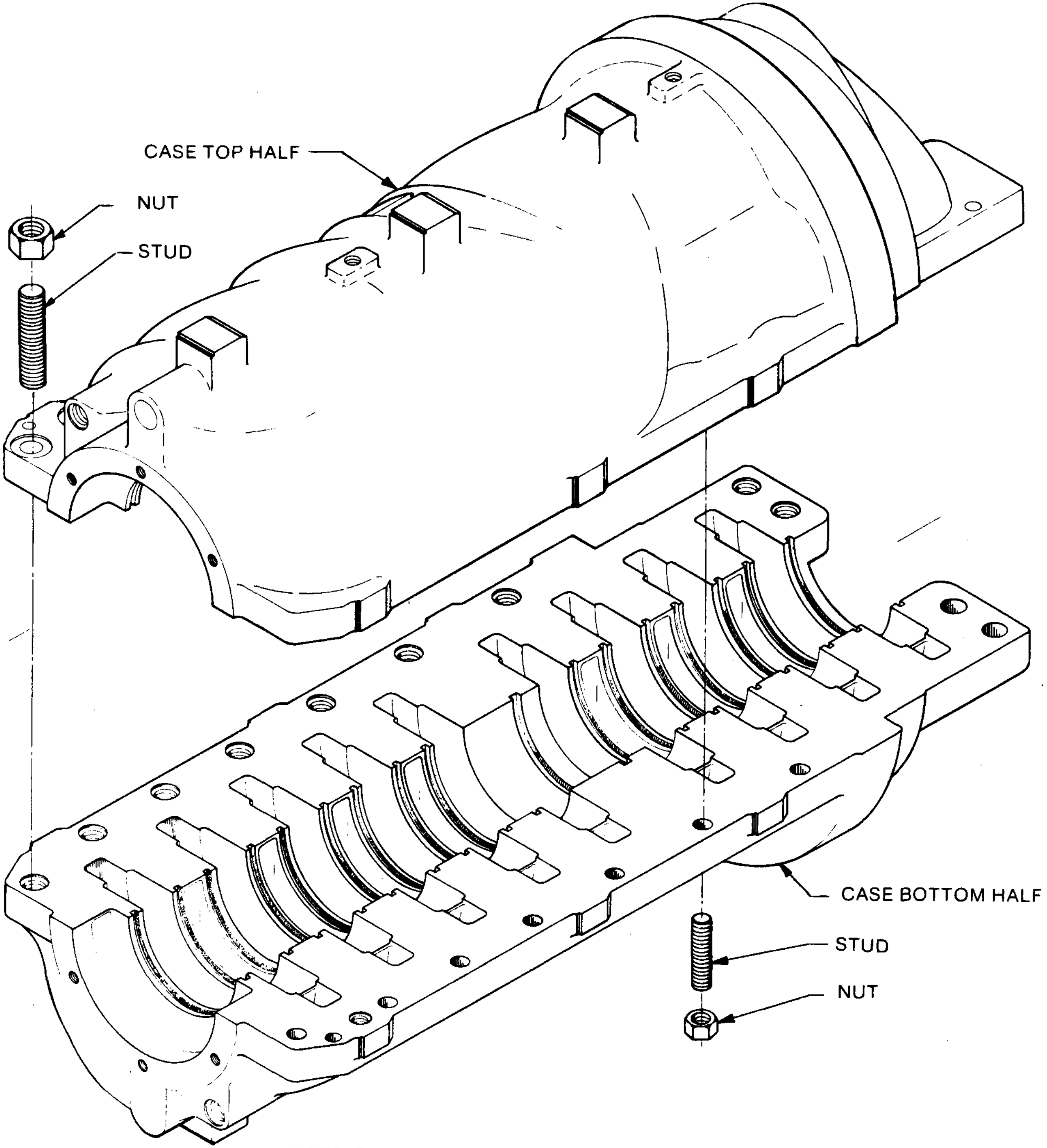


Fig. 27 Inner case removal

7. Mount dismantling fixture on end cover studs. Secure by installing spacers, then nuts on three studs. Place one spacer-nut on the bottom stud and position the other two equidistant, 90 degrees from the bottom stud.
8. Place a jack or other support under the outer end of the dismantling fixture. Level the fixture.
9. Rig a mechanical advantage pulling device between the dismantling fixture crossbars and eyebolts installed in end of inner case.
10. Apply a small amount of grease to dismantling fixture surfaces which inner case will contact.
11. Draw inner case from outer case and into dismantling fixture. During pull, use a bar leveraged between inner case and dismantling fixture in order to keep projection of inner case bottom on track of fixture.



NOTE: This illustration is for reference only and may differ from specific application.

Fig. 28 Typical 9-stage CP inner case

ROTATING ELEMENT REMOVAL

NOTE: Components and procedures referenced here may differ from a specific application. Parts orders and other assured identification must be made by use of specific cross section and parts list.

Move inner case to a work station by rigging a sling around the case.

NOTE: Do not lift inner case and rotating element assembly by a sling placed under the shaft.

1. Remove inner to outer case gasket.
2. Unfasten inner case bushing and remove.
3. Remove taper pins from case split line.
4. Remove case nuts.
5. Install and equally tighten jackscrews to break joint.
6. Utilize installed eyebolts to carefully lift off case top half. Lower onto a flat surface, padded with cloth to prevent damage to flange surface.

NOTE: Flange surfaces of the case halves are precisely machined and lapped. Take every precaution to prevent damage.

7. Remove the top half of a *split* center stage piece. (Rotating element may have to be lifted a few inches to provide access.)
8. Use a suitable rope sling to lift rotating element from case lower half. Place slings around shaft just inboard of stuffingboxes. Apply a slight strain to sling and use a bar under the shaft to free case rings. Shaft distortion can be caused by any binding of parts during removal. Be careful that the bottom half of a split center stage piece does not fall free.
9. Place rotating element on three "V" bocks, supported under two ends and center.

NOTE: Rotating element assembly should be moved to a maintenance shop where proper facilities are available for further disassembly.

INSPECTION

NOTE: Also see ROTATING ELEMENT DISASSEMBLY AND INSPECTION.

CLEAN AND INSPECT After pump disassembly, clean parts in solvent (not mechanical seal) and inspect for wear or damage. Inspect bearings, shaft sleeves, wear rings, throttle bushings, seal parts, and stage pieces.

All running clearances (wear rings, etc.) must be accurately measured for excessive wear. No damaged or excessively worn parts should be re-used.

Grooves and bores within case halves must be clean and free of burrs so that wear rings and throat bushings seat properly.

If pump is not immediately reassembled protect machined surfaces against rust. A thin application of light machine oil is normally adequate for short-term storage.

PIVOT SHOE THRUST BEARING Carefully inspect every thrust bearing shoe. Shoes should be replaced if they show extreme wear, scratches or "smearing" of the babbitt. New and used shoes should not be mixed. If a shoe is replaced, replace all on that side of bearing.

Inspect both sides of thrust bearing collar. Running surfaces should be very smooth. Rough surfaces can be ground or lapped to 16 AA if proper equipment is available. Grinding or lapping the collar will affect pump end movement, therefore be sure to check end movement. Also check runout of a reworked collar when it is reinstalled on shaft.

If thrust collar was reworked, a runout check should be run on both sides. Mount a dial indicator to any fixed location to run against collar bearing mating surfaces. Rotate element 360 degrees. The runout must not exceed .001 in. (.025 mm) TIR. If runout exceeds limit, collar must be reworked or replaced.

SLEEVE JOURNAL BEARINGS Carefully inspect all sleeve journal bearings. Minor irregularities can be removed with a scraper. Never use abrasive materials to smooth bearing surfaces. Replace if there is extreme wear, scratches or "smearing" of the babbitt. Never mix new with worn, replace both halves.

Allowable sleeve journal bearing to shaft diametrical clearance depends on shaft diameter (Fig. 29).

Bore diameter of sleeve bearing at running clearance	Clearance min to max
1.50 - 2.99 in.	.003 - .004 in. (.076 - .102 mm)
3.00 - 4.49	.004 - .005 (.102 - .127)
4.50 - 5.49	.005 - .006 (.127 - .152)
5.50 - 6.99	.006 - .007 (.152 - .178)

Fig. 29 Sleeve bearing clearance

BALL BEARING It is generally considered good practice to replace ball bearings during a major overhaul. Estimated bearing life for a specific application will provide guidance.

BEARING HOUSING Check all bearing housing fits for burrs and irregularities. Dress down any metal that will interfere with proper fit of machined surfaces. Remove all old sealer from housing flanges.

WEAR RING A measurement rule of thumb is to replace when the diametrical clearance between running parts exceeds *140* percent of design clearance. A minimum of 85 percent total wear surface must "clean up" to the acceptable wear diameter and the balance must not vary more than .002 in (.051 mm).

THROTTLE BUSHING, CENTER BUSHING A measurement rule of thumb is to replace when the diametrical clearance between running parts exceeds *125* percent of design clearance. A minimum of 85 percent total wear surface must "clean up" to the acceptable wear diameter and the balance must not vary more than .002 in. (.051 mm).

MECHANICAL SEAL The sealing surfaces of mechanical seals are highly polished and optically flat. Care must be used to keep these surfaces perfectly clean and free from substances that would mar seal faces.

Before completing seal installation, wipe lapped sealing faces of seat and washer perfectly clean.

Be sure to follow seal manufacturer's instructions for installation and maintenance. See the seal manufacturer's drawing for correct assembly and seal setting. New O-rings, springs, and faces should be installed.

ROTATING ELEMENT DISASSEMBLY AND INSPECTION

NOTE: As dismantling proceeds it is essential that wear parts be marked as to relative placement.

Clean and polish shaft ahead and behind impellers during dismantling.

IMPELLER REMOVAL

1. Some pumps are equipped with shaft nuts. These shaft nuts are right and left hand thread, tightening against rotation. They are locked against reverse rotation by socket head setscrews. Loosen setscrews and use a spanner wrench to unscrew shaft sleeve nuts.

THRUST END:

2. Use heat to remove throttle sleeve.
3. Remove throttle sleeve key.
4. Dress shaft at throttle sleeve location.
5. Use a "soft" flame to heat impeller. Use wet cloths to keep shaft cool while heating impeller. Begin at outer perimeter of impeller and work toward center, heating the hub last.

   Slide impeller towards center, remove any split thrust rings and remove impeller. (If a *soft* hammer is used, be sure to tap only the face of the ring fit area.)

   Mark or tag each impeller with stage location identification in preparation for reassembly.

   Check that shaft is adequately cool before removal of next impeller.

   Continue to remove impellers from thrust end, up to center stage piece.

6. Remove any unsplit center stage piece and center stage sleeve.

DRIVER END:

7. Turn shaft end for end and remove remaining impellers from shaft.

NOTE: This illustration is for reference only and may differ from specific application.

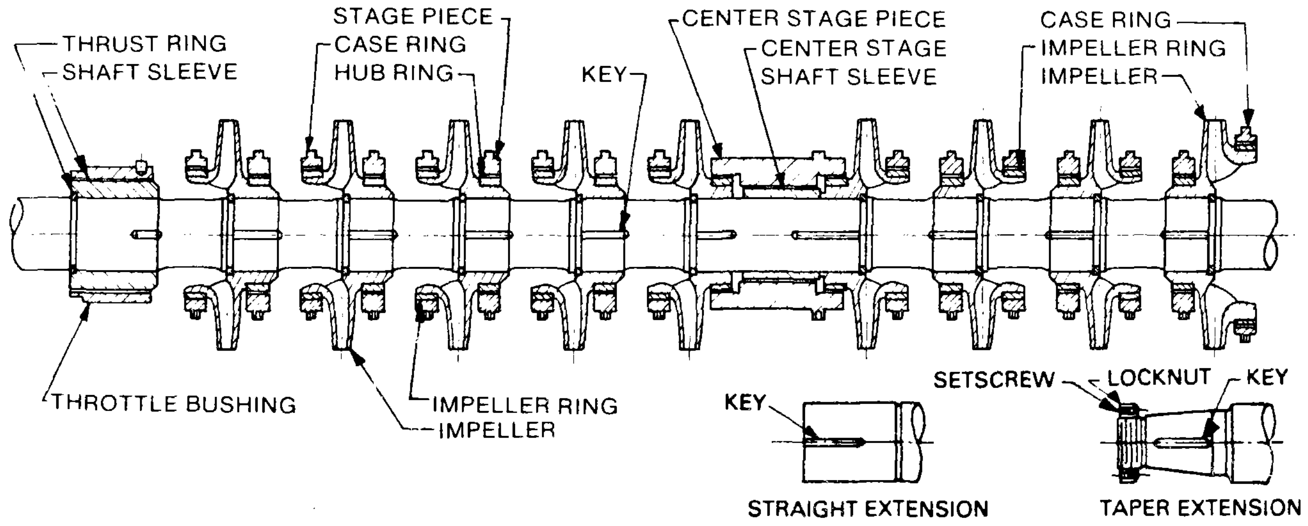


Fig. 30 Typical CP 9-stage rotating element

SHAFT Inspect pump shaft for burrs or scratches. Carefully file off burrs and smooth resulting file marks with crocus cloth. Polish shaft with crocus cloth at location of impeller, seal, coupling, bearing, and shaft sleeve.

The shaft must be handled with care and supported evenly throughout its length to insure straightness. Avoid bumping, hitting, or springing the shaft.

Shaft straightness must be within .002 in. (.051 mm) TIR maximum for applications up to 3600 rpm, .001 in. (.025 mm) TIR maximum for above 3600 rpm. Rest shaft on precision rollers at shaft bearing locations. Use dial indicator to determine runout at impeller and seal locations.

IMPELLER Inspect impeller for wear or damage. Particularly look for cavitation marks (pits) in the suction opening, erosion of vanes and cracks in the shroud. Minor irregularities may be smoothed with a fine file and crocus cloth.

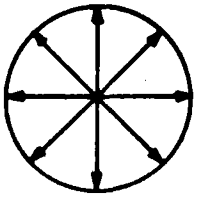
DESIGN CLEARANCES Bingham Standard Clearances are regularly used on pump types CP and CPA. API 610 Standard Clearances are provided when customer specified.

Interstage bushings and sleeves are considered as bearings and these components are ordinarily furnished to Bingham Standard Clearance, even when the wear ring design clearance is specified to API 610 Clearances. Customer requirements or operating conditions may also require interstage bushings and sleeves to be furnished to API Clearances.

The use of running clearances larger than original manufactured clearance will result in an efficiency loss.

WEAR RING CLEARANCES Replace wear rings when pump performance drops below acceptable system standards. A measurement rule of thumb is to replace when diametrical clearance between running parts exceeds 140 percent of design clearance.

Measure clearance between corresponding sets of rings. Compare impeller ring OD and case ring ID. Use several measurement locations, then subtract smallest impeller ring OD from largest case ring ID to determine diametrical clearance.



largest case ring ID — smallest impeller ring OD = diametrical clearance

BORE DIAMETER OF OUTER PART AT RUNNING CLEARANCE	DESIGN DIAMETRICAL CLEARANCE	
	BINGHAM STANDARD	BINGHAM "HOT" OR API STANDARD
2.000 - 2.499 in.	0.008 in. (0.203 mm)	0.011 in. (0.279 mm)
2.500 - 2.999	0.009 (0.229)	0.012 (0.305)
3.000 - 3.499	0.010 (0.254)	0.014 (0.356)
3.500 - 3.999	0.011 (0.279)	0.016 (0.406)
4.000 - 4.499	0.011 (0.279)	0.016 (0.406)
4.500 - 4.999	0.012 (0.305)	0.016 (0.406)
5.000 - 5.999	0.013 (0.330)	0.017 (0.432)

For diameters greater than 5.999 in., add 0.001 in. (0.0254 mm) for each additional inch of diameter or fraction thereof.
API 610 "HOT": For materials with greater galling tendencies and/or operating temperature above 500°F (260°C), 0.005 in. (0.127 mm) shall be added to API Standard diametrical clearances.

WEAR RINGS

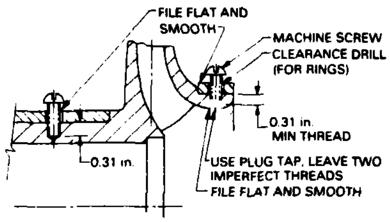


Fig. 32 Locking of impeller rings

INSPECT Wear rings should be inspected for grooves and uneven wear. Minor irregularities can be dressed with fine file and crocus cloth. Rings may be machined if proper equipment is available. but only within allowable clearance.

WEAR RING REMOVAL Rings may be removed by machining on a lathe, splitting by cutting with a grinding disc (use care not to contact impeller) or by removing (drilling out) setscrews then applying even heat to ring.

Insert a pulling tool or pry bar between ring and seat. Apply pressure evenly to remove ring.

IMPELLER RINGS Before installing new impeller rings, be sure rings and impeller seats are clean and free of burrs.

NOTE: Preferred method of heating wear rings is by electric oven or hot oil bath. Heating by torch is not recommended due to uneven heating stresses. If heated with a torch, use a "soft" flame and heat slowly and evenly.

1. Place impellers open ring side up. Heat open side rings and install. Install rings so locking screw holes do not align with old holes, keyway or any impeller vanes. Note that chamfered inside diameter is placed to impeller. Let cool.
2. Similarly, install impeller hub rings.
3. Drill new locking screw holes into impeller, using ring holes as guide. Holes must be at least as deep into impeller as they are wide. Be very careful not to drill through impeller shroud.
4. Tap threads but leave imperfect threads at bottom so screws will bind to lock.
5. Install stainless steel machine screws so that they bind tightly within imperfect threads. Being very careful of ring surface, saw off tops of screws, file flush and finish with crocus cloth. Remove any slivers left after filing.

RING DIA OD, in.	ROUND HD MACHINE SCREWS AISI 316 MATERIAL qty & size, in.	DRILL SIZE (FOR RINGS) "alpha" drill = in.
to 6.50	3 of ¼ - 28 x .75 long	"F" drill = .257
6.51 - 10.00	6 of ¼ - 28 x .75 long	"F" drill = .257
10.01 - 15.00	6 of 5/16 - 18 x 1.00 long	"P" drill = .323
15.01 - up	6 of ⅜ - 24 x 1.00 long	"W" drill = .386

Fig. 33 Locking screw size

CAUTION: Check dress of screws. High spots or loose pieces of metal can quickly score the close-fit wear ring surfaces.

ASSEMBLY, GENERAL

CLEANLINESS During assembly, it is essential that all parts be absolutely clean and free of oil or dust. Technical grade acetone is recommended for cleaning machined surfaces immediately before assembly. Air dry (use clean, filtered air) cleaned parts in a dust-free area.

WARNING: Acetone is extremely volatile and flammable. Work only in a well ventilated area, away from heat or flame. A "no smoking" rule must be strictly enforced, and care must be taken to prevent sparks.

O-RINGS AND GASKETS Always use new O-rings, gaskets and retaining rings. Replace gaskets with same material and thickness as original.

NOTE: O-ring material is ethylene propylene. Use only glycerine, ethylene glycol or distilled water for assembly. Do not allow oil or grease to contact O-rings.

ROTATING ELEMENT Ensure that shaft has been polished.

ROTATING ELEMENT ASSEMBLY

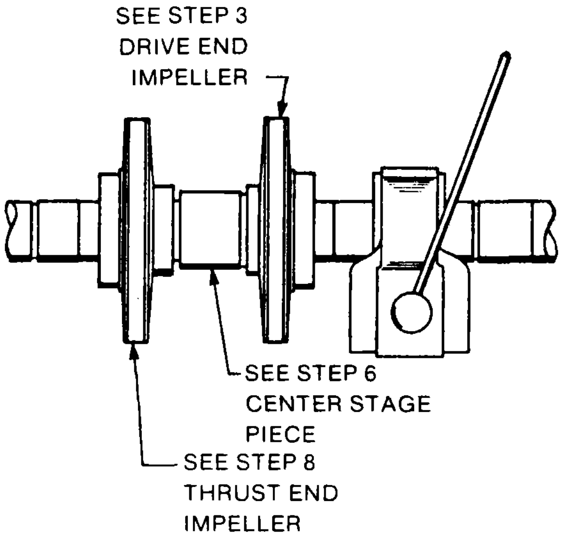


Fig. 34 Impeller mounting sequence

NOTE: Refer to previously noted marked match marks during reassembly.

NOTE: Powdered molybdenum disulphide may be used as a lubricant for shaft fits.

1. A soft-jaw vice will facilitate assembly. Clamp shaft at the driver end and support in the middle, just behind the first impeller to be mounted.
2. Check all thrust ring and key fit.

NOTE: Offset by 90 degrees the thrust ring split of each succeeding stage in order to maintain weight balance. Position the rings so that a split does not align with a keyway.

3. The first impeller to be mounted is the final stage impeller on the low pressure end next to the center stage sleeve. Place this impeller key into the shaft. This key also holds the center stage sleeve.
4. Wire thrust rings to the shaft in order to temporarily hold the thrust rings during impeller installation.

NOTE: Preferred method of heating impellers is by electric oven or hot oil bath. Heating by torch is not recommended due to uneven heating stresses.

5. Heat impeller and place on shaft with impeller opening facing the driver end. Line up on the key and slide impeller over the key and thrust ring. *Do not attempt to pull the impeller back once it has bottomed on the thrust rings.*
6. Install center stage sleeve tightly against impeller hub.
7. An unsplit center stage piece is now installed. Correctly install with the O-ring groove facing the discharge end.

NOTE: Parts should be allowed to air cool before the next impeller is heated and mounted. The shaft will be comfortable to the hand. Do not use water to cool parts as it may cause damage to impellers or shaft.

8. Next impeller to be mounted is the final stage impeller on discharge end. Place key in shaft.
9. Heat impeller, then slide to a position past the thrust ring groove.

10. Place thrust rings into the shaft groove. Slide the impeller home over the key and thrust rings, making sure impeller is seated tightly against thrust rings.
11. Install case eye ring after the impeller has air cooled.
12. Repeat procedure to mount remaining impellers on *thrust* bearing end of shaft. Check that stage piece is placed on hub side of impellers during remaining assembly of impellers.

NOTE: On CP-DS and CPA-DS pumps the first stage, double suction impeller does not utilize thrust rings. A sleeve, with thrust rings and stage piece, is installed on the shaft between second and first stage impellers. Direction of vanes of the double suction impeller must be correctly matched to the pump rotation.

13. Place the throttle key into shaft, heat throttle sleeve and install. If sleeve is retained axially by a thrust ring, install in same manner as impeller thrust rings. If sleeve is held by a shaft nut, install with setscrews.
14. Turn shaft end for end and mount the remaining impellers. Remove the wire that held the thrust rings for the first impeller mounted.

WEAR PART CONCENTRICITY Rest shaft on precision rollers and check wear ring surfaces for runout. Where required, slide stage pieces toward adjacent impellers to allow access. Allowable maximum TIR is .002 in. (.051 mm) for operating speed up to 3600 rpm and .0015 in. (.037 mm) above 3600 rpm.

ASSEMBLY, ROTATING ELEMENT AND INNER CASE

TORQUE VALUES Prior to assembly refer to suggested torque values table. See TORQUE VALUES.

PACKINGLESS STUFFINGBOX Throttle bushing and shaft sleeves are placed on shaft before rotating element installation. Piping connections are required.

INSTALLATION OF ROTATING ELEMENT

NOTE: Check correct installation of case rings and throttle bushing on the rotating element.

Inspect flange surfaces of case halves and blow out any foreign matter.

Place bottom half of a split center stage piece into case bottom half.

Lift and carefully lower rotating element into lower case half, carefully guiding case rings into ring seat surfaces. All slots for lock pins are located on the bottom of the element.

NOTE: Rotate and align slots in the stage pieces, case rings and throttle bushings with pins of the case. Recheck shaft seating and slot-pin seating in every piece. Place top half of a split center stage piece onto rotating element.

INNER CASE ASSEMBLY

1. Lift case top half and place squarely over case bottom half studs. Check that jackscrews are backed off.

2. Lower case top half until nearly seated. Install taper pins to assist in final seating.
3. Lower case top half.

CAUTION: Case should seat properly without any pressure other than gravity. Do not provide additional pressure. Check reason for non-seating before proceeding.

4. Seat taper pins.
5. Lubricate and install case nuts finger-tight.
6. Properly tighten case nuts. See TORQUE VALUES. Start with center studs and alternate tightening sequence to ensure even loading. Develop required fastener stress in a minimum of three steps, with a maximum 50 percent stress on first pass.
7. Release taper pins by tapping until free. Remove and store.
8. Fasten inner case bushing in place.

INNER CASE INSTALLATION

PRELIMINARY Review procedures used in INNER CASE REMOVAL. Dismantling fixture is attached to thrust end of outer case. Return inner case to dismantling fixture.

1. Apply a small amount of grease to dismantling fixture slide surface which inner case will contact during installation.
2. *INNER CASE SEATING MEASUREMENT* The inner case may be installed without removal of drive end outer case end cover. Reference measurements must be taken in order to know when inner case is fully seated. Use gasket mating surface as measurement starting point, taking into account the gasket thickness. Subtract inner case measurement from outer case measurement. Record measurement for later determination of proper seating.

   Service personnel may elect to remove drive end outer case end cover to insure proper seating by visual means.
3. Install inner-outer case gasket. Avoid gasket displacement during inner case installation by adhering gasket with a light coat of Permatex.

CAUTION: Stop, invstigate, and correct problem if any binding occurs during installation.

4. Use a pry bar to ease inner case into outer case. If cover has been removed, look into drive end of outer case to determine that inner-outer case gasket does not become displaced during inner case installation.
5. Determine that inner case is completely pushed into the outer case. Use previously recorded inner case seating measurement or a visual check if end cover was removed. The inner case will be firmly seated against the outer case shoulder.

6. If removed earlier, reinstall drive end outer case cover. Use a new gasket. See TORQUE VALUES for proper tightening of fasteners.
7. Remove dismantling fixture.
8. *INNER CASE SHIMS* Inner case clearance will not change unless the original drive end outer case end cover or inner case center bushing is replaced. If neither component is replaced then original thickness inner case shims may be reused. If either of these components are replaced contact a Bingham-Willamette representative for new shim pack determination.

   INNER CASE CLEARANCE If inner case, drive end cover or center bushing is replaced the proper inner case shim thickness needs to be redetermined:

   a. Place a straight edge across end surface of outer case, just above pump shaft. Measure distance A between straight edge and outermost surface of inner case bushing (Fig. 35).
   b. Measure distance B, between end cover shim seat surface and case mating surface.
   c. Difference between distance A and B is inner case clearance. Choose a shim pack thickness to bring inner case clearance within tolerance. Contact a Bingham-Willamette representative for specific recommended shim pack thickness.

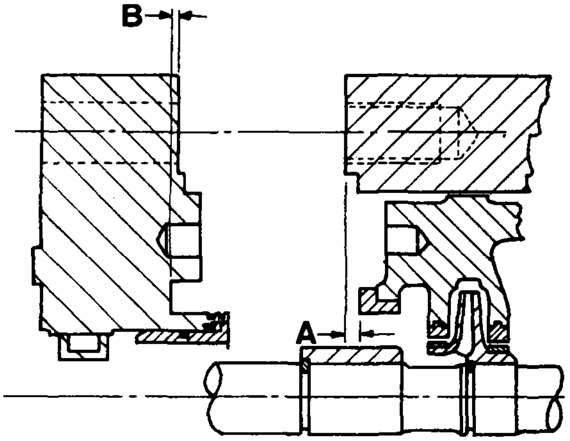


Fig. 35 Dimensions of inner case clearance determination

9. Insert antirotation pin into inner case.
10. Install thrust end outer case cover. use a new gasket. See TORQUE VALUES.

PACKED STUFFINGBOX See INSTALLATION, STUFFINGBOX.

ASSEMBLY, PIVOT SHOE THRUST BEARING & MECHANICAL SEALS

THRUST END:

1. Check seal setting spacer between seal drive collar and seal gland.
2. Install mechanical seal onto shaft and push into stuffingbox bore until gland is seated.
3. Install 4 nuts and washers onto seal gland studs until finger-tight.
4. Slide inboard deflector disc as far as possible onto shaft.
5. Slide inboard end cover onto shaft, beyond bearing surface.
6. Move oil rings onto shaft, rest on bearing surface.
7. Slide seal ring onto shaft.
8. Lift lower bearing housing half into position, carefully guiding inboard cover and seal ring to proper housing location.
9. Determine that cover groove and seal ring are locked into position on housing.

10. Install taper pins through lower housing half, into pump bracket.
11. Install capscrews finger-tight, seat taper pins, then properly torque capscrews.
12. Wipe and generously lubricate shaft journal surface and the lower bearing shell half babbit surface. Slightly raise shaft and install bearing and oil rings.
13. Wipe and generously lubricate shaft journal surface and upper bearing shell half babbit surface. Install bearing.
14. Install bearing dowels and capscrews.
15. Slide adjusting plate into position.
16. Install thrust bearing collar key.
17. Install thrust bearing collar.
18. Install thrust bearing collar locknut.
19. Tighten locknut setscrew.

NOTE: All thrust bearing shoes must be thoroughly lubricated before installation.

20. Place bottom half of inboard base ring over shaft. Bottom half is half with no drive key. Rotate base ring into lower half bearing housing.
21. After two bottom shoes are inserted, rotate base ring so split line aligns with bearing housing flange. Then install top half base ring.
22. Rotate base ring to move it away from housing parting flange about 30 degrees, then insert another thrust shoe. Then rotate base ring back so drive key is in top position.
23. Install new O-ring in thrust bearing end cover. (Install oil pump or speed transmitter, if previously removed.) Install capscrews finger-tight, through cover to lower bearing housing half.
24. Install remaining thrust bearing ring and shoes.
25. Measure distance between inboard cover and dowel pin hole of top cover. Center bearing so pin will enter top cover locating hole.
26. Lift and temporarily install upper bearing housing cover, taper pins and at least 4 capscrews.
27. Install remaining end cover capscrews. Tighten securely.

DRIVE END:

28. Install mechanical seal in same manner as thrust end.
29. Slide inboard deflector disc as far as possible onto shaft.
30. Slide inboard end cover onto shaft, beyond bearing surface.
31. Slide oil rings onto shaft, rest on bearing surface.

32. Slide outboard end cover onto shaft, rest on bearing surface.

33. Lift lower bearing housing half into position, carefully guiding inboard cover to proper housing location.

34. Determine that cover groove is locked into position on housing.

35. Install taper pins through lower housing half, into pump bracket.

36. Install capscrews finger-tight, seat taper pins, then properly torque capscrews.

37. Wipe and generously lubricate shaft journal surface and lower bearing shell half babbit surface. Slightly raise shaft and install bearing and oil rings.

38. Wipe and generously lubricate shaft journal surface and upper bearing shell half babbit surface. Install bearing.

39. Install bearing dowels and capscrews.

40. Measure distance between inboard cover and dowel pin hole of top cover. Center bearing so pin will enter top cover locating hole.

41. Lift cover, apply a thin coat of silicone sealer between bearing housing halves. This will assure a complete seal. Install upper cover, then insert taper pins.

42. Install cover capscrews and properly tighten. See TORQUE VALUES. Release taper pins (between bearing housing halves) by tapping until free. Allow pins to remain loosely in place.

THRUST END:

43. *CHECK END PLAY* End movement of thrust bearing must be checked before pump is ready to run. Mount a dial indicator to bearing housing, with indicator tip in contact with end of shaft.

    Push shaft back as far as it will go toward thrust bearing and hold in place. Set dial indicator to zero. Move shaft as far as it will go to driver end and note reading.

Recommended end play of selected sizes of pivot shoe bearings:

Kingsbury #	**End Play**	
JHJ-4	.005-.007 in.	(.127-.178 mm)
JHJ-5	.005-.007	(.127-.178)
JHJ-6	.006-.008	(.152-.203)
JHJ-7	.007-.009	(.178-.229)
JHJ-8	.009-.011	(.229-.279)

END PLAY ADJUSTMENT If end play adjustment is to be changed, remove thrust bearing end cover and remove adjusting plate.

If clearance is too large, add shims behind adjusting plate. If too small, remove shims. In cases when there are no shims left to remove, the plate must be ground to size. Ground surfaces must be parallel within .002 in. (.051 mm). After adjustment, reinstall end cover and check end movement again.

44. Remove capscrews from end cover to top bearing housing half.
45. Remove dowel pins of top to bottom bearing housing halves, then remove capscrews.
46. Lift cover and apply a thin coat of silicone sealer between bearing housing halves.
47. Install taper pins, then capscrews. Release taper pins (between bearing housing halves) by tapping until free. Allow pins to remain loosely in place.
48. Slide outboard and inboard deflector discs into .035 in. (.9 mm) clearance to housing and tighten setscrews. Check that deflector disc is square to shaft.
49. Tighten setscrews of seal drive collar, using existing dimples of shaft.
50. Remove seal setting spacers between seal drive collar and seal gland.

DRIVE END:

51. Slide inboard deflector disc into .035 in. (.9 mm) clearance to housing and tighten setscrews. Check that deflector disc is square to shaft.
52. Tighten setscrews of seal drive collar, using existing dimples of shaft.
53. Remove seal setting spacers between seal drive collar and seal gland.
54. Use spanner wrench to check freedom of rotation of rotating element.
55. Install coupling shroud.
56. Install coupling key.
57. Install coupling hub.
58. Install coupling nut and tighten setscrew.
59. Check alignment of pump and driver. See INSTALLATION.
60. Install coupling spacer.
61. Check coupling lubrication.
62. Replace all auxiliary piping, probes, etc. See INSTALLATION and OPERATION.

ASSEMBLY, BALL THRUST & SLEEVE JOURNAL BEARINGS & MECHANICAL SEALS

THRUST END:

1. Check seal setting spacer between seal drive collar and seal gland.
2. Install mechanical seal onto shaft and push into stuffingbox bore until gland is seated.

3. Install 4 nuts and washers onto seal gland studs until finger-tight.
4. Slide inboard deflector disc as far as possible onto shaft.
5. Slide inboard end cover onto shaft, beyond bearing surface.
6. Slide oil rings onto shaft, rest on bearing surface.
7. Lift lower bearing housing half into position, carefully guiding inboard cover to proper housing location.
8. Determine that cover groove is locked into position on housing.
9. Install taper pins through lower housing half, into pump bracket.
10. Install capscrews finger-tight, seat taper pins, then properly torque capscrews.
11. Wipe and generously lubricate shaft journal surface and lower bearing shell half babbit surface. Slightly raise shaft and install bearing and oil rings.
12. Wipe and generously lubricate shaft journal surface and upper bearing shell half babbit surface. Install bearing.
13. Install bearing dowels and capscrews.
14. Slide thrust bearing shims into position.
15. If ball bearing is to be replaced, remove bearing retainer fasteners and press apart retainer ring and bearing.

    Thrust bearings are mounted "DB", back-to-back. The bearings are mounted with stamped backs of outer rings together. The contact angle lines of bearings converge outwardly. Replacement DB pairs are ordinarily packaged together in same relationship as they are to be used.

    The new bearing should be placed with an excess of shims. Return bearing and retainer ring to bearing housing.

    Check clearances between bearing cover and housing. Remove or replace shims to provide a total bearing end play of .002 to .004 in. (.051-.102 mm).

16. Install oil ring sleeve and oil ring, lockwasher and locknut. Tighten securely, back off 1/4 turn, bend lockwasher tab into locknut.
17. Lift cover and apply a thin coat of silicone sealer between bearing housing halves. This will assure a complete seal. Install upper cover, then insert taper pins.
18. Install cover capscrews and properly tighten. See TORQUE VALUES. Release taper pins (between bearing housing halves) by tapping until free. Allow pins to remain loosely in place.
19. Install end cover, O-ring and capscrews.

DRIVE END:

20. Install mechanical seal in same manner as thrust end.
21. Slide inboard deflector disc as far as possible onto shaft.
22. Slide inboard end cover onto shaft, beyond bearing surface.
23. Slide oil rings onto shaft, rest on bearing surface.
24. Slide outboard end cover onto shaft, rest on bearing surface.
25. Lift lower bearing housing half into position, carefully guiding inboard cover to proper housing location.
26. Determine that cover groove is locked into position on housing.
27. Install taper pins through lower housing half, into pump bracket.
28. Install capscrews finger-tight, seat taper pins, then properly torque capscrews.
29. Wipe and generously lubricate shaft journal surface and the lower bearing shell half babbit surface. Slightly raise shaft and install bearing and oil rings.
30. Wipe and generously lubricate shaft journal surface and upper bearing shell half babbit surface. Install bearing.
31. Install bearing dowels and capscrews.
32. Measure distance between inboard cover and dowel pin hole of top cover. Center bearing so pin will enter top cover locating hole.
33. Lift cover and apply a thin coat of silicone sealer between bearing housing halves.
34. Install taper pins, then capscrews. Release taper pins (between bearing housing halves) by tapping until free. Allow pins to remain loosely in place.
35. Slide outboard and inboard deflector discs into .035 in. (.9 mm) clearance to housing and tighten setscrews. Check that deflector disc is square to shaft.
36. Tighten setscrews of seal drive collar, using existing dimples of shaft.
37. Remove seal setting spacers between seal drive collar and seal gland.

THRUST END:

38. Slide inboard deflector disc into .035 in. (.9 mm) clearance to housing and tighten setscrews. Check that deflector disc is square to shaft.
39. Tighten setscrews of seal drive collar, using existing dimples of shaft.
40. Remove seal setting spacers between seal drive collar and seal gland.

DRIVE END:

41. Use spanner wrench to check freedom of rotation of rotating element.
42. Install coupling shroud.
43. Install coupling key.
44. Install coupling hub.
45. Install coupling nut and tighten setscrew.
46. Check alignment of pump and driver. See INSTALLATION.
47. Install coupling spacer.
48. Check coupling lubrication.
49. Replace all auxiliary piping, probes, etc. See INSTALLATION and OPERATION.

ASSEMBLY, BALL THRUST AND BALL RADIAL BEARINGS & MECHANICAL SEALS

THRUST END:

1. Check seal setting spacer between seal drive collar and seal gland.
2. Install mechanical seals onto shaft and push into stuffingbox bores until gland is seated.
3. Install 4 nuts and washers onto seal gland studs until finger-tight.
4. Slide inboard deflector disc as far as possible onto shaft.
5. Install new end cover O-ring. Slide inboard end cover onto shaft, beyond bearing surface.
6. Slide on oil ring mounting sleeve.
7. Slide oil ring into mounting sleeve position.
8. Install ball bearing.

   Thrust bearings are mounted "DB" back-to-back. The bearings are mounted with stamped backs of outer rings together. The contact angle lines of bearings converge outwardly. Replacement DB pairs are ordinarily packaged together in same relationship as they are to be used.

9. Install bearing, lockwasher and locknut. Tighten nut snugly, back off 1/4 turn, bend lockwasher tab into slot of nut.
10. Slide bearing housing over bearing.
11. Engage oil ring with a wire hook and lift oil ring in order to complete housing assembly.
12. Push housing into final position.
13. Lower oil ring into oil ring sleeve position.
14. Install end cover capscrews.
15. Slide inboard deflector disc into .035 in. (.9 mm) clearance to housing and tighten setscrews. Check that deflector disc is square to shaft.

DRIVE END:

16. Install mechanical seal in same manner as thrust end.
17. Slide inboard deflector disc as far as possible onto shaft.
18. Install new end cover O-ring. Slide inboard end cover onto shaft, beyond bearing surface.
19. Slide on oil ring mounting sleeve.
20. Slide oil ring into mounting sleeve position.
21. Install ball bearing.
22. Install lockwasher and locknut. Tighten nut snugly, back off 1/4 turn, bend lockwasher tab into slot of nut.
23. Slide bearing housing over bearing.
24. Engage oil ring with a wire hook and lift oil ring in order to complete housing assembly.
25. Push housing into final position.
26. Lower oil ring into oil ring sleeve position.
27. Install end cover and capscrews.
28. Slide inboard and outboard deflector discs into .035 in. (.9 mm) clearance to housing and tighten setscrews. Check that deflector discs are square to shaft.
29. Remove seat setting spacers between seal drive collar and seal gland.
30. Use spanner wrench to check freedom of rotation of rotating element.
31. Install coupling shroud.
32. Install coupling key.
33. Install coupling hub.
34. Install coupling nut and tighten setscrew.
35. Check alignment of pump and driver. See INSTALLATION.
36. Install coupling spacer.
37. Check coupling lubrication.
38. Replace all auxiliary piping, probes, etc. See INSTALLATION and OPERATION.

TORQUE VALUES

Suggested torque values are recommended to attain proper gasket compression and achieve tight, evenly stressed joints with a minimum probability of nuts, bolts or studs breaking or loosening.

THREAD LUBE Lubricate all threads with graphite and oil, molybdenum disulphide, white lead, or another lubricant of comparable quality, except in instances where lubricants are incompatible with fastener application.

EVEN LOADING Tighten opposing fasteners in an alternating sequence to ensure even loading. Avoid possible case distortion by use of correct tightening sequence. Start at or near the center of the case, alternating from side to side while progressing to the case ends.

Run up all nuts finger-tight. Develop the required fastener stress in three steps, with a maximum 50 percent torque on the first pass.

VENDOR EQUIPMENT Refer to vendor instructions for proper torque values on vendor-supplied equipment.

APPLICATION	SIZE & TYPE	TORQUE
outer case cover	1 ¼ in. nut	1400 lbf•ft (1898 N•m)
	1 ½	2450 (3322)
	1 ⅝	3200 (4339)
	1 ¾	3700 (5017)
	2	4525 (6135)
	2 ¼	6525 (8847)
	2 ½	9000 (12,202)
	2 ¾	12,050 (16,338)
inner case halves	¾ nut	220 lbf•ft (289 N•m)
bearing housing	⅝ in. capscrew	75 lbf•ft (102 N•m)
	¾	135 (183)
	⅞	210 (285)
pump/driver hold-down	⅞ in. capscrew	210 lbf•ft (285 N•m)
	1	325 (441)
	1 ½	1150 (1559)
	1 ¾	1875 (2542)
seal gland (flange)	½ in. stud-hex nut	15 lbf•ft (20 N•m)
	⅝	30 (41)
	¾	50 (68)
	⅞	65 (88)

TROUBLESHOOTING

MALFUNCTION	PROBABLE CAUSE	REMEDY
Pump fails to start pumping.	A. Pump not properly primed.	Reprime pump, be sure that suction line shutoff valve is fully open.
	B. Suction line clogged.	Check suction line pressure. If low, locate and remove obstructions.
	C. Impeller clogged with foreign material.	Back-flush pump to clean impeller.
	D. Wrong direction of rotation.	Be sure pump and driver rotate in indicated direction. See "direction of rotation" arrows on pump and driver cases.
	E. Foot valve or suction pipe opening not submerged enough.	Lower foot valve in suction inlet, or lower suction pipe. Be sure foot valve does not leak.
	F. Suction lift too high.	Check with vacuum gauge. Suction pipe too long; shorten.

MALFUNCTION	PROBABLE CAUSE	REMEDY
Pump output not up to capacity or pressure.	A. Air leak in suction line or through stuffingbox.	Check for leakage and correct.
	B. Impeller partly clogged.	Back-flush pump to clean impeller.
	C. Worn case rings or impeller rings	Replace defective parts as required.
	D. Insufficient positive head in suction line	Ensure that suction line shutoff valve is fully open and line is unobstructed.
	E. Defective or broken impeller.	Inspect and replace if necessary.
Pump starts, then stops pumping	A. Improperly primed pump.	Reprime pump.
	B. Air or vapor pockets in suction line.	Rearrange piping as necessary, to eliminate air pockets.
Bearings run hot.	A. Insufficient lubrication or lube cooling.	Check lubricant and cooling system.
Undue vibration of pump.	A. Improper shaft alignment.	Align shafts.
	B. Partly clogged impeller causing imbalance.	Back-flush pump to clean impeller.
	C. Broken or bent impeller or shaft.	Replace defective parts as required.
	D. Foundation not rigid enough.	Tap ⅜" holes in baseplate. Weld a ¼" half pipe column coupling to each hole and insert epoxy grout under pressure through the column coupling to dampen the foundation.
	E. Worn bearings.	Replace.
	F. Suction or discharge piping not anchored or properly supported	Anchor them per Hydraulic Institute Institute Standard Manual recommendations.
	G. If pump is noisy, it is vaporbound.	Vent and bleed case. Reprime pump.
Excessive leakage from stuffingbox	A. Packing gland improperly adjusted.	Tighten gland nuts.
	B. Defective mechanical seal parts.	Replace defective parts.
	C. Overheating mechanical seal.	Check lubrication and cooling lines.
Motor runs hot.	A. Suction head lower than rating pumping too much liquid.	Contact nearest Bingham-Willamette sales office for rating review.
	B. Motor rated at lower viscosity/ specific gravity than that of pumpage.	Contact nearest Bingham-Willamette sales office for rating review.
	C. Stuffingbox packing too tight.	Adjust per installation instructions. Replace if worn.

REPLACEMENT PARTS

SPARE PARTS

Spare parts should be kept on hand to reduce downtime. Service of a particular pump determines number of spare parts. It is recommended that following parts be stocked:

Pump Shaft
Impellers and Lockwashers
Shaft Sleeves
Throttle Bushing ,
Set Wear Rings with Setscrews
Set Dowel Pins
Set Gaskets and O-Rings
Set Bearings and Lockwashers
Set Inner Case Shims
Mechanical Seals
or
Sets of Packing Rings

For pumps used in critical service, it is recommended that a complete rotating element, preassembled as far as practical, be stocked at job site.

PARTS ORDERS

Order parts through a local Bingham-Willamette field office. Provide:

(1) Pump serial number
(2) Cross section drawing number
(3) Description of part
(4) The number of part, as shown on cross section drawing and parts list.

BINGHAM-WILLAMETTE COMPANY
A Division of GUY F. ATKINSON Company
PORTLAND, OREGON • SHREVEPORT, LOUISIANA

BINGHAM-WILLAMETTE LTD.
A GUY F. ATKINSON Company
VANCOUVER, B.C. • CAMBRIDGE, ONTARIO
CANADA

PUMP STORAGE

RECOMMENDED STORAGE PROCEDURE FOR HORIZONTAL PUMPS

LONG TERM STORAGE

Check upon arrival. This pump was thoroughly inspected at the factory prior to shipment, to assure its conformity with all specifications. Upon receipt of the unit, check for any damage incurred during shipment. Any such damage should be reported to the carrier immediately.

LONG TERM STORAGE...
If a new pump is to be stored for a period of time prior to installation, a number of precautions must be observed to prevent damage. The pump and its components, as packaged at the factory, are adequately protected for inside storage prior to installation, with the following stipulations;

1) If the unit is stored in an unheated warehouse, there must be protection from the weather. Water must be prevented from accumulating in the pump casing. NOTE that the plywood covers installed over the suction and discharge nozzles at the factory are not watertight and will leak if exposed to prolong moisture. If water accumulates in the pump casing, then is allowed to freeze, the pump will be seriously damaged. To prevent condensation of atmosphere moisture in the pump, packages of silica gel desiccant should be placed in the suction and discharge openings before they are sealed. Attach a caution notice to the pump indicating that the silica gel must be removed when the pump is installed.
2) Precautions must also be taken to prevent mice or other small animals from nesting in the pump casing while it is in storage. All openings in the casing must be tightly covered, as the debris such animals would leave in the pump could cause serious damage if undetected.
3) The pump should be located so as to permit air to circulate freely around it, and should be protected from the possibility of damage by warehouse traffic. A visual inspection of the exterior of the unit should be conducted every thirty days.
4) All bearing surfaces are coated with a protective layer of Lubriplate No. 4 prior to shipping. When the pump is placed in storage and at least once every six months thereafter, the bearings must be recoated as follows:
   a) Remove the filler plug on the top of the bearing housing, and fill the housing to the overflow pipe with Lubriplate No. 4 (or equal).
   b) Rotate the pump shaft by hand, at least ten revolutions in the proper direction of rotation as indicated on the tag. Position the shaft at least 90° from its original position.
   c) Remove the bearing housing drain plugs and drain the housings. Replace the plugs, and clean up any spilled preservative.
5) An inspection record should be maintained on the equipment. This record should contain the following information
   a) Date of inspection.
   b) Signature of person performing the inspection and/or maintenance.
   c) Result of all visual inspections.
   d) Date of any maintenance performed.
   e) Description of any maintenance performed.
6) If the equipment is stored longer than 6 months, it will be necessary to disassemble the bearing housings and inspect the bearings prior to startup.
7) It is recommended that a Field Service Representative be requested to commission pumps which have been in extended storage.

Parts List

FORM NO 429

PUMP: HIGH PRESSURE MULTI-STAGE PUMP HORIZONTAL DOUBLE CASE

PUMP SERIAL NO.

TYPE: CP

SHEET NO. 1 of 2

DRAWING NO. B-38000

PART NO.	DESCRIPTION
101	INNER CASE
105	BUSHING (INNER CASE TO COVER)
107	GASKET
108	PIN - (INNER CASE LOCATING)
109	GASKET (INNER CASE TO OUTER CASE)
111	SHIM (INNER CASE ADJUSTING)
112	CASE - OUTER
113	COVER (SUCTION END)
116	COVER (DISCH. END)
117	"O" RINGS
122	GASKET (SUCTION END)
123	GASKET (DISCH. END)
201	THROTTLE BUSHING (DISCH END)
202	"O" RING
204	RING. CASE STG. 1 (EYE SIDE)
205	RING. CASE STG. 2-4
206	STAGE PIECE (SERIES)
207	STAGE PIECE (CENTER)
208	"O" RING
215	RING, IMP. (STG #1 IMP. EYE)

FOR BINGHAM OFFICE USE ONLY

PART NO.	DESCRIPTION
216	RING, IMP. (STG. 2-14 IMP. EYE)
217	RING, IMP. (SERIES IMP. EYE)
225	IMPELLER - STG. 1
226	IMPELLER - STG. 2
227	IMPELLER - STG. 3
228	IMPELLER - STG. 4
229	IMPELLER - STG. 5
230	IMPELLER - STG. 6
231	IMPELLER - STG. 7
232	IMPELLER - STG. 8
233	IMPELLER - STG. 9
234	IMPELLER - STG.10
235	IMPELLER - STG.11
236	IMPELLER - STG.12
237	IMPELLER - STG.13
238	IMPELLER - STG.14
240	SLEEVE - THROTTLE
241	SHAFT SLEEVE (CENTER)
242	SHAFT
244	KEYS (IMPELLER)
245	KEYS (THR. SLEEVE)
247	[illegible]

FOR BINGHAM OFFICE USE ONLY

Bingham [illegible] CANADA

Parts List

FORM NO 429

PUMP: HIGH PRESSURE MULTI-STAGE PUMP HORIZONTAL DOUBLE CASE		PUMP SERIAL NO.
TYPE: CP	SHEET NO. 2 of 2	DRAWING NO. B-38000

PART NO.	DESCRIPTION	PART NO.	DESCRIPTION
248	THRUST RINGS		
401	SHAFT SLEEVE (SUCT.END)		
403	SHAFT SLEEVE (DISCH.END)		
405	LOCKNUT, SLEEVE (SUCTION END)		
407	LOCKNUT, SLEEVE (DISCH. END)		
409	INJECTION BUSHING (R.H.)		
410	INJECTION BUSHING (L.H.)		
413	GLAND COVERS		
415	"C" RING (SHAFT SLEEVES)		
417	"C" RINGS (THROTTLE BUSH. TO CASE)		
419	"O" RING (THROTTLE BUSH. TO GLAND)		
427	RETAINING RINGS		
429	KEY (SHAFT SLEEVE)		

FOR BINGHAM OFFICE USE ONLY

FOR BINGHAM OFFICE USE ONLY

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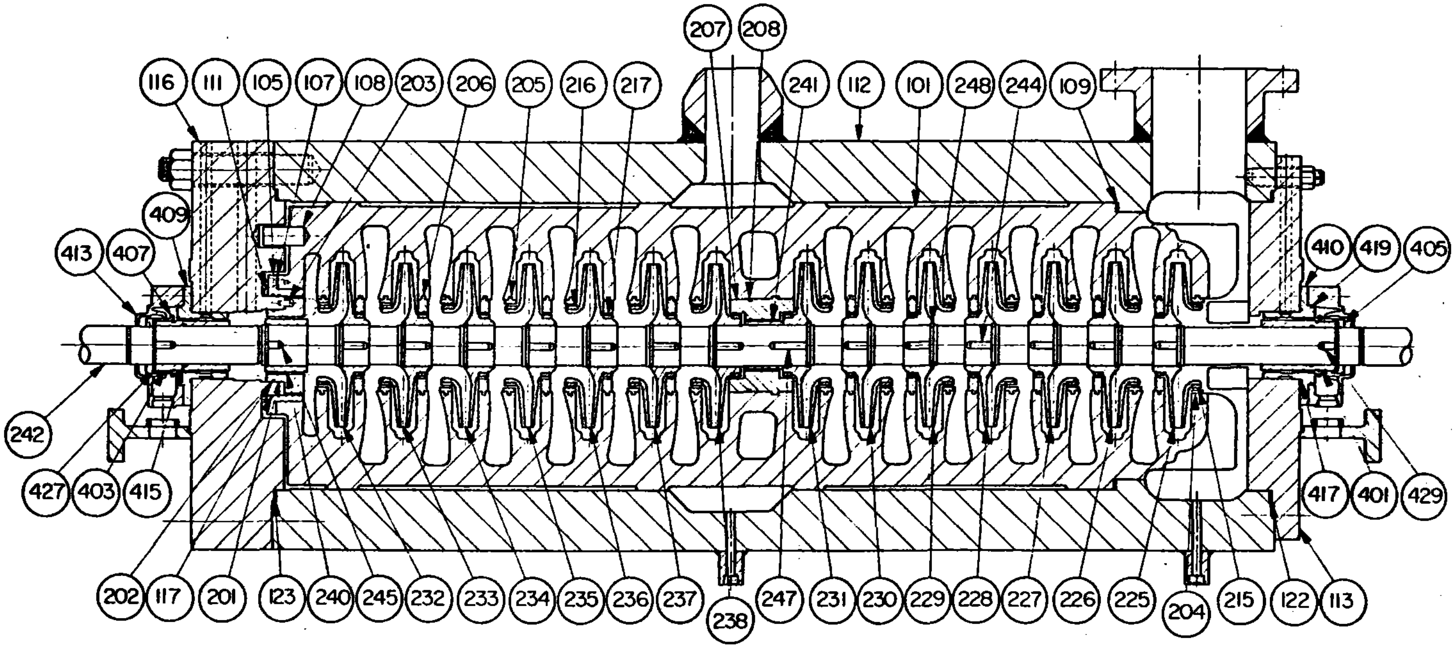


Bingham-Willamette Company	PORTLAND, OR. SHREVEPORT, LA.	HIGH PRESSURE MULTI-STAGE PUMP HORIZONTAL DOUBLE CASE BINGHAM TYPE "CP"	B-38000
Bingham-Willamette Ltd.	VANCOUVER, B.C. CAMBRIDGE, ONT		

Parts List

FORM NO 429

PUMP: BRG. ASS'Y JOURNAL W/KINGSBURY THRUST BRG. (JHJ-5 AND LARGER)

PUMP SERIAL NO.

TYPE:

SHEET NO. 1 of 2

DRAWING NO. B-37131

PART NO.	DESCRIPTION
301	BEARING HOUSING ASSEMBLY DRIVE END (INC. 301-1 THRU 301-3)
303-1	BEARING HOUSING TOP HALF, BOTTOM HALF
301-2	CAPSCREW-TOP TO BOTTOM HALF
301-3	PIN, TAPER-TOP TO BOTTOM HALF
302	BEARING HOUSING ASSEMBLY THRUST END (INC. 302-1 THRU 302-3)
302-1	BEARING HOUSING TOP HALF, BOTTOM HALF
302-2	CAPSCREW-TOP TO BOTTOM HALF
302-3	PIN, TAPER-TOP TO BOTTOM HALF
303	JOURNAL BEARING ASSEMBLY (EA. INCL. 303-1 THRU 303-4)
303-A	JOURNAL BEARING ASSEMBLY -DRIVE END
303-B	JOURNAL BEARING ASSEMBLY -THRUST END
303-1	BEARING SHELL
303-2	5 lb. BABBIT
303-3	DOWEL
303-4	SCREW
304	CLOSURE/ACCESSORY ASS'Y KIT (INC. 305 THRU 329)

FOR BINGHAM OFFICE USE ONLY

PART NO.	DESCRIPTION
305	CAPSCREW - BEARING HOUSING TO PUMP
305-A	CAPSCREW - DRIVE END
305-B	CAPSCREW - THRUST END
306	PIN, TAPER - BRG. HSG. TO PUMP
306-A	PIN, TAPER -DRIVE END
306-B	PIN, TAPER - THRUST END
307	PLUG, PIPE - OIL DRAIN, LUBE CONN. & THERMOWELL (UNUSED)
307-A	PLUG, PIPE - DRIVE END
307-B	PLUG, PIPE - THRUST END
308	PLUG, PIPE - LUBE RAIL CLOSURE
309	CAPSCREW - BRG. COVER TO BRG. HOUSING
310	COVER, BEARING
311	DOWEL - LOCKING
311-A	DOWEL - END COVER - DRIVE END
311-B	DOWEL - END COVER - THRUST END
311-C	DOWEL - SEAL RING - THRUST END
312	"O" RING - BEARING COVER SEALING 6230-26
313	RING, SEAL
314	PLATE, ADJUSTING

FOR BINGHAM OFFICE USE ONLY

Unnumbered [illegible]

Parts List

FORM NO. 429

PUMP:	BRG. ASS'Y JOURNAL W/KINGSBURY THRUST BRG. (JHJ-5 AND LARGER)
PUMP SERIAL NO.	
TYPE:	
SHEET NO.	2 of 2
DRAWING NO.	B-37131

PART NO.	DESCRIPTION	FOR BINGHAM OFFICE USE ONLY.
315	SCREW, MACHINE - ADJ. PLATE	
316	SETSCREW	
316-A	SETSCREW - LOCKNUT	
* 316-B	SETSCREW - KINGSBURY BRG. OILERS (SEE ITEM 329)	
317	KEY - THRUST BRG.	
318	RING, SHAFT ADJUSTING	
319	END COVER - W/"O" RING	
319-A	END COVER - DRIVE END	
319-B	END COVER - THRUST END	
320	SETSCREW - DEFLECTOR DISC	
320-A	SETSCREW - DRIVE END	
320-B	SETSCREW - THRUST END	
321	BUSHING, PIPE - FILTER TO BRG. HSG.	
322	FILTER, AIR BREATHER	
322-A	FILTER, AIR BREATHER-DRIVE END	
322-B	FILTER, AIR BREATHER-THRUST END	
323	WASHER, LOCK-EYE BOLT LOCKING	
323-A	WASHER, LOCK-DRIVER END	
323-B	WASHER, LOCK-THRUST END	
324-A	BOLT, EYE-DRIVE END	
324-B	BOLT, EYE-THRUST END	

PART NO.	DESCRIPTION	FOR BINGHAM OFFICE USE ONLY.
325	PLUG, PIPE	
326	PLUG, INSP. W/"O" RING	
326-A	PLUG, INSP.-DRIVE END	
326-B	PLUG, INSP.-THRUST END	
327	GUARD, OIL DRIP	
328	CAPSCREW-OIL DRIP GUARD	
330	KINGSBURY JHJ-5 THRUST BRG.	
331	LOCKNUT-KINGSBURY BRG.	
332	RING, OIL-JOURNAL BRG.	
332-A	RING, OIL-DRIVE END	
332-B	RING, OIL-THRUST END	
333-A	DEFLECTOR DISC. (DRIVE END)	
333-B	DEFLECTOR DISC. (THRUST END)	

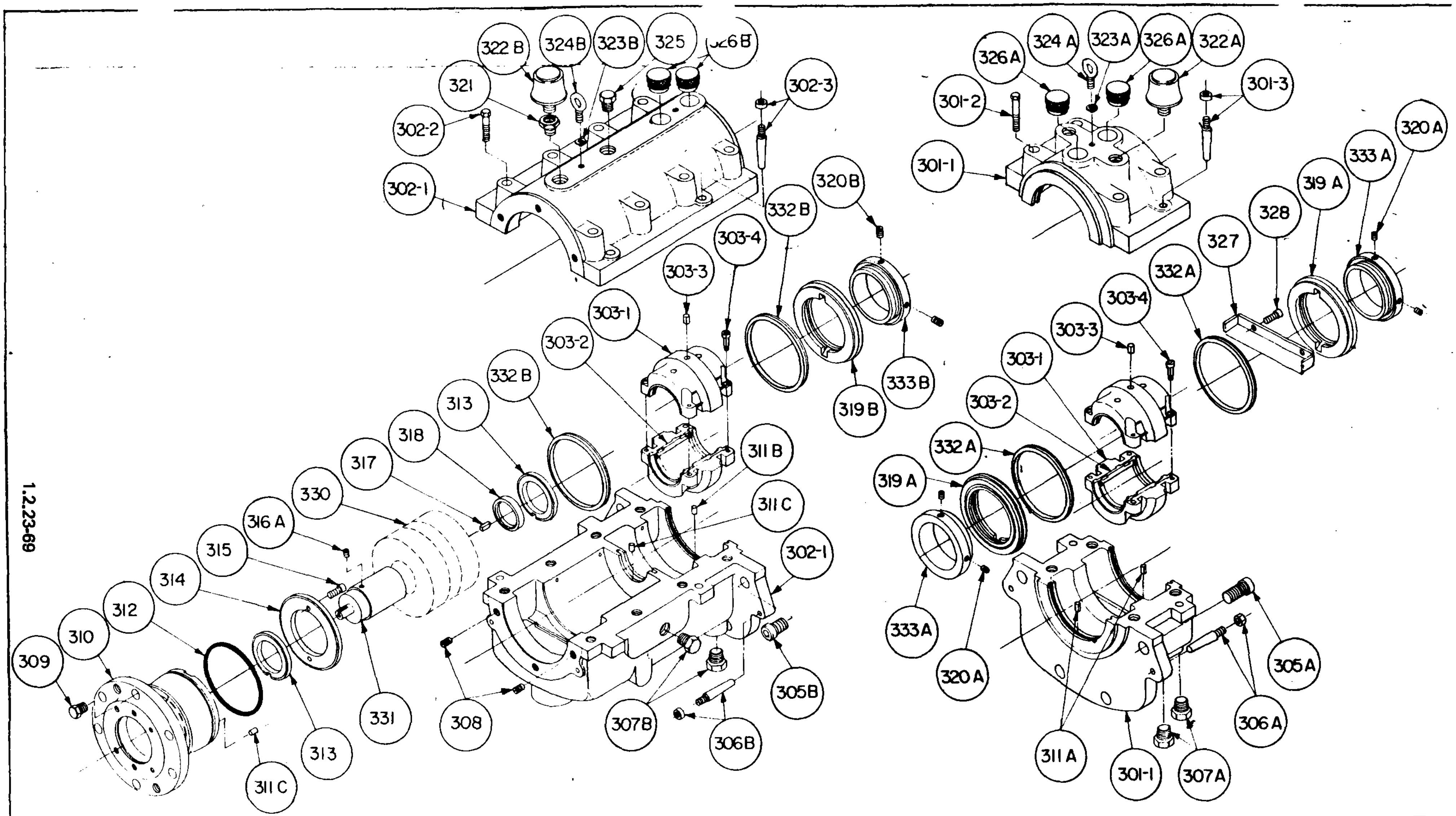
* NOT ILLUSTRATED

Unnumbered parts in the illustrations are the same as corresponding parts with numbers

Bingham Factories: PORTLAND OREGON • SHR[illegible]UISIANA • VANCOUVER, B. C. CANADA

1.2.23-68

1.2.23-69



Bingham-Willamette Company PORTLAND, OR. SHREVEPORT, LA

Bingham-Willamette Ltd. VANCOUVER, B.C.

SLEEVE : JOURNAL W/ KINGSBURY THRUST BEARING (JHJ-5 AND LARGER)

B-37131

FORM NO 429

Parts List

PUMP: JHJ-5 LUBE PUMP OPTIONS	PUMP SERIAL NO.
TYPE:	SHEET NO. 1 of 1
DRAWING NO. A-52516	

PART NO.	DESCRIPTION	
	OPTIONS (SELECT AS REQ'D ITEMS 334 thru 347)	
	WITHOUT LUBE PUMP	
334	CAPSCREW-COVER PLATE TO BEARING HOUSING	4
335	COVER PLATE	1
336	GASKET	1
	WITH IMO LUBE PUMP B3EBA-87	
334	CAPSCREW-IMP TO BRG. HSG.	2
337	PUMP, DELAVAL IMO. B3EBA-87	1
338	COUPLING-IMO TO LOCKNUT	1
339	SETSCREW-COUPLING	2
340	KEY-LOCKNUT TO COUPLING	1
	WITH IMO LUBE PUMP A21N100	
334	CAPSCREW-IMO TO BRG. HSG.	4
338	COUPLING-IMO TO LOCKUNT	1
339	SETSCREW-COUPLING	2
340	KEY-LOCKUT TO COUPLING	1
341	PUMP, DELAVAL IMO A21N100	1
342	RING, SNAP	1
	WITH IMO LUBE PUMP A31N100, A31N112, A31N131	
339	SETSCREW-COUPLING	2
340	KEY-LOCKUNT TO COUPLING	1
*343	PUMP, DELAVAL IMO A31N100	1

FOR BINGHAM OFFICE USE ONLY.

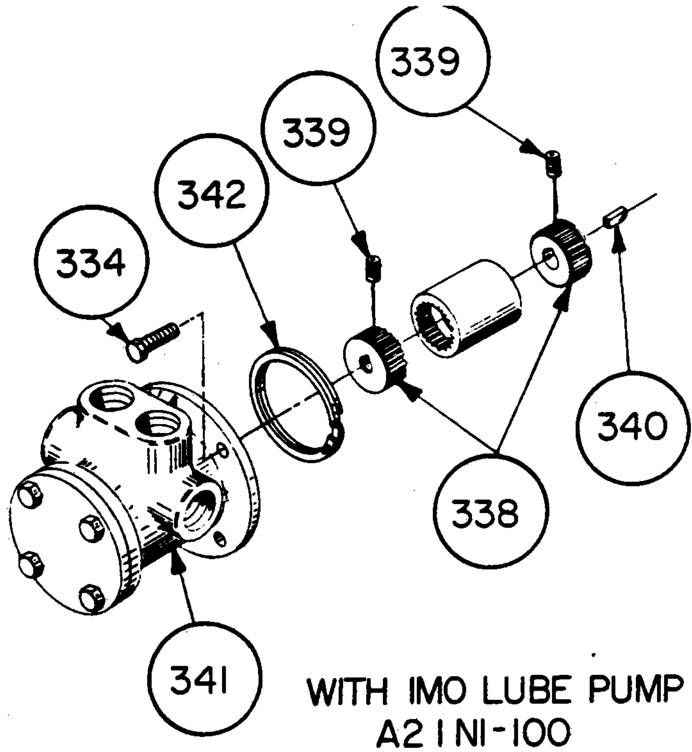
PART NO.	DESCRIPTION	
344	CAPSCREW-IMO TO ADAPTOR	8
345	ADAPTOR	
346	CAPSCREW-ADAPTOR TO BRG.	6
347	COUPLING-IMO TO LOCKNUT	1

* A31N100, A31N112 & A31N131 ARE DIMENSIONALLY INTERCHANGEABLE. MAKE SELECTION BASED UPON FLOW REQUIREMENTS.

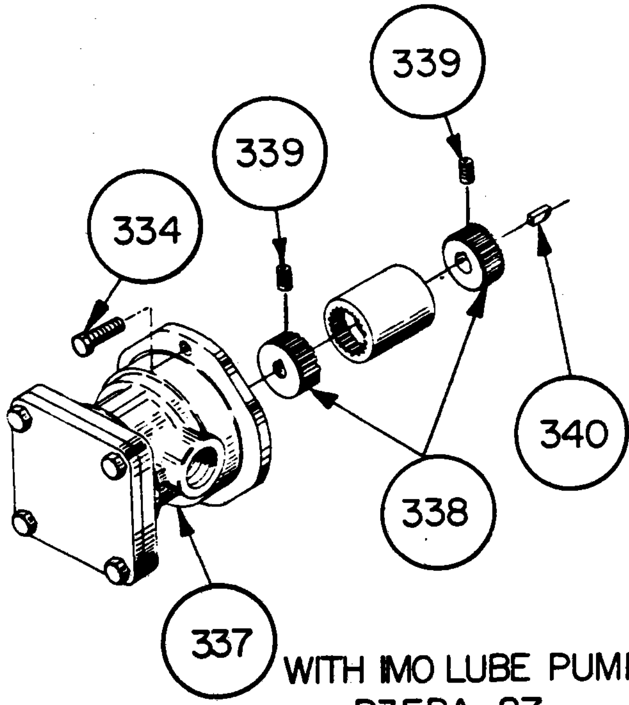
FOR BINGHAM OFFICE USE ONLY.

Unnumbered [illegible]

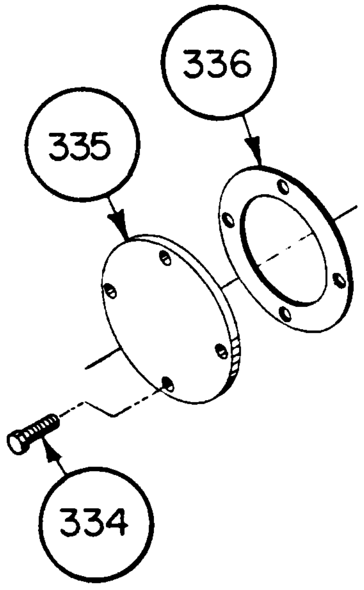
Bingham



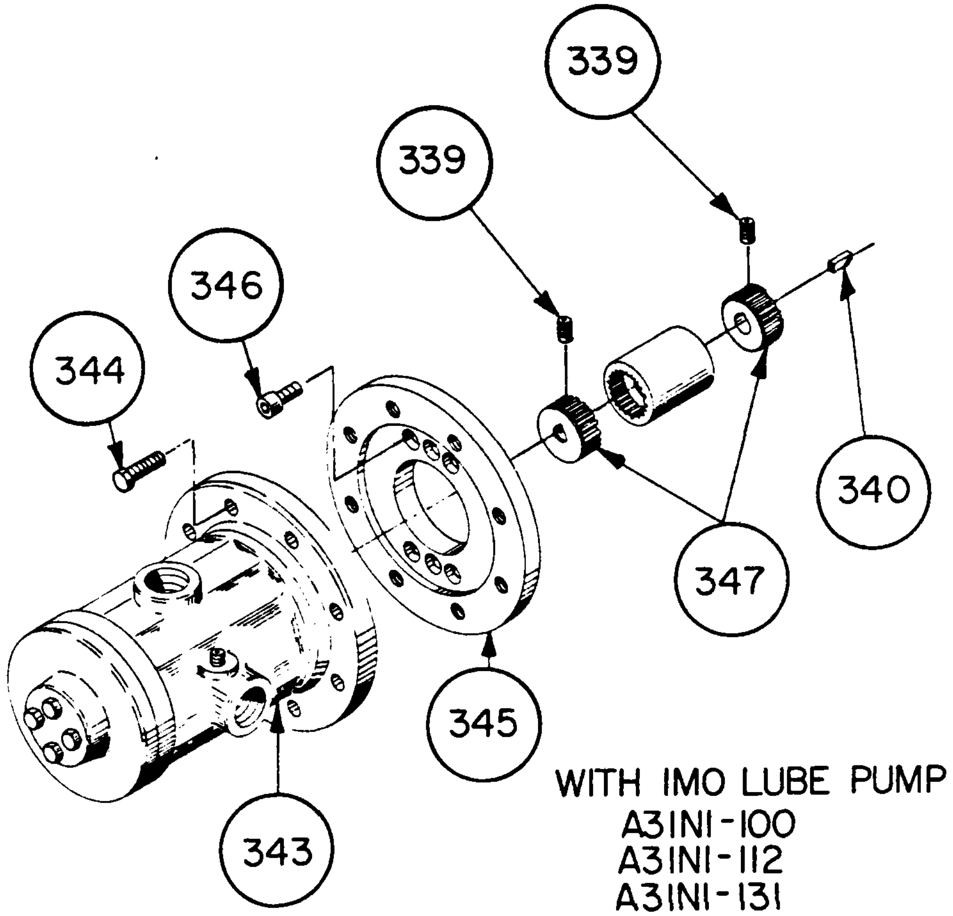
WITH IMO LUBE PUMP
A2 I NI-100



WITH IMO LUBE PUMP
B3EBA-87



WITHOUT IMO
LUBE PUMP



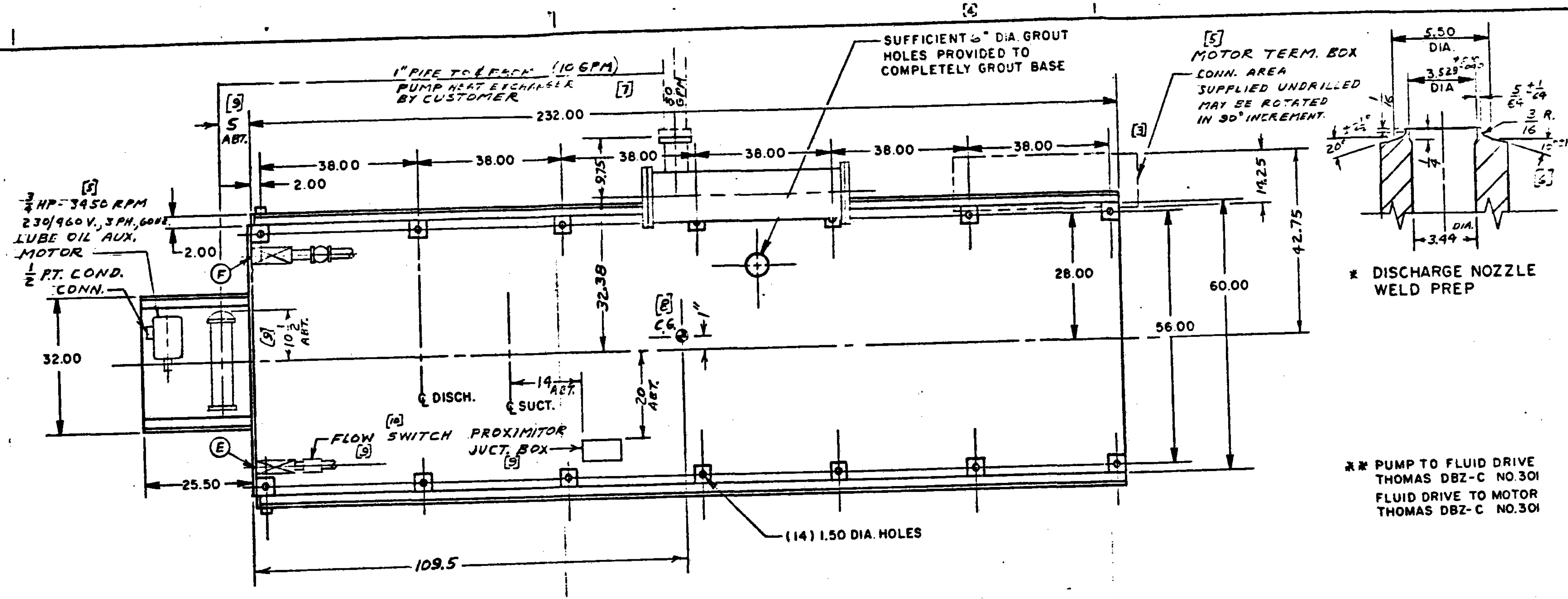
WITH IMO LUBE PUMP
A3INI-100
A3INI-112
A3INI-131

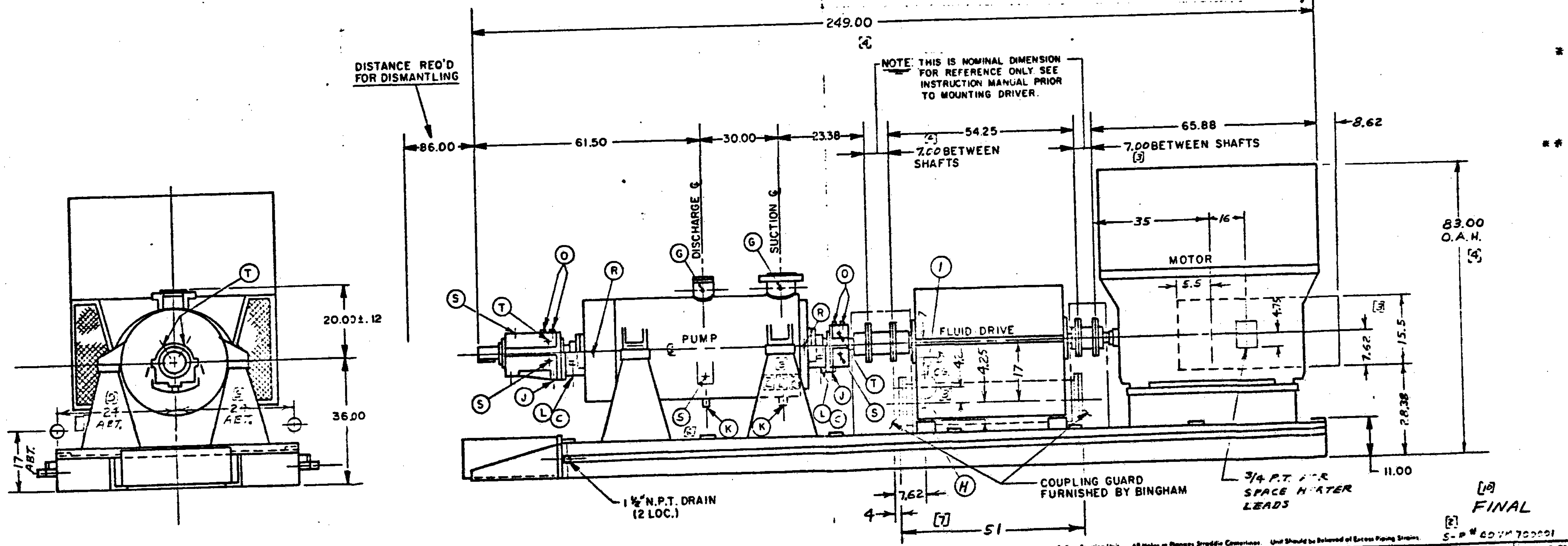
gham-Willamette Company
PORTLAND, OR.
SHREVEPORT, LA.

Bingham-Willamette Ltd.
VANCOUVER, B.C.

A-52516

ITEM	LEGEND ▲ PIPE PLUG ■ PROTECTIVE CAP ● PIPED BY BINGHAM		PIPE TAP SIZE	
A	~~BEARING HOUSING COOLING INLET~~			
B	~~BEARING HOUSING COOL. OUTLET~~			
[2] C	STUFFING BOX COOLING OUTLET	●	1"	
D	~~STUFFING BOX COOLING OUTLET~~			
[2] E	SEALING LIQUID INLET	▲	1"	(6-22 GPM@ 80 PSI MIN)
[2] F	SEALING LIQUID OUTLET	▲	2"	
	GAGE CONN. (2) SOCK. WLD.		3/4"	
	~~PEDESTAL~~ COOLING INLET H.E			3"-125# F.F.
I	~~PEDESTAL~~ COOLING OUTLET H.E.			3"-125# F.F.
J	OIL DRAIN	▲	1/2"	— DOUBLE VALVE
K	PUMP DRAIN SOCK. WLD.		1"	
L	BEARING BRACKET DRAIN	▲	1"	
M	~~FLUSHING LIQUID~~			
N	~~CONSTANT LEVEL OILER~~			
[4] O	OIL INSPECTION HOLE COVER	▲	20	
P	~~PUMP VENT~~			
Q	~~CUSHION LIQUID OUT~~			
R	STUFF. BOX INJECTION	●	1/2"	
S	T'CPLE L&N TYPE T		?	COND. CONN.
T	VIB. PROBE - BENTLY NEVADA		3/4	COND. CONN.





[10] FINAL

[2] S-P # 40 VM 700091

CAUTION: Carefully Check Alignment Before Starting Unit. All Holes in Flanges Straddle Centerlines. Unit Should be Relieved of Excess Piping Strains.

UNIT DATA
PUMP SPECIFICATIONS
SIZE and TYPE: 4 x 6 x 9E CP
NO. STAGES: 14 RPM- 3450
ROTATION: CCW
* DISCHARGE FLG. 4" WELD PREP
SUCTION FLANGE 6"-300 # ANSI R.F.
MECH. SEAL: B.W.C. INJECT SYSTEM
TYPE: TEMPERATURE CONTROL
PACKING: ——
NO. RINGS: —— SIZE ——
ASSEMBLY: ——
COUPLING
** TYPE: THOMAS SIZE:
GUARD: BY B.W.C.

DRIVER SPECIFICATIONS
MOTOR ~~[illegible]~~ - RELIANCE
FURNISHED BY: BINGHAM
FRAME: E-5810 [illegible]
HP: 800 SPEED 3600 RPM
4160 VOLT, 3 PHASE, 60 CYCLE
DIMEN. PRINT: E08991- [illegible]
FLUID DRIVE: AMERICAN STD.
TYPE: VS CLASS [illegible]
FURNISHED BY: BINGHAM
DIMEN. PRINT: [illegible]

WEIGHTS
PUMP: 9225 LBS.
BASE: 4700 #
DRIVER: [illegible]
TOTAL: 24,500 #

CUSTOMER DATA
USER: SOUTHERN CALIFORNIA EDISON
FOR INSTALLATION AT: DAGGET, CALIFORNIA
PURCHASER: STEARNS & ROGER ENGINEERING CORP
PURCHASE ORDER NO.: 2000 C2170C
ITEM NO.: P-517
SERVICE: RECIEVER FEED PUMP
PUMP SIZE: and TYPE: 4x6x9E CP

WAS METER' & FINAL ADDED [10] 1-29-81 APP. 1-29-81	DATA ADDED [9] 11-5-80	C.G. ADDED [8] 9/5	ADDED FLUID DRIVE HEAT EXCH. [7] 8-29-80 APPR. 8-30-80	REVISED WELL-PREP 6/10	DATA ADDED 5-6-80 [5]	GEN. REV. [4] BY WM DATE 4-7-80	CONDUIT BOX DIMS. ADDED & WAS 6 1/8, WEIGHTS ADDED [3] DATE 3-7-80	SEALING LIQUID INLET & OUTLET ADDED [2]	GEN. REV. [1] BY H.K. DATE 2-19-80

CERTIFIED FOR INSTALLATION — LDG 2-180

Bingham-Willamette Company PORTLAND OR SHREVEPORT, LA

Bingham-Willamette Ltd. VANCOUVER B.C.

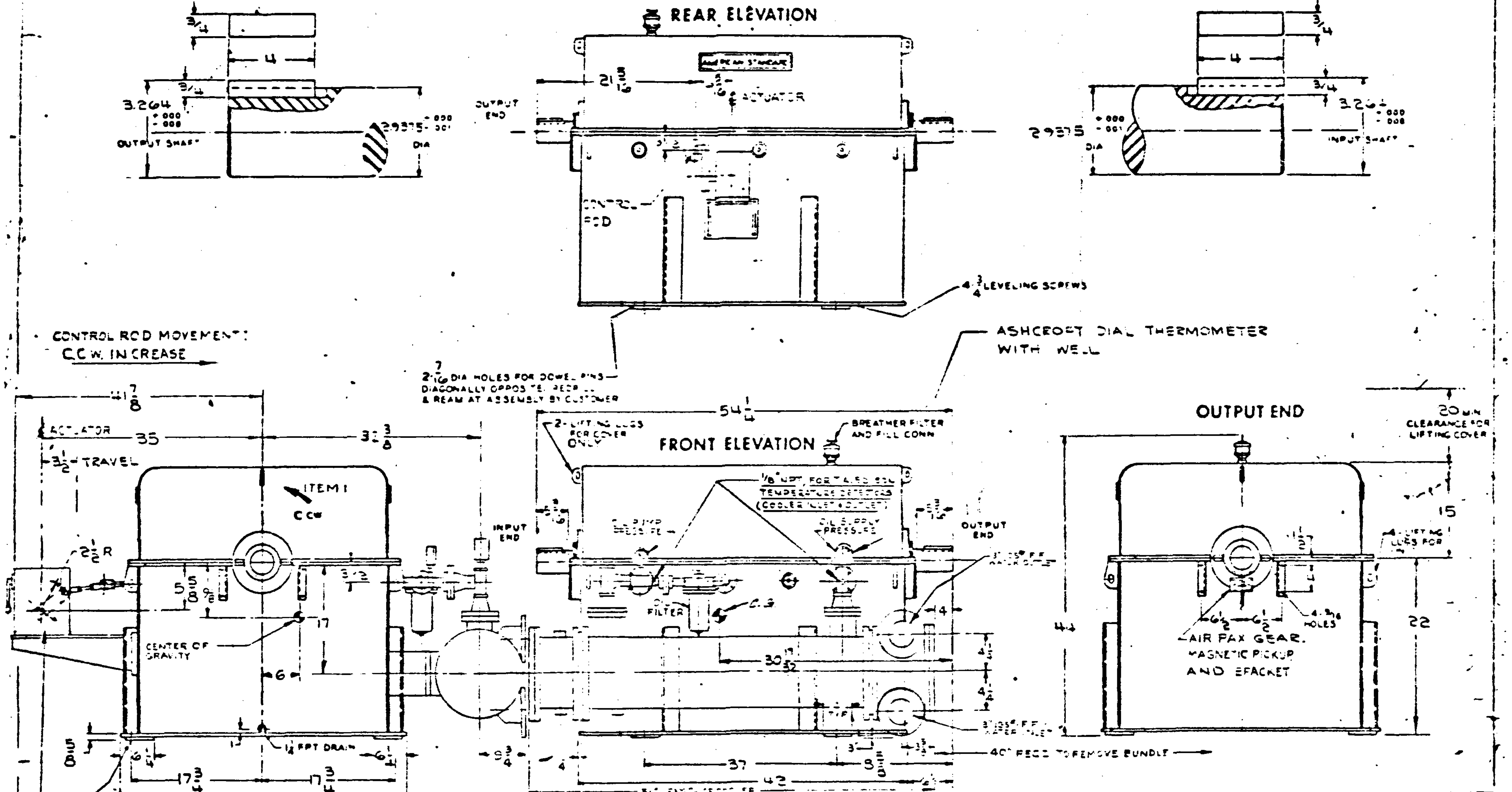
E-1A995-1 E X REV. 10

1.2.23-72

NOTES

1 FLUIDRIVE MAXIMUM RATING SEE ORDER BILL OF MATERIAL 78-AD-6271
2 TOTAL WEIGHT OF THE FLUID DRIVE IS 2700 POUNDS
WEIGHT EQUALLY DISTRIBUTED ON THE FOUR BASE PADS

3 FOR EQUIPMENT FURNISHED SEE ORDER BILL OF MATERIAL 78 AD-6271
4 FOR ADDITIONAL INSTALLATION NOTES SEE DRAWING 78 AD 6270



REV			DESCRIPTION	DATE	CHK	APPD
A			COOLER ADDED			
B			COOLER REVISED CENTER OF GRAVITY AND			
C			TEMP DETECTOR LOCATIONS ADDED			
D			CENTER GRAVITY ADDED FRONT ELEV.			

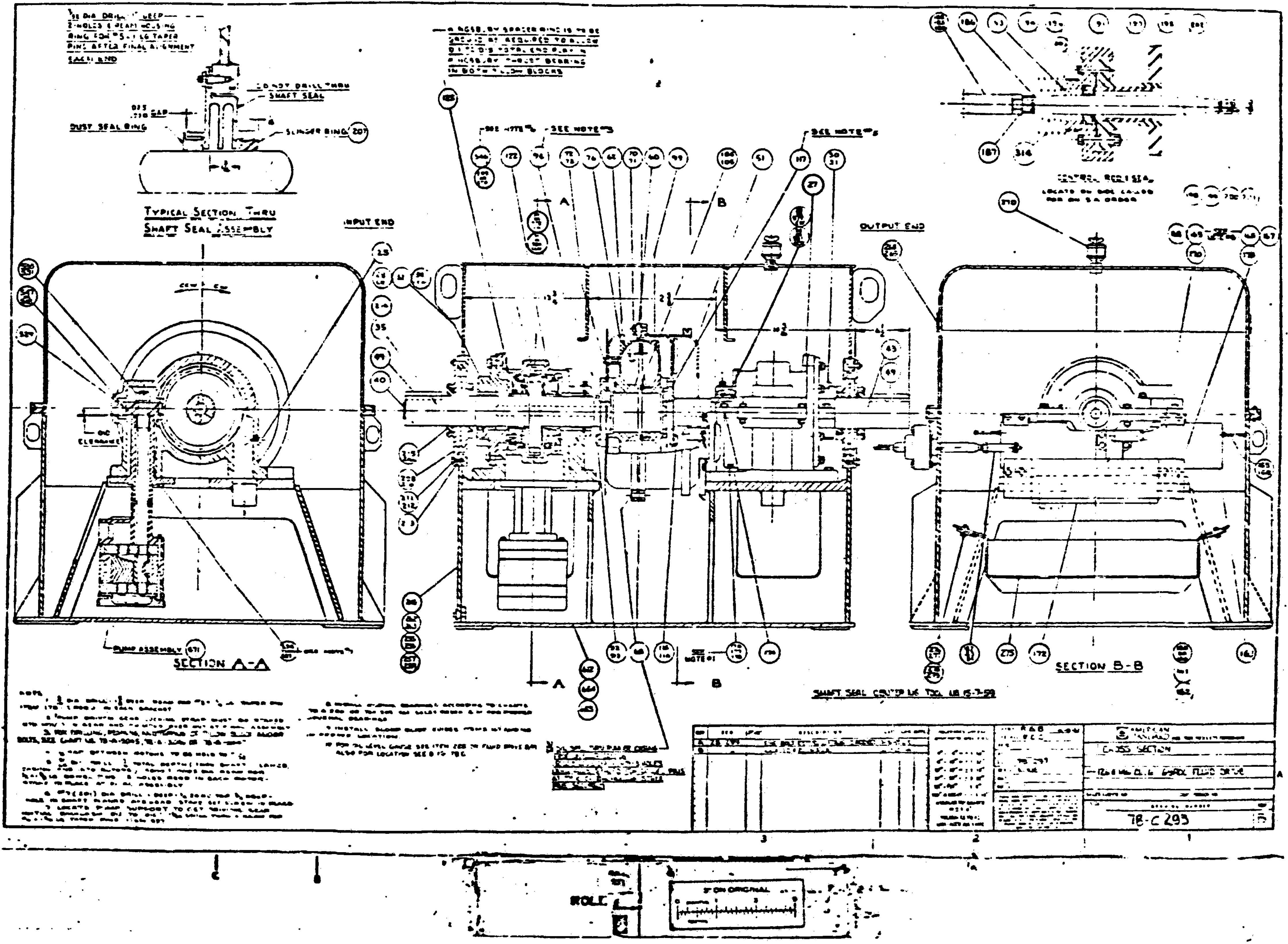
TOLERANCE UNLESS OTHERWISE SPECIFIED NON-ACCUMULATIVE
FRACTION ± 1/16
DECIMAL ±
ANGULAR ±

DRAWN DATE
CHECKED
APPD
APPD
ECN
SCALE NONE
DATE
MAT'L SPEC

AMERICAN STANDARD

TITLE OUTLINE DIMENSIONS-FH COOLER CONN'S
SIZE 146 CLASS 6 GYROL FLUID DRIVE
FOR BINGHAM WILLAMETTE CO.
AT PORTLAND, OREGON
SALES ORDER NO. 2-83303

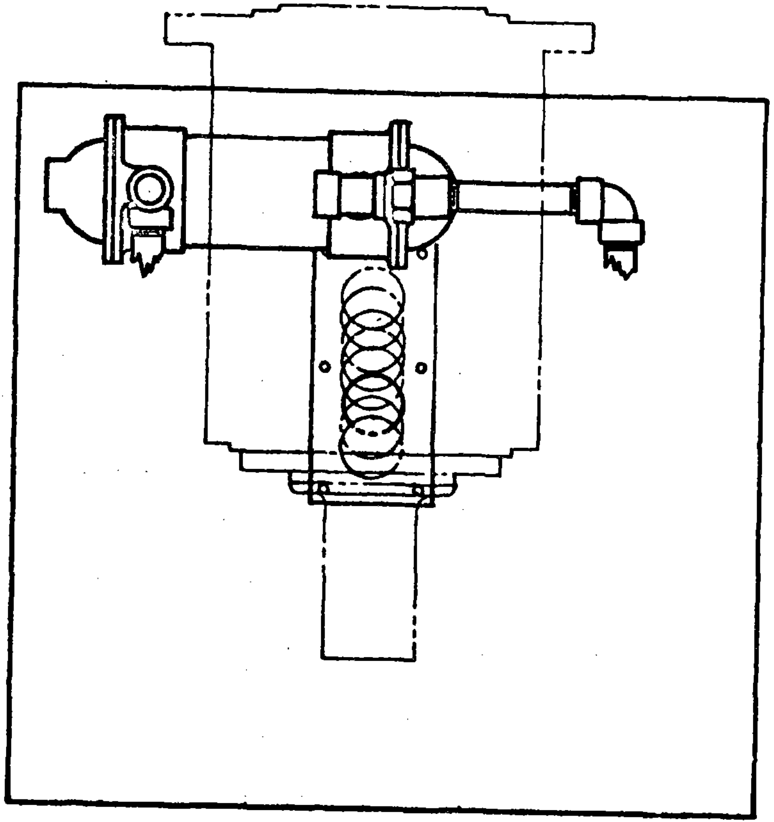
SIZE C
78-AD-6266 D

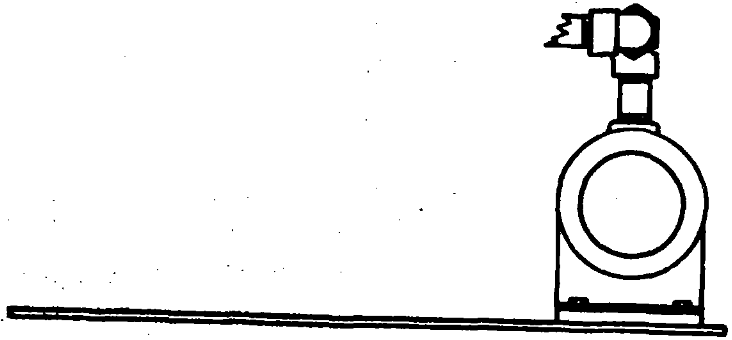

DO NOT DRILL THRU
SHAFT SEAL
DUST SEAL RING
GAP
SLINGER RING 207
EACH END
TYPICAL SECTION THRU SHAFT SEAL ASSEMBLY
INPUT END
OUTPUT END
SEE NOTE
CCW CW
A
B
PUMP ASSEMBLY
SECTION A-A
SECTION B-B
SHAFT SEAL CENTERING TOOL
CROSS SECTION
FLUID DRIVE
78-C 293
3
2
1
ROLL
3" ON ORIGINAL

1.2.23-75

B-3727

REV.	REVISION DESCRIPTION	INIT.	APPD.	D
[A]				
[B]				





UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
GENERAL TOLERANCES:

MACHINING:	FABRICATION:
ANG. ±0°20'	ANG. ±1°0'
LIN. ±.02	LIN. ±.12

Bingham-Willamette Company	PORTLAND, OR. SHREVEPORT, LA.	CUST. NO.	
Bingham-Willamette Ltd.	VANCOUVER, B.C.	REF. D-20443,4,&5	

FORM NO. 867-1

BASIC OIL COOLER PIPING LAYOUT

DR. AR	APPD. DH	DATE: 1-28-80	SCALE: 1"=4"	B-37279

1.23-76

REV.	REVISION DESCRIPTION	INIT.	APPD.	DATE
[A]	NOTES ADDED	XOL	[illegible]	5/6/80
[B]				

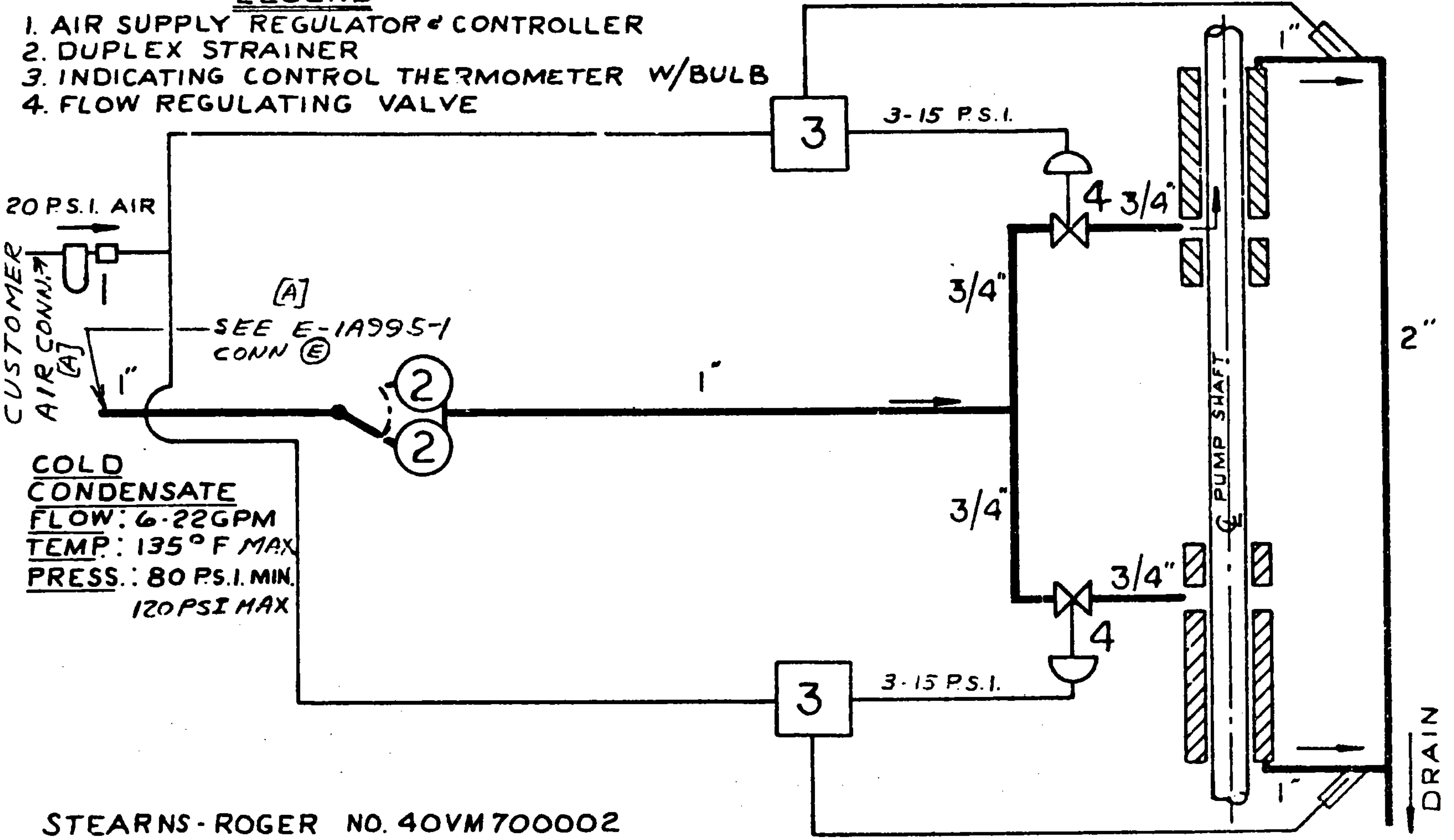
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
GENERAL TOLERANCES:

MACHINING:	FABRICATION:
ANG ±0°30'	ANG ±1°0'
LIN ±.02	LIN ±.12

A-54924

LEGEND

1. AIR SUPPLY REGULATOR & CONTROLLER
2. DUPLEX STRAINER
3. INDICATING CONTROL THERMOMETER W/BULB
4. FLOW REGULATING VALVE



COLD CONDENSATE
FLOW: 6-22GPM
TEMP: 135° F MAX
PRESS.: 80 P.S.I. MIN.
120 PSI MAX

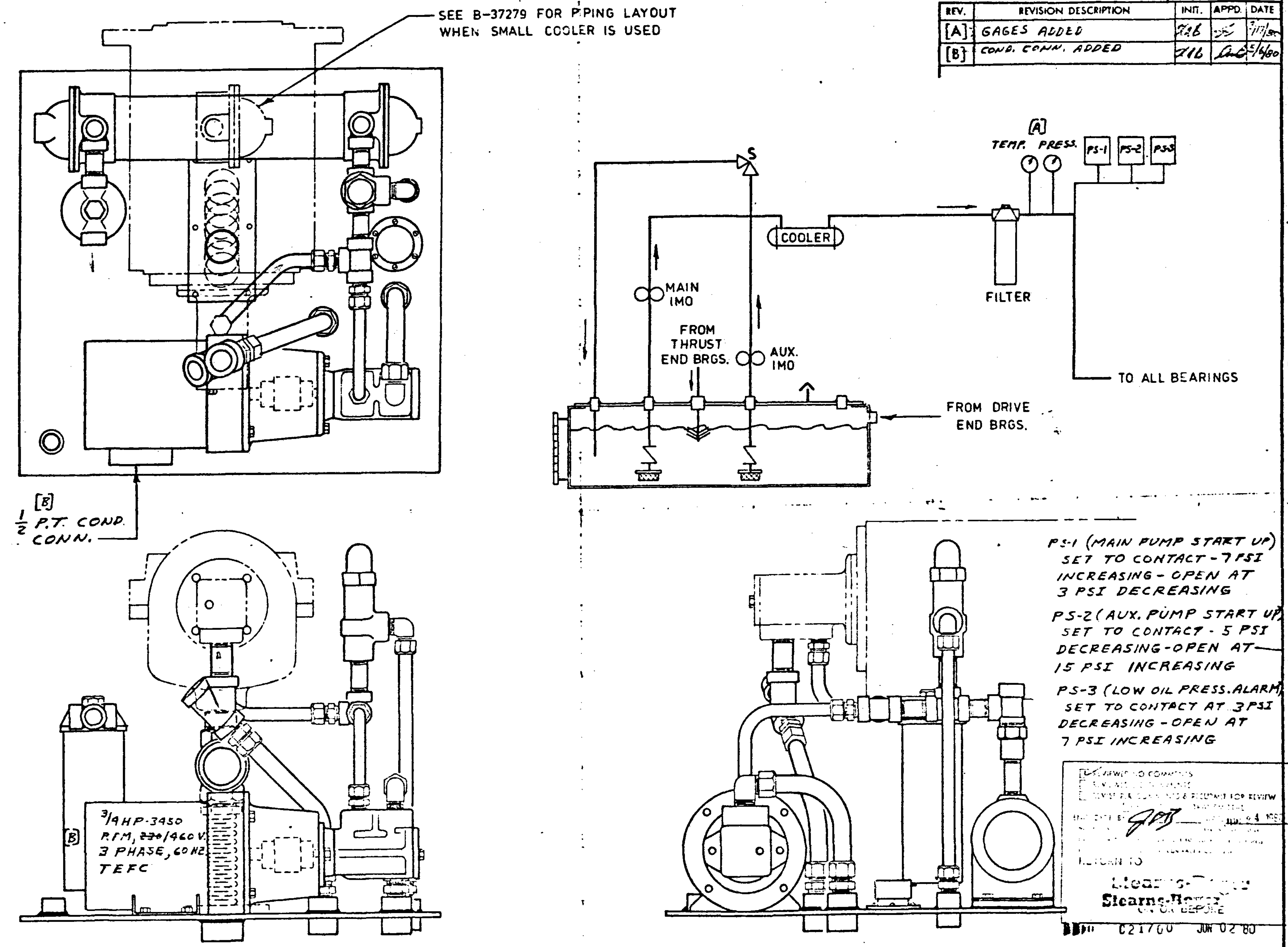
STEARNS-ROGER NO. 40VM700002

Bingham-Willamette Company	PORTLAND, OR. SHREVEPORT, LA.	PATT. NO.	INJECTION SYS. SCHEMATIC - TEMP. CONT.
		DR. WM | APPD. [illegible] | DATE: 2-26-80 | SCALE: [illegible] = 12 IN.	A-54924 REV. A
Bingham-Willamette Ltd.	VANCOUVER, B. C.	REF. | USED FIRST 1A995	

FORM No. 566-1

D-1A995-1

REV.	REVISION DESCRIPTION	INIT.	APPD.	DATE
[A]	GAGES ADDED	KAB		3/17/80
[B]	COND. CONN. ADDED	KAB		5/6/80



PS-1 (MAIN PUMP START UP)
SET TO CONTACT - 7 PSI
INCREASING - OPEN AT
3 PSI DECREASING

PS-2 (AUX. PUMP START UP)
SET TO CONTACT - 5 PSI
DECREASING - OPEN AT
15 PSI INCREASING

PS-3 (LOW OIL PRESS. ALARM)
SET TO CONTACT AT 3 PSI
DECREASING - OPEN AT
7 PSI INCREASING

☑ REVIEWED NO COMMENTS
☐ REVIEWED [illegible]
☐ REVISE [illegible] & RESUBMIT FOR REVIEW
[illegible] JUN 24 1980
RETURN TO
Stearns-Roger
ON OR BEFORE
C21700 JUN 02 80

No. 1941 File No. [illegible]

S-R #40 VM 700003

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
GENERAL TOLERANCES:

MACHINING:	FABRICATION:
ANG ±0°30'	ANG ±1°0'
LIN ±.02	LIN ±.12

Bingham-Willamette Company	PORTLAND, OR. SHREVEPORT, LA.	BASIC KINGSBURY LUBE OIL SYSTEM					D-1A995-1
Bingham-Willamette Ltd.	VANCOUVER, B.C.	REF. D-20443	FIRST USED 1A995	DR. KAB	APPD.	DATE: 3/13/80	SCALE: 1"= 4"

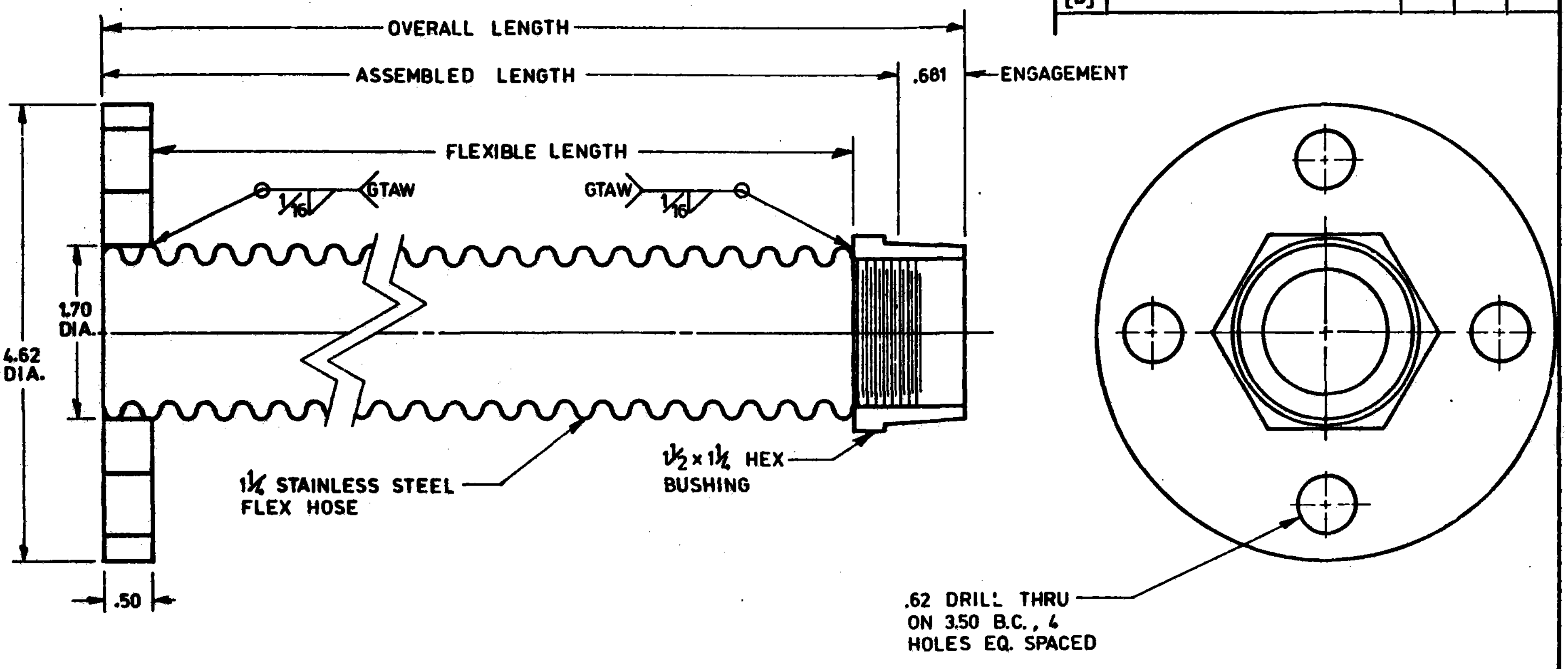
REV. B

1.2.23-77

1.2.23-78

B-37323

REV.	REVISION DESCRIPTION	INIT.	APPD.	DATE
[A]				
[B]				

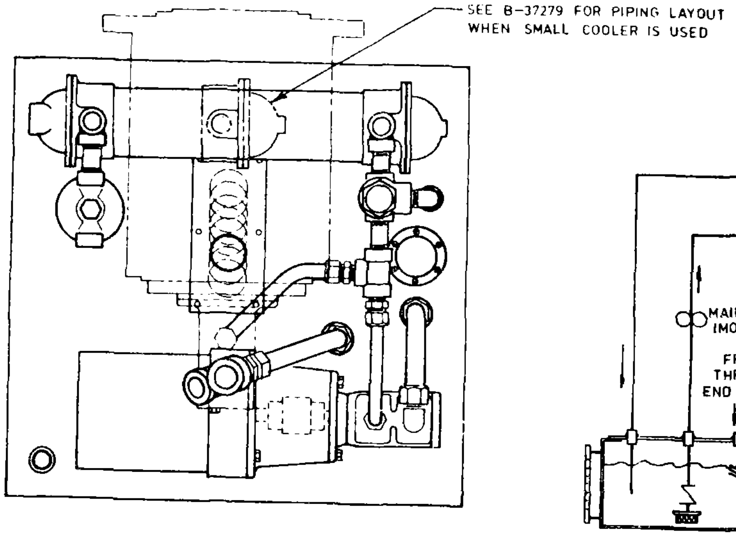


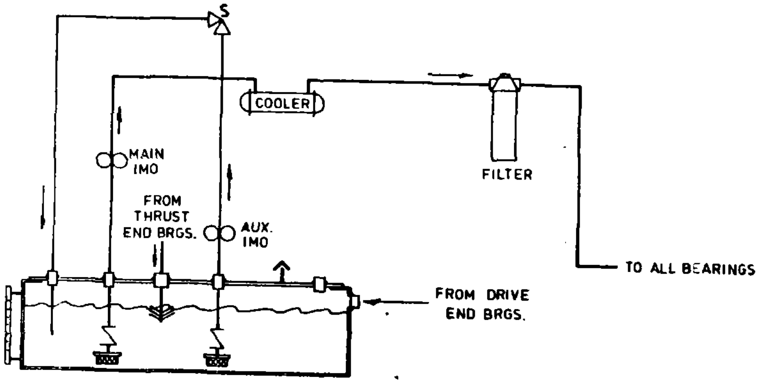
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
GENERAL TOLERANCES:
MACHINING: ANG ±0°30' LIN ±.02
FABRICATION: ANG ±1°0' LIN ±.12

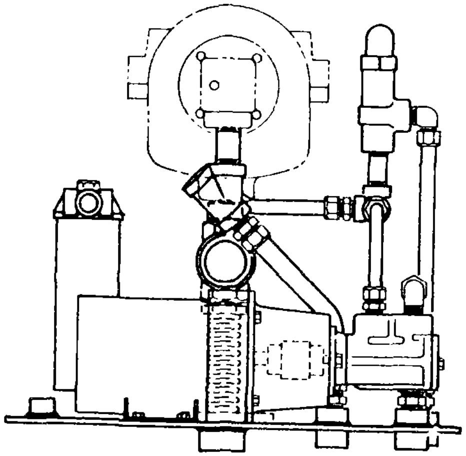
Bingham-Willamette Company	PORTLAND, OR. SHREVEPORT, LA.	PATT. NO.	FLEX HOSE—LUBE OIL RETURN TO TANK-KINGSBURY END					B-37323	REV.
Bingham-Willamette Ltd.	VANCOUVER, B.C.	REF.	FIRST USED	DR. AR	APPD.	DATE: 3-7-80	SCALE: FULL		

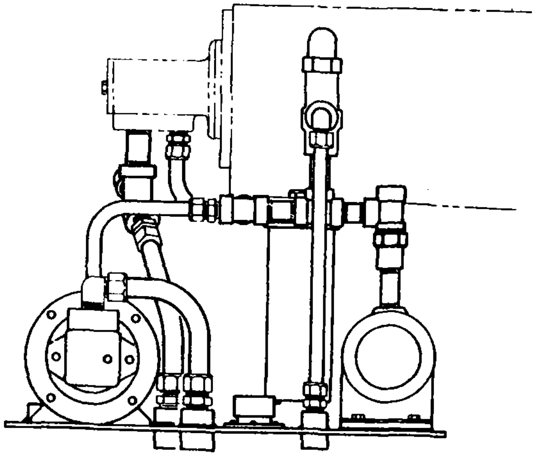
D-20443

REV.	REVISION DESCRIPTION	INIT	APPD	DATE
[A]				
[B]				









UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
GENERAL TOLERANCES:

MACHINING:	FABRICATION:
ANG ± 0°30'	ANG ± 1°0'
LIN ± .02	LIN ± .12

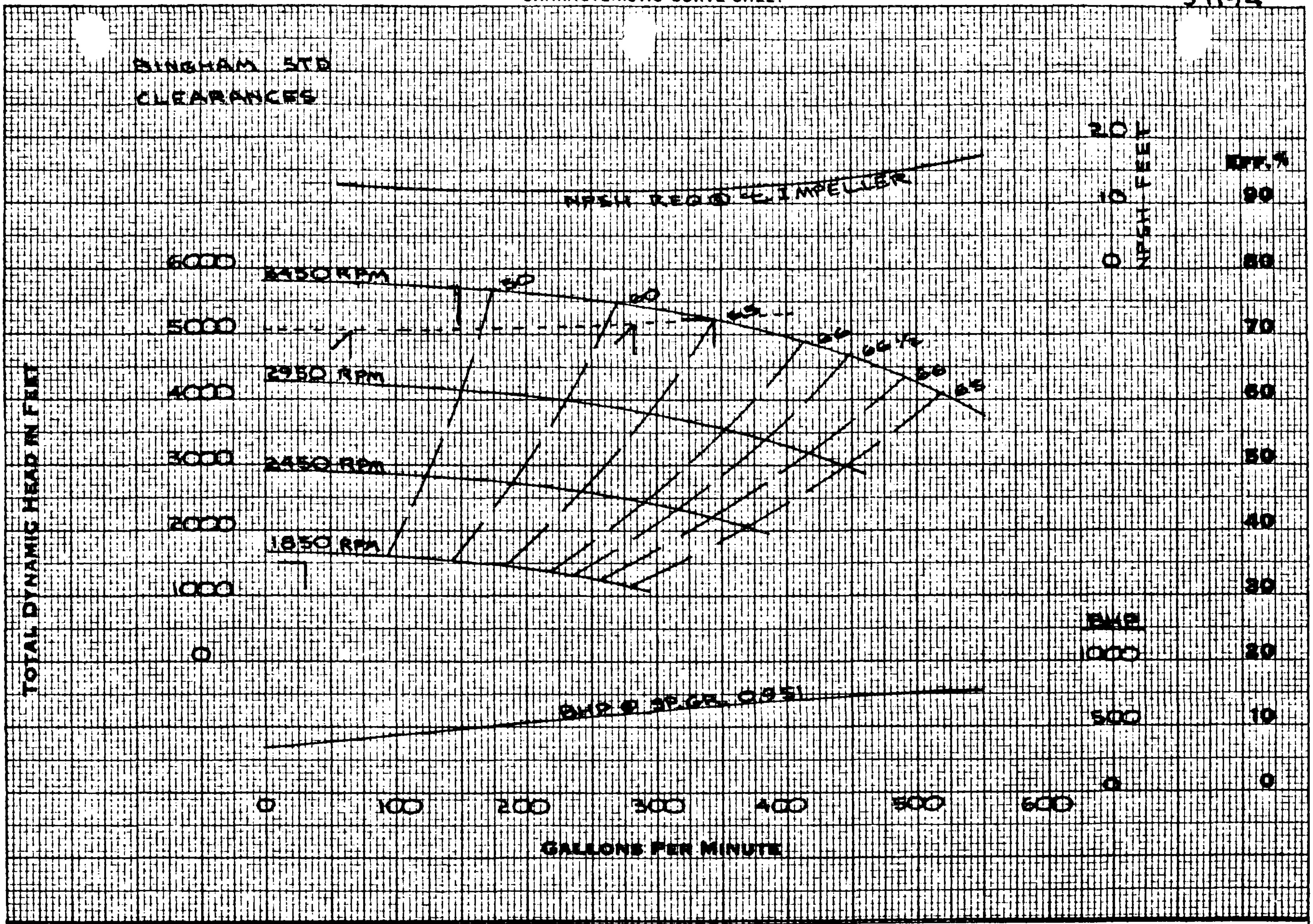
Bingham-Willamette Company PORTLAND, OR / SHREVEPORT, LA
Bingham-Willamette Ltd. VANCOUVER, B.C.

BASIC KINGSBURY LUBE OIL SYSTEM

REF.
FIRST USED
DR. AR
APPD.
DATE: 1-2-80
SCALE: 1"=4"
D-20443
REV.

CHARACTERISTIC CURVE SHEET

37194



STEARNS, ROGERS

PUMP ENGINEERING DEPT.
BINGHAM-WILLAMETTE COMPANY
PORTLAND OREGON & SHREVEPORT, LA
BINGHAM-WILLAMETTE LTD.
VANCOUVER B C

IMPELLER
MAX. DIA. 10 3/8
MIN. DIA.
EYE AREA 11.9 SQ. IN.

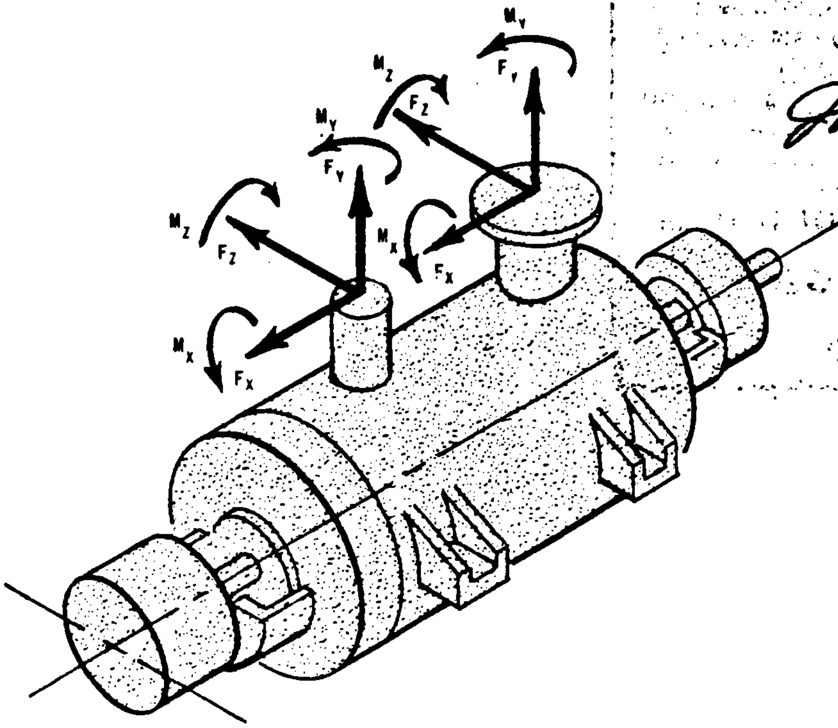
4 x 6 x 9E CP - 14 STG PUMP

DIA. IMPELLER 10 1/8
IMPELLER PATT.
AS SHOWN R.P.M.
N.P.S.H REQUIRED
REFERENCE T-290694-A&E
CURVE No. 37194

Form No. 3121

Maximum Allowable Nozzle Loading Data

HORIZONTAL, MULTI-STAGE, DOUBLE BEARING.
(Top Suction & Discharge)



PROPOSAL NUMBER
S.O. NUMBER 1A995
SIZE & TYPE 4×6×9E CP
CUSTOMER STEARNS-ROGER
PROJECT 10 MWe SOLAR PILOT PLANT
SOLAR ONE

LOCATION DAGGETT, CAL.
P.O. NUMBER 2000 C 21700
ITEM NUMBER
SERVICE RECEIVER FEED PUMP
PUMPAGE DEAERATED CONDENSATE
COMPLETED BY: DATE 5/1/80

	Size	F_X	F_Y	F_Z	F_R	M_X	M_Y	M_Z	M_R
SUCTION	6"	1500	1700	1500	1900	2600	2900	2600	3250
DISCHARGE	4"	1050	1170	1050	1300	1200	1350	1200	1500

Forces in (Lb.) Moments in (Ft-Lb.)

The relationship of actual component loads to the allowable resultant load must satisfy the expressions:

$$\sqrt{(F_X \text{ Actual})^2 + (F_Y \text{ Actual})^2 + (F_Z \text{ Actual})^2} \leq F_R \text{ Allowable}$$

and:

$$\sqrt{(M_X \text{ Actual})^2 + (M_Y \text{ Actual})^2 + (M_Z \text{ Actual})^2} \leq M_R \text{ Allowable}$$

D46.1 014

FORM NO. 651

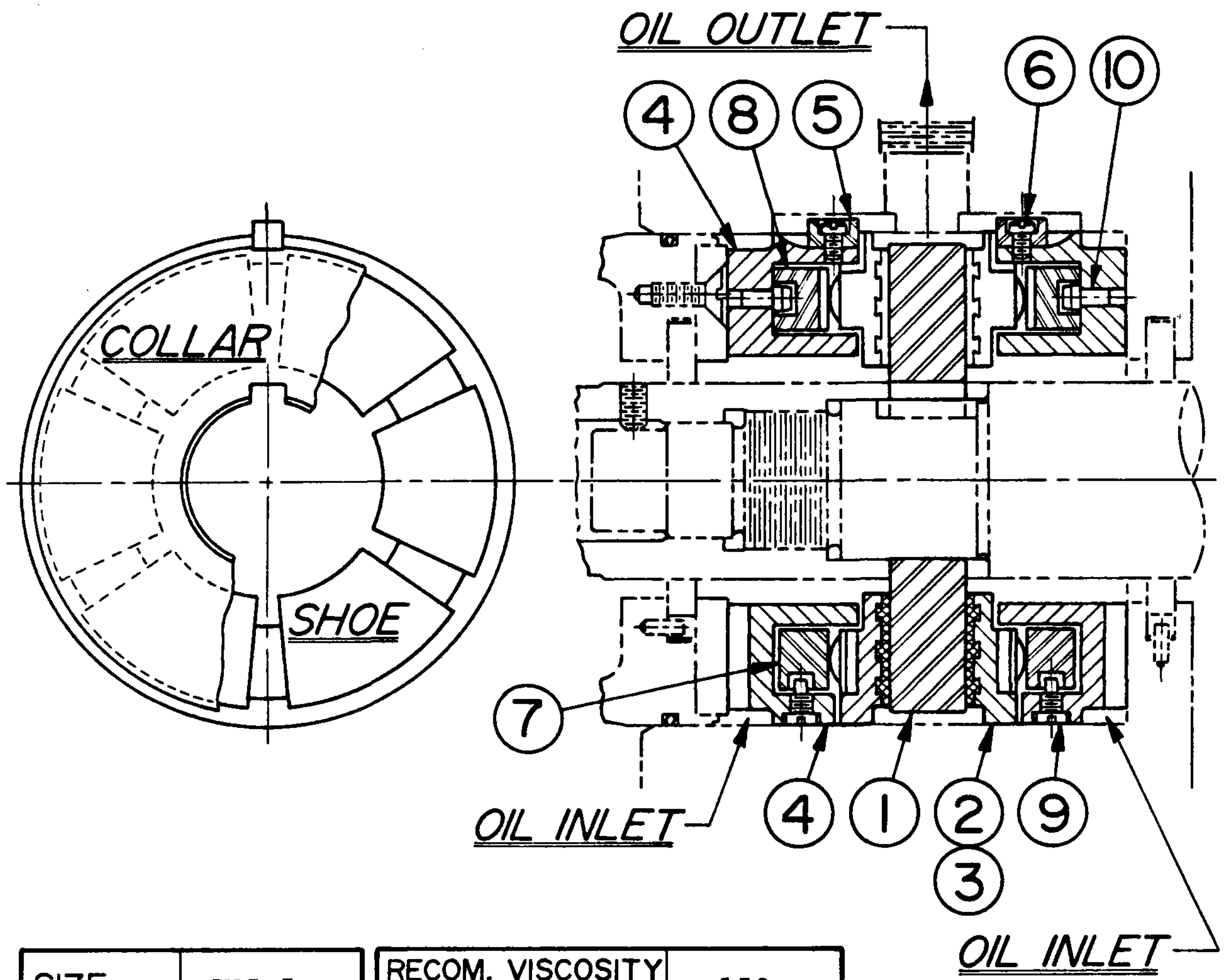
Bingham Factories: PORTLAND, OREGON • SHREVEPORT, LOUISIANA • VANCOUVER, B.C. CANADA.

PARTS LIST

ITEM	REQ'D. FOR ONE BRG.	DESCRIPTION
1	1	COLLAR
2 3	12	SHOE (babbitt faced) and SHOE SUPPORT assembled as one unit.
4	2	BASE RING (in halves)
5	2	BASE RING KEY
6	2	BASE RING KEY SCREW

PARTS LIST

ITEM	REQ'D. FOR ONE BRG.	DESCRIPTION
7	12	UPPER LEVELING PLATE
8	12	LOWER LEVELING PLATE
9	12	LEVELING PLATE SCREW
10	12	LEVELING PLATE DOWEL



SIZE	JHJ-5	RECOM. VISCOSITY S.S.U. at 100° F.	150
R.P.M.	3450	RECOMMENDED OIL FLOW in G.P.M.	——
REF. No.	1A995	RECOMMENDED END PLAY in INS.	.005/.007

REFERENCE ASSEMBLY DRAWING	————

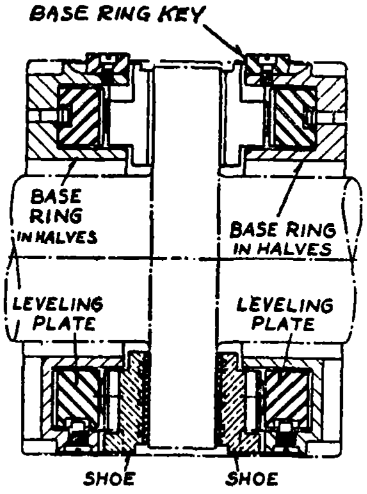
Instruction Form
No. 163866

INSTRUCTIONS

for Installing and Operating

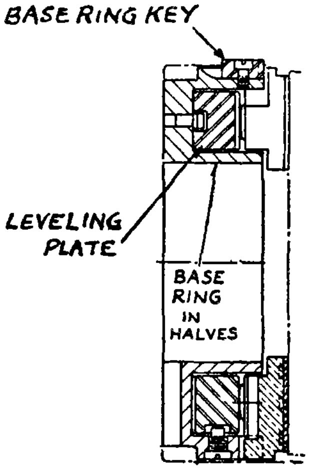
Double Horizontal Equalizing

KINGSBURY THRUST BEARINGS
(6 x 6) and (6 x 0)
with Forced Lubrication



6 x 6 Shoe Bearing

Folder 271-H-66



6 x 0 Shoe Bearing

KINGSBURY, INC.
10385 Drummond Road Philadelphia, Pa. 19154
Cable Address "ALKING," Philadelphia

PRINTED IN U. S. A.

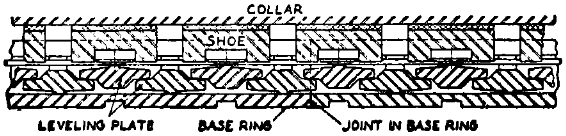
I. GENERAL DESCRIPTION

1. The 6x6 thrust bearing is of the Kingsbury equalizing type having six thrust segments or shoes on each side of the collar and is consequently capable of transmitting the full designed thrust load in either direction. The 6x0 bearing has 6 shoes on the side of normal thrust and a "bumper ring" on the unloaded side. In either case the thrust of the rotating element is transmitted through the thrust collar to the shoes, by the shoes to the shoe supporting elements, and thence to the stationary housing and the foundation.

2. The general design of the bearing is shown in the accompanying illustration and the load equalizing means in the diagram below. As will be evident upon referring to the diagram, the load transmitted by the *collar* to any one *thrust shoe* causes that shoe to press against the *upper leveling plate* immediately behind it. Each leveling plate, in turn, is supported upon one edge of each of two adjacent *lower leveling plates*, the other edges of which take part in supporting the next upper leveling plates on either side. As a result of this arrangement, any incipient excess of thrust on one shoe is immediately shared, through the interaction of the leveling plates, by the adjacent shoes, and this interaction and load sharing is distributed all around the circle so that all the shoes automatically receive equal loading.

3. The terms "upper" and "lower" leveling plate do not refer to the accompanying drawing (in which the "lower" leveling plate appears above the shaft centerline while the "upper" is below it). The "upper" leveling plates are the ones in contact with the shoes and "lower" the ones in contact with the base ring, regardless of their apparent relative positions in the illustration.

4. If the bearing is not to be used immediately, all parts—especially the collar—should be protected against dampness, rust and bruises.



Equalizing construction used in six-shoe bearings.

II. DETAILED DESCRIPTION

1. Referring to the accompanying drawing which shows a typical bearing of the kind under consideration, it will be noted that on each side of the collar (in 6x6 bearings) or on the load carrying side of the collar in uni-directional thrust bearings (6x0), there is a *base ring* which supports the lower leveling plates. The lower plates are positioned by dowels or dowel discs. The upper leveling plates rest upon the edges of the lower leveling plates and are held loosely in the base ring by the *leveling plate set screws*. The backs of the shoes are provided with hardened inserts called *shoe supports* through which the shoes are carried on the upper leveling plates.

2. Each base ring is fitted with a *base ring key*, which may be a rectangular block secured by a *base ring key screw*, or alternatively may be cylindrical pin pressed into a hole in the base ring. In either case the key fits into a corresponding recess in the housing cover and prevents the base ring from rotating. Base rings may be made in one piece, or split with, or without, the halves secured together with screws. In most normal applications they are split to facilitate installation and removal.

3. Oil is admitted to the bearing through inlets behind the base rings. Radial grooves in the base rings permit the oil to flow inward to the shaft and along through the spaces between the base rings and the shaft to the inner edges of the thrust collar faces. Thence it flows outward and around with the rotation of the shaft and enters between the collar faces and the leading edges of the shoes, forming a wedge shaped film of oil between each shoe and the collar. The oil escapes from the trailing edges of the shoes and flows outward to be discharged from the collar rim into the housing.

III. INSTALLATION INSTRUCTIONS

(A) CLEANING AND INSPECTION:

1. As packed for shipment from the factory, the bearing surfaces are carefully protected against bruises, scratches, and corrosion. They are slushed with a neutral water-proof coating, and no wood or damp packing material is allowed to touch them. Subsequent damage may occur in re-shipment or storage, unless the same precautions are observed.

2. All parts of bearings, housings, and oil piping should be taken apart and thoroughly cleaned before assembling. Remove all anti-rust coatings with kerosene or suitable solvent. Use rags or cloth for cleaning, as waste leaves lint, which might cause trouble in the bearing.

IMPORTANT. A poorly-cleaned bearing will score and wear out rapidly. A bearing surface is not clean till a white cloth wiped over it shows no soil.

3. Inspect all bearing parts after cleaning. Remove with a scraper any bruises on the babbitt faces. Remove slight bruises or rust on journal or collar surfaces with a fine oil stone. Deep rust requires refinishing.

4. The thrust collar must be exactly square with the shaft. If it is separate, remove any bruises on the shaft shoulder before assembling.

(B) ASSEMBLING:

1. Any solid oil-seal rings used **must** be assembled over the end of the shaft in proper sequence.

2. Six-shoe bearing "base rings" are usually split for radial assembling. To assemble the split six-shoe type, first put the lower half, with its "leveling plates," over the shaft, and rotate into bottom position. Put the upper half on shaft similarly, being sure the ends of leveling plates interlock properly. (Retaining screws or spring clips are furnished to hold the leveling plates.) Then insert all shoes rotating base ring as needed. Bolt the halves together if bolts are provided.

3. Oil all bearing surfaces when assembling. The upper half of each base ring has a key that enters a keyway in upper half of housing. *Never use force when assembling;* if parts do not go together easily, something is out of place.

4. *If shaft is threaded to hold collar, drive* collar nut *very tight,* using a heavy spanner, and lock securely.

(C) END-PLAY:

1. To allow for oil films between the bearing surfaces, and for expansion by heat, it is necessary to provide end-play. This end-play increases with the bearing size and the shaft speed. The attached print specifies the desired amount.

2. The end-play and the axial location of the shaft are usually determined by filler rings that are solid or split according to the bearing requirements. To adjust the end-play and to obtain the desired axial location of the shaft, shim or machine the filler pieces as needed, being careful to secure any split shims so that edges of halves will not overlap.

3. The end-play is best checked by jacking the shaft fore-and-aft, and measuring accurately the change in position. The housing cap must first be doweled or bolted in its exact position.

IV. OPERATION

(A) LUBRICATION AND COOLING:

1. These bearings are intended for forced lubrication and outside cooling. The bearing housing should be filled with oil before starting. The rate of circulation is specified approximately in the attached print. It should be such as to keep the outlet temperature within about 25° F. above the inlet (unless otherwise agreed upon). The oil pump and the piping should be designed to handle the required flow.

2. A suitable orifice should be installed in the oil supply pipe to control the flow.

3. The oil is cooled, usually by a cooling coil or separate oil-cooler supplied with water, but sometimes, for low-speed service, merely by radiation from the piping. Air cooling, if used, is favored by good ventilation.

(B) GRADE OF OIL:

1. Correct viscosity is important. Usually the thrust bearing has been selected with a view to using the same oil as the rest of the machine. Any special requirement will be found noted on the attached print and also on the Kingsbury nameplate.

2. Changing to an oil much lighter than originally intended may cause the lubricating films to become dangerously thin. A much heavier oil will needlessly increase friction.

3. The oil must be clean and free from grit and other injurious substances. Fine grit has a scouring action. Poor oil may cause corrosion, or sludge, or excessive evaporation.

(C) OPERATION:

1. The only attention normally required is to maintain proper circulation of clean, cool oil.

2. Since the bearing surfaces when running are completely separated by oil, there is practically no wear; hence no take-up is provided. The original scraper marks on thrust shoes in the larger sizes are visible, as a rule, even after years of service. This may reasonably be expected if the bearing is clean when installed, and is kept supplied with clean oil of proper viscosity.

V. CARE AND MAINTENANCE

(A) INSPECTION AND REPLACEMENT:

1. To inspect: (a) Lift housing cap; (b) Rotate base rings and withdraw shoes radially. Shoes of larger sizes have tapped holes for lifting.

2. Six-shoe base rings are usually split so as to be lifted out in halves. Remove other bearing parts over the end of shaft.

3. Thrust collars, if separate, have a sliding fit on shaft, and are readily removable after taking off the nut. To draw off collars of the larger sizes, use tapped holes near bore. Be careful not to bruise the collar.

4. When replacing collar, re-locate nut locks after re-tightening collar nut.

(B) REPAIRS AND SERVICE:

1. The attached print shows the bearing construction and lists the principal parts. In correspondence and when ordering parts, give the order number marked on the Kingsbury nameplate.

2. In case the shoes are rebabbitted, or the collar refinished, elsewhere than at our works, the following precautions should be observed:

(a) The collar faces must be perfectly flat, parallel and square with the shaft. Remove tool or grinding marks by lapping, by smooth grinding or by hand stoning.

(b) Use high-tin babbitt for the shoes. Scrape to a surface plate after machining. Round the radial edges slightly.

3. Prompt service is available from our home office in Philadelphia, Pa.

KINGSBURY

INSTALLATION INSTRUCTIONS Type DBZ-C

flexible couplings

WARNING: ALL ROTATING POWER TRANSMISSION PRODUCTS ARE POTENTIALLY DANGEROUS AND MUST BE PROPERLY GUARDED IN COMPLIANCE WITH OSHA STANDARDS FOR THE SPEEDS AND APPLICATIONS FOR WHICH THEY ARE INTENDED. IT IS THE RESPONSIBILITY OF THE USER TO PROVIDE PROPER GUARDING.

GENERAL INSTRUCTIONS

1. Disassemble coupling. Note arrangement of bolts, washers, and nuts as they must be replaced in the same order. Tie a string or wire through one bolt hole of each disc pack to retain the dialed position of individual discs.
2. Inspect both driving and driven shafts and hub bores, making sure they are free from burrs. Be sure the keys fit the shafts properly,
3. Mount hub on shaft. If hub is bored for an interference fit on the shaft, we recommend the hub be heated in water, or oil and quickly positioned on the shaft. Do not spot heat hub as it may cause distortion.
4. Bring equipment into position, making sure the distance between hub flanges is equal to the dimension shown in the table on reverse side.
5. Reassemble coupling. Refer to sectional view on reverse side.

Care in initial aligning will permit this coupling to operate to full capacity in correcting future misalignments.

METHOD 1 - INDICATOR METHOD - Recommended

ANGULAR MISALIGNMENT ADJUSTMENT

1. Rigidly attach dial indicator to flange, as shown in Figure 1. Rotate coupling 360° to locate point of minimum reading on the dial; set indicator to read zero at this point.
2. Rotate coupling 360° while watching indicator for misalignment reading. Move or shim equipment to bring reading within maximum allowable angular variation as shown in table at right.
3. Repeat operations 1 and 2 after each alignment adjustment.

PARALLEL MISALIGNMENT ADJUSTMENT

4. Rigidly attach dial indicator to flange, as shown in Figure 2. Rotate coupling 360° to locate point of minimum reading on the dial, set indicator to read zero at this point.
5. Rotate coupling 360° while watching indicator for misalignment reading. Move or shim equipment to bring reading within maximum allowable parallel variation as shown in table at right.
6. Repeat operations 1 thru 5 until coupling is properly aligned.
7. The coupling should be rotated several revolutions to make sure no "end-wise creep" in connected shafts is measured.
8. Tighten all lock-nuts to the values shown in table at right. It is recommended that all lock-nuts be retightened after several hours of operation.

Indicator mounting to be worked out to suit conditions at hand.

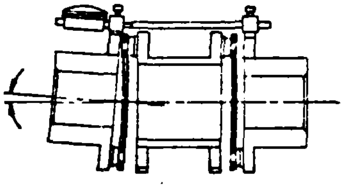


Figure 1
Test for Angular Misalignment

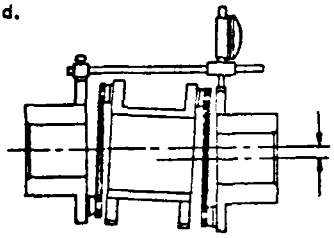


Figure 2
Test for Parallel Misalignment

Cpl. Size	Total Ind'r Read'g		*Locknut Tightening Torque (ft. lbs.)
	Ang.	Para.	
50	.004	.002 Per Inch of "C" Dim. as listed in table on reverse side of this sheet.	2
62	.005		3
75	.005		3
101	.006		8
126	.008		13
163	.009		13
201	.011		25
226	.012		43
263	.014.		63
301	.016		95
351	.019		175
401	.022		200
451	·025		265

Indicator readings are suggested maximum allowable variations from zero at time of initial alignment. There are occasions when equipment manufacturers require closer alignment in which case the manufacturer's recommendations should be followed. When indicator fixture is used the measurement is at a point slightly greater than the dia. of the flange but the obtained readings can be safely used.

*Approx. Tightening Torque for lubricated locknuts.

METHOD 2 - CALIPER AND STRAIGHT EDGE METHOD

1. A less accurate method of alignment is the caliper and straight edge method. Extreme care must be exercised to insure good coupling performance.
2. Use calipers to check the gap between hubs as shown in Figure 3. Gap should be the same at all points around the hub and should equal dimension shown on the table on the reverse side of this sheet.
3. Place a straight edge on the rims at the top and sides as shown in Figure 4. When the coupling is in alignment the straight edge should rest evenly on both coupling rims and both disc pack assemblies should be in a perfect plane at right angles to the straight edge.
4. Tighten all locknuts to specified values.
5. After several hours of operation recheck hub gap with calipers and recheck tightness of all nuts.

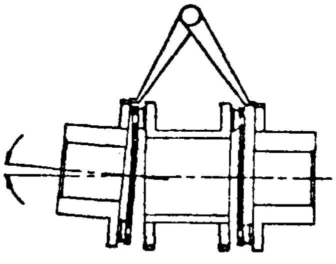


Figure 3
Test for Angular Misalignment

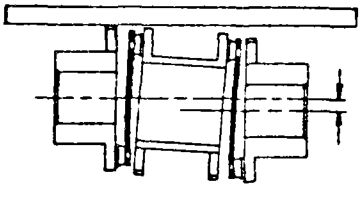
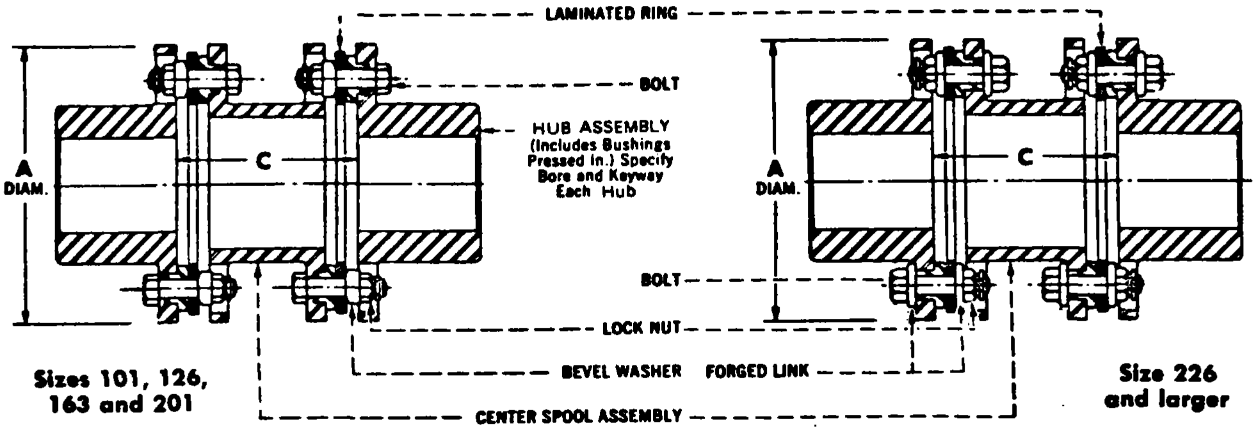


Figure 4
Test for Parallel Misalignment

Rexnord Inc.
Coupling Division
Warren, Pa. 16365

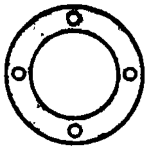
Type DBZ-C | PARTS ASSEMBLY DIAGRAMS

Thomas
flexible couplings

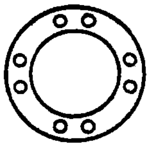


NOTE: Disc packs must be assembled in coupling exactly as received. Adjacent discs of disc packs are dialed to give maximum strength and uniformity. Do not order less than a complete pack.

Disc Packs are supplied in complete sets only.



DISC PACK
sizes 50 to 126



DISC PACK
sizes 163 and larger

DIMENSIONS AND PART NUMBERS

Size and Type	Dim. A	Hub Assembly* 2 per cplg.	Center Spool Assembly* 1 per cplg.		Laminated Disc Pack 2 per cplg.	Part Kit Consists of Bevel Washers or Forged Links, Bolts and Locknuts for One Coupling						
						Part Kit Number	Quantity Per Kit					
							Bevel Washer [1] or Forged Link [2]		Bolt		Locknut	
		Part No.	Part No.	Dim. C			Part No.	Qty.	Part No.	Qty.	Part No.	Qty.
101DBZ-C	3¼	16105	14439	3½	10619	16320-15	11192 [1]	8	11161	8	16503	8
126DBZ-C	3⅞	16107	14446	3½	10618	16320-17	10731 [1]	8	10728	8	16504	8
			14448	4								
			14450	4⅜								
163DBZ-C	4 19/32	16109	14457	3½	10954	16320-19	10731 [1]	16	10728	16	16504	16
			14459	4								
			14461	4⅜								
			14463	4¾								
			14465	5								
201DBZ-C	5 7/16	16111	14472	3½	10624	16320-21	11205 [1]	16	10721	16	16505	16
			14474	5								
			14476	5½								
226DBZ-C	6⅛	16113	14483	5	10689	16320-23	11874 [2]	16	10634	16	16506	16
			14485	5½								
263DBZ-C	7⅛	16115	14492	5	20357	16320-25	11875 [2]	16	10787	16	16507	16
			14494	5½								
			16258	7								
301DBZ-C	8 3/16	16117	14501	5½	20359	16320-27	11876 [2]	16	10655	16	16508	16
			14503	7								
351DBZ-C	9½	16119	14510	7½	20361	16320-29	11877 [2]	16	10733	16	16510	16
401DBZ-C	11	16121	———	8	20363	16320-31	11878 [2]	16	10240	16	16511	16
451DBZ-C	12⅝	16123	———	9½	10646	16320-33	11879 [2]	16	10641	16	16512	16

*Hubs and Center Spools are supplied with bushings pressed in place.

Rexnord
Rexnord Inc.
Coupling Division
Warren, Pa. 16365

RELIANCE ELECTRIC
24701 Euclid Avenue, Cleveland, Ohio 44117

REPORT OF ROUTINE TESTS
For Induction Motor

Purchaser: Bingham Willamette
2800 NW Front Ave.
Portland, Oregon 97210

Date of Test ......10-15-80.......

Manufacturer's Order No. ......X-336765.......

Purchaser's Order No. ......1-58962........

Nameplate Data

Rated HP	Service Factor	Rated Speed r/min	Phase	Frequency Hz	Volts	Amperes
800	1.0	3576	3	60	4160	96

Type	Frame	(Temp Rise By Method Indicated)	(Ambient Temp & Insulation Class)	Time Rating	Design Letter	Code Letter For Locked kVA/hp
P	E5810	80°C.**	47/B	Cont.	-	E

Test Characteristics

Serial No.	No Load					Locked Rotor				Shaft Run Out	Wound Rotor Open-Circuit Voltage	@High Potential Test Voltage	Stator Winding Resistance Between Terminals	
	Volts	Frequency Hz	Speed r/min	Amperes	Kilowatts*	Volts	Frequency Hz	Amperes	Kilowatts*				Ohms	Temperature °C
A-1	4160	60	3599	19.8	16.4	1600	60	167	78.4	-	-	9320	.341	20

* If measured, optional:

Notes: By RTD. @ for 60 seconds.

Data on test from ....this.............. motor.
(This or Duplicate)

Data by

Approved by .... J.S. Pokelsek

Date 10-20-80

RE 1293VV3 Printed in U.S.A.

RELIANCE ELECTRIC

PURCHASER: Bingham Willamette
2800 NW Front Ave.
Portland, Oregon 97210

DATE OF TEST: 10-15-80

MANUFACTURER'S ORDER NUMBER: X-336765-A1

PURCHASER'S ORDER No.: 1-58962

FILTER OUT **BALANCE IN MILLS AT** 1040 **VOLTS**

	HORIZ.	VERT.	AXIAL
F.E.	.16	.22	.12
B.E.	.19	.30	.14
SHAFT	.44	.52	-

FILTER OUT **BALANCE IN MILLS AT RATED SPEED**

	HORIZ.	VERT.	AXIAL
F.E.	.12	.18	.042
B.E.	.07	.13	.064
SHAFT	.29	.21	-

FILTER IN **BALANCE IN MILLS AT** 7200 **CYCLES/**PER MIN.

	HORIZ.	VERT.	AXIAL
F.E.	.029	.032	.023
B.E.	.054	.066	.057
SHAFT	.16	.09	-

DATA BY:

APPROVED BY: JSPokelsek
J.S. POKELSEK

DATE: 10-20-80

[illegible] ROAD, P.O. BOX [illegible], CLEVELAND, OHIO 44110 / TELEPHONE [illegible]
GENERAL OFFICES, CLEVELAND, OHIO

RELIANCE ELECTRIC COMPANY
MOTOR DIVISION, CLEVELAND, OHIO 44117, U.S.A.

[illegible] 1 '80

RECEIVED
OCT 24 19[illegible]
PURCHASING DEPT

DATA TRANS[illegible]TA AND CERTIFICA[illegible]IO

REFER TO THIS NUMBE
IN ALL CORRESPONDEN

CUSTOMER ORDER NO. [illegible] 1A995
DATE [illegible]/25/79
REQ. NO.
S.O. NO. [illegible]336765

S. TC
[illegible] WILLAMETT
28[illegible] FRONT AVE
PO[illegible]L[illegible] ORE
97210

SHIP TO: SAME AS "SOLD TO" UNLESS SHOWN

DATA PROVIDED WITH THIS TRANSMITTAL AND CERTIFICATION IS:
☐ FOR CUSTOMER APPROVAL BY DATE: ____________
Return of approval prints by the above date is required to assure scheduled shipment, delay in return and/or revision of approval prints may require shipment reschedule. Return approved D/S to data source.
☒ FINAL, APPROVED FOR CONSTRUCTION OR INSTALLATION.
☐ PRELIMINARY, ENGINEERING IS COMPLETED.
☐ REVISED, SUPERSEDES DATA PREVIOUSLY ISSUED.
☒ SEE REMARKS.

DATA SOURCE
TRANSMITTAL AND CERTIFICATION ISSUED BY: G PERRY DATE 2-1-80 CK BY NHL DATE 2-1-80
[illegible] PLANT
[illegible]
CLEVELAND, OHIO 441[illegible]
DATE PRINTED:01/11/[illegible]

MOTOR OR GEN. DATA
ITEM
USED FOR
USERS PLANT
QTY.
FRAME
HP
SERV. FA 1.00
TYPE F
R.P.M. 3600
PH/HZ/VOLTS-WINDING 3/60 / 4[illegible]
DUTY CONT
ENCLOSURE WPII
AMB./INSL. 40/B /VPI
PWR. CODE
BEARINGS [illegible]
MOUNTING & METHOD OF DRIVE [illegible]
RAILS OR BASE
MODEL NUMBER
ROTAT FROM OPP. DR. END [illegible]
D-C FIELD EXCITATION
DOUBLE SHAFT EXTEN.

MOTOR OR GEN. D/S: 608991-3[illegible]
C BOX D/S 415802
MOTOR OR GEN. C/D:
REDUCER OR AUX. D/S 416820-55
BRAKE OR AUX. D/S: V38588.200 (1)
BLOWER MOTOR PH/HZ/VOLTS/HP

REDUCER DATA
REDUCER STYLE
CLASS
FRAME
RATIO
OUTPUT RPM
ASSEMBLY

BRAKE DATA
BRAKE TYPE
SIZE
RATING FT/LB
DUTY
P.O.

DATA FOR CONTROL
D-C MOTOR ARMATURE CURRENT: ____________ AMPS
FIELD CHARACTERISTICS PER CURVE: ____________
F_1-F_2. ______ MAX. AMPS ______ ______ RPM
$F_{11}-F_{22}$. ______ MAX. AMPS ______ ______ RPM
F_3-F_4. ______ MAX. AMPS ______ ______ RPM

A-C MOTOR INFORMATION FOR SELECTION OF STARTER HEATERS:
CODE: E LOCKED AMPS: 52[illegible]
F.L. CURRENT: 90 AMPS.

SPCL. INSTALLATION FEAT. AND MISC. DATA
ADDITIONAL MOTOR OR GEN DATA:
[illegible] - STL
FR CONST NO.
ADD PROT QTY 2 DESCRIPTION RTD/PHASE ON THREE PHASES
SPCL C/B REQUIRED
AUX C/B REQUIRED
TC [illegible] TEMP DETECTOR

SPECIAL PARTS:
MOUNT CUST HALF CPLG

SPECIAL FEATURES:
80% OF FULL VOLTAGE STARTING
SS SCREENS & MONEL FILTERS
PROVISION FOR FILTERS
SPACE HTRS W/SEPARATE C/B FOR HTR LEADS
10 OHM COPPER STATOR RTDS
BEARING THERMOCOUPLES
MOUNTED FLEXIBLE HALF-COUPLING SUPPLIED ON CPT-X336765

CONTINUED ON PAGE 2

* REMARKS : Added TEST REPORTS. 10-21-80

RELIANCE ELECTRIC COMPANY
MOTOR DIVISION, CLEVELAND, OHIO 44117, U.S.A.

DATA TRANSMITTA AND CERTIFICATIO

CUSTOMER ORDER NO.	DATE	REQ. NO.	S.O. NO.
			X 336765

REFER TO THIS NUMBE IN ALL CORRESPONDENC

SC TC

SHIP TO: SAME AS "SOLD TO" UNLESS SHOWN

DATA PROVIDED WITH THIS TRANSMITTAL AND CERTIFICATION IS:

- ☐ FOR CUSTOMER APPROVAL BY DATE: ______
  Return of approval prints by the above date is required to assure scheduled shipment, delay in return and/or revision of approval prints may require shipment reschedule. Return approved D/S to data source.
- ☐ FINAL, APPROVED FOR CONSTRUCTION OR INSTALLATION.
- ☐ PRELIMINARY, ENGINEERING IS COMPLETED.
- ☐ REVISED, SUPERSEDES DATA PREVIOUSLY ISSUED.
- ☐ SEE REMARKS.

DATA SOURCE: TRANSMITTAL AND CERTIFICATION ISSUED BY: ______ DATE ______ CK BY ______ DATE ______

MOTOR OR GEN. DATA

ITEM	USED FOR		USERS PLANT		MOTOR OR GEN. D/S:
QTY.	FRAME	SERV. FA	TYPE	R.P.M.	C BOX D/S
PH HZ/VOLTS-WINDING	DUTY	ENCLOSURE	AMB./INSL.	PWR. CODE	MOTOR OR GEN. C/D:
BEARINGS	MOUNTING & METHOD OF DRIVE	RAILS OR BASE	MODEL NUMBER		REDUCER OR AUX. D/S:
ROTAT FROM OPP. DR. END	D-C FIELD EXCITATION	DOUBLE SHAFT EXTEN.			BRAKE OR AUX. D/S:

REDUCER DATA

REDUCER STYLE	CLASS	FRAME	RATIO	OUTPUT RPM	ASSEMBLY	BLOWER MOTOR PH/HZ/VOLTS/HP

BRAKE DATA

BRAKE TYPE	SIZE	RATING FT/LB	DUTY	P.O.

DATA FOR CONTROL

D-C MOTOR ARMATURE CURRENT: ______ AMPS
FIELD CHARACTERISTICS PER CURVE: ______
F_1-f_2 ______ MAX. AMPS ______ ______ RPM
$F_{11}-f_{22}$ ______ MAX. AMPS ______ ______ RPM
F_3-f_4 ______ MAX. AMPS ______ ______ RPM

A-C MOTOR INFORMATION FOR SELECTION OF STARTER HEATERS:
CODE: ______ LOCKED AMPS: ______
F.L. CURRENT: ______ AMPS.

SPCL. INSTALLATION FEAT. AND MISC. DATA

SPECIAL FEATURES CONTINUED
PROVISION FOR GROUNDING
SPLIT SLEEVE BRG SELF LUBRICATED W/OIL SUMP HEATERS
FOR [illegible] OPERATION AT 113F AMB WITH A SURVIVAL TEMP
OF [illegible] 177F
VACUUM PRESSURE IMPREGNATED CLASS B INSULATION
SPARE BEARING AND OIL RING SUPPLIED ON E336765
SPARE BRG TO SHIP SEPARATE W/MOTOR
COMPLETE NON-WITNESS COMMERCIAL TESTS & NOISE TEST
SEE SKETCH WSK-E15 FOR DIMENSIONS OF C/B

5 cert. D/S-9 P/L and section DWG-9 I/M
TO CUSTOMER SERVICE ATTN: Purchasing Department
1 cert. D/S-1 P/L and section DWG-1 I/M
1 recommended Spare Parts List w/ Prices
ATTN: Mr. Jarry J. Glass II
Performance curves later

INSTRUCTIONS

—*For*—

Installing and Operating

Gyrol Fluid Drive

EQUIPMENT – SIZE 146, CCW ROTATION, TYPE VS CLASS 6

SERIAL NO. – 78-146-6-104

PURCHASER – Bingham-Williamette Company

PURCHASER'S ORDER NO. – 1-58963

A.S.I.P.D. ORDER NO. – 3-82308

FOR – Boiler Feed Pump Drive

INDUSTRIAL PRODUCTS DIVISION
AMERICAN-STANDARD
8111 TIREMAN AVE.–P.O. BOX 76
DEARBORN, MICHIGAN 48121

AMERICAN STANDARD
INDUSTRIAL PRODUCTS DIVISION
DETROIT MICH 48232

TYPE VS
CLASS 6
FLUID DRIVES

S.O. NO. 3-82308

INDEX

FOREWORD

The information given in this bulletin covers generally the installation, operation and maintenance of the equipment. It is intended for use by operating and maintenance personnel who have the technical knowledge and experience to apply sound safety and operational practices. The engineering department of American-Standard's Industrial Products Division shall be glad to provide further information upon request.

FLUID DRIVES

GENERAL DESCRIPTION

OPERATION

The Fluid Drive input shaft, impeller, impeller casing, and runner casing rotate together at the driving equipment speed. The output shaft and runner rotate together at output speed. There is no mechanical connection between the input and output members. Power is transmitted from the impeller to the runner by a vortex of oil. The impeller pumps oil into the runner where the kinetic energy of the oil is absorbed and transmitted to the output shaft. The output speed is adjusted by regulating the amount of oil in the working vortex.

The oil pump moves oil from the housing reservoir through the oil cooler. Oil from the cooler is returned to the inside of the Fluid Drive and enters the working circuit.

Oil entering the working circuit is acted upon by centrifugal force and takes the form of an annular ring in the rotating casings. The scoop tube is positioned by the external speed control to set the level of oil in the casings. This determines the amount of oil in the working circuit and, therefore, the output speed of the Fluid Drive.

HOUSING

A welded steel oil tight housing encloses the rotating parts of the Fluid Drive and provides a reservoir for oil. The housing is split on the horizontal centerline with the cover removable for inspection and maintenance.

Machined flanges with a gasket seal are used between the cover and the lower part of the housing. Labyrinth grooves and shaft slingers form a seal at the shaft ends.

ROTORS

The Fluid Drive impeller, runner, and casings are machined from solid alloy steel forgings, with the exception of sizes 126 and 146, which have cast aluminum impeller and runner.

INTERNAL OIL PUMP

Some Fluid Drives are provided with an internal oil supply pump or auxiliary external pumps. To establish the type of pumping system used refer to the enclosed equipment specifications.

Lithographed in U.S.A.

EXTERNAL OIL PUMP

Some Fluid Drives are provided with separately mounted positive displacement oil pumps. The pumps are mounted on a subbase usually located at an elevation lower than the Fluid Drive.

BEARINGS

The journal bearings are removable bronze backed babbitt line precision sleeve bearings.

A double, self aligning Kingsbury thrust bearing is mounted in each pillow block. It reacts against thrust plates machined integrally with the shaft. This effectively absorbs the hydraulic thrust developed by the Fluid Drive rotating parts and a specified amount of external thrust.

Each pillow block is pressure lubricated with filtered and cooled oil from a lubrication system. The Kingsbury thrust bearing runs full of oil with overflow out the top of the pillow block.

The cast steel pillow blocks are split horizontally so that one or both shafts may be lifted out without disturbing alignment.

SHAFTS

Input and output shafts are machined and ground to close tolerances from alloy steel forgings.

SPEED CONTROLLER

The sizes 171 and 198 speed control scoop tube slides in bronze bearings in the runner pillow block. An external control shaft is joined to the scoop tube by a system of linkages which utilize needle bearings and fitted keys to eliminate excessive motion. The external control shaft is fitted with a contact seal at the housing to eliminate leakage. The sizes 126, 146 and 212 to 270 have a horizontal sliding speed controller supported in bronze guide bushings. It is operated by a rod extending outside the unit through oil resistant synthetic rubber seals. The external rod end piece is furnished with a drilled hole for attachment of automatic or manual controllers.

FACTORY TEST

All Fluid Drives are statically and dynamically balanced. After complete assembly and inspection, each unit is tested at full operating speed for an extended period. Periodic measurements are taken of vibration, oil, and bearing temperature, oil pressure and flow.

SHIPPING STRAP

Lift housing cover and remove shipping strap from rotor assembly by loosening strap at tension take-up. It is not necessary to remove brackets from tank wall.

FOUNDATION

The Fluid Drive must be mounted on a substantial foundation. A steel subbase filled with concrete or equivalent is desirable. When mounted on a steel subbase, it is recommended that holes in the subbase be located from the unit after it has been aligned with the other equipment. If a steel subbase is not used, sole plates with machined pads should be grouted into the top of a concrete foundation. Subbase or sole plates should be securely anchored.

ALIGNMENT

Since the Fluid Drive housing serves as an oil reservoir its temperature will change with the operation of the unit. Therefore, allowance for expansion of the metal must be made during alignment of the Fluid Drive to the driving and driven equipment. Final alignment must be made at operating temperature.

Flexible coupling alignment is usually made when the equipment is at the temperature of the surrounding ambient conditions. When the Fluid Drive is placed into service the oil temperature will rise, increasing the metal temperature of the housing. This will result in a rise of Fluid Drive centerline.

The following allowance for expansion or rise can be made.

Centerline Height	Expansion Allowance	Centerline Height	Expansion Allowance
25"	.010"	45"	.017"
27"	.011"	47"	.018"
29"	.011"	49"	.019"
31"	.012"	51"	.020"
33"	.013"	53"	.021"
35"	.014"	55"	.021"
37"	.014"	57"	.022"
39"	.015"	59"	.023"
41"	.016"	61"	.024"
43"	.017"	63"	.025"

ALIGNMENT (Cont'd.)

The procedure for alignment of the Fluid Drive is as follows:

1. Subtract the rise that will occur in the driving and driven equipment from that of the Fluid Drive.
2. Set the Fluid Drive lower that the driving and driven equipment by the amount calculated in Step 1 above.
3. Align the Fluid Drive to the driving machine. Jacking screw are provided for temporary alignment.
4. See the instructions furnished by the flexible coupling manufacturers for aligning the flexible couplings.
5. Align the driven machine to the Fluid Drive.
6. Use only flat plate metal shims between the Fluid Drive housing and the subbase.
7. **Final alignment must be obtained when the entire installation is at operating temperature.**
8. Dowel the equipment in place after a trial operation proves that the alignment is satisfactory.

AUXILIARY EQUIPMENT

Locate and install auxiliary equipment such as, oil pumps, coolers, filters, control panel, etc. as specified on applicable drawings and equipment specifications, SEC. III. It is essential that the oil pump base be firmly grouted to provide a sound foundation for the pumps. See SEC. II for detailed auxiliary equipment instructions.

OIL PIPING

All piping must be installed in such a manner that no strain or load is imposed on the Fluid Drive or the pumps. Follow the approved schematic piping diagram for proper installation of the piping.

OIL PIPING (Cont'd.)

All oil piping used for installation must be thoroughly cleaned inside. It must be free from all scale, dirt, chips, weld spatter, and other foreign material. It is recommended that inside of the piping be wire brushed and flushed with oil or pickled and flushed with oil. See the flushing instructions for recommended flushing procedure.

SPEED CONTROLLER

Remove the wire holding the scoop slide and install the speed control rod if shipped loose.

Attach automatic control linkage to the speed control rod. Adjust the controller movement to stop about 1/64 inch before hitting internal stops on scoop tube support assembly.

THERMOCOUPLES

Connect up thermocouples according to Bearing Thermocouple Arrangement Drawing, Sec. III.

INSTRUMENT PANEL

If shipped disassembled, install according to Outline Dimensions drawing and Instrument Panel Assembly drawing.

CLEANING

Remove all protective coatings from external finish machined surfaces. The protective oil used on internal surfaces is soluble in the Fluid Drive oil and need not be removed.

Flush the Fluid Drive tank, piping, and coolers until clean.

Prior to flushing install auxiliary equipment. See Sec. II, Installation Instructions.

The fluid drive was thoroughly cleaned before shipment and prepared for limited storage. Disconnect all lube oil and circuit oil lines from pillow blocks and turn 90° to discharge into tank. All piping between the fluid drive and auxiliary equipment must be free of scale, dirt, chips, weld spatter or other foreign material. It is recommended that inside of piping be wire brushed with oil or pickled and flushed with oil.

FLUSHING (Cont'd).

For flushing and cleaning external piping, a professional flushing rig consisting of high capacity centrifugal pump with suitable filters and/or strainers should be employed, **by-passing fluid drive oil pump which was not designed *for flushing.*** *If fluid drive oil pump must be used for flushing, then special in*structions and permission must be obtained from American Standard's Engineering Department.

Fill the fluid drive with light turbine oil and replace housing cover. The entire system should be flushed using hot and cold oil circulated at high velocities. During flushing, the strainer ahead of flushing pump suction manifold, will load up causing pump to cavitate. Repeated shutdown and cleaning of pump strainer is necessary during flushing operation. When the suction pressure reaches 5 inches or mercury (vacuum), the flushing should cease and strainer cleaned. Flushing should continue until there is no further collection of material on the strainer screen.

After flushing, remove the housing cover and reconnect internal piping. Drain all the oil from the housing tank and remove inspection manhole cover from the ends of the lower housing portion of the tank to facilitate thorough cleaning of the tank bottom.

To prepare unit for normal operation, the following checking procedure may be used.

1. Check all tubing and piping connections for proper connections and tightness.
2. Check the motion of the scoop tube and examine scoop tube tip for possible damage.
3. Check scoop tube stops.
4. Spot check bolts for tightness.
5. Check the position or location of oil slingers and seals.
6. Check the continuity of thermocouples.
7. Check the inside of housing for cleanliness.

GYROL FLUID DRIVES FLUSHING PROCEDURE

1. GENERAL

1.1 Gyrol Fluid Drives having an externally mounted oil supply require that oil carrying pipes, vessels, valves, coolers, etc., be flushed prior to placing the unit into operation. Since a considerable amount of piping is involved in connecting the pump and cooler to the Gyrol, it is essential that circuit and lube oil systems be thoroughly flushed to achieve the cleanest possible system. A system is considered clean when no foreign materials, metal chips, weld spatter, oxide scale, sand, or other debris are captured in the strainer and/or filters. The engineer in charge of start-up is responsible for the cleanliness of the system.

1.2 The Gyrol, cooler, pump(s), valves, and piping furnished by American Standard has been thoroughly cleaned prior to shipment and does not require additional cleaning unless contaminated during installation.

1.3 The positive displacement pump furnished with the Gyrol is designed with close tolerances in the pumping element and is not intended for use during flushing. A professional flushing rig consisting of a suitable duplex filter and/or strainer, differential pressure gauges, temperature gauges, and a high capacity centrifugal pump that supplies flush flow at a velocity of approximately 15 ft/sec is recommended for flushing the system. The supplemental flushing pump must be connected to the piping system as close to the permanent positive displacement pump(s) as possible. It is not intended that the permanent pump(s) be used in cooperation with supplemental pump during flushing.

2. FLUSHING PREPARATIONS

2.1 Lift the Gyrol cover from the lower half of the housing and prepare the internal piping for flushing. Disconnect and remove circuit feed line from pillow block(s) and blank off oil entrance to lube manifold up-stream of the external filter. To prevent entrance of debris-laden flush flow into the disconnected bearing and circuit feed ports during flushing, redirect the oil feed lines so that the flush flow is directed toward the bottom of Gyrol housing. It is important that the internal piping is rearranged so that no oil enters the circuit and lube manifold during flushing.

2.2 Remove all orifices, check valves, and instruments in the piping system which impede oil flow or could be damaged due to the high oil velocity during flushing.

2.3 Prepare equipment lubricated from the Gyrol system for flush in accordance with manufacture's specifications.

2.4 Heat should be supplied to the flushing oil by a suitable heater or by attaching a temporary low-pressure steam line not to exceed 5 PSIG to the service water side of the Gyrol cooler. Great care must be taken to insure that not over 5 PSIG steam is admitted to the cooler, so that the cooler is not damaged and the flushing oil temperature does not exceed 180° F. A recommended method for heating the oil is to fill the cooler with water and bubble low-pressure steam through the water. The cooler must be vented to the atmosphere to prevent build-up of pressure. The heating of the oil can also be accomplished by other means, such as wrapping electric coils around the pipes or supplying hot water in place of steam to the water side of the Gyrol cooler.

2.5 The piping system, particularly at the joints and flanges should be vibrated frequently, either manually or mechanically, during flushing to dislodge any scale or weld spatter that has adhered to the piping surface.

2.6 After all piping installation has been completed and no further welding, burning, drilling of piping or valves, etc. is anticipated, the system must be inspected for cleanliness. It is recommended that all accessible areas of the Gyrol and piping system be thoroughly inspected and if the slightest evidence of contamination is encountered, it should be removed.

2.7 A good grade of mineral oil as used for steam turbine operation should be used for flushing. The oil should have a viscosity of 150 SSU @ 100° F. To determine quantity of oil required, estimate the quantity of oil required to fill the system piping and add the quantity required to fill the Gyrol. The Gyrol Instruction Manual specifies the quantity and type of oil recommended.

3. FLUSHING PROCEDURE

3.1 The minimum oil level in the Gyrol housing, as specified in the Instruction Manual, must be maintained during flushing so that the supplement oil pump may maintain suction and operate properly.

3.2 Start the supplement pump and circulate the oil. Gradually heat the oil to 180° F. by introducing steam or hot water to the tube-side of the heat exchanger.

3.3. Cycle the oil between room temperature and 180° F. periodically as rapidly as possible and vibrate the piping system during the temperature increasing intervals. This will effectively loosen foreign material that has adhered to the piping surfaces. When using the Gyrol cooler for heating the oil during the flushing cycle, do not immediately use cold water to cool the oil. Allow the temperature of the tube bundles and tube sheets to cool to oil temperature before applying the cold water.

3.4 The hot oil circulation should be continued as long as necessary to insure proper system cleanliness. The flushing period may vary from 4 hours on small systems up to several days on the larger systems.

3.5 Experience in flushing oil systems has shown that a large percentage of foreign material is collected in the Gyrol housing, filter and/or strainer during the first few hours of flushing. During this time, whenever a noticeable increase in pressure drop, 5 PSIG above initial, across the strainer and/or filter is observed, the strainer and/or filter should be cleaned.

3.6 Continuous flushing deposits foreign material in the Gyrol housing and should be drained and thoroughly cleaned periodically to prevent the recirculation of the debris-laden flush flow. Clean housing with lint-free rags and remove all traces of residual and foreign material before refilling housing with clean oil.

3.7 The hot oil flush should continue until no evidence of foreign material appears in the strainers and/or filters. The following amount of foreign material is allowed in the Gyrol system:

Class 4 and 5 Gyrol Fluid Drives

For these machines, a cleanable edge-type filter is used with filtration capacity of 0.0015 inches. Total permissable volume of contaminants inside tank equivalent to 1 particle per 25 square inches.

Class 6 and 7 Gyrol Fluid Drives

For these machines, a full flow filter is used on the lubrication supply only. The filtration capacity of this filter is 0.0004 inch equivalent to 10 microns. Total permissable contamination inside drive equivalent to 1 particle per 25 square inches.

3.8 When flushing is completed, stop heating and continue circulating the oil until the temperature is approximately 120° F. As soon as this temperature is reached, remove the flushing oil from the system. Open oil lines at the lowest points and allow oil to drain.

3.9 All temporary equipment used for flushing the system must be removed and all piping, valves, orifices, and instrumentation removed prior to flushing must be replaced in their original locations.

3.10 Remove cooler bundle from cooler and submerge in a trough of cleaning solvent for thorough cleaning. It is recommended that new cooler gaskets be used while reassembling cooler.

NEW

RECOMMENDED OIL LIST

THE FOLLOWING RECOMMENDED OIL LIST ARE APPROVED OILS FOR USE IN GYROL FLUID DRIVES

MANUFACTURER	
Amoco Oil Company	Industrial Oil No. 32, Turbine Oil No. 32
Atlantic Richfield Company	Duro 32 (S-150), Ideal 32 (S-150)
Chevron U.S.A. Inc.	OC Turbine Oil 32
Cities Service Company	Citgo Pacemaker 32
Conoco, Inc.	Conoco Turbine Oil 32
Exxon Company, USA	Teresstic 32, Nuto H32
Gulf Oil Corporation	Gulf Harmony 32
Keystone Division of Pennwalt Corp.	KLC-654A
Mobil Oil Corporation	DTE Oil Light, DTE 797
Phillips Petroleum Company	Magnus Oil 150
Shell Oil Company	Tellus 32, Turbo Oil 32
Sun Petroleum Products Company	Sunvis 916
Texaco, Inc.	Regal Oil R & O 32, Rando Oil HD32
Union Oil Company of California	Union Unax RX 150, Union Turbine Oil 32

GENERAL CHARACTERISTICS [BASED ON MOBIL DTE OIL LIGHT]

Gravity, API		31.7
Specific Gravity		0.871
Pour Point		20° F, -7° C
Flash Point		395° F, 201° C
Viscosity:	Saybolt Universal Seconds	150/165 SUS @ 100° F
	Saybolt Universal Seconds	44 SUS @ 210° F
Viscosity:	Centistokes	27.8/32.0 @ 40° C
	Centistokes	5.3 @ 100° C
Viscosity Index [Min.]		100
ISO Viscosity Grade		32
Color ASTM [Max.]		1.5
Neutralization Number		0.20
Rust Test [A & B] [ASTM D665-IP135]		Pass
Demulsibility [ASTM 1401]		Pass

NOTE: Other properties of Mobil DTE Light, not shown, should be conformed to when using other similar high grade mineral oils. Synthetic fluids are not acceptable for use in Gyrol Fluid Drives.

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OIL

Oil is not furnished with the Fluid Drive. A good grade of mineral oil such as is used for steam turbine lubrication and having a viscosity of about 150 SSU at 100° F. should be used.

INITIAL OIL FILLING

The following table lists the quantity of oil required to fill the Fluid Drive prior to start-up.

Size	Qty. (Gals.)	Size	Qty. (Gals.)
126	53	212	270
→ 146	53	231	400
171	100	250	600
198	100	270	600

Additional oil will be required to fill the oil cooler and piping. Initial oil may be added directly to the lower housing when cover is removed, or thru a fill connection on the output end of the tank.

When feasible all separately mounted oil coolers and connecting piping should be filled with oil before initial starting of the Fluid Drive.

START-UP

Prior to start-up the following equipment must be checked under simulated operating conditions:

1. All pumps including D.C. Motor Driven Pump.
2. Pressure switches.
3. Automatic valves (2-way, 3-way, etc.)
4. All temperature and pressure sensing devices.
5. Water flow through coolers.

See Sec. II, Installation and Operating Instructions for auxiliary equipment.

If the fluid drive has an internal oil pump, it is necessary to remove the pipe plug in top of each bearing pillow block and pour oil into each bearing before starting. **Do not start fluid drive without lube oil in bearings.**

Move the scoop tube to the declutched position and check the fluid drive oil level.

Verify that all valves in piping are open.

Start main driving motor and determine if rotation is correct before proceeding. (Rotation is determined from input end of fluid drive.)

Determine if oil supply pressure is as given in following table, measured at 3600 RPM:

Size	Press. Range	Size	Press. Range
126	10-20 PSI	212	20-35 PSI
→146	10-20 PSI	212A	20-35 PSI
171	8-12 PSI	231	20-35 PSI
198	8-12 PSI	250	100-125 PSI
198A	8-12 PSI	270	100-125 PSI

The allowable variation to these pressures is ∓ 5% depending upon oil temperatures. If considerably lower pressures occur, then look for pump problems, low tank oil level or misplaced orifice. Oil temperatures above 190° F. are considered excessive.

START-UP (Cont'd.)

While drive is warming up at low speed, recheck tank oil level and bring up to maximum level on sight glass with speed controller at minimum speed position. When operating temperature is reached, see Sec. III, move speed controller to full speed position and allow a short period of time for load to reach full speed. Recheck oil level at full speed. Sight glass should show minimum level.

Temperature indicating thermometers on the instrument panel should have readings during normal operation within the range shown below:

Thermometer Designation	Normal Range
Circuit and Bearing Oil Entering Manifold	70° F. to 130° F.
Input Outboard Journal Bearing Input Inboard Journal Bearing Output Inboard Journal Bearing Output Outboard Journal Bearing Thrust Bearings	100° F to 160° F.

Temperature indicators shown on Bearing Thermocouple Arrangement drawing should have readings during normal operation as shown below:

Temperature Indicator Designation	Normal Range
Input Outboard Journal Bearing Input Inboard Journal Bearing Output Inboard Journal Bearing Output Outboard Journal Bearing Input Thrust Bearing-Oil Temp. Output Thrust Bearing-Oil Temp.	100° F. to 160° F.

START-UP (Cont'd.)

The circuit oil leak off box located inside the Fluid Drive collects oil leaving the circuit through a nozzle in the rotating casing. Temperature of oil in this box should give an alarm at 200°F. and full declutch the Fluid Drive (minimum speed position) at 215°F.

Gage No. 1 indicates oil temp. from input outboard bearing.
Gage No. 2 indicates oil temp. from input inboard bearing.
Gage No. 3 indicates bearing lube pressure.
Gage No. 4 indicates oil temp. from output inboard bearing.
Gage No. 5 indicates oil temp. from output outboard bearing.

NOTE: Lube oil and circuit oil temp. are equal.

See Sec. II *for operating instructions of any auxiliary* equipment.

VIBRATION

Note driving motor and fluid drive to be operating smoothly. Re-check after load is brought up to normal operating speed. The normal and allowable vibrations of input and output shafts are as follows:

Normal Shaft Vibration	Allowable Shaft Vibration
.001 to .002 mils	Up to .005 mils

Transient swings or increase in vibration would be normal during changes in scoop position.

OIL MAINTENANCE

The fluid drive should be free of any leaks. The oil level should be checked periodically and oil added if necessary. The supplier of oil should be consulted for their recommended maintenance procedure. In the absence of suppliers recommendations, the following should be observed.

TROUBLE SHOOTING (Cont'd.)

a. Pump suction restricted due to foreign material in line to pump.
b. Oil bypass arrangement may not be fully closed.
c. Low oil level causing pump(s) to cavitate.
d. Loose gaskets or breaks in internal piping of fluid drive.

7. Fluid drive overloaded.
8. Damaged bearing or insufficient lube pressure.

Low oil pressure may be caused by:

1. Improper setting of pressure regulating valve.
2. Dirty oil filters.
3. Restriction in pump suction line.
4. Damaged bearings.
5. Loose gaskets or break in internal lube piping.
6. Defective oil pump.
7. Inadequate oil supply or suction conditions.

PRECAUTIONS

Disconnect input and output flexible couplings and external control linkage prior to disassembly. All components and tank should be thoroughly cleaned during disassembly and kept clean by suitable coverings to minimize intake of foreign material into fluid drive.

HOUSING COVER REMOVAL

Remove all bolts from horizontal split flange and from upper half of shaft seals at both ends of drive. **Shaft seals do not lift off with top half of housing.** Loosen bolts in seal lower halves and pull seals out away from housing to limit of bolts. Be careful of gaskets under bolting faces. Lift housing cover straight up with lifting lugs provided and set off to one side.

REMOVAL OF PILLOW BLOCK COVERS

Remove piping and any thermocouples attached to bearing pillow block covers. Mark piping and thermocouples for reassembly. See Sec. III, page 10. Remove all bolts from horizontal split flange. Lift cover straight up and level, to avoid bearing damage, with lifting lugs provided. **Do not lift entire pillow block with lifting lugs.**

REMOVAL OF THRUST BEARINGS

Carefully lift out individual shoes from upper half of thrust bearing. Keep all shoes together in a protected location. Next remove thrust cage assembly. Rock-out lower half cage and shoes for removal. Remove bearing spacer shims and matchmark for location. Use bearing scraper and carefully remove imbedded dirt in shoe faces. **Do not over-scrape** shoe faces. Shoes and cages are in matched sets which must be maintained and replaced **exactly.**

REMOVAL OF JOURNAL BEARINGS

Upper half of journal bearings are bolted to and lift with pillow block covers. Lift shafts just enough with rope slings to take weight off lower half of journal bearing and rock-out lower halves. To remove upper half of journal bearing, loosen locknut on bearing retainer bolt and tap bolt head to loosen bearing. **When reassembling bolts in upper bearing halves, snug bolts and back off 1/2 turn to prevent damage to bearings.** On units with internal pumps remove pump driven gear by removing locking strap and hex. nut.

REMOVAL OF JOURNAL BEARINGS (Cont'd.)

NOTE: The sizes 250 and 270 fluid drives contain a pilot bearing i.e. The output inboard (pilot) bearing is located and contained by the impeller shaft shrouded by the rotors. To examine the pilot bearing a complete disassembly of rotating parts is necessary.

NOTE: If necessary, journal bearing labyrinth rings may be removed from the upper and lower halves of the pillow blocks by removing the retainer cap screws.

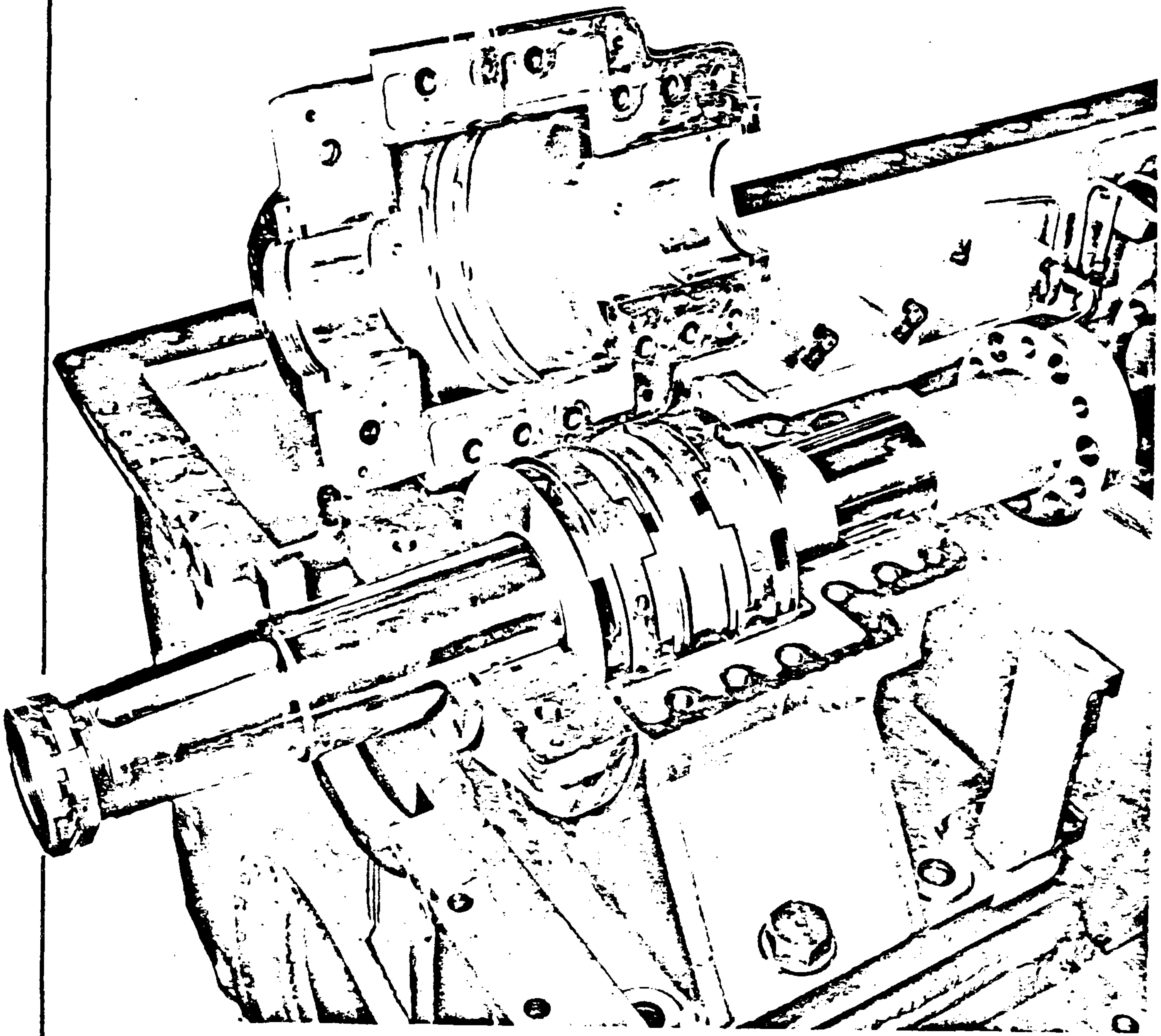
REMOVAL OF ROTORS

Remove the scoop tube assembly. Be careful not to damage tip end of tube. Remove bolts and dowels from lower halves of shaft seals. Remove seal drains. Remove bolt circle bolts and dowel pins from rotor flanges. To preserve dynamic balance, carefully mark location of each cap screw by number and matchmark; or they may be rethreaded into the back of the casing flange from which removed. Use jacking screws in three locations 120° apart to separate rotors. Place rope sling around input shaft and eye bolt installed in impeller bolting flange. Lift out the input shaft and impeller assembly and place on a previously prepared cradle or pallet. Lower the runner casing assembly slowly until it rests on the runner and a block on the runner shaft. Lift out the runner casing, runner and shaft assembly and place on a previously prepared cradle or pallet. Shafts may be removed from rotors after matchmarking.

NOTE: On sizes 250 and 270 fluid drives an axial clearance of 3-1/2" must be provided to remove the shaft from the pilot bearing. If this space is not provided, input and output rotating assemblies must be removed as one assembly.

DISASSEMBLY TOOL SIZES 250-270

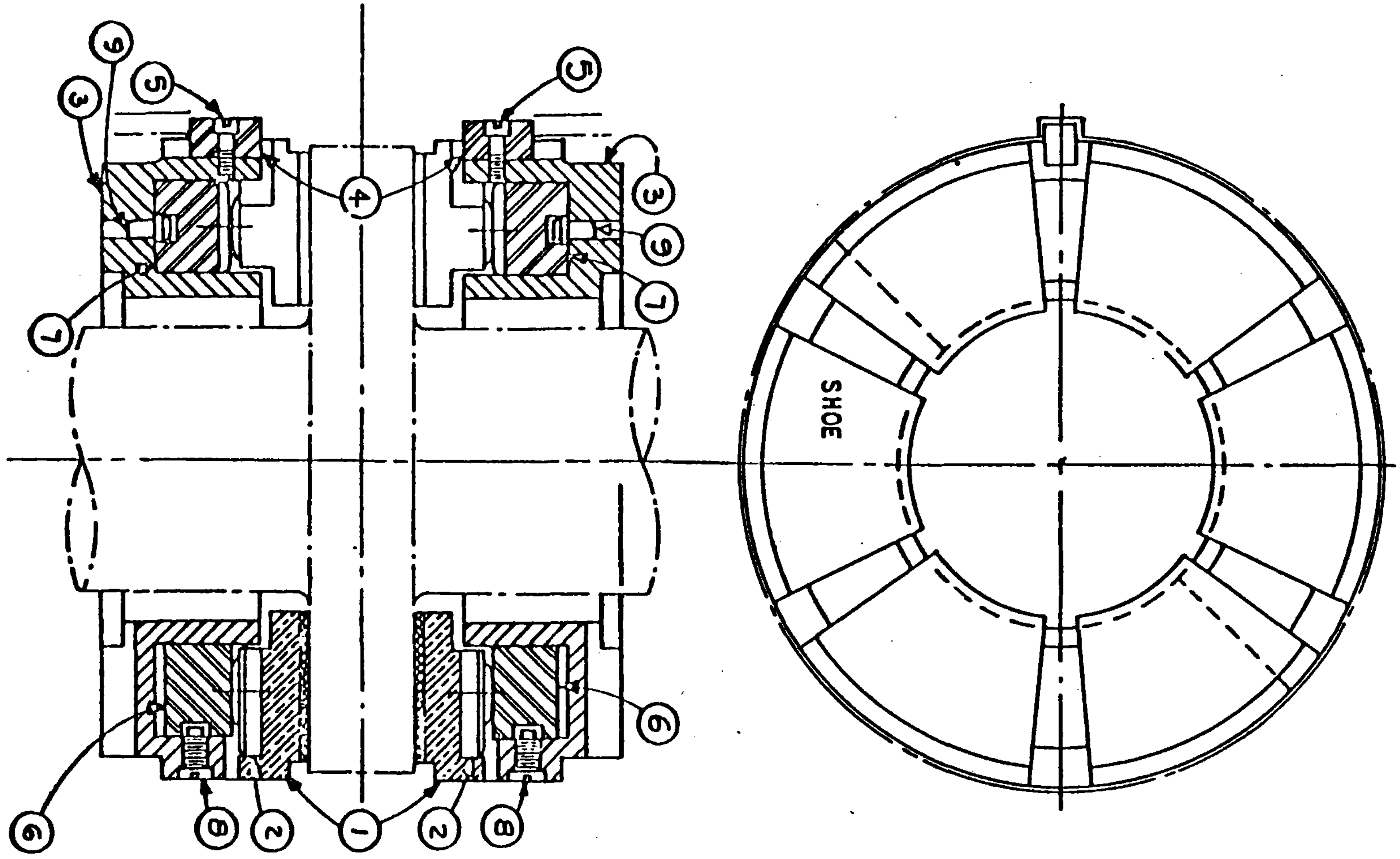
Special support A-frame and lifting plates are provided to facilitate disassembly and assembly of sizes 250 and 270.



PILLOW BLOCK ASSEMBLY

FLUID DRIVES

Item	Req. for One Brg.	Name
1	12	Shoe (Babbitt Face)
2	12	Shoe Support (In Shoe)
3	2	Base Ring (In Halves)
4	2	Base Ring Key
5	2	Base Ring Key Screw
6	12	Upper Leveling Plate
7	12	Lower Leveling Plate
8	12	Leveling Plate Set Scr.
9	12	Leveling Plate Dowel



THRUST BEARING ASSEMBLY

INDUSTRIAL PRODUCTS DIVISION
AMERICAN-STANDARD
8111 TIREMAN AVE.—P.O. BOX 76
DEARBORN, MICHIGAN 48121

INTERNAL PUMP REMOVAL

If necessary, pump and support assembly may be removed in the following manner:

1. Disconnect piping to pump.
2. Remove input pillow block hold down bolts and lift out bottom half of the input pillow block with pump and support assembly attached.

   IMPORTANT: Any shims under the pillow block must not be disturbed if pillow block alignment is to be preserved.
3. Remove cap screws and dowels to remove pump and support assembly.
4. Remove pump screen, screen guard, and screen grill from bottom of the pump.
5. Remove pump bottom flange, and gear and shaft assemblies may be removed.

PILLOW BLOCK ALIGNMENT

IMPORTANT: Do not disturb the lower halves of the pillow blocks, except to check the tightness of the hold down bolts, in order that the alignment between pillow block will not be changed.

Impeller and casing assembly and the runner assembly, may be removed from the shafts by removing dowels and cap screws on Size 250, or dowel cap screws on Size 270, and using jacking screws in tapped holes provided in shaft flanges. Dowels have tapped puller holes.

IMPORTANT: Be sure to identify match marks between parts and to return cap screws and lock washer to their exact location in order to preserve dynamic balance. Use a temporary marking of cap screws which will not mar the polished surfaces.

GENERAL

When assembling the fluid drive, follow the disassembly instructions in the reverse order. In addition follow the instructions below and also refer to Sec. II, Assembly Instructions for Auxiliary Equipment.

CLEANING

All parts must be thoroughly cleaned and maintained clean through the reassembly of the unit.

GASKETS

Where flat paper type gaskets are used it is recommended that new gaskets be cut out exactly like original gaskets from "Vellumoid" or equal material having same thickness as original gaskets. "O" rings where used may be reused provided they have not been damaged or stretched out of shape.

IMPORTANT: The mating faces of the pillow block bearings are ground surfaces and do not require a gasket or sealing compound. Use of either will effect the bearing clearances and the operating conditions for which the bearings were designed.

SIZE 270 CASING "O" RINGS

On Size 270, use rubber cement to hold the casing "O" rings, in their grooves during assembly. It is very important that these "O" rings be properly assembled.

BEARINGS

Any rust, burrs, scar marks, etc., in the machined surfaces of the pillow blocks or shafts must be removed by stoning, crocus cloth or other suitable means. If the babbitted surfaces of the bearings are marred, they should be lightly scraped to blend with the bearing surfaces and any particles imbedded in the babbitt cleaned out. The oil feeder grooves should be closely inspected and any sharp edges or signs of wiping carefully scraped to blend into the bearing surface profile. If there is any question regarding the suitability of the bearing, it should be replaced with a new bearing. Never use force when assembling the bearings. If the parts do not assemble easily, something is out of place or not cleaned properly.

Lithographed in U.S.A.

THRUST BEARING

After the bearing pillow blocks have been assembled, check the clearance or end float in the Kingsbury thrust bearings by prying or jacking the shafts back and forth and measuring the movement with a dial indicator. The original clearance is clearly stamped on each pillow block and if the movement is not within these specified limits, it should be corrected by grinding the existing shim plates or by making a new shim plate. If a change has to be made, the shim plate must be made flat and parallel to .002 inches total indicator reading.

IMPORTANT: Before making a shim adjustment, double check the end play clearance with all the oil wiped off the thrust shoes and collar faces. Also, turn the shaft slowly to ascertain if the shoes are seated properly. If the end play is still above or below limits, correct as outlined in the previous instructions.

JOURNAL BEARINGS

The bearing halves should be rolled into place after lining up the positioning tongue and/or groove in the bearing shell back wall with a mating tongue and/or groove in the bearing housing. Pressure cap type bearings are used and **must** be installed with the dam located about 30° off the vertical centerline in the direction of rotation. In some instances, it is possible to get the bearings on backwards. Place the upper half of the bearing into the bearing cap and align the tapped hole on the bearing shell to the hole in the bearing housing cap. Install the holding cap screw and turn down until it bottoms lightly, then back out 1/2 turn and lock in place.

IMPORTANT: Do not bottom the locking screw tightly and leave bottomed, as it can deflect the bearing cap and cause trouble due to inadequate clearances in the area of the locking screw.

PILOT BEARING SIZE 250 & 270

If replacement is made of the internal journal bearing, (Pilot Brg.) do the following:

1. Determine location of bearing in input shaft.
2. Remove the retaining set screws.
3. With an internal puller, draw the internal journal bearing out of the impeller shaft.
4. Press the internal journal bearing into the impeller shaft to the proper location as determined in Step. 1

   IMPORTANT: Open end of internal journal bearing oil grooves must be pressed into impeller shaft first.

5. Drill for dog point retaining set screws in four places:

   IMPORTANT: Do not drill any deeper than necessary. Install retaining set screws and stake in place.

6. Bore the internal journal bearing to $^{+.001}_{-.000}$ inches concentric with the input shaft bearing journals within .001 total indicator reading.
7. Reshape oil grooves according to internal journal bearing drawing. See Journal Bearing drawing.

Check line up of the internal journal bearing as follows:

1. Place the input shaft in the Fluid Drive and close the input pillow block. Input pillow block should be completely assembled including thrust bearing.

PILOT BEARING SIZE 250 & 270 (Cont'd.)

2. Place the runner shaft without runner in the Fluid Drive (with a spare journal bearing in place of the bronze labyrinth on the inboard end of the pillow block) and close the output pillow block. The runner shaft is to be in a position clearing the internal bearing so the thrust bearing is omitted from the pillow block

3. Mount an indicator on the output shaft and indicate the flange O.D. of the impeller and casing assembly. Alignment of the pillow blocks is satisfactory if the total indicator reading is within .005 inches.

4. If a reading over .005 T.I.R. is obtained in step (3) check the concentricity of the internal bearing bore with the impeller shaft bearing journals. They must be concentric within .001 inches total indicator reading.

5. If the internal bearing bore is concentric within .001 inches T.I.R. with the input shaft bearing journals, then the runner pillow block must be shimmed until the runner shaft runs concentric within .005 inches T.I.R. with the O.D. of the impeller casing flange **and also within .010 inches T.I.R. with the face of the impeller.** Use flat plate metal shims as large as possible under each hold down bolt. Calculate the intermediate shims to give a straight line across the top of the shims so that shims under all bolts are tight.

SEAL CLEARANCES

The housing shaft seals are located with dowel pins to maintain the proper clearance. See Sec. III, Page 2. The internal and external slinger ring seal elements should fit concentrically in the seal and cover bores and the slinger lip should have about 1/32" axial clearance as shown on cross section Drwg., Sec. III, Page 2. If realignment is necessary, pull the dowel pins, realign the end covers, bolt up tight and either redowel the end covers or if possible ream out for the next larger size dowel pin.

SCOOP TUBES

The scoop tube should be set so that it clears the casing by 1/8 inch. This can be accomplished by moving the scoop tube towards the casing by hand.then move the scoop tube away from the casing 1/8 inch and set one internal scoop stop. Check to be sure there is no rub over a full revolution of the casing. Set the other internal stop to give full travel as indicated in Sec. III, Page 3. Check for rub during full revolution of casing with scoop tube in full clutch position.

OIL COOLER(S)

Oil flowing through the power vortex also acts as a coolant, in that it carries away the heat load to the oil cooler. Oil to water coolers are American Standard Shell and tube type construction. The tubes are made of Admiralty metal for long life and are removable from the shell for ease of cleaning. Other construction details are Muntz metal tube sheets, steel shells and steel channels.

Separately mounted air-oil coolers are sometimes used. When used, care should be taken to insure that pipe size and length be chosen for minimum pressure drop. A bypass valve and piping is recommended for cold weather operation.

EXTERNAL OIL PUMP(S)

Separately mounted external positive displacement type oil pumps supply the necessary oil for use in the fluid drive circuit and bearings when a greater quantity of cooled oil is required than can be supplied with an internal gear driven pump or special applications deem external pumps necessary.

EMERGENCY LUBE PUMP

An emergency DC Motor driven pump is used to supply bearing lubrication during the coast down to prevent bearing damage.

Thermocouples and a terminal box may be used to monitor input and output journal bearings and tank oil temperatures. Their location will be shown on Sec. III.

SWITCH PANEL

The switch panel may be direct or remote mounted and is used to house pressure and temperature switches.

PRESSURE CONTROLS

Pressure switches are powered to insure adequate lube and circuit oil pressure for trouble-free operation. The switch locations are shown on Sec. III. For specific operating and setting instructions see Sec. III.

FLEXIBLE COUPLINGS

If the flexible coupling has the usual straight key construction in the hub, follow normal assembly practices and "shrink" on shaft. When aligning flexible couplings on the driving and driven equipment, allowance for expansion or rise in the fluid drive centerline height should be .0004 per inch of centerline height.

OIL MIST ELIMINATOR

The oil mist eliminator is boxed separately to avoid damage in shipment. Mount on housing flange provided. See Sec. III.

SWITCH PANEL

When assembling external piping connect tubing for pressure switches and capillaries for temperature controllers to the switch panel. See Sec. III.

EXTERNAL SPEED CONTROLLER

Mount external speed controller and adjust stops to stop 1/64 inch before hitting internal stops. Make sure full scoop travel is available. See Sec. III.

PUMPS, COOLERS, VALVES, ETC.

Prior to flushing, all remaining auxiliary equipment should be located and installed. See Sec. III for location and details.

FLUSHING

If not already provided, provisions should be made to allow installation of strainer screens at the suction of the oil pumps. This can be in the form of a spool piece or a "Y" type strainer assembly with suitable shut-off and drain arrangements to allow removal of screen for cleaning and inspection during flushing. The strainer should have an opening area of four times the pipe area — 100 mesh screen minimum. Once the piping system is thoroughly cleaned, the suction strainer must be removed.

THERMOCOUPLE ASSEMBLY

Customer to connect his leads as required to terminal strip in terminal box. Customer's terminal connections are indicated with black dots on drawing.

TEMPERATURE CONTROLS

Temperature switches are provided to shut down main driving motor and inform operator when fluid drive oil temperature is abnormal. The switch locations are shown on Sec. III. For specific operating and setting instructions see Sec. III.

PRESSURE VALVES

Pressure valves may be supplied to maintain the customer's lubricating oil at a predetermined pressure.
specific details.

OIL FILTERS

Cleanable oil filters provide filtered oil to the fluid drive during normal and emergency operations. See Sec. III.

EXTERNAL SPEED CONTROLLER

Various types of actuators may be attached to the fluid drive speed control rod for manual or automatic control of the fluid drive. Automatic actuators may be electric, pneumatic or hydraulic systems. Some actuators must be mounted on a separate base next to the fluid drive. See Sec. III.

OIL MIST ELIMINATOR

The oil mist eliminator is a self-contained assembly side-mounted on the fluid drive housing. The assembly includes a motor and blower to induce the proper vapor flow through the eliminator. The oil vapor laden air is drawn out of the fluid drive tank and through the filter element of the eliminator. See Sec. III.

PRESSURE REGULATING VALVE

This valve reduces fluid drive lube pressure for customer's bearings and can be adjusted at the job site if required. If the valve fails it fails open so customer's bearings are over-supplied and not under-supplied in case of failure. See Sec. III,

STARTING PROCEDURE

Follow normal operating instructions in Section I of manual with the following exception:

EXTERNAL OIL PUMPS*

Prior to starting main driving motor, energize the circuit and lubrication pumps in the following manner:

Follow normal starting procedures for one circulation and lubrication pump set. ENERGIZE AC STAND-BY PUMP PRIOR TO STARTING MAIN DRIVING MOTOR TO INSURE PROPER LUBRICATION DURING START-UP.

NOTE: If two or more external pump sets are used, rotate the operation of the pump sets to extend life and insure reliability.

COLD OIL OPERATION

Pumps may have a tendency to be noisy with cold oil. As oil heats up, noise should abate. If noise appears excessive, check to see if all valves on pump base are open. See schematic piping, Sec. III,

PRESSURE AND TEMPERATURE CONTROLS

Check pressure and temperature switch settings prior to starting main driving motor. See Specifications, Sec. III

MAIN DRIVING MOTOR

With the scoop tube in the declutch position and the system requirement for pressure in lubricating system having been satisfied, the main driving motor can be energized.

NOTE: Rotation of motor to match fluid drive. Allow unit to warm up slowly. See Sec. I, Normal Operating Instructions.

* Applies only to special starting instructions for two or more external oil pumps.

EXTERNAL SPEED CONTROLLER

If no excessive vibration is present and all components are functioning properly the external speed controller can be moved slowly to the full speed position and allow a short period of time for load to reach full speed. Recheck oil level at full speed. Sight glass should show minimum level.

NORMAL SHUT DOWN

Move speed control to declutch position. De-energize main driving motor. De-energize circuit and lube pump motor(s) only after input shaft has stopped. De-energize remaining auxiliary equipment such as: oil mist eliminator, low pressure alarms, etc.

NOTE: It is not necessary that water supply to oil coolers be shut off during limited time down - i.e. 5 days or less. Water conservation may dictate whether this is followed.

EMERGENCY SHUT DOWN

The external speed controller may be set to lock in position or return to declutch or full clutch position per customer's requirements upon loss of manifold oil pressure. Pressure switches trip the main driving motor upon loss of manifold oil pressure and activate DC motor driven lubrication pump after a nominal time delay of 5 seconds. See Sec. III.

FORM NO. 1185FD REV. 11-77 K&E 10 5135

ITEM	REQ.	DESCRIPTION
1	1	SIZE #146, CCW ROTATION, TYPE VS, CLASS 6, GYROL FLUID DRIVE WITH OIL COOLER ITEM #2, MOUNTED ON RIGHT HAND SIDE WITH LEFT HAND CONTROL, WITH INTERNAL 44 GPM PUMP PER B/M 78-146D-6-104 AND SERIAL NO. 78-146-6-104 DUTY: CUSTOMERS MOTOR: 800 H.P. @ 3600 RPM BOILER FEED PUMP DRIVE: VARIABLE TORQUE LOAD 5:1 SPEED REDUCTION MARK ITEM #1: S.O. 1A995 FLUID DRIVE COMPLETE WITH THE FOLLOWING: - (1-A) MOUNT ACTUATOR ITEM NO. 4, COMPLETE WITH BRACKET & LINKAGE (1-B) MOUNT PICK-UP BRACKET (PICK-UP INCLUDED IN ITEM #3) ON OUTPUT END OF FLUID DRIVE. (1-C) PROVISIONS IN OIL COOLER INLET & OUTLET PIPING FOR TEMPERATURE DETECTORS (ITEM #10)
2	1	CPK 08042 OIL COOLER WITH 5/8" DIA. LO-FIN ADMIRALTY TUBES, CAST IRON CHANNELS, & MUNTZ TUBE SHEETS, P/N 5-046-08-042-009 REV. 1 CONNECTIONS TO BE POS. A, 1 & 4Z. COOLER DUTY: HEAT LOAD @ 407,200 OIL FLOW @ 44 GPM OIL ENTERING @ 179.1°F OIL LEAVING @ 135°F WATER FLOW @ 80 GPM WATER ENTERING @ 85°F WATER LEAVING @ 95.2°F
3	1	GYROLTROL CONTROLLER, MODEL 430 WITH NEMA 12 ENCLOSURE, P/N 67954.
4	1	MODEL A510 JORDAN ELEC. ACTUATOR WITH NEMA 12 ENCLOSURE, P/N 73-CP-5587-1.

A
TEM #1
OOLER IS NOW
OUNTED
TEM #2
ONN. POS. ADDED
-18-80 JPW C.K.

B
TEM #2
OOLER P/N
DDED
3-1-80 C.K.

C
ITEM #1-C
ADDED
11-6-80

D

E

F

INDUSTRIAL PRODUCTS DIVISION
AMERICAN-STANDARD
INDUSTRIAL PRODUCTS GROUP

ORDER BILL OF MATERIAL

SIZE #146, CLASS 6 GYROL FLUID DRIVE
CUST. BINGHAM-WILLAMETTE CO.
JOB
CUST. P.O. NO. 1-58963
SIZE A
ORDER NO. 3-82308
DRAWING NUMBER 78-AD-6271 PG. 1 OF 2 PGS.
REV. C

DWN. C. McC 3.13.80
CHKD.
APPD.

ITEM	REQ.	DESCRIPTION
5	1	AIRPAX SPLIT GEAR, 60 TOOTH, P/N 67366
6	1	ASHCROFT BI-METAL DIAL THERMOMETER, P/N 67350, CAT. #30A160L, 0° - 250°F.
7	1	ASHCROFT THERMOMETER WELL, P/N 67351, CAT. #T38S75T040, 304 STAINLESS ST'L
9	1	STATIONARY END TWO-PASS CHANNEL & HARDWARE FOR THE CPK 08042 OIL COOLE (ITEM #2) FOR CONNECTIONS POS. A, 1 & 4 Z.
10	2	T.A. EDISON #1GG NC 720 RESISTANCE TEMPERATURE DETECTOR, PART Nº 78PP1900 T.A. EDISON #3578G DETECTOR HOLDER, PART Nº 78PP1895

TEM 9 DDED -18-80 P.W.	A C.K.
ITEM # 10 ADDED 11-6-80	B
	C
	D
	E
	F

INDUSTRIAL PRODUCTS DIVISION
AMERICAN-STANDARD
INDUSTRIAL PRODUCTS GROUP

ORDER BILL OF MATERIAL

SIZE #146, CLASS 6 GYROL FLUID DRIVE

CUST. BINGHAM-WILLAMETTE CO.

JOB

CUST. P.O. NO. 1-58963

SIZE	ORDER NO. 3-82308		REV.
A	DRAWING NUMBER 78·AD·6271	PG. 2 OF 2 PGS.	B

DWN.	L McC	3-13-80
CHKD.		
APPD.		

FORM AV-1185 REV 8-79 K&E 10 8155 8-79 2417

REV.	ECN	DESCRIPTION	DATE	CHK.	APPD.

INSTALLATION NOTES
FLUID DRIVE

SEE OUTLINE DIMENSION DRAWING 78 CD 6266

1. THE DIMENSIONS SHOWN ON THESE DRAWINGS ARE CORRECT WITHIN LIMITS SUITABLE FOR INSTALLATION REQUIREMENTS. DO NOT SCALE THE DRAWING.

2. OPENING IN BUILDING OR STRUCTURE OF SUFFICIENT SIZE TO PERMIT ENTRANCE OF THE EQUIPMENT SHOWN ON THE DRAWINGS MUST BE PROVIDED.

3. AN ADEQUATE AND LEVEL FOUNDATION MUST BE PROVIDED TO SUPPORT THE WEIGHT OF THE EQUIPMENT FURNISHED. DIFFERENTIAL SETTLEMENT SHOULD NOT BE ALLOWED BETWEEN THE FLUID DRIVE AND DRIVING OR DRIVEN MACHINES. WHEN FLUID DRIVE IS TO BE MOUNTED ON A STEEL SUB-BASE WITH OTHER EQUIPMENT, IT IS RECOMMENDED THAT HOLES IN SUB-BASE BE LOCATED FROM UNIT AFTER IT HAS BEEN ALIGNED WITH THE OTHER EQUIPMENT. WHEN A STEEL SUB-BASE IS SPECIFIED UNDER FLUID DRIVE, USE ONLY FLAT METAL SHIMS TO ALIGN SUB-BASE TO PREVENT SPRINGING BEFORE TIGHTENING HOLD DOWN BOLTS PRIOR TO GROUTING. SUB-BASE TO BE FILLED COMPLETELY WITH GROUT FLUSH WITH GROUT RISES AT LEAST 2-1/2" OF GROUT REQUIRED UNDER SUB-BASE.

4. WHEN SOLE PLATES ARE SPECIFIED, CUSTOMER TO ALLOW 2-1/2" (MIN.) GROUT UNDER SOLE PLATE.

5. DOWEL HOLES TO BE DRILLED AND REAMED FOR DOWEL PINS BY CUSTOMER AFTER ALIGNMENT IS PROVED CORRECT.

6. PIPING BETWEEN FLUID DRIVE AND OTHER EQUIPMENT IS TO BE FITTED IN THE FIELD AFTER ALIGNMENT AND SUPPORTED TO ELIMINATE ALL STRAIN AND LOAD ON EQUIPMENT CONNECTIONS. PIPING TO BE CLEAN AND FREE FROM ALL FOREIGN MATERIAL BEFORE START-UP.

7. SPECIAL FEATURES, SUCH AS SOLE PLATES, SUB-BASE AND FLEXIBLE COUPLING GUARDS ARE FURNISHED ONLY IF SPECIFICALLY LISTED ON THE ORDER BILL OF MATERIAL.

8. TEMPERATURE SENSORS IN THE FLUID DRIVE BEARINGS WHEN SPECIFIED WILL BE MADE FOR THE FOLLOWING:

   LEEDS & NORTHRUP OR T.A. EDISON - SEE ORDER BILL OF MATERIAL

9. ACCESS OPENING MUST BE PROVIDED TO FLUID DRIVE ACCESS COVER WHEN FURNISHED ON INPUT END, FOR CLEANING HOUSING.

10. NO OIL IS FURNISHED WITH THE FLUID DRIVE. A GOOD GRADE OF MINERAL OIL SUCH AS IS USED FOR STEAM TURBINE LUBRICATION AND HAVING A VISCOSITY OF ABOUT 150 SSU AT 100°F SHOULD BE USED. MORE OIL WILL BE NECESSARY TO FILL OIL COOLERS AND P PIPING.

ON	DRAWN N. LUTZ	DATE 3-10-80
MAT'L.	CHECKED C.McC	
MAT'L. SPEC.	APPD.	
SCALE		

INDUSTRIAL PRODUCTS DIVISION
AMERICAN-STANDARD
POWER & CONTROLS GROUP

TITLE INSTALLATION NOTES
SIZE 146, CLASS G FLUID DRIVE
CUSTOMER BINGHAM-WILLAMETTE CO.
AT PORTLAND, OREGON
CUSTOMER P.O. NO. 1-58963
SALES ORDER NO. S-82308
SIZE A DRAWING NUMBER 78-AD-6270 REV.

AMERICAN BLOWER CORPORATION-DETROIT

BILL OF MATERIAL

REV. NO.	ITEM NO.	PART NO.	REQ'D	DESCRIPTION	NET WT.	DRWG. NO.	REMARKS
	1	78SA1858	2	P-Blk. Up & Lower - Fin. Mach.		78C240	
	2	78P1859	2	Up-half - Semi-Mach.		78C240	
	3	78CI-1859	2	Rough Casting		78C240	
	4	78P1860	2	Lower Half - Semi-Machine		78C240	
	5	78CI-1860	2	Rough Casting		78C240	
	6	70054	12	Hex. Hd. Cap Screw		HDW-100-10.1	1/2-13x 1-1/2 Lg.
	7	66857	4	Hex. Hd. Cap Screw		HDW-100-10.1	1/2-13 x 2-1/2 Lg.
	8	879	16	LOCKWASHER		HDW 209-1	1/2
	9	25961	4	Taper Pin and Nut		HDW515-4	#6 x 1-1/2 Lg.
	~~10~~	~~78P346~~	~~4~~	~~Bolt Locking Strap~~	.036	~~78A444~~	
	11	1742	4	Plug		HDW861-2	3/8"
	12	78SA1299	2	P-Blk. End Cover Assembly		78B211	
	13	78P360	4	End Cover Half		78B211	
	14	78CI-5	4	Rough Casting		78B211	
	15	70054	4	Hex. Hd. Cap Screw		HDW 100-10.1	1/2-13 x 1-1/2 Lg.
	16	879	4	LOCKWASHER		HDW 209-1	1/2
	17	25957	4	Taper Pin and Nut		HDW515-4	#5 x 1-1/4" Lg.
	~~18~~	~~78P345~~	~~4~~	~~Bolt Locking Strap~~	.016	~~78A444~~	
	19						
	20	70054	12	Hex. Hd. Cap Screw		HDW-100-10.1	1/2-13x 1-1/2 Lg.
	21	879	12	LOCKWASHER		HDW 209-1	1/2
	22	25958	4	Taper Pin and Nut		HDW515-4	#5 x 1-1/2 Lg.
	~~23~~	~~78P345~~	~~4~~	~~Bolt Locking Strap~~	.016	~~78A444~~	
	24						
A	~~25~~	~~78P913~~	~~4~~	~~Magnetic Plug~~		~~78A435~~	~~1" N.P.T.~~
	26		2	Yellinoid Gasket 1/64 THK			14 x 20
	27	1742	2	PIPE PLUG		HDW 861-2	3/8 STD.
	~~28~~	[illegible]	~~2~~	~~JOURNAL BEARING } C.W.~~		~~78B337~~	~~I.O.R. & O.I.R.~~
	~~29~~	[illegible]	~~2~~	~~Journal Bearings } Rotation~~		~~78B338~~	~~I.I.R. & O.O.R.~~
	~~30~~	[illegible]	~~4~~	~~Set Screw Hex. Cup Pt.~~		[illegible]	~~3/4-16 x 1-1/4 Lg.~~
	31	26017	4	Hex. Jam Nut		HDW113-1	3/8-16 x 1-1/4 THK
	32	22630	4	Dowel Pins		HDW515-6	1/4 x 1/2 Lg.
	33	78PP2464	2	JOURNAL BEARING } CCW		78B337	I.IR & C.O.R.
	34	78PP2465	2	JOURNAL BEARING } ROTATION		78B338	I.OR & O.I.R.
	35	78SA 2012	1	Impeller Shaft Assembly		78B314	
	36	78P371	1	Shaft-Rough Mach.	51.8	78B314	
	37	78P373	1	Bolting Flange	16.4	78A7	
	38	78P372	1	Bearing Flange	19.9	78A7	
	39						
	40	78P357	1	Spacer Button - 1/4	0.45	78A158	
	41						
	42						
	43	78SA 2013	1	Runner Shaft Assembly		78B315	
	44	78P376	1	Shaft - Rough Mach.	78.7	78B315	
	45	78P373	1	Bolting Flange	16.4	78A7	
	46	78P372	1	Bearing Flange	19.9	78A7	
	47						

BILL OF MATERIAL

REV. NO.	ITEM NO.	PART NO.	REQ'D	DESCRIPTION	NET WT.	DRWG. NO.	REMARKS
	48						
	49	2788	2	Key		HDW 301-1	3/4 x 3/4 x 4" LG.
	50						
	51	78SA840	1	Runner Casing Assembly		78B163	
	52	78P378	2	Casing Spinning	29.5	78A70	
	53	78P383	1	Bolting Ring	37.1	78A75	
	54	78P387	1	Balance Ring	4.9	78A449	
	55	78P172	12	Channel	.16	78A25	
	56						
	57						
	58						
	59						
	60		1	Gskt.-Run.& Imp.Cases-15-3/8 ID x 17-7/8 OD.			1/32 Yellin[illegible]
	61						
	62	78SA839	1	Impeller Casing Assembly		78B162	
	63	78P378	1	Casing Spinning	29.5	78A70	
	64	78P382	1	Balance Disc	12.4	78A74	
	65	78P383	1	Bolting Ring	37.1	78A79	
	66						
	67						
	68						
	69	28639	3	Dowel Pin		HDW515-6	1/2 x 1-1/4 Lg.
	70	70413	24	Hex. hd. Cap Screw		HDW 206-11	7/16-14 x 1-3/4
	71	1301	24	Spring Lock Washer		HDW 209-1	7/16 Std.
	72	28	12	Hex. Hd. Cap Screw		HDW-104-2	5/16-18 x 1 Lg.
	73	695	12	Spring Lock Washer		HDW209-1	5/16 Std.
	74						
	75						
	76	78SA835	1	Impeller Assembly		78B160	
	77	78P836	1	Impeller - Machined		78B160	
	78	78AL-836	1	Rough Casting		78B160	
	79	78AL-836A	1	Vane Core Box		78B160	
	80	78P1391	6	Heli-Coil Thread		HDW 828-1	1/2-13 x 1 Lg.
	81	77P22	12	Heli-Coil Thread		HDW 828-1	5/16-18 x 5/8 Lg.
	82						
	83						
	84						
	85						
	86						
	87						
	88						
	89						
	90						
	91						
	92	66855	6	Hex. Hd. Cap Screw		HDW 100-10.1	1/2-13 x 2 Lg.
	93	879	6	LOCKWASHER		HDW 209-1	1/2
	94	78P844	2	Dowel Pin	.09	78A160	

DO NOT USE FOR CONSTRUCTION UNLESS PRINT IS SIGNED ON BACK	MADE BY J. WITTBRODT	CHECKED BY	S126-8148 - GYROL FLUID DRIVE - TYPE "HS" CLASS 6 CUST. - BINGHAM-WILLAMETTE CO. ORDER NO 3-82308 SERIAL #78-146-6-104
S.O. NO.	DATE 3-21-80	CUSTOMER NO.	APPROVED BY

78C-293
78CD6[illegible]
1,2,23-130

78-146-6-104 CCW

PAGE NO. 1
CONT'D FROM -
CONT'D ON 2
FINAL PAGE

R.H.
ITEM #1

AMERICAN BLOWER CORPORATION-DETROIT

REV A 8/ NR ID 7-18-80 J.P.W. C.K.

REV. NO.	ITEM NO.	PART NO.	REQ'D	DESCRIPTION	NET WT.	DRWG. NO.	REMARKS
	189						
	190						
	191	78P1089	1	Rod Seal End Cover		78A104	
	192	78AL-1089	1	Rough Casting		78A104	
	193	78PF246	2	Perfect Oil Seal		78AA19	#17330
	194	78P247	1	Rod Guide	.491	78AA8	
	195	78P248	2	Rod Seal Plate	.038	78AA9	
	196	70PF690	1	Gasket - 1/16 Granite		HDW 869-9	1-1/4 x 150#
	197	69PF1315	1	Companion Flange		HDW 866-6	1-1/4 x 150°
	198	133	4	Hex. Hd. Cap Screw		HDW 104-1	5/16-18 NC x 2-1/4
	199	69	4	Hex. Nut		HDW 112-1	5/16-18 NC
	200	623	4	Flat Washer		HDW 210-1	5/16
	201	495	4	Spring Lock Washer		HDW 209-1	5/16
	202	1189	1	Nipple		HDW 870-2	1-1/4 x 1-5/8
	203	25956	2	Taper Pin & Nut		HDW 515-4	#5 x 2
	204						
	205						
	206						
	207	78P1031	2	Shaft Vapor Seal Ring	.71	78AA68	
	208	78P1233	2	Shaft Seal		78E207	
	209	78AL-1232	2	Rough Casting		78E207	
	210						
	211	156	16	Hex. Hd. Cap Screw		HDW 104-5	1/2-13 NC x 1 1/4 Lg.
	212	626-C	16	Spring Lock Washer		HDW 210-1	1/2 Std.
	213	78P1291	2	Gasket		79A108	
	214	28811	4	Taper Pin & Nut		HDW 515-4	#5 x 1
	215	78P801	2	Dust Seal Ring	1.46	78A62	
	216	695	2	Hol. Hd. Set Screw - Cup Pt.		HDW 202-1	3/8-16 NC x 3/8 Lg.
	217						
	218	78 DS 3071-1	1	HOUSING & COVER ASSEMBLY		78 D 3071	RIGHT HAND
	219						
	220						
	221	78 AS 3045	1	HOUSING & PILLOW BLOCK ASS'Y		78 A 3045	
	222						
	223						
	224	~~78P1266~~	~~1~~	~~Cover - Fin. Machined~~		~~78C152~~	SEE PAGE 8
	225	~~78SA1265~~	~~1~~	~~Cover - Welding Assembly~~		~~78C151~~	
	226	~~78P 2109~~	~~1~~	~~Housing - Fin. Machined~~		~~78C255~~	
	227	[illegible]	~~1~~	~~Housing - Welding Assembly~~		~~78C262~~	
	228	66967	1	OIL LEVEL GAUGE		[illegible]	
	229	~~2648~~	~~2~~	~~REDUCING ELL~~		~~HDW 865-2~~	~~3/4 - 1/2 x 90°~~
	230	~~28461~~	~~4~~	~~Nipple~~		~~HDW 870-3~~	~~3/4 x 2~~
	231	~~25631~~	~~1~~	~~NIPPLE~~		~~HDW 870-3~~	~~3/4 x 4~~
	232	~~69PF1313~~	~~2~~	~~Companion Flanges~~		~~69AA37~~	~~3/4 x 150#~~
	233	~~1632~~	~~2~~	~~Elbow~~		~~HDW 865-9~~	~~3/4 x 90°~~
	234	~~1668~~	~~2~~	~~Nipple~~		~~HDW 870-3~~	~~1/2 x 1 1/8~~
	235	~~70PF690~~	~~1~~	~~Gasket - 1/16 Granite~~		~~HDW 869-9~~	~~3/4 x 150#~~
	236	~~571~~	~~4~~	~~Hex. Hd. Bolt~~		~~HDW 100-3~~	~~1/2-13 NC x 1-~~
	237						
	238	~~879~~	~~4~~	~~Spring Lock Washer~~		~~HDW 209-1~~	~~1/2~~
	239	~~156~~	~~4~~	~~Hex. Hd. Cap Screw~~		~~HDW 104-5~~	~~1/2-13 x 1-1/4 Lg.~~
	240	~~571~~	~~36~~	~~Hex. Hd. Bolt & Nut~~		~~HDW 100-3~~	~~1/2-13 NC x 1-3/4 Lg.~~
	241	~~879~~	~~40~~	~~Spring Lock Washer~~		~~HDW 209-1~~	~~1/2 Std.~~
	242	~~28811~~	~~2~~	~~Taper Pin & Nut~~		~~HDW 515-4~~	~~#5 x 1 Lg.~~
	243		~~2 Req'd.~~	~~Gasket - 2-1/2 x 24~~			[illegible]
	244						
	245						
	246	26665	4	Set Screw-HH CUP Pt.-Leveling		HDW 202-3	3/4-10 NC x 1 1/4 Lg.
	247						
	248	78P 843	4	Hol. Hd. Cap Screw		79AA66	
	249	26292	4	Slotted Nut - Heavy		HDW 121-1	3/4-10
	250	836	4	Cotter Pin		HDW 515-1	3/16 x 2 Lg.
	251	70514	4	Hex. Hd. Cap Screw		HDW 100-7.2	3/4-10 x 2 1/4 Lg.
	252	882	4	LOCKWASHER		HDW 203-1	3/4
	253	~~78P769~~	~~4~~	~~Flat Washer~~		~~79AA65~~	
	254						
	255	1747	5	Pipe Plug - Hol. Hd.		HDW 861-2	1-1/4
	256	1214	1	Pipe Plug - Hol. Hd.		HDW 861-2	1-1/2
	257	1217	1	PIPE PLUG - SQ. HD.		HDW 861-1	3/4
	258	951	2	Pipe Plug - Sq. Hd.		HDW 861-1	1/4
	259						
	260						
	261	~~78P1525~~	~~2~~	~~SIGHT GAUGE POINTER~~		~~78AA99~~	
	262	100AP3007	1	Nameplate		100A3007	
	263	5862	4	Drive Screw		HDW 519-1	#4 x 1/4
	264						
	265						
	266						
	267	100BP3000	2	Nameplate		100B3000	
	268	30126	6	Hol. Hd. Cap Screw		HDW 204-8	1/4-20 NC x 5/8
	269	~~885~~	~~6~~	~~Spring Lock Washer~~		~~HDW 209-1~~	~~1/4~~
	270	78P1257	1	Breather Filter		78A67	Air-Maze #7
	271						
	272						
	273	78PP669	2	PRESSURE GAUGE		78AA11	AS-CROFT #10096
	274						
	275	78SA1088	1	Oil Pan		78B138	
	276	78P1082	4	Clamp		78AA82	
	277	127471	4	Hex. Hd. CAPSCREW & NUT		HDW 104-3 " 112-1	3/8-16 x 1-1/2 Lg.
	278	624	8	Flat Washer		HDW 210-1	3/8
	279	608	4	Spring Lock Washer		HDW 209-1	3/8
	280						
	281						
	282						

DO NOT USE FOR CONSTRUCTION UNLESS PRINT IS SIGNED ON BACK

MADE BY J. WITTBRODT

CHECKED BY

S.J. NO.

DATE 3-21-80

REVISION NO.

APPROVED BY

SIZE #146 - GYROL FLUID DRIVE - TYPE "VS" CLASS 6
CUST. - BINGHAM-WILLAMETTE CO.
ORDER NO. 3-82308 SERIAL #78-146-6-104

ASSEMBLY DRAWING NUMBER 78C233
78CC[illegible]

SIZE DESCRIPTION 78-146D-6-104 CCW

PAGE NO. 3
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FINAL PAGE 7

B/M NUMBER R.H. ITEM #4

MERCHANDISE BILL OF MATERIAL

1,2,23-131

REVISION	S. J. NO.	DATE	BY

AMERICAN BLOWER CORPORATION - DETROIT

REV. A. B/M No.

REV'D. 7-18-80 J.P.W.

						WT.	DRWG. NO	REMARKS
	283							
	284		1 Ft.	Aviation Permatex No. 3				
	285	~~79P392~~	~~1~~	~~Shipping Container~~		~~2.6~~	~~79AA74~~	
	286		1	Instruction Book	ONE PER			
	287		1	Water Proof Paper	SALES			
	288	28419	2	Cotter Pin	ORDER		HDW515-1	3/16 x 4" Lg.
	289	519	2	Hex. Hd. Bolt & Nut			HDW100-3	1/2-13 x 1" Lg.
	290	879	2	Spring Lock Washer			HDW209-1	1/2 Std.
	291							
	292			~~BALANCING SPECIFICATIONS~~			~~DSN 560.6~~	
	293			Cleaning & Painting			DSN595-1	
	294	66673		Paint			HDW950-101	
	295							
1	~~296~~	~~79P1635~~	~~4~~	~~Shipping Bearing~~			~~[illegible]~~	~~Per Order~~
1	~~297~~	~~79A1-1635~~	~~4~~	~~Rough Casting~~			~~[illegible]~~	
	298	~~78S1868~~	~~1~~	~~Sub Base~~		See Dwg.	~~78C165~~	~~For Order~~
	299	~~78S4937~~	~~1~~	~~Sole Plate~~		~~685.9~~	~~78C160~~	~~For Order~~
	300							
	301	~~78PP909~~	~~4~~	~~Hex. Hd. Cap Screw~~			~~78AA64~~	~~3/4-10 x 2-1/4 Lg.~~
	302	~~882~~	~~4~~	~~Spring Lock Washer~~			~~HDW209-1~~	~~3/4 Std.~~
	303	~~25985~~	~~2~~	~~Taper Pin and Nut~~			~~HDW515-5~~	~~#8 x 2 Lg.~~
	304	~~78P1223~~	~~4~~	~~Housing Shim~~		~~1.14~~	~~78A113~~	
	305							
	306							
	307	~~78SA729~~	~~2~~	~~Flex. Coupling Guard - Hinged~~		See Dwg.	~~78C140~~	~~For Order~~
	308	~~78SA269~~	~~2~~	~~Flex. Coupling Guard~~		~~26.5~~	~~78B156~~	~~For Order~~
	309	~~503~~	~~4~~	~~Hex. Hd. Bolt and Nut~~			~~HDW100-3~~	~~1/2-13 x 1" Lg.~~
	310	~~879~~	~~4~~	~~Spring Lock Washer~~			~~HDW209-1~~	~~1/2 Std.~~
	311							
	312							
	313							
	314	78PP1378	1	Control Rod Sleeve W/Clamps			78E184	
	315							
	316							
	317	67096	1	SHIPPING STRAP ASSY.			HDW890-229	
	318		2	EYE BOLT				
	319							
	320							
	321							
	322							
	323							
	324							
	325							
	326							
	327							
	328							
	329							

REV. NO.	ITEM NO	PART NO.	REQ'D	DESCRIPTION	NET WT	DRWG. NO.	REMARKS
	330		~~1~~	~~Dig. Thermocouple, Assembly [illegible]~~		~~78P212~~	L&N No.8792
	331						
	332	954	2	Pipe Plug		HDW861-1	1-1/4 Std.
	333	~~78PP1026~~	~~2~~	~~Temp. Thermocouple - 6 Ft.~~		~~78AA76~~	~~Imp. P.B.~~
	334	~~78PP1027~~	~~2~~	~~Temp. Thermocouple - 8 Ft.~~		~~78AA76~~	~~Run. P.B.~~
	335	~~78PP376~~	~~4~~	~~Compression Fitting~~		~~HDW896-3~~	~~For 3/16 OD Tube~~
*	336	78P529	4	Hex. Hd. Screw		78AA54	3/8-16 NC [illegible]
	337						
	338	2686	12	Tube Clip		HDW853-4	For 1/4 OD Tube
	339	756	24	Rd. Hd. Mach. Screw		HDW109-1	#8-32 NC x 3/8 Lg.
	340	25263	24	Spring Lock Washer		HDW209-1	#8 Std.
	341	78P1881	1	Thermocouple Support	2.5	78A157	
	342	78P1877	1	Clip Angle	1.8	78AA115	3x 4 x 5/16 - 3" Lg.
	343						
	344	78SA1039	1	Terminal Box Sub-Assembly	9.48	78A102	
	345	78P1043	1	Gasket		78AA73	
	346	78P1044	1	Cover	4.61	78AA74	
	347	78PP1045	2	Terminal Strip		78AA75	
	348	28553	8	Rd. Hd. Mach. Screw		HDW109-1	#6-32 x 1/2 Lg.
	349	1132	12	Hex. Hd. Bolt with Nut		HDW100-1	5/16-18 x 1 Lg.
	350	495	12	Lock Washer		HDW209-1	5/16 Std.
	351						
	352						
	353	~~WHEN LEEDS AND NORTHRUP IRON CONSTANTAN THERMOCOUPLES ARE CALLED FOR ON ORDER~~					
	354	USE THE FOLLOWING - AND OMIT 333, 334.					
	355		1	Thermocouple Assembly		78P212	L&N No.8793
	356	78PP1871	2	Thermocouple - 6 Ft.		78AA114	Imp. P.B.
	357	78PP1872	2	Thermocouple - 8 Ft.		78AA114	Run. P.B.
	358						
	359						
	360	WHEN T.A. EDISON TEMP. DETECTORS ARE CALLED FOR ON ORDER - USE THE FOLLOWING -					
	361	~~AND OMIT ITEM 333 AND 334. & 335~~					
	362		1	Temp. Detector Assembly		78C374 Pc. 2	T.A.E. No.166 NC
	363	78PP1900	2	Temp. Detector - 6 Ft.		78AA119	Imp. P.B.
	364	78PP1902	2	Temp. Detector - 8 Ft.		78AA119	Run. P.B.
	365	78PP1895	4	Detector Holder		78AA117	
	366	78PP1896	4	Oil Seal Fitting		78AA118	
*	367	NOTE: REDRILL-3/16 HOLE IN PART #78-P529 (ITEM #336) TO .221 DIA.					
	368	WHEN T.A. EDISON TEMP. DETECTORS ARE REQUIRED					
	369	~~WHEN THERMOCOUPLES OR TEMP. DETECTORS ARE NOT INSTALLED BY A.B. DIV. -~~					
	370	USE ITEM 372 OR 373.					
	371						
	372	950	4	Pipe Plug (For L&N)		HDW861-1	1/8 Std.
	373	952	4	Pipe Plug (For T.A.Edison)		HDW861-1	1/2 Std.
	374						
	375						
	376						

DO NOT USE FOR CONSTRUCTION UNLESS PRINT IS SIGNED ON BACK	MADE BY J.WITTEBOLT	CHECKED BY	SIZE #146 - GYROL FLUID DRIVE - TYPE "VS" CLASS 6 CUST.-BINGHAM-WILLAMETTE CO. ORDER NO. 3-82308 SERIAL NO. 78-146-6-104	ASSEMBLY DRAWING NUMBER 78C-293 78CD-6266	SIZE DESCRIPTION 78-146D-6-104 CCW
S.J. NO.	DATE 3-21-80	REVISION NO	APPROVED BY		

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B/M NUMBER R.H.
ITEM #1

MERCHANDISE BILL OF MATERIAL

REVISION	S. J. NO.	DATE	BY

1,2,23-132

AMERICAN-Standard INDUSTRIAL DIVISION DETROIT 32, MICH.

BILL OF MATERIAL

REV. NO.	ITEM NO.	PART NO.	REQ'D	DESCRIPTION	NET WT.	DRWG. NO.	REMARKS
	377		1	PIPING ASSEMBLY R.H.		78CD6273	INTERNAL
	378						
	379	25507	2	PIPE-NIPPLE-T.B.E		HDW 870-5	1¼" x 3" LG
	380	5459	7	PIPE-ELBOW		HDW 865-9	1¼" x 90°
	381	~~3858~~	~~?~~	~~PIPE ELL 90° SLIP JOINT~~		[illegible]	~~DRESSER STYLE~~
	382	4712	1	PIPE-TEE		HDW 865-12	1¼"
	383	66718	3	PIPE-COUPLING-SLIP JOINT		HDW 865-18	1¼" DRESSER STYLE 38
	384	3950	1	PIPE-NIPPLE-T.O.E.		HDW 870-4-1.1	1¼" x 4¼" LG
	385	28727	1	PIPE-NIPPLE-T.B.E.		HDW 870-5	1¼" x 6½" LG
	386	3953	2	PIPE-NIPPLE-T.B.E.		HDW 870-5-1	1¼" x 7" LG
	387	26087	1	PIPE-NIPPLE-T.B.E.		HDW 870-5	1¼" x 9" LG
	388		1	PIPE-T.B.E.			1¼" x 22½ LG
	389		2	PIPE-T.S.E.			1¼" x 7½ LG
	390	3902	1	PIPE-NIPPLE-T.O.E.		HDW 870-4-1.2	1¼" x 9¾" LG
	391	3902	1	PIPE-NIPPLE-T.O.E.		HDW 870-4-1.2	1¼" x 9¾" LG
	392	3901	2	PIPE-NIPPLE-T.O.E.		HDW 870-4-1.2	1¼" x 4½" LG
	393						
	394	26201	1	STREET ELL-THD.		HDW 865-10	1¼" x 90°
	395						
B	396	78CS6563-1	1	PIPING ASSEMBLY R.H.		78CD6563	EXTERNAL
	397						
	398	~~4712~~	~~1~~	~~PIPE TEE~~		~~HDW 865-12~~	~~1¼~~
	399						
	400		~~1~~	~~PIPING ASSEMBLY L.H~~		~~78CD-5758~~	~~INTERNAL~~
	401						
	402	1189	4	PIPE-NIPPLE-T.B.E.		HDW 870-5	1¼" x 1⅝" LG.
	403	5459	9	PIPE-ELBOW		HDW 865-9	1¼" x 90°
	404	~~3858~~	~~1~~	~~PIPE ELL 90° SLIP JOINT~~		[illegible]	~~DRESSER STYLE 90~~
	405	4712	1	PIPE-TEE		HDW 865-12	1¼"
	406	66718	2	PIPE-COUPLING-SLIP JOINT		HDW 865-18	1¼" DRESSER STYLE 38
	407	3951	1	PIPE-NIPPLE-T.O.E		HDW 870-5-1	1¼" x 5¼" LG
	408	3893	2	PIPE-NIPPLE-T.O.E		HDW 870-4-1.2	1¼" x 2½" LG
	409	3953	2	PIPE-NIPPLE-T.B.E.		HDW 870-5-1	1¼" x 7" LG
	410	3896	2	PIPE-NIPPLE-T.O.E.		HDW 870-4-1.1	1¼" x 4¼" LG
	411	3904	2	PIPE-NIPPLE-T.O.E.		HDW 870-4-1.2	1¼" x 11" LG
	412	1618	2	PIPE COUPLING		HDW 864-1	3/4
	413	954	2	PIPE PLUG		HDW 861-1	1¼
	414	28516	1	PIPE-NIPPLE-T.B.E.		HDW 870-5	1¼" x 10½" LG
	415						
	416	26211	1	PIPE UNION		HDW 866-1	1¼
	417	~~3952~~	~~1~~	~~PIPE NIPPLE T.B.E.~~		~~HDW 870-5-1~~	~~1¼ x 6¼"~~
	418	26084	1	STREET ELL		HDW 865-10	3/4 x 90°
	419	26231	1	REDUCING BUSHING		HDW 862-1	3/4 x 3/8
	420	70PP-207	1	PARKER RUN TEE		HDW 875-16	8 RBU-S
	421	79PP-153	2	PARKER MALE ELBOW		HDW 875-17	8 CBU-S
	422	2566	72 IN	TUBING ½ COPPER		HDW [illegible]	
	423		1	PIPE NIPPLE T.B.E			3/4 x 5 [illegible]

REV. NO.	ITEM NO.	PART NO.	REQ'D	DESCRIPTION	NET WT.	DRWG NO	REMARKS
	424						
	425	70PP698	2	CONCENTRIC REDUCER-BUTT WELD		HDW 878-3	2" x 1¼
	426		1	PIPE-NIPPLE-NO THREADS			2" x 4½ LG.
	427	70PP666	1	WELD. ELBOW 90° L.R.		HDW. 878-6	2"
	428	26084	1	PIPE ELBOW-STREET		HDW 865-10	3/4" x 90°
	429	26231	1	REDUCING BUSHING		HDW 862-1	3/4" TO 3/8"
	430	70PP207	1	PARKER RUNNING TEE		70AA17	#8-RBU-S
	431	79PP189	2	PARKER MALE ELBOW		79AA47	#8-CBU-S
	432	3499	2 PCS	TUBING #8-COPPER		HDW 890-14	APPROX. 6 FT.
	433		1	PIPE-NIPPLE-T.O.E.			3/4" x 4½ LG
	434	70PP678	4	COMPANION FLANGE-SLIP-ON		HDW 869-2	3/4" x 150#
	435	78P618-6	1	ORIFICE PLATE		78B182	
	436	70PP688	3	GASKET-1/16 CRANITE OR EQ.		HDW 869-9	3/4"
	437	163 & 75	8	HEX. HD. CAPSCREW & NUT		HDW 104-5 112-1	½"-13NC x 2" LG
	438	879	8	SPRING LOCKWASHER		HDW 209-1	½" STD
	439	70PP260	1	"CUNO" OIL FILTER		HDW 820-2	TYPE "G"
	440	26084	1	STREET ELL		HDW 865-10	3/4 x 90°
	441	26088	1	PIPE-NIPPLE-T.O.E.		HDW. 870-4	3/4 x 2" LG.
	442		1	PIPE-NO THREADS-PER PLAN			3/4" x 2" LG
	443		1	PIPE-NIPPLE-T.O.E.			3/4" x 3¼" LG
	444	2740	2	PIPE-NIPPLE-		HDW 870-4	1¼" x 3" LG
	445	78PP258	2	HALF PIPE COUPLING.		HDW 876-6	¼" STD.
	446		~~2~~	~~PIPE ELBOW-BUTT WELD~~		~~HDW~~	~~[illegible]~~
	447	66200	2	BACKING RING-NUB TYPE		HDW 869-18	1¼
	448		1	PIPE-NO THREADS PER PLAN			2" x 7¼" LG.
	449		1	PIPE-NO THREADS			2" x 6¾ LG.
	450	69P1357	1	THERMOMETER CONNECTION		69AA42	2" TO 3/4"
	451	4974	1	PIPE PLUG		HDW 861-2	3/4"
	452		1	PIPE-NO THREADS-PER PLAN			2" x 5" LG
	453	66202	8	BACKING RING-NUB TYPE		HDW 869-18	2"
	454	70PP680	2	FLANGE-SLIP ON		HDW 869-2	2" x 150#
	455	69PP773	2	GASKET-1/16 CRANITE OR EQ.		HDW 869-9	2"
	456	213 & 78	8	HEX. HD. CAPSCREW & NUT		HDW 104-6 112-2	5/8-11 x 2½ LG
	457	881	8	SPRING LOCKWASHER		HDW 209-1	5/8 STD.
	458	~~3895~~		~~PIPE NIPPLE T.O.E.~~		[illegible]	[illegible]
	459	70PP675	3	TEE-BUTT WELD		HDW 878-4	2"
	460	75P1688	2	SCREWED WELDING REDUCER		63AA42	2" TO ½
	461	952	2	PIPE PLUG		HDW 861-1	½
	462						
	463	~~1597~~	~~2~~	~~REDUCER BUSHING~~		[illegible]	~~2" TO ½"~~
	464		1	COOLER			SEE ORDER B/M
	465	78AP3334-7	2	COOLER SPACER		78A3334 Pc 2	
	466	157 & 75	8	HEX. HD. CAPSCREW & NUT		HDW 104-5	½-13 x 1½ LG.
	467	879	8	SPRING LOCKWASHER		HDW 209-1	½
	468	5342	2	PIPE PLUG		HDW 861-1	1/8" STD
	469		~~1~~	~~SCREWED WELDING REDUCER~~		[illegible]	
	470			[illegible]			

REV. A ITEM ADDED 7-24-80 J.P.W. C.K.
ITEM REV'D 7-18-80 J.P.W. C.K.

DO NOT USE FOR CONSTRUCTION UNLESS PRINT IS SIGNED ON BACK	MADE BY J.WITTBRODT	CHECKED BY C.K.	UNIT DESCRIPTION SIZE # 146 GYROL FLUID DRIVE TYPE VS CLASS 6 CUSTOMER - E.I. GHANT WILLAMETTE CO.	ASSEMBLY DRAWING NUMBER 78C273
S.J. NO.	DATE 3-21-80	REVISED BY	APPROVED BY	ORDER 3-82305 / SERIAL Nº 78-146-6-104 / 78CD[illegible]

REVISION | S. J. NO. | DATE | BY

SIZE DESCRIPTION 78-146L-6-104 CCW

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CONT'D FROM 4
CONT'D ON 6
FINAL PAGE 7

R.H.
ITEM # 1

1,2,23-133

AMERICAN BLOWER CORPORATION-DETROIT

REV. NO.	ITEM NO.	PART NO.	REQ'D	DESCRIPTION	NET WT.	DRWG. NO.	REMARKS
	95						
	96						
	97						
	98						
	99	78SA3405	1	Runner ASSY.		73B-22	
	100	78P838	1	Runner - Machined		73B22	
	101	78AL-836	1	Rough Casting		78B160	
	102	78AL-8364	1	Vane Core Box		78B160	
	103	78PP391	6	Heli-Coil Threads		HDW 828-1	1/2-13 x 1 Lg.
	104	78P841	1	LOAD RING	2.26	78A132	Standard
	105	~~78P842~~	~~1~~	~~Baffle Plate - 1.2~~	~~2.73~~	~~78A132~~	~~Per Order~~
	106	79PP359	6	Flat Hd. Cap Screw		71AA7	1/4-20 x 3/4 Lg.
	107						
	108						
	109						
	110						
	111						
	112						
	113						
	114						
	115	66854	6	Hex. Hd. Cap Screw		HDW 100-10.1	1/2-13x 1-3/4 Lg.
	116	879	6	LOCKWASHER		HDW 209-1	1/2
	117	78PP844	2	Dowel Pin	.077	78AA60	
	118						
	119						
	120						
	121						
	122	78PP361	2	Thrust Bearing Assembly		78AA45	#JJ-6 Kingsbury
	123	78PP1226	4	Thrust Bearing Cage Assembly		78AA45	#JJ-6 Kingsbury
	124	78PP1225	24	Thrust Shoe		78AA45	#JJ-6 Kingsbury
	125	78P362	2	Spacer Ring		78AA46	
	126						
	127						
	128						
	129						
	130						
	131						
	132						
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	135						
	136						
	137						
	138						
	139						
	140						
	141						

REV. NO.	ITEM NO	PART NO	REQ'D	DESCRIPTION	NET WT.	DRWG. NO.	REMARKS
	142						
	143						
	144						
	145						
	146						
	147						
	148						
	149						
	150	~~78SA2967~~	~~1~~	~~Scoop Tube Assembly~~		~~78B419~~	~~C.W.~~
	151	~~78P2969~~	~~1~~	~~Scoop Body~~		~~78B424~~	~~C.W.~~
	152	~~78MB2978~~	~~1~~	~~Rough Casting~~		~~78B424~~	~~C.W.~~
	153	~~78P2971~~	~~1~~	~~Scoop Tip~~		~~78A266~~	
	154	~~78MB2971~~	~~1~~	~~Rough Casting~~		~~78A266~~	
	155						
	156	78SA2968	1	SCOOP TUBE ASSY.		78B419	CCW
	157	78P2970	1	SCOOP BODY		78B424	CCW
	158	78MB2979	1	ROUGH CASTING		78B424	CCW
	159	78P2971	1	SCOOP TIP		78A266	
	160	78MB2971	1	ROUGH CASTING		78A266	
	161	78AP3459-10	4	Hex. Hd. Cap Screw		78A3459	3/8-16x 3/4 Lg.
	162		2 Pcs.	Wire			1/16 Dia. x 12" Lg.
	163	78P2196	1	SCOOP SLIDE - MACH.		78B336	
	164	78PP2023	1	SCOOP SLIDE - PUNCH.	11.9	78A179	
	165	78P729	2	Stop Rod	.095	78AA58	3/8 x 1-1/16" Lg.
	166	71	2	Hex. Nut		HDW 112-3	3/8-16
	167	78P2210	2	SCOOP SLIDE GUIDE - TOP	.78	78A16	
	168	78P2211	2	Scoop Slide Guide - BOTTOM	.78	78A19	
	169	78AP3459-7	8	Hex. Hd. Cap Screw		78A3459	5/16-18x 1-3/4 Lg.
	170		4 Pcs.	Wire - 1/16 Dia. x 8" Lg.			
	171						
	172	~~78P413~~	~~1~~	~~Oil Deflector~~	~~2.1~~	~~78P62~~	
	173						
	174	78P400	2	Scoop Slide Guide Bracket		78A78	
	175	78C1-400	2	Rough Casting		78A78	
	176	78AP3459-13	4	Hex. Hd. Cap Screw		78A3459	3/8-16x 1-1/2 Lg.
	177		2 Pcs.	Wire			1/16 Dia. x 12" Lg.
	178	25950	4	Taper Pin & Nut		HDW 519-4	#3 x 1-1/4" Lg.
	179						
	180						
	181		1	CONTROL ROD END FOR 1/2 ROD		78AD4309	AT CUST. CONN.
	182	78PP94	1	Adjustable Clevis		HDW 807-12	1/2" Light
	183	78P193	1	Clevis Pin		HDW 515-9	
	184	1983	1	Cotter Pin		HDW 515-1	1/8 x 1-1/4 Lg.
	185						
	186	78P2463	1	Control Rod	2.4	78AA17	
	187	28560	2	Hex. - Jam Nut		HDW 113-1	1/2-20 N.F.
	188						

DO NOT USE FOR CONSTRUCTION UNLESS PRINT IS SIGNED ON BACK

MADE BY J. WITTEBOLDT

CHECKED BY

DATE 3-21-50

SIZE #146 - GYROL FLUID DRIVE - TYPE "VS" CLASS 6
CUST. - BINGHAM WILLAMETE CO.
ORDER No. 3-82308 SERIAL # 78-146-6-104

ASSEMBLY DRAWING NUMBER 78C293 78CD6266

78-146D-6-104 CCW

PAGE NO. 2
CONT'D FROM 1
CONT'D ON 3
FINAL PAGE 7

R. H.
ITEM # 1

REV A B/N 7-18-80 J.P.W. C.K.

REVISION | B. J. NO. | DATE | BY

1.2.23-134

A ICAN BLOWER CORPORATION—DETRO

BILL OF MATERIAL

ITEM	DESCRIPTION	REQ.	DWG. NO.	REMARKS	44 GPM 3600 RPM													
					PART NO	WT	PART NO	WT	PART NO.	WT.	PART NO	WT	PART NO.	WT.	PART NO.	WT.	PART NO	WT
471	Pump & Pump Support Assembly	1	78C206		78SA2517													
472	Pump Support Assembly	1	78B224		78SA2520													
473	Pump Support Machined	1	78B224		78F 2524													
474	Welding Assembly	1	78B225		78SA2528													
475	Top Flange	1	78A83		78F 2531													
476	Rough Casting	1	78A83		78CS-508													
477	Bottom Flange	1	78B226		78F 2532													
478	Rough Casting	1	78B226		78CS-1429													
479	Tube	1	78A125		78F 2533													
480	Rib	2	78A126		78F 2536													
481	Bearing	1	79AA9		78PF1427													
482																		
483	Pump Body	1	78B227		78F 2539													
484	Rough Casting	1	78B227		78CI-1428													
485																		
486	Pump Top Flange - Assembly	1	78B228		78SA1430													
487	Top Flange - Machined	1	78B228		78F1431													
488	Rough Casting	1	78A127		78CI-1431													
489	Bearing - Small	1	79AA9	*SEE NOTE	78PF1426													
490	Bearing - Large	1	79AA9		78PF1427													
491																		
492																		
493	Pump Bottom Flange - Assembly	1	78B229		78SA1432													
494	Bottom Flange - Machined	1	78B229		78F1433													
495	Rough Casting	1	78A127		78CI-1431													
496	Bearing	2	79AA9		78PF1426													
497																		
498	Gear & Idler Shaft Assembly	1	78AA132		78SA2540													
499	Idler Shaft	1	78A206		78F 2541													
500	Key	1	HDW301-1	1/4 x 1/4 x 2" LG.	26128													
501	Gear	1	78A207		78PF 2542													
502																		
503																		
504																		
505																		
506	Lead Gasket, .005 Thick	1		As Required														
507	Thrust Bearing	2	79AA10		78PF1436													
508	Drive Shaft & Gear Assembly	1	78B262		78SA2543													
509	Pump Drive Shaft	1	78B230		78F 2546													
510	Key	1	HDW301-1	1/4 x 1/4 x 2 LG	26128													
511	Gear	1	78A207		78PF 2542													
512																		
513	Taper Pin with Nut	2	HDW515-4	#5 x 1-1/4	25957													
~~514~~	~~Bolt Locking Strap~~	~~2~~	~~78A44~~		~~78F345~~	~~.016~~												
515																		
516	*WHEN REPLACING THESE BEARINGS FOR REPAIR PARTS USE 78-F-1440 PER DRAWING 79-AA-103																	
517																		

3-21-50

DO NOT USE FOR CONSTRUCTION UNLESS PRINT IS SIGNED ON BACK

MADE BY J.WITTBRODT

CHECKED BY

REVISION NO.

APPROVED BY

SIZE #146 - GYROL FLUID DRIVE - TYPE "VS" CLASS 6
CUST. - BINGHAM-WILLAMETTE CO.
ORDER NO. 5-82808 SERIAL NO. 78-146-6-104

ASSEMBLY DRAWING NO. 76C-293
78CD-6266

DATE OF LAST REVISION

PAGE NO 6
CONT'D FROM 5
CONT'D ON 7
FINAL PAGE 7

78-146D-6-104 CCW

1.2.23.135

AMERICAN BLOWER CORPORATION—DETROIT

ITEM	DESCRIPTION	REQ.	DWG. NO.	REMARKS	44 GPM 3600 RPM PART NO	WT.	PART NO	WT.	PART NO.	WT.	PART NO.	WT.	PART NO.	WT.	PART NO.	WT.	PART NO.	WT.
~~518~~	~~Strainer Grill~~	~~1~~	~~78A129~~		~~78F1441~~													
~~519~~	~~Rough Casting~~	~~1~~	~~78A129~~		~~78C1-1441~~													
520																		
~~521~~	~~Strainer Screen~~	~~1~~	~~78A496~~		~~78F1442~~													
~~522~~	~~Strainer Guard~~	~~1~~	~~78A130~~		~~78F1443~~													
~~523~~	~~Rough Casting~~	~~1~~	~~78A91~~		~~78C1-790~~													
524	HOL. HD. CAP SCREW	4	HDW-206-10	3/8-16×2"LG.	66618													
525	Hol. Hd. Cap Screw	4	HDW206-1	3/8-16x 2-1/2 Lg.	25833													
526	Spring Lock Washer	8	HDW209-1	3/8 Std.	608													
527	Dowel Pin	4	HDW515-6	3/8 x 2	28724													
528																		
529	Driven Gear Spacer	1	78AA102		78P1585	.11												
530	Gear Locking Strap	1	78AA103		78P1588	.097												
531	Hex. Nut Special	1	78AA101	3/4-10 N.C.	78P1583	.41												
532																		
533																		
534	Hex. Hd. Cap Screw	4	HDW 104-3	3/8-16 x 1-1/2 Lg.	127													
535	Flat Washer	4	HDW210-1	3/8 Std.	624													
536	LOCKWASHER	4	HDW209-1	3/8	608													
537	Taper Pin with Nut	2	HDW515-4	#6 x 1-3/4 Lg.	25962													
~~538~~	~~Bolt Locking Strap~~	~~2~~	~~78A~~		~~78F366~~													
539																		
540																		
541																		
542																		
543																		
544																		
545	Key -	1	79AA25	3/16x 3/16x 1 Lg.	78P1994													
546	Set Screw	1	HDW202-1	1/4-20 x 3/4 Lg.	25921													
547	Driven Gear - Bronze	1	78C222	CCW Unit	78PP1599													
~~548~~	~~Driven Gear - Bronze~~	~~1~~	~~78C222~~	~~CCW Unit~~	~~78PP1599~~													
549	Driving Gear - Steel	1	78A150	CCW UNIT	78PP1597													
~~550~~	~~Driving Gear - Steel~~	~~1~~	~~78A150~~	~~CCW Unit~~	~~78PP1597~~													
551																		
552																		
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563																		
564																		

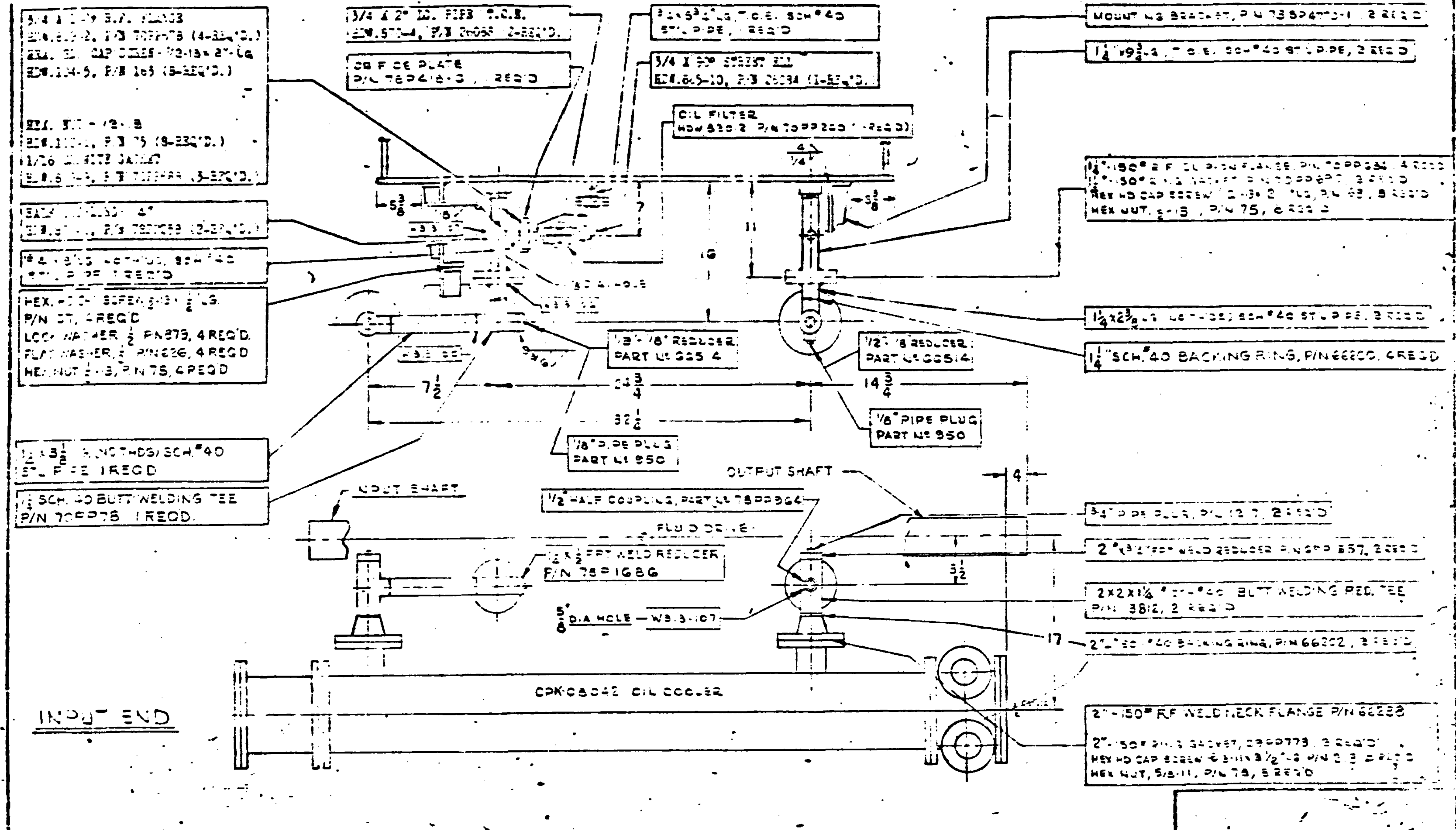
REV D 7-18-80 J.P.W. C.K.

REV A E/

PRINT ISSUE CODE	DO NOT USE FOR CONSTRUCTION UNLESS PRINT IS SIGNED ON BACK 3-21-80	MADE BY J. WITTBRODT	CHECKED BY CMC	SIZE #146 - GYROL FLUID DRIVE - TYPE "VS" CLASS 6 CUST. - EINGHAM-WILLAMETTE CO. ORDER No. - 3-82308 SERIAL No. 78-146-6-104	ASSEMBLY DRAWING NO. 78C233 78CD2333	DATE OF LAST REVISION	PAGE NO. 7 CONT'D FROM: 6 CONT'D ON: - FINAL PAGE 7	78-146D.6-104 CCW
		REVISION NO.	APPROVED BY					

REVISION	S.J. NO.	DATE	BY

1.2.23-136



ITEM # 1 – RIGHT HAND COOLER MOUNTING REQUIRED
PART No 78CS6563-1

SUPERSEDES DWG 78-CD-6272

NOTES:

USE LOCTITE (P/N 00359) ON ALL FLANGE CAP SCREW THREADS – DO NOT USE LOCTITE ON COOLER BRACKET MOUNTING CAP SCREWS. TORQUE AS SHOWN.

SIZE	TORQUE FT/LBS
½-13	37-47
⅝	77-96

ALL WELDS MUST BE OIL TIGHT

REV	ECN	DATE	DESCRIPTION	DATE	CHK	APPD
A			OIL COOLER LENGTH REVISED			
B			ALL PIPING REVISED FOR TEMP. DETECTORS			

AMERICAN STANDARD

OIL COOLER MOUNTING ASSEMBLY

SCALE NONE

78-CD-6563

3

1,2,23-139

Order No		Start Date	Complete Date	Page	
Quantity				Sheet No. of	
WC	OP	Operation Description		SU	STD.

3-82308

1.2.23-140

Item No	Mat'l Stat	From Dept.	Quan Req'd	Total Quan	DESCRIPTION	MATERIAL	SPEC.	PATTERN NO. OR SIZE	PART NUMBER	Dwg Size	REMARKS
22			1		COVER	STL.			3-219-5-07-901-06	A	REV. COVER
21			4		STUDBOLT 4.000LG.	ALLOY STL.		.625 DIA.-11T.P.I.-T.F.L.	2-012-5-10-901-16	A	STA. END (COVER)
20			4		STUDS 2.500LG.	ALLOY STL.		.625 DIA.-11T.P.I.-T.F.L.	2-012-5-10-901-10	A	STA. END (COVER)
19			4		STUDBOLT 4.750LG.	ALLOY STL.		.625 DIA.-11T.P.I.-T.F.L.	2-012-5-10-901-19	A	STA. END
18			1		PIPE PLUG	STEEL		.375 P.T.	2-135-5-96-901-03	A	
17			4		PROTECTOR ROD	ZINC			3-386-9-03-101-04	A	
16			48		HEX NUT	STEEL		.625 DIA-11TPI	2-122-5-00-902-07	A	
15			08		STUDBOLT 4.500LG.	* STL		.625 DIA-11TPI-TFL	2-012-5-10-901-18	A	* ALLOY (FLO)
14			04		STUD 3.250LG.	* STL		.625 DIA-11TPI-TFL	2-012-5-10-901-13	A	* ALLOY (STA)
13			08		STUD 2.250LG.	* STL		.625 DIA-11TPI-TFL	2-012-5-10-901-09	A	* ALLOY (REV.CO
12											
11			1		GASKET	ASB.			3-299-8-00-901-06	A	
10			2		GASKET	ASB.			3-298-8-00-901-08	A	
09			1		GASKET	ASB.			3-299-8-00-901-08	A	
08			2		PACKING RING	NEO.			3-359-8-00-901-08	A	
07			1		LANTERN RING	NYLON			3-338-8-00-901-08	A	
06			2		CRADLE	* STL			1-147-5-08-210-01	B	* CAST
05			1		COVER	STEEL			3-219-5-08-115-03	A	STA. COVER
04			1		CHANNEL FLO.	C.I.			3-191-7-08-807-01	B	
03			1		CHANNEL STA.	C.I.			3-177-7-08-207-01	B	
02			1		BUNDLE ASS'Y				4-121-08-042-001	A	
01			1		SHELL ASS'Y				4-608-08-042-002	A	

1	REVISED STA. CHAN. TO 4Z, ADDED IT.# 19, 20, 21, 22, DELETED IT.# 12	DPZ	7-24-80

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TOLERANCE UNLESS OTHERWISE SPECIFIED

		in	mm
2 Place Dec.	XX	± .06	± 1.5
3 Place Dec.	XXX	± .030	± 0.8
Angles		1 Degree	

DIMENSIONS NOT TO BE INSPECTED

MADE COMPUTER

HEAT TRANSFER DIVISION
AMERICAN-STANDARD
POWER & CONTROLS GROUP
BUFFALO, N.Y. 14240

TITLE 08042 CP EXCHANGER

SIZE	PART NUMBER	REV
A	5-046-08-042-009	1

INDUSTRIAL PRODUCTS DIVISION
AMERICAN-STANDARD
8111 TIREMAN AVE.—P.O. BOX 76
DEARBORN, MICHIGAN 48121

REPLACEMENT AND SPARE PARTS

GYROL FLUID DRIVE
TYPE VS CLASS 6
SIZE 146

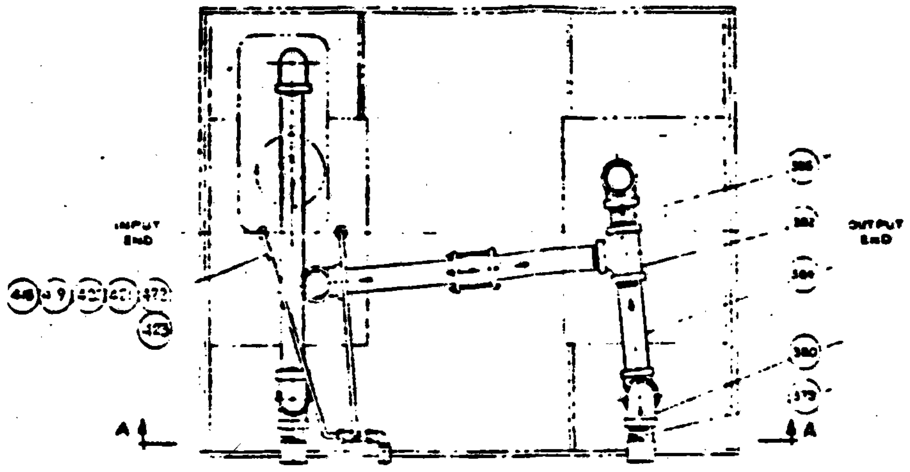
ITEM NO. ★	QTY. REQ'D.	DESCRIPTION	PART NO. ◆	ITEM NO. ★	QTY. REQ'D.	DESCRIPTION	PART NO. ◆
~~28~~	~~2 ●~~	~~Journal Brg. - C.W. - I.O.R. & O.I.R.~~	~~78PP2464~~	193	2 ●	Perfect Oil Seal	78PP246
~~29~~	~~2 ●~~	~~Journal Brg. - C.W. - I.I.R. & O.O.R.~~	~~78PP2465~~	207	2 ●	Shaft Vapor Seal Ring	78P1031
33	2 ●	Journal Brg. - C.C.W. - I.I.R. & O.O.R.	78PP2464	208	2 ●	Shaft Seal	78P1233
34	2 ●	Journal Brg. - C.C.W. - I.O.R. & O.I.R.	78PP2465	215	2 ●	Dust Seal Ring	78P801
122	2	Thrust Brg. Assembly	78PP361	314	1	Control Rod Sleeve W/Clamps	78PP1378
123	4	Thrust Brg. Cage Assembly	78PP1226	471	1 ●	Pump & Supt. Assembly	78SA2517
124	24 ●	Thrust Shoe	78PP1225	~~547~~	~~1 ●~~	~~Driven Gear, Bronze - C.W.~~	~~78PP1598~~
~~150~~	~~1~~	~~Scoop Tube Assembly - C.W.~~	~~78SA2967~~	548	1 ●	Driven Gear, Bronze - C.C.W.	78PP1599
156	1	Scoop Tube Assembly - C.C.W.	78SA2968	~~549~~	~~1~~	~~Driving Gear, Steel - C.W.~~	~~78PP1596~~
167	2 ●	Scoop Slide Guide - Top	78P2210	550	1	Driving Gear, Steel - C.C.W.	78PP1597
168	2 ●	Scoop Slide Guide - Bottom	78P2211				

- ● RECOMMENDED SPARE PARTS.
- ◆ PART NUMBERS PER B/M 78-146D-6.
- ★ ITEM NUMBERS PER B/M 78-146D-6 AND DRAWING NUMBER 78-C-293. NUMBERS FOR OTHER B/M MAY VARY & MUST BE CHECKED.

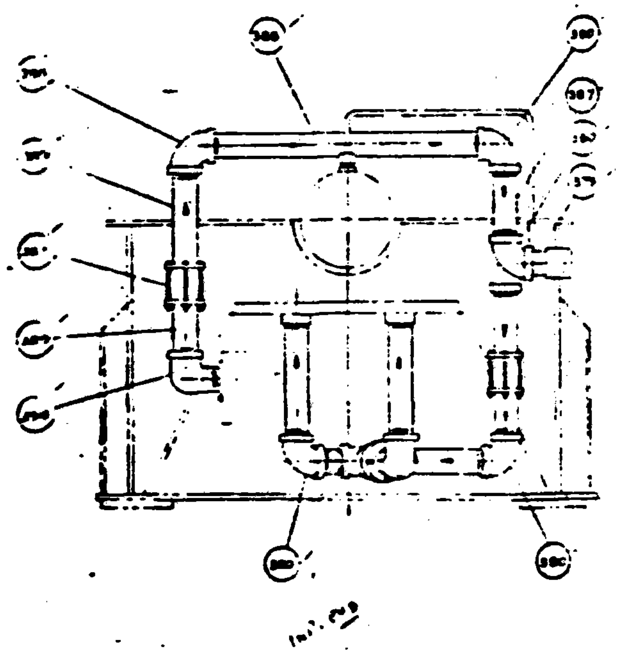
● CONTACT REPLACEMENT PARTS DEPT. WITH SERIAL NUMBER FROM NAME PLATE.

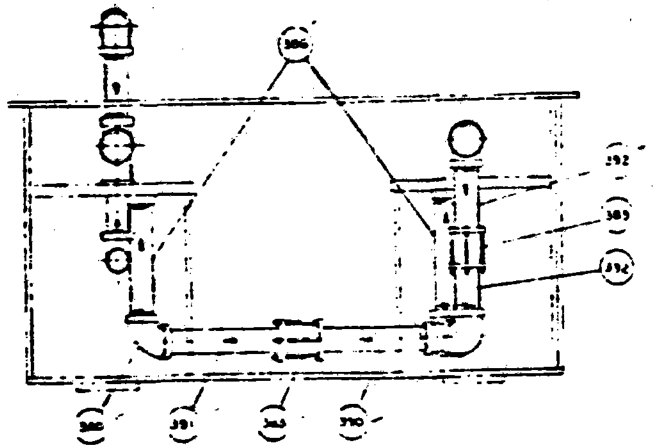
ALL INQUIRIES AND ORDERS FOR REPLACEMENT PARTS MUST BE SUBMITTED WITH SERIAL NUMBER OF UNIT — EXAMPLE: 78-146-6-307.

Lithographed in U.S.A.



NOTE:-
ALL WELDING ON PIPE TO BE OIL TIGHT





VIEW A-A

FOR B/M SEE DRWG. NO.

THE FOLLOWING ITEMS APPLY UNLESS OTHERWISE SPECIFIED:
FOR FEATURES OF SIZE, PERFECT STRAIGHTNESS NOT REQUIRED AT MMC. FOR DIAMETRAL FEATURES, BOUNDARY MUST BE WITHIN THE MMC AND LMC (LEAST MATERIAL CONDITION) BOUNDARY. TRUE POSITION TOLERANCES, AND RELATED DATUMS, (EXCEPT PLANE SURFACES), APPLY AT MMC. OTHER GEOMETRIC TOLERANCES, AND RELATED DATUMS, APPLY RFS. SEPARATE TRUE POSITION CALLOUTS MAY BE GAGED SEPARATELY, REGARDLESS OF DATUM REFERENCE.

GEOMETRIC DRAWING SYMBOLS:
FLAT
STRAIGHT
SQUARE
PARALLEL
RUNOUT
TRUE POSITION
PROFILE OF A SURFACE
MAXIMUM MATERIAL CONDITION MMC
REGARDLESS OF FEATURE SIZE RFS
ROUND
CYLINDRICAL
DIAMETER
ANGULAR
CONCENTRIC
SYMMETRICAL
PROFILE OF A LINE
PROJECTED TOL ZONE
BASIC DIMENSION

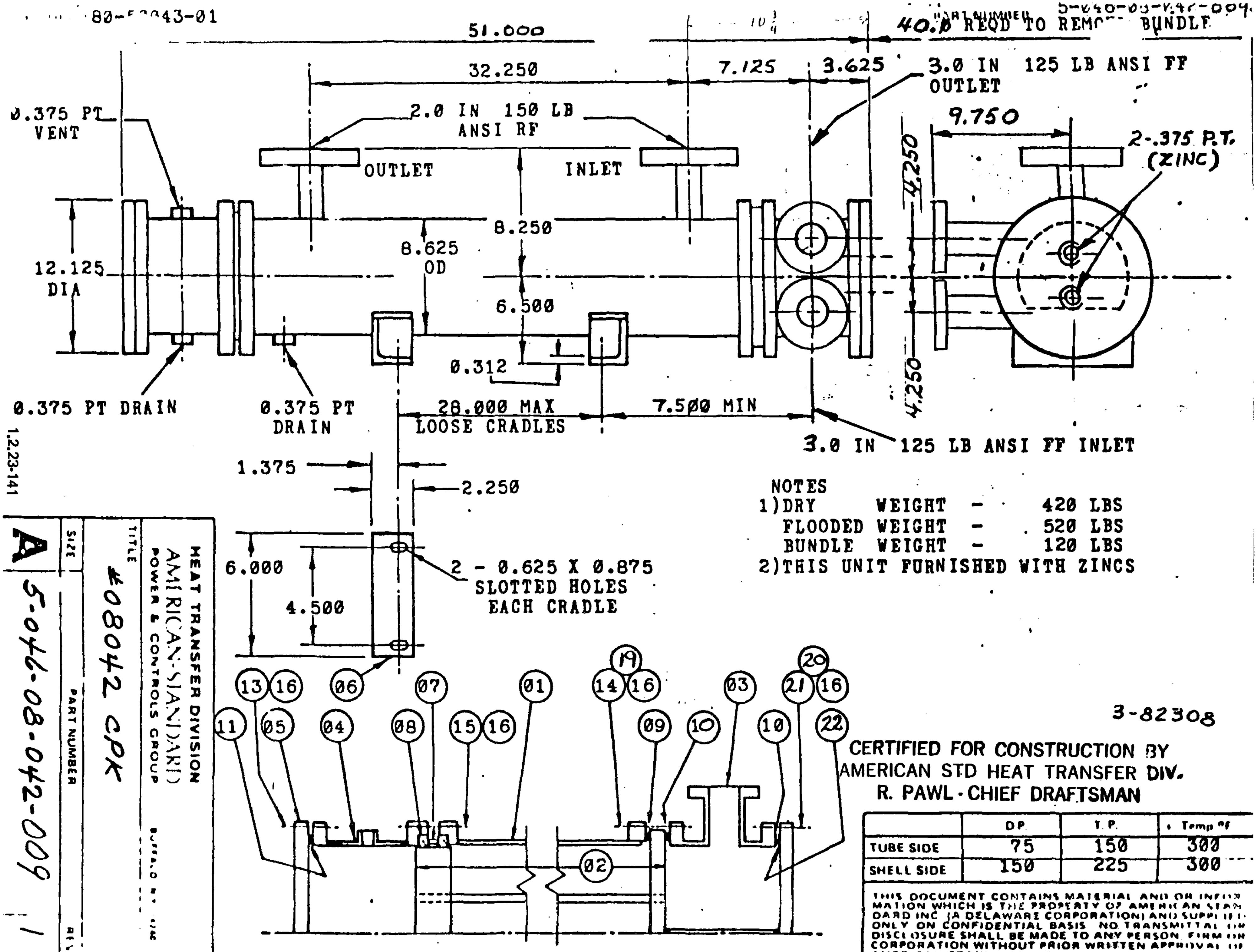
REV	EN	ZONE	DESCRIPTION	DATE	CHK	APPD

TOLERANCES UNLESS OTHERWISE SPECIFIED
DEC .000 = ± .015
FRACTIONAL
0" - 18" = ± 1/32"
18" - 30" = ± 1/16"
30" - 90" = ± 1/8"
90" & ABOVE = ± 3/16"
ANGULAR TOLERANCE = ± 1/2°
TOLERANCE TO BE NON-ACCUMULATIVE

DRAWN J. AUTTERS [illegible]
CHECKED [illegible]
APPD
EN
SCALE NONE
MAT'L
MAT'L SPEC

INDUSTRIAL PRODUCTS DIVISION
AMERICAN [illegible]
INDUSTRIAL PRODUCTS GROUP

TITLE INTERNAL PIPING ASSEMBLY - RIGHT HAND
SIZE 14G CLASS 6 GYROL FLUID DRIVE
CUSTOMER
JOB
CUSTOMER P.O. NO.
SALES ORDER NO 3-8230S
SIZE C
DRAWING NUMBER 78-CD-6273
REV



NOTES
1) DRY WEIGHT - 420 LBS
FLOODED WEIGHT - 520 LBS
BUNDLE WEIGHT - 120 LBS
2) THIS UNIT FURNISHED WITH ZINCS

3-82308

CERTIFIED FOR CONSTRUCTION BY
AMERICAN STD HEAT TRANSFER DIV.
R. PAWL - CHIEF DRAFTSMAN

	D.P.	T.P.	Temp °F
TUBE SIDE	75	150	300
SHELL SIDE	150	225	300

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1.2.23-141

HEAT TRANSFER DIVISION
AMERICAN-STANDARD
POWER & CONTROLS GROUP
BUFFALO N.Y. 14240

TITLE
#08042 CPK

SIZE
A

PART NUMBER
5-046-08-042-009

REV
1

HEAT TRANSFER DIVISION
AMERICAN-STANDARD
BUFFALO, N.Y. 14240

OPERATING INSTRUCTIONS AND PARTS LIST

TYPE CPS, CP & CPK EXCHANGERS

INSTALLATION

1. Provide sufficient clearance at the channel or bonnet end of unit to permit removal of tube bundles from shells. On the floating head end, a space of 3 or 4 feet should be provided to permit the removal of the floating head.

2. Provide valves and by-passes in the piping system so that both the shells and tube bundles may be by-passed to permit cutting out the unit for inspection or repairs.

3. Provide convenient means for frequent cleaning of the unit as suggested under "Maintenance."

4. Provide thermometer wells and pressure gage connections in all piping to and from the unit, as near the unit as possible.

5. Provide necessary air vent cocks so that the unit can be purged to prevent or relieve vapor or gas binding of either the tube bundles or the shell.

6. Foundations must be adequate so that exchangers will not settle and cause piping strains. Foundation bolts should be set to allow for setting inaccuracies. In concrete footings, pipe sleeves at least one size larger than bolt diameter slipped over the bolt and cast in place are best for this purpose, as they allow the bolt center to be adjusted after the foundation has set.

7. Loosen foundation bolts at one end of unit to allow free expansion of shells. Oval holes in foundation brackets are provided for this purpose.

8. Set exchangers level and square so that pipe connections may be made without forcing.

9. Inspect all openings in exchanger for foreign material. Remove all wooden plugs and shipping pads just before installing. Do not expose units to the elements with pads or other covers removed from nozzles or other openings since rain water may enter the unit and cause severe damage due to freezing.

10. Be sure entire system is clean before starting operation to prevent plugging of tubes with sand or refuse. The use of strainers or settling tanks in pipe lines leading to the unit is recommended.

11. Drain connections should not be piped to a common closed manifold.

12. To guard against pulsation of fluids caused by reciprocating pumps, compressors or other equipment a surge drum should be installed.

OPERATION

A heat exchanger is a pressure vessel designed for operation at certain specific limits of pressure and temperature, and the system must be safeguarded with safety valves and controls so that these design conditions are not exceeded and that all operating personnel are alerted.

1. When placing a unit in operation, open the vent connections and start to circulate the cold medium only. Be sure that the passages in the exchanger are entirely filled with the cold fluid before closing the vents. The hot medium should then be introduced gradually until all passages are filled with liquid. Then, close vents and slowly bring the unit up to temperature.

2. Start operation gradually. Do not admit hot fluid to the unit suddenly when it is empty or cold. Do not shock unit with cold fluid when it is hot.

3. In shutting down, flow of hot medium should be shut off first. If it is necessary to stop circulation of cooling medium, the circulation of hot medium should also be stopped by by-passing or otherwise.

4. Do not operate equipment under conditions in excess of those specified on nameplate.

5. In all installations, there should be no pulsation of fluids since this causes vibration and strain with resulting leaks.

6. All gasketed joints should be rechecked for tightness after the unit has been heated to prevent leaks and blowing out gaskets.

7. The packed end joints on Lube Oil Coolers may require adjustment from time to time to eliminate slight leakage. This joint contains Neoprene packing rings which require only a small amount of bolting pressure to seal tight.

Many heat exchangers handle fluids which are irritating or dangerous to the human system and could cause problems if bolted and packed joints are not maintained in a leak tight condition both at operating pressures and temperatures, and also at no flow, ambient conditions.

If fluids are not irritating or dangerous a leak will at least cause a slippery situation on the floor below.

Since one fluid in the heat exchanger is at higher temperatures, any leaks might cause burns.

If leakage should appear at the packed end joint after the cooler is placed in operation, the bolting should be pulled up only enough to stop it. This can be accomplished by taking a one-half turn on each successive bolt starting at one point and continuing around the cooler until all leakage has been eliminated. Do not tighten this joint any more than is required to stop the initial leakage.

When the packing has been repeatedly tightened to the point where there is almost a metal-to-metal contact between the bonnet (or channel) and shell flanges, the two packing rings should be replaced. To accomplish this, proceed as follows:

(A) Remove the bonnet (or channel), lantern ring, and all packing rings from the cooler.

(B) Clean the packing ring recess in both the bonnet (or channel) and shell flanges and the latern ring, if necessary.

(C) Place one of the new packing rings over the floating tube sheet and slide it into the recess in the shell flange. Be sure the packing ring is not twisted and fits squarely into this recess.

(D) Place the lantern ring over the floating tube sheet and slide it against the first packing ring.

(E) Place the second new packing ring over the floating tube sheet and slide it against the lantern ring, making sure the packing ring is not twisted.

(F) With the studbolts pulled up only finger tight, the bonnet (or channel) should be positioned so that the second packing ring is secure in the recess of the bonnet (or channel) flange.

(G) Each bolt should now be pulled up only one or two turns.

(H) When the cooler is either hydrostatically tested or placed in operation, any final adjustment should be made as previously described.

8. Be sure that all parts of the system are clean and in proper operating condition. An exchanger cannot perform properly unless all connected equipment is functioning properly, yet, the exchanger is frequently blamed for non-performance when the actual trouble is elsewhere in the system.

Observe the following precautions to obtain maximum performance.

(A) Exchanger must be full of fluid in both shell and tube sides.

(B) Provide periodic venting if air tends to accumulate in system.

(C) Maintain rated flow of both mediums.

(D) Avoid excessive flow of cooling water in exchangers used as coolers. It is a frequent cause of tube failure through erosion, and may decrease cooling efficiency, especially with heavy oils.

(E) Inspect exchanger periodically and clean thoroughly when necessary, especially inside of the tubes.

MAINTENANCE

1. Provide convenient means for frequent cleaning of heat exchangers as suggested below:

(A) Circulating hot wash oil or light distillate through tubes or shell at good velocity will effectually remove sludge or other similar soft deposits.

(B) Soft salt deposits may be washed out by circulating hot fresh water.

(C) Some cleaning compounds on the market, such as "Oakite" may be used to advantage for removing sludge or coke, provided hot wash oil or water, as described above, does not give satisfactory results.

(D) If none of the above described methods are effective for the removal of hard scale or coke, a mechanical means may be used.

When the heat exchanger is cleaned, it is important that full characteristics of the fouling material and the cleaning agent be known and care exercised in handling them according to instructions.

2. Frequently and at regular intervals, observe interior and exterior condition of all tubes and keep them clean. Neglect in keeping all tubes clean may result in complete stoppage of flow through some tubes, with consequent overheating of these tubes as compared to surrounding tubes, resulting in severe expansion strains and leaking tube joints.

When shutting down for repairs it is imperative that all fluids be drained from the heat exchanger and that no bolting be loosened until the pressures are down to atmospheric and the temperatures of the parts are down to ambient.

3. Do not attempt to clean tubes by blowing steam through individual tubes. This overheats the tube and results in the same severe expansion strains and leaks as in plugged tubes.

4. Do not blow out heat exchangers with air when fluids normally handled are of an inflammable nature.

5. Do not open heads until all pressure is off equipment and the unit drained.

6. Do not handle tube bundles with hooks or other tools which might damage tubes. Bundles should be moved about on cradles or skids.

7. Do not tighten bolts until gasket is positioned properly. This precaution will eliminate one cause for taking down units because of leaks.

Since many of the removeable components or the heat exchanger, particularly in the larger sizes are too heavy for men to handle care must be used to take this weight with proper rigging to avoid injury.

When a heat exchanger is dismantled for any cause, it is recommended that new gaskets be used in reassembly. This will tend to lessen the possibility of future leaks. Because composition gaskets become brittle and dry out, they do not provide an effective seal when reused. Metal or metal jacketed gaskets when compressed initially tend to match their gasket contact surfaces. In so doing, they are work hardened to the point that their reuse provides an imperfect seal and possible damage to the gasket contact surfaces of the heat exchanger.

8. To tighten a loose tube joint, use a suitable roller type tube expander. Do not roll tubes that are not leaking as it needlessly thins the tube wall.

9. Exchangers subject to fouling or scaling should be cleaned periodically. A light sludge or scale coating on the tube greatly reduces its effectiveness. A marked increase in pressure drop and/or reduction in performance usually indicates cleaning is necessary. If the unit has been checked for air or vapor binding and this has been found not to be the cause. Since the difficulty of cleaning increases rapidly as the scale thickens or deposit increases, the intervals between cleanings should not be excessive.

10. To clean or inspect inside of tubes, remove channel covers (or bonnets). Do not remove channels.

OPERATING INSTRUCTIONS AND PARTS LIST

HEAT TRANSFER DIVISION
AMERICAN-STANDARD
BUFFALO, N.Y. 14240

TYPE CPS, CP & CPK EXCHANGERS

11. To locate leaking joint between tube and tube sheet or a split tube, proceed as follows:

Channel Type
(a) Remove channel covers.
(b) Apply hydrostatic pressure in shell.

Bonnet Type
(a) Remove bonnets.
(b) Bolt test rings in place with gaskets and packing.
(c) Apply hydrostatic pressure in shell.

Use only cold liquid for hydrostatic test. The point where the water escapes indicates the defective tube or joint.

12. When removing tube bundles from exchangers for inspection or cleaning, care should be exercised to avoid damage by improper handling. Although tube bundles are often of great weight, the tubes are small and of relatively thin metal. The dead weight of the bundle, therefore, should never be supported on individual tubes, but should rest on those parts that are designed to carry it, i.e., the tube sheets, support plates or wood blocks, cut to fit the periphery of the bundle. In withdrawing tube bundles, it is recommended that rods or steel cables be passed through two or more of the tubes and the load taken on the floating tube sheet. Rods should be threaded and provided with nuts and should pass through a bearing plate at either end of the bundle. A soft wood filler board should be inserted between bearing plates and tube sheets, in order to prevent damage to tube ends. A forged steel eye bolt which may be screwed into either plate is used for pulling and lifting.

When steel cables are used for lifting, the cable is threaded through one tube and returned through another. Loops are formed in the ends of the cable by use of thimbles and wire rope clips. A hard wood spreader block is inserted between the cable and the floating tube sheet to prevent crushing of tube end.

If the tube bundle has been in service for a considerable length of time without being removed it may be necessary to use a hydraulic jack on the floating tube sheet to get it started. A good sized steel bearing plate should be inserted between jack and tube sheet and the tube ends protected by means of a filler board.

Tube bundles may be raised horizontally by means of slings formed by bending light plates into a U-Form and attaching lifting lugs to the ends of the sheets. Baffles can be easily bent and damaged by dragging a bundle over a rough surface. Diameter of the baffles is practically the same as the inside of the shell and a close fit must be maintained for the apparatus to function properly. Any damage to baffles should, therefore, be carefully avoided.

In cleaning a tube bundle, tubes should not be hammered on with any metallic tool. In case it is necessary to use scrapers, care should be exercised to see that the scraper is not sharp enough to cut the metal of the tubes.

The following are safe loads for rods and eye bolts:

RODS

Size Tubes	Size Rods	Safe Load per Rod
⅝"	⅜"	1000 lbs.
¾"	½"	2000 lbs.
1"	⅝"	3000 lbs.

Size	EYE BOLTS	Safe Load
¾"		4000 lbs.
1"		6000 lbs.
1¼"		10000 lbs.
1½"		15000 lbs.

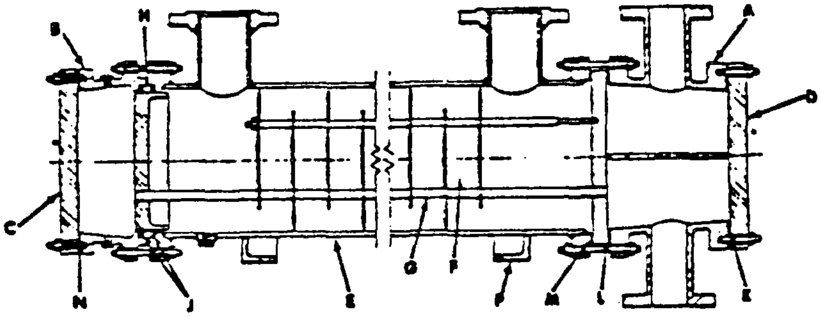
PARTS LIST

Any parts listed below and indicated alphabetically on the typical cross sectional drawings can be furnished.

When ordering parts, use part name indicated in parts list. Give cooler size and serial number as stamped on name plate of cooler. Special care in following above instructions will facilitate quick shipment.

If parts are required in materials of construction differing from those originally furnished, specify the desired changes and reason for changing.

CHANNEL TYPE



- A CHANNEL STATIONARY END
- B CHANNEL PACKED END
- C CHANNEL COVER, PACKED END
- D. CHANNEL COVER, STATIONARY END
- E SHELL ASSEMBLY
- F. BUNDLE ASSEMBLY, Consisting of:
  1. Stationary Tube Sheet
  2. Floating Tube Sheet
  3. Tubes
  4. Baffle Plates
- G. TUBE
- H. LANTERN RING
- J. PACKING RINGS
- K GASKET, STATIONARY CHANNEL COVER
- L GASKET, TUBE SHEET TO CHANNEL
- M. GASKET, TUBE SHEET TO SHELL
- N GASKET, PACKED CHANNEL COVER
- P. CRADLE ASSEMBLY

WARRANTY

WARRANTY OF SELLER'S PRODUCTS—Except where a different express written warranty has been issued with respect to a particular product, no warranty of any kind, express or implied, is extended by the Seller to any person or persons other than its direct Buyers. To direct Buyers, the Seller warrants only that it will furnish by freight a replacment for, or at its option repair any product of its manufacture or part or portion thereof, proved to its satisfaction to be defective in material or workmanship under normal use and service within one year from the date the equipment is first placed in use, or two years from the date of shipment, whichever shall be less.

The Seller shall have no responsibility for the performance of any product sold by it under conditions varying materially from those under which such product is usually tested under existing industry standards, nor for any damage to the product from abrasion, erosion, corrosion, deterioration or the like due to abnormal temperatures or the influence of foreign matter or energy, nor for the design or operation of any system of which any such product may be made a part or for the suitability of any such product for any particular application.

The Seller shall not be liable for any cost or expense, including, without limitation, labor expense, in connection with the removal or replacement of alleged defective equipment or any part or portion thereof, nor for incidental or consequential damages of any kind, nor under any circumstances for any damage beyond the price of the goods sold. Any freight allowance in connection with a replacement will be on the same terms as were applicable to the original sale, except that a replacement for a product or part or portion thereof which is proved to the Seller's satisfaction to be defective in material or workmanship as provided herein above, will in any event be furnished with freight (but not local cartage) allowed, inside the continental United States (excluding Alaska and Hawaii), to the first destination.

OTHER WARRANTIES—The foregoing warranty is in lieu of all other warranties of any kind, express or implied, and of all other obligations or liabilities, on the part of the Seller. The Seller neither assumes, nor does it authorize any other person to assume on its behalf, any other liability in connection with the sale of its products.

GOODS OF OTHER MANUFACTURERS—Goods of other manufacturers sold by the Seller are not warranted except by express warranties which may be issued in writing from time to time with respect to a particular product or a particular sale but the Seller will endeavor to secure for its direct Buyers the benefits of warranties extended by the manufacturers of such goods sold but not manufactured by the Seller.

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INSTRUCTIONS FOR THE INSTALLATION AND USE OF ASHCROFT® BI-METAL DIAL THERMOMETERS

GENERAL

In removing the thermometer out of the packing box, handle it by the case or case outlet. Avoid handling it by the stem.

INSTALLATION OF THERMOMETERS

The thermometer should be mounted at any convenient location where it will be subjected to the average temperature variations to be indicated.

Avoid bending the stem as this will cause misalignment of the internal parts, resulting in undue frictional errors.

To tighten the thermometer to the apparatus, use a wrench applied to the hexagon head of the threaded connection located just outside of the case.

INSTALLATION OF BULB

Locate bulb so that at least last two inches will be subjected to the average temperature to be measured.

Exposing the bulb to a temperature in excess of the highest dial reading should be avoided.

When a thermometer is equipped with a well, the well should be installed onto the apparatus first. The stem of the thermometer should then be coated with a heat conducting medium (a mixture of glycerine and graphite or vaseline or any other heavy lubricant may be used), after which the thermometer stem is inserted, and tightened into the well.

The thermometer is normally provided with a threaded connection. To tighten the thermometer to the apparatus or into the well, use an open-end wrench applied to the hexagon head of the threaded connection. Turn until reasonably tight, then tighten still further in the same manner as a pipe elbow or similar pipe fitting until the scale is in the desired position for reading. DO NOT TIGHTEN BY TURNING THE THERMOMETER CASE. *Install the thermometer so that the maximum case temperature is kept below 200°F at all times.*

TESTING

Ashcroft Bi-metal Dial Thermometers are carefully calibrated at the factory and under most operating conditions will retain their accuracy indefinitely. However, as in the case of all instruments, it is well to make periodic checks for accuracy against known standards.

ADJUSTMENT

If it is necessary to make an adjustment to the thermometer, proceed as follows:

a.) On thermometers fitted with a removable ring only.—Hold the tail end of the pointer close to the center with one hand and, by means of a small screw driver, turn the slotted center bushing. Release the pointer and check its reading. Repeat above operation until the pointer is brought to the proper reading on the scale. Be sure to replace the gasket, glass and ring after the adjustment has been made. (See caution note below.)

b.) On thermometers fitted with an "External Adjustment"—Use a small wrench, small screw driver or a coin to turn the slotted hexagon head in the back of the case until the pointer indicates the proper temperature on the dial.

MAINTENANCE OF DIAL THERMOMETERS

Aside from occasional testing, little or no maintenance is required.

Be sure that the gasketed glass cover is on the case at all times, as moisture and dirt inside the case will eventually cause the thermometer to lose its accuracy. (See caution note below).

If the thermometer is used for measuring the temperature of a material that may harden and build up an insulating layer on the stem, the thermometer should be removed from the apparatus occasionally, and the stem cleaned. Observe this precaution to insure the sensitivity of the instrument.

CAUTION: Bi-metal Thermometers operating below freezing must have a perfectly tight case to prevent entrance of moisture which eventually will condense and freeze inside the stem. This condition shows up as a failure of the thermometer to read accurately below 32°F or 0°C. For this reason it is important to avoid removal of the glass front from thermometers fitted with a removable ring, while the stem temperature is at freezing or below. If for any reason such a thermometer shows signs of stickiness when indicating a low temperature, remove the thermometer to a dry location and allow it to remain at room temperature for 24 to 48 hours with ring and glass removed. After this "drying out" period replace the ring, glass and gasket, tighten securely and reinstall. Be sure the gasket is in good condition; replace if necessary.

Thermometers fitted with the non-removable ring are hermetically sealed in a dry atmosphere at the factory and require no further maintenance.

SPARE PARTS LIST

(For Thermometers with removable bayonet lock rings only.)

Name of Part	*Part Numbers*		
	2" Size	*3" Size*	*5" Size*
Glass Circle	NE131A	NE131	BD131D
Gasket for Glass Circle	NX121	NV121A	NW121

DRESSER INDUSTRIES DRESSER

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OVER

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INSTRUCTIONS FOR THE SELECTION, INSTALLATION AND USE OF THE TYPE 91 SERIES ADAPTER SET

The Type 91 series adapter sets were designed to provide a simple means of installing a Bi-metal Dial Thermometer into an existing Industrial Glass Thermometer well.

The adapter set consists of:

1. A metal liner and spring assembly.
2. An adapter nut.
3. A small supply of heat conducting medium.

METHOD OF SELECTING THE SET

The adapter sets are available in four different sizes, to cover various depths of wells. The "Selection Chart" shows the adapter set number and the Bi-metal Dial Thermometer stem length to use for any well depth from 3⅜" up to 25⅛".

To select the proper adapter set and Bi-metal Dial Thermometer stem length, measure first the well depth by inserting a pencil, or any small diameter rod or stiff wire until it reaches the bottom. (See Figure 1). Be sure the rod does not hang up on any shoulder inside the well. Using your thumb as an index, withdraw the rod and measure the distance from the end of the rod to the index point. (See Figure 2).

Then use the chart to select the adapter set and the Bi-metal Dial Thermometer stem length to fit the well.

Note that one stem length of thermometer covers several different well depths by using the correct adapter set.

For example, a thermometer with a 9" long stem can be used for all well depths between 7⅛" and 10⅛", by choosing the correct adapter set.

The liner is tapped with a $\frac{5}{16}$"-18 machine thread so it can be removed from the well if desired.

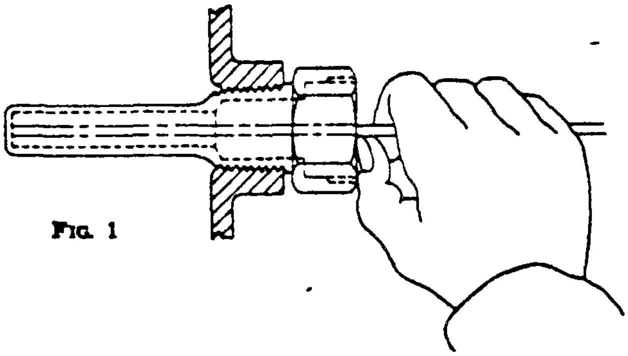


FIG. 1

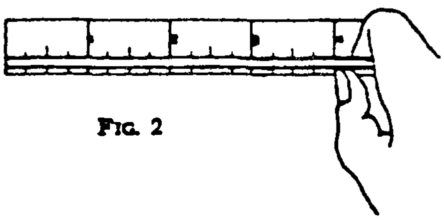


FIG. 2

INSTALLATION

Assemble the adapter nut into the well and tighten securely. (See Figure 3).

Before installing the Bi-metal Dial Thermometer into the adapter and well, coat the lower 3" section of the thermometer stem with a layer of heat conducting medium. This will improve the temperature response of the thermometer.

The metal liner is then slipped over the end of the thermometer stem and a coating of heat conducting medium is applied to the outside wall of the liner.

The thermometer and liner are then inserted into the well and tightened in position. Do not tighten more than is necessary to prevent the thermometer from turning.

Where service temperatures exceed 350°F the heat conducting medium may smoke when first subjected to a high temperature. This is caused by the vehicle, in the heat conducting medium, vaporizing and leaving the dry solids behind. This should not be cause for alarm. The dry solids will act equally well as a heat conducting medium for temperatures up to 1000°F.

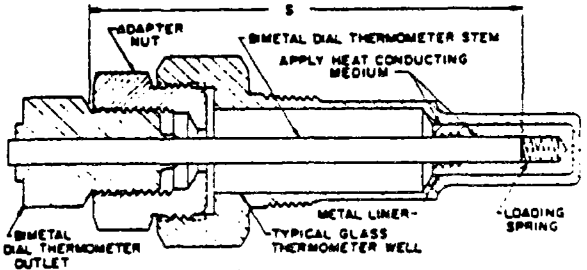
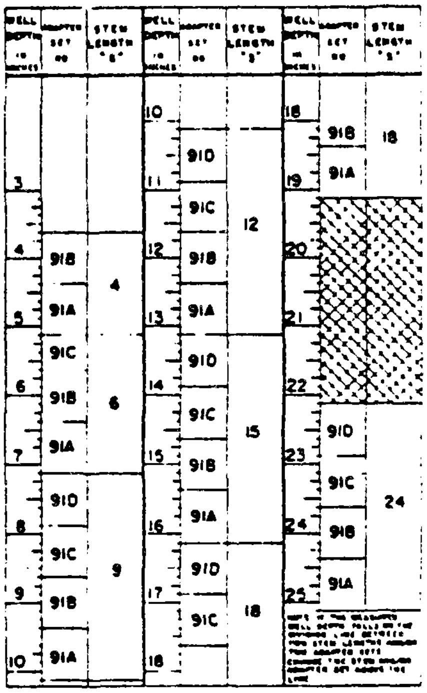
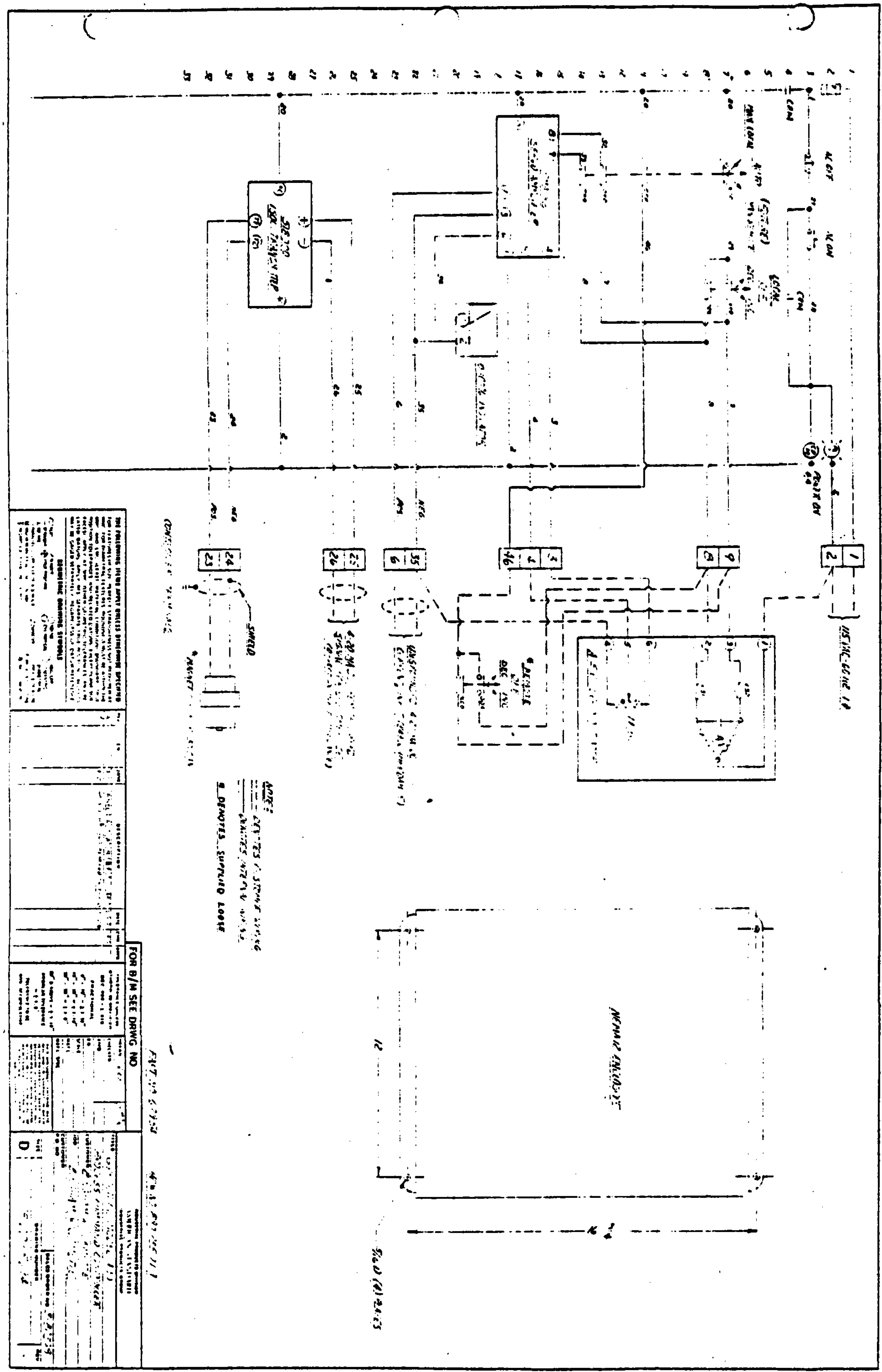


FIG. 3



SELECTION CHART


FOR B/M SEE DRWG NO
SHIELD
NOTE:
DENOTES SUPPLIED LOOSE
NEMA 12 ENCLOSURE
16 3/4
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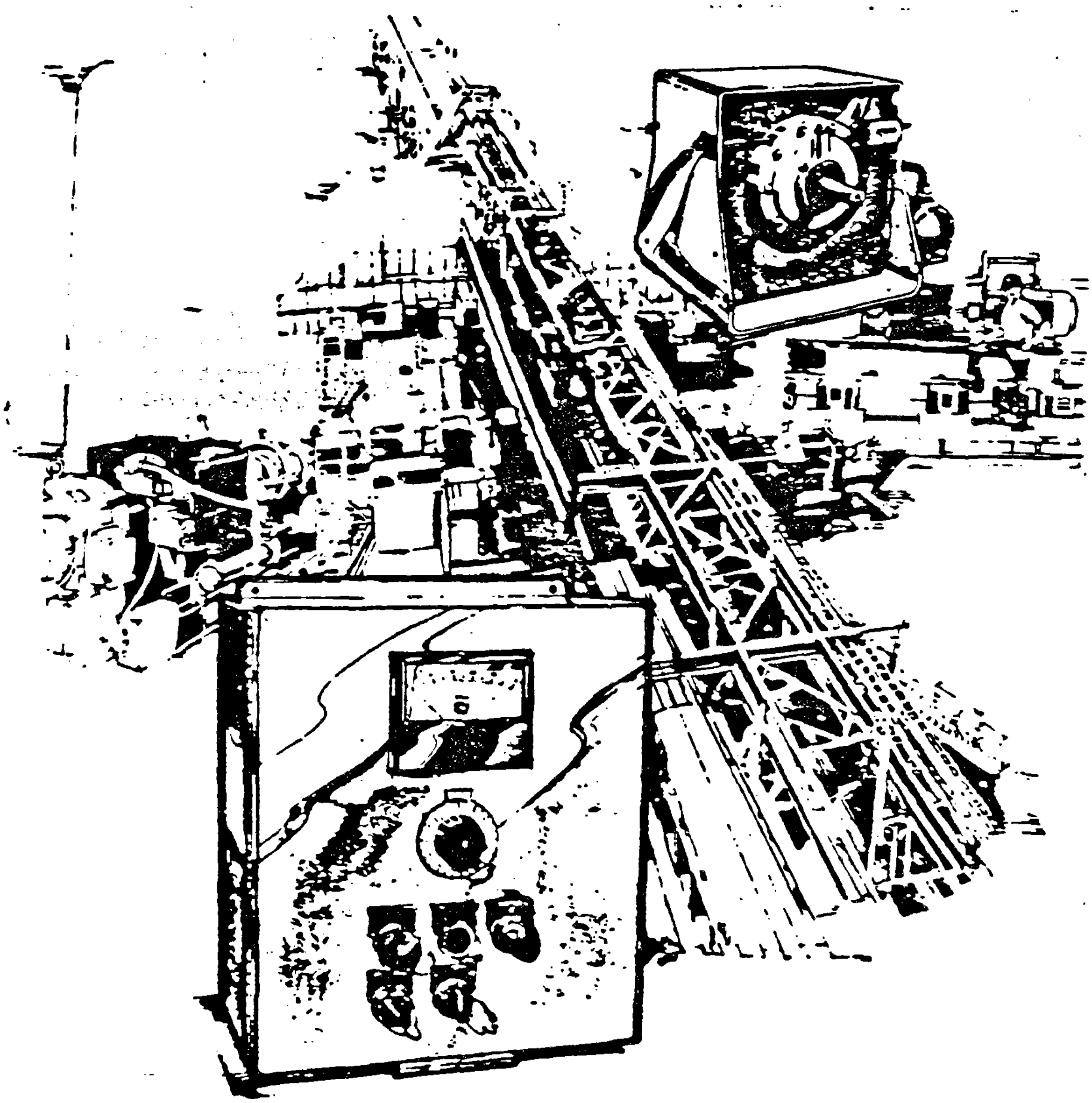
INDUSTRIAL PRODUCTS DIVISION
AMERICAN-STANDARD
8111 TIREMAN AVE.—P.O. BOX 76
DEARBORN, MICHIGAN 48121

INSTRUCTIONS

—For—

Installing and Operating

Gyroltrol® Series 200 and 400 control



MANUAL D-3490
Page 1
Issue 1
May 15, 1978

in U.S.A.

I. INTRODUCTION

Gyroltrol controllers are designed specifically to be used with American Standard Gyrol fluid drives and provide electrical control of scoop tube position. They are available in two [2] basic series of controllers. The Series 200 Gyroltrols are a group of manual push button controls. The Series 400 Gyroltrols are a group of automatic or modulating controls with manual override.

All Gyroltrol controllers are designed to drive and/or control electric actuators manufactured by Jordan Controls, Inc. for American Standard, Inc. Consult American Standard, Industrial Products Division, for correct Gyroltrol electric actuator selection.

IMPORTANT NOTICE

Proper operation of these American-Standard products depends on correct selection and use in accordance with sound engineering practices. It is the responsibility of the user to provide for proper installation, operation, periodic maintenance and inspection procedures under prevailing conditions. The user (not American Standard Inc.) must provide and install proper guards and other suitable safety devices or procedures which may be specified by safety codes or required by recognized safety standards.

II. CONTROLLER GENERAL INFORMATION

A. Enclosures - The standard Gyroltrol enclosure is a Nema 12 cr general industrial oil tight enclosure. Optional enclosures include Nema 4 weatherproof [not submersible], or Nema 7 and 9 explosion-proof [not weather-proof]. Consult factory for details on various types of enclosures.

B. Manual Controls - All Gyroltrol controllers can be operated in a manual mode of operation whereby the operator presses the desired INCREASE [move toward clutch] or DECREASE [move toward Declutch] switch to initiate and continue scoop tube positioning to a desired point. A Manual/Auto selector switch is provided on the series 400 Gyroltrols to enable the operator to select this mode.

C. Automatic Controls - The series 400 Gyroltrols operate in an automatic or closed loop proportional pulse modulating mode. They accept a command input signal from either a standard 0 to 100% dial/pot set point or an externally supplied process current of 1 to 5, 4 to 20 or 10 to 50 ma DC or an externally supplied 0 to 5 VDC, compare it to a comparable Gyrol controlled process feedback signal, and initiate the appropriate AC or DC output to the control actuator. The electric control actuators are rated at either 115 VAC, 50/60 HZ in the AC version or 90 VDC in the DC version. If this command to feedback comparison or error signal is greater than a preset gain point, full output power is applied in the appropriate polarity to the control actuator. As the error signal decreases to the preset gain point, pulse modulated output power of fixed frequency but decreasing time duration is applied to the control actuator; thus maintaining a set point correction for varying Gyrol speed and load changes or varying command changes.

D. Power Requirement - 105 to 125 VOLTS AC, 50/60 HZ.

E. Case Ground - The case of the controller enclosure is electrically isolated from the internal circuitry. A ground lead in the power supply [usually green] should be connected to a subpanel mounting stud inside the enclosure to assure protective grounding.

F. Front Panel Controls and Indicators

Series 200 control functions [except Model 230 and 240] are as follows:

1. DECREASE/OFF/INCREASE two [2] position spring return to center selector switch to initiate and continue scoop tube positioning to a desired point.

II. CONTROLLER GENERAL INFORMATION [Continued]

F. Front Panel Controls and Indicators [continued]

2. INDICATING METER calibrated in the appropriate process feedback signal range. Example: Model 210 - Actuator Position Indicating Meter calibrated 0 to 100 PERCENT FULL RANGE. Meter accuracy is ± 2% of full scale. Each meter is diode protected and contains a calibration pot mounted on a PC board on the back of the meter.

Model 230 and 240 - Control functions: refer to Appendix C-3 and C-4 respectively.

Series 400 control functions are as follows:

1. AC POWER ON push button latches in CRM power relay. Indicated by panel lamp ON.

2. AC POWER OFF push button unlatches CRM power relay. Indicated by panel lamp OFF.

3. MANUAL/AUTO two [2] position selector switch to select desired mode of operation.

4. DECREASE/OFF/INCREASE two [2] position spring return to center selector switch to initiate and continue manual scoop tube positioning to a desired point. Operates when above mode switch is in the MANUAL position.

5. 0 to 100% SET POINT DIAL to adjust the desired command input to the controller. Operates when above mode switch is in the AUTOMATIC position. Not supplied when either a process current or process voltage command input signal is specified by customer.

6. INDICATING METER calibrated in the appropriate process feedback signal range. Example: Model 410 - Regulated Speed Control - Meter calibrated 0 to 2000 RPM for 1800 RPM max input speed. Meter accuracy is ± 2% of full scale. Each meter is diode protected and contains a calibration potentiometer mounted on a PC board on the back of the meter.

II. CONTROLLER GENERAL INFORMATION [Continued]

F. Front Panel Controls and Indicators [continued]

Additional Series 200 and 400 control functions:

When Adjustable-Rate Acceleration with High Speed De-clutch option is selected are as follows:

NOTE: DC CONTROL ACTUATORS MUST BE USED WITH THIS OPTION

1. EMERGENCY DE-CLUTCH push button latches in the emergency de-clutch relay in the controller. This relay selects the HIGH SPEED pot in the VS-8 variable speed control and signals it to apply output power in the decrease direction to the DC control actuator. Any other manual or automatic control is disconnected in this mode. An emergency de-clutch panel lamp indicates this condition. Refer to Appendix B for use and calibration of the Model VS-8 two [2] speed select variable speed control.

2. RESET push button unlatches the emergency de-clutch relay and returns control to either the manual or automatic mode, whichever has been selected. This button is pushed ONLY after the emergency condition has been removed.

When NO LOAD START Option is selected are as follows:

NOTE: AC or DC control actuators may be used with this option.

1. A panel lamp indicating AT DE-CLUTCH is provided with this option. This lamp and an internal control relay are energized when the electric control actuator de-clutch limit switch is tripped.

III. INSTALLATION INSTRUCTIONS

A. Controller - Mount the Gyroltrol enclosure securely to a wall or separate structure free of vibration. The controller should be located at distances of 250 feet or less from the control actuator or feedback transducer. Consult factory if greater distances are required.

B. Feedback Transducer - Refer to the appropriate model Appendix for recommendations concerning the mounting of the various feedback transducers.

C. Electric Actuator - Mount the electric control actuator to the Gyrol fluid drive using the mounting hardware and drawing supplied by American Standard.

D. Electrical Connections - A standardized controller terminal designation for customer wiring applies to all Gyroltrol Series 200 and 400 controllers. Refer to Figure 1A for the correct basic wiring designation used when controlling with an AC electric actuator. Refer to Figure 2A when controlling with a DC actuator. Additional terminals may exist in the enclosure, but they are usually not for customer wiring except when specified in a "SPECIAL" Gyroltrol.

E. Process Signals - The COMMAND signal or FEEDBACK signal may be a process current or voltage as outlined in section II-C. This of course applies to the series 400 Gyroltrols only and must be specified when the controller is ordered. Refer to Appendix A and the appropriate model Appendix for instructions concerning the use of process signals.

CAUTION: When a process signal is wired into the controller, the negative side of the signal will be GROUNDED. Optional process signal isolation is available. Consult factory for details.

F. Linkage - Care should be taken to insure proper end to end linkage adjustment per American Standard drawings to prevent interference of motion of scoop tube and control arm. The control linkage can be temporarily disconnected from the electric actuator and moved by hand to test for smooth operation.

IV. OPERATING INSTRUCTIONS

A. Wiring Checkout [200 and 400 series] - It is important before applying power to carefully re-check all wiring as shown on the detailed wiring diagram supplied with the equipment. To reduce shock hazards and prevent possible damage to the Gyroltrol, AC HOT and AC COMMON must be wired to the correct terminals and AC NEUTRAL must be wired to a subpanel mounting stud for case grounding.

With main AC power on but BEFORE pressing the controller AC ON button:

Check with a VOM to read zero volts AC between AC COMMON [Terminal 2] and AC NEUTRAL [Chassis Ground]. Also check to read 115 VAC ± 10 volts between AC HOT [Terminal 1] and AC COMMON.

If OK, proceed as follows:

With the Gyrol fluid drive motor [prime mover] off and the controller in the manual mode, turn the controller AC power ON and use the DEC/INC switch to move the scoop tube in or out as indicated by the pointer on the fluid drive. Due to various actuator mounting configurations, it may be possible that the scoop tube moves towards de-clutch when the switch is pressed to increase. If so, turn off the AC power and reverse the wires at the electric actuator as instructed to do on the actuator drawing. [Figure 1B or 2B].

Check the actuator end of travel limit switch settings by pressing and holding the increase and/or decrease switch and observing the point at which the mechanical stop on the scoop tube stops. Avoid hitting the stop against the casting. The stop should come to rest about 1/16" from the casting. These limits have been set at the factory, however, it may be necessary to touch them up by rotating the cams inside the actuator housing. A small allen head screw within the cam or locking key holds it in place. It may be necessary to hold the switch for 45 seconds or so to go from full clutch to declutch. The actuator wiring, direction, and limits should now be correct.

B. Controller Checkout - Proceed as follows:

1. No Load Start Option [200 & 400 Series except 210 & 220] - If this option has been provided in the Gyroltrol, the operator will not be able to start the fluid drive motor unless the scoop tube is in the full de-clutch position as indicated by the "AT DE-CLUTCH" panel lamp ON. A normally open [closed at de-clutch only] contact is provided by the Gyroltrol and MUST be wired in series with the fluid drive motor starter coil as

IV. OPERATING INSTRUCTIONS [Continued]

B. Controller Checkout - Proceed as follows:

1. No Load Start Option [continued]

shown in figure 3. The scoop tube must be driven via the electric actuator to the full de-clutch position with the use of the manual decrease push button. Be sure that the optional extra de-clutch limit switch [LS3] in the actuator is set to trip at the same time as the decrease limit switch [LS2]. The cam notches of these two limit switches should be in line.

2. Manual Control [200 & 400 Series] -
With the controller AC power on and in the Manual mode, the Gyrol fluid drive motor running and the Gyrol loaded, again use the DEC/INC switch to move the scoop tube in and out and thus vary the fluid drive output speed.

NOTE: The fluid drive must be loaded to obtain a variation in the output speed.

3. Adjustable-Rate Acceleration with High Speed De-Clutch Option [200 & 400 Series except 210 & 220] -
If this option has been provided in the Gyroltrol, the operator can at any time drive the scoop tube to full de-clutch at a high rate of speed by simply pressing the "Emergency De-Clutch" push button. The "High Speed" and "Normal Speed" calibration pots on the Model VS-8 variable speed control are set at the factory for nominally 45 seconds stroke time in the normal mode [de-clutch to clutch or clutch to de-clutch] and 12 seconds stroke time in the emergency mode [clutch to de-clutch only]. Refer to Appendix B for specific instructions on the use and calibration of the Model VS-8 two [2] speed select variable speed control.

4. Automatic Control [400 Series Only] -
At this point the Gyroltrol should be capable of being operated in the Automatic control mode.

With the controller in the Automatic mode, the output speed of the fluid drive and therefore the process being controlled should vary in proportion to the input command signal. The indicating meter should also indicate some value of process variable.

IV. OPERATING INSTRUCTIONS [Continued]

B. Controller Checkout - Proceed as follows: [continued]

5. Controller Calibration - [Indicating Meter]
All Gyroltrol controllers are pre-calibrated on a test bench simulator and therefore only slight adjustments should be required on field start up.

Only the indicating meter calibration will be covered in this section as it is common to all Series 200 and 400 Gyroltrols using indicating meters. The calibration of all other control elements such as the PMA-8 Servo Amplifier, the feedback transducer, etc. will be covered in the appropriate appendixes included with this manual for the particular Gyroltrol Model with Options as required.

Indicating Meter Calibration -

- With controller AC power OFF, adjust the mechanical zero of the meter by turning the screw located on the meter face.
- With a known process feedback signal value, adjust the electrical indication of the meter by turning the calibration pot mounted on the PC board on the back of the meter until the meter reads correctly. Best accuracy will be obtained with a process feedback signal calibration at about 75% of full scale.

NOTE: The feedback transducer must be calibrated first before this meter adjustment can be made properly.

C. Maintenance

The Gyroltrol controller should require virtually no maintenance as industrially rated components have been selected and solid state technology applied wherever possible. Periodic checks of operating performance and calibration of control elements would be prudent. In certain critical applications where justified, it may be advisable to keep a complete spare Gyroltrol controller.

V. Gyroltrol Specifications

Input Power	-	115 VAC ±10 volts, 50/60 Hz
Enclosure	-	Nema 12 Standard [Optional Nema 4, or Nema 7 & 9]
Enclosure Size	-	16" H x 14" W x 6" D [Except Nema 7, 9, Specials and Models 210 and 220]
Indicating Meter		
Scale	-	50 divisions calibrated in the appropriate process range
Accuracy	-	± 2% of full scale
Movement	-	0 to 5 VDC diode protected and adjustable
Input Signals		
Command	-	0 to 100 & Set Point Dial
	*-	1 to 5 ma DC, Input Z = 1000 ohms
	*-	4 to 20 ma DC, Input Z = 250 ohms
	*-	10 to 20 ma DC, Input Z = 100 ohms
	*-	0 to 5 VDC, Input Z = 100 K ohms
Feedback	-	1 K ohm potentiometer
	-	Feedback transducer supplied with Gyroltrol
	*-	1 to 5 ma DC, Input Z = 1000 ohms
	*-	4 to 20 ma DC, Input Z = 250 ohms
	*-	10 to 50 ma DC, Input Z = 100 ohms
	*-	0 to 5 VDC, Input Z = 100 K ohms

*Denotes non-isolated or grounded at Gyroltrol process signals. Optional isolating transmitters also available in Gyroltrol.

Output Signals		
200 Series	-	115 VAC line power via contacts or solid state triax
400 Series	-	Pulse modulated solid state triax
Accuracy	-	± 1% of full range assuming a stable load
Operating Temperature	-	-30° F to + 120° F
Controller Location	-	Up to 250 Feet from actuator or transducer

Lithographed in U.S.A.

FIGURE 1A. GYROLTROL STANDARD WIRING DESIGNATION
(AC Actuator)

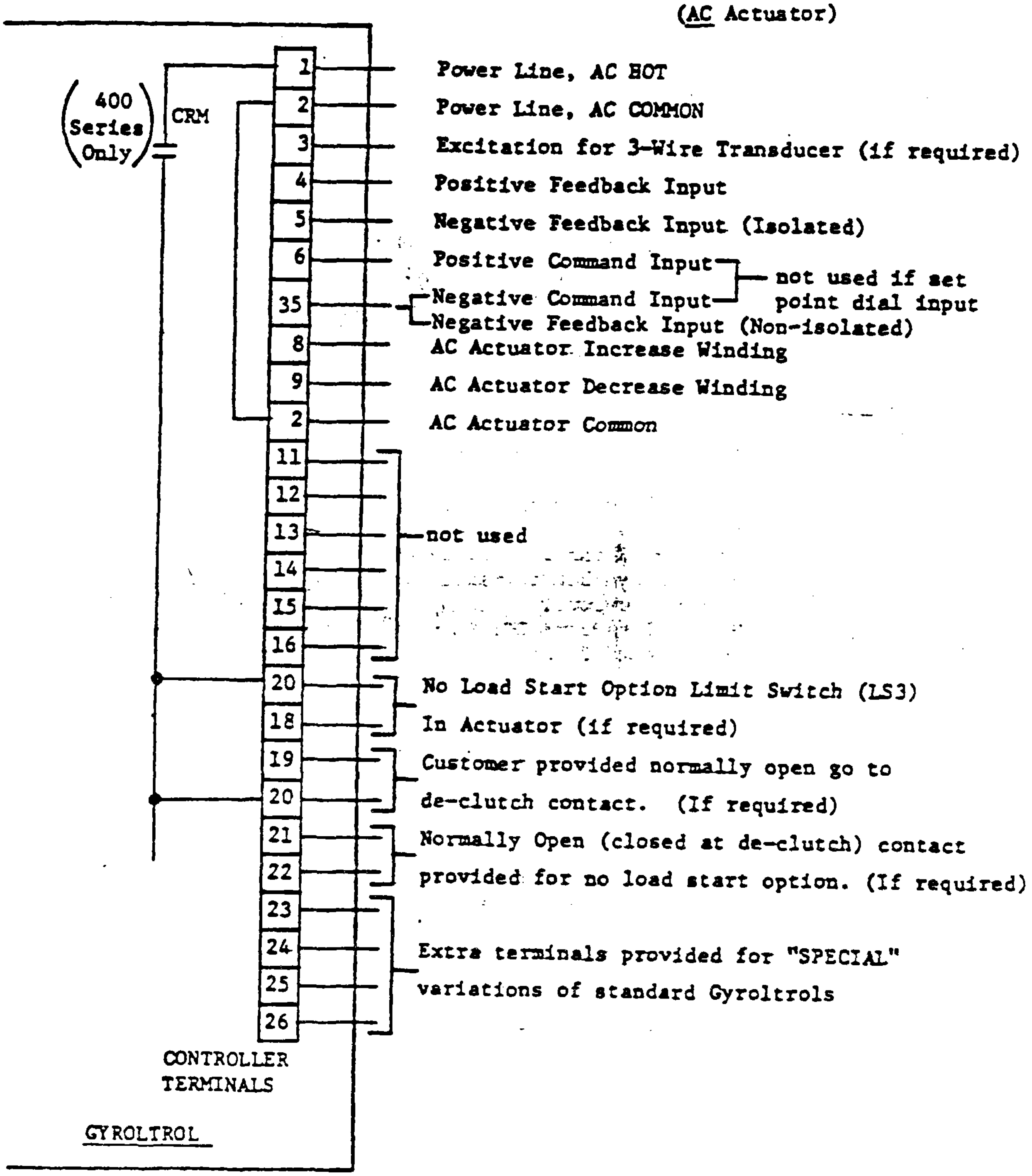


FIGURE 2A. Gyroltrol Standard Wiring Designation (DC Actuator)

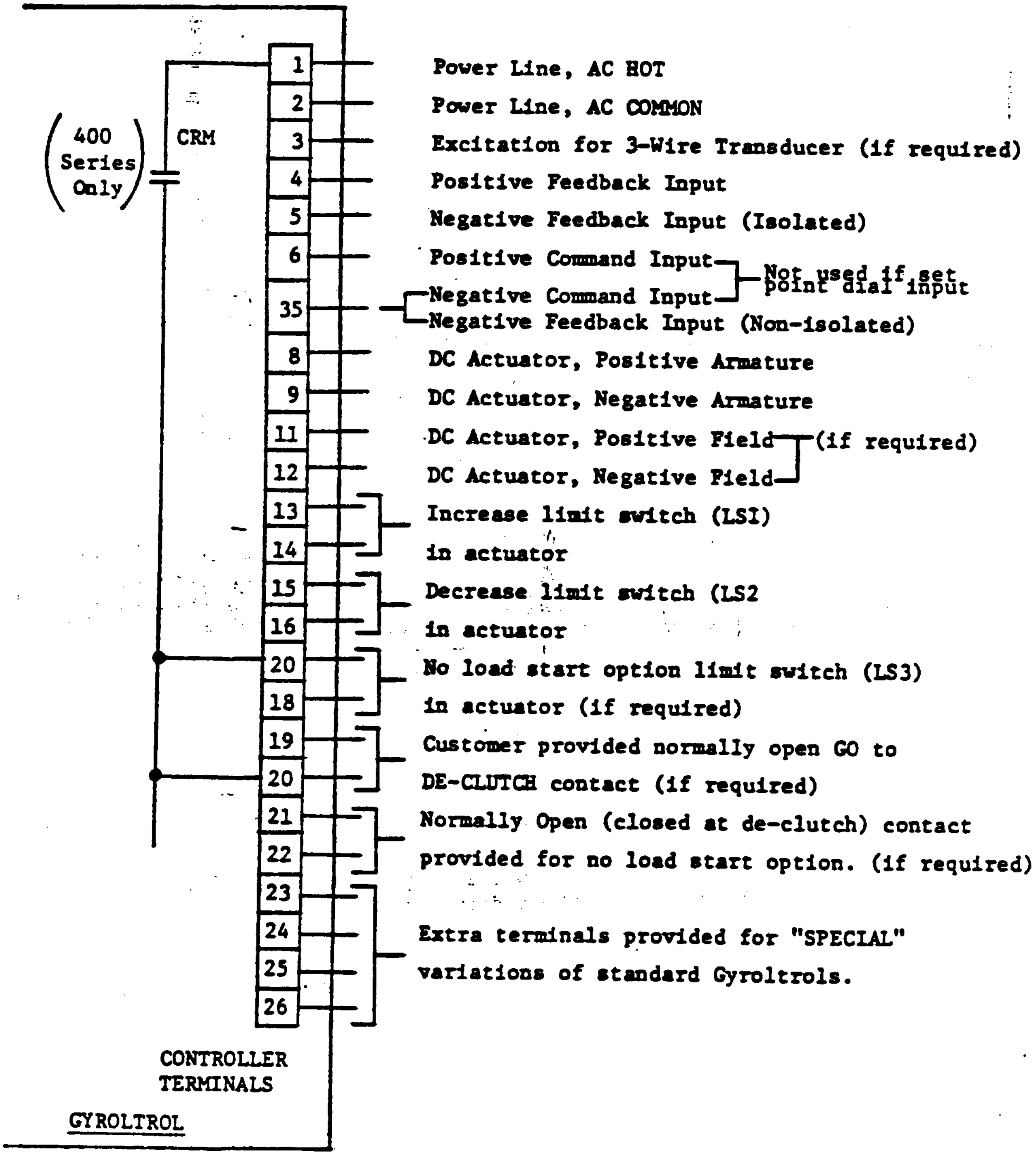
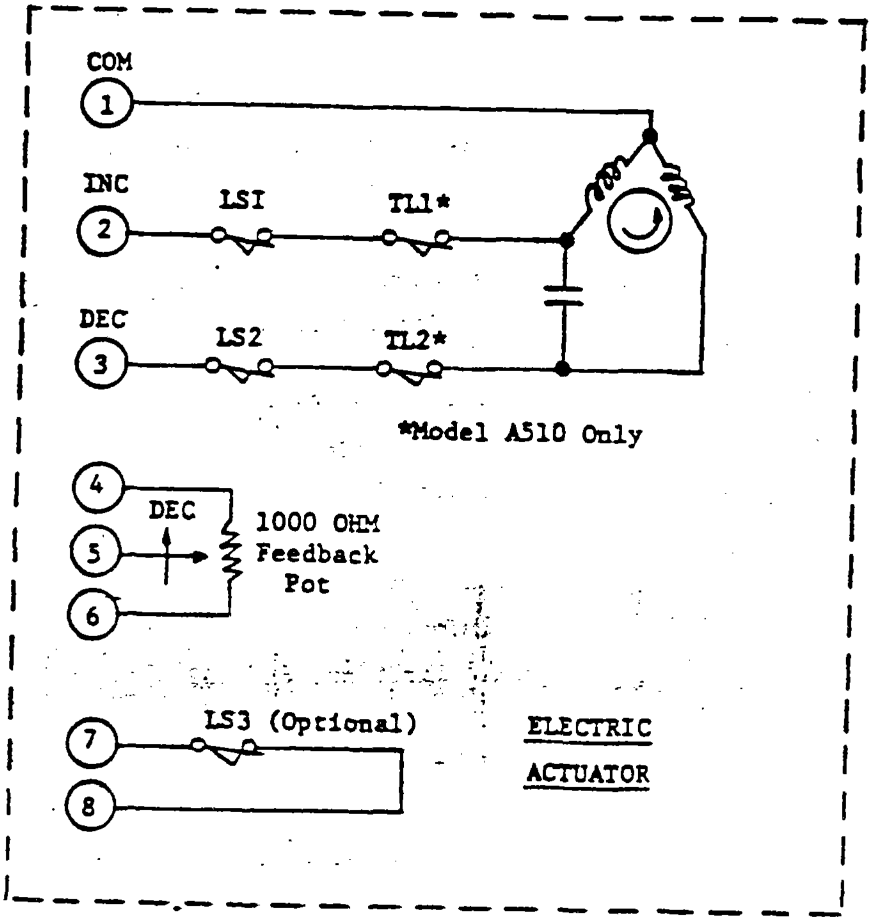


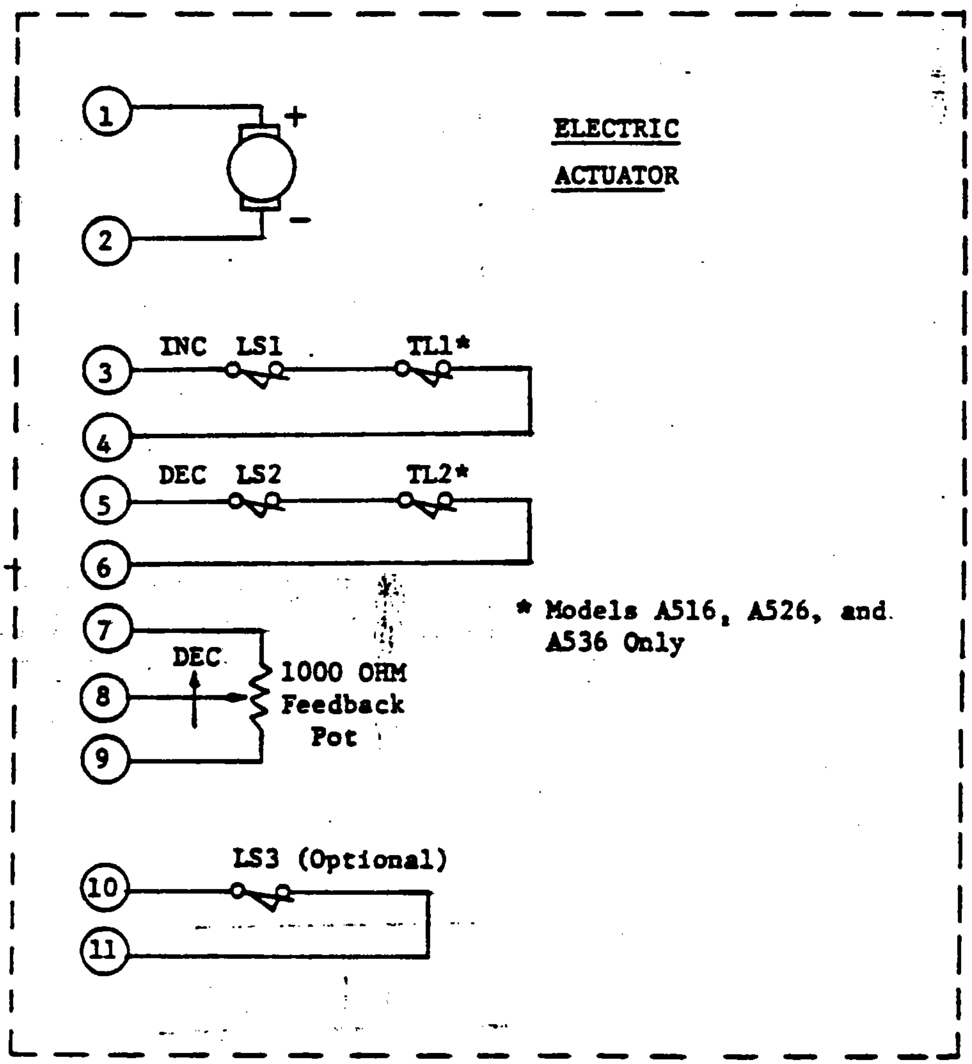
FIGURE 1B - AC ACTUATOR WIRING



NOTE: Above wiring includes models: A110R, A150R and A510 only.
Models A520 and A530 contain 3 phase motors and therefore cannot be driven by Gyroltrol Series 400 controllers.

To Reverse Direction: Interchange wires to terminals 2 and 3 and 4 and 6

FIGURE 2B - DC ACTUATOR WIRING



* Models A516, A526, and A536 Only

NOTE: Above wiring includes Models: A116R, 156R, A516, A526, A536.

To avoid damage to the actuator, LS1 and LS2 limit switches must be wired in series with the proper increase and decrease control circuits.

To Reverse Direction: Interchange wires to terminals 1 & 2 and 7 & 9. Also, rewire LS1 and LS2 in proper circuit for end of travel limit.

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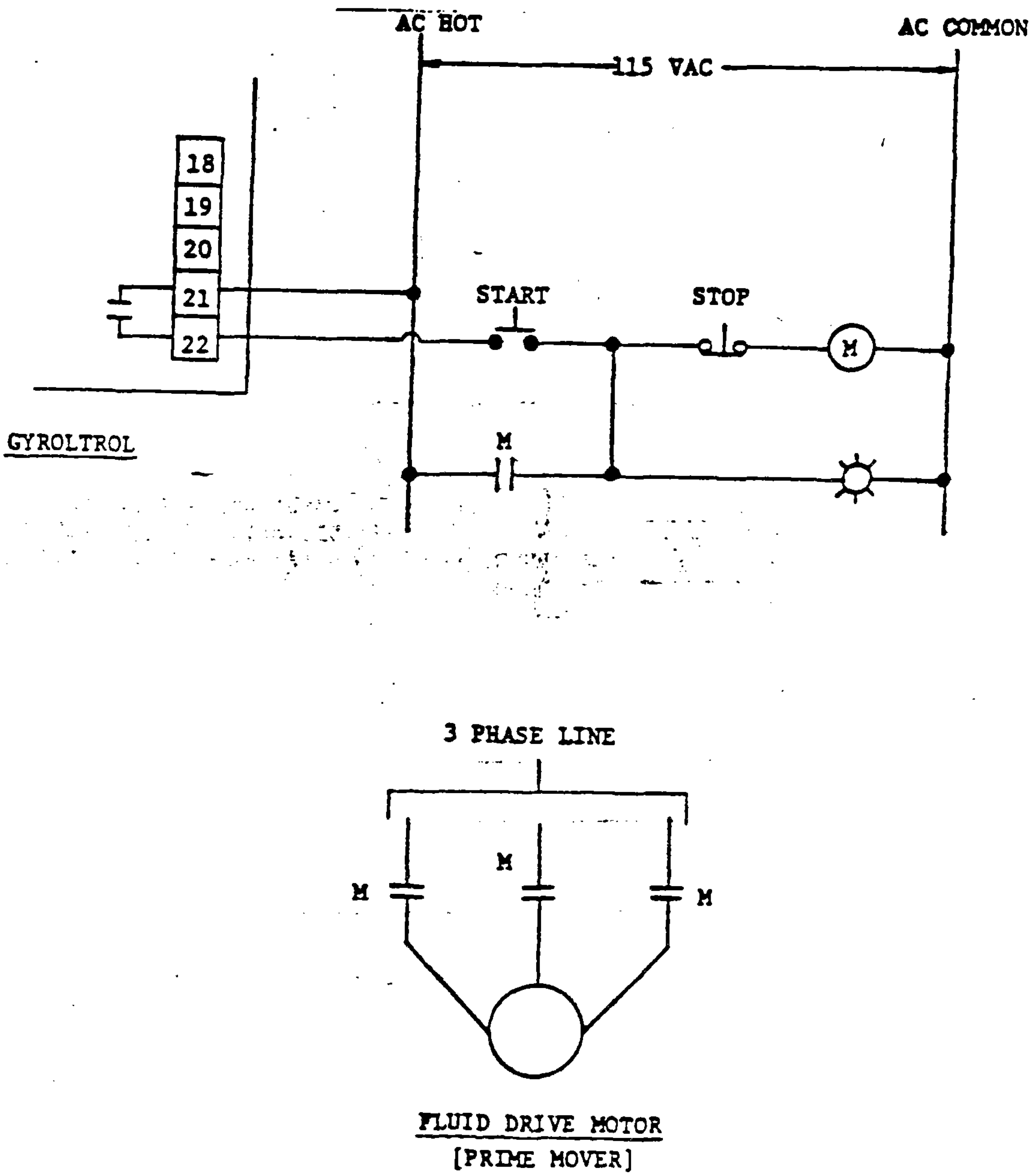
FIGURE 3 - (No Load Start Option)
TYPICAL CUSTOMER MOTOR CONTROL CENTER



APPENDIX A
MODEL PMA-8 SERVO AMPLIFIER

DESCRIPTION - The Model PMA-8 servo amplifier is an all solid state proportional pulse modulating control. It is utilized in series 400 Gyroltrols to provide an automatic or closed loop type of control. The amplifier essentially compares a command input signal to a comparable Gyrol controller process feedback signal and initiates the appropriate Increase or Decrease solid state output. If this command to feedback comparison or error signal is greater than a preset gain point, full output power is applied to the control actuator. As the error signal decreases to the preset gain point, pulse modulated output power [of fixed frequency but decreasing time duration] is applied to the control actuator, thereby maintaining a constant point for varying Gyrol speed and load changes or varying command changes.

STANDARD FEATURES

- Input power of 115 VAC, single phase, 50/60 Hz
- Suitable for sub-panel mounting
- Terminal strip connections
- Process signal inputs
- Power supply of 12 VDC @ 50 ma
- 100% solid state electronics
- Proportional pulse modulated output
- Opto-Isolated 115 VAC triac outputs
- ± .25% electronics
- + .1% linearity
- Separate indicating meter driver
- Input impedance of 100 K ohms
- 4 turn calibration pots for precise adjustment
- Internal 2000 ohm high trim pot
- Temperature range of 0° C to 55° C

CALIBRATION - All Gyroltrol controllers are pre-tested, burned in, and calibrated on a test bench simulator. Although the exact field conditions cannot be duplicated, this test bench calibration should reduce field start-up to a minimum.

A. MODEL PMA-8 SERVO AMPLIFIER - Refer to Figure A-2

1. Field Calibrations

TRIM - Terminal 4 of the amplifier may be wired if a 0 to 100% Command dial/pot is supplied or a feedback transducer containing a potentiometer is used. The value of these pots should be 1 K ohms. Adjust the pot indicated as "TRIM" for 5.0 VDC input at terminal 1 with the command dial at 100% or 5.0 VDC input at terminal 2 with the feedback transducer at full range.

NOTE: Terminal 4 cannot drive both together.

GAIN - Adjust the pot indicated as "GAIN" to obtain a stable or non-hunting operation. The value of GAIN can be measured with a VOM on test point one (TPI) and is typically 0.5 to 0.75 VDC. The pointer of the VOM will be oscillating around an average amount. It is this average amount that is read. Set the Gain as low as possible in order to obtain the optimum response providing the controller is not hunting.

2. Factory Calibrations

FREQUENCY - This pot adjusts the pulse modulating frequency for nominally:
5 Hz with an AC actuator
20 Hz with a VS-8/DC actuator

DEADBAND - This pot is set for optimum sensitivity, usually 0 VDC at TP2.

BALANCE - This pot is set for optimum overall amplifier linearity for a 0 to 5 VDC input.

JUMPER - Factory installed jumper in position #1 when controlling with an AC actuator and in position #2 when controlling with a VS-8/DC actuator. This jumper activates or de-activates terminal 7.

B. NON-ISOLATED PROCESS SIGNAL INPUT - Refer to Figure A-2

The resistor indicated as Rx is used to develop an input voltage of 5.0 VDC maximum when a process current command of 1 to 5, 4 to 20, or 10 to 50 ma DC is specified by the customer. This resistor is located externally across terminals 2 and 3 if a process current feedback of the same values is specified by the customer. The values of this resistor are as follows:

1 to 5 ma DC input - 1000 ohms, 1/4 watt, ± 1%

4 to 20 ma DC input - 249 ohms, 1/4 watt, ± 1%

10 to 50 ma DC input - 100 ohms, 1/4 watt, ± 1%

0 to 5 VDC input - Rx not required

C. ISOLATED PROCESS SIGNAL INPUT - Refer to Figure A-3

1. An isolating current transmitter is utilized when this type of input is required. Resistor Rx or an external Rx is not required as the current transmitter provides the proper output voltage. Also, a single isolated process current input signal can be used to drive more than one Gyroltrol by simply wiring the inputs [T1 & T2] of the isolating transmitters in series.

2. Calibration Steps

   a. Set the input current to the value corresponding to the low voltage output and adjust the ZERO [Z] control for 0 VDC output. As you approach and pass zero, you will notice that your output does not reverse polarity, therefore, stop adjusting when zero has been reached.

   b. Set the input current to the value corresponding to the high voltage output and adjust the SPAN [S] control for 5.0 VDC output.

   c. Reset the input current to the value corresponding to the low voltage output and adjust the ZERO [Z] control until the low voltage is correct.

   d. Reset the input current to the value corresponding to the high voltage output and adjust the SPAN [S] control until the high voltage is correct.

   e. Repeat steps c and d until proper calibration is achieved.

3. The input or loop resistor of 2.0 ohms is mounted on the base plate terminals T1 and T2. When the electronic module is removed from the base plate the current loop remains closed.

WIRING - Always wire your Gyroltrol per the American Standard drawing supplied with each controller. Refer to Figure A-1 for the correct typical PMA-8 wiring when used with a set point dial/pot command and process feedback signal. Note that terminal 7 is used only in conjunction with the Model VS-8 variable speed control when driving a DC actuator.

TERMINAL DESCRIPTION

Term. 1 - Positive Command Input [0 to 5 VDC]

Term. 2 - Positive Feedback Input [0 to 5 VDC]

Term. 3 - DC Common and Negative Command and Feedback Input

Term. 4 - DC Reference Voltage using Internal Trim Pot

Term. 5 - Positive 12 VDC Power Supply @ 50 ma.

Term. 6 - Positive Indicating Meter Output [0 to 5 VDC]

Term. 7 - Proportional Pulse Output for VS-8 [DC only]
[Internal Jumper must be in DC position]

Term. 8 - Decrease Output [Opto-Isolated Triac]

Term. 9 - Increase Output [Opto-Isolated Triac]

Term.10 - AC Hot, 115 VAC, 50/60 Hz

Term.11 - AC Common

FIGURE A - 1 - PMA-8 WIRING

(Example with Set Point Command and Process Feedback)

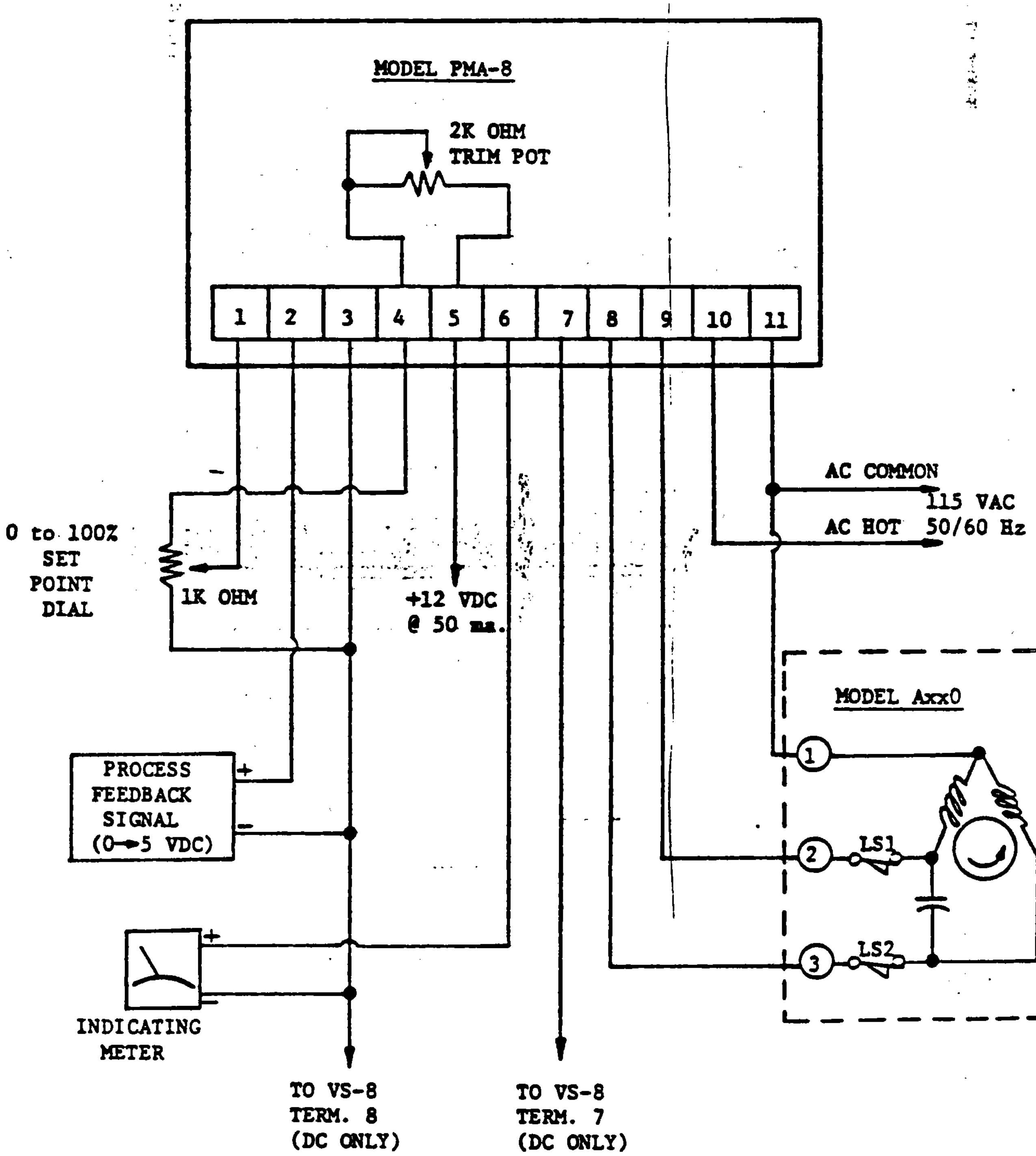


FIGURE A-2 - PMA-8 PHYSICAL LAYOUT

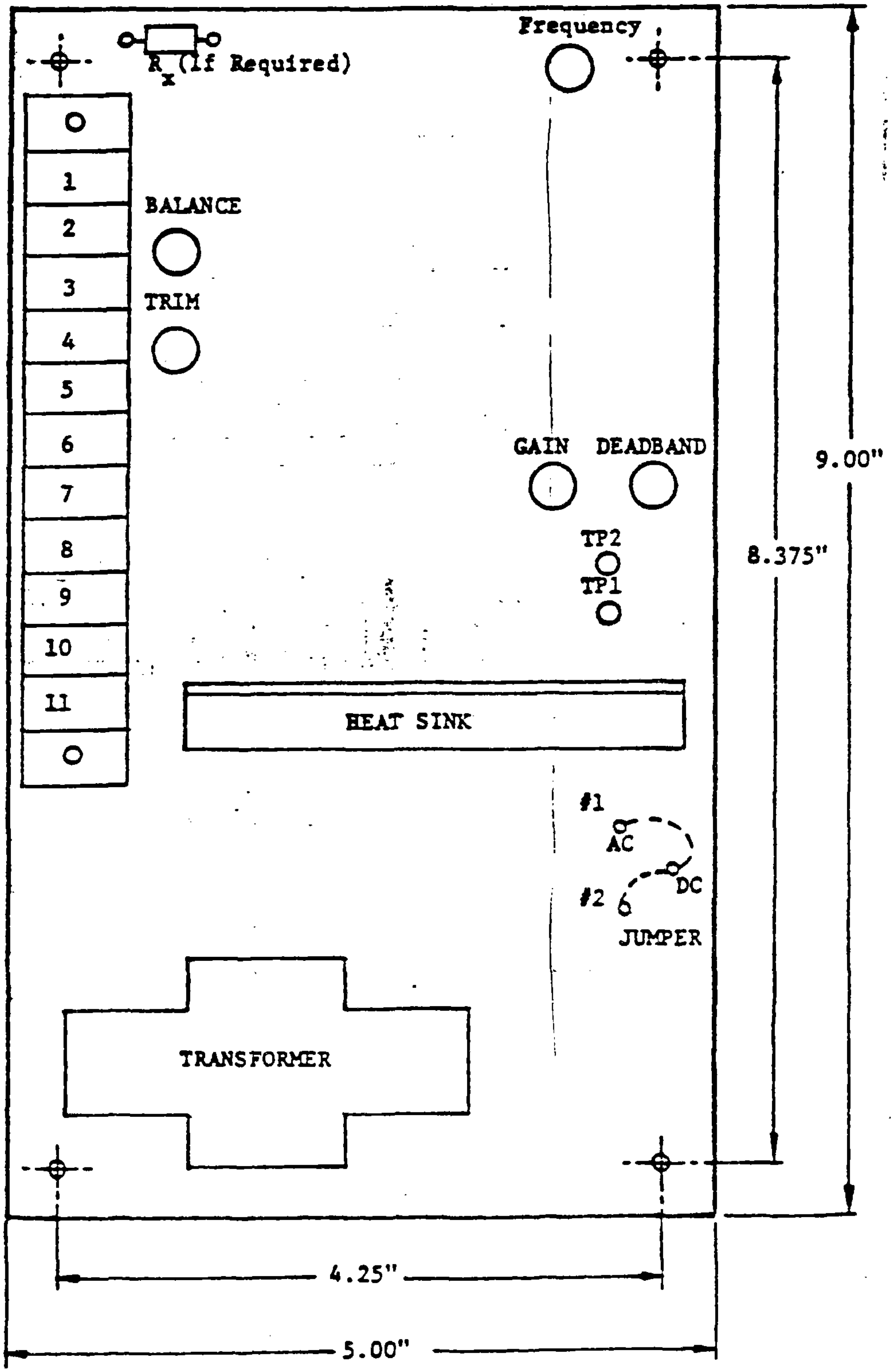
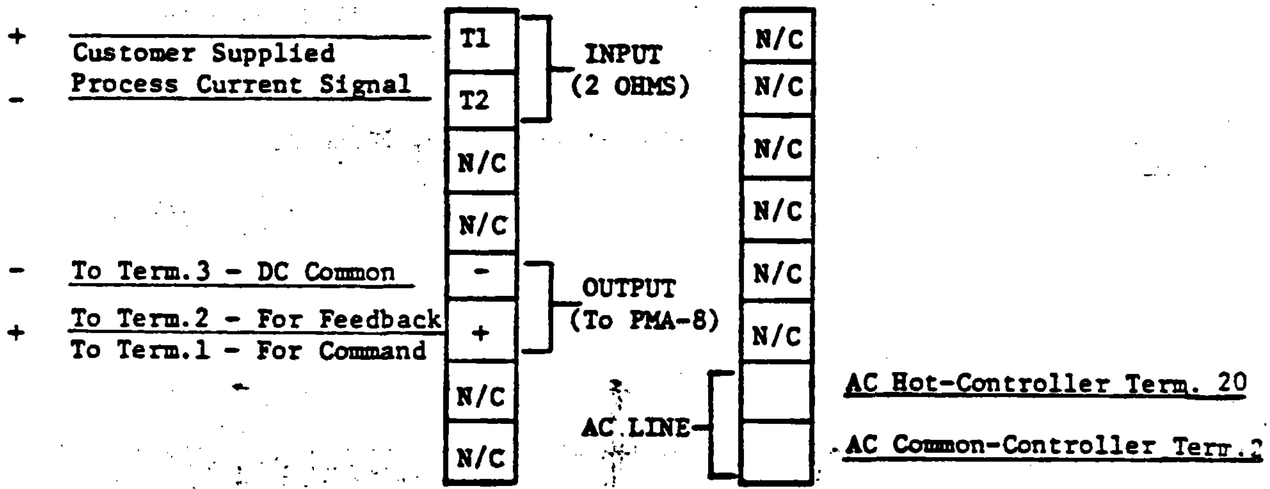


FIGURE A - 3 - #515000 ISOLATING TRANSMITTER WIRING



MODEL #515000

ISOLATING CURRENT TRANSMITTER

APPENDIX B
MODEL VS-8 VARIABLE SPEED CONTROL

DESCRIPTION - The Model VS-8 variable speed control is a solid state variable DC drive with polarity reversing relays and two speed pots selected by external form C contacts. [One NO and one NC]. It is utilized in series 400 Gyroltrols when the Variable Stroke Time with High Speed De-Clutch Option has been selected or in certain variable stroke time series 200 Gyroltrols such as Conveyor Start Controllers. The VS-8 will drive only actuators containing 90 VDC PM motors such as the series Axx6 electric actuators.

STANDARD FEATURES

- Input power of 115 VAC, single phase, 50/60 Hz
- All solid state except for INCREASE and DECREASE polarity reversing relays.
- Full wave DC output.
- Constant torque over 10:1 speed range.
- Transient voltage protection.
- Suitable for sub-panel mounting.
- Barrier type terminal strip.

CALIBRATION - The only calibration required for the VS-8 is the adjustment of the normal and high speed stroke times. With the controller in the manual mode, press and hold the Increase switch and adjust the normal speed pot for a stroke time for full de-clutch to full clutch of approximately 45 seconds. Then press the "Emergency De-Clutch" push button and adjust the high speed pot for a stroke time for full clutch to full de-clutch of approximately 12 seconds. These switches are called simply "Clutch" and "De-Clutch" respectively in Conveyor Start Controllers. The above stroking times are nominal and could possibly be varied depending on the response and stability of the particular application.

CAUTION: Care must be taken to avoid hitting the actuator linkage against the fluid drive mechanical stops as a result of too fast of a stroking speed. As this could cause damage to the electric actuator or linkage, it is always best to start this calibration at a slow rate of stroking speed.

WIRING - Always wire your Gyroltrol per the American Standard drawing supplied with each controller. Refer to Figure B-1 for the correct typical VS-8 wiring when used with simple INCREASE/DECREASE push buttons. Note that terminals 7 and 8 are used only in the series 400 Gyroltrols.

TERMINAL DESCRIPTION -

Term. 1 - AC hot, 115 VAC, 60 Hz.

Term. 2 - AC Common.

Term. 3 - Common point for Form C speed select contacts.

Term. 4 - Increase input, 115 VAC with respect to Terminal 2.

Term. 5 - Normal speed select input, a connection between this terminal and terminal 3 will select the normal speed pot.

Term. 6 - High speed select input, a connection between this terminal and terminal 3 will select the high speed pot.

Term. 7 - Positive pulse input from Model PMA-8 Servo amplifier. [400 series only].

Term. 8 - Negative pulse input [DC common] from Model PMA-8 Servo amplifier [400 series only].

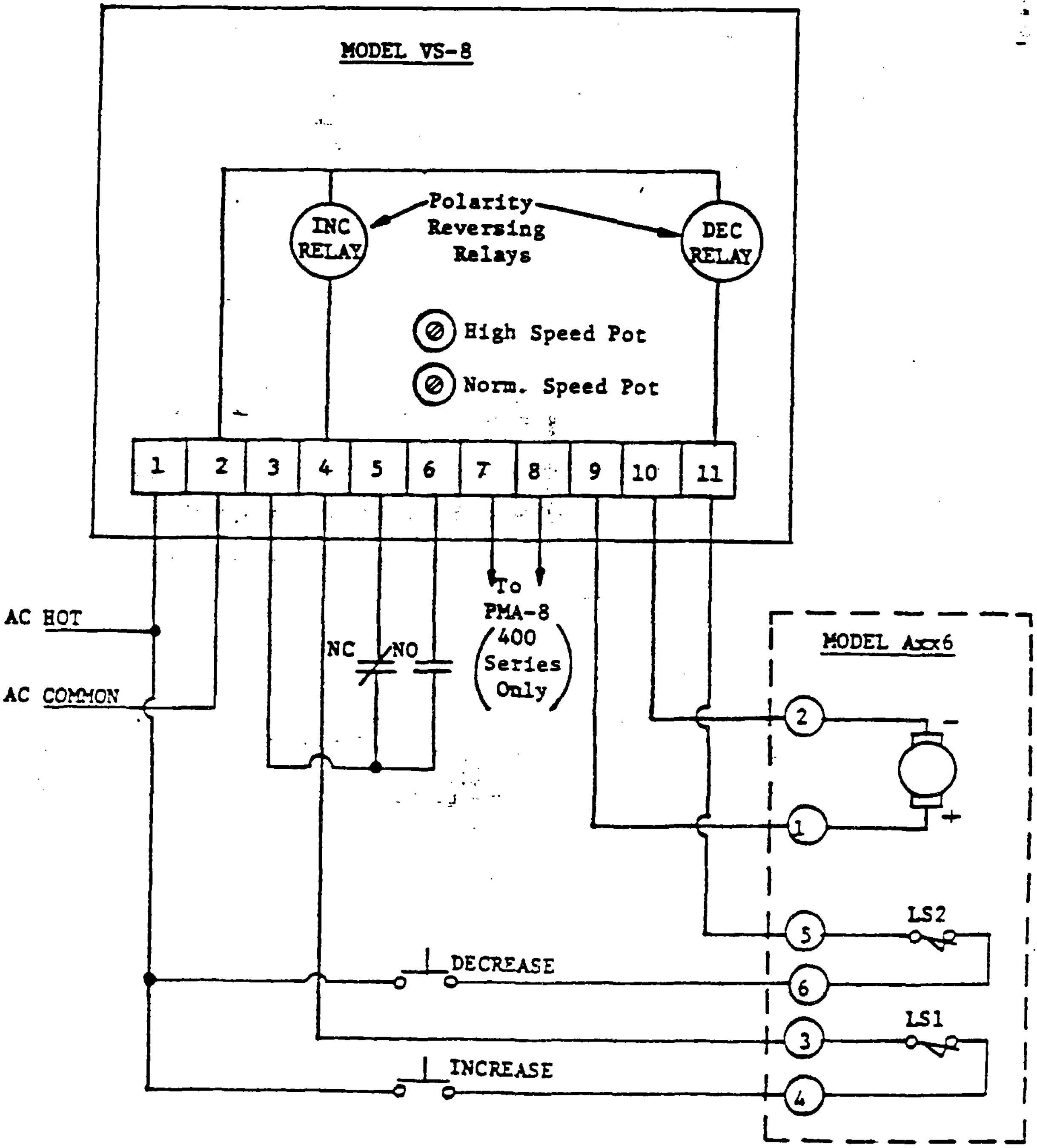
Term. 9 - Positive actuator armature output.
NOTE: Polarity subject to state of reversing relays.

Term.10 - Negative actuator armature output.
NOTE: Polarity subject to state of reversing relays.

Term.11 - Decrease input, 115 VAC with respect to terminal 2.

FIGURE B-1 - VS-8 WIRING

(Example with increase/decrease push buttons)

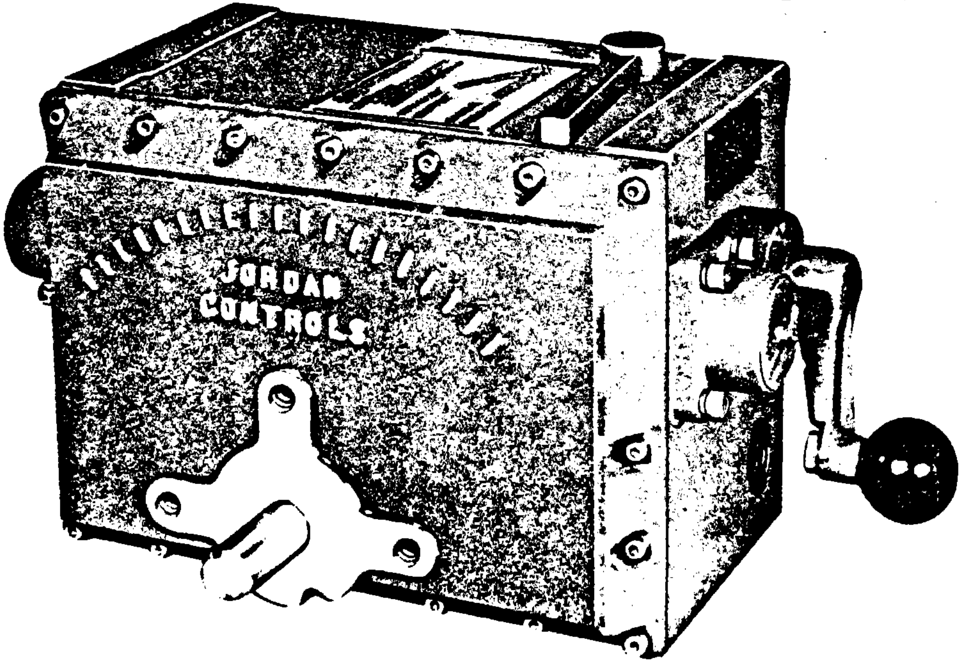


FOXBORO/JORDAN, INC.

IM 0422-A

JORDAN 90° ROTARY ACTUATOR

SM-5100 *Series*



weatherproof or explosion proof

MODELS

SM-5110W
SM-5120W
SM-5140W
SM-5160W

SM-5110X
SM-5120X
SM-5140X
SM-5160X

FOXBORO

1.2.29-172

SM-5100 ROTARY ACTUATOR

DESCRIPTION

These rugged Jordan electric motor-driven actuators are built for heavy duty 90° applications. Available in torque ratings from 150 to 300 ft. lbs., they provide a complete range of positioning control. Performance under continuous modulation for extended periods of time was the main consideration in designing this line. The SM-5100 series actuators are built to operate even under the adverse environmental conditions and still perform with maximum precision. Jordan actuators have all the features necessary for such demanding duty.

FEATURES

Standard

Variable position limit switches.
Torque limit cutoff.
Long term power train lubrication.
Foot or flange mount installation.
Ratings to 300 ft. lbs.
AC or DC motor drives.
NEMA 4, NEMA 7 or NEMA 9 housing.
Modulating or on-off control.

Optional

Potentiometer for remote control.
Characterized cam position feedback.
Manual override.
Hammer blow start.

APPLICATION

The Jordan SM-5100 Series Rotary Actuators are specifically designed to provide rugged power and dependable operation as positioners for dampers, diverters, valves and similar applications requiring 90 degree actuation. Torque ranges up to 300 ft. lbs. ensure positive positioning even under adverse conditions encountered in extended service.

BASIC MODELS

SM-5100
115V, AC, 50/60 Hz, 1 phase, modulating duty.
The motor is three-wire, plug-reversible.
Control compatibility – Jordan MT-6220, AA or D-8200, AD-8810 or bi-directional contacts.

SM-5120
115V, AC, 50/60 Hz, 1 phase, 20% duty cycle with 5 min. max. on time.
The motor is three-wire, plug-reversible.
Control compatibility – Jordan MT-6220, AA or D-8200, AD-8810 or bi-directional contacts.

SM-5140
24V, DC, P.M., modulating duty.
The motor is capable of plug reversing and speed control with proper input.
Control compatibility – Jordan AD-7530 or any 24V, DC servo amplifier compatible with P.M. motors.

SM-5160
90V, DC, P.M., modulating duty.
The motor is capable of plug reversing and speed control with proper input.
Control compatibility – Jordan AD-7310 or any 90V, DC servo amplifier compatible with P.M. motors.

HOW TO USE THE FOLLOWING SELECTION CHART

1. The basic motor characteristics must be determined from the descriptions of the various models at the top of each specification page. The selection of AC or DC continuous or intermittent duty and the type of control.

2. Next, these questions must be answered about your application and the driven load:
   a. How much torque to move the load?
   b. Time in seconds to cover the full 90° travel.

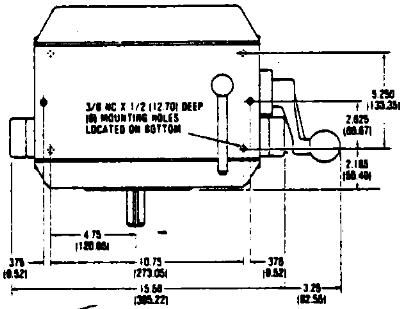
3. Now proceed through the 12 selections on the selection chart. All sections must be filled in before we can proceed with manufacturing. The following are aids in your selection.
   a. The spline is a special and if it is to be used with a drive arm, the drive arm should be ordered with the actuator.
   b. The heavy duty limit switches supplied with this unit are the Jordan key lock adjustments that require no special tool. Guaranteed positive cam location.
   c. All Jordan amplifiers require a 1K OHM feedback potentiometer when actuator position is the feedback. Your selection in this case is between a potentiometer that gives a linear relationship with output shaft or our characterized cam driven potentiometer where feedback may be matched to the non-linearity of the driven load. A linear, square, square root and max. cam are supplied. These are hard aluminum cams with printed scales on each side and may be hand contoured in the field.
   d. The motor matches the basic actuator selection and should be transferred into the selection column.
   e. A brake may be supplied on AC units where the normal coast of an on-off AC unit would be excessive. If there is a question concerning your application, please contact the factory.
   f. A manual override may be supplied offering complete isolation of the motor. This allows manual driving of the output shaft for emergency or set up positioning.
   g. A heater is required whenever the ambient operating temperature of the actuator would go below freezing in outdoor applications.

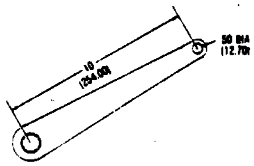
SM-5100 SELECTION CHART

SM-5100 SELECTION CHART — Description (TO ORDER ENTER ONE BOLD FACE CHARACTER FROM EACH SECTION)						WRITE SELECTION HERE
BASIC UNIT	**SM-5110**	**SM-5120**	**SM-5140**	**SM-5160**	1	
ENCLOSURE	**E** — NEMA TYPE 4 Water-tight **X** — NEMA TYPE 7 and 9 Explosion Proof				2	
POWER OUTPUT		**17.5 sec.** 150 ft. lbs.	**20 sec.** 150 ft. lbs.	**13 sec.** 150 ft. lbs.	3	
Time sec./Ft. lbs.	**72 sec.** 150 ft. lbs.	**36 sec.** *300 ft. lbs.	**33 sec.** *300 ft. lbs.	**26 sec.** *300 ft. lbs.		
All times for 90°		**60.5 sec.** *300 ft. lbs.		**44 sec.** *300 ft. lbs.		
OUTPUT SHAFT	**S** — 20 tooth splined shaft - drive arm required				4	
	K — 1/4" square keyway					
	Z — Special (specify requirements)					
MOUNTING	**S** — Standard tapped holes				5	
	F — Foot mount					
OUTPUT SHAFT REVOLUTIONS	**90°** — 90° Rotation standard				6	90°
LIMIT SWITCHES	**0** — None required				7	
	2 — 2 Heavy duty 20 amp rated					
	4 — 4 Heavy duty 20 amp rated					
	Z — Special (specify requirements)					
FEEDBACK	**0** — None required				8	
	1P — 1K ohm precision					
	1CC — 1K ohm characterized cam					
	Z — Special (specify requirements)					
MOTOR	**1AC3**	**1AI3**	**2DC2**	**9DC2**	9	
BRAKE	**0** — None required				10	
	B — Consult factory for brake requirements					
MANUAL OVERRIDE	**0** — None required				11	
	M — Auto preference manual override					
HEATER	**0** — None required				12	
	H — Heater required on all outside installations in freezing areas.					

*Note. The 300 ft. lb. version of the 5100 is to be used for on-off service only. It is not to be used for modulating duty.

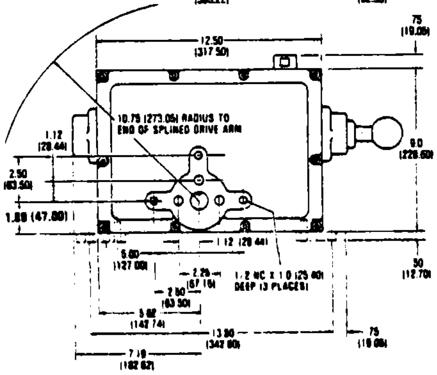
Top View



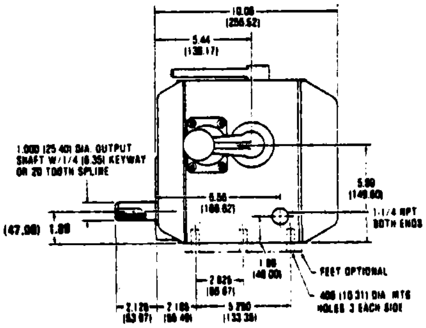


Drive Arm

Side View



End View



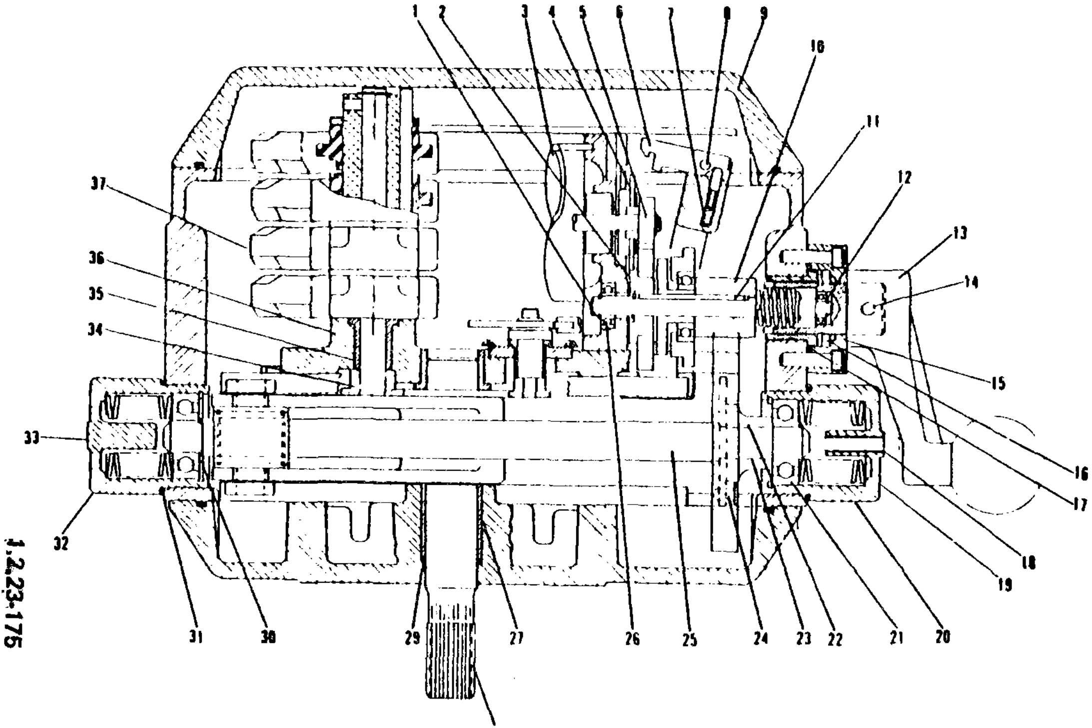
Dimensions in parenthesis, ( ) are metric

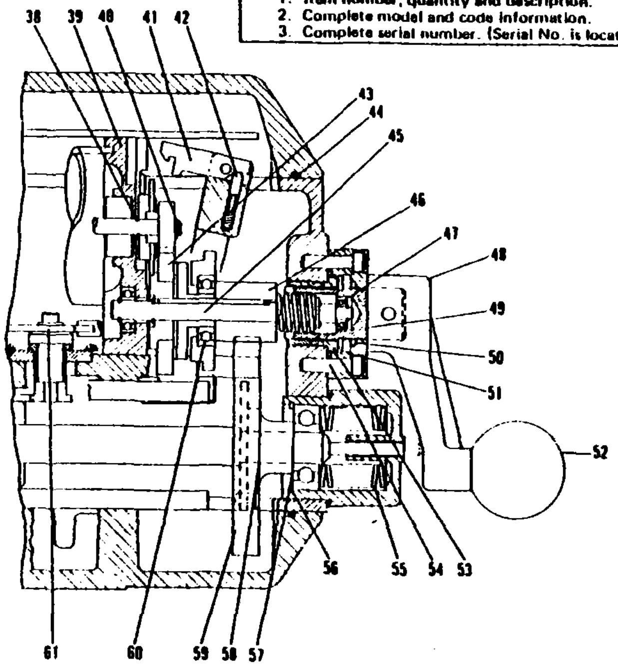
PARTS LIST

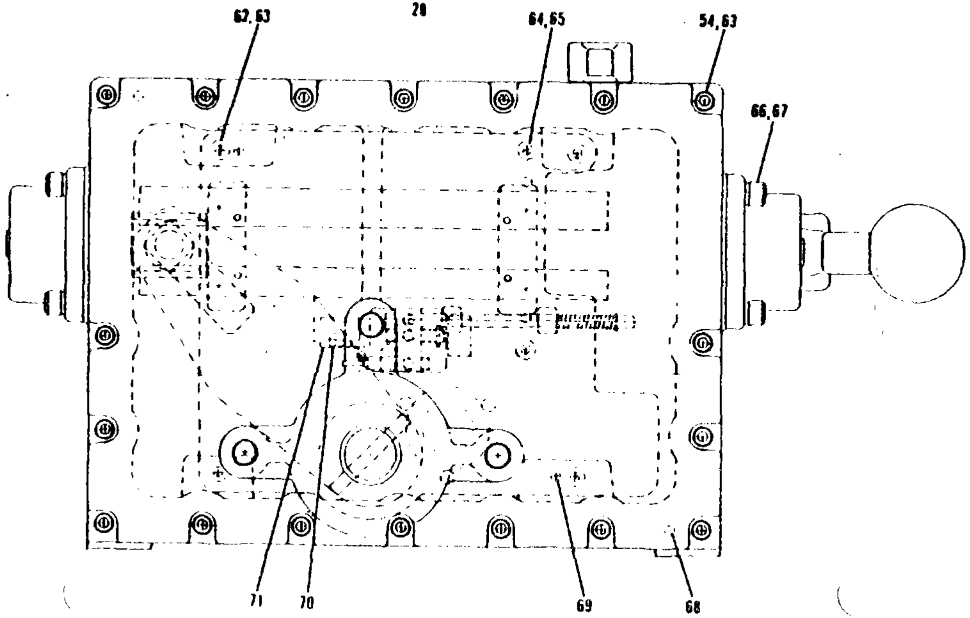
PARTS ORDERING PROCEDURE

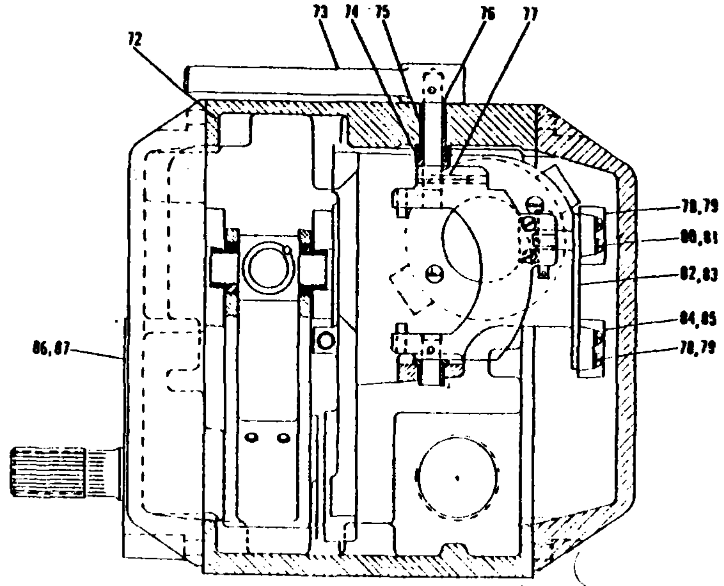
All parts shown are not supplied with all units, or may differ slightly. To order, furnish the following information:

1. Item number, quantity and description.
2. Complete model and code information.
3. Complete serial number. (Serial No. is located on nameplate)



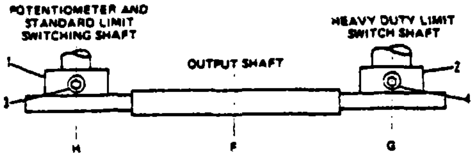






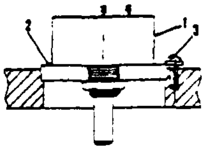
Item	Description	Stock No.	Qty.
1	Ring, Retaining	58-B-014183-037	3
2	Washer, Thrust	56-B-004107-007	1
3	Motor, AC, SM-5110	23-B-005978-010	1
	Motor, AC, SM-5120	23-B-011999-004	1
	Motor, DC, SM-5140	23-B-014103-001	1
	Motor, DC, SM-5160	23-B-014103-002	1
4	Gear Adapter Assy, 15 sec (SM-5120, SM-5140, SM-5160)	68-A-012212-001	1
	Gear Adapter Assy, 30 sec (SM-5120, SM-5160)	68-A-012212-002	1
	Gear Adapter Assy, 60 sec (SM-5110, SM-5120)	68-A-012212-003	1
5	Key, 3/32 Sq x 1/2" Lg	61-B-010954-116	1
6	Lockout Arm Assy	68-B-014021-001	1
7	Spring	20-A-012222-001	1
8	Pin, Pivot	61-A-012218-001	1
9	Cover, Back	60-D-014521-001	1
10	Clutch Assy, 15 sec	70-B-012203-001	1
	Clutch Assy, 30 sec	70-B-012203-002	1
	Clutch Assy, 60 sec	70-B-012203-003	1
11	Key, 3/32 x 3/32 x 2-1/16 Lg	61-B-010954-166	1
12	Ring, Retaining	58-B-014183-025	1
13	Handcrank Assy	68-B-015425-001	1
14	Pin, Roll, 0.25 Dia. x 1.50 Lg	57-A-014215-150	1
15	Collar Assy	68-A-015351-001	1
16	Bearing, Thrust	56-B-004107-006	1
17	"O" Ring	74-B-010957-128	1
18	Bushing	18-B-003814-046	2
19	Screw Thrust Housing Assy	68-A-014529-002	1
20	Housing, Screw Thrust w/Hole	60-B-014523-002	1
21	Bearing	17-B-003813-030	1
22	Key, Woodruff	404	1
23	Hub, Gear	60-A-012269-001	1
24	Rivet, Round Hd 3/16 Dia. x 1/2 Lg		3
25	Screw, Drive w/Indicator Shaft (3/4-10)	68-B-014528-001	1
26	Bearing	17-B-003813-025	1
27	Sleeve, Bearing, 1 x 1-3/16 x 1-1/2	18-B-003814-035	1
28	Output Shaft Assy (See Page 6)	68-C-014532-1	1
29	"O" Ring	74-B-010957-022	1
30	Ring, Retaining, Truarc 5160-59	58-B-014186-059	1
31	"O" Ring	74-B-010957-033	2
32	Screw Thrust Housing Assy	68-A-014529-001	1
33	Housing, Screw Thrust	60-B-014523-001	1
34	Gear, 61T, 48P, 20°P.A.	16-A-014221-001	1
35	Bushing	18-B-SP1988-057	1
36	Output Shaft Support Assy	68-D-013973	1
37	Heavy Duty Feedback Switch Assy (See Page 6)	68-C-014213-1	1
38	Ring, Retaining	58-B-014183-031	1
39	Motor Bracket Assy, 60 sec (SM-5110)	68-C-014028-001	1
	Motor Bracket Assy, 15 sec (SM-5120)	68-C-014028-002	1
	Motor Bracket Assy, 30 sec (SM-5140)	68-C-014028-003	1
	Motor Bracket Assy, 15 sec (SM-5160)	68-C-014028-004	1
40	Ring, Retaining	58-B-014187-031	1
41	Latch, Manual Crank	61-A-012214-001	1
42	Pin, Latch	61-A-012215-001	1
43	Gear, 64T, 32P (SM-5120, SM-5160)	16-B-003806-092	1
	Gear, 79T, 32P (SM-5140)	16-B-003806-093	1
	Gear, 93T, 32P (SM-5110)	16-B-003806-094	1
44	String, "O" Ring, 37" Lg	74-B-010957-995	2
45	Shaft, Clutch	62-A-012196-001	1
46	Gear, Slide	16-A-012201-001	1
47	Bearing	17-B-003813-028	1
48	Machining, Handcrank	60-B-010978-002	1
49	Housing, Bearing	61-A-012202-001	1
50	"O" Ring	74-B-010957-214	1
51	Ring, Retaining, Truarc 5160-98	58-B-014186-098	1
52	Knob	47-A-007639-001	1
53	Bearing, Flanged	18-B-SP1988-034	1
54	Screw, 1/4-20 x 1" Lg Soc Hd Cap	54-A-0015060-100	42
55	Washer, Belleville AM-401620	56-B-010462-003	12
56	Ring, Retaining, Truarc N5000-165	58-B-014184-165	1
57	Spacer	13-A-014549-002	AR
58	Drive Screw Assy	68-B-012271-002	1
59	Gear, 100T, 24P, 20°P.A.	16-A-012268-001	1
60	Bearing	17-B-003813-010	1
61	Characterized Feedback Assy (See Page 6)	68-D-015436	1
62	Screw, Cap, 1/4-20 x 3/4" Lg Soc Hd	54-A-015060-075	4
63	Lockwasher, 1/4	56-A-015211-001	42
64	Screw, Cap, 3/8-16 x 1" Lg Soc Hd	54-A-015080-100	2
65	Lockwasher, 3/8	56-A-015231-001	2
66	Screw, Cap, 5/16-18 x 1" Lg Soc Hd	54-A-015070-100	8
67	Lockwasher, 5/16	56-A-015221-001	8
68	Pin, Dowel, 0.188 Dia. x 0.32" Lg	57-A-015206-031	2
69	Pin, Dowel, 0.188 Dia. x 0.75" Lg	57-A-015206-075	2
70	Switch, Actuator	46-B-004053-406	1
71	Switch, Limit	46-B-004053-405	2
72	Housing, Main	60-D-010278-001	1
73	Lockout Handle Assy	68-A-015492-001	1
74	Spacer	61-B-SP1324-091	1
75	Bushing, Flanged	18-B-SP1988-049	1
76	"O" Ring	74-B-010957-012	1
77	Pin, Roll, 0.156 Dia. x 1.00 Lg	57-A-015195-100	1
78	Strip, Term. (16 pin)	43-B-003888-316	1
79	Insulator	32-A-014123-006	1
80	Screw, 8-32 x 0.50 Lg Rd Hd	54-A-015033-050	8
81	Lockwasher, No. 8	56-A-015191-001	8
82	Plate, Term. Strip Mounting	61-B-014014-001	1
83	Screw, 10-24 x 0.50 Lg Flat Hd	54-A-015044-050	2
84	Strip, Term. (12 pin)	43-B-003888-312	1
85	Insulator	32-A-014123-005	1
86	Front Cover Assy	68-B-014142	1
87	Cover, Front	60-D-014141-001	1

FEEDBACK GEARING



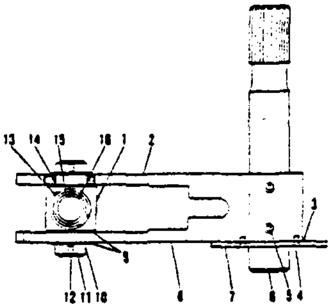
Item	Description	Stock No.
1	Gear	16-8-003803-096
2	Gear	16-A-014221-001
3	Setscrew, 6-32 x 3/16	54-A-015027-019
4	Setscrew, 8-32 x 3/16	54-A-015037-019

STANDARD FEEDBACK – POTENTIOMETERS



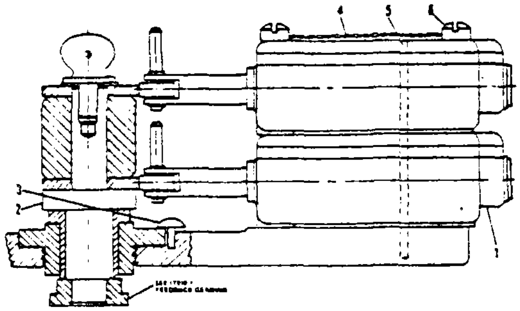
Item	Description	Stock No.
1	Commercial One Turn, 1K	34-8-100078-005
	Precision One Turn, 1K	34-B-003956-043
2	Disc, Adapter (Commercial)	61-A-SM3304-001
	Disc, Adapter (Precision)	61-A-SM3304-003
3	Screw, Truss Hd, 8-32 x 0.25 Lg	54-A-015032-025

OUTPUT SHAFT ASSEMBLY



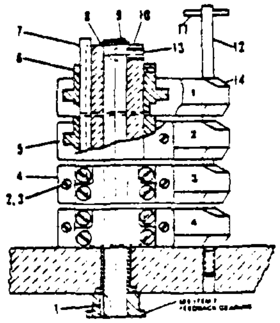
Item	Description	Stock No.
1	Housing, Nut, 15 sec shift (SM-5120, SM-5140, SM-5160)	60-8-014519-001
	Housing, Nut, 72 sec shift (SM-5110)	60-8-014519-002
2	Plate, Output Shaft Drive	60-8-014531-001
3	Gear, Spacer	61-A-015505-001
4	Screw, Flat Hd, No. 6-32 x 3/8 Lg	54-A-015024-038
5	Roll Pin, 1/4 Dia. x 2" Lg	57-A-015215-200
6	Shaft, Output (Key)	62-A-013783-001
	Shaft, Output (Splined)	82-A-013784-001
7	Gear, 115T, 48P, 20°P.A.	16-8-003804-093
8	Plate, Output Shaft Drive	60-8-014531-002
9	Washer, Thrust	61-A-014689-001
10	Block, Pivot (72 sec – 2 req'd)	61-A-014773-001
11	Washer, Retaining	61-A-014770-001
12	Screw, Flat Hd, No. 6-32 x 1/4 Lg	54-A-015024-025
13	Key, 1/8 Sq. x 1-1/4 Lg	61-8-010954-240
14	Block, Pivot, 4 req'd (72 sec – 2 req'd)	14-A-014533-001
15	Ring, Retaining, Truarc N5008-100	58-8-014185-100
16	Nut, 3/4-10 Thread	61-A-010829-001

CHARACTERIZED FEEDBACK ASSEMBLY



Item	Description	Stock No.
1	Linear Pot Assy (Single)	68-C-015435-001
	Linear Pot Assy (Tandem)	68-C-015435-002
2	Cam Shaft Assy (Single)	68-8-015488-001
	Cam Shaft Assy (Tandem)	68-8-015488-002
3	Screw, Truss Hd, 8-32 x 0.25 Lg	54-A-015032-025
4	Wire, Tie	
5	Pin, Dowel, 0.093 Dia. x 0.31 Lg (Single)	57-A-015176-031
	Pin, Locating, 0.093 Dia. x 1.38 Lg (Tandem)	61-A-015525-001
6	Screw, Fil Hd, "Drilled" 10-32 x 1-3/8 (Single)	
	Screw, Fil Hd, "Drilled" 10-32 x 2-3/8 (Tandem)	

HEAVY DUTY FEEDBACK SWITCH ASSEMBLY



Item	Description	Stock No.
1	Key, Woodruff	404
2	Screw, Rd Hd, 6-32 x 0.50 Lg	54-A-015023-050
3	Lockwasher, No. 6 Standard	56-A-015180-002
4	Switch, Limit (Standard) AC	46-A-010017-001
	Switch, Limit (Used with amp) DC	46-A-010017-003
5	Molding, Cam	14-8-012775-001
6	Ring, Retaining, Truarc 5103-125	58-8-017287-125
7	Key, Machining Feedback	61-A-013519-003
8	Ring, Retaining, Truarc 5100-50	58-8-014183-050
9	Shaft, Inner	62-A-014212-001
10	Shaft, Feedback	62-A-014211-001
11	Pin, Roll, 1/8" Dia. x 1" Lg	57-A-015185-100
12	Key, Feedback (Round)	61-A-014789-001
13	Setscrew, Soc Hd, 1/4-20 x 0.38 Cup Pt	54-A-015067-038
14	Molding, Feedback Plate	61-8-014592-001

INSTALLATION

MOUNTING

The outline and mounting dimensions for a standard unit are shown on the last page of this brochure. The rear cover opposite output shaft must have clearance so that it may be removed for adjustments and interconnect wiring. When the actuator is directly coupled to a drive shaft, it is recommended that a flexible no backlash type coupling be used. The output shaft is also available with a splined output for standard lever arms and linkage drive to the driven load. The unit may be mounted on the standard foot mount, or a flange mount. Mounting may be in any position convenient to the driven load. When mounting the unit, be sure that no excessive axial or side loading is applied to the output shaft. The limit switches and position feedback are connected through gearing to the output shaft of the actuator which should be positively secured to the driven load shaft so that no slippage can occur which would cause misalignment or damage.

When manual override is required, as in the event of a power failure, the crank is engaged by operating the auto-manual selector lever at the top of the actuator. The crank may then be turned in the proper direction for the desired output shaft rotation. If during manual operation, electric power is applied to the actuator, the selector lever will return to the "auto" position and the actuator will respond to the power command. The shift from "manual" to "auto" disengages the manual crank, which cannot be power driven, thereby protecting the operator.

Care, however, should be taken when driving a load to recognize that excessive output torque may be developed by forcing the handcrank. A mechanical telltail-indicator shaft adjacent to the crank indicates over-torquing. The telltail-indicator shaft will either protrude or recede depending on the direction of over-torquing. Discontinue cranking on over-torque warning.

The motor, limit switch and feedback area of the actuator depends upon the cover to maintain the NEMA 4 rating. This cover should be removed only when actual work is being done in that area and reinstalled immediately thereafter.

This actuator contains no internal mechanical stops. If it is allowed to run outside of the initial factory alignment of the limit switches, a realignment of switches and feedback might be required. However, no internal damage will have occurred.

ELECTRICAL INTERCONNECT

The wiring diagram on page 8 shows the fundamental interconnect for the standard three-wire reversible single-phase motor and the standard permanent magnet DC motor. These units show an arrangement with torque switches, 4 limit switches, 1 feedback pot and heater. To meet special requirements certain items shown may not be supplied and in that case the terminals will be blank. In all instances the wiring diagram appropriate to the equipment will be supplied with the equipment.

A barrier type terminal strip is located under the rear cover opposite the output shaft. One conduit entry is located at each end of the unit to accommodate standard 1¼ inch N.P.T.

CAUTION: On standard single phase wiring the position limit switches and torque switches, if ordered, are wired directly in the motor circuit and protect it at the extremes of travel or at torque cutout. DC units must have these torque and position limit switches wired into the controlling device to cause end of travel or torque shutdown. Care must be taken in installing these in the controlling device so that the appropriate direction of control is turned off when that direction's limit switch is actuated. If care is not taken in phasing the equipment, damage may occur to the actuator or driven load.

START-UP

If the actuator is to be used with a Jordan Servo Amplifier, factor phasing has been completed. All that is necessary is the zeroing of the actuator to match the minimum/maximum requirements of the equipment being controlled. (See appropriate amplifier Service Bulletin.)

Before mounting, insure actuator is moving in the correct direction. To change direction:

3 wire motors — Reverse wires 2 with 3.
DC motors — Reverse wires 1 with 2.

Apply power and drive actuator to zero position. Move controlled equipment to mechanical zero position and couple. Small final adjustments may be made by loosening the 3 truss head screws and rotating complete feedback pot-limit switch assembly.

Limit switches are actuated by the flat of the cam or by the adjustment screw in the multiplier assembly. When the mechanical zero is reached, adjust the proper limit switch to cut motor power at this point. Apply power and drive actuator to maximum desired position and adjust other limit switch. See special instructions for characterized feedback and heavy duty limit switches.

TECHNICAL DATA

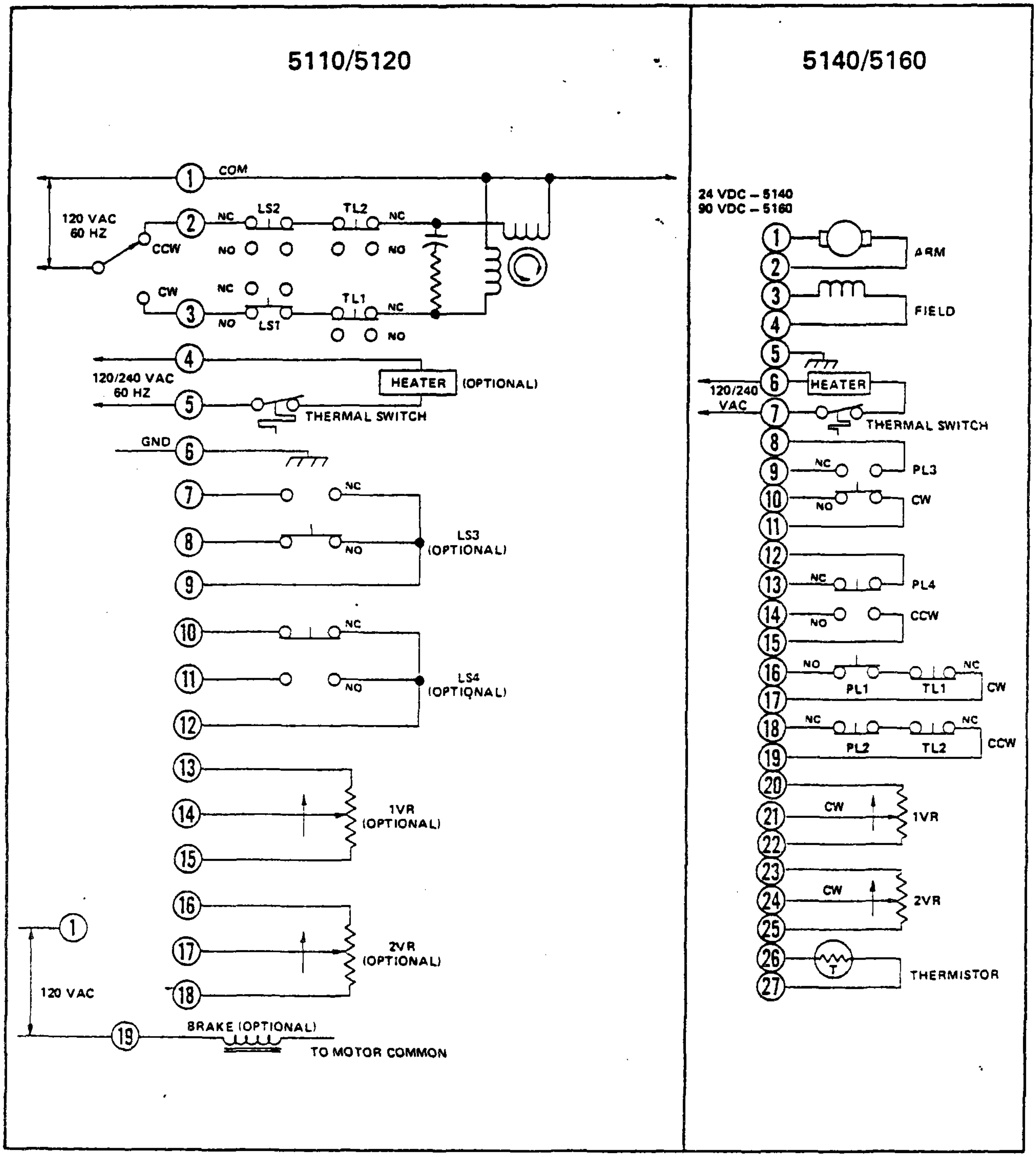
AC units have dual balanced windings and use a capacitor for phase shift and reversal of direction. DC units are permanent magnet and require polarity reversal of armature voltage to reverse direction.

Several gear reductions are available to provide a choice of speed-torque ranges. Maximum torque rated at 300 ft-lbs for the SM-5100.

MAINTENANCE

Under normal service conditions the motor, gearing, bearings and parts are all pre-lubricated and should not require periodic maintenance. If for any reason the unit is disassembled in the field, all oilite bushings should be resaturated with a S.A.E. 30 oil and all gearing heavily coated with an Andok B or equal grease. Care should be taken to insure that no foreign material is allowed to become entrained with the grease in the gear train, which will cause premature failure.

SM-5100 SERIES WIRING DIAGRAMS



FOXBORO/JORDAN CONTROLS, INC.
5607 WEST DOUGLAS AVENUE
MILWAUKEE, WISCONSIN 53218
PHONE: (414) 461-9200

IM-0422-A 2:79

HILCO HYFLOW OIL FILTERS

WARRANTY

The Hilliard Corporation warrants the equipment of its manufacture for one year and no more from the date of the invoice thereof against defective material or workmanship (but not against damage caused by accident, abuse or faulty installation) when the goods are installed in accordance with its specifications and will replace free of charge (F.O.B. factory, Elmira, New York) all such defective equipment if returned to its factory, charges prepaid.

THE WARRANTY DESCRIBED ABOVE SHALL BE IN LIEU OF ANY OTHER WARRANTY EXPRESS OR IMPLIED INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTY OF MERCHANTIBILITY OR FITNESS FOR A PARTICULAR PURPOSE.

The repair and replacement of such defective equipment as above provided shall constitute buyer's exclusive remedy and buyer shall have no other remedy or claim against The Hilliard Corporation for alledged incidental or consequential damages or lost profits, lost sales, injury to person or property or any other direct, incidental or consequential loss. This exclusive remedy shall not be deemed to have failed of its essential purpose so long as The Hilliard Corporation is willing and able to repair or replace such defective equipment in the above prescribed manner.

Buyer shall not be required to return such defective equipment if (1) the equipment was destroyed as the result of any defect covered by this Warranty and (2) The Hilliard Corporation is reasonably satisfied that the equipment was so defective at the time of sale. Under such conditions, The Hilliard Corporation will replace the equipment or part thereof in the same manner provided for herein as if the buyer had returned the same to the factory of The Hilliard Corporation.

The Warranty provided for herein does not apply to equipment not manufactured by The Hilliard Corporation such as hoses, electrical parts etc. and these parts are covered by the Warranty, if any, of the manufacturer thereof.

SERVICE POLICY

All requests for service, or repair parts, shall be directed to The Hilliard Corporation, Elmira, New York, or one of its authorized representatives. Complete information must be furnished regarding the difficulty experienced, and the part and serial numbers of the equipment involved.

The installation, operation and maintenance instructions furnished with the equipment should be carefully read and followed before the equipment is placed in service. The Hilliard Corporation cannot assume responsibility for any installation difficulties encountered due to leaks, contamination, malfunctions, etc. in connecting lines or equipment.

Repair or replacement of defective materials will be made in accordance with the Warranty. Other replacement parts or suitable alternates are made available at current prices throughout the life of the equipment.

When motors or other electrical components are ordered, if incorrect information regarding the electrical specifications is furnished by the purchaser, no charge will be made to cover the cost of exchange if the equipment furnished is considered by The Hilliard Corporation to be a stock item. The Purchaser, however, will be required to prepay charges involved in the exchange.

The Hilliard Corporation will not accept the return of any unused goods except by prior written agreement with the factory, and a minimum handling charge of 20% of the original purchase price of the material will be made.

INSTALLATION-OPERATION AND MAINTENANCE INSTRUCTIONS

1.0 INSTALLATION

1.1 GENERAL:

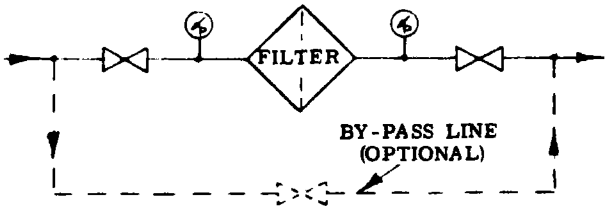
1.1.1 Read all instructions, attachments, and assembly drawings carefully before installing, operating and servicing your HILCO filter.

1.1.2 Inspect the filter for shipping damage. If damage is found, notify carrier immediately.

1.1.3 The filter should be installed as close to the equipment being served as possible.

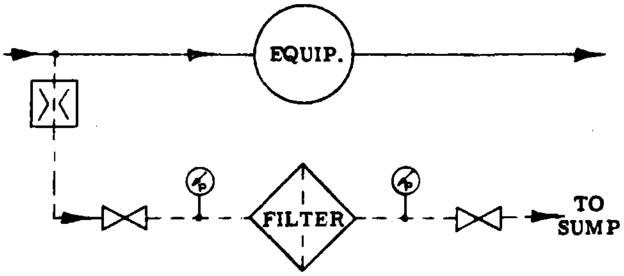
1.1.4 Locate the filter so there is adequate space overhead for cartridge removal. Refer to data sheet or assembly drawing supplied for clearance required.

1.1.5 On Full-Flow installations the filter is installed in the main fluid pump line. A by-pass line may be installed around the filter to permit cartridge changes without equipment shutdown.



TYPICAL FULL-FLOW FILTER INSTALLATION

1.1.6 On By-Pass installations having a main line operating pressure higher than the pressure rating of the filter, a flow control orifice or valve should be installed as near the high pressure source as possible.



TYPICAL BY-PASS FILTER INSTALLATION

1.1.7 For Duplex Filters, refer to Section 4.0 for additional instructions.

1.1.8 Install inlet line. Line size should be sufficiently large to handle the rated fluid flow without excessive pressure drop. Install a shut-off valve in the inlet line. Make sure connecting piping is clean and free of dirt, scale, etc.

Note: If the filter is installed without shut-off valves on inlet and outlet, the filter must be located above the highest oil level in the system.

On installations employing a motor/pump set at the filter, the pump suction line should be no smaller than that recommended by the pump manufacturer in order to prevent pump cavitation. Install a strainer at the pump inlet. If the fluid sump is at a higher elevation than the pump inlet, install a shut-off valve ahead of the strainer.

If continuous fluid circulation is not required for equipment operation, and the motor starter is interlocked with the equipment motor starter; install a shut-off valve between the pump and filter and a relief valve around the pump. This will permit cartridge changes without equipment shutdown.

1.1.10 When filter discharge pressure is less than the pressure of the oil head in the filter casing, install a check or relief valve designed to provide 5 PSIG back-pressure in the outlet line. This will insure complete filling of the filter. Install a check-valve in the outlet line if the fluid sump is at a higher level than the filter.

The installation of sight/flow glasses in the clean fluid line will permit observation of flow, and fluid condition. Spinner type glasses can be installed in either horizontal, or vertically-down positions. Non-spinner types must be installed vertically-down only.

1.1.11 Filter drains may be piped to the fluid sump or a drain tank. If gravity drainage is not possible, a motor/pump set can be used for both draining and refilling.

1.1.12 Filter vents may be piped to the fluid sump for continuous venting. Make sure connection at sump is made above the highest fluid level in the sump.

1.2 ELECTRICAL:

1.2.1 Check electrical specifications on filter nameplate and/or motor nameplate. On electrically heated filters, also see wiring diagram furnished with filter.

1.2.2 Filters using separate motor/pump sets may be installed:

a. With the motor starter separate from the equipment control for independent operation of the filter and equipment.

b. With the motor/pump set interlocked with the equipment control to prevent operation of the equipment without the filter.

1.2.3 Connect electrical line to the control box. Important:

a. A properly fused disconnect switch should be installed in the line.

b. Wire size must be large enough to carry the full rated current load with no voltage drop.

c. Wiring must meet all applicable electrical codes.

1.3 STEAM OR WATER HEAT:

See the separate data sheet or assembly drawing supplied with the HILCO filter for connection and capacity information.

1.4 COVER LIFTER:

If a filter cover lifter has been furnished. assemble and install in accordance with Data Sheet DD-80-4 or DD-80-8.

1.5 FILTER CARTRIDGES/STRAINERS:

1.5.1 Remove the filter cover and make sure the filter cartridges/strainers are in place and undamaged. If filter cartridges are not installed, see FILTER CARTRIDGE/STRAINER SERVICING section.

1.5.2 Check cover seal/gasket for damage and proper placement. Replace cover and tighten bolts using a staggered tightening pattern to insure uniform sealing. Refer to values below for proper torquing.

Bolt Size	Torque: Lb.-Ft.	Kg.-Metres
5/8"	90	12.4
3/4"	150	20.7
7/8"	240	33.1
1"	370	51.1
1-1/8"	560	77.3

- IMPORTANT -

"R" Series filters having a single center bolt closure should be torqued to 120 ft./lb/

2.0 STARTING AND OPERATION

2.1 Open inlet valve. Start motor/pump set if installed.

- IMPORTANT -

Care must be taken when initially filling the HILCO filter at start-up, or after a cartridge change, to avoid dangerously lowering the level in the fluid sump. Sufficient fluid should be added for filter "make-up" as required.

2.2 Open vent valve on filter cover and bleed off trapped air if filter is not equipped with an automatic air vent. Close the valve when fluid appears.

Periodically bleed off trapped air which accumulates at the top of the filter cover during normal operation.

2.3 Turn on electric heaters if filter so equipped.

2.4 Refer also to the PERIODIC SERVICE NOTES section.

3.0 FILTER CARTRIDGE/STRAINER SERVICING

3.1 WHEN TO CHANGE FILTER CARTRIDGES:

3.1.1 As a minimum, filter cartridges should be changed when the pressure drop approaches or exceeds the recommended value above the "clean" (new cartridge) pressure drop; or every twelve months, whichever occurs first. A periodic analysis of fluid condition should be used to determine cartridge changing intervals in critical applications.

3.1.2 Filter cartridges should be changed when pressure drop reaches 20-25 PSI above starting pressure.

3.2 HOW TO CHANGE FILTER CARTRIDGES:

3.2.1 On full flow installations, stop equipment, or separate motor/pump unit if not interlocked with main equipment control. Close inlet and outlet valves if installed.

3.2.2 If a by-pass installation is being used, close inlet valve to filter.

3.2.3 If a duplex filter installation is being used, turn transfer valve to divert fluid flow to the stand-by or "clean" filter. See DUPLEX FILTERS section.

3.2.4 Turn off filter heaters if so equipped.

3.2.5 Open filter drain valve. When pressure gage reads zero, open filter cover vent valve.

3.2.6 Loosen cover bolt(s) and remove cover. If a filter cover lifter has been installed, refer to Data Sheet DD-80-4 or DD-80-8 for operating instructions.

- CAUTION -

BE SURE PRESSURE IN FILTER IS AT ZERO BEFORE LOOSENING COVER.

WHEN FILTERING FLUIDS THE HANDLING OF WHICH MAY BE IRRITATING OR HARMFUL TO PERSONNEL, BE SURE TO READ AND OBSERVE THE FLUID MANUFACTURER'S HANDLING INSTRUCTIONS.

3.2.7 Remove and discard cover seal/gasket.

3.2.8 Drain cartridges in filter for about one hour before removing when possible to reduce fluid loss. Always drain fluid level below bottom of lowest cartridge to prevent contamination from dirty fluid passing into clean side of filter casing.

3.2.9 Remove separate cartridge hold-down cap or relief-valve assembly on top of each cartridge stack when used. DO NOT DISCARD.

3.2.10 Remove cartridge or cartridge adapter assemblies from filter casing. Take care not to damage cover sealing surfaces.

3.2.11 Install new or replaced filter cartridges in filter casing as follows:

Types PL, SF, SFD, & F - Throwaway pleated paper or disc cartridges with a built-in support core in each cartridge: Discard complete cartridge and install new ones as required on filter center post. On cartridges having loose elastomer (rubber) gaskets, make sure gaskets are in place on both ends of each cartridge.

Type PLW - Throwaway pleated paper cartridges without a built-in support core in each cartridge: Do not discard center cartridge adapter assembly. Remove dirty cartridges from adapter and install new ones per Data Sheet DC-2464-32. Install complete adapter assembly with new cartridges on filter center post with separable cap/spring on top.

Types FW, SFW, & SFDW - Throwaway disc type cartridges without a built-in support core in each cartridge: Do not discard center cartridge adapter assembly. Remove dirty cartridges from adapter and install new ones per Data Sheet DD-2464-34. Install complete adapter assembly with new cartridges on filter center post.

- IMPORTANT -

Install adapter assemblies with spring up (toward filter cover). To prevent by-passing of dirty fluid due to deterioration, replace end gaskets and radial seal on adapter assemblies every (24) months. If visibly defective/damaged, change immediately. See Data Sheet DD-2464-34 for replacement instructions.

Type FFC - Throwaway fuller's earth (HILITE) cartridges: Proceed as for PL, SF & F cartridges.

Type FFL - Repackable fuller's earth (HILITE) cartridges: Repack cartridge(s) per Data Sheet FC-217-F and install repacked cartridges on filter center post.

Type SC - "Star" filter cartridge with renewable HILPAK Tube filter media: Renew or replace HILPAK Tube per Bulletin F-182-5 as required. Install new cartridges on filter center post.

Strainers - Remove strainers and clean as required. Strainers may be solvent cleaned and blown dry, or may be cleaned with high-pressure steam. Strainers with steel hardware must be immediately coated with oil or other suitable rust preventative. The pump inlet strainer on filters so equipped should also be similarly cleaned at every cartridge change.

3.2.12 After cartridges/strainers or cartridge adapter assemblies have been installed in filter, replace hold-down cap or relief-valve assembly on top of each cartridge/strainer stack: (1) Make sure sealing surface of cap assembly is clean, and free of nicks and scratches; (2) Check relief-valve assemblies for dirt in ports and on valve seat. Disassemble and clean as required.

3.2.13 Clean cover sealing surfaces as required and inspect for nicks and scratches. Put new cover seal in place. In an emergency, old seal/gasket may be reused if not damaged or hardened. For trouble-free operation, replacement is recommended.

3.2.14 Carefully close cover, and retighten bolts to recommended torque values. Refer to values below for porper torquing.

Bolt Size	Torque: Lb.-Ft.	Kg.-Metres
5/8"	90	12.4
3/4"	150	20.7
7/8"	240	33.1
1"	370	51.1
1-1/8"	560	77.3

- IMPORTANT -

"R" Series filters having a single center bolt closure should be torqued to 120 ft./lb. max.

3.2.15 Close drain and vent valves.

3.2.16 Open inlet and outlet valves to filter if installed.

3.2.17 Restart equipment and/or filter motor/pump set as required.

3.2.18 Turn on filter heaters if so equipped.

4.0 DUPLEX FILTERS

4.1 GENERAL:

Transfer valves furnished with HILCO duplex filters permit flow through either or both filters depending on valve position. Continuous flow is provided to the equipment during transfer from either side. Flow cannot be shut off.

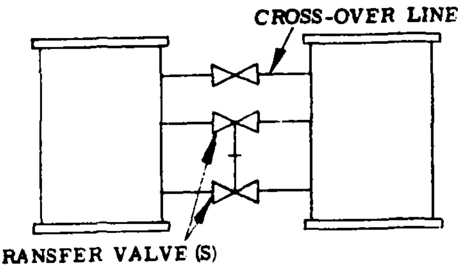
4.2 INSTALLATION:

4.2.1 Refer to Section 1.0 for general instructions common to all filters.

4.2.2 The installation of a cross-over line between filters is recommended for all duplex installations except those units having the casings and valve as an integral assembly in a common cover such as the Model

511-150. The cross-over line may be used for filling the "clean" or stand-by filter before putting it into service, and will also ease the turning of the transfer valve(s) by equalizing the pressure on both sides. A cross-over line is required for operating pressures above those shown in the table:

Transfer Valve Pipe Size	Operating Pressure PSIG	Cross-Over Pipe Size
To 1-1/2"	100	3/8"
2" to 3"	80	1/2"
4" to 8"	15	3/4"



TYPICAL DUPLEX FILTER WITH CROSS-OVER LINE

4.2.3 If special cross-over fittings have not been furnished, the connection can be made between the dirty oil drain fittings. A shut-off valve must be installed in all cross-over lines.

4.2.4 In order to prevent excessive flow through the cross-over, an orifice should be installed in the line.

4.3 STARTING/OPERATION:

4.3.1 Refer to the general STARTING & OPERATION section for additional instructions common to all filters. Refer also to the PERIODIC SERVICE NOTES section.

4.3.2 When starting a cold system, center the transfer valve handle so flow will be equal through <u>both</u> filters.

4.3.4 After fluid reaches operating temperature, turn valve for flow through desired filter only.

4.4 FILTER CARTRIDGE SERVICING:

4.4.1 When the filter cartridges in the on-line filter require replacing, slowly rotate the transfer valve handle to the center position so flow will be equal through both filters.

4.4.2 Vent the stand-by or clean filter until oil appears and then close vent.

4.4.3 Allow a few minutes of parallel operation to purge the cold oil from the stand-by filter, then slowly rotate the transfer valve to flow through the stand-by filter.

- IMPORTANT -

Rapid switching of the valve from one unit to the other may cause:

Discharge of an air pocket into the fluid line.

A surge of cold, viscous fluid into the system.

An instantaneous high differential pressure across the stand-by filter cartridge(s) resulting in possible cartridge failure.

4.4.4 After the stand-by filter becomes the on-line filter, the cartridges in the dirty filter may be changed in accordance with the general FILTER CARTRIDGE/STRAINER SERVICING section.

- CAUTION -

BE SURE PRESSURE IN FILTER IS AT ZERO BEFORE LOOSENING COVER.

WHEN FILTERING FLUIDS THE HANDLING OF WHICH MAY BE IRRITATING OR HARMFUL TO PERSONNEL, BE SURE TO READ AND OBSERVE THE FLUID MANUFACTURER'S HANDLING INSTRUCTIONS.

4.4.5 After the cartridges in the dirty filter have been changed, the filter may be refilled by one of the following:

4.4.5.1 Auxiliary filling from oil reservoir.

1 4.4.5.2 Open cross-over valve and vent clean filter until filled.

- IMPORTANT -

Do not permit filter downstream pressure to fall below acceptable values when filling clean filter.

4.4.5.3 Turn transfer valve handle slightly toward the clean filter to permit a small portion of fluid to fill it. Vent filter until filled.

5.0 PERIODIC SERVICE NOTES

5.1 If filter is not equipped with an automatic air vent, open manual vent valve periodically to bleed off trapped air as required.

5.2 Service electric motor(s) and pump(s) per manufacturer's instructions.

5.3 On electrically heated filters, inspect heaters at least every six months for shorts, fluid spillage on heaters, and properly tightened connections to prevent premature heater failure.

5.4 Clean filter/pump inlet strainer at every cartridge change if strainer installed.

5.5 Replace filter cover seal/gasket at every cartridge change.

SUPPLEMENTARY ATTACHMENTS

DC-2464-32	☐	DD-80-8	☐
DD-2464-33	☐	DD-600	☐
DD-2464-34	☐	F-152-5	☐
DD-80-4	☐	FC-217-F	☐

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CORPORATION
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Transamerica Delaval

IMO® PUMP

INSTRUCTIONS and PARTS LIST

SERIES C3E,
PUMP TYPES 87P-87-95

WARNING

READ THIS INSTRUCTION BOOK BEFORE
INSTALLATION, OPERATION, OR MAINTENANCE

Instructions C3E-A

Transamerica Delaval Inc.
IMO Pump Division
Box 447
Airport Road
Monroe, NC 28110
USA

NOVEMBER 1979

FOREWORD

This instruction manual covers the C3E Series TRANSAMERICA DELAVAL IMO pumps 87P, 87 and 95. The specific models covered by this manual are identified in Table 1. Refer to the assembly drawing, Figures 3 through 7, corresponding to your pump type as you use this instruction manual. The type of each particular pump is identified on the end cover. Refer to Figure 1 for definition of type designator.

TABLE 1
C3E SERIES IMO PUMP TYPES

Rotor Sizes* – 87P, 87PD, 87, 87D, 95 and 95D					
Pump Model*	Assembly Drawing No.	Fig. No.	Pump Model*	Assembly Drawing No.	Fig. No.
C3EBC-	SC6112	3	C3EBFS-	SC6114	5
C3EBCS-	SC6112	3	C3ELC-	SC6115	6
C3EX-	SC6113	4	C3ELCS-	SC6115	6
C3EIC-	SC6113	4	C3ELF-	SC6116	7
C3EICS-	SC6113	4	C3ELFS-	SC6116	7
C3EBF-	SC6114	5	*Pump model number precedes rotor size.		

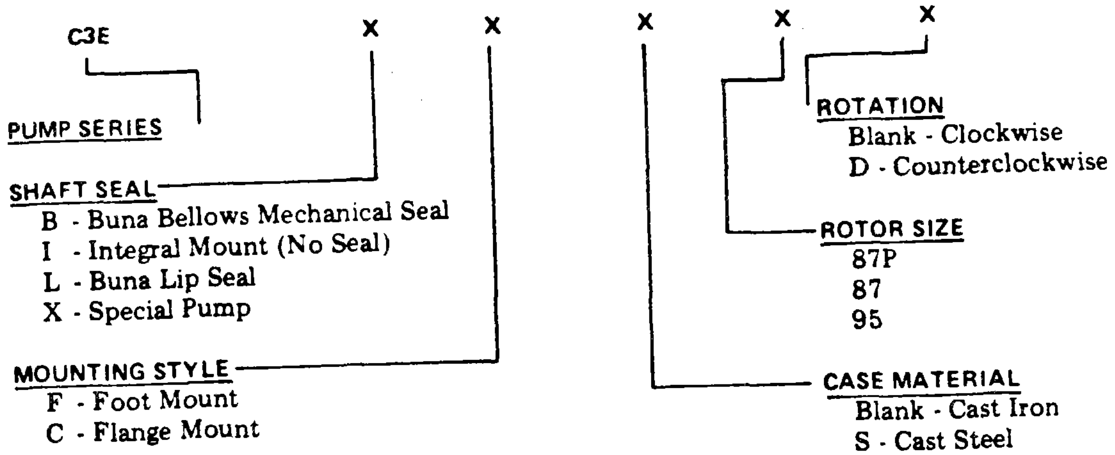


FIGURE 1. Definition of Model Designator of C3E Series Pumps.

ORDERING INSTRUCTIONS

All correspondence pertaining to renewal parts for the equipment must refer to the instruction book number and should be addressed to the nearest TRANSAMERICA DELAVAL representative

The handling of renewal orders will be greatly facilitated if the following directions are carefully observed.

1. Give the number of the instruction book.
2. Give the serial number of the machine for which part is desired. This number appears on the nameplate.
3. Designate the desired part by the number and name as listed in this instruction book.
4. Give the drawing number or figure number in which the part is shown.

STRUCTURAL LIMITS

Operating conditions, such as speed, fluid viscosity, inlet pressure, discharge pressure, temperature, filtration, duty cycle, mounting, drive type, etc. are interrelated. Due to these variable conditions, the specific application may be different from that of the structural limitations. This equipment must not be operated without verification that operating requirements are within published capabilities are shown in the appropriate pump data book (available from local Transamerica Delaval offices and representatives).

Under no circumstances are the following structural limitations to be exceeded.

DISCHARGE PRESSURE: 150 PSIG (Maximum)

MAXIMUM SPEED: Contact Transamerica Delaval for rating Tables. For #6 fuel oil, crude oil and other fluids known to contain fine abrasives, pump speed should not exceed 1800 RPM.

VISCOSITY: 2.0 cst (33SSU) Minimum
3000 SSU maximum for type B shaft seal. No maximum for other versions except when using #6 fuel oil the type B seal is not recommended for use regardless of specified operating viscosity range.

TEMPERATURE: 0° to 180° F for types C3EB/L/P/I

SUCTION: 25 PSI Maximum

DRIVE: Direct only.

SEALS

Two types of seals are installed in the C3E pumps. A Buna Lip Seal (023) is installed in Figures 6 and 7 pumps. The lip of the seal (023) conforms to the power rotor (007) by pressure in the discharge chamber for sealing. Integral mounted pumps, Figure 4, are not equipped with a seal. Mechanical seals, CRANE Type 21 are installed in Figures 3 and 5 pumps. Refer to Figure 2 for an illustration of the CRANE Type 21 Mechanical Seal Assembly.

Because of the number of seal variations available, it is important that the pump designator number be forwarded with purchase order. Where the full designator number cannot be ascertained, a listing of the operating conditions should be made in order that the proper seal for replacement can be supplied.

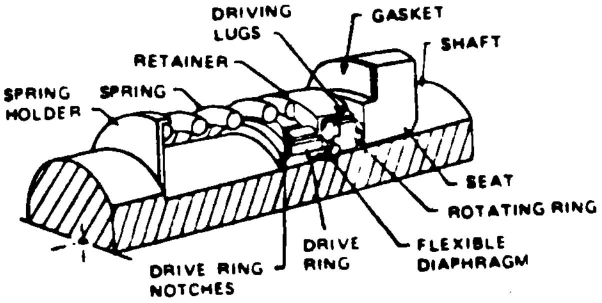


FIGURE 2. CRANE Type 21 Mechanical Seal Assembly.

MAINTENANCE

PUMP DISASSEMBLY

GENERAL: Close the and outlet valves and tag "Out of Service." De-energize pump driver motor controller and tag " of Service." Vent all pressure from pump housing. Remove pump from driver and coupling from Remove coupling key (013).

FIGURES 3): Complete General steps, then remove retainer bolts (006) and retainer (012). Remove cover and po rotor assembly by rotating the power rotor (007) in the direction opposite to its normal rotation and simultaneously pull the cover (004) and power rotor assembly from the pump housing (001). Removal of the cover (004) and power rotor assembly includes removal of the gasket (005), power rotor (007), idler stop (009), ball bearing (011), truarc rings (014) and (15) and mechanical seal (016).

Remov truarc ring (015) and press power rotor (007) from the ball bearing (011). Remove mechanical seal (016) from the power rotor (007). Remove ball bearing (011) from the cover (004). Remove truarc rings (014) and mechanical seal seat from cover (004). NOTE: Do Not remove the idler stop (009) from the power roto . Replacement of the Idler stop (009) is considered a major repair. See major repair note located on the back p of this manual.

Remove bolts (00 an lockwashers (017 on steel case only). Remove cover (002) and gasket (010). Remove idlers (0 from housing (001).

FIGURE 4: P pump for disassembly following General steps then remove capscrews (027). Remove cover (004) fr ousing (001). Remove power rotor (007), piston (024) and idler stop (009) from housing by ro the power rotor (007) in the direction opposite to its normal rotation and simultaneously withdra the power rotor (007).

Remove cover 2) and gasket (010) from the housing by removing bolts (003) and lockwashers (017 steel case only emove idlers (008) from housing (001). NOTE: Do Not remove idler stop (009) or piston (024) fr ower rotor (007). Replacement of the idler stop (009) or the piston (024) is considered a major repair. major repair note located on the back page of this manual.

FIGURES 6 and Complete General steps, then remove bolts (006) and retainer (012). Remove cover and power rotor assembly by rotating the power rotor (007) in the direction opposite to its normal and simultaneously pull the cover (004) and power rotor assembly from the pump housing (001). Removal of the cover (004) and power rotor assembly includes removal of the gasket (005), power rotor (007), ball bearing (011), truarc ring (015), lip seal retainer (022) and lip seal.

Remove truarc ring (015) and press power rotor (007) from the ball bearing (011). Remove ball bearing (011) from the cover (004). Remove lip seal (023) from lip seal retainer (022).

Remove bolts (003) and lockwashers (017 on steel case only). Remove cover (002) and gasket (010). Remove idlers (008) from housing (001). NOTE: Do Not remove the idler stop (009) from the power rotor (007) or the lip seal retainer from the cover. Replacement of the idler stop or lip seal retainer is considered a major repair. See major repair note located on the back page of this manual.

PUMP ASSEMBLY

ENERAL: Inspect, clean and wipe all internal and rotating parts with SAE30 lubricating oil immediately before assembly. Do Not open seal or bearing packages until they are to be installed. A new mechanical seal or lip seal should be installed if the old seal has been disturbed. A new bearing should be installed when a seal is replaced or if unit has been in operation for an extended length of time. Rotate the power rotor (007) frequently during installation to assure freedom of rotation.

FIGURES 3 and 5: Clean gasket (005) seating surfaces and mechanical seal gasket seating surface. Install mechanical seal gasket, mechanical seal seat and truarc rings (014) in cover. Wipe the outer race of ball bearing (011) with lubricating oil and install ball bearing (011) in cover (004). Place new mechanical seal (016) on power rotor (007).

Press assembled cover on power rotor assembly until truarc ring groove of power rotor (007) passes through the inner race of ball bearing (011). Install truarc ring (015) on power rotor (007). When installing truarc ring (015), ensure the ring "snaps" into the power rotor (007) groove and the ball bearing (011) is positioned flush with the truarc ring (015). Place gasket (005) and cover assembly on housing (001). Place retainer (012) on cover assembly (007) and install bolts (006). Torque bolts (006) to 70" lbs. (±5" lbs.).

Clean gasket (010) seating surface. Install idlers (008) in housing (001). Place gasket (010) and cover (002) on housing (001) and install bolts (003) and lockwashers (017 steel case only). Torque bolts (003) to 70" lbs. (±5" lbs.). Install pump on driver.

FIGURE 4: Install power rotor (007) in housing (001). Place gasket (005) and cover (004) on housing (001) and install capscrews (027). Torque capscrews (027) to 45" lbs. (±5" lbs.) on C3EIC and C3EICS pumps. Contact Transamerica Delaval for correct torque measurement of C3EX pumps.

Clean gasket (010) seating surfaces. Install idlers (008) in housing (001). Place gasket (010) and cover (002) on housing (001) and install bolts (003) and lockwashers (017 steel case only). Torque bolts (003) to 70" lbs. (±5" lbs.). Install pump on driver.

FIGURES 6 and 7: Install lip seal (023) in lip seal retainer (022). Wipe outer race of ball bearing (011) with lubricating oil and install ball bearing (011) in cover (004).

Press assembled cover on power rotor assembly until truarc ring groove of power rotor (007) passes through the inner race of ball bearing (011). Install truarc ring (015) on power rotor (007). When installing truarc ring (015), ensure the ring "snaps" into the power rotor (007) groove and the ball bearing (011) is positioned flush with the truarc ring (015).

Clean gasket (005) seating surface. Place gasket (005) and cover assembly on housing (001). Place retainer (012) on cover assembly and install bolts (006). Torque bolts (006) to 70" lbs. (± 5" lbs.).

Clean gasket (010) seating surface. Install idlers (008) in housing (001). Place gasket (010) and cover (002) on housing (001) and install bolts (003) and lockwashers (017 steel case only.) Torque bolts (003) to 70" lbs. (± 5" lbs.). Install pump on driver.

INSTALLATION

ALIGNMENT

Proper pump coupling and motor alignment are essential for satisfactory operation. The pump shaft (power rotor) should be aligned to the motor shaft within 0.005" (0.012 mm) TIR. Alignment should be checked after all piping is completed and the pump is in operation. NOTE: Pump rotational direction is identified on the nameplate (pump type designator).

MOUNTING

FIGURES 3 and 6 (SAE "A" Flange Mounted): SAE "A" flange mounted pumps are equipped with two 7/16-inch diameter holes for mounting in any attitude. The pump inlet and outlet ports can be located 90 degrees from the mounting holes. A "C" Face motor bracket is available for mounting to "C" Face motors.

FIGURES 5 and 7: Foot mounted pumps are equipped with two 7/16-inch diameter holes for mounting on a conventional baseplate with the driver in any attitude. The inlet and outlet ports are to be located 180 degrees from the foot standard position.

FIGURE 4: Integral flange mounted pumps are equipped with four 7/16-inch diameter holes equally spaced on a 4-1/2-inch diameter bolt center for mounting in any attitude.

PIPING

Suction pipe should be as short and direct as possible with the suction piping one size larger than the suction opening of the pump. Install a suitable strainer (60 mesh on light fluids and 1/16-inch to 1/8-inch on heavy fluids) in the suction piping and a pressure relief valve in the discharge piping. The relief valve should be set 10 pounds above the maximum working pressure. Support all piping independent of the pump and avoid pockets or loops in the suction line.

TROUBLESHOOTING

SYMPTOMS	CAUSE	SOLUTION
NO DELIVERY	Pump not primed	Fill suction pipe.
	Wrong direction of Rotation	Compare rotation of motor with direction arrow on pump.
	Suction lift too high	Check pipe friction losses.
	Obstructions in piping	Inspect piping and suction strainer.
	Air pocket or vapor lock	Loop in suction line.
	Air in system	Check all piping joints on suction side, and pump case joints.
LOW CAPACITY	Speed too slow	Check motor voltage.
	Pump internals worn	Inspect rotors and rotor housing clearances.
	Relief valve bypassing	Check for low setting or for foreign matter.
MOTOR OVERLOADED	Pump Alignment	Realign pump and driver.
	Mechanical Defect	Bent shaft. Pump must turn freely by hand.
	Obstruction in Discharge Line	Check shut-off valves to make certain they are not partially closed.
	Liquid Viscosity higher than specified	Heat liquid to lower viscosity or use motor of higher horsepower.
NOISE OR VIBRATION	Misalignment	Realign pump and driver.
	Entrained air or gases	Inspect all joints in suction line for tightness.
	Pump cavitating	Suction lift excessive. Fluid not getting into pump.
	Chattering relief valve	Check pressure setting or valve damage.

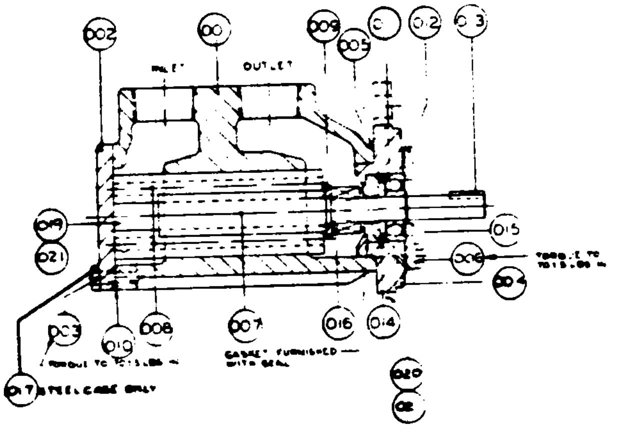


FIGURE 3. Assembly Drawing SC6112.

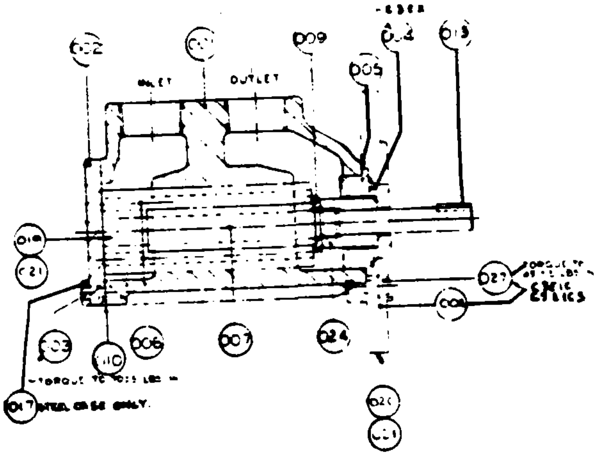


FIGURE 4. Assembly Drawing SC6113.

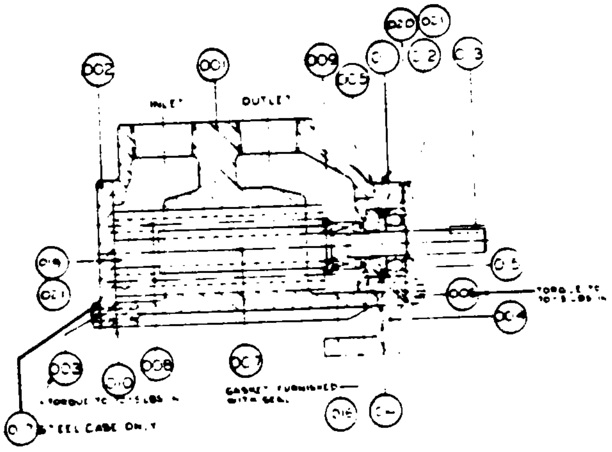


FIGURE 5. Assembly Drawing SC6114.

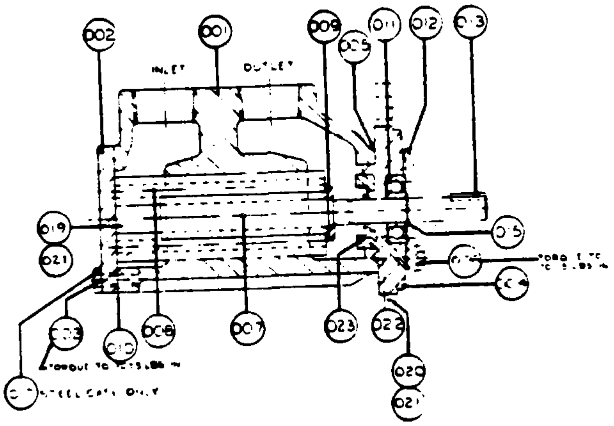


FIGURE 6. Assembly Drawing SC6115.

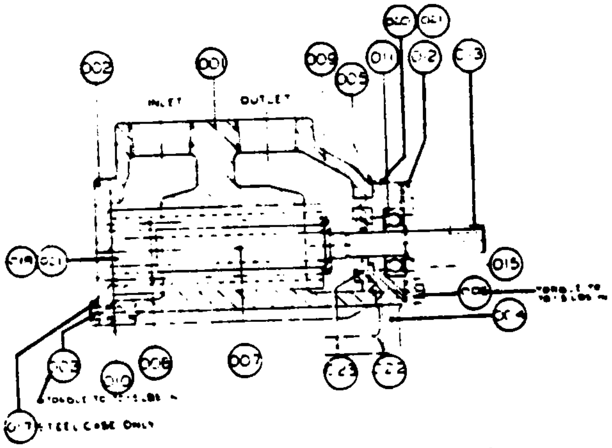


FIGURE 7. Assembly Drawing SC6116.

TABLE 2
LIST OF MATERIAL FOR FIGURES 3 THROUGH 7

ITEM	PART DESCRIPTION	ITEM	PART DESCRIPTION
001	Housing	013	Key
002	Cover	014	Truarc Ring
003	Bolt 1/4" x 3/4"	015	Truarc Ring
004	Cover	016	(2) Seal
005	(2) Gasket 0.015"	017	(1) Lockwasher
006	Bolt 1/4" x 1-1/4"	019	(1) Nameplate
007	Power Rotor	020	(1) Nameplate
008	Idler	021	(1) Brad Screw
009	Idler Stop	022	Retainer
010	(2) Gasket 0.015"	023	(2) Lip Seal
011	(2) Ball Bearing	024	Piston
012	Retainer	027	Capscrew

(1)Steel housing only.

(2)Minor Repair Kit: Minor repair kits contain items frequently damaged during pump disassembly and are available in kit form only. Identify pump type when ordering a minor repair kit.

NOTE: Major Repair: Major repair parts for a C3E Series pump are not offered. The C3E Series pumps are not considered economically repairable. If extensive repair is required to a C3E Series pump, the pump should be discarded and a new pump purchased.

SPECIAL NOTE

The instructions given herein cover generally the operation and maintenance of subject equipment. Should any questions arise which may not be answered specifically by these instructions, they should be referred to TRANSAMERICA DELAVAL Inc., for further detailed information and technical assistance.

This manual cannot possibly cover every situation connected with the operation, adjustment, inspection, test, overhaul and maintenance of the equipment furnished. Every effort is made to prepare the text of the manual so that engineering and design data are transformed into the most easily understood wording. TRANSAMERICA DELAVAL, in furnishing this equipment and this manual, must presume that the operating and maintenance personnel assigned thereto have sufficient technical knowledge and experience to apply sound safety and operational practices which may not be otherwise covered herein.

In applications where TRANSAMERICA DELAVAL furnished equipment is to be integrated with a process or other machinery, these instructions should be thoroughly reviewed to determine the proper integration of the equipment into the overall plant operational procedures.

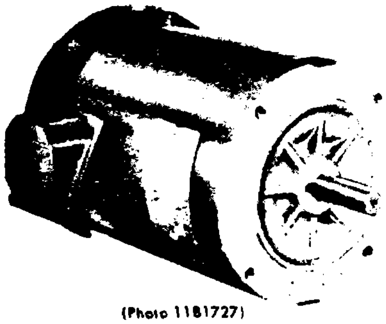
NEMA
56 Frame

TOTALLY ENCLOSED, FAN-COOLED NEMA 56C END-MOUNTED MOTORS

Type KC, Capacitor Start • Type K, Three-phase

Features

- **Easy to install.** Standard mounting; large connection box allows easy access to leads for fast electrical hook-up.
- **Long bearing life.** Preloaded ball bearings carry heavy thrust loads, are lubricated with special grease for 10 years of normal service.
- **Effective cooling.** Large external fan, protected by pressed-steel cover, forces air over outer surfaces.



(Photo 1181727)
Typical G-E 40-size Motor

WHERE TO USE

These end-mounted, totally enclosed, fan-cooled motors are specially designed for applications requiring motors adapted for end mounting directly on the equipment to be driven in ambient conditions of extreme dust, dirt, and airborne abrasives. Typical among the uses for these motors are machine tools, compressors, close-coupled pumps, and material-handling systems.

CONSTRUCTION DETAILS

The totally enclosed construction of these motors prohibits the entry of foreign particles and abrasives, thereby contributing to long motor life. The motors are effectively cooled by a large, external fan which bathes the outer surfaces with a continuous flow of air.

The preloaded ball bearings of these motors are smooth running and carry the heavy thrust loads inherent in machine-tool, pump, and compressor applications. An extra-large supply of special heavy-duty grease makes relubrication unnecessary for 10 years of normal operation.

G-E magnet wire, polyester film slot insulation, and a special protective stator varnish are combined into an insulation system which is highly resistant to the harmful effects of heat, aging, moisture, and electrical stresses.

A special gun-metal-like shaft treatment combats rust and corrosion, allows easy removal of couplings and equipment; threaded shaft extensions are stainless steel. Motors are available with welded-on steel base for foot-mounting.

The attractive blue-gray, baked-on enamel finish is extremely durable and will serve as an excellent base for repainting motor to match your equipment.

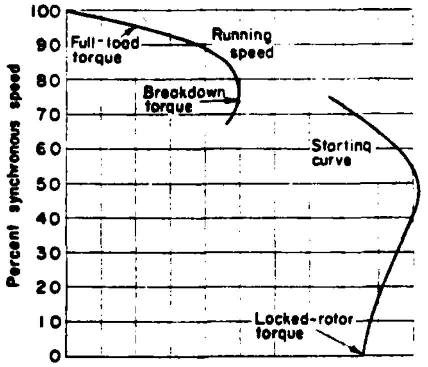
ORDERING DIRECTIONS

Information on this sheet should help you describe the motor you want. The nearest General Electric Apparatus Sales Office will then determine the proper model number from your description.

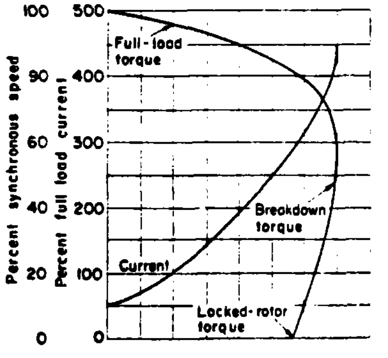
IMPORTANT SPECIFICATIONS

Starting torque . . . . High
(Except Type KC 3450- and 2850-rpm motors which have moderate starting torque.)
Starting current . . . . Normal
Speed . . . . Constant
Ambient temperature . . . . . 4 C
Time rating . . . . Continuous

TYPICAL SPEED-TORQUE CURVES



Type KC, 1725- and 1425-rpm



Type K, three-phase

RATINGS AND MOTOR SIZES

Hp	Type KC—60 Cycles		Type KC—50 Cycles		Type K—60 Cycles		Type K—50 Cycles	
	3450 Rpm§	1725 Rpm	2850 Rpm§	1425 Rpm	3450 Rpm§	1725 Rpm	2850 Rpm§	1425 Rpm
1/4	......	37‡	......	......	......	36‡	......	......
1/4	......	42	......	......	......	42	......	......
1/3	42	42	......	42	42	42	......	42
1/2	43F	43M	43H	......	43F	42	43F	......
	42							
3/4	43H	43P	......	45S	43G	43K	......	43M
1	45N	47U	47P	......	43J	43M	43K	......
1 1/2	48	49	......	......	43K	43P	......	45
2	......	......	......	......	47S	47U	......	......

‡ These motors are General Electric 30-size, NEMA 56 C, with inboard fan construction and built-in terminal board.

§ 3450- and 2850-rpm motors are listed in General Electric Apparatus Handbook under TEFC centrifugal-pump motors.

GENERAL ELECTRIC

CONSTRUCTION FEATURES

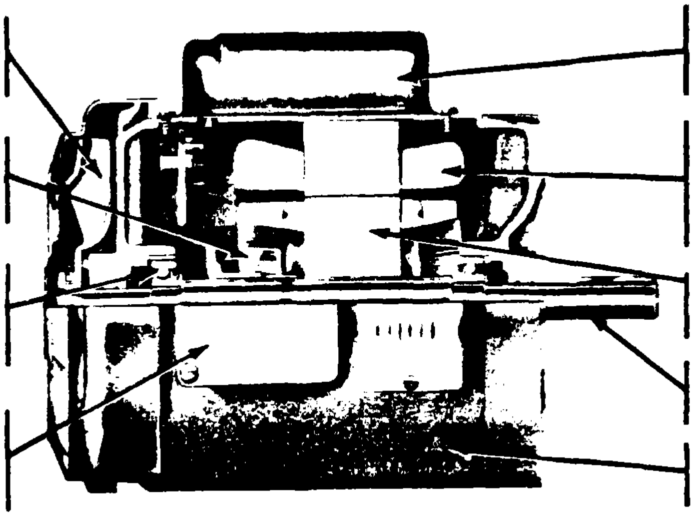
Outboard Fan Only

Heavy-duty outboard fan, protected by pressed-steel cover, forces air over outer surfaces for effective cooling.

Durable centrifugal mechanism, securely fastened to shaft, is positive, smooth and quiet in operation (on Type KC motors only).

Precision, pre-loaded ball bearings absorb heavy end thrust loads, are lubricated with extra-large supply of long-life grease for 10 years of normal operation.

Large, roomy connection box allows easy access to motor leads for fast hook-up; conduit outlet is on bottom, box can be repositioned to locate outlet on top or either side.



Compact, dielectrically strong capacitor helps start heavy loads, reduces starting current (on Type KC motors only).

Slot and between-phase insulation of polyester film, G-E magnet wire, and insulating varnish treatment make stator winding highly resistant to heat, aging, moisture, electrical stresses and other hazards.

Advanced magnetic design and precision cast-aluminum rotor winding provide quiet operation.

Gun-metal-like shaft treatment combats rust and corrosion, simplifies product maintenance.

Totally enclosed construction prevents entry of dust, dirt, airborne abrasives and foreign particles.

NEMA 56C Totally enclosed with outboard fan

DIMENSIONS (For reference only, unless approved for construction)

Where the dimensions are the same for all General Electric 30-size or 40-size motors, they are shown in the drawings. Where the dimensions are different, they are listed in the table below. Dimensions shown over and under a line are the maximum and the minimum respectively.

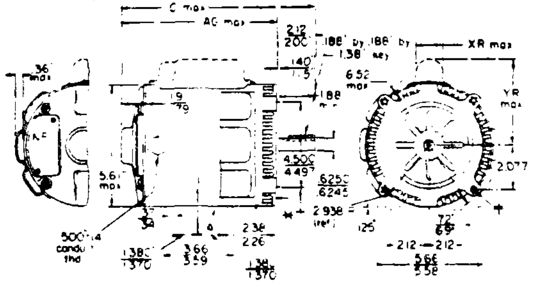


Fig. 1. G-E 30-size motors; NEMA 56C frame

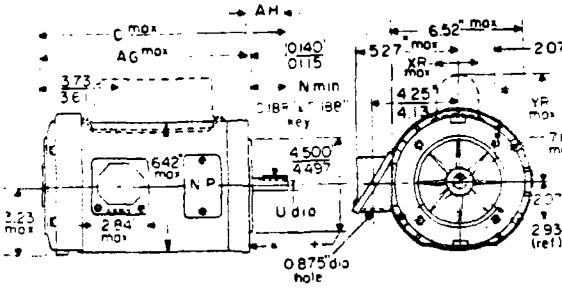


Fig. 2. G-E 40-size motors; NEMA 56C- and 56CZ-frame

G-E Motor Size	Net Wt §	NEMA Frame	Fig. No.	Dimensions in Inches C	AG	Capacitor Only XR	YR	AH Min.	N Min.	U Max. +.0000 Min. −.0005
36	14	56C	1	10.29	8.22	. . .	. . .	. . . .	. .	. . . .
37	18	56C	1	10.69	8.62	1.60	4.34	. . . .	. .	. . . . .
42	23	56C	2	10.70	8.59	1.60	4.74	2.04	1.88	.6250
43F, G, H, J	23	56C	2	11.60	9.49	1.60	4.74	2.04	1.88	.6250
43K, M, P	31	56C	2	11.60	9.49	2.22	5.37	2.04	1.88	.6250
45N	29	56C	2	12.08	9.97	2.22	5.37	2.04	1.88	.6250
45S	33	56C	2	12.08	9.97	2.72	5.87	2.04	1.88	.6250
47P, S, U	38	56C	2	12.60	10.49	2.22	5.37	2.04	1.88	.6250
47U	37	56CZ	2	12.92	10.47	. . .	. . .	2.38	2.25	.8750
48	35	56C	2	13.41	11.30	2.22	5.37	2.04	1.88	.6250
49ψ	46	56C	2	13.94	11.86	2.72 2.72	5.31 5.31	2.04	1.88	.6250

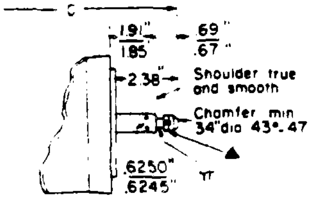


Fig. 3. Threaded-shaft dimensions for General Electric 40-size TEFC motors as on NEMA 56J jet-pump motors. φ

* Face runout of this surface (with indicator mounted stationary relative to shaft) to be within .004 gage reading.

† Eccentricity of this surface (with indicator mounted stationary relative to shaft) to be within .004 gage reading.

‡ These 4 holes (.375—16 UNC—2B .83 min full) fit a gage having a rabbet 4.5005 in. diameter and 4 pins .2917 in. diameter located on the basic hole positions.

§ For shipping weight of motor, add 15 percent to the net weight.

△ These bases are optional.

ψ Motor has two capacitor cases.

φ All other dimensions except "C" are the same as those for Fig. 2 above. For "C" dimension add .51" to "C" in chart at left. These motors have a screwdriver slot opposite the pulley end.

╤ Mating parts should be relieved one thread to clear fillet.

▲ 0.4375-20 UNF—2A thread. The eccentricity of the threaded portion of shaft is held within .004 inch total gage reading, with indicator on outside diameter of 2-inch-diameter ring gage. The ring gage is held stationary with respect to the rotor, with the gaging point 3/16 inch from end of shaft.

DIMENSIONS APPROVED FOR CONSTRUCTION

Customer .... Customer's Order No. .... Item ....

Our Req. No. .... Item .... Approved by ....

For further information, contact your nearest General Electric Apparatus Sales Office or Distributor

GENERAL ELECTRIC

GENERAL PURPOSE MOTOR DEPT. | **FORT WAYNE**
LINTON, DECATUR • **INDIANA**

1-66 (5M) 500

Instruction Manual

67F & 67FR Series Regulators

Form 1692, December 1972

Supersedes Form 1692C

WARNING

Regulators should be installed, operated and maintained in accordance with federal, state and local codes, rules and regulations, and Fisher instructions.

If the regulator vents gas or a leak develops in the system, it indicates that service is required. Failure to take the regulator out of service immediately may create a hazardous condition.

Call a serviceman in case of trouble. Only a qualified person must install or service the regulator.

Introduction

The Type 67F and 67FR regulators are designed to provide a constant reduced pressure (air or gas) to pilot operated controllers and instruments. They can also be used for air spray guns, air jets, and other miscellaneous air and gas applications.

Both the Type 67F and 67FR regulators are constructed with a filter. The cellulose filter removes particles greater than 0.0015" diameter. A stainless steel or brass filter removes particles greater than 0.002" diameter.

The 67FR is designed with an integral low capacity relief valve. The metal valve stem seats against an orifice in the diaphragm head which allows some leakage. (The amount is insignificant on air service.) A downstream pressure increase above the control point will move the diaphragm off the valve stem, venting the excess pressure to the atmosphere through a drilled vent in the spring case.

Installation

WARNING

The vent hole drilled in the bonnet must not be plugged. On outdoor installations this hole should be in the down position. If this is impractical, protect the regulator so that moisture cannot enter the vent.

The Type 67FR must not be used for applications where gas cannot be vented to the atmosphere.

All pipe lines should be thoroughly cleaned and blown out before installing the regulator. Be sure that flow is in accordance with the letters denoting "IN" and "OUT" on the body. Inlet and outlet connections are tapped 1/4" NPT. Install with the drain cock down.

The drain cock (key 17) should be opened periodically to allow moisture which has accumulated to drain. The regularity with which this is done will depend on how much moisture is in the system.

Over-Pressure Protection

As is the case with most regulators, the Series 67F and 67FR have an outlet pressure rating lower than the inlet pressure rating. Some type of over-pressure protection is needed if the actual inlet pressure exceeds the 100 psig maximum operating outlet pressure rating. The maximum inlet pressure rating is 250 psig.

Over-pressure protection should also be provided when the inlet pressure is greater than the safe working pressure of downstream equipment.

Full-capacity downstream relief protection must be provided with the 67F design if upstream pressure is high enough to damage equipment downstream. This also applies to the 67FR design, which only provides for low capacity relief.

Adjustment

The outlet spring range is shown on the paper label attached to the bonnet. Outlet pressure spring ranges are as follows:

Spring Range PSIG	Spring Color
3-20	Green
5-35	Cadmium
30-60	Blue
35-100	Red

The above spring ranges are recommended, although reduced pressure down to 0 psig may be obtained with each spring.

To change the outlet setting of the spring, first loosen locknut (key 11). Then turn adjusting screw (key 10) clockwise to increase outlet setting or counterclockwise to decrease outlet setting. Be sure to tighten locknut after changing the setting.

Maintenance

CAUTION

Before disassembly or removing the regulator from the line, isolate it from the pressure system and release all the pressure from the regulator.

Due to normal wear, parts must be periodically inspected and replaced if necessary. The frequency of inspection depends on the severity of the service conditions.

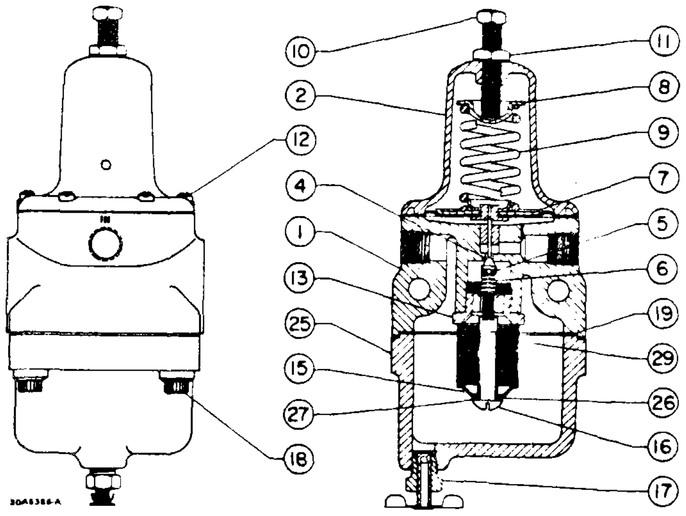
Before disassembling the unit for diaphragm replacement, loosen the locknut and turn the adjusting screw counterclockwise until there is no compression on the spring. Remove the six screws (key 12) and separate the bonnet from the body. This exposes the diaphragm (key 7) for replacement.

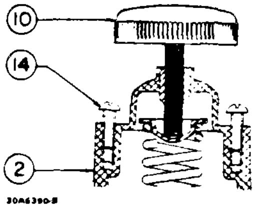
To replace the valve plug, remove the four cap screws (key 18) and remove the filter cap (key 25). The filter adaptor (key 13) may now be removed with a deep socket wrench to gain access to the valve plug (key 4).

When the filter element (key 29) becomes dirty, it should be cleaned with solvent and blown out with air or replaced.

Type Number

When corresponding with the factory or representatives in regard to this regulator, always give the type number found stamped on the body. Refer to the complete part numbers when ordering parts.





Optional Panel Mounting Feature

Parts Reference

Key	Part Name
1	Body Assembly
2	Bonnet
4*	Valve Plug with Stem
5	Lower Spring Seat
6	Valve Spring
7*	Diaphragm Assembly
8	Upper Spring Seat
9	Spring
10	Adjusting Screw
11	Adjusting Screw Locknut
12	Screw
13	Adaptor
14	Panel Mounting Screws
15	Washer
16	Filter Post
17	Drain Valve
18	Cap Screw
19*	Gasket
25	Filter Cap
26*	Gasket
27	Spring Washer
29*	Filter Element

*Recommended Spare Part

FISHER® Controls

Parts Supplement to Instruction Manual
67F and 67FR Series Regulators

Form 5536, December 1972

The following list contains complete part numbers for all components of this unit which are normally replaceable in the field. Only the materials used most frequently are included. The key numbers given correspond to the key numbers shown on the assembly drawing of this unit in the appropriate instruction manual. Items designated as "Recommended Spare Parts" are noted with an asterisk (*). Consult your Fisher representative if parts are needed in materials other than those shown below. Include the serial number of your unit in all correspondence concerning replacement parts.

KEY	DESCRIPTION	PART NUMBER
1	Body Assembly	
	One Outlet, Alum. & Brass (Std)	1C1270 000A2
	Alum. & SST	1C1270 000B2
	Two Outlets, Alum. & Brass (Std)	1C1270 000C2
	Alum. & SST	1C1270 X00A2
2	Bonnet	
	Plain, Aluminum	2B7974 08012
	Panel Mounting, Zinc Iridited	3B9855 000B2
4*	Valve Plug With Stem	
	Brass & Rubber	1D5604 000A2
	304 SST & Rub.	1D5604 000B2
5	Lower Spring Seat	
	Aluminum	1E5322 11032
	316 SST	1L2511 35072
6	Valve Spring	
	302 SST	1C1273 37022
7*	Diaphragm Assembly	
	67F, Std Trim	1B7980 000B2
	67FR, Std Trim	1B7989 000B2
	67FR, SST Trim	1B7989 000C2
8	Upper Spring Seat	
	Steel, Zinc Pl.	1B7985 25062
9	Spring, Steel	
	3-20 psig, Green, Zinc Pl.	1B9860 27212
	5-35 psig, Cadmium, CD PL	1B7883 27022
	30-60 psig, Blue, CD PL	1B7884 27022
	35-100 psig, Red, Zinc Pl.	1K7485 27202
10	Adjusting Screw, Steel, Pl.	1B7986 28982
	Handwheel, Steel, Zinc Pl.	1B7992 000A2
11	Locknut, Adj. Screw, Steel, CD PL	1A9463 24122
12	Screw (6 Req'd) Steel, Pl.	1B7839 28982
13	Adaptor, Alum.	1C1274 09012
14	Panel Mtg. Screw, Steel (2 Req'd)	1C2760 28992
15	Washer, Alum.	1C1276 11992
16	Filter Post, Aluminum	1C1277 09032
17	Drain Valve	
	Brass	1K4189 18992
	Alum.	1K4189 000B2
	303 SST	AH3946 000B2
18	Cap Screw (4 Req'd) Steel, CD PL	1K7647 24052
19*	Gasket Neoprene	1C1280 03012
25	Filter Cap Aluminum	2C1272 08042
26*	Gasket, Asb. (Use w/Cell. Filter)	1F8268 04022
27	Spring Washer, Steel (Use w/Cell. Filter)	1H8851 28982
29*	Filter Element	
	Brass	1C1275 99012
	Cellulose	1F2577 06992
	SST	1J9892 38992

*Recommended Spare Part

Printed in U.S.A.

WORLDWIDE MANUFACTURING SALES SERVICE

Fisher Controls Company

Fisher Controls Company, Marshalltown, Iowa 50158 • Other Plants Woodstock, Ont., Coraopolis Pa., McKinney, Tex. Toluca Edo de Mexico ELECTRONIC INSTRUMENTATION Fisher Process Equip. Ltd. Cornwall Eng

FEAT ES CTORIALLY TYPICAL-ORIENTATION MAY DIF R

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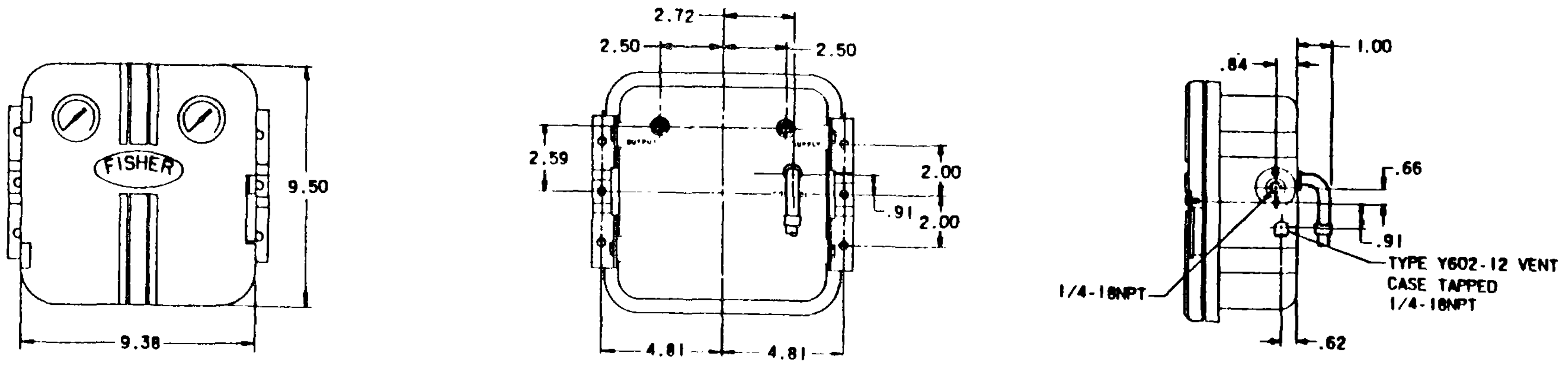
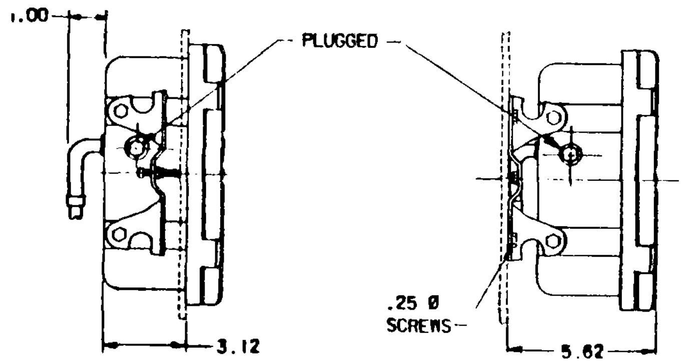
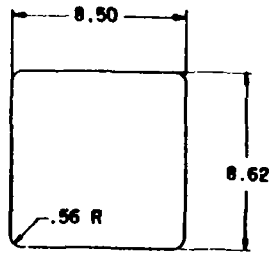


BACK VIEW



FLUSH PANEL MOUNTING

SURFACE MOUNTING



DIMENSIONS FOR PANEL MOUNTING

NOTE: ALL PRESSURE CONNECTIONS ARE 1/4-18NPT

ENVELOPE DIMENSIONS ARE ± .25

CUSTOMER Bingham-Willamette Co.	P.O. NO. 1-61654	JOB NO.	TAG NO.
REQN NO.	SERIAL NO. 7656836-37	OUR NO. 20-19723	DIMENSIONS CERTIFIED CORRECT DATE 3-26-80 BY Mendenhall

FISHER® Controls
MARSHALLTOWN, IOWA

PROPORTIONAL TEMPERATURE CONTROLLER

TYPE ~~4156~~ 4166

C

DWN STIEHL 4-17-78
CHKD OTTEN 4-21-78
APVD 4-21-78

SCALE-NONE

REVISIONS
B MLD 1-4-80

DWG NO. 15A7452

REV. B

```
3487-X      FISHER CONTROLS COMPANY RECOMMENDED SPARE PARTS      03/21/80  PAGE  1


 C   CMER ORDER NUMBER  REPRESENTATIVE PO CO               ORDER DATE  SERIAL NUMBER
 1-   54                020 -19723                         03/10/80    7656834-835

 SOLD TO                                        SHIP TO
 BINGHAM-WILLAMETTE COMPANY                     BINGHAM-WILLAMETTE COMPANY
 2800 N.W. FRONT AVENUE                         2800 N.W. FRONT AVENUE
 PORTLAND, OREGON                               PORTLAND, OREGON
                                 97210                                              97210

 ITEM    0001  TAG                                                             ITEM-QTY
       3/4 INCH TYPE 513R-3 DIAPH ACTUATED CONTROL VALVE                              2

 COMP QUANTITY    LIST PR/EA PART NUMBER     PART NAME               MATERIAL


 A
    BX1-A8-B25-C200-D2-E7-F2-G2-H2-J1-K2-9A1-9B1
       3       EA        2.25 1C752601012     PACKING,RING            TFE FMS 17D7
       1       EA        2.25 1F124401012     PACKING ADAPTOR,FEM     TFE FMS 17D7
       1       EA        2.25 1F124801012     PACKING ADAPTOR,MALE    TFE FMS 17D7
       1       EA       27.00 1H587940152     BUSHING                 N10276(HAST C)
       1       EA       45.00 1H755635072     SEAT RING               S31600,20B20
       1       EA        4.50 1J174106242     GASKET                  TFE FMS 17F3

 B  FS513R-16
    513X1-A1-B3-C5-D2-E1-H1-9A11-9B2
       1       EA        1.25 1F159306992     O-RING                  NITRILE/MOS2
       1       EA       46.00 1N447806992     DIAPHRAGM               NITRILE/DACRON
       1       EA         .25 1N448604022     GASKET                  ASB-17A2/17A4
       1       EA        1.50 1V115706992     O-RING                  NITRILE/MOS2
       1       EA        1.25 1V117006992     SEAL,DUST               NEOPRENE-BLACK















 LT   PRICES SUBJECT TO CHANGE WITHOUT NOTICE                         PAGE  1 OF  1
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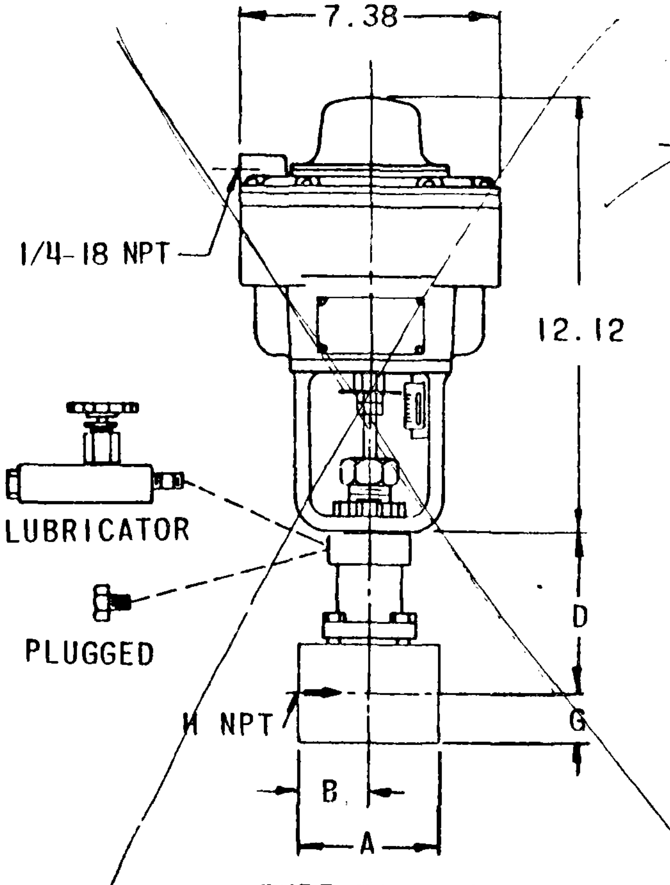
1.2.23-199

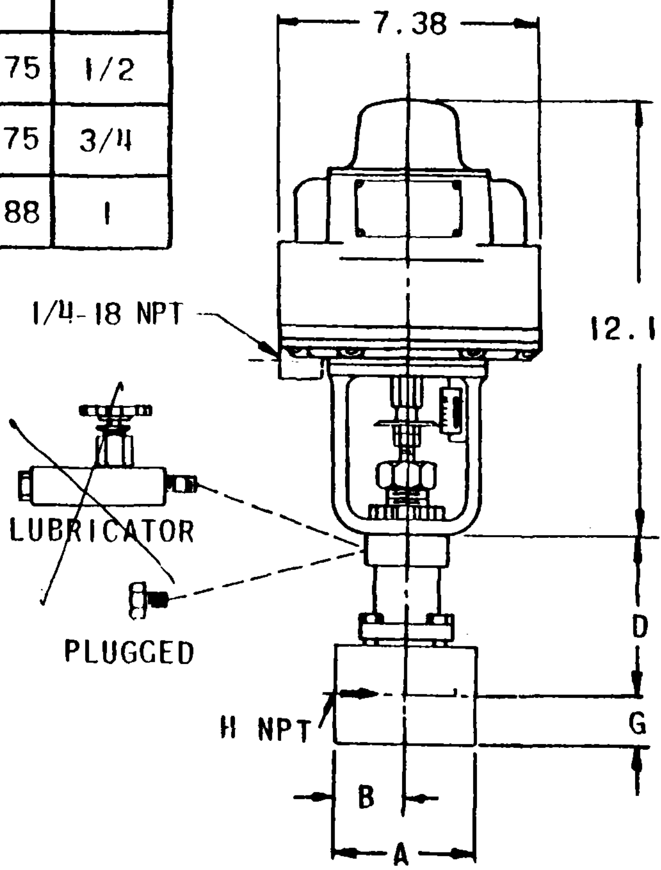
SIZE	A	B	G	D	H
1/2	4.00	2.00	1.38	3.75	1/2
3/4	4.12	2.06	1.38	3.75	3/4
1	5.00	2.50	1.50	3.88	1



TYPE 513 - B

INCREASING PRESSURE TO DIAPHRAGM
CLOSES VALVE PLUG

VALVE PLUG OPENS ON AIR FAILURE



TYPE 513R - B

INCREASING PRESSURE TO DIAPHRAGM
OPENS VALVE PLUG

VALVE PLUG CLOSES ON AIR FAILURE

CUSTOMER Bingham-Willamette Co.	P.O. NO. 1-61654	JOB NO.	TAG NO.
REQN NO.	SERIAL NO. 7656834-35	OUR NO. 20-19723	DIMENSIONS CERTIFIED CORRECT DATE 3-26-80 BY Smendenhall

FISHER® Controls
MARSHALLTOWN, IOWA

DIAPHRAGM ACTUATED CONTROL VALVE

TYPE ~~513 - B~~
513R - B

DWN JR 8-28-63
CHKD RMD 8-28-63

REVISIONS
G RMD 10-25-72

DWG NO. AN7783

REV. G

Instruction Manual

Type 513 and 513R Diaphragm Actuators

Form 2248, July 1979

INTRODUCTION

Scope of Manual

This instruction manual provides installation, operation, maintenance, and parts ordering information for Types 513 and 513R diaphragm actuators. For information regarding accessories, consult separate instruction manuals.

Description

The Fisher Types 513 and 513R are reversible diaphragm actuators for use with small control valve bodies. The Type 513 actuator stem moves downward with increasing signal pressure, and the Type 513R actuator stem moves upward with increasing signal pressure. The standard actuator can be reversed easily in the field without additional parts and without taking the valve body out of the line. The actuators are available in size 20 and size 32.

Specifications

Specifications for the Types 513 and 513R diaphragm actuators are given in table 1.

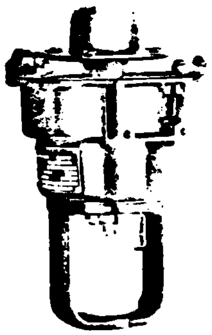


Figure 1. Type 513 Diaphragm Actuator Mounted on a Design GS Valve Body

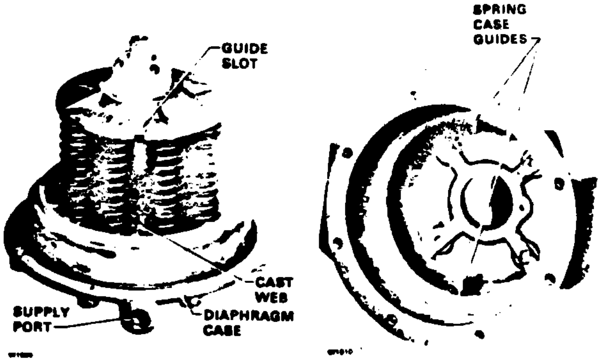


Figure 2. Diaphragm Case Assembly and Spring Case

INSTALLATION

The actuator is normally furnished on a valve body. If the valve body and actuator were ordered separately, mount the actuator on the valve body according to the procedure outlined in the "Actuator Mounting" section of this instruction manual. Follow the valve body instructions when installing the control valve in the pipeline.

Table 1. Specifications

EFFECTIVE DIAPHRAGM AREA	26 in.^{2} (168 cm^2)
MAXIMUM DIAPHRAGM PRESSURE	50 psig (3.5 bar)
RATED TRAVEL	3/4 inch (19.1 mm)
DIAPHRAGM PRESSURE RANGES	■ 3 to 15 psig (0.2 to 1.0 bar), or ■ 6 to 30 psig (0.4 to 2.0 bar)
YOKE BOSS SIZES	**Size 20**: 1-1/4 inch (3.2 mm) yoke boss for ■ 1/4 inch (6.4 mm), ■ 5/16 inch (7.9 mm), and ■ 3/8 inch (9.5 mm) stems **Size 32**: 2-1/8 inch (54 mm) yoke boss for 3/8 inch (9.5 mm) stem
MATERIAL TEMPERATURE CAPABILITIES	With Nitrile Diaphragm: −40° to 180°F (−40° to 82°C)
PRESSURE CONNECTION	1/4 inch NPT female
APPROXIMATE SHIPPING WEIGHTS	**Size 20**: 12 lb (5.4 kg) **Size 32**: 17 lb (7.7 kg)
OPTIONS	Adjustable travel stop (figure 6), Top-mounted handwheel (figure 5)

The actuator will operate satisfactorily in either a horizontal or vertical position. From the standpoint of ease of maintenance, the preferred position is in a horizontal pipe run with the actuator vertical above the pipe. However, when using a Type 513R actuator in high humidity areas, it is advisable to install the actuator below the valve to allow condensation to drain out of the actuator. If this orientation is used, drill a 1/16-inch (2 mm) hole in the actuator cap (key 18, figure 5). *Be certain that flow through the valve is* the same as indicated by the flow direction arrow or letters on the valve body.

The Types 513 and 513R actuators depend upon a pneumatic signal for their operation. Connect the signal line (copper tubing is adequate) to the pressure connection on the actuator. On the Type 513 actuator, the pressure connection is on the top of the case. On the Type 513R actuator, the connection is on the bottom of the case. If the actuator is furnished with a valve positioner that has been mounted at the factory, it will include a pressure reducing regulator. Connect the pneumatic signal line to the appropriate connection on the positioner and connect a pneumatic supply pressure line to the pressure reducing regulator.

ADJUSTMENTS

WARNING

To avoid personal injury and damage to the process system, isolate the control valve from the pressure system and release all pressure from the valve body and actuator before attempting adjustments or disassembly.

Spring Adjustment

Note

Changing the spring compression may result in less seating force to the valve. If the seating force is not great enough, the valve may not meet the required shutoff classification.

All key numbers refer to figures 3, 4 and 5 unless otherwise indicated. Although the actuator is set to operate according to the conditions specified on the customer order, it is possible to make minor adjustments. On reverse-acting (Type 513R) actuators with an adjustable travel stop (see figure 5), it will be necessary to remove cap screws (key 22), actuator cap (key 18), and adjustable stop (key 55) in order to make spring adjustments. If it takes too much air pressure to start diaphragm movement, turn the spring adjustor (key 16) counterclockwise as viewed from the visible end of the adjustor so that the main springs (key 14, figure 3) are decompressed. If diaphragm movement begins with too little air pressure, turn the adjustor clockwise. Rotate the adjustor with a rod 1/4 inch (6.4 mm) or less in diameter inserted into one of the four holes drilled into the adjustor.

Travel Adjustment

Key numbers used in the following procedure are shown in figure 3.

Loosen the stem nuts (key 31). On size 32 actuators, also loosen the cap screws in the stem connector (key 32).

CAUTION

> Do not use pliers or other tools directly on the valve plug stem, or damage to the stem surface and subsequent damage to the packing may result. Also, do not rotate the stem while the valve plug is on its seat, or damage to the valve plug and seat ring seating surfaces may result.

Looking down on the valve plug stem, rotate it clockwise to increase travel or counterclockwise to decrease travel. On Type 513 actuators, the valve plug stem screws into the actuator rod (key 13) on size 20 units, and into the stem connector (key 32) on size 32 units. On Type 513R actuators, the valve plug stem screws into the stem nut (key 5) on size 20 units, and into the stem connector on size 32 units.

Handwheel

If the actuator is equipped with a handwheel, the handwheel can be used to limit valve plug travel, and to position the valve plug if the actuator becomes inoperable because of loss of air. Looking down on the handwheel and turning it clockwise causes a push-down-to-close valve plug to close on both Type 513 and Type 513R actuators.

The handwheel indicator (key 50, figure 4) near the top of the handwheel body permits viewing the position of the handwheel nut (key 48, figure 4). To prevent limiting of actuator travel by the handwheel assembly, line up the top shoulder of the handwheel nut with the line marked "NEUTRAL" on the indicator.

Note

> If the handwheel is not in the "Neutral" position during normal control valve operation, the handwheel may prevent the valve plug from opening or closing completely.

Adjustable Travel Stop

The following procedure describes setting the travel stop on units equipped with an adjustable travel stop. Key numbers used in this procedure are shown in figure 5.

Unscrew four machine screws (key 22) and remove actuator cap (key 18).

To prevent damage to diaphragm and dust seal (keys 2 and 34), keep the actuator rod from turning by holding a wrench on the stem locknuts (key 31). Turn the travel stop (key 55) to attain the desired setting. Clockwise rotation of the travel stop decreases the amount of downward travel.

Replace actuator cap and machine screws.

MAINTENANCE

Actuator parts are subject to normal wear. They should be inspected and replaced as necessary. The frequency of inspection is dependent on the severity of service conditions. Instructions are given below for complete disassembly and assembly of the actuator. When replacing the diaphragm or changing the springs, travel stop, or other parts, perform only those steps necessary to accomplish the job. Some of the steps of this procedure have been divided due to construction differences between actuators. Steps which are not divided pertain to all constructions, and the key numbers refer to figures 3, 4, and 5. For divided steps, refer to figure 3 for standard Type 513 actuators, figure 4 for actuators with handwheels, and figure 5 for Type 513R actuators and actuators with an adjustable travel stop.

WARNING

> To avoid personal injury and damage to the process system, isolate the control valve actuator from all pressure and release trapped pressure before attempting disassembly.

Disassembly

1. **Type 513 and 513R actuators with handwheel:** Remove cap screws (key 23) that secure the handwheel body (key 35) to the actuator. Rotate the handwheel counterclockwise until the threads of the handwheel screw (key 36) disengage from the handwheel nut (key 48). Lift off the handwheel body and unscrew the travel bolt (key 46) using a 3/8 inch hex wrench and remove the handwheel nut (key 48).

Size 20 Type 513 and 513R actuators with travel stop: Remove cap screws (key 22) and actuator cap (key 18). Unscrew cap screw (key 54) and lift off adjustable stop and guide (keys 55 and 56).

Size 32 Type 513 and 513R actuators with travel stop: Remove cap screws (key 22) and actuator cap (key 18). Unscrew adjustable stop (key 55). Drive out groove pin (key 54) and remove adjustable guide (key 56).

Standard Type 513 actuator: Unscrew machine screws (key 22) and remove the actuator cap (key 18).

2. **Size 20 actuators only:** Loosen hex nuts (key 31) and unscrew valve stem from actuator rod. Remove indicator disc.

Size 32 actuators only: Loosen hex nuts (key 31) and cap screws from stem connector assembly (key 32) and remove the stem connector halves and indicator disc (key 20).

3. Remove the yoke locknut and lift the actuator off of the valve body.

4. Relieve spring compression by using a 1/4 inch (6.4 mm) rod to rotate the spring adjustor (key 16) counterclockwise as viewed from the visible end of the adjustor.

5. Remove the diaphragm case screws (key 24) and dust seal (key 34) and, on Type 513 actuators, invert the unit so that the spring adjustor (key 16) is up. Lift off the spring case (key 3), springs (key 14), spring seat (key 15), spring adjustor (key 16), thrust washer (key 17), and travel stop (key 21).

6. If diaphragm replacement is required, lift out diaphragm assembly and place actuator rod (key 13) in vise being careful not to damage the stem surface. Use wrench on flats of stem nut (key 5) to loosen. Remove stem nut, gasket (key 9), and plate (key 11). The diaphragm is now accessible.

7. If O-rings (keys 6 and 7) must be replaced, remove machine screws (key 25), bushing retainer (key 10), and bushing (key 8). Inspect O-rings and replace as necessary.

Assembly

1. Insert O-rings (keys 6 and 7) into bushing (key 8) grooves and clamp bushing into diaphragm case (key 1) using the bushing retainer (key 10) and machine screws (key 25).

2. Slide the diaphragm plate (key 12), diaphragm (key 2), plate (key 11), and gasket (key 9) onto the stem and fasten in place with the stem nut (key 5).

3. Slide the diaphragm assembly described in step 2 into the diaphragm case (key 1) as shown in figures 3, 4, and 5. When replacing diaphragm assembly in the diaphragm case, be sure that one of the cast webs in the diaphragm plate is directly in line with the supply port as shown in figure 2.

4. Slide the travel stop (key 21) over the actuator rod (key 13) and set springs (key 14) on the cast guides in the diaphragm plate. Place spring adjustor and spring seat (keys 16 and 15) over the actuator stem, being sure all springs are properly centered around the cast guides in the spring seat and that one of the guide slots in the outer edge of the spring seat is aligned with the supply port as shown in figure 2.

5. Replace thrust washer (key 17). See figure 1 for proper alignment of the spring case (key 3) and yoke in relation to the diaphragm case (key 1). Align spring case guides with spring seat guide slots (shown in figure 2) and lower the spring case over the diaphragm case and spring assembly.

6. Invert the entire unit. Replace screws (key 24), and dust seal (key 34).

7. **Type 513 and 513R actuators with handwheel:** Attach the handwheel nut (key 48) to the stem nut (key 5) with the travel bolt (key 46). Slide the handwheel body (key 35) over the handwheel nut and rotate the handwheel clockwise until the threads engage the handwheel nut. Secure the handwheel body to the actuator with cap screws (key 23).

Size 20 Type 513 and 513R actuators with travel stop: Fasten the adjustable stop and guide (keys 55 and 56) to the stem nut (key 5) with a cap screw (key 54). Attach actuator cap (key 18) to the actuator with cap screws (key 22).

Size 32 Type 513 and 513R actuators with travel stop: Screw the adjustable guide (key 56) onto the stem nut (key 5) and align the holes in stem nut and adjustable guide. Drive the groove pin (key 54) in to secure stem nut and adjustable guide. Screw the adjustable stop (key 55) onto the guide (key 56). Attach the actuator cap (key 18) to the actuator with cap screws (key 22).

Standard Type 513 and 513R actuators: Attach the actuator cap (key 18) to the actuator using cap screws (key 22).

8. Mount the actuator on the valve body according to the "Actuator Mounting" section of this instruction manual.

CHANGING THE ACTION

WARNING

To avoid personal injury and damage to the process system, isolate the control valve and actuator from all pressure and relieve trapped pressure before attempting disassembly.

Note

All standard Type 513 and 513R actuators are field reversible without additional parts. Also, the handwheel version in size 20 [5/16 inch (8.0 mm) and 3/8 inch (9.5 mm) stem sizes only], and the size 32 [3/8 inch (9.5 mm) stem only] with the adjustable travel stop, need no additional parts for field reversal. Other combinations will require change of the stem nut and actuator rod (keys 5 and 13, figure 4). Direct-acting (Type 513) actuators extend the actuator rod with increasing pressure while reverse-acting (Type 513R) actuators retract the actuator rod with increasing pressure.

If the actuator is equipped with a handwheel, it will be necessary to remove the handwheel assembly as outlined in step 1 of the "Maintenance" section of this instruction manual.

Converting From Direct-Acting to Reverse-Acting

CAUTION

Do not use pliers or other tools directly on the valve plug stem, or damage to the stem surface and subsequent damage to the packing may result. Also do not rotate the stem while the valve plug is on its seat, or damage to the valve plug and seat ring seating surfaces may result.

All key numbers refer to figures 3, 4, and 5 unless otherwise indicated.

1. Remove the actuator from the valve body by loosening stem locknuts (key 31) and, on the size 32 only, the cap screws in the stem connector (key 32). Unscrew the valve stem from the actuator rod (key 13) and remove the yoke locknut.

2. Take the yoke (key 4) off the spring case (key 3) by removing four cap screws (key 23).

3. Take off actuator cap (key 18, figure 3) by removing four machine screws (key 22, figure 4). The actuator cap is not used with the handwheel.

4. Fasten the actuator cap, if used, to the opposite end of the diaphragm case with four machine screws (key 22, figure 3).

5. Turn the diaphragm case over and fasten it to the yoke, using the same four cap screws (key 23).

6. Remount the actuator on the valve body. It will be necessary to adjust valve plug travel as outlined in the section "Travel Adjustment".

7. To remount the handwheel, replace the handwheel nut (key 48) and the travel bolt (key 46) on the actuator rod (key 13).

8. Place the handwheel (key 40) and the handwheel body (key 35) over the handwheel nut (key 48) and turn the handwheel clockwise. This engages the threads. Continue rotating until the handwheel assembly seats on the flange of the spring case (key 3). To prevent limiting of actuator travel by the handwheel assembly, line up the top shoulder of the handwheel nut with the line marked "NEUTRAL" on the indicator (key 50, figure 4).

Note

If the handwheel is not in the "Neutral" position during normal control valve operation, the handwheel may prevent the valve plug from opening or closing completely.

9. Replace the cap screws (key 23).

Converting from Reverse-Acting to Direct-Acting

Be certain the plug is off its seat before loosening the stem connection. The procedure for changing the action from reverse acting to direct acting is the same except that the valve plug stem (stem connector on size 32) will be attached to the actuator rod (key 13) instead of the stem nut (key 5) when reversal is complete.

ACTUATOR MOUNTING

All key numbers refer to figures 3, 4, and 5 unless otherwise indicated.

1. Mount the actuator on the valve yoke boss, securing it with the yoke locknut provided with the valve body. Make sure the valve plug is in the closed position. Screw the stem locknuts (key 31) all the way onto the valve stem threads. Place the indicator disc (key 20) on the stem locknuts.

2. **Type 513 actuators**: Pressure the actuator until the actuator rod moves down from the top travel stop the specified valve travel as indicated on the actuator nameplate.

Type 513R actuators: Pressure the actuator to move the actuator stem to the extreme upward position. Then reduce loading pressure until the actuator stem moves down the distance specified for valve plug travel as indicated on the actuator nameplate.

CAUTION

Do not rotate the valve plug while it is seated or the seating surfaces may be damaged. Also, do not use tools directly on the valve stem or the stem surface may be damaged. Nicks and scratches on the valve stem may damage the stem packing when the stem travels through the packing.

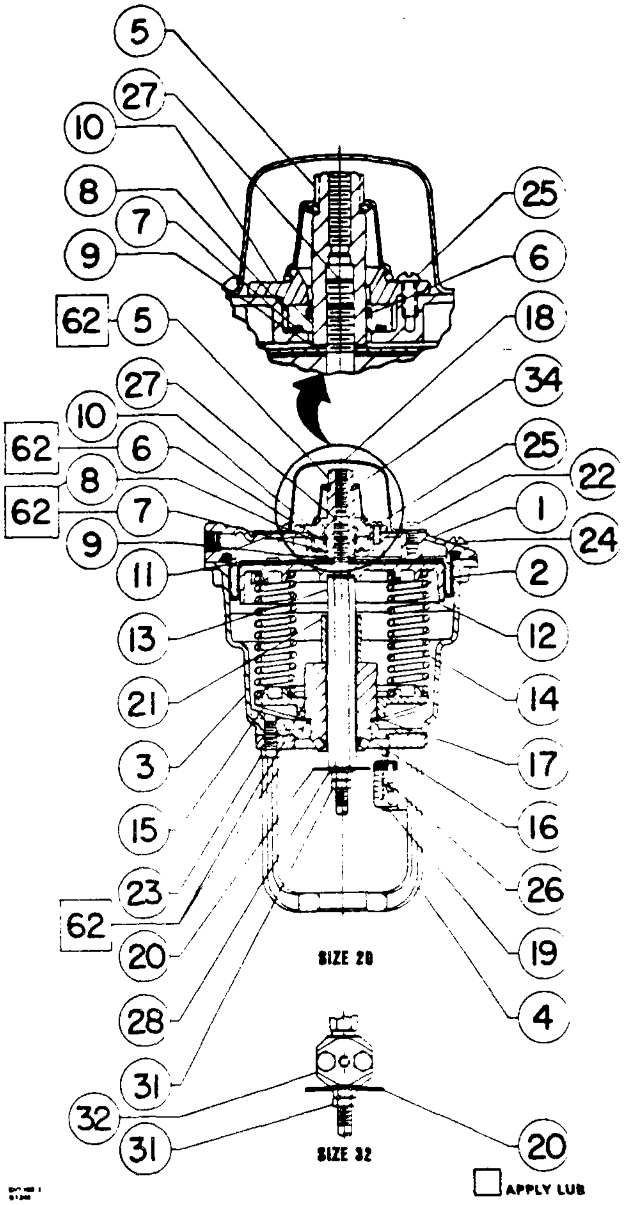


Figure 3. Type 513 Actuator

3. Cycle the actuator to check availability of desired total travel and to check that the valve plug seats before the actuator contacts the lower travel stop. Minor travel adjustments can be made, if necessary, by loosening the stem connector (size 32 only), tightening the locknuts together, and screwing the stem either into or out of the stem connector (key 32, size 32) or actuator rod (key 13, size 20) by using a wrench on the locknuts.

4. If the total travel is adequate, tighten the stem connector, (size 32 only). Lock the stem locknuts against the connector or actuator rod, and adjust the travel indicator scale (key 19) to show the correct valve plug position.

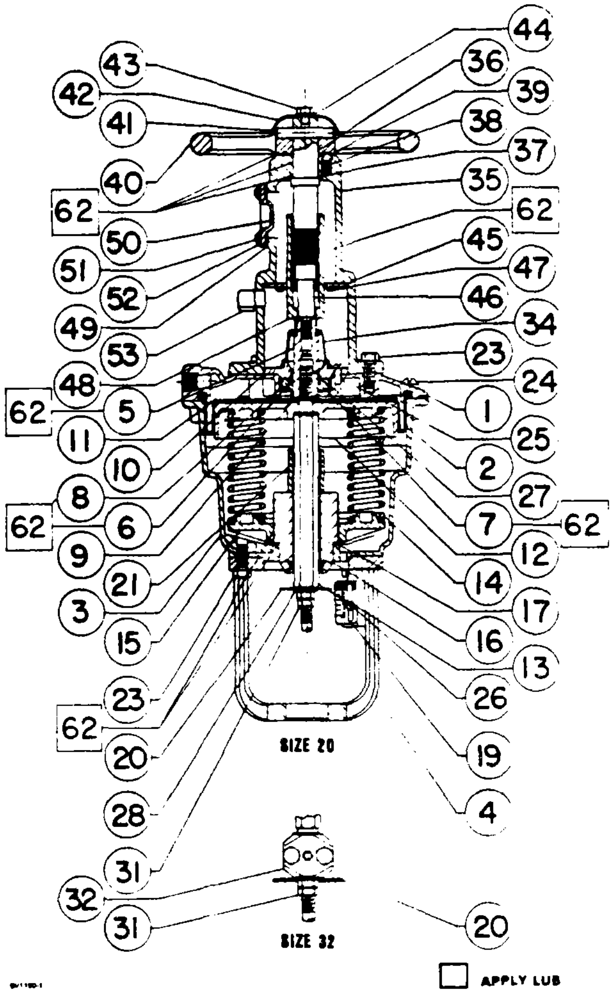


Figure 4. Type 513 Actuator with Handwheel

5. Provide a gauge to measure the pressure to the actuator. Make a final adjustment on the actuator (see "Spring Adjustment" section of this instruction manual) or its positioner (or other instrument) to set the starting point of valve travel and to obtain full travel for the given pressure signal range.

PARTS ORDERING

Each actuator has a nameplate attached to the actuator housing and a serial number is stamped on it. Always refer to this serial number when corresponding with your Fisher representative regarding replacement spare parts or when requesting technical information. When ordering replacement parts, also specify the complete eleven character part number of each part required as found in the following parts list.

PARTS LIST

Types 513 & 513R

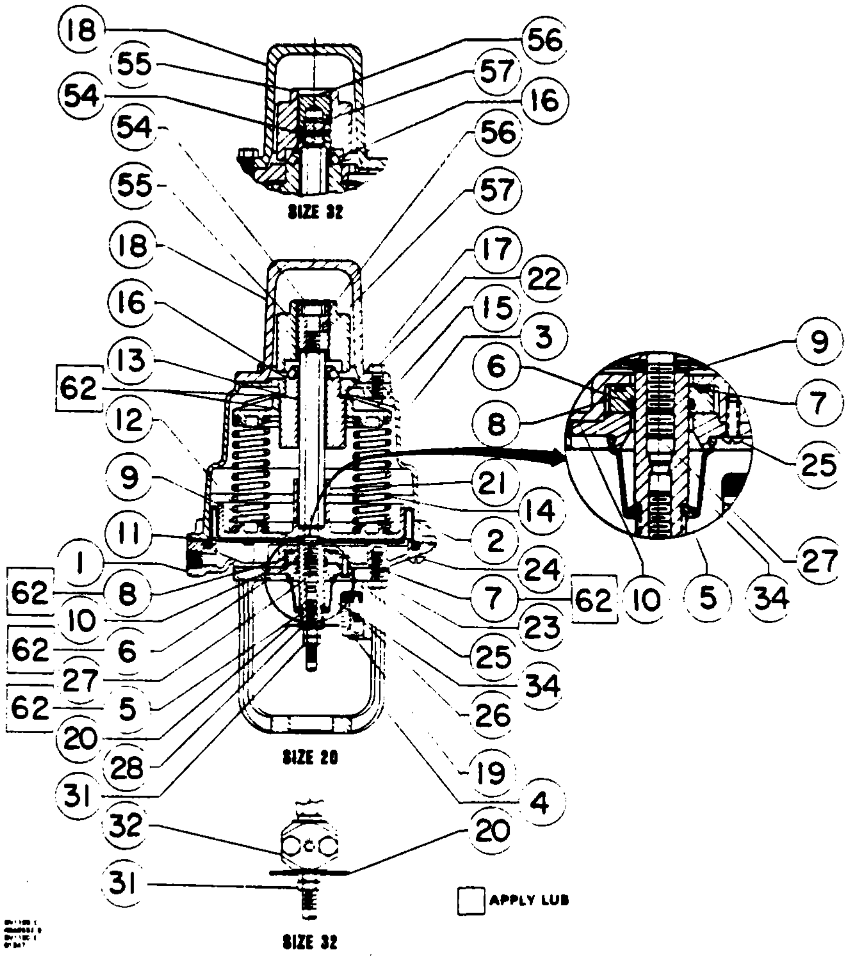


Figure 5. Size 20 Type 513R Actuator with Adjustable Travel Stop

Key	Description	Part Number
1	Diaphragm Case, alum.	3V1151 08012
2*	Diaphragm, Nitrile & Dacron†	1N4478 06992
3	Spring Case, alum.	4V1152 08012
4	Yoke	
	Size 20, alum.	3N4480 08022
	Size 32, cast iron	
	Standard	2R1796 19042
	Lower boss tapped	3R8080 19042
5	Stem Nut, Cr pl 416 SST	
	W/o handwheel or adj travel stop	
	Size 20	
	1/4" (6.4 mm) stem	1V1153 46322
	5/16" (8.0 mm) stem	1V1154 46322
	3/8" (9.5 mm) stem	1V1155 46322
	Size 32	1V1182 46322
	W/handwheel	
	Size 20	
	1/4" (6.4 mm) stem	
	Type 513	1V1154 46322
	Type 513R	1V1153 46322
	5/16" (8.0 mm) stem	1V1154 46322
	3/8" (9.5 mm) stem	1V1155 46322
	Size 32	
	Type 513	1V1155 46322
	Type 513R	1V1182 46322
	W/adj travel stop	
	Size 20	
	1/4" (6.4 mm) stem	
	Type 513	1V1155 46322
	Type 513R	1V1153 46322
	5/16" (8.0 mm) stem	
	Type 513	1V1155 46322
	Type 513R	1V1154 46322
	3/8" (9.5 mm) stem	1V1155 46322
	Size 32	1V1182 46322
6*	O-Ring, nitrile	1V1156 06992
7*	O-Ring, nitrile	1V1157 06992
8	Bushing, brass	1V1158 14012
9*	Gasket, asb	1N4486 04022
10	Bushing Retainer, alum.	1V1159 09012
11	Plate, Cd pl steel	1N4489 25072
12	Diaphragm Plate, alum.	2V1160 08012
13	Actuator Rod, Zn pl steel	
	W/o handwheel or adj travel stop	
	Size 20	
	1/4" (6.4 mm) stem	1V1161 24272
	5/16" (8.0 mm) stem	1V1162 24272
	3/8" (9.5 mm) stem	1V1163 24272
	Size 32	1V1183 24272
	W/handwheel	
	Size 20	
	1/4" (6.4 mm) stem	
	Type 513	1V1161 24272
	Type 513R	1V1162 24272
	5/16" (8.0 mm) stem	1V1162 24272
	3/8" (9.5 mm) stem	1V1163 24272
	Size 32	
	Type 513	1V1183 24272
	Type 513R	1V1163 24272
	W/adj travel stop	
	Size 20	
	1/4" (6.4 mm) stem	
	Type 513	1V1161 24272
	Type 513R	1V1163 24272
	5/16" (8.0 mm) stem	
	Type 513	1V1162 24272
	Type 513R	1V1163 24272
	3/8" (9.5 mm) stem	1V1163 24272
	Size 32	1V1183 24272
14	Spring—See following table	
15	Spring Seat, alum.	2V1165 08012
16	Spring Adjustor, Cd pl steel	1N4495 24102
17	Thrust Washer, SST	1N4496 36012
18	Actuator Cap	
	W/o handwheel or adj travel stop	
	Size 20	
	Steel	2N4497 28992
	Size 32	
	Cast iron	1P8710 19042
	W/adj travel stop	
	Cast iron	1P8710 19042
19	Indicator Plate, SST	
	1/4" (6.4 mm) travel	1N4498 38992
	3/8" (9.5 mm) travel	1N4499 38992
	7/16" (11.1 mm) travel	1N4500 38992
	5/8" (15.9 mm) travel	1N4501 38992
	3/4" (19.1 mm) travel	1N4502 38982

*Recommended spare part.
†Trademark of Du Pont Co.

Type 513

Key	Description	Part Number
20	Indicator Disc, SST	
	Size 20	1A3704 36102
	Size 32	1E7931 38992
21	Travel Stop, steel	
	1/4" (6.4 mm) travel	1V1166 26012
	3/8" (9.5 mm) travel	1V1167 26012
	7/16" (11.1 mm) travel	1V1168 26012
	5/8" (15.9 mm) travel	1V1169 26012
	3/4" (19.1 mm) travel	1N4505 26012
22	Cap Screw, pl steel (4 req'd)	
	W/o handwheel or adj travel stop	
	Size 20	1J8302 28992
	Size 32	1C6312 24052
	W/adj travel stop	1C6312 24052
23	Machine Screw, pl steel (4 req'd)	1A3816 24052
24	Machine Screw, pl steel (8 req'd)	1A8349 28992
25	Machine Screw, pl steel (4 req'd)	1A3406 28982
26	Machine Screw, pl steel	
	Size 20	1A3319 28982
26	Self-Tapping Screw, SST (2 req'd)	
	Size 32	1E7932 38992
27	Set Screw, Cd pl steel	1N4508 28982
28	Washer, SST	
	Size 20	
	1/4" (6.4 mm) stem	1C8454 35032
	5/16" (8.0 mm) stem	1F1282 36012
29	Nameplate, SST	1L4115 38982
30	Drive Screw, SST (4 req'd)	1A3682 28982
31	Hex Nut, Cd pl steel (2 req'd)	
	1/4" (6.4 mm) stem	1P1313 24142
	5/16" (8.0 mm) stem	1R1605 24142
	3/8" (9.5 mm) stem	1P1312 24142
32	Stem Connector Ass'y	
	Size 32	1E7977 000A2
33	Twin-Speed Nut, SST (not shown)	
	Size 32	1E7939 38992
34*	Dust Seal, Neoprene	1V1170 06992
62	Lubricant	1M1100 X0012

Handwheel

Key	Description	Part Number
23	Cap Screw, pl steel (4 req'd)	1A3816 24052
35	Handwheel Body, alum.	1N6863 07012
36	Handwheel Screw, 416 SST	1N6864 35132
37	Washer, 416 SST	1N6865 46172
38	Spring, Cd pl steel	1K6191 27012
39	Ball, SST	1H4851 38992
40	Handwheel, cast iron	1N6866 19042
41	Pin, 416 SST	1N6867 46172
42	Cap, pl steel	1N6868 28992
43	Cap Screw, pl steel	1B8480 24052
44	Lockwasher, pl steel	1C2256 28982
45	Guide Plate, Cd pl steel	1N6869 25072
46	Travel Bolt, 416 SST	
	1/4" & 5/16" (6.4 & 8.0 mm) stems	1V1184 46172
	3/8" (9.5 mm) stem	1N6870 46172
47	Machine Screw (4 req'd)	1B7839 28982
48	Handwheel Nut, brass	1N6871 14012
49*	Handwheel Gasket, cork	1N6872 04042
50	Handwheel Indicator, plastic	1N6873 06082
51	Machine Screw, pl steel (4 req'd)	1A9548 28992
52	Washer, steel (4 req'd)	1E8730 28992
53	Vent Ass'y	Y602-A12

Adjustable Travel Stop

Key	Description	Part Number
54	Cap Screw, SST	
	Size 20	1L9424 38982
54	Groove Pin, SST	
	Size 32	1P8218 38992
55	Adjustable Stop, Cd pl steel	1P8708 24102
56	Adjustable Guide, steel	
	Size 20	1P8711 24012
	Size 32	10A250 2X012
57	Plug, nylon	
	Size 20	1P8709 06162
	Size 32	10A249 9X012

Key 14 Spring, steel
(Total of 8 springs required for each actuator)

COMBINED COMPRESSION RATE		NO. REQ'D	PART NUMBER	COLOR CODE
lbf/in	N/mm			
200	35	8	1V1171 27052	Gray
240	42	8	1V1172 27202	Blue
265	46	6	1V1172 27202	Blue
		2	1V1173 27202	Red
340	60	8	1V1173 27202	Red
360	63	4	1V1172 27202	Blue
		4	1V1174 27052	Green
400	70	8	1V1177 27202	Natural
480	84	8	1V1174 27052	Green
500	88	6	1V1177 27202	Natural
		2	1V1181 27202	Black
630	110	6	1V1180 27202	Orange
		2	1V1174 27052	Green
680	119	8	1V1180 27202	Orange
800	140	8	1V1181 27202	Black
960	168	8	1V1175 27202	Lt. Blue
1184	207	8	1V1179 27052	Pink
1376	241	8	1V1178 27202	Yellow
1624	284	8	1V1176 27052	Brown

*Recommended spare part.

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Fisher Controls Company

Specifications are subject to change
Metric equivalents of English units are shown in parentheses and are in millimeters unless otherwise noted.

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FISHER Controls

Instruction Manual

Designs B and BA Valve Bodies

Form 1978, December 1975

SCOPE OF MANUAL

This manual describes the Designs B and BA control valve bodies and provides instructions for their installation and maintenance, plus parts listings for commonly-used constructions. Although these bodies usually are each shipped with an installed actuator as part of a control valve assembly, actuator instructions and parts listings will be found in a separate instruction manual.

PRODUCT DESCRIPTION

The Designs B and BA both consist of screwed- or socket-weld-end bar stock bodies with unbalanced stem-guided valve plugs, screwed-in seat rings, metal seats, and push-down-to-close valve plug actions. The Design B globe body has a bolted bonnet and the Design BA angle body has a screwed bonnet. Both bodies come in 1/2-inch screwed and 3/4 and 1-inch screwed and socket-weld sizes. The Design B also is available in a 1/2-inch socket-weld size.

These bodies are suitable for either throttling or on-off control. They are designed for both general and corrosive service, and the Design BA additionally is useful in angle piping or any other application where a self-draining body is required.

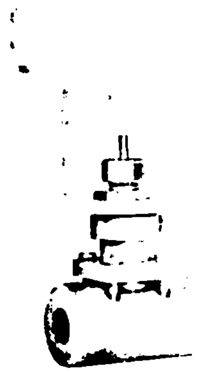


Figure 1. Design B Body with Type 513R Actuator

INSTALLATION

WARNING

Personal injury or damage to the process system may result if either the maximum temperature rating of 450°F or the maximum pressure rating of 1500 psig is exceeded.

Before installing the valve body, inspect it for any shipment damage and any foreign material that may have collected during crating and shipment. Make certain the body interior is clean, that pipelines are blown out, and that the valve is installed so that pipeline flow is in the same direction as the arrow on the side of the body. Be sure to allow enough room around the control valve assembly for removal and installation of actuator and trim.

Although Design B and BA valve bodies may be mounted with the actuator in any position relative to the body, the normal orientation is with the body in a horizontal run of pipe and the actuator vertical above the body. The actuator should be supported in any position other than vertical. Install the valve according to good piping and/or welding practices. Make sure the male pipe threads on a screwed-end body are sharp, and use a good grade of pipe compound on them.

Install a three-valve bypass around the body if continuous operation will be required during maintenance. If the actuator is separated from the body, install the actuator and make up the stem connection according to the appropriate actuator instruction manual.

MAINTENANCE

WARNING

To avoid personal injury and damage to the process system, isolate the control valve from the system and release all pressure from the valve body and actuator before beginning disassembly.

Note

Part key numbers and references are in figure 2. Proceed through the following **Disassembly** and **Assembly** sequences only as far as necessary to complete the maintenance required.

Disassembly

1. With the valve plug slightly off the seat, disconnect the actuator valve stem connection. On 2-1/8-inch yoke boss constructions, also remove the two packing flange nuts (key 20).

2. Remove the packing nut or flange (key 5), yoke locknut (key 27), actuator, actuator travel indicator, and actuator stem nuts. On the Design B, also remove the four cap screws (key 12).

3. Remove the bonnet flange (key 10), bonnet (key 3), split or snap ring (key 13), and body gasket (key 6). Remove the valve plug and stem (key 2) and guide bushing (key 7) from the bonnet. On 2-1/8-inch yoke boss constructions, also remove the wiper (key 28).

CAUTION

Do not use the valve stem to push packing parts out of the bonnet in the following step, as the metal packing parts can damage the stem threads.

4. Remove the packing follower (key 8). Using care to avoid scratching the inside of the bonnet, pull the other packing parts out with a hooked wire or similar tool. An alternative method is to push the packing parts out with a rod inserted through the other end of the bonnet.

5. Clean out the inside of the bonnet and all metal parts—packing follower (key 8), washer (key 18), and spring (key 17).

6. To obtain better shutoff, grind the valve plug and seat ring (key 4). The valve plug and stem may be converted into a grinding tool by attachment to the stem of a makeshift handle, such as a piece of strap iron secured by nuts. Use a commerical grinding compound and solidified vegetable oil. Apply white lead to the seating surfaces to prevent excessive cutting or tearing during grinding. To help align the valve plug and seat ring properly during grinding, the body must be completely assembled according to the **Assembly** section below, the gasket in place, and the bonnet installed in the same orientation as when removed. After grinding, again remove the bonnet and trim according to steps 1 through 5 above, clean the seating surfaces, reassemble, and test for shutoff. Repeat this grinding procedure if leakage is still excessive.

7. If necessary to replace the seat ring, unscrew it from the body (key 1) with a suitable seat ring puller.

Assembly

1. Install a new seat ring if necessary.

2. Install the guide bushing and valve plug and stem in the bonnet. Install a new body gasket, the split or snap ring, bonnet, and bonnet flange. On the Design B, also install the four cap screws.

3. Slide the following packing parts down over the valve stem, being careful not to damage the packing on the stem

threads: spring (key 17), washer (key 18), male adaptor (key 9B), three V-rings (key 9C), female adaptor (key 9A), and packing follower (key 8). On 2-1/8-inch yoke boss constructions, also install the wiper (key 28).

4. With the yoke locknut and packing nut or flange held in position on the actuator yoke boss, mount the actuator down on the bonnet boss. Secure the actuator with the yoke locknut and packing nut or flange. On 2-1/8-inch yoke boss constructions, also install the two packing flange nuts.

5. Make up the stem connection according to the appropriate actuator instruction manual.

ORDERING INFORMATION

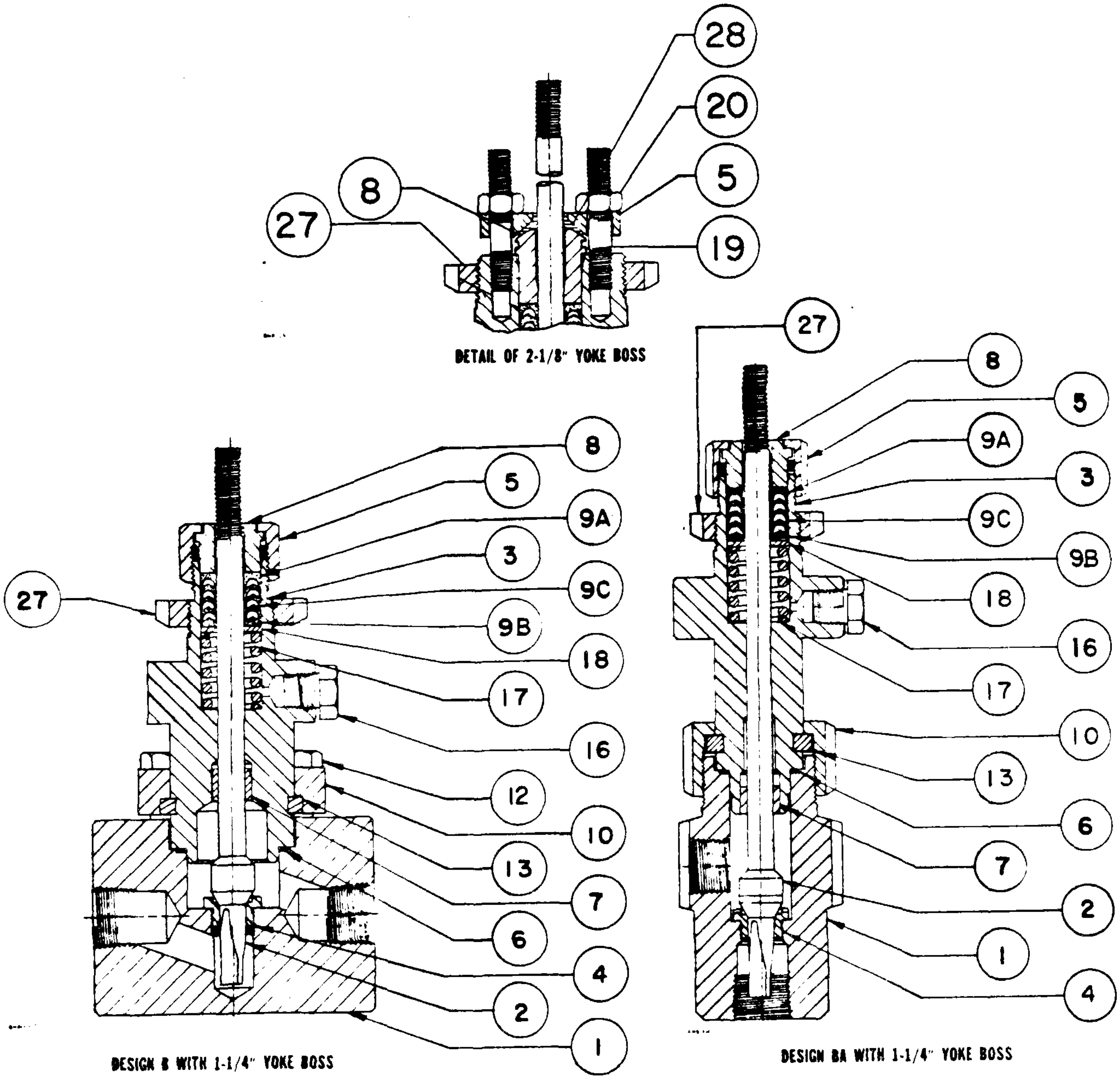
Each valve body is assigned a serial number which can be found on the body. This same number also appears on the actuator nameplate when the body is shipped from the factory as part of a control valve assembly. Refer to the number when contacting your Fisher representative for technical assistance, or when ordering replacement parts.

When ordering a replacement part, be sure to include the 11-character part number from the following parts list.

PARTS LIST (figure 2)

Key	Description	Part Number
1	Valve Body	See following table
2*	Valve Plug & Stem	See following table
3	Bonnet	
	Design B	
	Steel	
	1-1/4" yoke boss	2J8776 24092
	2-1/8" yoke boss	2K4831 24092
	316 SST	
	1-1/4" yoke boss	2J8776 35072
	2-1/8" yoke boss	2K4831 35072
	Design BA	
	Steel	
	1-1/4" yoke boss	
	1/2" body size	1J8950 24092
	3/4" body size	1J8949 24092
	1" body size	1J8948 24092
	2-1/8" yoke boss	
	1/2" body size	2N2469 X0012
	3/4" body size	2P3152 24492
	1" body size	2U5477 X0012
	316 SST	
	1-1/4" yoke boss	
	1/2" body size	1J8950 35072
	3/4" body size	1J8949 35072
	1" body size	1J8948 35072
	2-1/8" yoke boss	
	1/2" body size	2N2469 X0022
	3/4" body size	2P3152 X0012
	1" body size	2U5477 X0022
4*	Seat Ring	
	316 SST	
	1/2" body size	
	1/4" port	1H7302 35072
	3/8" port	1H7303 35072
	3/4" body size	
	1/4" port	1H7557 35072
	3/8" port	1H7558 35072
	1/2" port	1H7556 35072
4*	Seat Ring (Continued)	
	1" body size	
	1/4" port	1H7559 35072
	3/8" port	1H7560 35072
	1/2" port	1H7561 35072
	3/4" port	0A0331 35072
	316 SST/Alloy 6 Seat	
	1/2" body size	
	1/4" port	1J7822 46052
	3/8" port	1K7215 46052
	3/4" body size	
	1/4" port	1K2560 46052
	3/8" port	1K2593 46052
	1/2" port	1K9789 46052
	1" body size	
	1/4" port	1K4879 46052
	3/8" port	1K5564 46052
	1/2" port	1K9500 46052
	3/4" port	1N9890 46052
5	Packing Nut (1-1/4" yoke boss only), Steel, Cd pl	0P0776 24102
5	Packing Flange (2-1/8" yoke boss only), Steel, Cd pl	1E9437 24102
6*	Body Gasket, TFE	
	Design B	1J1741 06242
	Design BA	
	1/2" body size	1J1739 06242
	3/4" body size	1J1740 06242
	1" body size	1J1741 06242
7	Guide Bushing, 17-4PH SST	1H5879 35012
8	Packing Follower, 316 SST	
	1-1/4" yoke boss	1K8850 35072
	2-1/8" yoke boss	1E9439 35072
9A*	Packing Female Adaptor, TFE	1F1244 01012
9B*	Packing Male Adaptor, TFE	1F1248 01012
9C*	Packing V-Ring, TFE (3 req'd)	1C7526 01012
10	Bonnet Flange	
	Design B	
	Steel	1H7901 24502
	316 SST	1H7901 36042
	Design BA	
	Steel	
	1/2" body size	1H7577 24102
	3/4" body size	1H7897 24502
	1" body size	1H7894 24102
	316 SST	
	1/2" body size	1H7577 35072
	3/4" body size	1H7897 35072
	1" body size	1H7894 35072
12	Cap Screw, Design B only (4 req'd)	
	Steel	1A3445 24052
	316 SST	1A3445 X0012
13	Split Ring (except 1/2" & 3/4" Design BA)	
	Steel	1H7902 24102
	316 SST	1H7902 35072
13	Snap Ring	
	1/2" Design BA	
	Steel	1H7899 24102
	316 SST	1H7899 35072
	3/4" Design BA	
	Steel	1H7896 24102
	316 SST	1H7896 35072
16	Pipe Plug	
	Steel	1A7675 24662
	316 SST	1A7675 35072
17	Spring, 316 SST	1F1254 37012
18	Washer, 316 SST	1F1252 36042
19	Packing Flange Stud (2-1/8" yoke boss only), steel, Cd pl (2 req'd)	1E9441 31032
20	Packing Flange Nut (2-1/8" yoke boss only), steel, Cd pl (2 req'd)	1E9440 24112
27	Yoke Locknut	
	1-1/4" yoke boss, brass	1U7971 14012
	2-1/8" yoke boss, steel	1E7930 23062
28	Wiper (2-1/8" yoke boss only), Felt	1J8726 06332

*Recommended spare part



DETAIL OF 2-1/8" YOKE BOSS

DESIGN B WITH 1-1/4" YOKE BOSS

DESIGN BA WITH 1-1/4" YOKE BOSS

Figure 2. Body Constructions with Single TFE V-Ring Packing

Key 1, Valve Body

BODY SIZE (INCHES)		DESIGN B		DESIGN BA	
		WCB Steel	316 SST	WCB Steel	316 SST
1/2	NPT	2J1732 24092	2J1732 35072	1J1729 24492	1J1729 35072
	SWE	2J6494 24092	2J6494 35072	. . .	. . .
3/4	NPT	2J1733 24092	2J1733 35072	1J1730 24092	1J1730 35072
	SWE	2J9980 24492	2J9980 35072	1J3390 X0012	1J3390 X0022
1	NPT	2J1734 24092	2J1734 35072	1J1731 24092	1J1731 35072
	SWE	2J5774 24492	2J5774 35072	1J9817 X0012	1J9817 X0022

TRANSDUCER ACCESSORIES

21000 Proximity Probe and Housing Assembly

The model 21000 Housing Assembly is a unit incorporating an integral, threaded adaptor/junction box housing and may be ordered with or without a proximity probe (option A).

The 21000 Housing accommodates both the standard and Tonox versions of the 190, 300 & 7200 (5 mm) Probe Series, option A. (Tonox probes are designed to be used in high pH - basic - environments, e.g., ammonia syn-gas trains.)

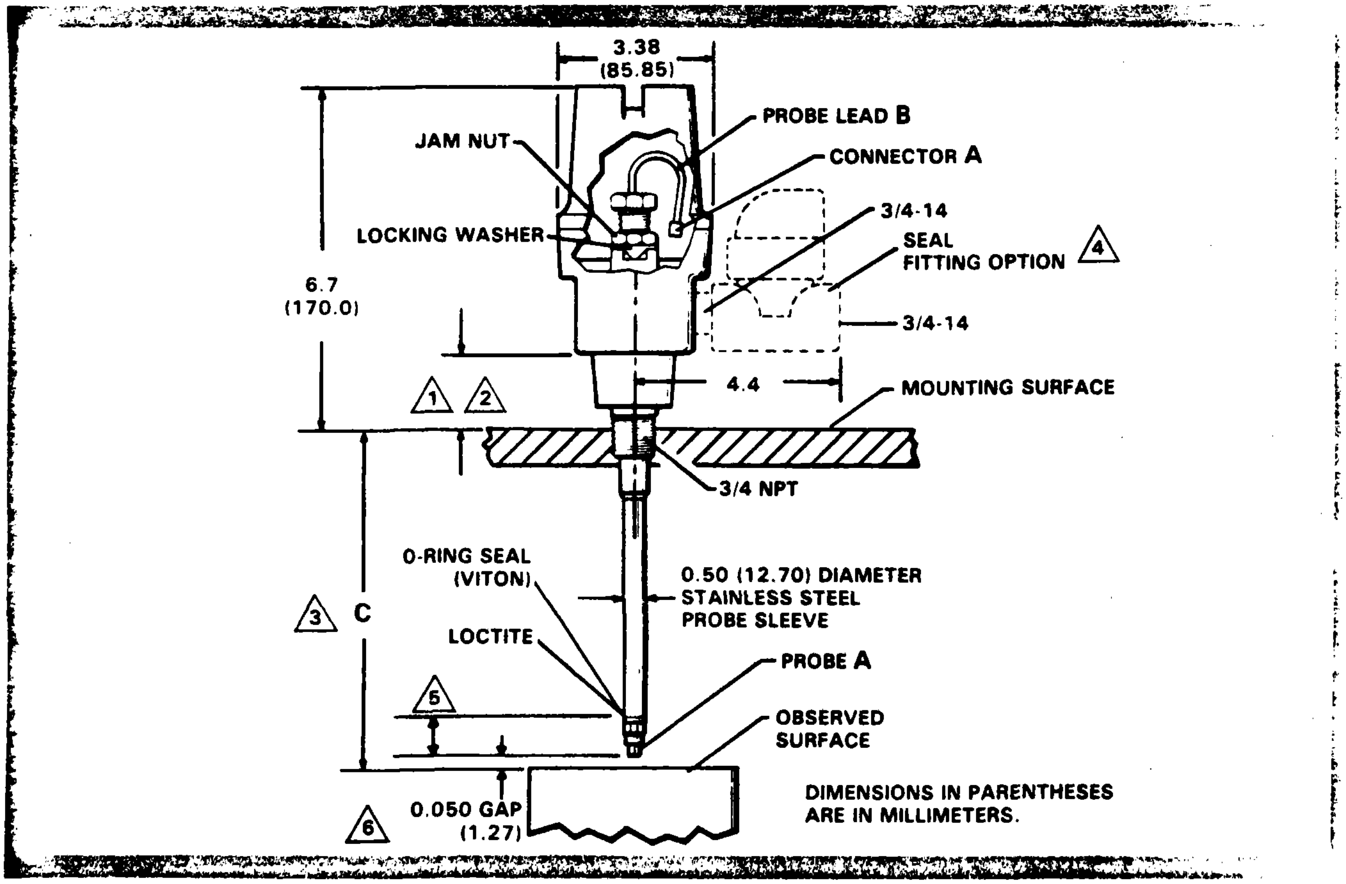
190 and 300 Probes can be ordered with lead lengths (option B) from a minimum of 12 inches to a maximum of 36 inches in increments of 6.0 inches. 7200 Probes (option B) can be ordered in either the 0.5 meter or 1.0 meter lengths.

Probe sleeve lengths (option C) are determined by probe lead length selections. Note table provided with C Dim and restrictions.

Option D allows a choice of fittings or no fittings, as required.

The 21001 Housing (page 5-1) is offered in three standard sleeve lengths, but without the probe and seal fitting options. This allows the customer to custom fit the 21001 to a desired length by cutting off the end. An O-ring seal is provided for NEMA 4 water tight requirements.

The 21000 and 21001 Assemblies provide advantages including: (1) compact housing; (2) O-ring seal around the probe sleeve to prevent fluids entering the housing under normally encountered pressure differentials, and an O-ring seal under the dome cover to provide water tight seal; (3) ease of adjustment with no offset wrenches required; and (4) standoff adaptors available to raise housing from machine case when required for clearance purposes.



DIMENSIONS IN PARENTHESES ARE IN MILLIMETERS.

△1 Adaptors are available if increased standoff dimensions are required (Dwg. 21002).

△2 Dimension is dependent on pipe thread engagement and should not be used in calculations for positioning of probe. To insure accuracy, dimension must be physically measured during installations of this unit.

△3 Dimension represents mid-setting distance between mounting surface and target surface. Threaded sleeve allows ±0.50 (12.70) adjustment from this point.

△4 Seal fitting option is supplied in kit form and is not installed by Bently Nevada.

△5 Dimension is 0.55 (13.97) for 190 Probe, 0.60 (15.24) for 300 & 7200 (5 mm) Probes and 1.20 (30.5) for 7200 (11 mm) Probe.

△6 Dimension is for reference only. Actual dimension is determined by probe used with assembly at time of unit installation.

ORDERING INFORMATION

BENTLY NEVADA
CATALOG NO.

21000 — A ☐☐ — B ☐☐ — C ☐☐☐ — D ☐☐

‡	PROBE TYPE	CONNECTOR TYPE
00	No Probe	
01	190-04 (FBG) (190)	BNPS
02	190-04 (FBG) (190)	Miniature Coaxial
03	300-04 (FBG) (300)	BNPS
04	300-04 (FBG) (300)	Miniature Coaxial
05	21508 (FBG) (5 mm)	Miniature Coaxial
06	29776 (FBG) (11 mm)	Miniature Coaxial
07	28411 (TNX) (300)	Miniature Coaxial
08	28411 (TNX) (300)	BNPS
09	28402 (TNX) (190)	Miniature Coaxial
10	28402 (TNX) (190)	BNPS
11	28424 (TNX) (5 mm)	Miniature Coaxial

PROBE CABLE LENGTH

3000 SERIES, TYPES 190 & 300

Increments of 6 inches
Min. length: 12 inches
Max. length: 36 inches
Example:

1 2 = 12 inches

3 0 = 30 inches

7200 SERIES 5 mm or 11 mm	
05	0.5 m
10	1.0 m
00	No Probe

PROBE PENETRATION

Increments of 0.1 inch
Min. length: 2.0 inches
Max. length: See chart below
NOTE: Lengths greater than 12.0 inches require additional sleeve support.

PROBE CABLE LENGTH	RECOMMENDED "C" DIMENSION MAXIMUM
12 Inches	5.0 Inches
18 Inches	10.5 Inches
24 Inches	16.1 Inches
30 Inches	21.7 Inches
36 Inches	27.3 Inches
0.5 Meter	11.5 Inches
1.0 Meter	29.2 Inches

‡	FITTING OPTION KIT
00	No fitting required
01	One explosion proof 3/4 NPT fitting; one 3/4 NPT plug
02	Two explosion proof 3/4 NPT fittings
03	One 3/4 NPT plug; one 3/4 to 1/2 NPT reducer; and one cable seal grip with grommets for cable sizes: 1/8 to 3/16, 1/4 to 5/16, & 5/16 to 3/8
04	One 3/4 NPT plug only

‡ Denotes option code

BENTLY
NEVADA
P.O. Box 157 • Minden, Nevada 89423 • (702) 782-2255 or 782-3811 • Telex: 354437

21000 RELATIVE PROBE ASSEMBLY -- INSTRUCTION SHEET

GENERAL The 21000 Relative Probe Assembly consists of a proximity probe and the coaxial cable contained in an explosion proof-weatherproof housing. Also included are a probe sleeve jam nut, lockwasher, and "O" rings. The probe senses machine shaft motion relative to the machine case. Wiring between the housing and proximitor may be routed through conduit. Refer to the Probe and Proximitor Operation and Maintenance Manual TW8019610 for a functional description of the probe and proximitor.

INSTALLATION Refer to Figure 1 for installation information.

WARNING

A probe assembly having a long sleeve may require support at the probe end to prevent excessive vibration.

a. Unscrew dome cover from housing, loosen sleeve jam nut, and unscrew the sleeve with locking washer and jam nut, being careful to turn the probe cable with the sleeve to prevent cable damage.

b. Do not remove probe from sleeve unless the probe is to be replaced. See Probe Replacement for correct procedures.

c. Apply anti-seize thread compound to all 3/4-14 NPT threads.

d. Install housing (or housing with adapter) into machine case.

e. Install conduit (or optional explosion proof fittings) to 3/4-14 NPT conduit connections in housing, (install conduit hole plugs in any unused conduit hole). Install extension cable through conduit, but do not connect to probe cable at this time.

f. With machine shaft stopped, carefully hand turn the sleeve (with probe, locking washer, and jam nut) into the housing (see Figure 1). Allow the probe cable to turn with the sleeve to prevent cable damage. Do not allow probe tip to accumulate any thread compound or foreign conductive material during installation because signal distortion may result. Adjust gap in accordance with BNC Probe and Proximitor Manual TW8019610.

g. Secure the sleeve in correct probe gap position with jam nut. Bend tongs of locking washer to secure nut.

h. Connect the probe cable to extension cable. Apply a double wrapping of Teflon tape or a coating of encapsulating compound around the connection to prevent entry of contaminants.

i. Install the dome cover to housing.

PROBE REPLACEMENT In order to replace the proximity probe, perform the following:

a. Unscrew dome cover from housing, remove tape or encapsulant from probe connector and separate the connection; bend tab on locking washer, loosen jam nut, and unscrew sleeve, being careful to turn probe cable with sleeve to prevent cable damage.

AUG. 1976

b. Unscrew probe from sleeve (turn probe cable with probe) and remove probe. If necessary, heat the probe thread area of the sleeve to soften the thread locking compound (T_{max}= 400°F).

c. Install "O" ring on replacement probe, insert probe cable into sleeve, apply Lockquic primer T and Loctite No. 40 retaining compound to probe threads in accordance with their instructions and thread probe into sleeve until "O" ring contacts sleeve. Continue tightening probe 1/2 to 3/4 turn.

d. Complete installation using Steps e through h of Installation paragraph.

RELATIVE PROBE KIT The 21001 Relative Probe Kit consists of a weatherproof housing, dome cover, "O" rings, lock washer, jam nut, and a probe sleeve. The unit is supplied as a kit and the sleeve must be cut to correct length and tapped (see drawing 21001) before probe can be mounted. After probe is installed (see Replacement, Steps c and d) unit can be considered the same as a 21000 and General, Installation, and Replacement paragraphs would apply.

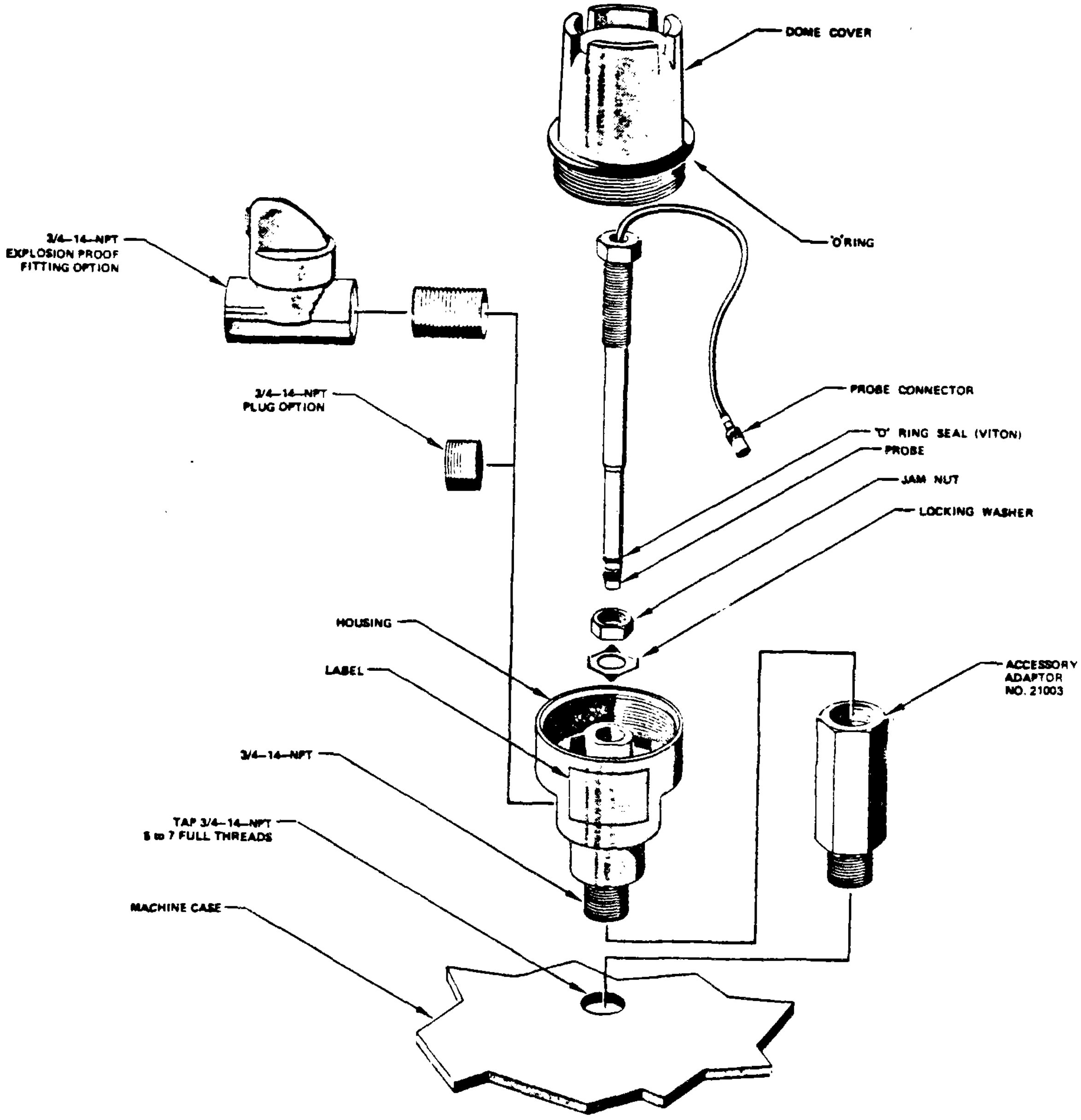


Figure 1

APPENDIX A
OPERATION AND MAINTENANCE MANUAL

7000 SERIES
PROBE AND PROXIMITOR

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A-II INSTALLATION

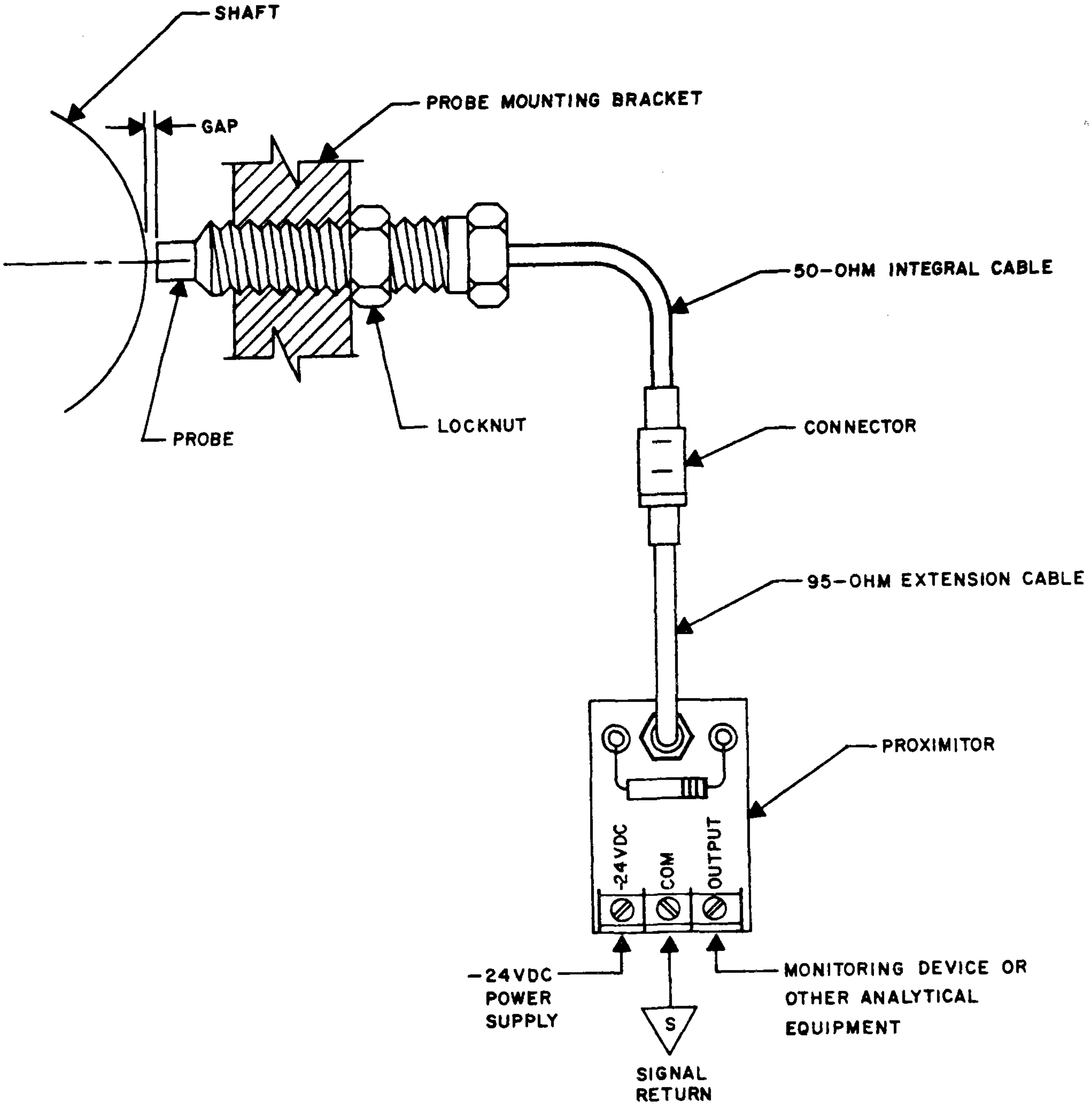


Figure A1-1. 7000 Series Probe and Proximitor Combination

SECTION A-I

GENERAL INFORMATION

A1-1 GENERAL

A1-2 This manual contains four sections that cover the Bently Nevada Corporation 7000 Series Probe and Proximitor combination. Section A-I contains a general description of the manual, general physical and functional descriptions of the equipment, description of the available options, definition of the non-standard terms used in this manual, and specifications for electrical, mechanical, and environmental. Section A-II contains receiving inspection, power and signal connections, proximitor installation, probe installation, and initial gap procedures. Section A-III contains calibration check procedures. Section A-IV contains a list of the replaceable parts.

A1-3 PHYSICAL DESCRIPTION

A1-4 The 7000 Series Probe and Proximitor system consists of three separate items; a Type 300 Probe, with 50-ohm integral cable and connector, a 95-ohm coaxial extension cable, and a 7000 Series Proximitor as shown in Figure A1-1. These components are required to make proximity measurements. The field wiring descriptions between the proximitor output and the monitor device are covered in the applicable monitoring device manual.

A1-5 PROBE WITH 50-OHM INTEGRAL CABLE AND CONNECTOR

A1-6 The Type 300 Probe shown in Figure A1-2 is a typical probe used with monitoring systems. The probe is ordered by the user with a specific length of 50-ohm integral cable and connector, and a specific body type. When ordering the probe and cable, the total physical length is defined as the distance measured from the probe tip to the connector end. When compared with the 95-ohm coaxial extension cable, the electrical length of the probe 50-ohm integral cable is approximately double its physical length.

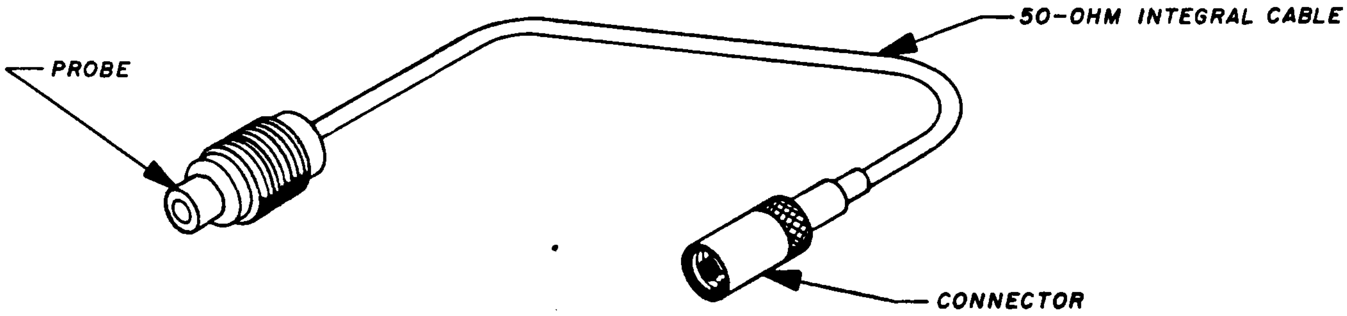


Figure A1-2. Type 300 Probe

A1-7 95-OHM EXTENSION CABLE

A1-8 The 95-ohm extension cable shown in Figure A1-3 is used to connect the probe with the proximitor with a specific matched electrical length of cable. When ordering the extension cable, the total physical length is approximately equal to the electrical length.

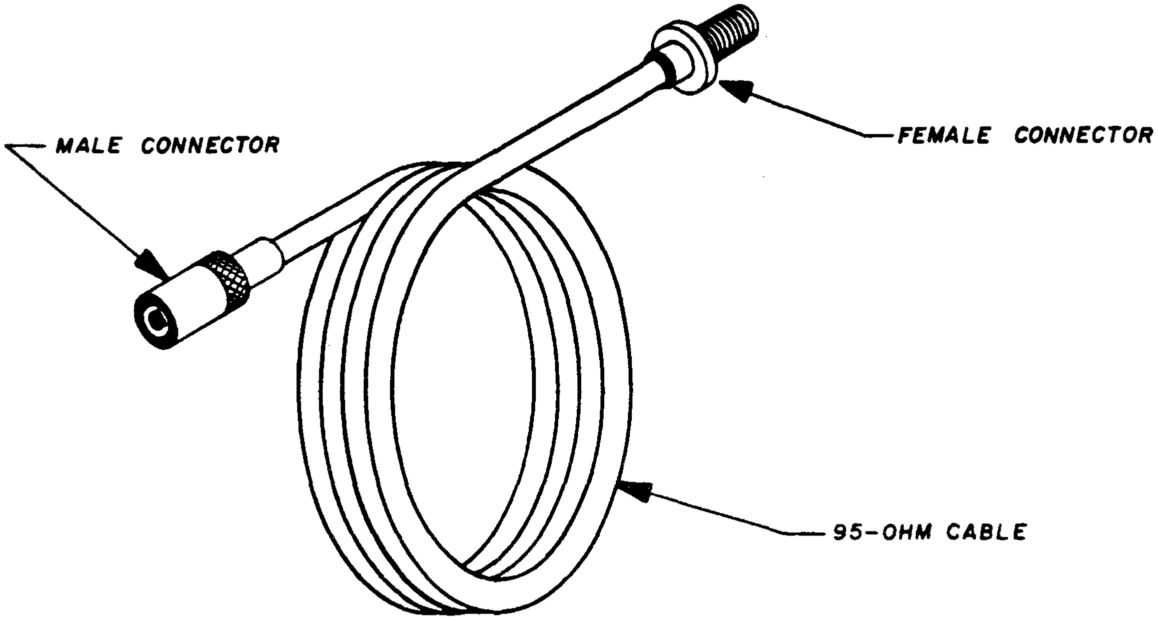


Figure A1-3. 95-ohm Extension Cable

A1-9 7000 SERIES PROXIMITOR

A1-10 The 7000 Series Proximitor shown in Figure A1-4 is used in conjunction with the Type 300 Probe and 95-ohm extension cable. The Proximitor catalog Number defines the case configuration, the total electrical length of the combined probe with 50-ohm integral cable and connector, and the 95-ohm coaxial extension cable, and the tip size of the probe used. The following shows the catalog numbers versus electrical cable length.

EXAMPLE:

CATALOG NO.	CABLE LENGTH (ELECTRICAL FEET)
C12237-01	15
C12237-02	20

A1-11 Part of the total length is the probe with 50-ohm integral cable and connector, and part is the 95-ohm coaxial extension cable. If the probe with 50-ohm integral cable and connector is 18 inches long (physical length), the total electrical length is approximately equal to 36 inches (3 feet). Using the first catalog number, the total electrical length, 15 feet minus 3 feet (50-ohm cable) equals 12 feet. This is the total electrical and approximate physical length of 95-ohm coaxial extension cable required to match the calibration of the example proximitor model number. The total physical length of this cable would be 1-1/2 feet (18 inches 50-ohm cable) plus approximately 12 feet (95-ohm cable), or approximately 13-1/2 feet.

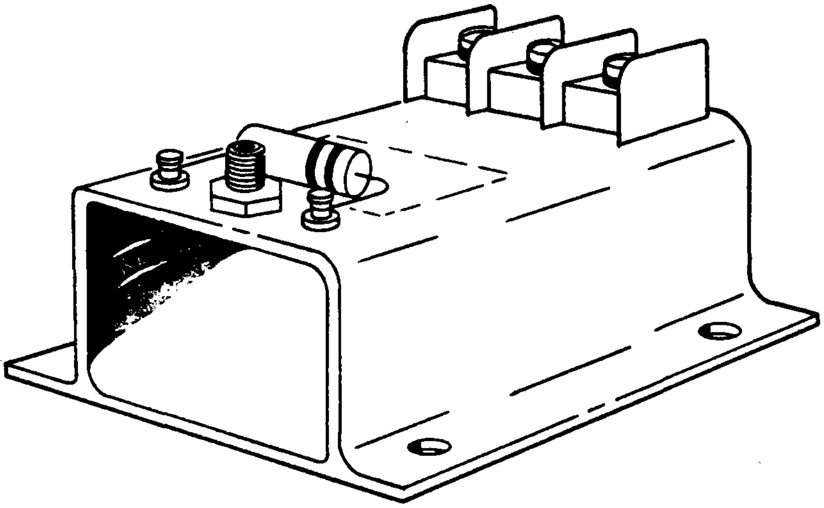


Figure A1-4. 7000 Series Proximitor

A1-12 FUNCTIONAL DESCRIPTION

A1-13 The functional operation can be divided into two distinct categories; gap measurement (initial gap setting and thrust or eccentricity measurements) and vibration measurement (varying gap measurement). The probe and proximitor covered by this manual are capable of both types of measurements without any modification. The monitoring device must be suited to the measurement application for the required readout.

A1-14 GAP MEASUREMENT

A1-15 The proximitor is normally driven by -24 volts from an external source, such as a power supply or monitoring device. The proximitor converts the dc drive voltage into an rf signal that is applied to the probe through the 95-ohm coaxial extension cable, as shown in Figure A1-5. The probe coil radiates the rf signal into the surrounding area as a magnetic field. If there is no conductive material within a specified distance to intercept the magnetic field, there is no power loss in the rf signal. With no power loss in the rf signal, the output signal at the proximitor OUTPUT terminal is maximum (approximately -16 volts). When a conductive material approaches the probe tip, eddy currents are generated on the surface of the material, resulting in a power loss in the rf signal. As a power loss is developed in the rf signal, the output signal at the proximitor OUTPUT terminal is reduced proportionately. As the observed conductive surface comes closer to the probe tip, more power is absorbed by the eddy currents on the surface of the material. When the gap reaches a specified minimum distance from the conductive material surface, the total rf energy radiated by the probe is absorbed by the material. This is reflected as a maximum power loss of the rf signal, resulting in a minimum dc output signal at the proximitor OUTPUT terminal. The proximitor measures the magnitude of the rf envelope, and provides a negative dc output signal proportional to the peaks of the envelope. Thrust measurements and eccentricity measurements are merely gap measurements at a slow rate of change in the gap.

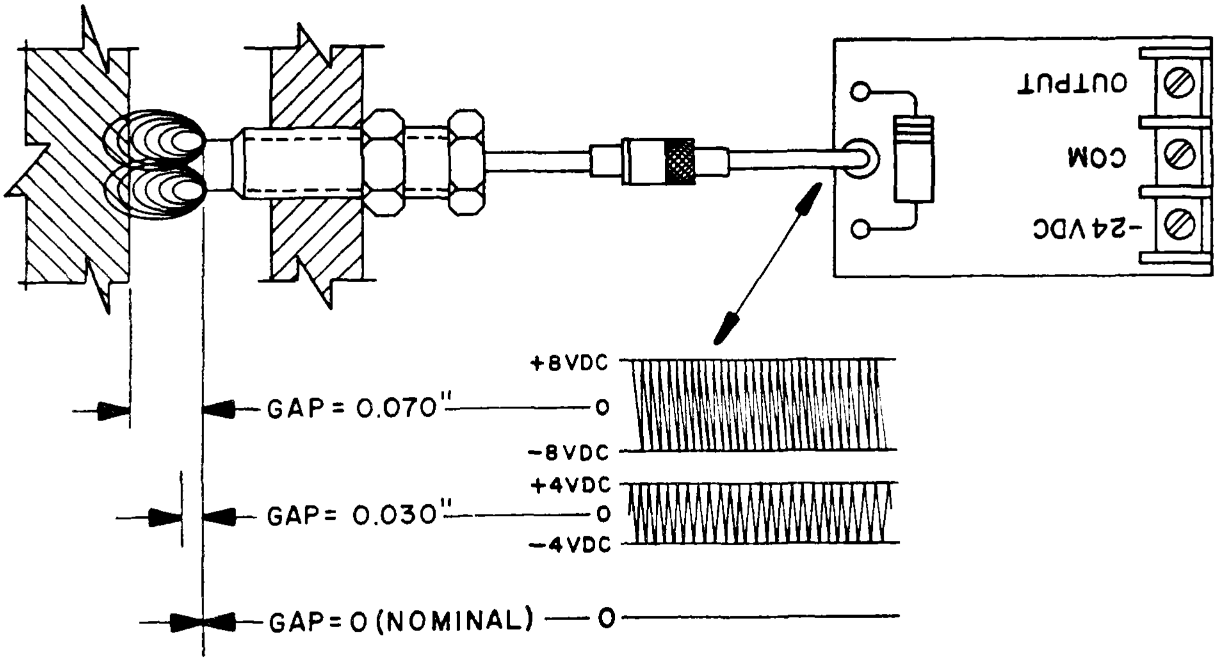


Figure A1-5. Gap Measurement Diagram

A1-16 VIBRATION MEASUREMENT

A1-17 If the observed surface is rotating and rapidly changing the gap distance, the rf envelope is not a constant amplitude, but varies in direct proportion to the peak-to-peak movement of the observed surface as shown in Figure A1-6. This peak-to-peak movement of the observed surface causes the rf envelope to be amplitude modulated.

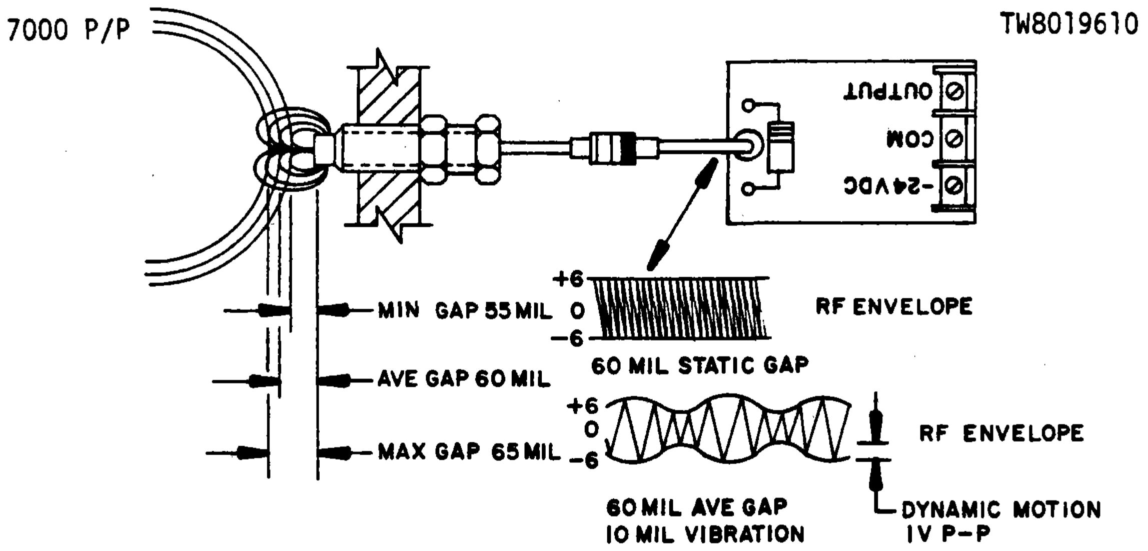


Figure A1-6. Dynamic Motion Measurement Diagram

A1-18 The proximitor detects the modulated rf envelope as an ac signal varying around a constant average dc voltage (initial probe gap setting), as shown in Figure A1-7.

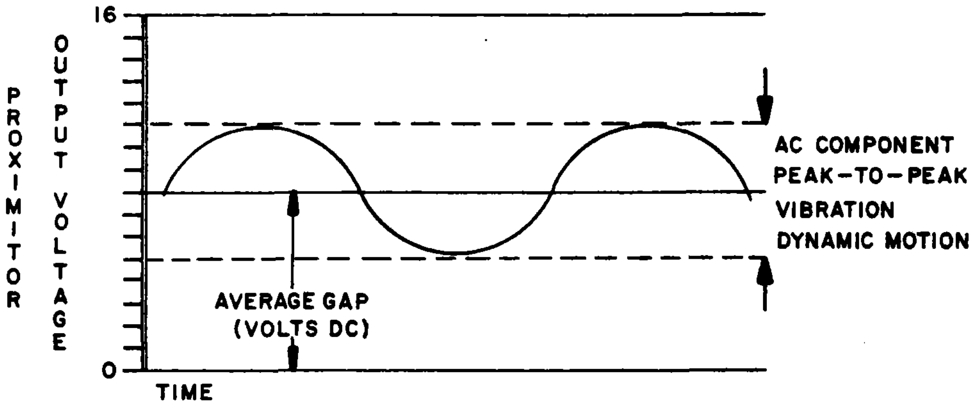


Figure A1-7. AC Component of Motion Measurement

A1-19 If the shaft vibration is 10-mils peak-to-peak, around an initial gap of 60 mils, the average dc voltage of approximately -6.9 volts remains constant, but the ac voltage is 1 volt peak-to-peak (-6.4 to -7.4 volts) in direct proportion to the shaft vibration (100 mv/mil scale factor), as shown in Figure A1-8. This is the process of radial vibration measurements, whether it is single plane or two plane (X-Y).

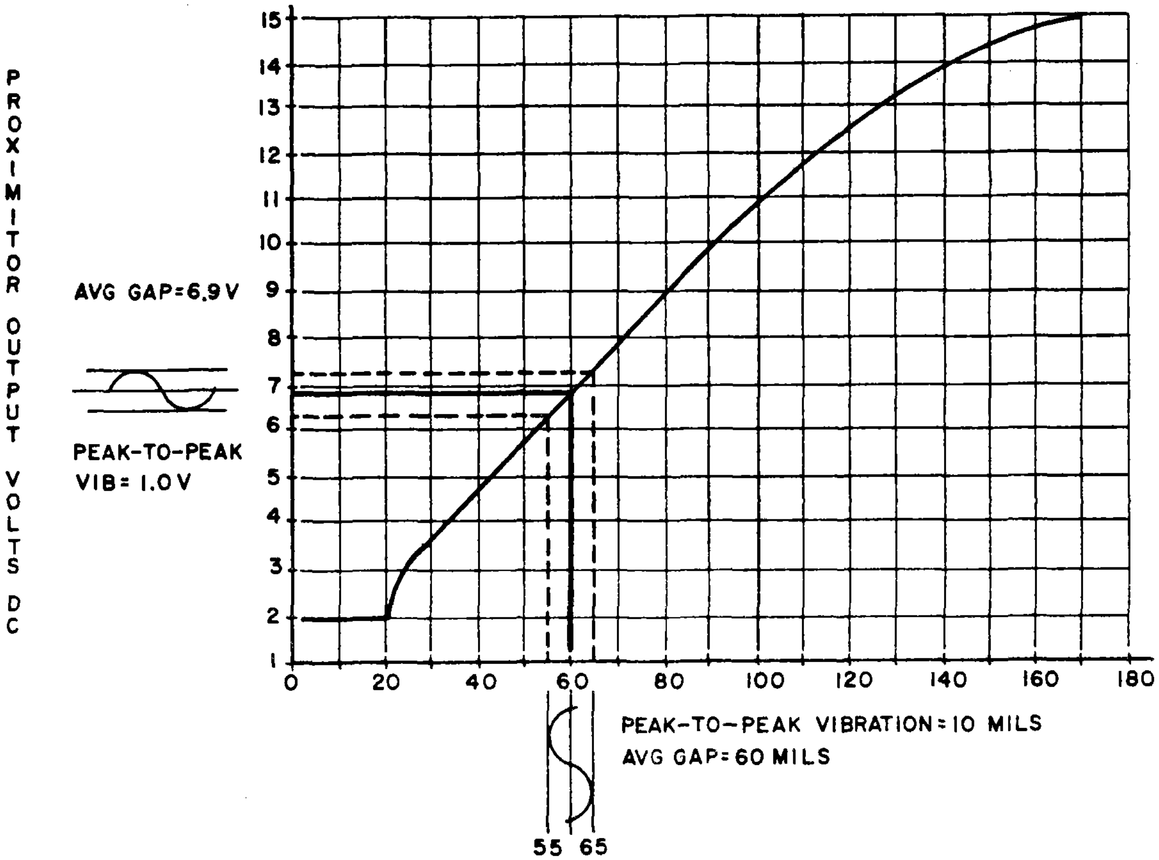


Figure A1-8. Gap Conversion in Mils to Volts

A1-20 DEFINITION OF TERMS

A1-21 The following terms are used throughout this manual and have the definitions noted for each. Any other definition of these terms does not apply to this manual.

PROBE - A proximity measurement device that radiates an rf field into a given area to allow non-contacting measurements of static and varying gaps. The probe in this manual is usually 0.300 inch in diameter.

7000 SERIES PROXIMITOR - A transducer and rf generating device that drives the probe and converts the probe gap information into a proportionally linear dc output voltage.

50-OHM INTEGRAL CABLE - A coaxial cable of specific length that is an integral part of the proximity probe. The cable is the main input/output connection for the probe.

95-OHM EXTENSION CABLE - A coaxial cable of specific length that interconnects the probe with 50-ohm integral cable and connector to the proximitor.

ELECTRICAL LENGTH - One electrical foot of cable has the same electrical characteristics at low radio frequencies as one physical foot of ideal 95-ohm coaxial cable.

PROBE CALIBRATION CURVE - A plotted curve of probe gap in mils versus proximitor output in dc voltage, that represents the linear operating range of the probe, extension cable, and proximitor. The plot also shows maximum and minimum operating limits, though not necessarily linear.

RECOMMENDED INITIAL GAP VOLTAGE - The point on the probe calibration curve that corresponds to the approximate center of the linear operating range. This point may also be expressed in mils, as translated from the probe calibration curve.

OBSERVED SURFACE - The surface from which the probe is gapped. This surface is also the surface being monitored for gap changes by the probe.

MECHANICAL RUNOUT - The physical probe-to-observed surface gap variation caused by physical surface imperfections and/or an eccentric shaft.

ELECTRICAL RUNOUT - The error signal read by the proximity system that is due to electrical imperfections in shaft surface caused by magnetism, non-uniform hardness, non-uniform composition, etc.

A1-22 SPECIFICATIONS

A1-23 The following specifications define the probe and proximitor electrical, environmental, and mechanical characteristics.

A1-24 PROBE

Electrical - Not applicable.

Environmental

Operating Temperature Range: -50° F to +350°F

Storage Temperature Range: -50° F to +350° F

Temperature Sensitivity: See graph, Figure A1-9

Pressure: Order P type probe for applications where probe is exposed to differential pressures. P type probe will withstand 500 psi differential pressure at 250° F

Humidity: 100% RH
If probe is to be submerged, order PG type. PG type will withstand submer-

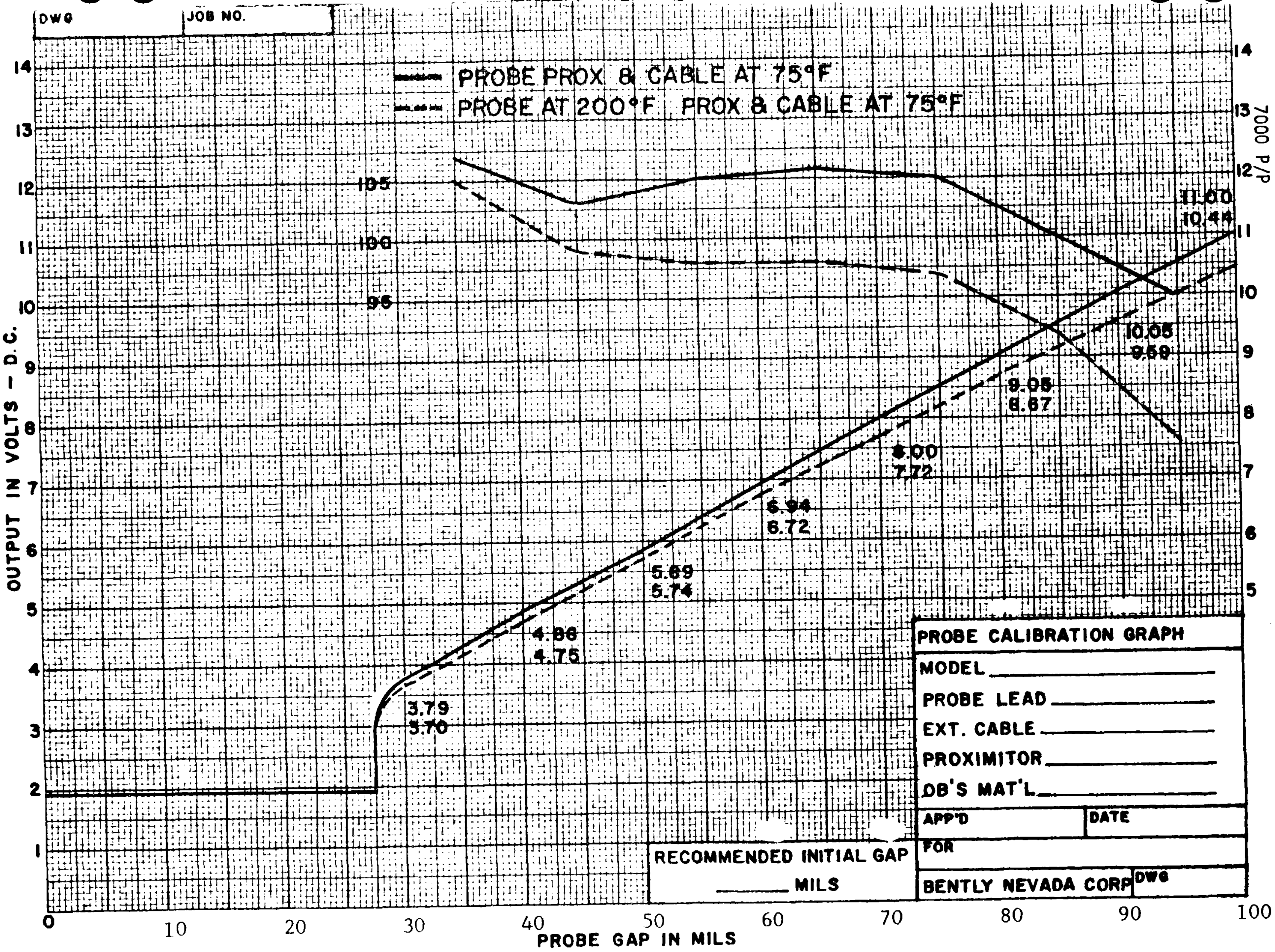


Fig 41-9. Probe Temperature Sensitivity Graph

sion of 500 psi at 350° F. A 100 mv shift occurs when gap medium is water instead of air

Corrosive Atmosphere: Generally atmospheres with a PH of less than 4 or more than 10 will damage the probe

Mechanical

Case Material: 300 Series Stainless steel

Tip Material: Epoxy resin with anhydride curing

Cable Material: Teflon jacket and dielectric

Connector Material: Body - stainless steel
Insulator - teflon

Tip Diameter: 0.300 inch

A1-25 PROXIMITOR

Electrical

Output: -2 vdc (0 gap) to approx -18 vdc (∞gap) at -24 vdc
-2 vdc (0 gap) to approx -17 vdc (∞gap) at -18 vdc
dc voltage proportional to average gap distance
ac voltage superimposed on dc gap voltage is proportional to vibration amplitude and frequency

Output Impedance: 50 ohms

Scale Factor: 100 mv/mil ±5% from 30 to 95 mils

Range: 65 mils of ±5% linearity

Frequency Response: 0 to 600,000 rpm

Resolution: 50 microinches

Power Requirements: Voltage - -18 to -30 vdc
-24 vdc normal operating range

Current - Maximum 25 ma
Typical 5 ma

Interchangeability Deviation: DC Output 2% maximum

0.5% typical

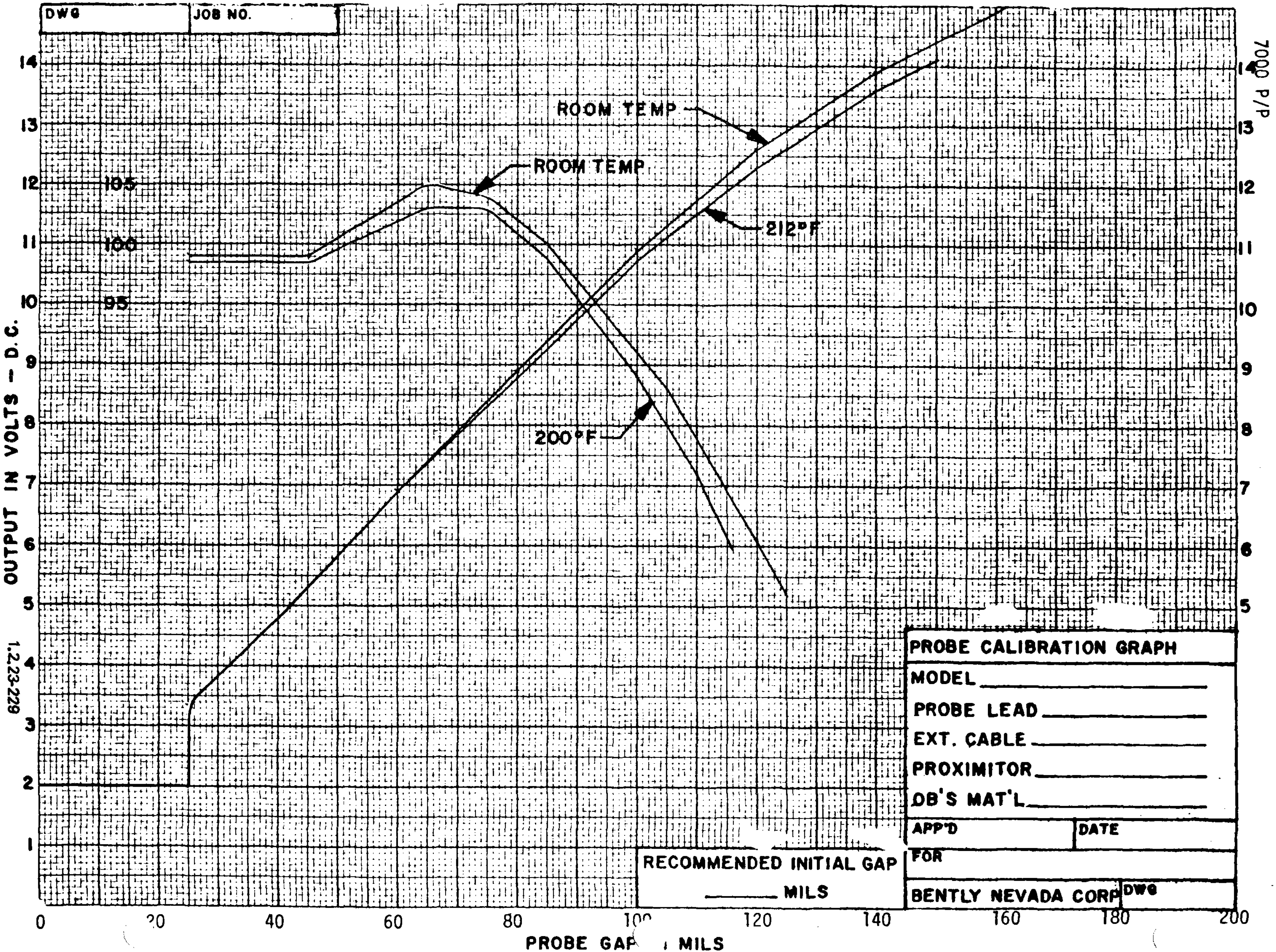


Figure A1-10. Proximitor Temperature Sensitivity Graph

Drift Due to Changes in Supply:	DC Output - maximum 16 mv change in output/ 1 volt change in supply typical 5 mv change in output/ 1 volt change in supply Slope - typical 0.01 mv/mil change in slope/ 1 volt change in supply maximum 0.50 mv/mil change in slope/ 1 volt change in supply

Environmental

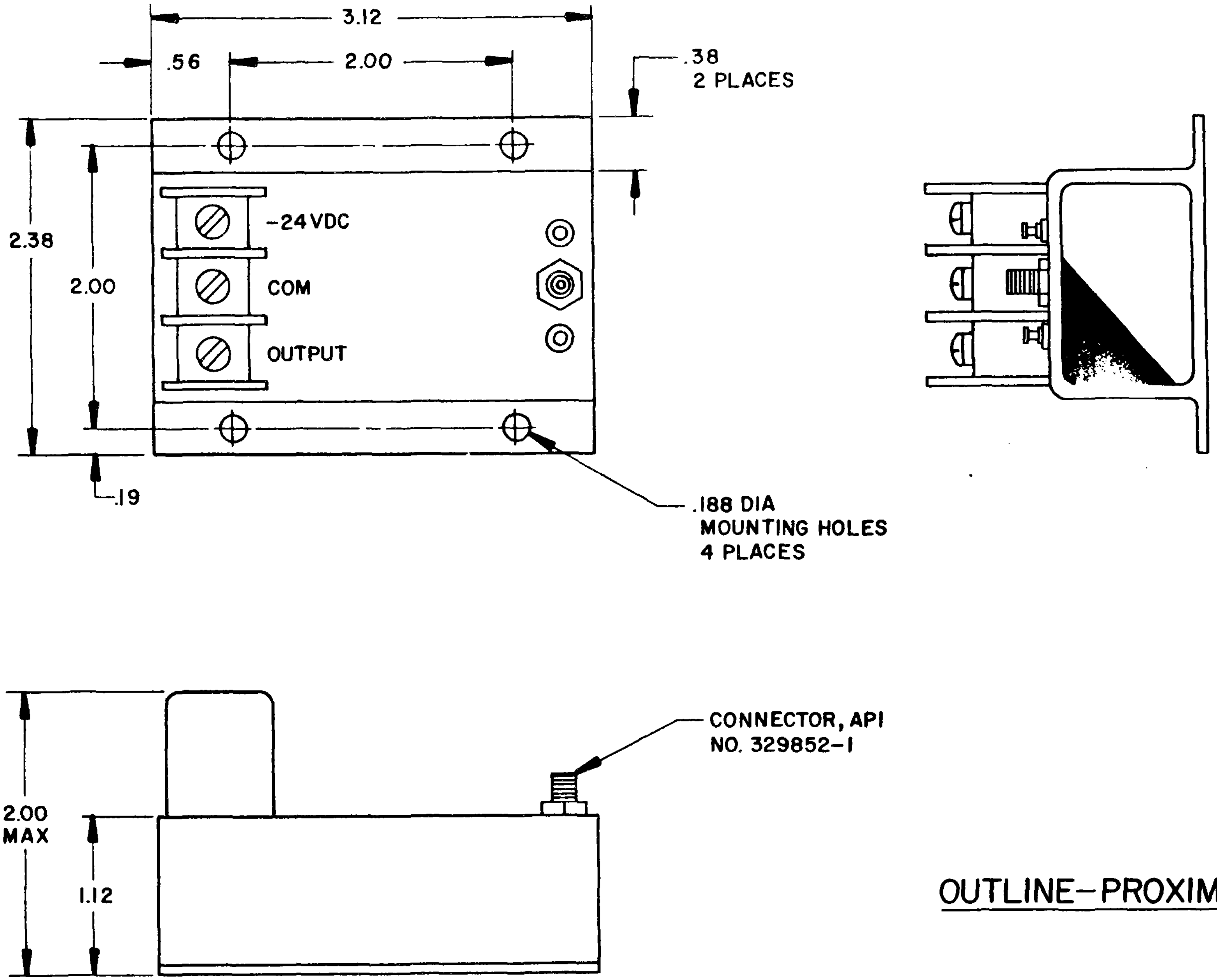
Operating Temperature:	-60° F to +212°F
Temperature Coefficient of Output:	(specified in linear range) DC Output maximum 2 mv/° F typical 0.5 mv/°F (see graph, Figure A1-10) Slope maximum 0.025/mv/mil°F typical 0.010 mv/mil°F (see graph, Figure A1-10)

Mechanical

Connectors:	Common, output, and power are thermal plastic barrier block with 3 each 6-32 screws and washers Probe input is BNJR
Size:	2-3/8 inches wide by 3-1/8 inches long by 2 inches high see outline drawing (figure A1-11) for mounting dimensions
Weight:	7-1/4 ounces

A1-26 OPTIONS

A1-27 The available options offered for the 7000 Series Probe and Proximitor combination are the calibrated length of the probe with 50-ohm integral cable and connector and 95-ohm coaxial extension cable. Refer to the example of Paragraph A1-9, 7000 Series Proximitor. Also there are several probe types offered for specific applications and environments.



(TERMINAL POSTS OMITED IN THIS VIEW FOR CLARITY)

Figure A1-II. Proximitor Outline Drawing

SECTION A-II

INSTALLATION

A2-1 GENERAL

A2-2 This section contains receiving inspection, power and signal connections, probe and proximitor mounting considerations, and an initial gap procedure. The exact installation instructions will depend upon the application and machine configuration where the probe and proximitor are to be used.

A2-3 RECEIVING INSPECTION

A2-4 Inspect the probe, extension cable, and proximitor as soon as it is received and unpacked, to determine if any in-transit damage has occurred. All shipping forms and invoices should be retained. If any shipping damage is apparent, file a claim with the carrier and submit a copy to Bently Nevada Corporation. Include the probe and proximitor model and serial numbers with all correspondence. The user will be advised concerning repair or replacement in accordance with the terms and conditions of sale.

A2-5 POWER AND SIGNAL CONNECTIONS

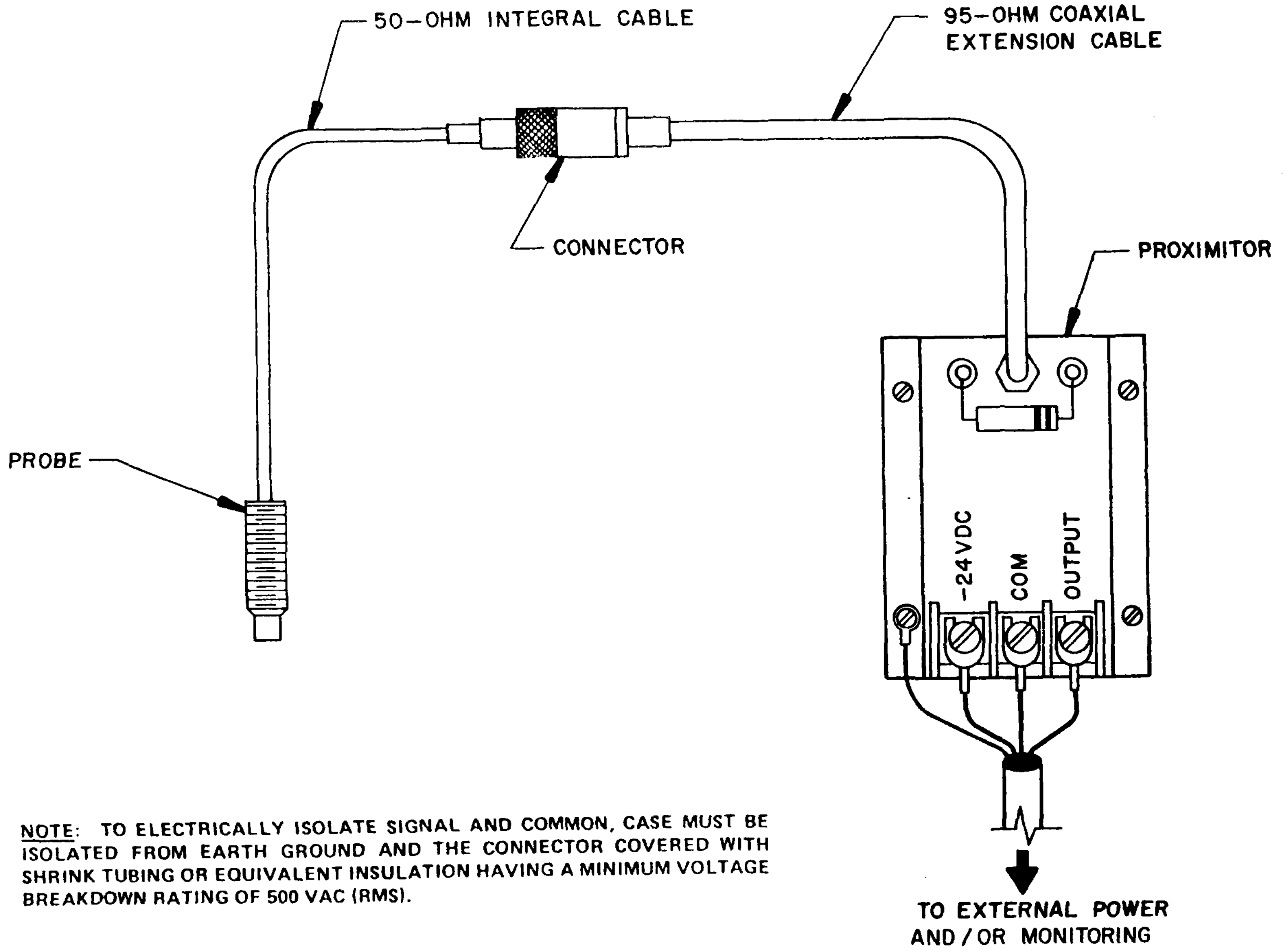
A2-6 All power and signal connections between the probe and proximitor and between the proximitor and the monitoring device must be made in the field. Figure A2-1 shows the probe connected to the proximitor through the extension cable, and the required power and output signal connections from an external source such as a monitoring device. The power and signal connections between the proximitor and the monitoring device should be made through three-wire shielded cable to avoid erroneous indications due to radiated interference.

A2-7 For specific monitoring applications, using the probe and proximitor described in this manual, refer to the applicable monitoring device manual.

A2-8 PROXIMITOR INSTALLATION

A2-9 The proximitor installation is primarily governed by the length of the extension cable to the probe and the environmental considerations. The proximitors are designed to operate with a specific length of 95-ohm coaxial extension cable and probe with 50-ohm integral cable and connector, refer to Section A-I for an explanation of these specific lengths. Provision should be made for protection from hazardous environments or weather.

A2-10 The 7000 Series Proximitor is not normally affected by vibration, dust, humidity, or most gases. However, it is necessary to mount the proximitor in a location where it is not subjected to temperatures in



NOTE: TO ELECTRICALLY ISOLATE SIGNAL AND COMMON, CASE MUST BE ISOLATED FROM EARTH GROUND AND THE CONNECTOR COVERED WITH SHRINK TUBING OR EQUIVALENT INSULATION HAVING A MINIMUM VOLTAGE BREAKDOWN RATING OF 500 VAC (RMS).

Figure A2-1. Probe and Proximitor Power and Signal Connections excess of 100°C (212°F). Temperatures in excess of 100° C (212°F) may cause permanent damage to the proximitor.

A2-11 PROBE INSTALLATION

A2-12 Standard probes for relative shaft motion measurements may be mounted in any location on or in the machine with the end of the probe facing the surface to be observed. When observing a vibration point, the machine surface should be of bearing type finish to minimize mechanical runout noise. Also, the observed surface should be checked for electrical runout, and if present, the runout should be removed.

A2-13 The probe observes the gap from the probe face to the running shaft. Therefore, for accurate measurements of vibration, the holding structure of the probe must not vibrate at amplitudes or frequencies in the range of the measurements to be made. If a probe cannot be mounted in a solid location on the machine, like a bearing housing, it is necessary to use a beam structure. Make certain the beam structure cannot vibrate appreciably. The resonant frequency of any such mounting structure vibration should be field checked by tapping the structure lightly, and observing the proximitor output on an oscilloscope (the proximitor output is available on the proximitor OUTPUT terminal). The lower frequency limit should not be less than ten times the rpm of the observed surface.

A2-14 When installing the probe, the 50-ohm integral cable and connector should be disconnected and the 50-ohm integral cable should be rotated with the probe as the probe is threaded into the mounting hole. Do not allow twist loads to occur at the probe and the joint of the 50-ohm integral cable as they may cause cable damage. The probe must be securely locked into its mount by a locknut, clamp, or other vibration secure device. Make certain the mounting hole is clear of obstructions. If the observed surface is moving, take care to prevent the probe face from being rubbed by the shaft.

A2-15 Initial probe gap is determined by consulting the typical probe calibration curve shown in Figure A2-2, or for specific applications, the probe calibration curve shown in the applicable monitoring device manual. In open installations, the gap can be set using a feeler gage or plastic shim, or by observing the proximitor output voltage. The output voltage of the proximitor should be set to correspond to the recommended initial gap voltage indicated by the typical probe calibration curve in Figure A2-2 or the specific application probe calibration curve in the applicable monitoring device manual. The proximitor output voltage method is useful in blind installations or with the machine running, where feeler gages or shims cannot be used. In blind mounting holes, make certain the probe is observing the shaft by moving the probe in and out to decrease or increase the gap while observing the proximitor output voltage. Decreasing gap will cause decreasing voltage (less negative) and increasing gap will cause increasing voltage (more negative).

A2-16 In the completed installation there should be no metal within twice the diameter of the probe face, except the observed surface, as shown in Figure A2-3. This is a minimum requirement, and in general, as much clearance as possible should be maintained.

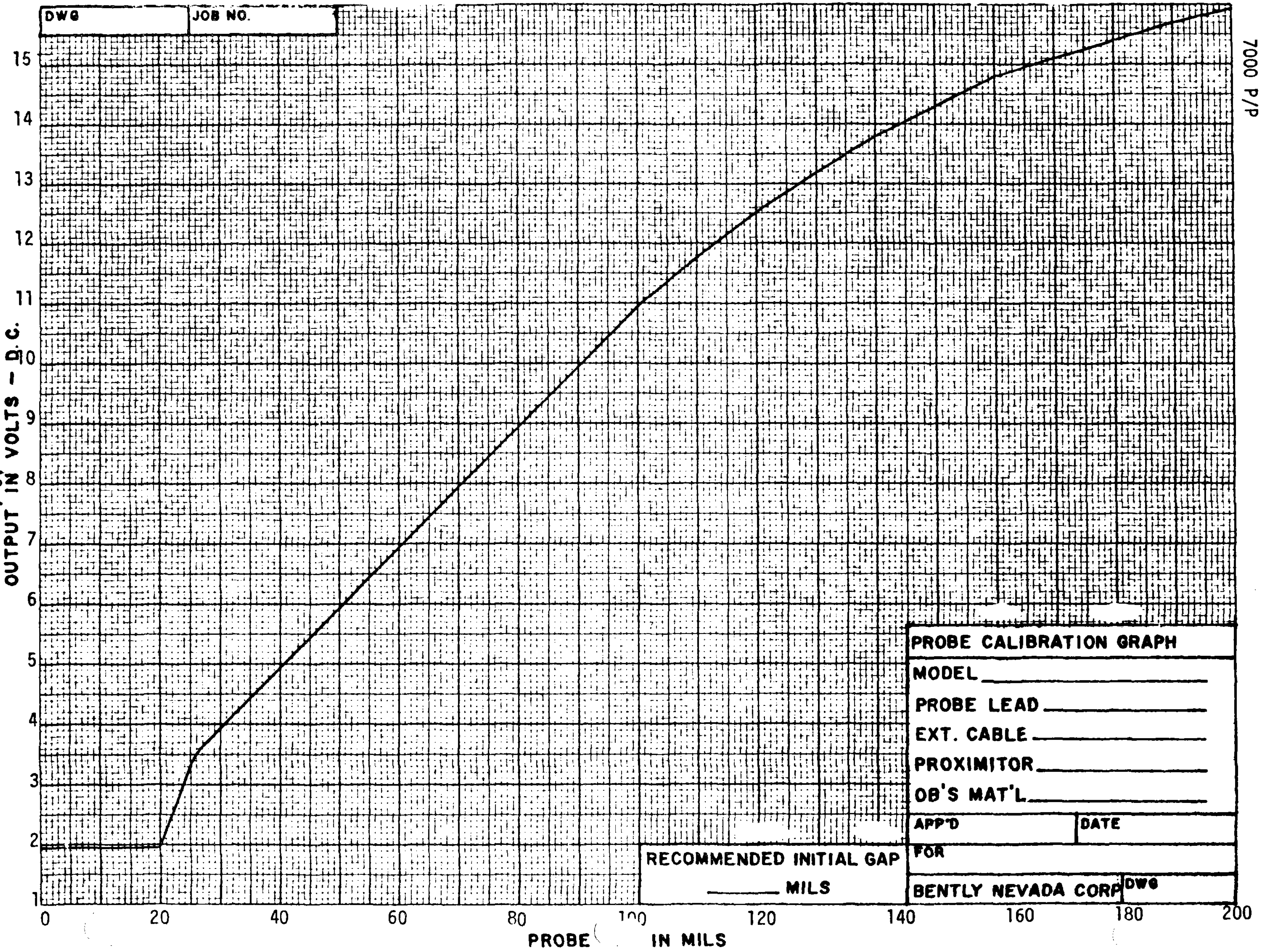


Figure A2-2. Typical Probe Calibration Curve

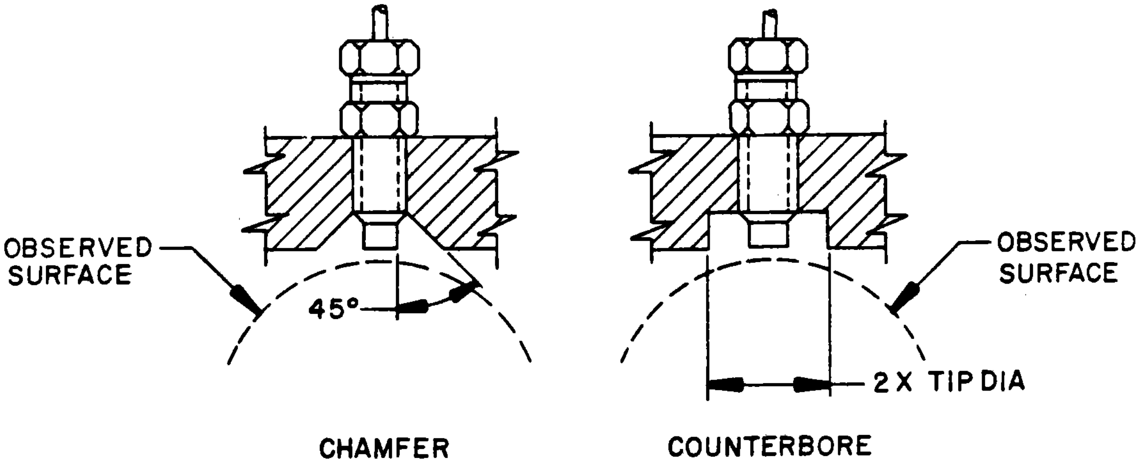


Figure A2-3. Probe Tip Relief Diagram

A2-17 INITIAL GAP PROCEDURE

A2-18 The following initial gap procedure may be used to set the initial probe operating gap in accordance with the typical probe calibration curve, Figure A2-2, or a specific probe calibration curve for a specific application. Specific application probe calibration curves will be found in the applicable monitoring device manual. The following procedure will be performed using the Digital Multimeter (DMM) or a direct equivalent. For open installations where the shaft is not rotating, a feeler gage or plastic shim may be used in lieu of this procedure.

a. With the probe installed in its normal mounting, connected to its proximitor in accordance with the instructions in this section, and with all proximitor power connected, connect the DMM between the OUTPUT and COM terminals on the proximitor. Set the DMM to indicate dc voltage.

b. Carefully rotate the probe and its 50-ohm integral cable toward the observed surface; the dc voltage indicated on the DMM will be decreasing in magnitude (approaching zero from a negative voltage).

c. Continue to rotate the probe and the 50-ohm integral cable toward the observed surface until the voltage indicated on the DMM has decreased to some value less than the recommended initial gap voltage on the probe calibration curve being used.

d. Rotate the probe away from the observed surface until the recommended initial gap voltage is reached as indicated on the DMM.

e. Secure the probe. If the 50-ohm integral cable has a twist load from rotation, disconnect it at the 95-ohm coaxial extension cable connector and relieve the twist load before reconnecting. Disconnect the DMM.

SECTION A-III

MAINTENANCE

A3-1 GENERAL

A3-2 This section covers calibration check procedures for the 7000 Series Probe and Proximitor combination. Part of the calibration check procedure is devoted to making a probe and proximitor calibration curve, similar to the typical curve shown in Figure A2-2. Table A3-1 lists the equipment recommended to perform the calibration check procedures.

TABLE A3-1. RECOMMENDED MAINTENANCE EQUIPMENT

RECOMMENDED EQUIPMENT	SPECIFICATION
Digital Multimeter (DMM)	3-1/2 digit display minimum, with ohms, ac volts, dc volts as minimum functions
TK-3 Test and Calibration Kit with Instruction Manual	Vibration rpm range = 1K to 10K rpm Displacement range (spindle micrometer) = 0 to 500 mils Vibration amplitude range = 0 to 5 mils peak-to-peak

A3-3 CALIBRATION CHECK PROCEDURES

A3-4 The following calibration check procedures will determine if the 7000 Series Probe and Proximitor combination are operating within tolerance.

a. Install the probe in the TK-3 spindle micrometer fixture, assuring the probe tip extends completely through the spindle micrometer mounting fixture.

b. Connect the probe to the proximitor with the proper length extension cable.

c. Connect the power supply -24 volts output between the -24 VDC and COM terminals on the proximitor.

d. Connect the DMM between the OUTPUT and COM terminals on the proximitor.

e. Set the TK-3 spindle micrometer to 60 mils, and adjust the probe position in the mounting fixture until the proximitor output voltage is approximately -7 vdc as indicated by the DMM.

f. Set the TK-3 spindle micrometer to 10 mils. The proximitor output voltage should be approximately -2 volts.

g. Measure and record the output voltage from the proximitor at each 10-mil increment as the TK-3 spindle micrometer is rotated away from the probe face, out to a setting of 120 mils.

h. Set the TK-3 spindle micrometer to 200 mils. The proximitor output voltage should be approximately -16 vdc.

i. Calculate the response sensitivity between each 10-mil increment from 30 mils to 90 mils.

NOTE

For example, if the voltage at 40 mils is -5.00 volts and the voltage at 30 mils is -4.02 volts, the difference is 0.98 vdc or 980 millivolts. Sensitivity is derived by dividing the voltage by the distance; 980 mv/10 mils = 98 mv/mil. The sensitivity between any 10-mil increment from 30 mils to 90 mils should be no less than 85/mv/mil nor greater than 115 mv/mil. If they are not within the specified limits, refer to the Field Wiring Tests, Paragraph A3-5. The voltages recorded in the preceding test may be used to plot a probe calibration curve on graph paper graduated 20 mils per inch for the horizontal scale and 2 volts per inch for the vertical scale. The probe graph should be similar to Figure A2-2.

A3-5 FIELD WIRING TESTS

A3-6 The field wiring test procedure need be performed only when the calibration check procedures of Paragraph A3-3 show that the sensitivity between 30 mils and 90 mils is greater than 115 mv/mil or less than 85 mv/mil. Field wiring includes the probe, probe 50-ohm integral cable and connector, 95-ohm coaxial extension cable, and proximitor. The wiring between the proximitor and the specific monitoring device is covered in the applicable monitoring device manual.

a. Measure regulated proximitor drive voltage (-18 to -24 volts) at the proximitor -24 VDC terminal.

b. Measure the probe gap voltage at the proximitor OUTPUT terminal.

c. If Step _b_ of this paragraph is not satisfactory, disconnect the extension cable at the proximitor and measure 4 to 10 ohms between the cable center conductor and cable shield.

NOTE

The approximate resistance of the probe with 50-ohm integral cable and connector is 4 to 10 ohms. The 95-ohm coaxial extension cable resistance is approximately 0.25 ohms per foot. However, the wide variation in resistance of probes with 50-ohm integral cable and connector causes most measurements to be between 4 to 10 ohms, except for very long extension cables. The measurement should not be a short or much more than 10 ohms.

d. If Step c of this paragraph is not satisfactory, disconnect the 95-ohm coaxial extension cable from the probe 50-ohm integral cable and connector, and measure 4 to 10 ohms between the probe center and conductor and the shield.

e. If all the preceding Steps of this paragraph are satisfactory, replace the proximitor.

SECTION A-IV

REPLACEABLE PARTS

A4-1 GENERAL

A4-2 This section contains a list of the replaceable parts required to maintain the 7000 Series Probe and Proximitor combination. When ordering either the probe or the extension cable, the cable length must be matched to that being replaced. If replacement of connectors is required, contact the Bently Nevada Corporation factory or field representative to determine the correct part numbers, tools, and replacement procedures.

TABLE A4-1. REPLACEABLE PARTS

QTY	PART NO.	NOMENCLATURE	SPECIAL REMARKS
1	*	Probe with 50-ohm cable	Specify length as measured from probe tip to cable connector end.
1	*	95-ohm coaxial extension cable	Specify length.
1	*	Proximitor	Specify probe size and total electrical cable length.

* When ordering replacement parts, assure the number on the order exactly matches the number of the part to be replaced.

BENTLY NEVADA CORP.

9000 SERIES SYSTEM
OPERATION AND MAINTENANCE
MANUAL PACKAGE

SYSTEM MODEL 9001253-01
BINGHAM WILLIAMETTE
P.O. NUMBER 1-63857

Bingham Williamette
P.O. Number 1-63857
Model Number 9001253-01

Bently Nevada Corp.
Job Number 77571-00

OPERATION AND MAINTENANCE

MANUAL PACKAGE

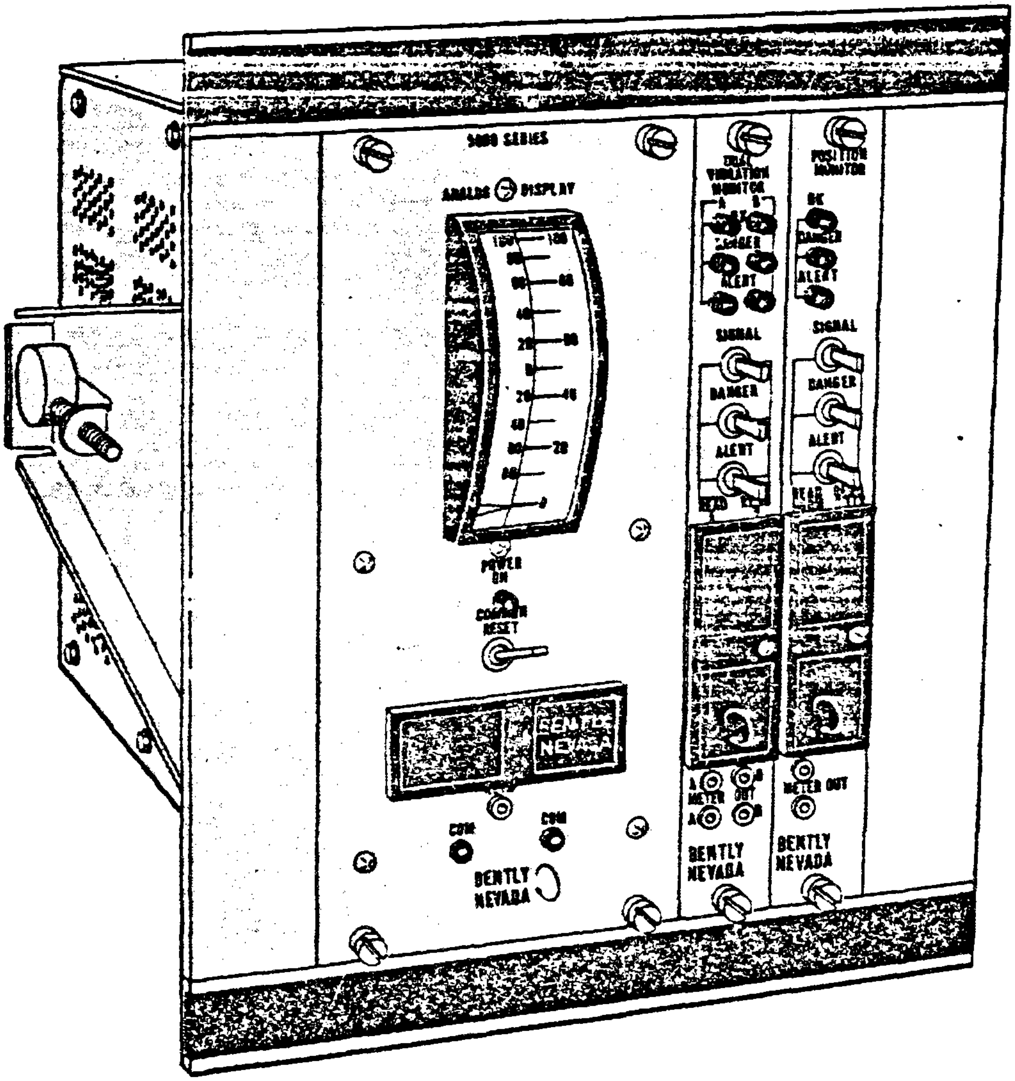
BENTLY
NEVADA
CORPORATION

9000 SERIES

The manuals listed below and contained herein are specific to the 9000 Series configuration shown on the 9000 System Drawing List.

QTY. MANUALS IN PACKAGE	MANUAL TITLE	MANUAL NUMBER
1	Instrument Rack Assembly 9000 Series Operation and Maintenance Manual	TW8025700
1	Power Supply 90050 Operation and Maintenance Manual	TW8025800
1	Analog Display 90120 Operation and Maintenance Manual	TW8025900
1	Dual Vibration Monitor 90100 Operation and Maintenance Manual	TW8026100
1	3000 Series Probe and Proximitor Operation and Maintenance Manual (Appendix A)	TW8019410

OPERATION AND MAINTENANCE MANUAL



9000 SERIES RACK ASSEMBLY

Rev. Jan. 1979

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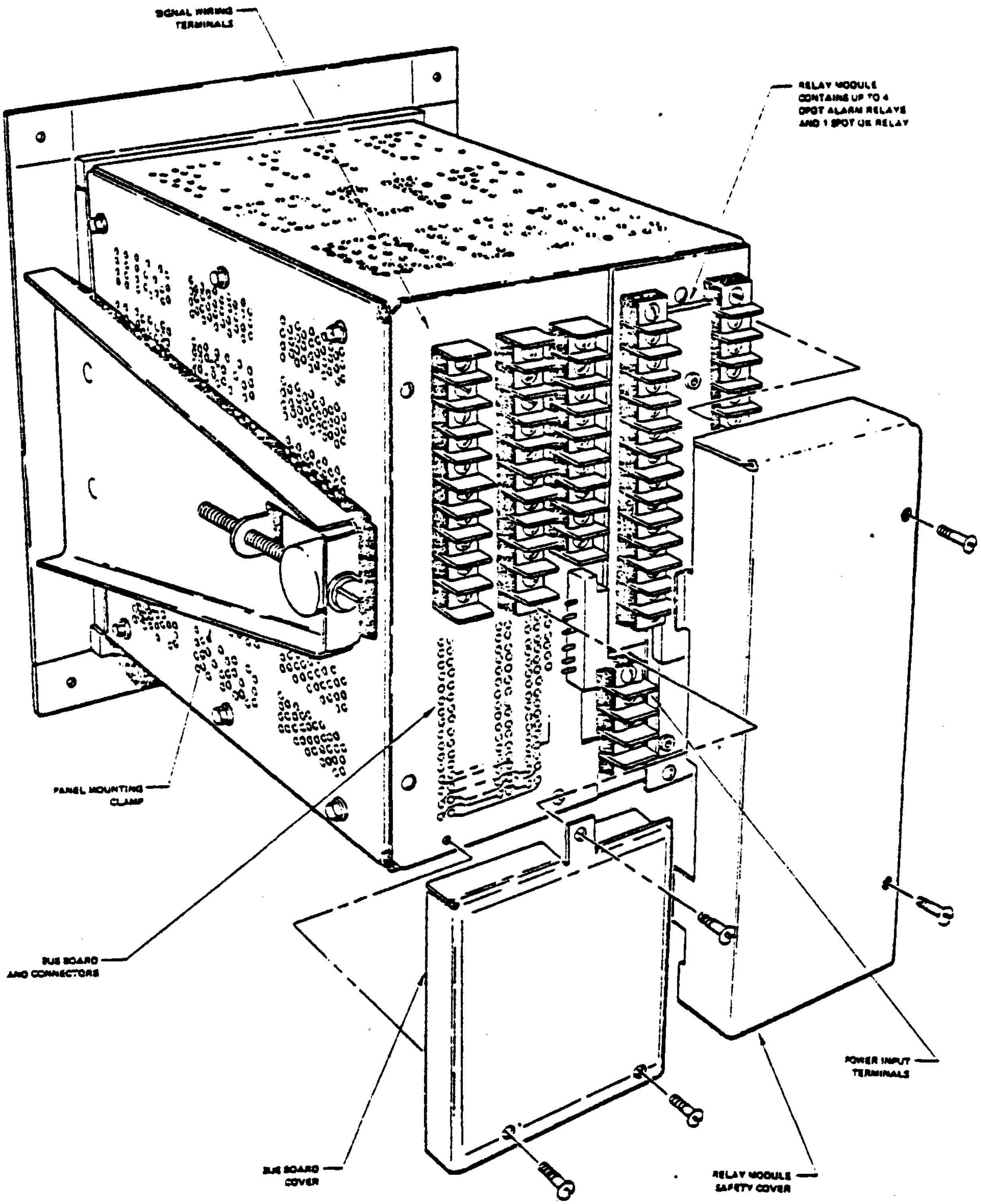


Figure 1-1. Rack Assembly Rear View

SECTION I

GENERAL INFORMATION

1-1 GENERAL DESCRIPTION

1-2 The 9000 Series Rack Assembly, Figure 1-1, provides the housing and electrical interconnection for the power supply, relay module, monitors and common display unit. The assembly consists of an instrument rack constructed of aluminum; a bus board with connectors; terminal strips for transducer power, signal, recorder and common reset connections; a relay module having OK and alarm relays and relay terminals; and protective covers for the relay module and bus board.

1-3 Either panel clamps or EIA 19-inch rack adaptors are furnished for mounting. When specified, the rack assembly is provided with an extender card service tool, a weatherproof door or housing, and special markings on strips located at the top and bottom of the rack face.

1-4 MODIFICATIONS

1-5 A modification is an alteration to a unit and is designed to meet special user requirements. The modification is described on a modification document, a copy of which is inserted in the appropriate operation and maintenance manual.

1-6 RACK CONSTRUCTION

1-7 The rack assembly is constructed of extruded and heavy sheet aluminum which is protected by either an anodizing or chromate conversion treatment. The physical size of the rack is determined by the quantity of monitors. Table 1-1 lists the four rack size options. The power supply and common display unit occupy the first four positions at the left of the rack. Positions on the right are occupied by monitors or blank position filler plates.

1-8 BUS BOARD AND CONNECTORS

1-9 All electrical connections within the rack are provided by a printed circuit bus board that has card-edge connectors for the power supply, relay module and all monitor positions. Refer to the rack assembly schematic diagram in Section IV of this manual for circuit information. The bus board circuit is designed so that any monitor can be installed in any position to the right of the power supply. In the case of a thermocouple temperature (TC) monitor, a cold-junction compensation module and jumper wire must be soldered to the bus board at the monitor position, thus limiting that position.

TABLE 1-1. RACK ASSEMBLY CATALOG NUMBER

BNC CATALOG NUMBER

90060 - 0 1

	PANEL MOUNTED INSTRUMENT RACK SIZE
01	6 Position
02	8 Position
03	12 Position
04	16 Position

90085 -

	19-INCH E.I.A. RACK MOUNTED INSTRUMENT RACK SIZE
01	16 Position

1-10 TERMINAL STRIPS

1-11 All field wiring to the 9000 Series System is connected to the barrier-type terminal strips at the rear of the rack. The low-voltage transducer and recorder terminals are exposed, but the high-voltage power and alarm terminals are shielded by an aluminum safety cover. A label below each exposed terminal strip identifies the function of each terminal.

1-12 RELAY MODULE

1-13 The relay module contains the optional OK relay and up to four optional alarm relays. The relay terminals are illustrated in the Customer Wiring Diagrams in Section IV. Contact configurations are shown in the relay module schematic diagram in Section IV. Refer to Table 1-2 for relay module configurations and to Table 1-3 for specifications.

1-14 The optional SPDT OK relay is normally energized. The OK relay de-energizes if any monitor detects a transducer fault, thereby causing the operation of any annunciator system connected to the OK relay.

1-15 The DPDT alarm relays operate when monitors in the system detect out-of-limit conditions. Alarm relay coils can be either normally energized or normally de-energized, depending on the configuration of the driver circuits in the power supply. The driver circuits are field changeable so that the user can change between normally energized and normally de-energized operating modes. Refer to the Power Supply Operation and Maintenance Manual, 8025800, for further information.

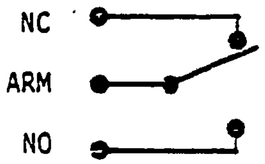
TABLE 1-2. RELAY MODULE CONFIGURATIONS

BNC CATALOG NUMBER

90040 - 0 4

	OK RELAY	ALARM RELAYS	ARC SUPPRESSORS
01	Installed	None	Omitted
02	Installed	No. 1	Omitted
03	Omitted	No. 1	Omitted
04	Installed	No. 1 and 2	Omitted
05	Omitted	No. 1 and 2	Omitted
06	Installed	No. 1, 2 and 3	Omitted
07	Omitted	No. 1, 2 and 3	Omitted
08	Installed	No. 1, 2, 3 and 4	Omitted
09	Omitted	No. 1, 2, 3 and 4	Omitted
10	Installed	None	Installed
11	Installed	No. 1	Installed
12	Omitted	No. 1	Installed
13	Installed	No. 1 and 2	Installed
14	Omitted	No. 1 and 2	Installed
15	Installed	No. 1, 2 and 3	Installed
16	Omitted	No. 1, 2 and 3	Installed
17	Installed	No. 1, 2, 3 and 4	Installed
18	Omitted	No. 1, 2, 3 and 4	Installed

TABLE 1-3. OK AND ALARM RELAY SPECIFICATIONS

Contact Arrangement	OK relay:SPDT; Alarm relay:DPDT
Contact Definition (Coil de-energized)	
Contact Ratings	3A at 28 vdc or 120 vac, resistive load
Contact Material	Gold-flashed silver
Arc Suppressor Option Clamp Voltage	212 v peak (minimum) suitable for use with up to 150 vac rms across contacts
Relay Construction	Hermetically-sealed metal enclosure

1-16 The alarm relays considered alone are non-latching, but some monitor alarm circuits latch after alarm conditions have ended, thereby holding the corresponding relays in the alarm state. Both the latching and non-latching type monitors can operate the same relay. The monitor alarm circuits are field changeable so that the user may change between latching and non-latching operaing modes if necessary. Refer to the specific monitor manual for circuit revision procedures.

1-17 PROTECTIVE COVERS

1-18 A safety cover at the rear of the relay module prevents accidental contact with the high voltage terminals. A second cover at the rear of the bus board (below the terminal strips) protects the bus board conductors. The bus board cover is not removed during normal installation and maintenance. However, installation of an additional thermocouple (TC) monitor requires removal for wiring.

1-19 CLAMP MOUNTING OR E.I.A. RACK MOUNTING

1-20 A panel-mounted rack is secured to the mounting panel by use of two clamps, one at each side of the rack. Clamp-type mounting is available for all rack sizes.

1-21 The 16-position E.I.A. mounted rack has mounting screw slots in the front vertical supports. Panel-mounting clamps are not included in this particular rack assembly.

1-22 EXTENDER CARD

1-23 The extender card is a printed circuit board that connects any 9000 Series monitor to the rack bus board during calibration or maintenance. The card permits monitor operation while the monitor is completely extended from the rack for access to components. Besides having conductors for all monitor-bus board connections, the extender card has 31 test points accessible at the front of the card when in use. The monitor is secured to the card by a pin latch that engages a hole in the monitor circuit board.

1-24 WEATHERPROOF DOOR OR HOUSING

1-25 A weatherproof door or housing is available for all panel-mounted rack sizes. The weatherproof door assembly provides weather protection for the front of the 9000 Series instrument. The rack mounting clamps secure both the door assembly and the rack to the mounting panel. Table 1-4 lists the weatherproof door options. If a weatherproof housing is used to provide complete weather protection, the housing is first panel mounted, then the rack assembly is installed in the housing. Table 1-5 lists the weatherproof housing options.

TABLE 1-4. WEATHERPROOF DOOR CATALOG NUMBER

BNC CATALOG NUMBER

72191 - ☐☐

	INSTRUMENT RACK SIZE
01	8 Position
02	12 Position
03	16 Position
07	6 Position

TABLE 1-5. WEATHERPROOF HOUSING CATALOG NUMBER

BNC CATALOG NUMBER

90080 - ☐☐ - ☐☐ - ☐☐

	HOUSING SIZE		CONDUIT FITTING OPTION		AIR PURGE OPTION
01	6 Position Rack	00	No Fittings Required	00	Not Required
02	8 Position Rack	01	Conduit Fittings Required	01	Air Purge Fittings Only
03	12 Position Rack				
04	16 Position Rack				

1-26 The weatherproof housing is rated NEMA Type 4. This rating applied to a housing in an indoor, nonhazardous location indicates that it protects against accidental contact with enclosed equipment; falling dirt; falling liquids and light splashing; dust, lint, fibers and flyings; and hosedown and splashing water.

1-27 The NEMA Type 4 rating applied to a housing in an outdoor nonhazardous location indicates that it protects against accidental contact with enclosed equipment; rain, snow and sleet (external mechanisms not required to be operable when ice covered); windblown dust; and hosedown.

1-28 MARKING STRIPS

1-29 Two marking strips on the rack face, one above and one below the monitor positions, are used to indicate the function of each monitor and the machinery being monitored. The information printed on the marking strips is selected by the user and is described in the Customer Marking Drawings contained in Section IV of this manual.

SECTION II

INSTALLATION

2-1 GENERAL

2-2 This section contains procedures for 9000 Series System receiving inspection, damage claim, and mechanical and electrical installation.

2-3 RECEIVING INSPECTION

2-4 Visually inspect the rack assembly when received to ensure that all components are free of shipping damage. Refer to procedures in this section for component removal and installation. Inspect the following items: rack assembly sheet metal; display unit and monitor front panels and components; power supply; and bus board terminal strips and rear covers.

2-5 DAMAGE CLAIM

2-6 If there is apparent shipping damage, file a claim with the carrier and submit a copy to Bently Nevada Corporation. Include the rack assembly part number and serial number on all correspondence. The user will be advised concerning repair or replacement in accordance with the guarantee.

2-7 SYSTEM INSTALLATION

2-8 Locate the 9000 Series System in an environment free from potentially damaging conditions such as excessively high temperature, humidity and corrosive atmosphere.

CAUTION

During installation of system or component parts, disconnect system power to prevent accidental short circuits that may damage components.

******

2-9 INSTRUMENT RACK-TO-PANEL INSTALLATION

2-10 As shown in Figure 2-1, the 9000 Series Rack Assembly is installed in the mounting panel as follows:

a. Cut a rack-mounting opening ① in the panel according to the panel cutout dimensions shown on the rack assembly outline drawing in Section IV of this manual.

b. Remove both panel clamps ② from the rack assembly by unscrewing the slide screw ③ until the slide button ④ disengages from the keyhole slot ⑤ .

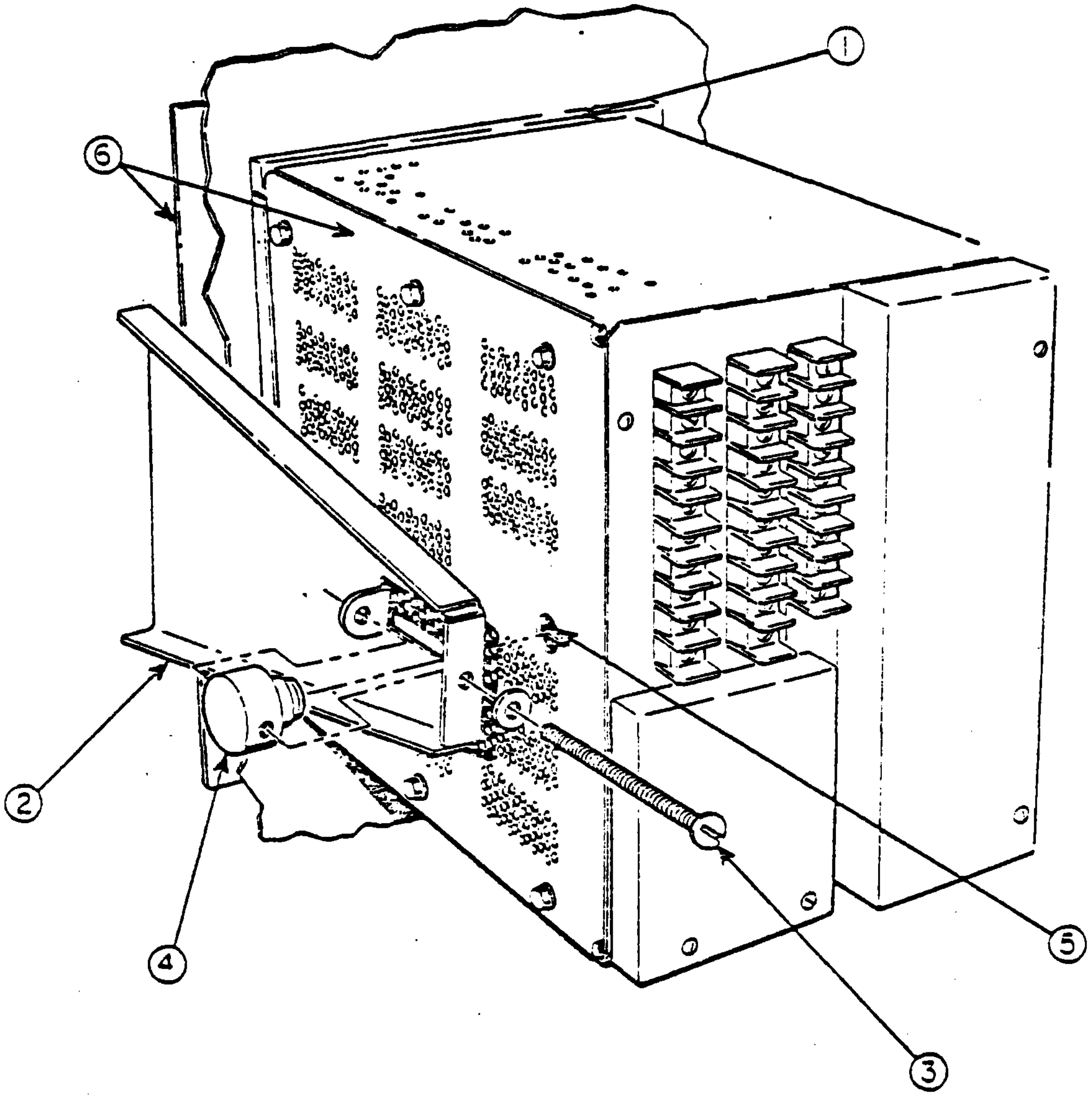


Figure 2-1. Rack-To-Panel Installation

c. Insert the rack assembly ⑥ into the panel cutout. Hold the assembly in a level position and install the panel clamps onto the rack and lightly tighten the slide screws.

d. Check for proper alignment of the rack and tighten the slide screws. Ensure that all fasteners have been properly secured.

2-11 WEATHERPROOF DOOR INSTALLATION

2-12 As shown in Figure 2-2, the weatherproof door is installed with a panel-mounted instrument rack as follows:

a. Cut a rack-mounting opening in the mounting panel according to the panel cutout dimensions shown on the rack assembly outline drawing in Section IV of this manual.

b. Remove both panel clamps from the rack by unscrewing the slide screw until the slide button disengages from the keyhole slot. Refer to Figure 2-1.

c. Examine the front mounting area of the panel and repair uneven areas that can cause leakage at the weatherproof door seal. The use of a sealing compound is not recommended because of possible damage to the neoprene seal.

d. Fully open the weatherproof door and insert the rack assembly all the way through the opening in the shroud. Close the door.

e. Insert the rack assembly with the door into the panel cutout. Hold the assembly in a level position. Install the panel clamps onto the rack and lightly tighten the clamp slide screws.

f. Check for proper alignment of the rack, door and seal, then fully tighten the clamp slide screws. Ensure that all fasteners have been properly secured.

2-13 WEATHERPROOF HOUSING INSTALLATION

2-14 As shown in Figure 2-3, the weatherproof housing for the 9000 Series System is installed as follows:

a. Cut an opening in the panel and drill bolt holes for the housing.

b. Refer to Drawing 90080 in Section IV of this manual for the panel cutout dimensions and bolt hole locations specific to the size of the weatherproof housing being installed.

c. If studs ① are to be installed on the panel for mounting the housing, install them at this time.

d. If conduit will be used for field wiring, remove the required 1.25 NPT conduit knockouts ② from the sides of the housing (at rear).

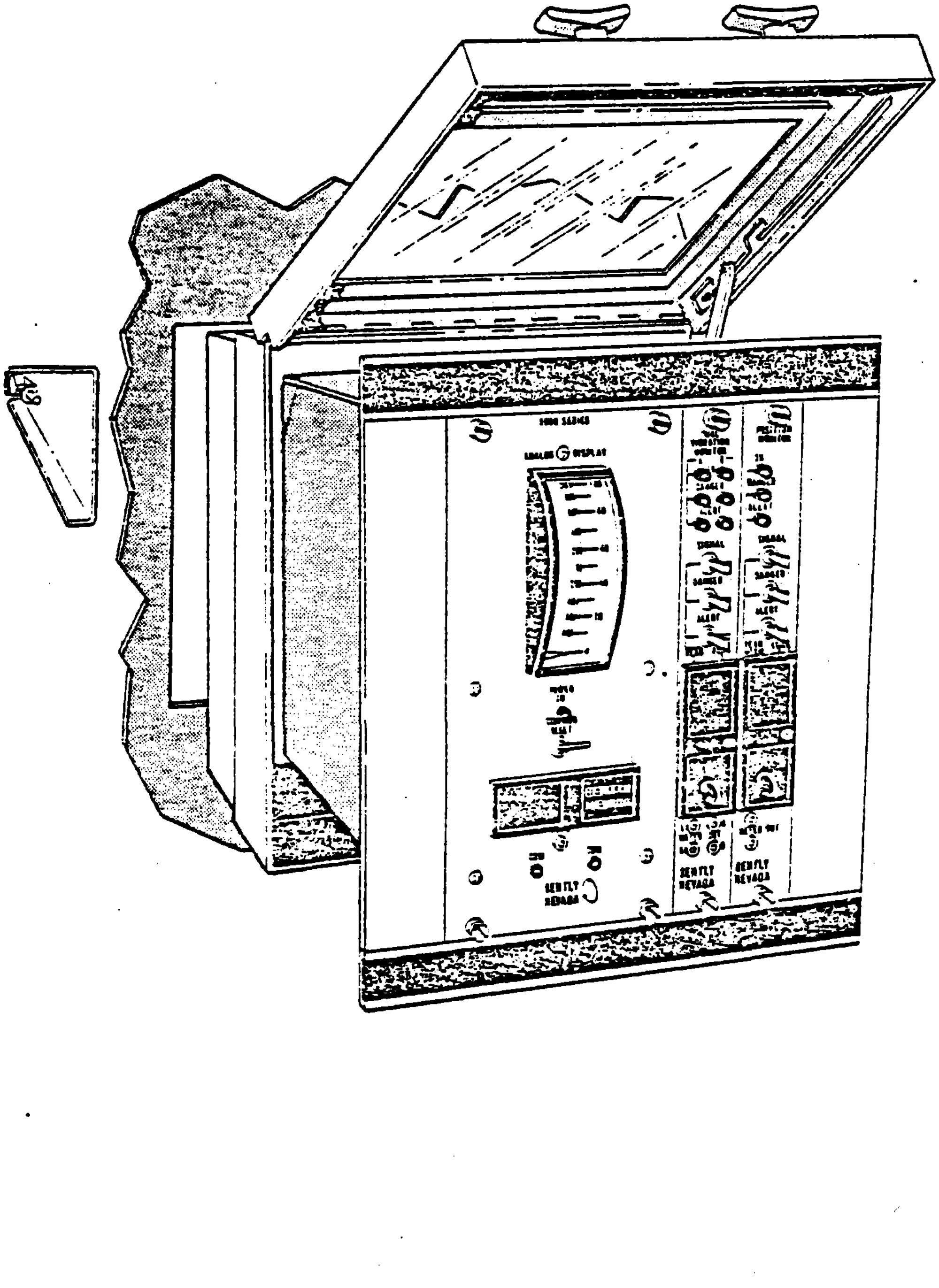


Figure 2-2. Weatherproof Door Installation

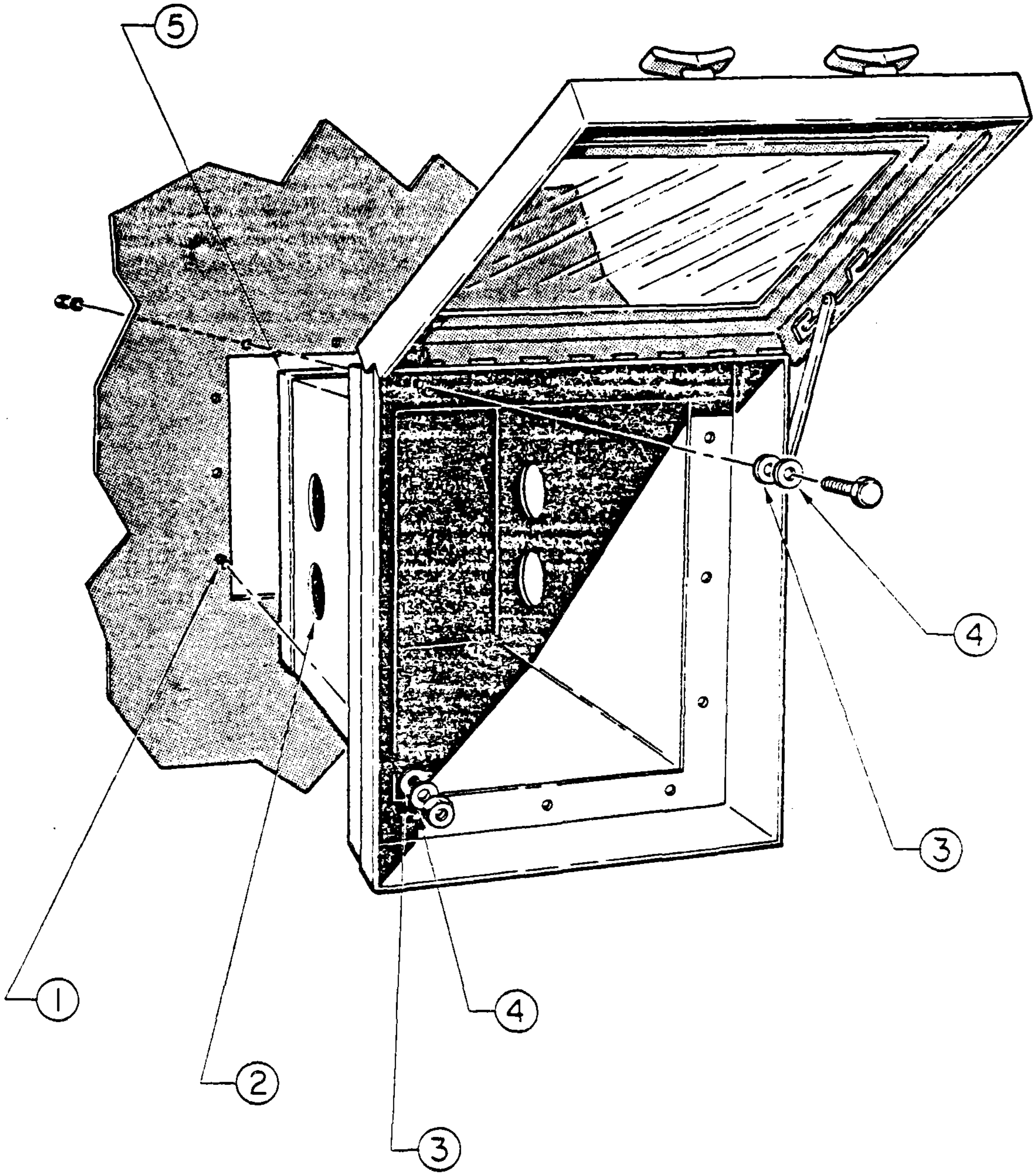


Figure 2-3. Weatherproof Housing Installation

e. Insert the housing into the panel and support it in a level position. Install the housing-to-panel fasteners with a thread sealing washer ③ against the housing and a flat washer ④ under the internal head of each fastener to obtain a watertight seal. Securely tighten all fasteners.

f. Remove the housing rear cover ⑤ and install the conduit fittings and conduit.

2-15 RACK-TO-WEATHERPROOF HOUSING INSTALLATION AND REMOVAL

2-16 The rack assembly is installed in a panel-mounted housing as follows:

a. Open the housing door and engage the support.

b. Remove both of the panel clamps from the rack assembly by unscrewing the slide screw until the slide button disengages from the keyhole slot. Refer to Figure 2-1.

c. Insert the rack assembly into the housing. Refer to Figure 2-4.

d. Install the panel clamps ① onto the rack assembly. Loosen the clamp slide screws as necessary to allow the slide buttons ② to engage the keyhole slots.

e. Lightly tighten the slide screws until the rack assembly panel clamp is clamped lightly against the interior flange of the weatherproof housing. Check the alignment of the rack and clamps, then fully tighten the slide clamp screws.

f. Connect the field wiring to the rack assembly terminals.

g. Ensure that all components are properly positioned and that all fasteners are secure.

h. Ensure that the housing rear sealing surface and the seal in the rear cover ③ are clean and undamaged. Do not apply sealing compound to the rear seal surfaces. Install the rear cover, then close the housing door.

2-17 The rack assembly is removed from the panel-mounted housing as follows:

a. Disconnect system power.

b. Remove the housing rear cover.

c. Disconnect field wiring from the rack assembly.

d. Remove the panel clamps from the rack assembly.

e. Open the housing door and engage the support. Remove the rack assembly from the housing.

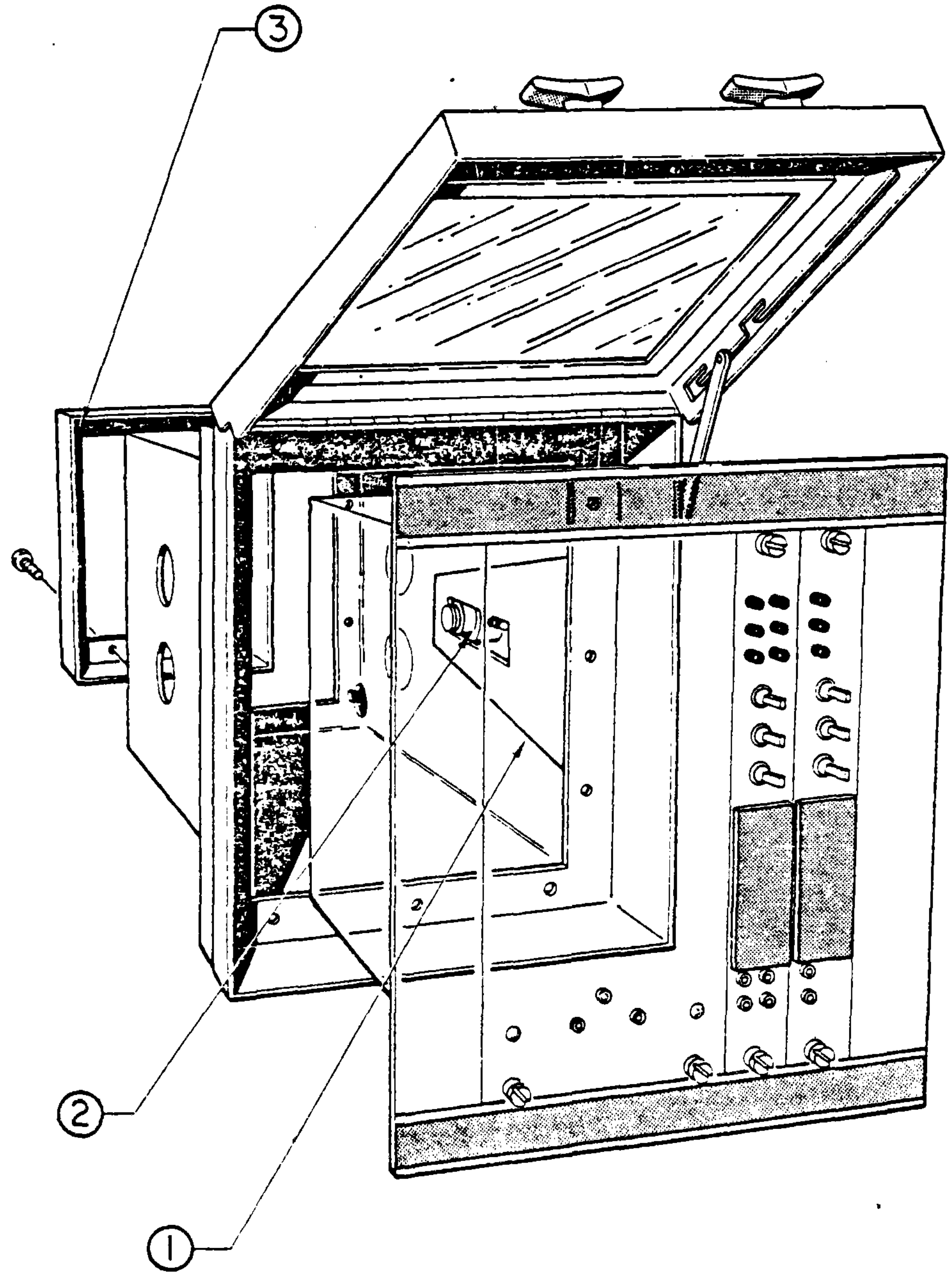


Figure 2-4. Rack-To-Weatherproof Housing Installation

2-18 FIELD WIRING INSTALLATION

2-19 Field wiring diagrams and instructions that specifically apply to the 9000 Series System as ordered by the user are contained in Section IV of this manual. Connect all field wiring in accordance with these diagrams and local electrical codes that apply. Label wiring as necessary for reconnection.

2-20 After completion of field wiring, ensure that all terminal screws are tightened securely and that wiring bundles are protected against damage.

2-21 RELAY TERMINAL DEFINITION

2-22 The applicable customer wiring diagram in Section IV shows the relay module field wiring terminals. Refer to the power supply part number option table in the Power Supply Operation and Maintenance manual, 8025800, to determine the alarm relay operation mode. For normally de-energized relays, the ARM-NC contacts are closed in the non-alarm condition, and the ARM-NO contacts are open. For normally energized relays, the ARM-NC contacts are open, and the ARM-NO contacts are closed when the relays are in the non-alarm state. Refer to Paragraph 1-12 and specification Table 1-3 for further descriptions of the alarm relay module.

2-23 MONITOR REMOVAL AND INSTALLATION

2-24 To remove a monitor, unfasten the captive screws at the top and bottom of the monitor front panel. Grasp the heads of the screws and pull forward. To install a monitor, carefully align the card edges with the rack guides. Push the card into the rack until the connectors mate. Tighten the captive screws.

2-25 ADDITIONAL MONITOR INSTALLATION

2-26 Installation of an additional monitor basically requires the following steps, but if a thermocouple temperature (TC) monitor is being installed, refer to Paragraph 2-27 for additional procedures.

a. Disconnect system power.

b. Install the field wiring label below the terminal strip of the additional monitor position.

c. Install the field wiring.

d. Remove the blank faceplate.

e. Connect the monitor to the extender card and install the extender card in the rack position to be occupied by the monitor. Refer to Paragraph 2-29.

f. Reconnect system power.

g. Check monitor performance according to the appropriate monitor manual.

h. Install the monitor in the rack. Refer to Paragraph 2-23.

2-27 THERMOCOUPLE MONITOR INSTALLATION

2-28 This procedure is necessary only when adding a thermocouple temperature (TC) monitor to an existing field-installed 9000 Series System. In addition to the procedure in Paragraph 2-25, perform the following steps before installing the thermocouple temperature monitor into the rack:

a. Remove several monitors and, if required, the power supply from the rack to gain access to the bus board inside the rack.

b. As shown in Figure 2-5, remove terminal strip screws ① through ④ at the additional thermocouple monitor position. Install the cold junction compensation module ⑤ with leads inserted through the bus board. Install the terminal screws to hold the module in position and solder the module leads to pads on the inside surface of the bus board. Avoid excess heat while soldering. Clip and remove the excess lead wire.

c. Remove the bus board rear cover ⑥ .

d. Install a jumper wire (24 gauge, insulated) ⑦ on the outside of the bus board from pad E7 to pad E2 or E4 of the additional monitor position. Refer to the rack assembly interconnecting diagram, drawing 90029 in Section IV, on which the jumper wire (W1) circuit is shown. Solder the jumper wire at the inside surface of the bus board. Clip and remove the excess wire.

e. Install the bus board cover.

f. Complete the monitor installation as described in Paragraph 2-25.

2-29 EXTENDER CARD

2-30 The extender card is a maintenance device used to electrically connect a monitor outside the rack for access to test and calibration points. Refer to Figure 2-6 for the sequence-numbered extender card installation procedure.

2-31 DISPLAY UNIT AND POWER SUPPLY REMOVAL AND INSTALLATION

2-32 Refer to Figure 2-7 for the sequence-numbered display unit and power supply removal procedure. Perform Steps ① through ③ to remove the display unit only. Installation is the reverse of the removal procedure.

2-33 RELAY MODULE REMOVAL AND INSTALLATION

2-34 Refer to Figure 2-8 for the sequence-numbered relay module removal procedure. Installation is the reverse of the removal procedure.

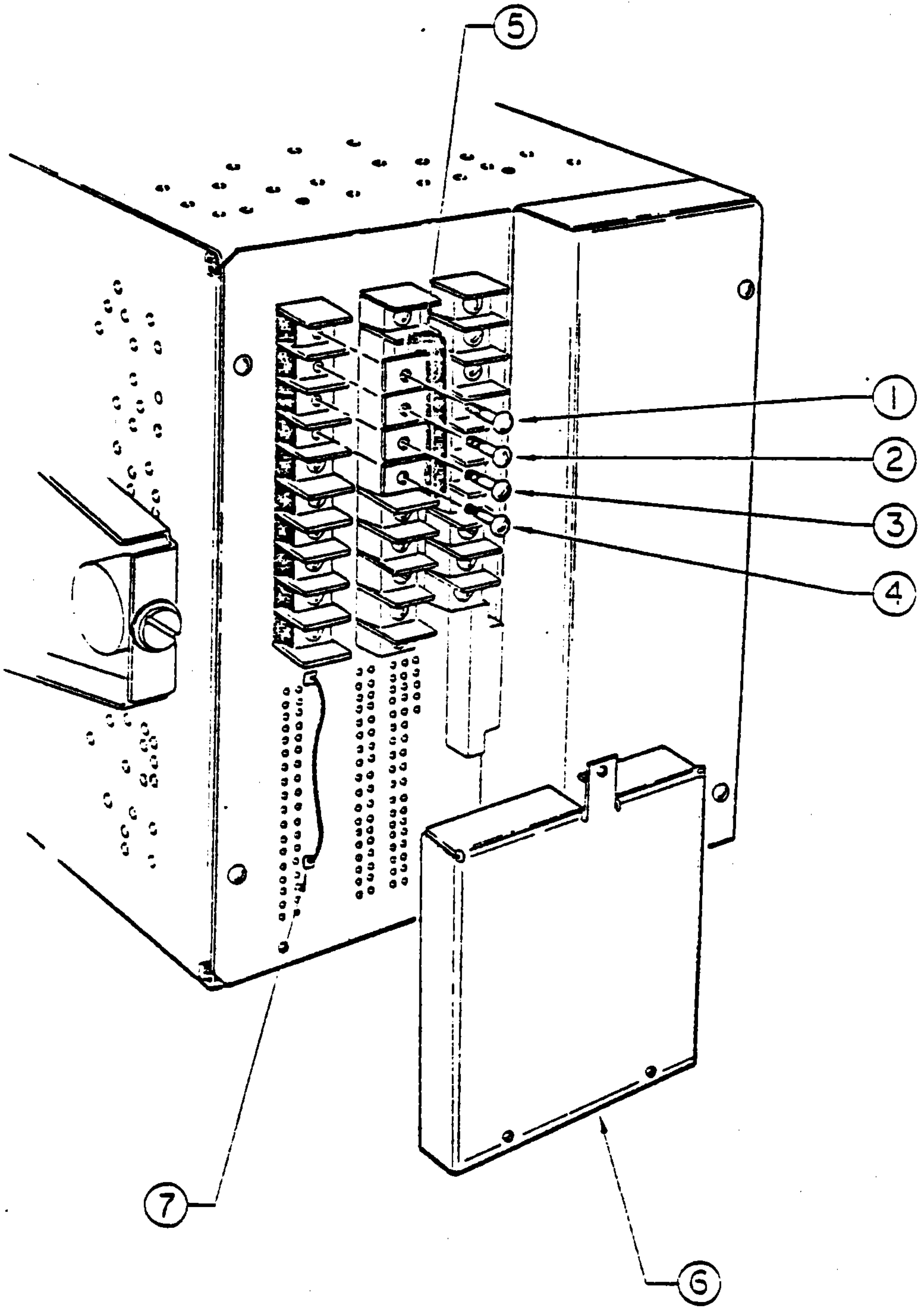
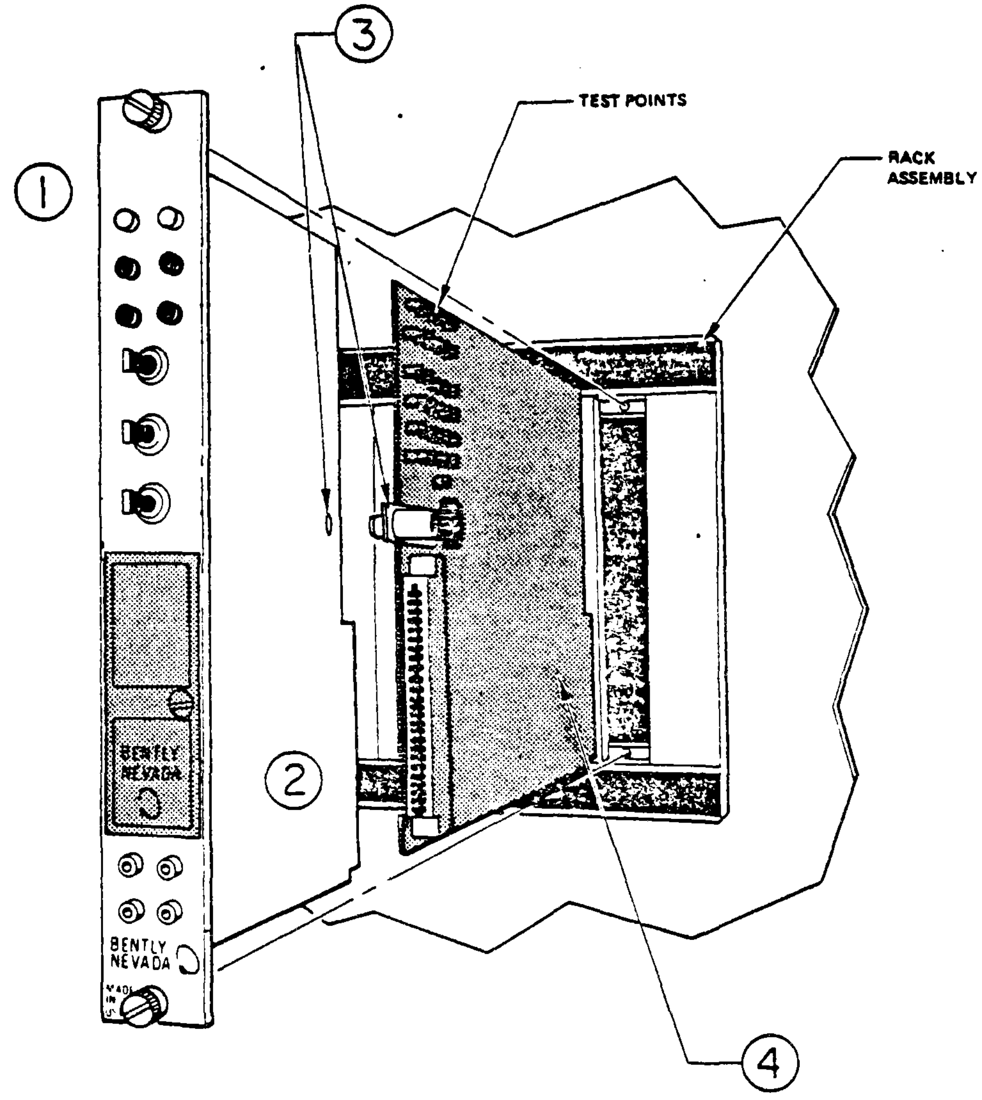


Figure 2-5. Cold Junction Compensation Module Installation



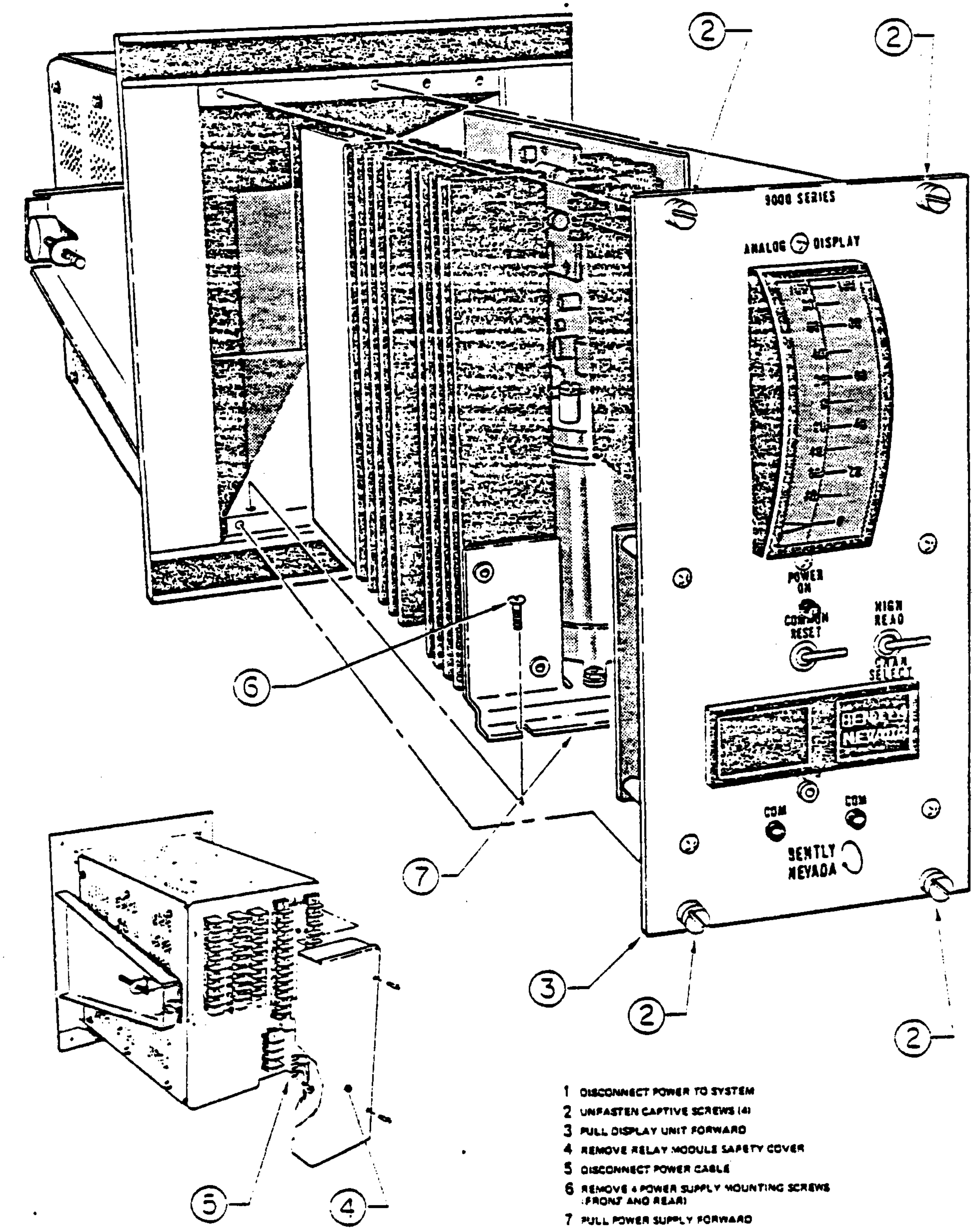
1 REMOVE MONITOR

2 PLUG MONITOR INTO EXTENDER CARD

3 ENGAGE LATCH PIN

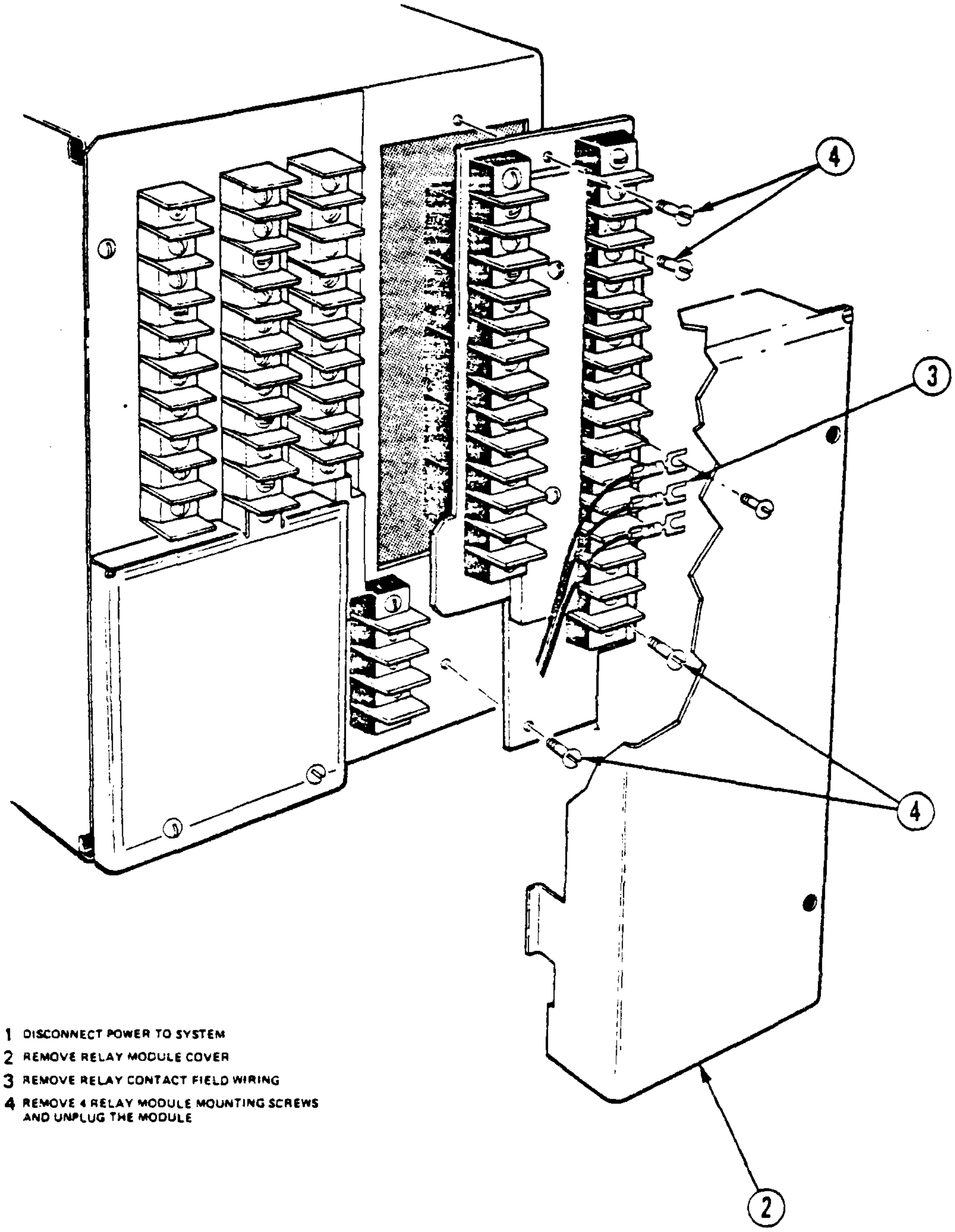
4 PLUG EXTENDER CARD INTO RACK

Figure 2-6. Extender Card Installation



1 DISCONNECT POWER TO SYSTEM
2 UNFASTEN CAPTIVE SCREWS (4)
3 PULL DISPLAY UNIT FORWARD
4 REMOVE RELAY MODULE SAFETY COVER
5 DISCONNECT POWER CABLE
6 REMOVE 4 POWER SUPPLY MOUNTING SCREWS (FRONT AND REAR)
7 PULL POWER SUPPLY FORWARD

Figure 2-7. Display Unit/Power Supply Removal



1 DISCONNECT POWER TO SYSTEM
2 REMOVE RELAY MODULE COVER
3 REMOVE RELAY CONTACT FIELD WIRING
4 REMOVE 4 RELAY MODULE MOUNTING SCREWS AND UNPLUG THE MODULE

Figure 2-8. Relay Module Removal

SECTION III

REPLACEMENT PARTS

3-1 GENERAL

3-2 This section contains information for ordering spare parts and returning equipment for repair.

3-3 Spare units from the factory are fully tested and calibrated. However, when installing a replacement unit, field testing and calibration procedures in the applicable manual should be performed to verify proper unit performance.

3-4 Bently Nevada Corporation recommends that at least one of each type of circuit board or assembly be kept on hand as a spare. If the 9000 Series instrument is located outside the U.S.A. or is used on an extremely critical application, the user may need several spares.

3-5 Orders for spare parts should be addressed to:

Marketing Department
BENTLY NEVADA CORPORATION
P.O. Box 157
Minden, Nevada 89423

Telephone:
(702) 782-2255

Telex: 354437

3-6 To order replacement parts, specify the complete part number including options. Specific part numbers are listed in the manual for each unit. If a unit has been modified, specify the modification number on the parts order.

3-7 Units being returned to Bently Nevada Corporation for repair can be shipped to the nearest BNC sales or service office. Carefully pack units using containers that will prevent damage during shipping.

SECTION IV

DRAWINGS

4-1 GENERAL

4-2 This section contains the engineering drawings, field wiring drawings and customer marking drawings that apply to the 9000 System Rack Assembly as ordered.

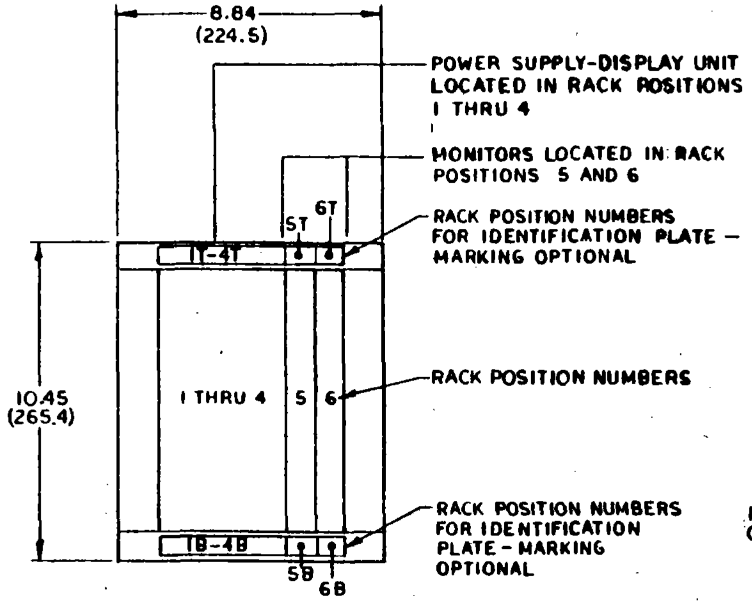
4-3 DRAWING LIST

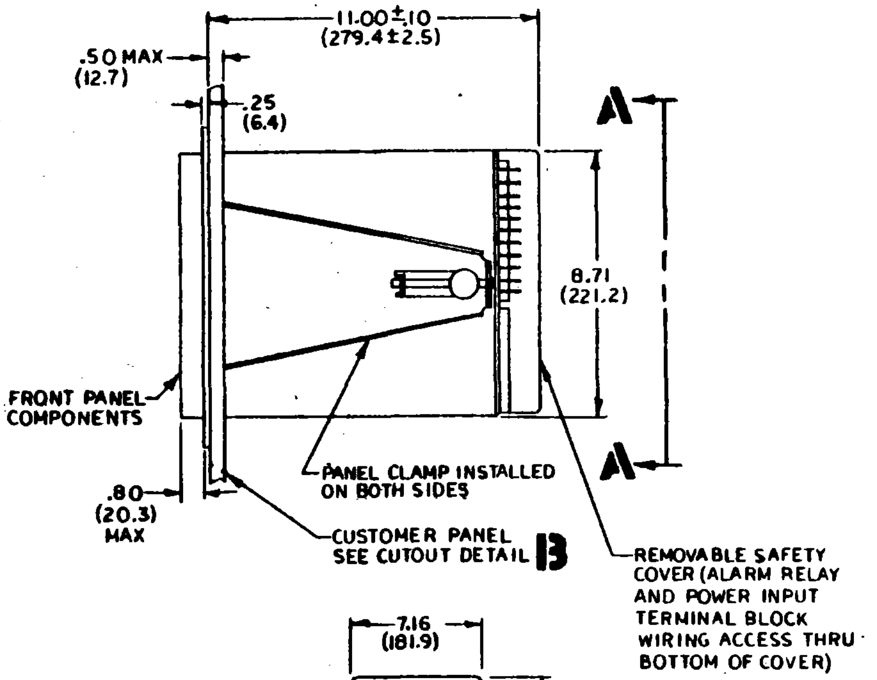
4-4

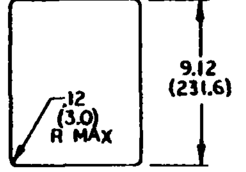
Drawing Number	Title
900XX	Outline, Monitor Rack System 9000 Series
72181	Outline, Weatherproof Door, 9000 and 7200 Series
90080	Outline, Weatherproof Housing 9000 Series
90029	Interconnecting Diagram, Rack Assemblies
90059	Schematic Diagram, Relay Module Assembly
XXXXX-XX	Field Wiring Diagrams
XXXXX	Customer Marking Drawings

1.2.23-208

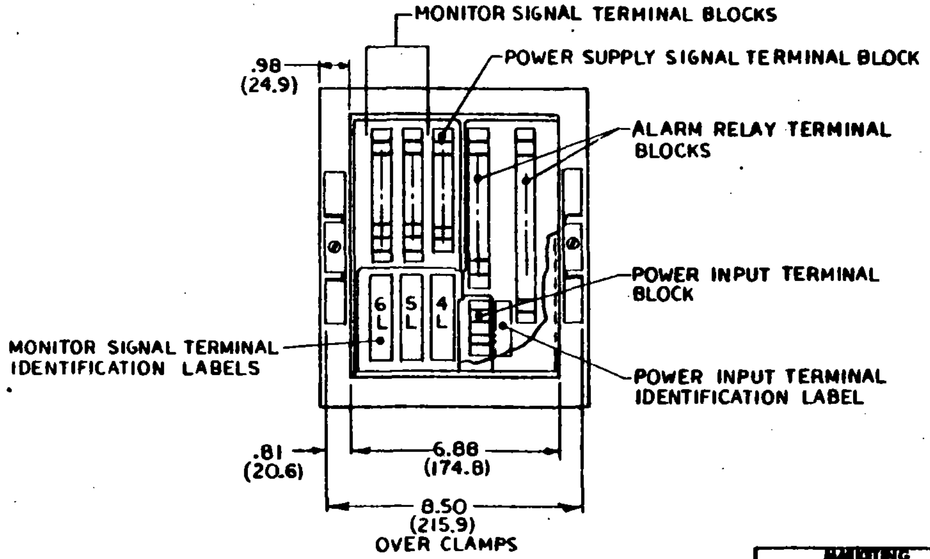
REVISION						
ZONE	LTR	DESCRIPTION	BY	DATE	APPD	DATE
	A	PRODUCTION RELEASE			RML	13 Oct 75







DETAIL B
PANEL CUTOUT



VIEW A A REAR

2. DIMENSIONS IN PARENTHESIS ARE MILLIMETERS
1. FOR POWER SUPPLY — DISPLAY PART NUMBERS AND MONITOR PART NUMBER AND POSITIONING, SEE SYSTEM LIST OF MATERIAL.

NOTES: UNLESS OTHERWISE SPECIFIED

SYSTEM PART NUMBER ____________

QTY	ITEM	CLASS	BNC NO./PART NO.	DESCRIPTION
LIST OF MATERIAL				

MARKING		
PREP. BY DATE		
CUST. NAME		
CUST. P.O.		
SALES ORDER NO.		
CUST. REF NO.		
REV. P/N	NEXT ASSY	USED ON
	APPLICATION	

UNLESS OTHERWISE SPECIFIED
FINISHED MACHINED SURFACES ✓
ANGULAR ±
FRACTIONAL ±
DECIMAL .XX = ±
.XXX = ±

DRAWN Siwicka	DATE 12 Sept 75
CHECK [illegible]	6 Oct 75
ENGRG. RMLW	13 Oct 75
MFG.	
APPD [illegible]	

BENTLY NEVADA
MINDEN-NEVADA
U.S.A.
LEADER IN PROXIMITY MEASUREMENTS

OUTLINE - 6 POSITION MONITOR
RACK SYSTEM 9000 SERIES

CODE IDENT NO. 20230 | SIZE C | DWG NO. 90020
SCALE NONE | WEIGHT | SHEET 1 OF 1

90020

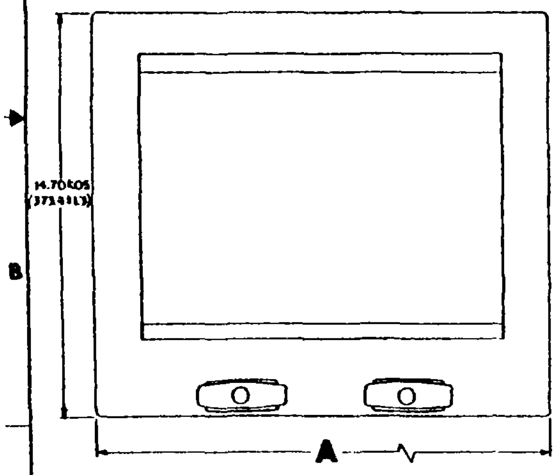
	A	ENGRG. RLSE	WD			
—	B	ADDED 9000 SERIES DATA	WG			

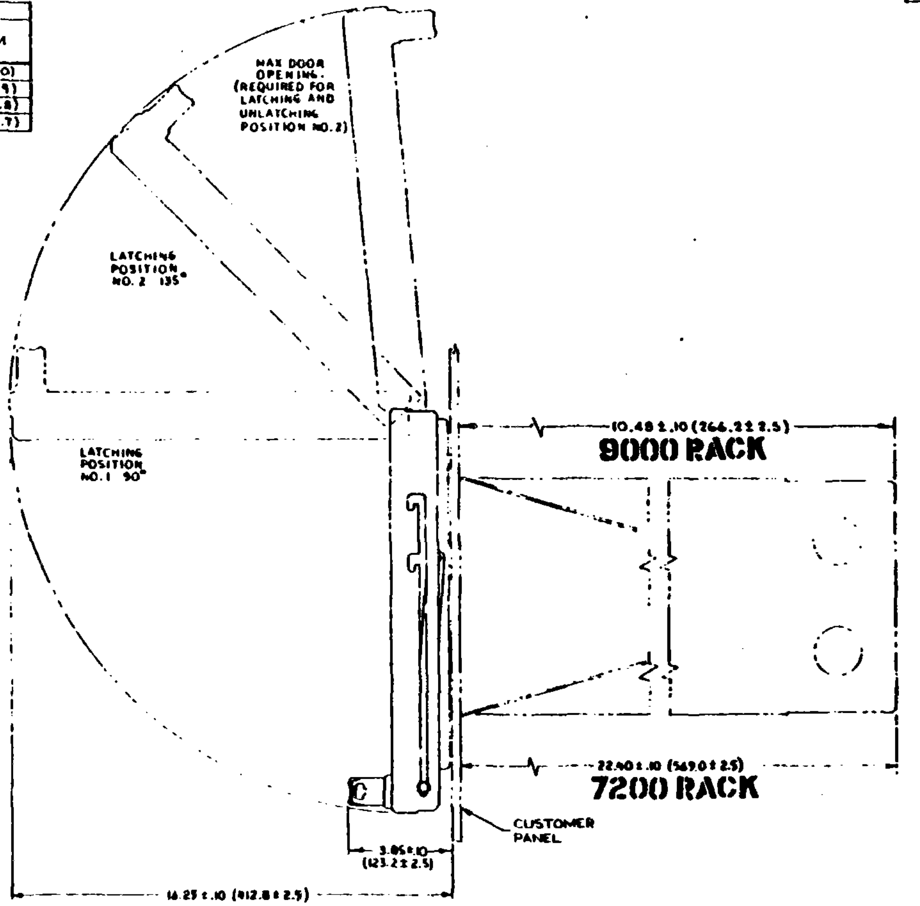
7200 SERIES

TABULATED DATA		
PART NO.	NUMBER OF RACK POSITIONS	"A" DIM
72191-01	4 POS	12.60 (320.0)
72191-02	6 POS	16.65 (422.9)
72191-07	8 POS	20.70 (525.8)
72191-04	10 POS	24.75 (628.7)
72191-05	12 POS	28.80 (731.5)
72191-06	14 POS	32.85 (834.4)

9000 SERIES

TABULATED DATA		
PART NO.	NUMBER OF RACK POSITIONS	"A" DIM
72191-01	8 POS	12.60 (320.0)
72191-02	12 POS	16.65 (422.9)
72191-03	16 POS	20.70 (525.8)
72191-07	6 POS	10.58 (268.7)





DWG CAT. NO. 72191 - ☐☐

1. DIMENSIONS IN PARENTHESIS ARE MILLIMETERS

REF. BY DATE		
CUST. NAME		
CUST. P.O.		
SALES ORDER NO.		9000
CUST. MF NO.		7200
REF. DW		
	APPLICATION	

BENTLY NEVADA

OUTLINE
WEATHERPROOF DOOR-
9000 / 7200 SERIES

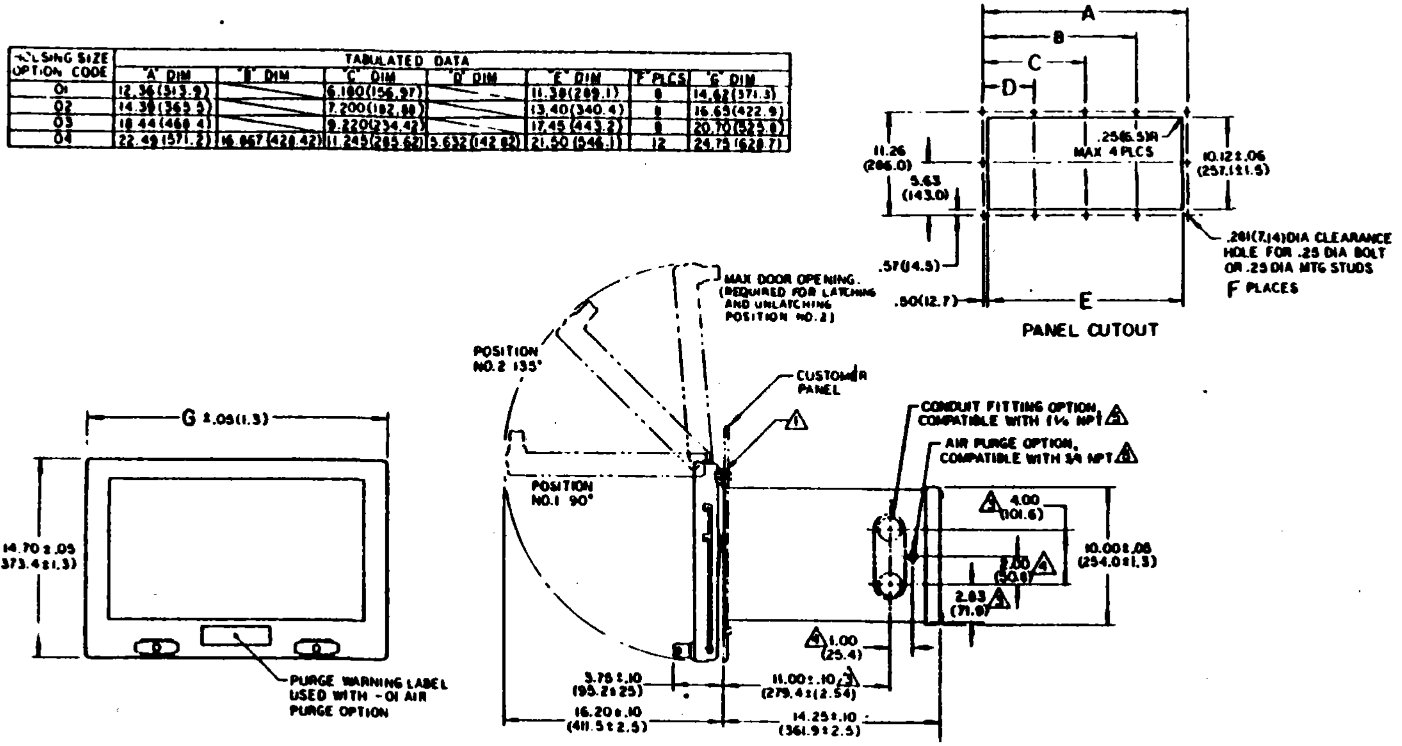
·20230 D 72181

SCALE: NONE

1 OF 1

	A	ENGRG. RELEASE
	B	REVISED REAR VIEW TO REFLECT PROPER RACK CONFIGURATION. PROD RLSE ECR 3848

HOUSING SIZE OPTION CODE	TABULATED DATA						
	'A' DIM	'B' DIM	'C' DIM	'D' DIM	'E' DIM	'F' PLCS	'G' DIM
01	12.36(313.9)		6.180(156.97)		11.38(289.1)	8	14.62(371.3)
02	14.39(365.5)		7.200(182.88)		13.40(340.4)	8	16.65(422.9)
03	18.44(468.4)		9.220(234.42)		17.45(443.2)	8	20.70(525.8)
04	22.49(571.2)	16.867(428.42)	11.245(285.62)	5.632(142.82)	21.50(546.1)	12	24.75(628.7)



BNC CAT NO. 90080 — ☐☐ — ☐☐ — ☐☐

OPTION CODE	HOUSING SIZE
01	6 POSITION RACK
02	8 POSITION RACK
03	12 POSITION RACK
04	16 POSITION RACK

OPTION CODE	CONDUIT FITTING OPTION
00	NO FITTINGS REQUIRED
01	CONDUIT FITTINGS REQUIRED △

OPTION CODE	AIR PURGE OPTION
00	NO AIR PURGE ACCESSORIES REQUIRED
01	AIR PURGE FITTING ONLY △

6. THIS HOUSING IS DESIGNED TO MEET NEMA-4 REQUIREMENTS.

△3 SEE SHEET 2 FOR: CONDUIT FITTING OPTION AND NOTES; AIR PURGE OPTION AND NOTES.

△4 LOCATING DIMENSIONS FOR AIR PURGE FITTING HOLES.

△5 LOCATING DIMENSIONS FOR CONDUIT FITTING HOLES.

2. DIMENSIONS IN PARENTHESIS ARE MILLIMETERS

△1 THREAD SEAL WASHERS ARE SUPPLIED WITH ALL HOUSINGS. THESE WASHERS SHALL BE INSTALLED UNDER ALL INTERNAL HEADS OF MOUNTING BOLTS OR NUTS TO OBTAIN A WATERTIGHT SEAL.

△7 CONDUIT FITTING OPTION (-01) INCLUDES FOUR 1¼ NPT WEATHERPROOF HUBS. AIR PURGE FITTING OPTION (-01) INCLUDES ONE ¾ NPT WEATHERPROOF HUB, WITH FITTINGS TO REDUCE DOWN TO ¼ NPT (FEMALE) FOR AIR INPUT

9000

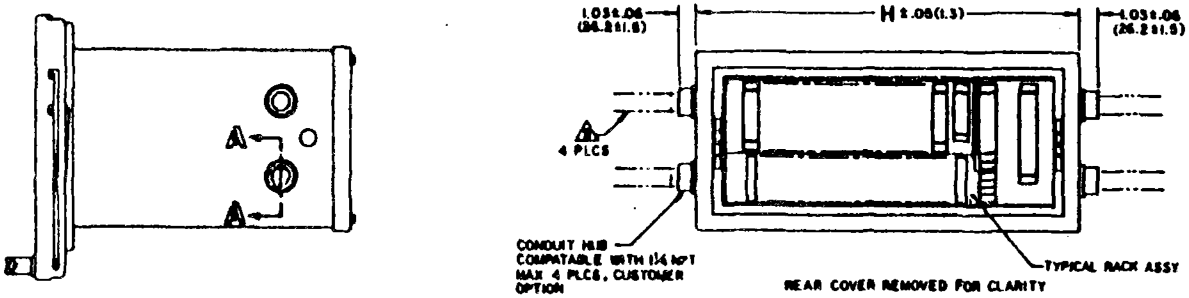
BENTLY NEVADA

OUTLINE
WEATHERPROOF HOUSING
9000 SERIES

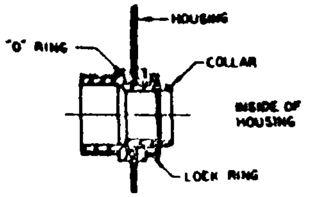
20230 D 90080

REVISIONS				
	E	DEL SHEET 1		✓

TABULATED DATA	
HOUSING SIZE OPTION CODE	"H" DIM
01	10.87(276.0)
02	12.90(327.7)
03	16.95(430.5)
04	21.00(533.4)



TYPICAL WEATHERPROOF HOUSING ASSEMBLY
SHOWING CONDUIT FITTING OPTION (72174-01)



SECTION A-A
NO SCALE

△ CONDUIT FILL: PERCENTAGE OF CONDUIT FILL SHOULD NOT EXCEED 40% AS SPECIFIED IN NATIONAL ELECTRICAL CODE, 1975, CHAPTER 9, TABLES 1 & 2.

8. WIRE ROUTING: BOTH UPPER CONDUITS ARE FOR TRANSDUCER POWER, SIGNAL INPUT AND RECORDER OUTPUT WIRING. BOTH LOWER CONDUITS ARE FOR POWER INPUT AND RELAY WIRING. POWER INPUT AND RELAY WIRING SHOULD NOT BE MIXED IN THE SAME CONDUIT WITH TRANSDUCER, SIGNAL AND RECORDER WIRING.

[illegible]

20230	D	900EC

A	ENGRG RLSE FOR PILOT RUN		

TABLE I ⚠2

UNIT	TB PIN NO. / FUNCTION									
	1	2	3	4	5	6	7	8	9	10
DUAL RV	V_T A	COM A	PROX A	V_T B	COM B	PROX B	REC A	COM A	REC B	COM B
OVP	V_T A	COM A	PROX A	V_T B	COM B	PROX B	REC A	COM A	REC 6	COM B
DUAL RTD	RTD A			RTD B			REC A	COM A	REC B	COM B
DUAL TC	+TC A	−TC A	+TC B	−TC B	COM	COM	REC A	COM A	REC B	COM B
ACC	V_T	COM	XDCR	—	—	—	REC	COM	—	—
POS MONITOR	V_T	COM	PROX	—	—	—	REC	COM	—	—
RV	V_T	COM	PROX	—	—	—	REC	COM	—	—
PWR SUPPLY	KEY Ø V_T	KEY Ø COM	KEY Ø PROX	REMOTE RESET		—	—	—	—	—

⚠3 ASSY 90236-01 AND W1 ARE TO BE INSTALLED ONLY WHEN A DUAL TC MONITOR (90225) IS REQUIRED.

⚠2 SEE TABLE I FOR TB PIN FUNCTIONS, TYPICAL ALL POSITIONS.

⚠1 ALL ELECTRICAL CONNECTIONS ARE TYPICAL FOR ALL POSITIONS (J3 THRU J14 & TB2 THRU TB13) J5 THRU J13 & TB4 THRU TB12 ARE NOT SHOWN FOR CLARITY.

90065	9000
90060	9000
APPLICATION	

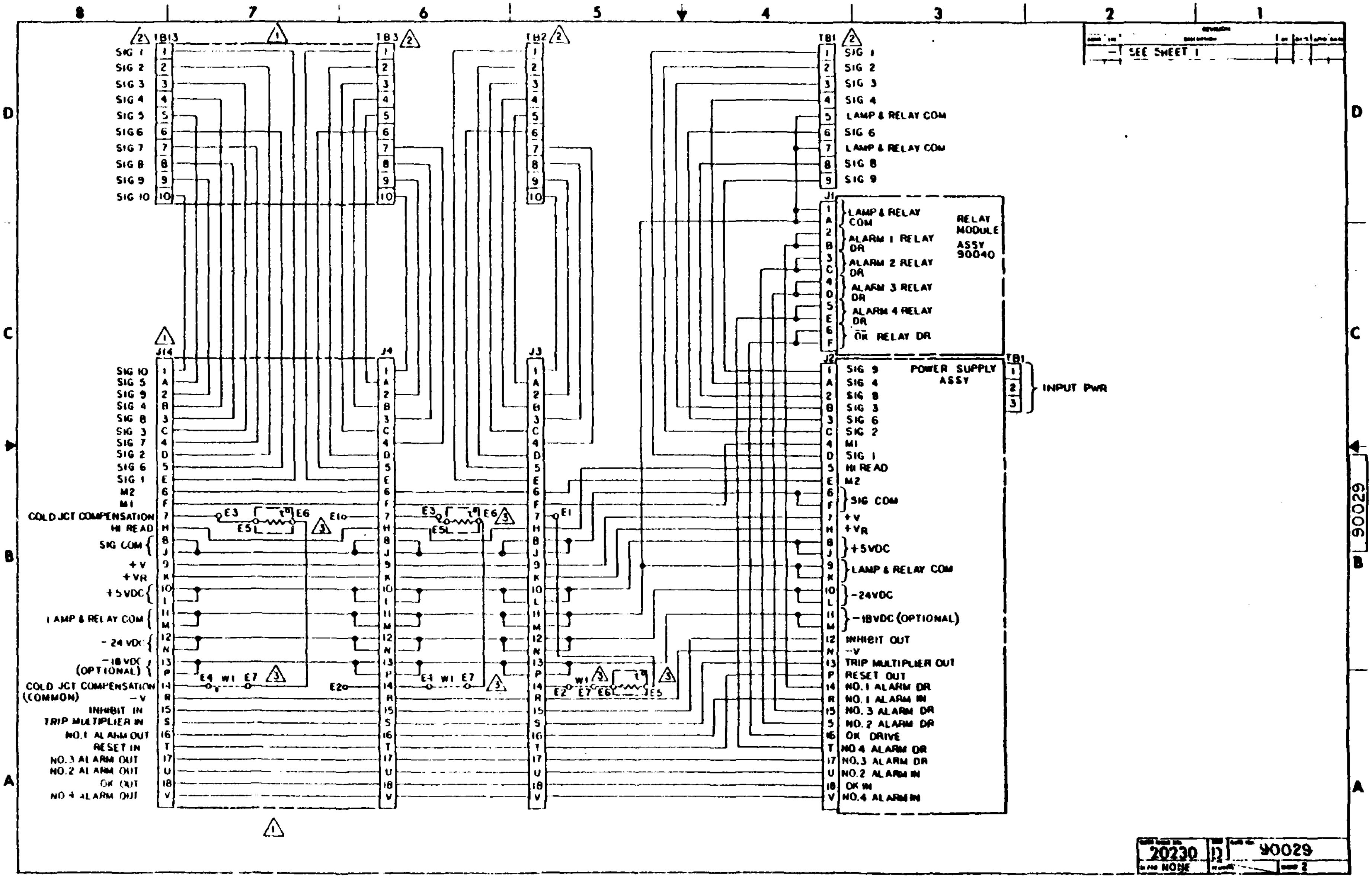
BENTLY NEVADA

INTERCONNECTING DIAGRAM
RACK ASSEMBLIES

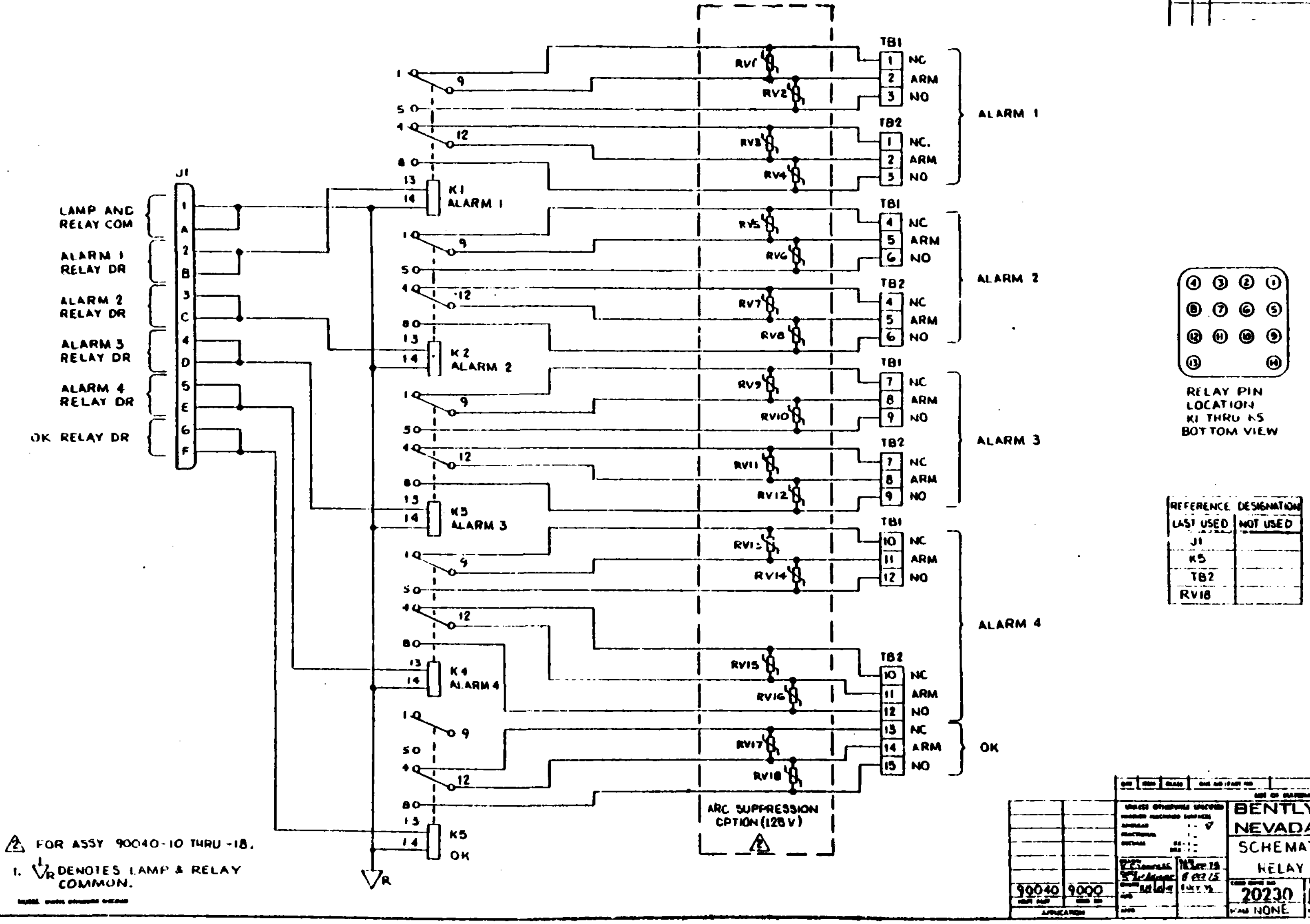
20230 D 90029

SCALE NONE

SHEET 1 OF 2


8
7
6
5
4
3
2
1
D
C
B
A
SEE SHEET 1
TB13
TB3
TB2
TB1
SIG 1
SIG 2
SIG 3
SIG 4
SIG 5
SIG 6
SIG 7
SIG 8
SIG 9
SIG 10
LAMP & RELAY COM
J1
LAMP & RELAY COM
ALARM 1 RELAY DR
ALARM 2 RELAY DR
ALARM 3 RELAY DR
ALARM 4 RELAY DR
OK RELAY DR
RELAY MODULE ASSY 90040
J14
J4
J3
J2
POWER SUPPLY ASSY
TB1
INPUT PWR
M2
M1
COLD JCT COMPENSATION
HI READ
SIG COM
+V
+VR
+5VDC
LAMP & RELAY COM
-24 VDC
-18 VDC (OPTIONAL)
COLD JCT COMPENSATION (COMMON)
-V
INHIBIT IN
TRIP MULTIPLIER IN
NO.1 ALARM OUT
RESET IN
NO.3 ALARM OUT
NO.2 ALARM OUT
OK OUT
NO 4 ALARM OUT
E1
E2
E3
E4
E5
E6
E7
W1
INHIBIT OUT
TRIP MULTIPLIER OUT
RESET OUT
NO.1 ALARM DR
NO.1 ALARM IN
NO.3 ALARM DR
NO.2 ALARM DR
OK DRIVE
NO.4 ALARM DR
NO.3 ALARM DR
NO.2 ALARM IN
OK IN
NO.4 ALARM IN
-18VDC (OPTIONAL)
20230
D
90029
NONE
2
90029

1.2.23-273



2 FOR ASSY 90040-10 THRU -18.

1. ∇_R DENOTES LAMP & RELAY COMMON.

REFERENCE	DESIGNATION
LAST USED	NOT USED
J1	
K5	
TB2	
RV18	

BENTLY NEVADA

SCHEMATIC DIAGRAM

RELAY MODULE

90040	9000

20230 D 90059

NONE

1 OF 1

1.2.23-274

90059

BENTLY
NEVADA

9000 SERIES

FIELD WIRING DIAGRAMS

SYSTEM NO. 9001253-01

CERTIFICATION

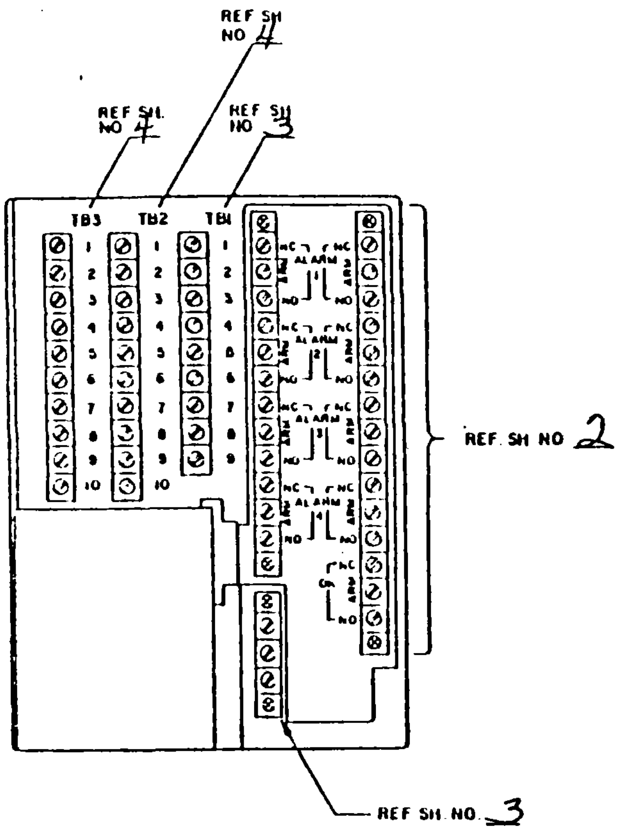
PER YOUR REQUEST, THIS DRAWING
SHEETS 1 THROUGH 4
IS CERTIFIED PER YOUR PURCHASE
ORDER

Signed Norma Arnold Date 18 Aug. 80
MANAGER, CUSTOMER DOCUMENTATION

MARKETING	
PREP BY	DATE
N ARNOLD	18 AUG. 80
CUST. NAME	
BINGHAM WILLAMETTE	
CUST. P.O.	
1-63857	
SALES ORDER NO.	
77571-00	
CUST REF. NO.	
DWG NO.	
57046	

1.2.23-275

BNC 492 M (b)



RACK, REAR VIEW

2 THE RELAY MODULE AND POWER INPUT TERMINALS ARE ENCLOSED BY A SAFETY COVER. THE SAFETY COVER SHOULD BE REMOVED DURING WIRING. ALL WIRING SHOULD BE ROUTED THROUGH THE BOTTOM OPENING OF THE SAFETY COVER

1 FOR RACK DIMENSIONS, REFERENCE DRAWING 90020.

NOTES: UNLESS OTHERWISE SPECIFIED

QTY	ITEM	CLASS	DWG NO / PART NO	DESCRIPTION

LIST OF MATERIAL

MARKETING
PREP. B. DATE
CUST. NAME
CUST. P.O.
SALES ORDER NO.
CUST. REF NO.
REV. P.P.

UNLESS OTHERWISE SPECIFIED
FINISHED MACHINED SURFACES ✓
ANGULAR ±
FRACTIONAL ±
DECIMAL

DRAWN L WOOD DATE APR 76
CHECK
ENGRG [illegible] 29APR 76
MFG
APPD

BENTLY NEVADA
MINDEN, NEVADA
U.S.A
LEADER IN PROXIMITY MEASUREMENTS

6 POSITION RACK
LOCATION AND WIRING REFERENCE DRAWING

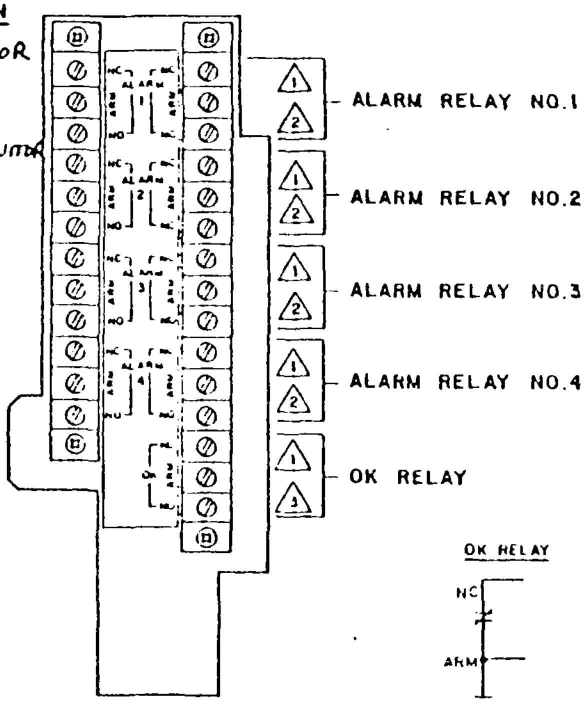
CODE IDENT NO 20230
SIZE C
DWG NO 57046
FORM NO 50093
SHEET 1 of 4

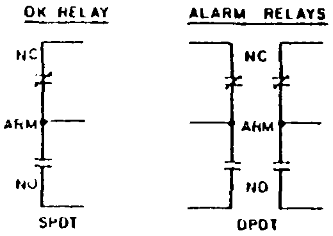
1.2.23-277

REVISION						
ZONE	LTR	DESCRIPTION	BY	DATE	APPD	DATE

ALARM RELAY FUNCTION

1. ALERT- DUAL RV MONITOR
   POSN. 5, 6
2. DANGER- DUAL RV MONITOR
   POSN. 5, 6
3.
4.





90040-04

5

OPTION CODE	APPLICABLE RELAYS		ARC SUPPRESSORS (6)
	OK RELAY	ALARM RELAYS	
01	INSTALLED	NONE	OMITTED
02	INSTALLED	NO. 1	OMITTED
03	OMITTED	NO. 1	OMITTED
04	INSTALLED	NO. 1 & 2	OMITTED
05	OMITTED	NO. 1 & 2	OMITTED
06	INSTALLED	NO. 1, 2 & 3	OMITTED
07	OMITTED	NO. 1, 2 & 3	OMITTED
08	INSTALLED	NO. 1, 2, 3 & 4	OMITTED
09	OMITTED	NO. 1, 2, 3 & 4	OMITTED
10	INSTALLED	NONE	INSTALLED
11	INSTALLED	NO. 1	INSTALLED
12	OMITTED	NO. 1	INSTALLED
13	INSTALLED	NO. 1 & 2	INSTALLED
14	OMITTED	NO. 1 & 2	INSTALLED
15	INSTALLED	NO. 1, 2 & 3	INSTALLED
16	OMITTED	NO. 1, 2 & 3	INSTALLED
17	INSTALLED	NO. 1, 2, 3 & 4	INSTALLED
18	OMITTED	NO. 1, 2, 3 & 4	INSTALLED

6. ARC SUPPRESSOR VOLTAGE RATING: 150 VAC RMS MAX

5. THE RELAY MODULE CATALOG NUMBER DETERMINES THE NUMBER OF RELAYS INSTALLED.

4. RELAY CONTACT RATING: 3 AMP @ 26 VDC OR 120 VAC RESISTIVE. CONTACT MATERIAL: GOLD FLASHED SILVER.

3. THE OK RELAY IS WIRED TO ALL SYSTEM VIBRATION OR POSITION MONITORS (NOT USED WITH TC OR RTD TEMP MONITORS) AND IS USED TO INDICATE FAULTY TRANSDUCER OPERATION. THE OK RELAY IS ALWAYS NORMALLY ENERGIZED AND WILL REVERT TO DE-ENERGIZED CONDITION DURING A TRANSDUCER FAULT OR POWER OUTAGE.

2. REFER TO POWER SUPPLY CATALOG NUMBER TO DETERMINE ENERGIZE TO ALARM OR DE-ENERGIZE TO ALARM OPERATION.

1. CONTACT MARKINGS, ARM-NO-NC, AND THE SCHEMATIC REPRESENTATIONS REFER TO THE DE-ENERGIZED (SHELF) CONDITION OF THE RELAYS.

NOTES: UNLESS OTHERWISE SPECIFIED

QTY	ITEM	CLASS	DWG NO / PART NO	DESCRIPTION

LIST OF MATERIAL

MARKETING
PREP. BY DATE
CUST. NAME
CUST. P.O.
SALES ORDER NO.
CUST. REF NO.
PREV. P/N

UNLESS OTHERWISE SPECIFIED
FINISHED MACHINED SURFACES
ANGULAR ± ✓
FRACTIONAL ±
DECIMAL .XX ± .
.XXX ± .

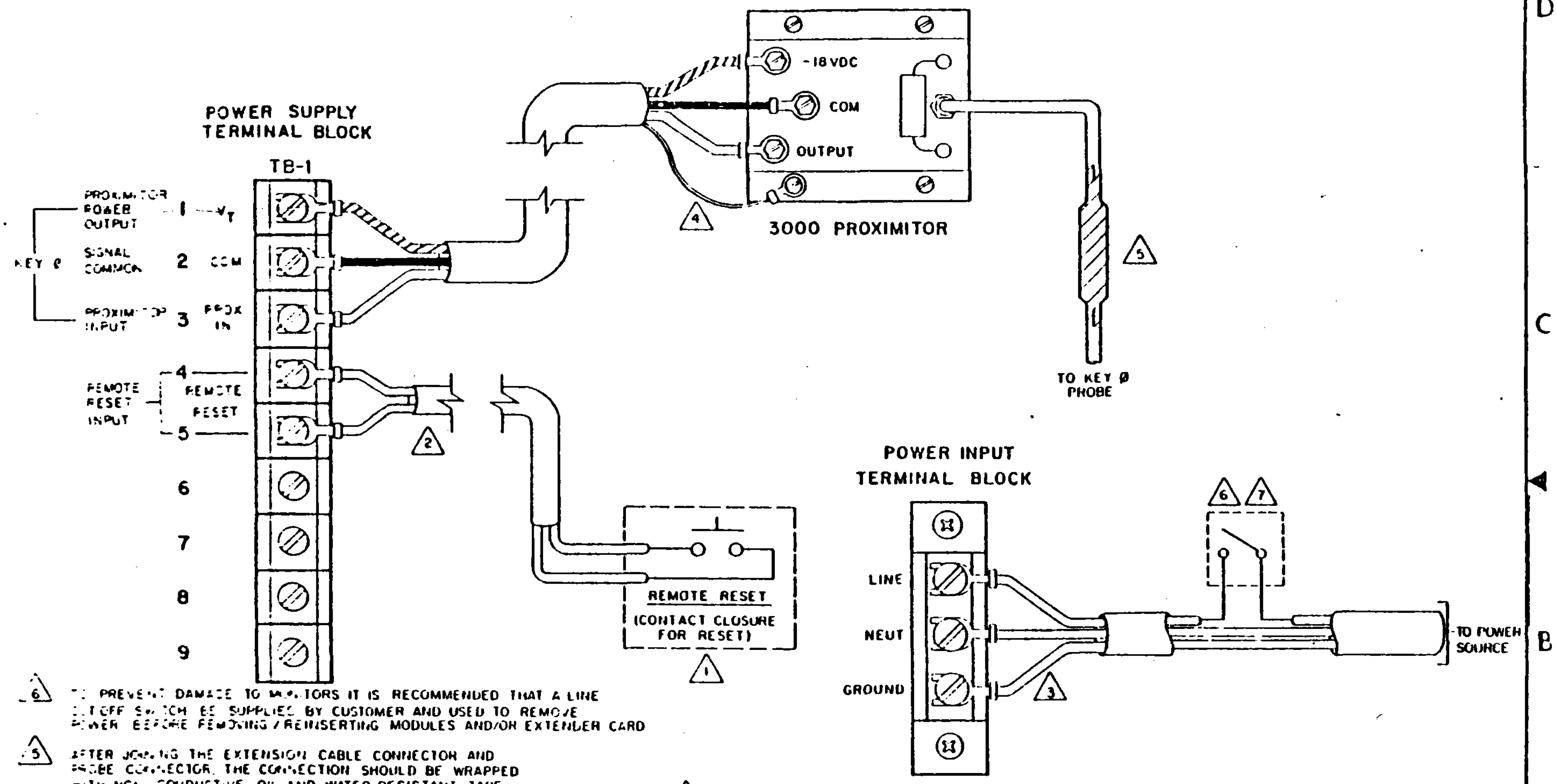
DRAWN [illegible] DATE APR 76
CHECK
PHOTO [illegible] [illegible] 76
MFG
APPD

BENTLY NEVADA
MINDEN NEVADA
U.S.A.
LEADER IN PROXIMITY MEASUREMENTS

RELAY MODULE INTERCONNECT

CODE IDENT NO 20230
SIZE C
DWG NO 57046
FORM NO 50101
SHEET 2

ZONE	LTR	DESCRIPTION		DATE	APPD	DATE
	A	ADDED LINE CUT OFF SWITCH	DE			



6. TO PREVENT DAMAGE TO MONITORS IT IS RECOMMENDED THAT A LINE CUTOFF SWITCH BE SUPPLIED BY CUSTOMER AND USED TO REMOVE POWER BEFORE REMOVING/REINSERTING MODULES AND/OR EXTENDER CARD

5. AFTER JOINING THE EXTENSION CABLE CONNECTOR AND PROBE CONNECTOR, THE CONNECTION SHOULD BE WRAPPED WITH NON-CONDUCTIVE, OIL AND WATER RESISTANT TAPE

4. SHIELD TERMINATED TO PROXIMITOR CASE

3. WIRE GAUGE AND TYPE SELECTED PER LOCAL CODE REQUIREMENTS. POWER REQUIREMENTS ARE: 95-125 VAC, 50-60HZ, 10 AMP MAX.

2. WIRING RECOMMENDATIONS 22 AWG STRANDED OR SOLID WITH INSULATING SHEATH. SHIELDING NOT REQUIRED.

1. RESET CONTACTS SHOWN FOR CLARITY ONLY, NOT SUPPLIED WITH SYSTEM.

7. WARNING: REMOVING POWER MAY CAUSE ALARM/TRIP CONDITION

NOTES UNLESS OTHERWISE SPECIFIED

QTY	ITEM	CLASS	DWG NO / PART NO	DESCRIPTION

LIST OF MATERIAL

MARKETING
PREP. BY DATE
CUST. NAME
CUST. P.O.
SALES ORDER NO.
CUST. REF. NO.
REF. PT.

UNLESS OTHERWISE SPECIFIED
FINISHED MACHINED SURFACES ✓
ANGULAR ±
FRACTIONAL ±
DECIMAL .XX ± .XXX ±
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MFG
APPD

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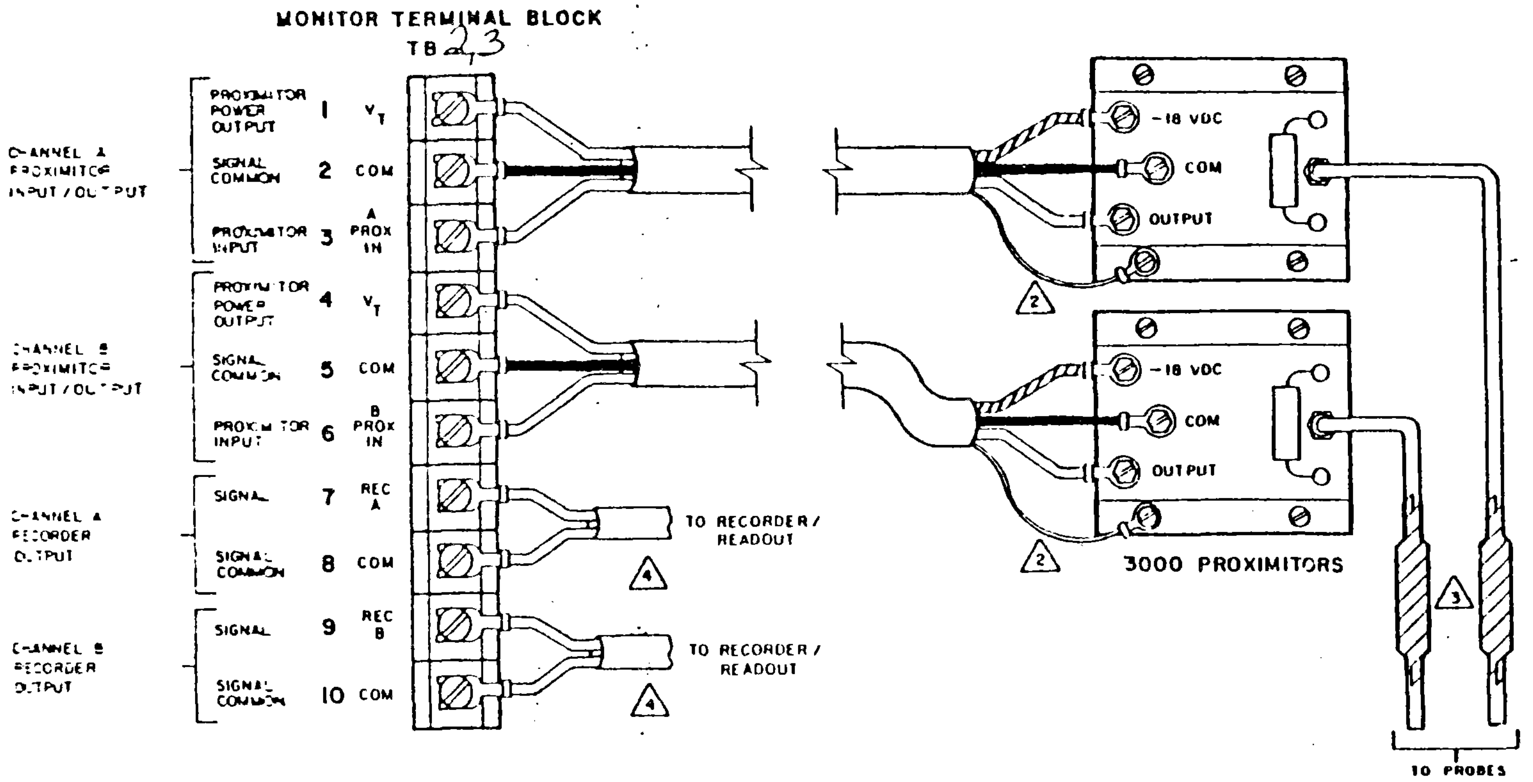
POWER SUPPLY TERMINAL BLOCK - POWER INPUT - PROXIMITOR INTERCONNECT

CODE IDENT NO 20230
SIZE C
DWG NO 57046
FORM NO 50098
SHEET 3

1.2.23-279

ZONE	LTR	REVISION DESCRIPTION	APPD	DATE



△4 OBSERVE POLARITY WHEN CONNECTING TO RECORDER OUTPUT TERMINALS. THE REC TERMINAL IS NEGATIVE WITH RESPECT TO THE COM TERMINAL FOR NEGATIVE VOLTAGE RECORDER OPTIONS AND POSITIVE FOR POSITIVE VOLTAGE RECORDER OPTIONS. CURRENT FLOWS OUT OF THE COM TERMINAL AND INTO THE REC TERMINAL FOR CURRENT RECORDER OPTIONS.

△3 AFTER JOINING THE EXTENSION CABLE CONNECTOR AND PROBE CONNECTOR, THE CONNECTION SHOULD BE WRAPPED WITH NON-CONDUCTIVE, OIL AND WATER RESISTANT TAPE.

△2 SHIELD TERMINATED TO PROXIMITOR CASE.

1. WIRING RECOMMENDATIONS:

   TERMINAL BLOCK TO PROXIMITOR : 18 TO 22 AWG SOLID OR STRANDED, 3 WIRE SHIELDED WITH INSULATING SHEATH, 1000 FT MAXIMUM.

   TERMINAL BLOCK TO RECORDER / READOUT : 18 TO 22 AWG SOLID OR STRANDED 2 WIRE SHIELDED WITH INSULATING SHEATH, 1000 FT MAXIMUM.

NOTES UNLESS OTHERWISE SPECIFIED

QTY	ITEM	CLASS	DWG NO / PART NO	DESCRIPTION

LIST OF MATERIAL

MARKETING
PREP. BY DATE
CUST. NAME
CUST. P.O.
SALES ORDER NO.
CUST. REF NO.
PREV. P/N

UNLESS OTHERWISE SPECIFIED
FINISHED MACHINED SURFACES ✓
ANGULAR ±
FRACTIONAL ±
DECIMAL .XX ±
.XXX ±

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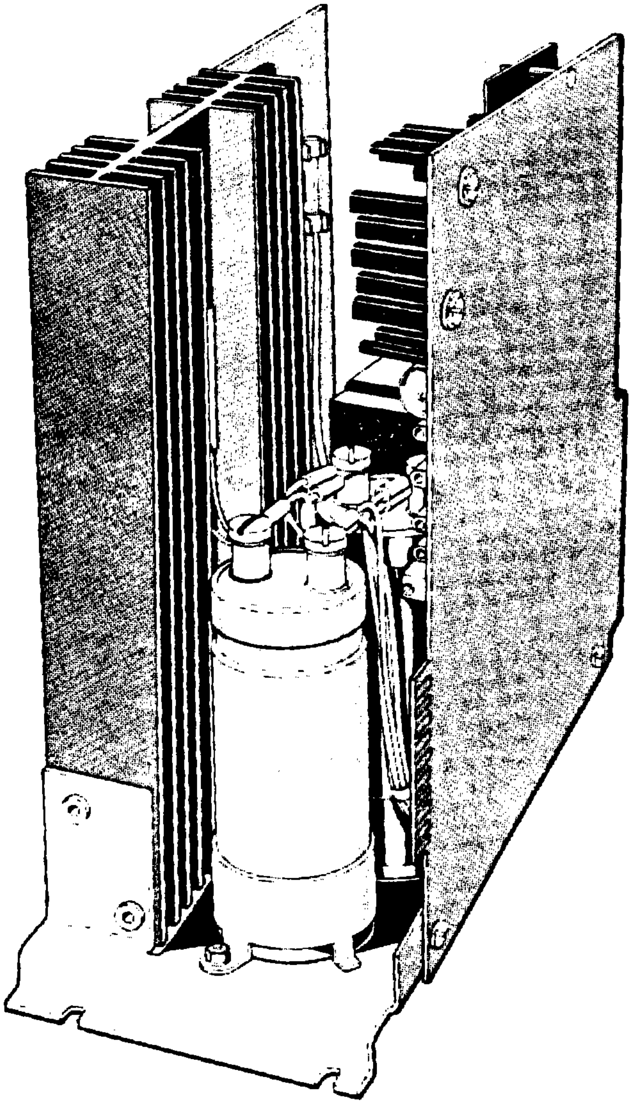
TERMINAL BLOCK – PROXIMITOR INTERCONNECT
DUAL CHANNEL VIBRATION OR POSITION MONITOR

CODE IDENT NO 20230
SIZE C
DWG NO 57046
FORM NO 50105
SHEET 4

OPERATION AND MAINTENANCE MANUAL



9000 SERIES POWER SUPPLY

MODEL 90050

REV. JAN. 1978

SPECIFICATIONS

90050 POWER SUPPLY

INPUTS

Power	
115 Vac option	95 to 125 Vac, 1 Ø, 50-60 Hz, 1.0 amp max (fused at 1.5 amps)
220 Vac option	190 to 250 Vac, 1 Ø, 50-60 Hz, 0.5 amp max (fused at 0.75 amp)
Nominal power consumption	100 watts (nominal value given is for a typical 16P system including power supply, monitors and relays)

OUTPUTS

Unregulated voltages	
$+V_R$	+9.0 to +15 Vdc at 2.0 amps max
+V	+28 to +49 Vdc at 0.25 amp max
-V	-29 to -48 Vdc at 1.5 amps max
Regulated voltages	
+5	+5.0 Vdc, ±0.25 Vdc at 400 ma max
-24 Vdc	-24.0 Vdc, ±0.1 Vdc at 1.0 amp max
-18 Vdc	-18.0 Vdc, -0.22 +0.38 Vdc at 360 mA max

ENVIRONMENTAL LIMITS

Rated performance	0 to +65°C
Long term storage	-40 to +85°C
Relative humidity	To 95% noncondensing

WEIGHT

9 lbs (4.08 kg) includes display module

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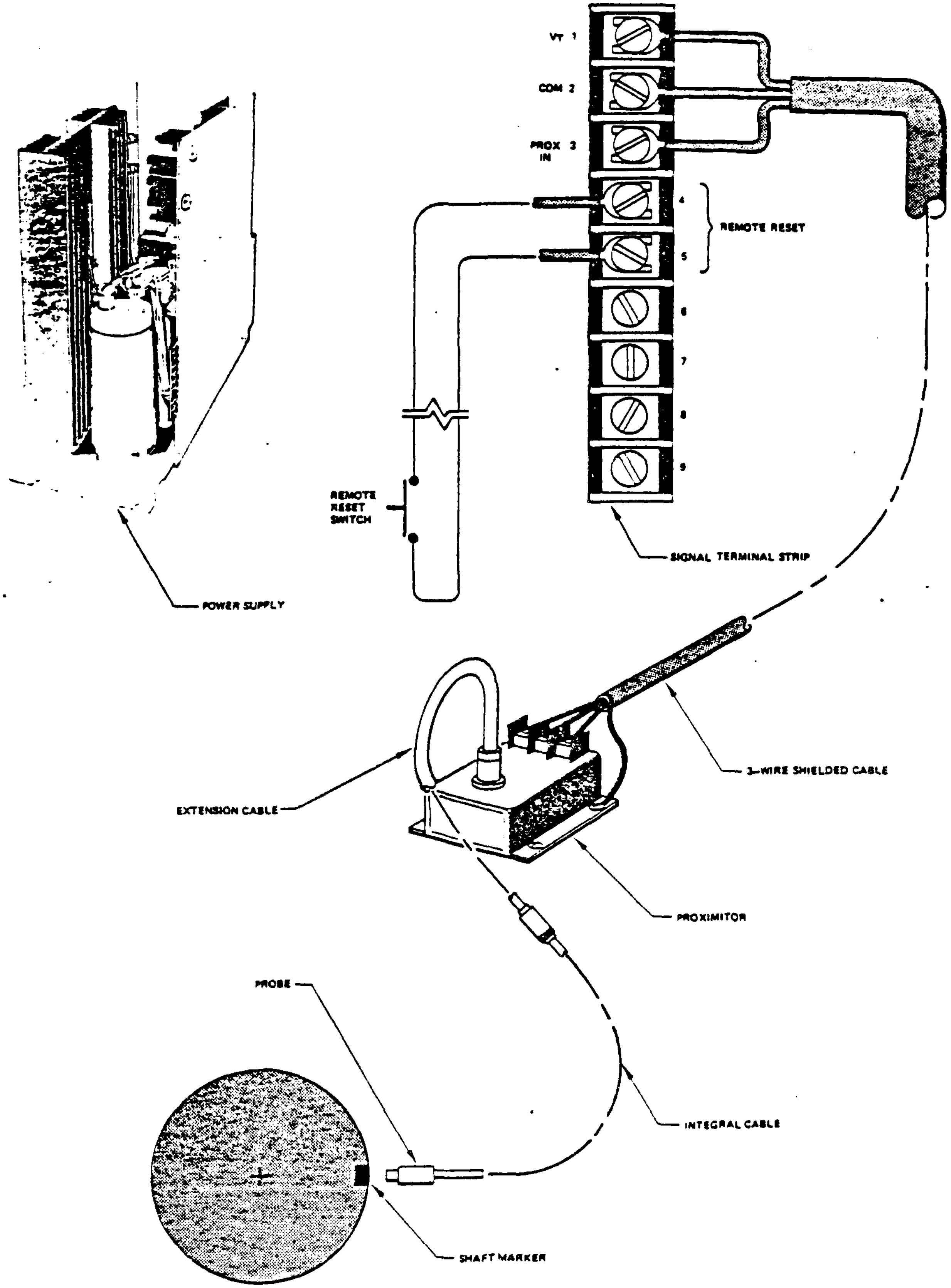


Figure 1-1. Power Supply System

SECTION I

GENERAL INFORMATION

1-1 GENERAL

1-2 The 9000 Series AC Power Supply shown in Figure 1-1 is comprised of a printed circuit board mounted to a sheet metal chassis assembly. The printed circuit board contains the voltage regulators, test points and latching OK and alarm reset circuit. The circuit board also contains the alarm and OK relay drive circuits for a 9000 System that employs either the 90060-XX or 90085-XX rack assembly (without individual relays). If the 9000 System employs the 90220-XX rack assembly (with individual relays located across the lower rear) the relay drive circuits are located in the relay modules. The chassis assembly contains a transformer, large heat sink, ac line fuses with adjacent spares, rectifiers, and filter capacitors. The primary function of the power supply is to provide all regulated or unregulated dc voltages to the 9000 Series instrument rack. The dc voltages are used to power all monitors within the rack assembly and all associated transducers.

1-3 When applicable, the power supply can be used with an auxiliary Keyphasor probe and Proximitor. The Keyphasor probe observes a shaft marker to produce a pulse train having a frequency proportional to rotational speed. A front panel Keyphasor output is not available in temperature systems employing a digital display module.

1-4 STANDARD OPTIONS

1-5 Standard options are installed at the factory according to the catalog number specified by the user. The standard options included in this system are shown in Table 1-1. The input power can be either 95 to 125 Vac or 190 to 250 Vac depending on the primary power requirement. The -24 volt transducer power is required for the 7000 and 7200 Series Proximitors, and the -18 volt supply is used for the 3000 Series Proximitors. If no Proximitors are used in the system the -24 volt transducer option is specified.

1-6 FIELD CHANGEABLE OPTIONS

1-7 All standard options are installed at the factory according to the catalog number specified by the user. However, the alarm relay options can be changed in the field to meet new requirements. When installed in a rack without individual relays, any of the four alarm relays can be connected for normally de-energized or normally energized operation by relocating a jumper wire in the power supply. See Section II, Paragraph 2-5 and Figure 2-1, for detailed instructions. If installed in a rack with individual relays, refer to the Rack Assembly Operation and Maintenance Manual 8029270 (Individual Relays) for instructions relative to relay configuration.

TABLE 1-1. OPTION LIST

BNC CATALOG NUMBER

90050 01 00 00 01 01 01 01

	POWER INPUT		TRANSDUCER POWER		POWER UP INHIBIT		ALARM RELAY NO. 1		ALARM RELAY NO. 2		ALARM RELAY NO. 3		ALARM RELAY NO. 4
						00	*	00	*	00	*	00	*
01	95-125 Vac 50-60 Hz 1 Phase	00	-24 Vdc	00	Not Required	01	Normally De-energized	01	Normally De-energized	01	Normally De-energized	01	Normally De-energized
		01	-18 Vdc & -24 Vdc	01	Required								
02	190-250 Vac 50-60 Hz 1 Phase					02	Normally Energized	02	Normally Energized	02	Normally Energized	02	Normally Energized

* EQUIPPED WITH INDIVIDUAL RELAYS; SEE 9000 RACK ASSEMBLY MANUAL 8029270.

1-8 MODIFICATIONS

1-9 Modifications are changes to the power supply that are not covered by the standard options and the field changeable options. The changes, if any, are described in the modification documents that immediately follow Section I of this manual. Modification document numbers are marked on the chassis label and circuit board. These numbers should be used when ordering replacement units.

1-10 <u>OPERATIONAL DESCRIPTIONS</u>

1-11 UNREGULATED VOLTAGES

1-12 As shown in Figure 1-2, the 9000 Series Power Supply receives primary power through the terminal strip on the rear and through fuses to the transformer. The transformer provides secondary ac voltages that are rectified to provide one negative and two positive unregulated dc voltages. The voltages are: -V(-29 to -48 volts), + V(+28 to +49 volts) and $+V_R$ (+9.0 to +15.0 volts). The three unregulated voltages are applied to the rack assembly for distribution to all monitors in the system. The unregulated voltages also are used within the power supply for regulation circuits and an optional power-up-inhibit circuit.

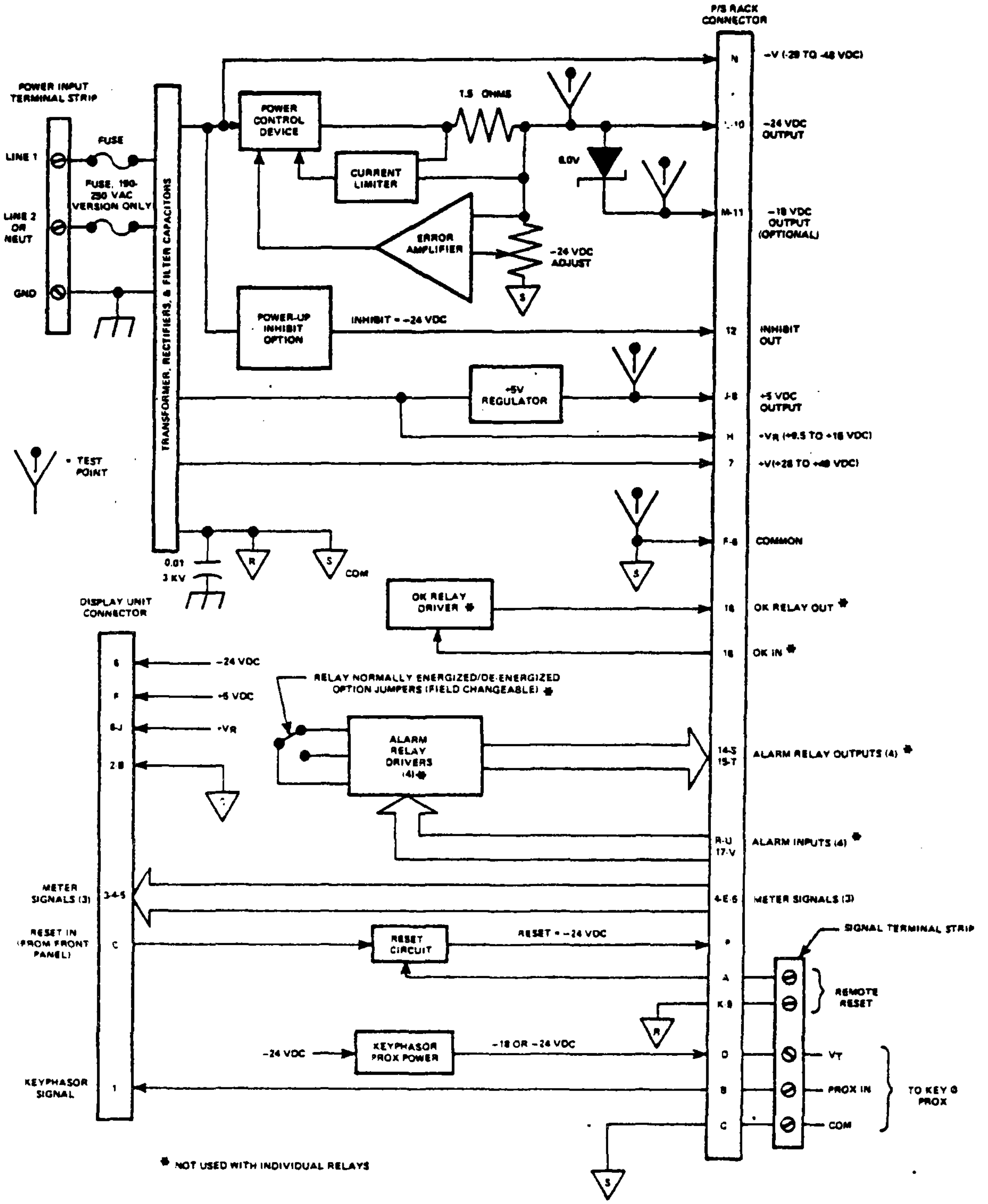
1-13 REGULATED VOLTAGES

1-14 The power supply also provides three regulated dc voltages: +5 volts, -24 volts, and an optional -18 volts. The voltages are short circuit protected within the power supply and are applied to the rack assembly for distribution. The -24 volt supply and optional -18 volt supply are used to power Proximitors and similar devices. The -24 volt supply is required for monitor circuitry and will always be included with the -18 volt option.

1-15 The +5 volt regulator is a single integrated circuit fed by $+V_R$. The device provides all the regulation and protection for the +5 volt supply. The -24 volt regulator contains three major elements: an error amplifier, a power control device mounted on a large heat sink, and a current limiter. The error amplifier is a feedback circuit that compares the regulator output voltage to a reference voltage. When the output voltage tends to increase or decrease, a signal is fed to the power control device causing the voltage to remain constant at -24 volts. The current limiter monitors the output current and, if the current reaches approximately 1.0 to 1.2 amperes, turns off the power control device to prevent excessive current flow. During short circuit conditions the current limiter will hold the output current to approximately 0.6 amperes so that the power control device will not overheat. The -18 volt supply is derived from the -24 volt supply by use of a zener diode regulator which effectively subtracts 6 volts from the 24 volts.

1-16 RESET CIRCUITS

1-17 The reset circuits are activated by pressing the front panel COMMON RESET switch or by closing a remote switch connected between terminals 4 and 5



* NOT USED WITH INDIVIDUAL RELAYS

Figure 1-2. Power Supply Functional Block Diagram on TB1 on the rear of the power supply. The reset signal is fed to all monitors in the system and resets any latching alarm or OK circuit that is not receiving an alarm level signal. The non-latching alarm and OK circuits automatically reset.

1-18 OK AND ALARM

1-19 Some monitors have OK circuits to detect transducer or field wiring malfunctions. When such a malfunction occurs, a not-OK signal is fed to the OK driver (refer to Figure 1-2). If equipped with individual relays, the not-OK signal is fed to the OK relay module which contains the relay drive circuit. The OK driver then causes the OK relay (optional) to de-energize or drop out.

1-20 If any of the alarm levels in the monitors are exceeded, one of the four alarm buses will receive a signal that will be passed on to the applicable alarm driver (refer to Figure 1-2). If equipped with individual relays, the alarm signal is fed directly or via a rack bus to the appropriate alarm relay module which contains the relay drive circuit. The alarm relay driver will amplify the signal, then pass it on to the alarm relay.

1-21 POWER-UP-INHIBIT

1-22 The power-up-inhibit option automatically disables the monitor alarm circuits and signals a not-OK condition when one of the power supply voltages drops below the normal operating level. The alarm relays, OK relay, and OK indicators are disabled until approximately 17 seconds after the voltage has returned to normal and then are automatically restored to full operation. When normally de-energized relays are used, the power-up-inhibit circuit provides protection from false alarms due to power transients. If the monitor contains latching OK circuits, the COMMON RESET switch on the display module must be pressed following a power outage to illuminate the OK indicators.

SECTION II

MAINTENANCE

2-1 GENERAL

2-2 This section contains performance testing and calibration procedures for the 9000 Series Power Supply and Keyphasor. The recommended maintenance equipment is listed in Table 2-1. If this maintenance equipment is not available, a direct equivalent should be used. Recommended maintenance is restricted to replacement of the power supply, power-up-inhibit plug-in board, fuses, and to changing jumper wires. Any maintenance by the user other than that recommended could void the guarantee. Refer to Table 2-3 for power supply replacement parts.

CAUTION

> To prevent damage to connectors and components, ensure that all connector pins are properly aligned and matched during removal and installation of the power supply, plug-in display module, and components.

******

TABLE 2-1. RECOMMENDED MAINTENANCE EQUIPMENT

DESCRIPTION	SPECIFICATIONS
Hewlett-Packard HP970A Digital Multimeter (DMM) with HP97002A current shunt	3 1/2 digit display, with: 0-1000 Vdc, 10 megohms input impedance 0-1000 Vac 0-1000 mA dc 0-1000 mA ac 0-10 megohms

2-3 POWER SUPPLY INTERNAL FUSES

2-4 The power supply contains internal ac line fuses plus spares. A 1.5 ampere slow blow fuse is used with the 95-125 Vac power input option, and two 0.75 ampere fuses are used with the 190-250 Vac option. If fuse replacement is required, remove the power supply from the rack using the procedure given in the Rack Assembly Operation and Maintenance Manual 8025700 or 8029270 (as applicable). See Figure 2-1 of this manual for fuse locations.

2-5 FIELD CHANGEABLE OPTIONS

CAUTION

To prevent damage to circuit board components, do not use excessive heat during soldering.

******

2-6 If the 9000 System rack is equipped with individual relays, refer to the Rack Assembly Operation and Maintenance Manual 8029270 for field changeable relay option information. If not equipped with individual relays, refer to Paragraph 2-7 of this manual.

2-7 If a change must be made in the alarm relay options for the system without individual relays, refer to Rack Assembly Operation and Maintenance Manual 8025700 for the power supply and display unit removal procedure. Remove the power supply, then remove the screws from the master printed wiring board and place it in a horizontal position. This operation will expose the four alarm jumpers as illustrated in Figure 2-1. To change a relay option to a normally de-energized or normally energized configuration, unsolder the upper end of the corresponding jumper, and connect it to the adjacent terminal. Jumper locations are specified in Table 2-2. After completing the change, mark the revised catalog number on the printed wiring board and chassis label for future reference.

2-8 PERFORMANCE TESTING AND CALIBRATION PROCEDURES

2-9 Successful completion of the following tests and calibration procedures will verify normal power supply operation. The tests should be performed in the order given. Unless otherwise specified, test point locations and adjustments are shown on Figure 2-1. For power supply and display unit removal procedures and individual relay (alarm and OK) test procedures, refer to the Rack Assembly Operation and Maintenance Manual.

2-10 VOLTAGE REGULATOR CALIBRATION

2-11 Successful completion of the following tests will verify proper operation of the voltage regulators.

a. Remove the display module.

b. Connect the DMM between the -24 VDC and COM test points. The DMM should indicate -23.9 to -24.1 volts. If not, adjust the -24 V potentiometer.

c. Connect the DMM between the +5 VDC and COM test points. The DMM should indicate +4.75 to +5.25 volts.

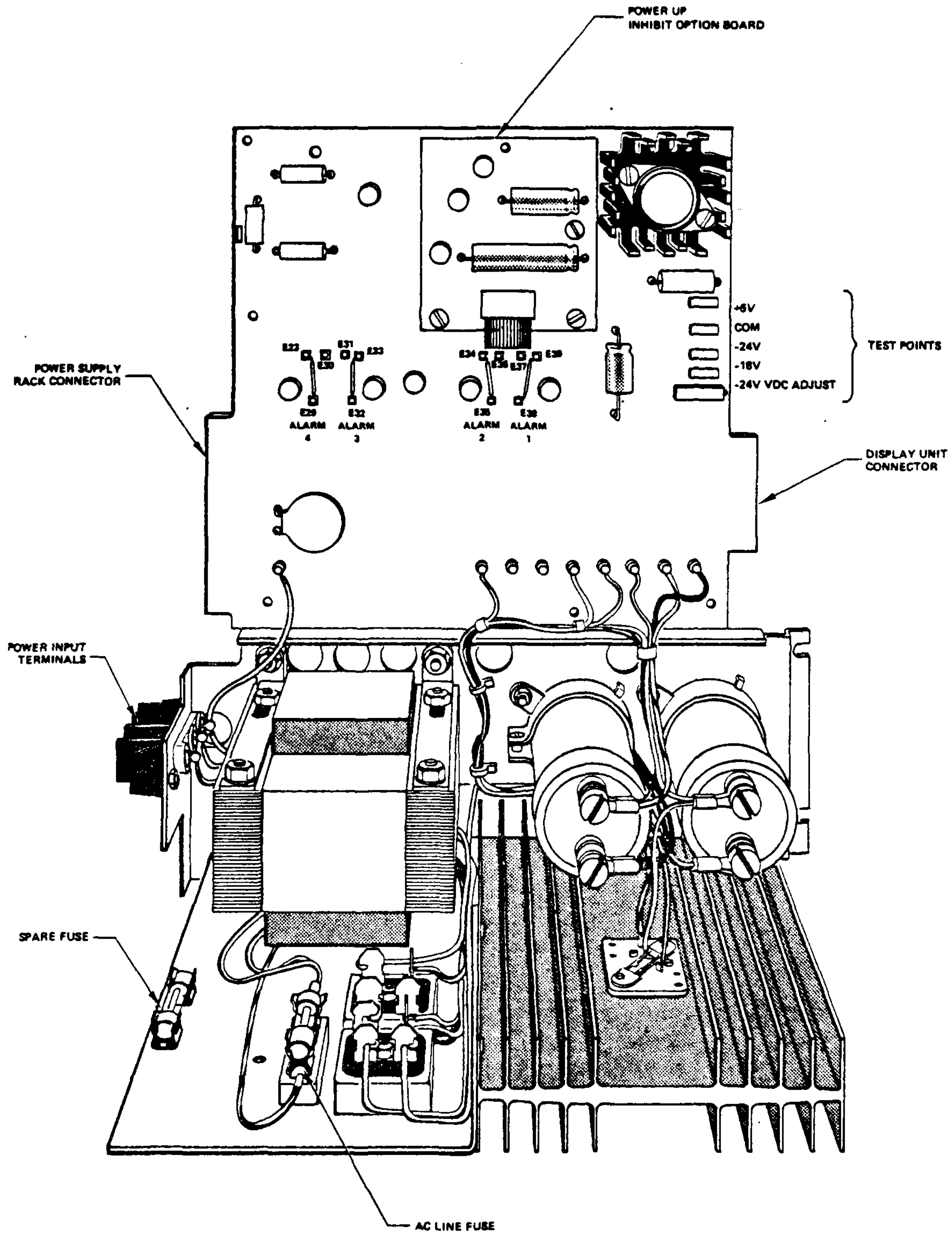


Figure 2-1. Power Supply Internal Features

TABLE 2-2. FIELD CHANGEABLE OPTIONS (WITHOUT INDIVIDUAL RELAYS*)

ALARM RELAY NO. 1	JUMPER BETWEEN	FUNCTION
01	E38-E39	NORMALLY DE-ENERGIZED
02	E38-E37	NORMALLY ENERGIZED

ALARM RELAY NO. 2	JUMPER BETWEEN	FUNCTION
01	E35-E36	NORMALLY DE-ENERGIZED
02	E35-E34	NORMALLY ENERGIZED

ALARM RELAY NO. 3	JUMPER BETWEEN	FUNCTION
01	E32-E33	NORMALLY DE-ENERGIZED
02	E32-E31	NORMALLY ENERGIZED

ALARM RELAY NO. 4	JUMPER BETWEEN	FUNCTION
01	E29-E30	NORMALLY DE-ENERGIZED
02	E29-E28	NORMALLY ENERGIZED

* SEE MANUAL 8029270 FOR INDIVIDUAL RELAY INFORMATION

NOTE

If the -18 volt option is included, perform Step d. If not, proceed with Step e.

d. Connect the DMM between the -18 VDC and COM test points. The DMM should indicate -17.78 to -18.38 volts.

e. Remove the DMM and reinstall the display module.

2-12 POWER-UP-INHIBIT TESTS

CAUTION

The preset alarm levels will be exceeded when performing the test procedures remaining in this manual. Disconnect or bypass external circuits to avoid a false alarm or machine shutdown.

******

2-13 Successful completion of the following tests will verify proper operation of the power-up-inhibit circuit when it is included in the power supply.

a. After power has been applied to the system for one minute or longer, cause at least one monitor to go into the alarm state by increasing the signal level or decreasing the alarm level.

b. If no system monitor will generate an alarm, check the power supply AC line voltage. Low line voltage will cause the power-up-inhibit circuit to disable the monitor OK and alarm circuits. The line voltage should be greater than 95 Vac for the 95-125 Vac input option and greater than 190 Vac for the 190-250 Vac input option.

c. If no system monitor will generate an alarm and the voltage measured in Step b is above the minimum value, replace the power-up-inhibit circuit board. See Figure 2-1 for board location.

d. With at least one monitor in the alarm state, turn off the system ac power and after about 30 seconds restore power.

e. Verify that all monitor OK and alarm indicators are extinguished.

f. Press and hold the COMMON RESET switch. If the respective transducer outputs are within normal limits, latching or non-latching OK indicators will illuminate 10 to 22 seconds after restoration of system power. OK indicators of monitors containing the timed OK/danger defeat option will be delayed an additional 8 to 18 seconds before illuminating. The alarm indicators illuminated in Step a will re-illuminate 11 to 27 seconds after power is restored unless delayed 8 to 18 seconds further by a timed OK/danger defeat circuit.

g. If Steps e and f cannot be completed successfully, replace the power-up-inhibit board and repeat the tests.

h. Restore the monitor used in Step a to its original condition.

2-14 COMMON RESET TEST

2-15 Successful completion of the following test will verify proper operation of the common reset circuits.

a. By either increasing the signal level or decreasing the alarm level, cause at least one system monitor that contains latching alarms to go into the alarm state.

b. Restore the signal level or alarm level to a non-alarm condition.

c. Press the COMMON RESET switch. All latching monitor OK and alarm circuits that are within normal levels should reset.

d. If pressing the COMMON RESET switch does not reset the OK and alarm circuits, and activating the remote reset switch does, the COMMON RESET switch may be defective. If it is, replace the display module.

e. If neither the COMMON RESET switch nor the remote reset switch operate properly, repeat the preceding procedure with another monitor. If the test is still unsuccessful, replace the power supply.

2-16 OK CIRCUIT TEST

2-17 The following procedure applies to 9000 Systems without individual relays. For a system equipped with individual relays, refer to Rack Assembly Operation and Maintenance Manual 8029270 (Individual Relays) for the OK relay test procedure.

NOTE

Omit the OK circuit test if the optional OK relay is not included in the relay module, or if no monitors in the system contain a transducer fault detection (OK) circuit.

2-18 The following test will verify proper operation of the OK relay (if so equipped).

a. Disconnect power to the 9000 System.

b. Remove all monitors from the rack.

c. Install the extender card in any position.

d. Restore system power and jumper extender card terminal 11&M (L/R COM) to 18 (OK) which establishes the OK signal to the OK relay. The relay coil should be energized and the relay contacts at the appropriate states (NO closed and NC open). Verify relay contact state by performing a continuity check. Remove jumper.

e. Jumper extender card terminal K (+V_R) to 18 (OK) which establishes the not-OK signal to the OK relay. The relay coil should be de-energized and the relay contacts switched from the states noted in Step d. Verify relay contact state.

f. Failure of the OK relay to operate properly requires replacement of the relay module. Refer to Rack Assembly Operation and Maintenance Manual 8025700 for relay module replacement procedure.

2-19 ALARM CIRCUIT TESTS

2-20 The following procedure applies to 9000 Systems without individual relays. For a system equipped with individual relays, refer to the Rack Assembly Operation and Maintenance Manual 8029270 (Individual Relays) for the alarm relay test procedure.

2-21 The following test will verify proper operation of a specific alarm relay.

a. Disconnect power to the 9000 System.

b. Remove all monitors from the rack.

c. Install the extender card.

d. Restore system power, and jumper extender card terminal K(+V_R) to terminal 16 (#1 ALM). This establishes the non-alarm signal to alarm relay 1. The relay contacts should be in the proper state for the mode (normally energized or normally de-energized) of the alarm relay. Verify relay contact state by performing a continuity check. Remove jumper.

e. Jumper extender card terminal 11&M (L/R COM) to the same alarm drive terminal used in Step d. This establishes the alarm signal to the alarm relay and the relay contacts should have changed from the state noted in Step d. Verify relay contact state.

f. Repeat Steps d and e for the other alarm relays using extender card terminals U (#2 ALM), 17 (#3 ALM), and V(#4 ALM). Failure of any alarm relay to operate properly requires replacement of the relay module. Refer to Rack Assembly Operation and Maintenance Manual 8025700 for relay module replacement procedure.

2-22 KEY 0 POWER OUTPUT TEST

NOTE

Omit the Key 0 Power Output test if the optional Keyphasor is not included in the system.

2-23 Successful completion of the following test will verify proper operation of the Keyphasor output power.

a. Connect the DMM between the V_T and COM terminals on the terminal strip on the rear of the rack adjacent to the power supply.

b. For the 00 transducer power option, the DMM should indicate -23.9 to -24.1 volts with no load on the Keyphasor supply, and several volts less when a Keyphasor Proximitor is connected. For the 01 transducer power option, the DMM should indicate -17 to -19.2 volts.

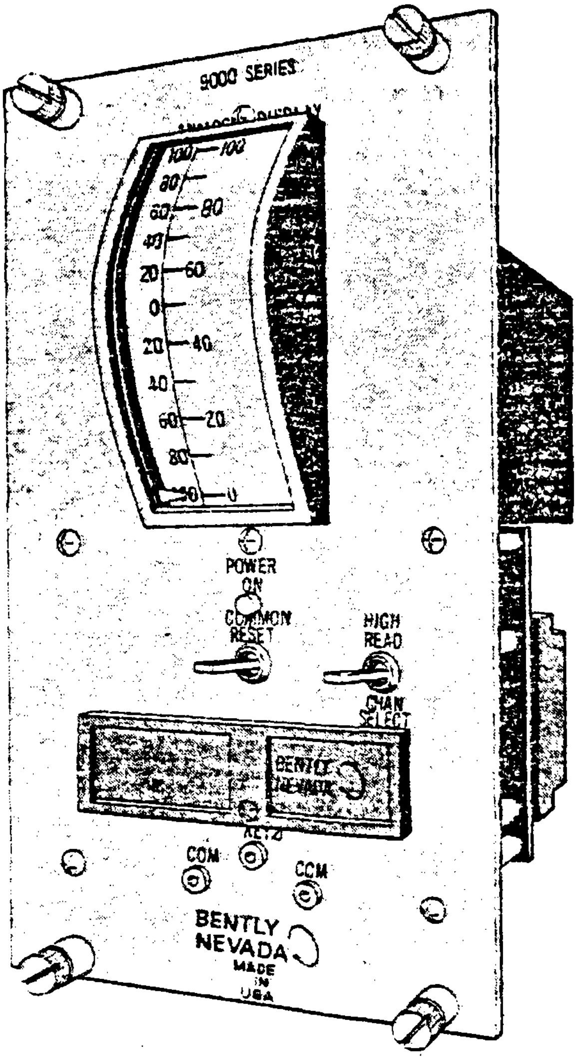
TABLE 2-3. POWER SUPPLY REPLACEMENT PARTS LIST

CATALOG NUMBER	OPTION NUMBER	DESCRIPTION
90050	- 01 - 01 - 00 - 01 - 01 - 01 - 01	ASSY, POWER SUPPLY
90047	- 60	OPTION KIT, POWER-UP-INHIBIT
N/A	N/A	FUSES: 1.5 AMP, 125V OR 0.75 AMP, 250 V (SLOW BLOW)

9000 ADM

8025900

OPERATION AND MAINTENANCE MANUAL



9000 SERIES ANALOG DISPLAY MODULE
MODEL 90120

1976
REVISION B NOV 1980

REVISION STATUS

The status of pages in this document is as follows:

PAGE	STATUS	DATE
ii	Revision B	Nov 1980
iii/iv	Revision A	Aug 1977
v	Revision B	Nov 1980
1-0	Revision A	Aug 1977
1-1, 1-2	Revision B	Nov 1980
1-3	Revision A	Aug 1977
2-1, 2-2	Revision B	Nov 1980

SPECIFICATIONS

90120 ANALOG READOUT

METER	
Error	± 0.5% maximum at full scale
Tracking Error	± 2.0% of full scale maximum
POWER CONSUMPTION	0.3 watts nominal
ENVIRONMENTAL LIMITS	
Rated Performance	0 to 65°C
Long Term Storage	-40 to 85°C
Relative Humidity	To 95% noncondensing

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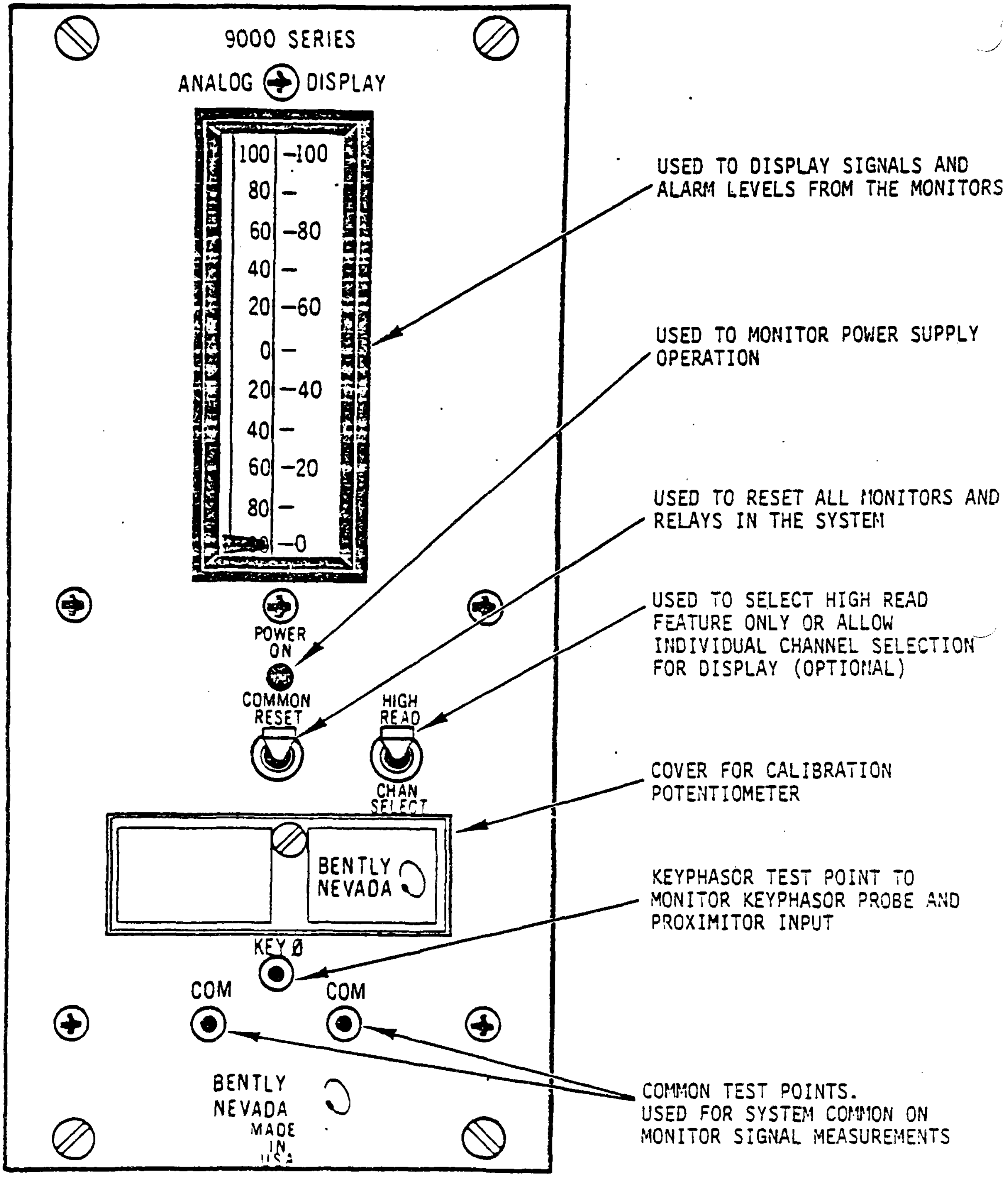

USED TO DISPLAY SIGNALS AND ALARM LEVELS FROM THE MONITORS

USED TO MONITOR POWER SUPPLY OPERATION

USED TO RESET ALL MONITORS AND RELAYS IN THE SYSTEM

USED TO SELECT HIGH READ FEATURE ONLY OR ALLOW INDIVIDUAL CHANNEL SELECTION FOR DISPLAY (OPTIONAL)

COVER FOR CALIBRATION POTENTIOMETER

KEYPHASOR TEST POINT TO MONITOR KEYPHASOR PROBE AND PROXIMITOR INPUT

COMMON TEST POINTS.
USED FOR SYSTEM COMMON ON MONITOR SIGNAL MEASUREMENTS

Figure 1-1. Analog Display Module Front Panel

SECTION 1

GENERAL INFORMATION

1.1 GENERAL DESCRIPTION

The 9000 Series Analog Display Module is used primarily to display switch selected signals and alarm levels from the monitors. The module contains a 3-1/2 inch panel meter, POWER ON indicator, COMMON RESET switch, optional HIGH READ/CHANNEL SELECT switch, and calibration adjustments and test points for KEY 0 (Keyphasor) and COM (common). Figure 1-1 illustrates the module front panel.

1.1.1 STANDARD OPTIONS

The standard options included in this module are shown in Table 1-1.

Table 1-1. Option List

BNC CATALOG NUMBER

90120 - 0 2 — 5 3 ——— ☐ ☐

OPTION CODE	HIGH READ	OPTION CODE	DISPLAY RANGE	OPTION CODE	DISPLAY RANGE
01	Standard Without High Read	01	0 to 100°C	45	0 to 100%
		02	0 to 150°C	46	Dual 0 to 100%/100-0-100%
02	With High Read	03	0 to 200°C	51	0 to 5 mils peak-to-peak
		04	0 to 250°C	52	0 to 3 mils peak-to-peak
		05	0 to 500°C	53	0 to 10 mils peak-to-peak
		21	0 to 200°F	54	0 to 15 mils peak-to-peak
		22	0 to 300°F	65	0 to 125 micrometers peak-to-peak
		23	0 to 400°F	66	0 to 80 micrometers peak-to-peak
		24	0 to 500°F	67	0 to 250 micrometers peak-to-peak
		25	0 to 1000°F	68	0 to 400 micrometers peak-to-peak

1.1.2 MODIFICATIONS

Modifications are changes to the module that are not covered by the standard options. The changes, if any, are described in the modification documents that immediately follow Section 1 of this manual. Modification document numbers are marked on the display module. These numbers should be used when ordering replacement modules.

1.2 OPERATIONAL DESCRIPTIONS

As shown in Figure 1-2, the monitor inputs (0 to -10 volts) are applied through the SPAN adjustment to the panel meter. If the high read option is installed the HIGH READ/CHANNEL SELECT switch must be in the CHANNEL SELECT position (shown) to allow the monitor signal and alarm levels to be selected for display. When the switch is in the HIGH READ position, only the highest vibration monitor output is displayed, even if the monitor signal switches or alarm switches are actuated.

The input signals applied to the display module, except for the high read signal, are received from the monitor signal and alarm switches. These switches are normally used one at a time. However, no damage or false alarms will result from simultaneous use of more than one switch, but the meter indication should not be considered accurate.

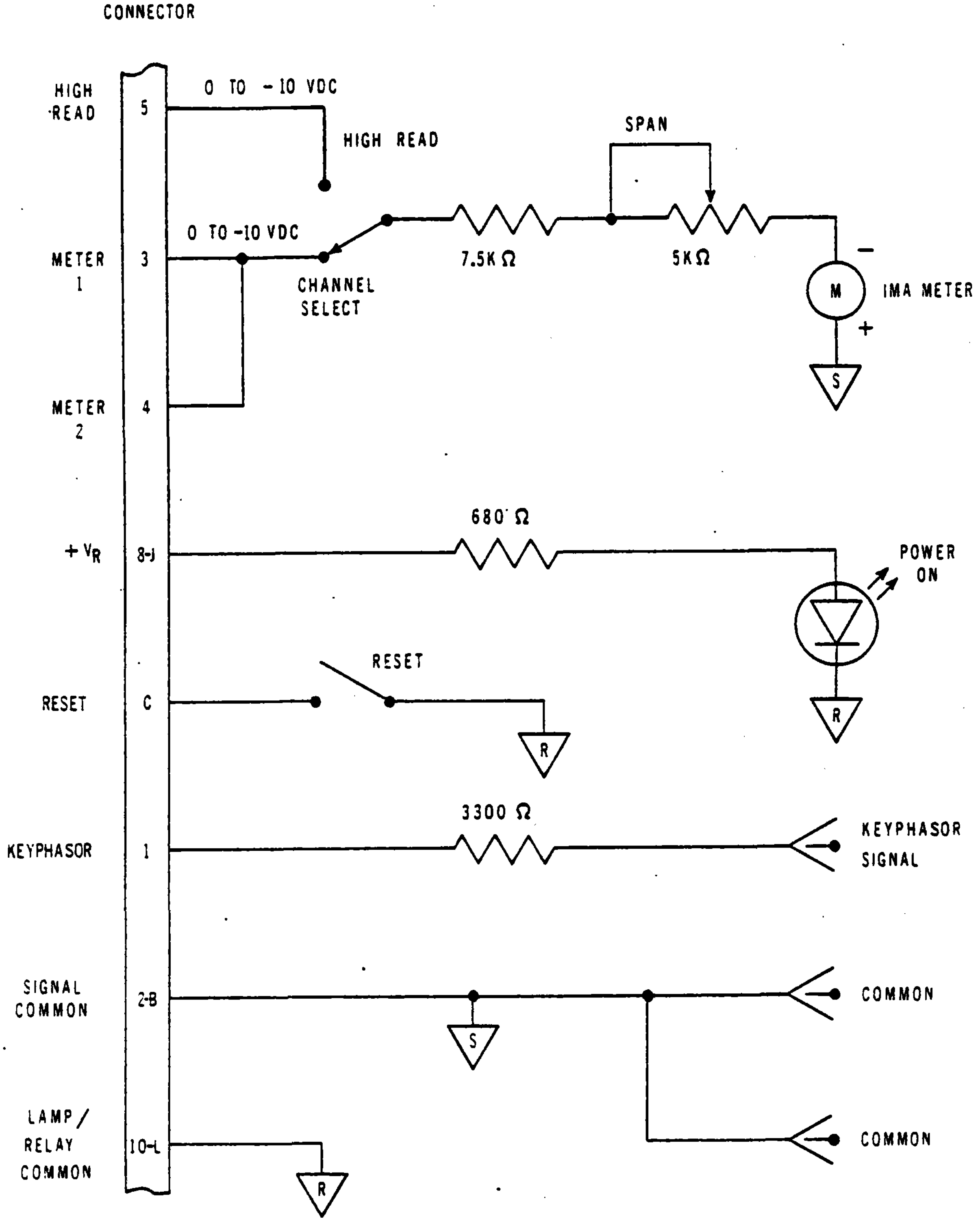

Figure 1-2. Analog Display Module Block Diagram

SECTION 2

MAINTENANCE

2.1 GENERAL

This section provides calibration and performance testing procedures for the analog display module. If trouble occurs, make certain that the power supply is operational and that all monitor inputs are within specifications before testing or replacing the module. Display module installation and removal procedures are given in the Rack Assembly Operation and Maintenance Manual, 8025700. Repair of the module is limited to replacement of the entire assembly. Failure to heed this recommendation could void the guarantee. If replacement of the module is required, use the specific part number given in Table 1-1 and include all option numbers and any modification numbers.

2.2 PERFORMANCE TESTING AND CALIBRATION PROCEDURES

Successful completion of the following procedures will verify proper module operation at minimum acceptable standards. To ensure proper calibration, the procedures must be followed in the order given. The recommended maintenance equipment for performing these procedures is listed in Table 2-1.

Table 2-1. Recommended Maintenance Equipment

RECOMMENDED EQUIPMENT	EQUIPMENT SPECIFICATIONS
Hewlett-Packard HP970A Digital Multimeter (DMM)	3-1/2 digit display with: 0 to ±1000 Vdc range
DC Power Supply	Variable negative output voltage with a minimum range of 0 to -10 Vdc
Bently Nevada Corporation 9000 Series Extender Card Part Number 90038	Contains all required test points for performing test and calibration

2.2.1 DISPLAY MODULE CALIBRATION

If the following calibration procedure cannot be completed successfully, replace the entire analog display module.

a. With all monitor signal and alarm switches in the neutral position (not pressed for display), and if included, the optional HIGH READ/CHANNEL SELECT switch set to the CHANNEL SELECT position, the display module meter should indicate zero.

b. If zero adjustment is required, perform Steps c through e. If zero adjustment is not required, proceed directly to Step f.

c. Remove the display module from the rack in accordance with the instructions provided in the Rack Assembly Operation and Maintenance Manual 8025700.

d. Hold the display module so that the meter is upright and braced on a table or bench, and adjust the meter zero control on the rear of the meter until the meter indicator points to zero.

e. Reinstall the display module in the rack by reversing the removal procedure referenced in Step c.

f. Install the extender card in a vacant monitor position. Connect the dc power supply between the meter bus 1 (M1) and the signal common (SIG COM) on the extender card.

g. Turn on the dc power supply and set its output for a -10.00 volt indication on the DMM. The module meter should indicate a full scale deflection.

h. If the module meter does not indicate full scale in Step g, remove the adjustment control cover and adjust the SPAN potentiometer for a full scale deflection.

NOTE

If a dc power supply is not available for this test and calibration, use one of the system monitors, with the output set to full scale (-10.00 Vdc).

OPERATION AND MAINTENANCE MANUAL

9000 SERIES DUAL VIBRATION MONITOR

MODEL 90100

Rev. Aug. 1978

SPECIFICATIONS

90100 DUAL RV MONITOR

INPUTS	
Signal	Two proximity vibration signals
Input impedance	10K ohms nominal
Scale factor	100 mv/mil (approx. 4V/mm) or 200 mv/mil (approx. 8V/mm)
Power Consumption	3.4 watts nominal
OUTPUTS	
Recorder	Voltage or current proportional to monitor range
Output impedance (voltage output options)	100 ohms
Maximum load impedance (current output options)	900 ohms
Meter output	0 to -10 VDC signal proportional to monitor range
Output impedance (front panel)	10K ohms ± 1%
Transducer voltage	
3000 series proximitor option	-18 VDC, +0.4, -0.3 VDC at 15 MA @ 25°C
7000 or 7200 series proximitor option	-24 VDC, + 0.1, -0.2 VDC at 20 MA @ 25°C
Proximitor out (front panel)	DC gap and dynamic motion signal
Output impedance	3.3K ohms ± 5%
Relay drive	Two system compatible alarm relay drive signals (alert & danger) and an OK relay drive signal. Alarm and OK relay drive signals are common to both channels.

SPECIFICATIONS

90100 DUAL RV MONITOR

PERFORMANCE

Signal conditioning

Frequency response	240 to 360,000 RPM, + 0 to -3 db 1,200 to 240,000 RPM, +0 to -5%

Mid-band accuracy
(rated sinusoidal input to output)

	Error at 25°C		Tempco
	Typical*	Maximum*	Typical*
Recorder output	± 0.6%	± 1.5%	± 0.01% per °C
Meter output	± 0.5%	± 1.0%	± 0.008% per °C
Meter output, high read	± 0.7%	± 1.5%	± 0.008% per °C

*% of full scale

ALARMS

Adjustment range	0 to 110% of full scale
Set point stability	± 0.0075% of full scale per °C, typical
Alarm repeatability	Within ± 0.1% of full scale at 25°C

ENVIRONMENTAL LIMITS

Rated performance	0 to +65°C
Long term storage	-40 to +85°C
Relative humidity	0 to 95% noncondensing

WEIGHT	0.69 lbs. (0.31 Kg)

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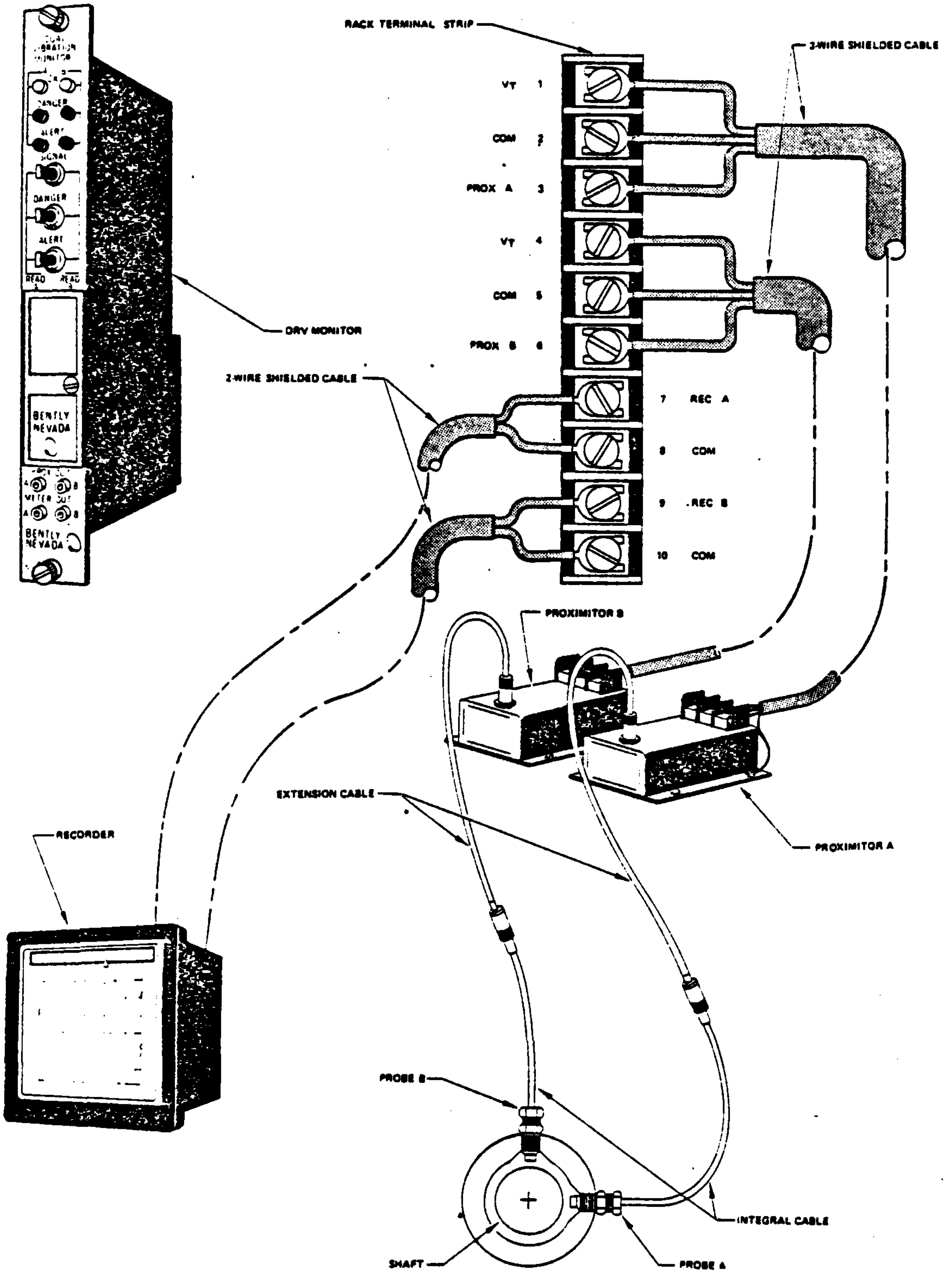


Figure 1-1. DRV Monitor System

SECTION I

GENERAL INFORMATION

1-1 GENERAL DESCRIPTION

1-2 The 9000 Series Dual Radial Vibration (DRV) Monitor System shown in Figure 1-1 continuously monitors two independent channels of radial vibration for machine protection. The two channels also may be used for X-Y vibration monitoring. The system consists of two transducers, each comprised of a probe, proximitor and associated cabling; and a 9000 Series DRV monitor mounted in a 9000 Series instrument rack.

1-3 The eddy current type probes and proximitors generate electrical signals that are proportional to the distance between the probes and a shaft or other observed surface. Detailed descriptions of the probes and proximitors are given in the Probe and Proximitor Operation and Maintenance Manuals.

1-4 The monitor consists of a front panel and circuit board which includes switches for display of signal and alarm levels, light-emitting diode (LED) indicators for annunciation of OK and alarm status, calibration and alarm adjustments, and connectors for output signals. The instrument rack assembly contains a common display module, power supply, relays for OK and alarm circuits, and terminals for field wiring. Field wiring information is furnished in the Rack Assembly Operation and Maintenance Manual, TW8025700.

1-5 The monitor converts each proximitor output to a signal that is used by the common system display to indicate peak-to-peak vibration. The monitor also provides recorder output signals which are available at the rack rear terminal strip. Each channel includes an OK circuit to detect transducer faults, field wiring faults or improper probe gap settings. The alert and optional danger alarm circuits have individually adjustable set points for each channel which can be read on the system display. If a vibration level exceeds a set point, the corresponding indicator will illuminate and a signal will actuate an alarm relay in the instrument rack.

1-6 STANDARD OPTIONS

1-7 The standard options included in this system are shown in Table 1-1. All standard options are factory installed according to the catalog number specified by the user.

1-8 FIELD CHANGEABLE OPTIONS

1-9 Certain of the standard options can be changed in the field to meet new requirements. The alarm timing and mode, alert relay select, and optional danger relay select options can be altered by relocating jumper wires on the printed circuit board. Refer to the procedure in Section II of this manual for detailed instructions.

TABLE 1-1. OPTION LIST

BNC CATALOG NUMBER

90100 – 03 – 02 – 01 – 02 – 02 – 01 – 01 – 02

	MONITOR RANGE		TRANSDUCER TYPE		RECORDER OUTPUT		OK CIRCUIT		ALARM QUANTITY		ALARM TIMING AND MODE		ALERT RELAY SELECT		DANGER RELAY SELECT
01	0-5 MILS	01	7000 PROXIMITOR 100 MV/MIL	01	0 TO -10 VDC	01	NON-LATCHING	01	CHANNEL A AND B ALERT ONLY	01	3 SEC DELAY LATCHING	01	RELAY 1	00	NONE
02	0-3 MILS	02	3000 PROXIMITOR 200 MV/MIL	02	0 TO +5 VDC	02	LATCHING	02	CHANNEL A AND B ALERT AND DANGER	02	3 SEC DELAY NON-LATCHING	02	RELAY 2	01	RELAY 1
03	0-10 MILS	03	7200 PROXIMITOR 200 MV/MIL	03	+1 TO +5 VDC	03	TIMED OK DANGER DEFEAT			03	1 SEC DELAY LATCHING	03	RELAY 3	02	RELAY 2
04	0-15 MILS			04	0 TO 20 MA					04	1 SEC DELAY NON-LATCHING	04	RELAY 4	03	RELAY 3
05	0-125 MICROMETERS			05	4 TO 20 MA									04	RELAY 4
06	0-80 MICROMETERS														
07	0-250 MICROMETERS														
08	0-400 MICROMETERS														

1-10 MODIFICATIONS

1-11 Modifications are changes to the monitor that are not covered by the standard options and the field changeable options. The changes, if any, are described in the modification documents that immediately follow Section I of this manual. Modification document numbers are marked on the circuit board. These numbers should be used when ordering replacement units.

1-12 OPERATIONAL DESCRIPTIONS

1-13 Figures 1-2 and 1-4 through 1-6 are functional diagrams that are presented to help the user better understand the DRV monitor operation. The text is keyed to these diagrams by the use of circled numbers. Only one channel of this dual channel monitor is described since both channels are identical in operation.

1-14 SYSTEM

1-15 As shown in Figure 1-2, the transducer signal ① is applied simultaneously to the ac amplifier ② , the OK circuit ③ and the PROX OUT A connector ④. A span adjustment control is provided on the ac amplifier for calibration of full-scale output. The ac amplifier output is fed to a peak-to-peak detector where the signal is converted to a 0 to -10 volt level that is proportional to the peak-to-peak movement of the observed surface. The 0 to -10 volt level is applied to the alarm comparators ⑤ , the METER OUT A connector ⑥ , the recorder A circuit ⑦, the front panel SIGNAL switch ⑧ and the high read circuit ⑨ . The recorder circuit provides a dc voltage or current output that corresponds to the 0 to -10 volt input. When pressed, the SIGNAL switch passes the 0 to -10 volt level to a display driver ⑩ , which feeds an output signal to the common system display module. The high read circuit applies the larger of the two vibration levels to the rack high read bus. When in the high read mode, the display module reads the largest vibration level present on the bus.

1-16 FRONT PANEL

1-17 See Figure 1-3, the DRV monitor front panel drawing, for indicator, switch and control definitions.

1-18 OK CIRCUIT

1-19 Figure 1-4 illustrates the OK circuit for one channel. The comparators ⑪ monitor the proximitor output voltage to determine if it is between the upper and lower OK limits, which define the range of normal proximitor operation. OK limit voltage values are listed in Section II, Transducer and OK Circuit Limit Test, for each proximitor type.

1-20 During normal operation the proximitor output is within the OK limits, the OK indicator is on, and if all channels in the system are in the OK state, the OK relay (if provided) is energized. If the proximitor signal exceeds an OK limit, the corresponding comparator feeds a signal to the indicator and relay driver ⑫ . The driver then extinguishes the OK indicator and de-energizes the OK relay. The driver can operate in a non-latching or latching mode. In the non-latching mode, the indicator and relay are energized the moment that OK

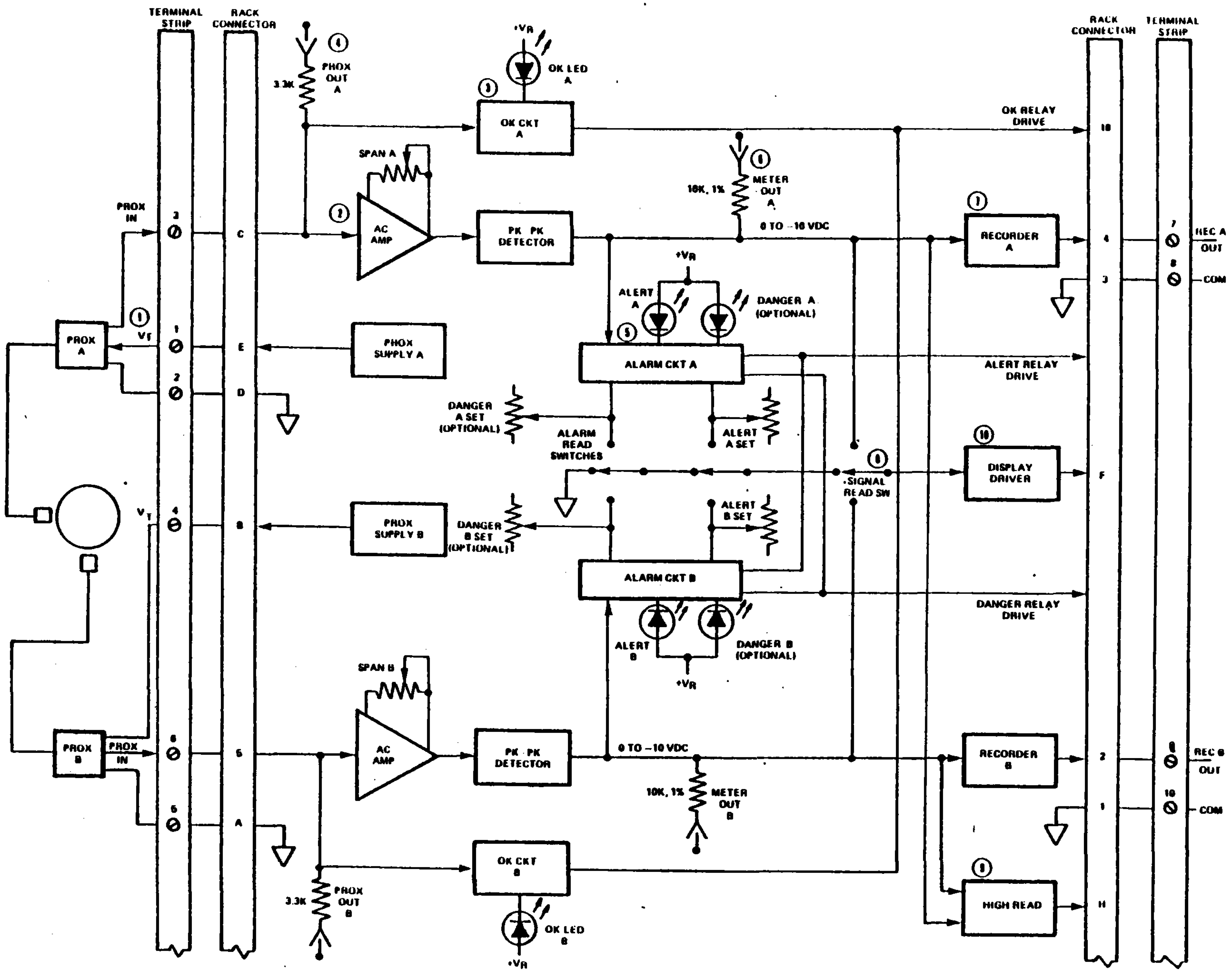
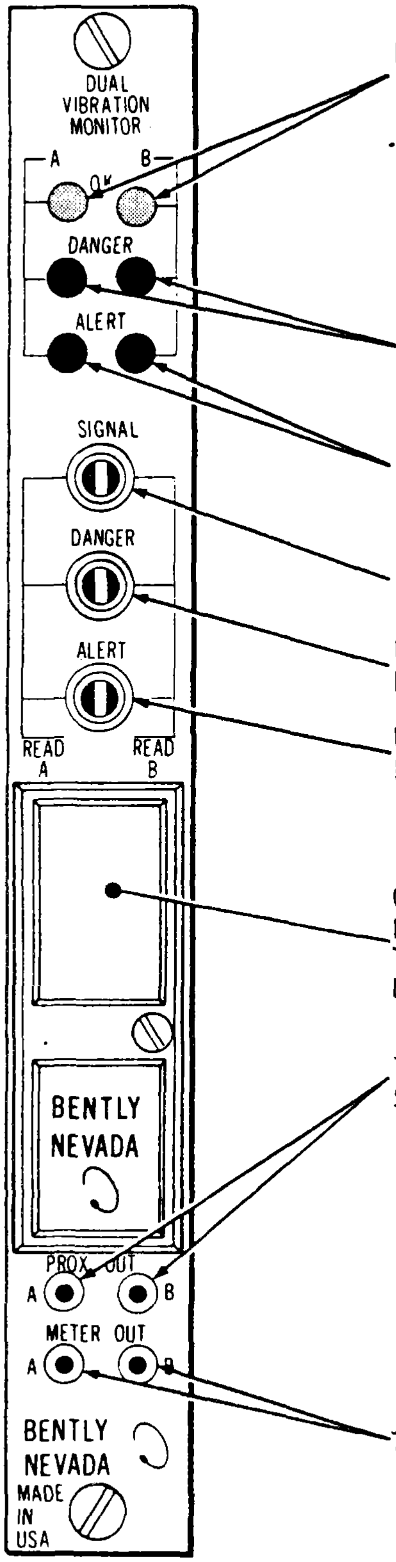


Figure 1-2. DRV Monitor System Functional Block Diagram

1.2.23-316

TW8026100



NORMALLY ILLUMINATED, THEREBY INDICATING THAT THE PROBE IS WITHIN SPECIFIED LIMITS AND THE FIELD WIRING IS INTACT.

ILLUMINATED IF EITHER CHANNEL EXCEEDS A DANGER LEVEL. (OPTIONAL)

ILLUMINATED IF EITHER CHANNEL EXCEEDS AN ALERT LEVEL.

USED TO SELECT EITHER CHANNEL SIGNAL LEVEL FOR SYSTEM DISPLAY.

USED TO SELECT EITHER CHANNEL DANGER LEVEL FOR SYSTEM DISPLAY. (OPTIONAL)

USED TO SELECT EITHER CHANNEL ALERT LEVEL FOR SYSTEM DISPLAY.

COVER FOR ALARM SET LEVEL POTENTIOMETERS. THE COVER LABEL INFORMATION DEFINES THE SPECIFIC MONITOR RANGE. THE XDCR TYPE AND RECORDER OUTPUT INFORMATION IS LISTED ON THE REAR SIDE OF THE COVER.

TEST POINTS FOR THE BUFFERED UNPROCESSED PROXIMITOR SIGNAL.

TEST POINTS FOR THE UNSWITCHED METER OUTPUT.

Figure 1-3. DRV Monitor Front Panel

conditions are restored. In the latching mode, the COMMON RESET switch or remote reset contact must be actuated after OK conditions are restored to energize the indicator and relay.

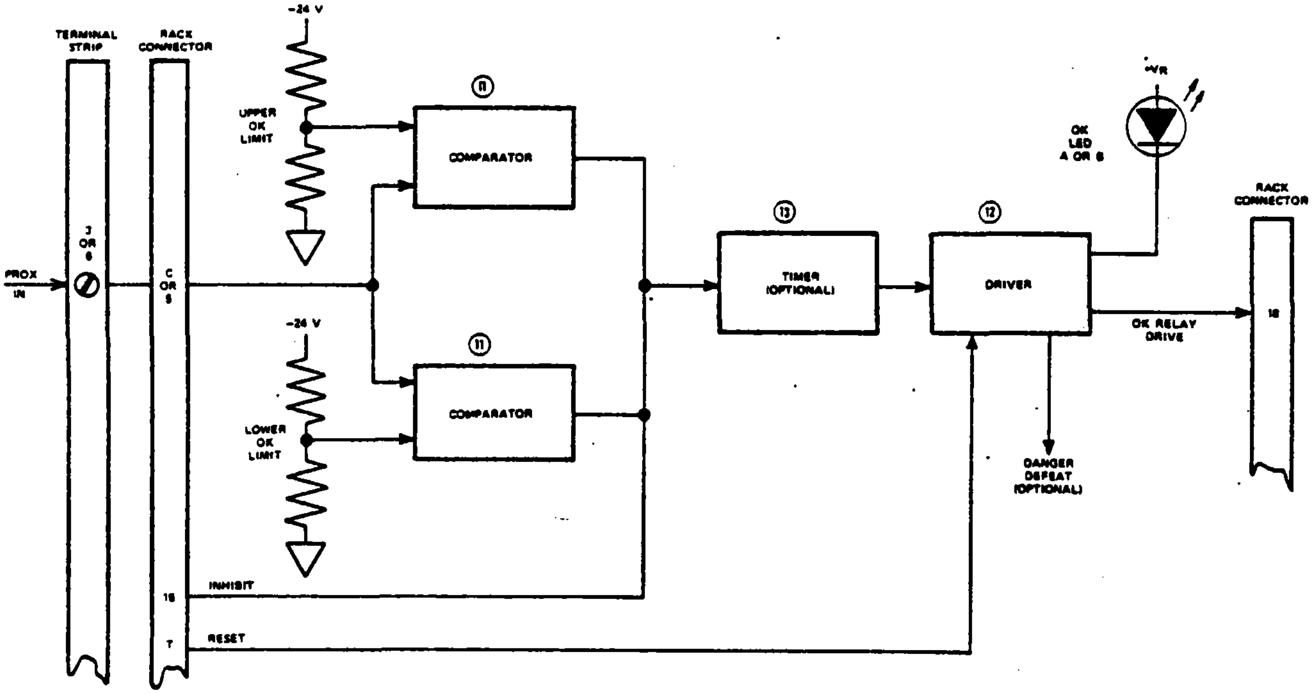


Figure 1-4. OK Circuit Flow Diagram

1-21 If the timed OK/danger defeat option is specified, a timer ⑬ is included in the circuit. This option disables the corresponding danger alarm circuit whenever the transducer output is not within the OK limits. When the transducer output returns within the OK limits, the timer waits approximately 15 seconds before allowing the driver to restore the OK lamp, OK relay and danger circuit to normal operation. This feature prevents false danger indications due to transducer failures or intermittent operation.

1-22 PROXIMITOR POWER SUPPLIES

1-23 As shown in Figure 1-5, the proximitor supply voltage is -18 vdc for the 3000 series transducer and -24 vdc for the 7000 and 7200 series transducers. Each supply voltage is current limited to prevent any circuit damage if a short circuit occurs in the proximitor supply. In addition, a short circuit will not affect the operation of the other proximitor and monitor channel.

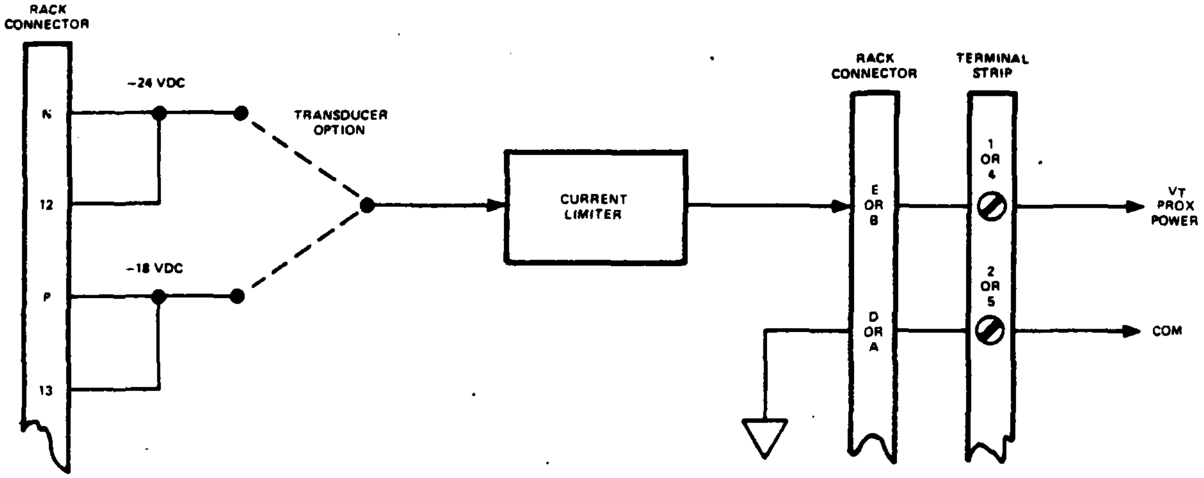


Figure 1-5. Proximitor Power Supply Flow Diagram

1-24 ALARM CIRCUIT

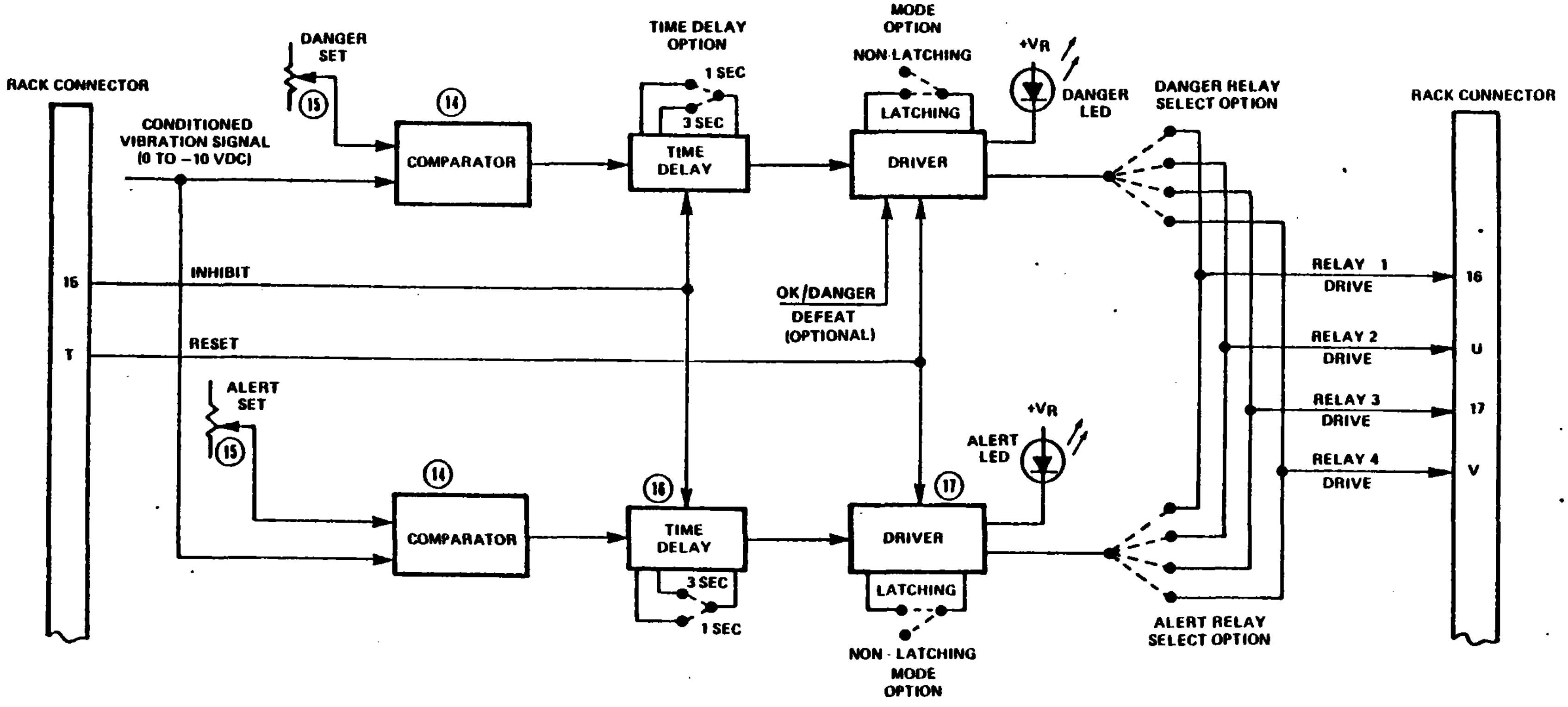
1-25 As shown in Figure 1-6, the conditioned proximitor signal is applied to the alert and, if included, the danger comparators ⑭ . Each comparator set level can be adjusted by using the controls ⑮ accessible through the front panel.

1-26 Whenever the alert level is exceeded, the comparator changes state and actuates the time delay circuit ⑯ . The time delay is a field changeable option. If the preset level continues to be exceeded until the time delay has elapsed, a signal is fed to the indicator and relay driver ⑰ . The driver illuminates the ALERT indicator and causes the selected alarm relay to change state. The alert alarm is either latching (manual reset) or non-latching (automatic reset) and is field changeable to either operating mode. If the latching option is installed, a reset signal will be required to return the circuit to a normal condition after the input signal has decreased below the alarm set level.

1-27 The optional danger alarm operation is the same as the alert alarm except for the timed OK/danger defeat option described in Paragraph 1-21.

1-28 POWER-UP-INHIBIT

1-29 The alarm and OK circuits respond to power-up-inhibit signals from the power supply. If the power-up-inhibit circuit detects a power transient or power loss, it will disable all monitor alarm and OK circuits in the system.



TW8026100

Figure 1-6. Alarm Circuit Flow Diagram

This operation annunciates loss of power and prevents false alarms. Refer to manual TW8025800, Power Supply Operation and Maintenance, for more information.

1-30 POWER SUPPLY REQUIREMENTS

1-31 The system power supply assembly provides +5 vdc, -24 vdc and optional -18 vdc regulated voltages. Unregulated voltages also are provided. See Table 2-3 for voltage values and test points used in the DRV monitor.

1-32 COMPUTER INTERFACING PRECAUTIONS

1-33 To assure compatibility when interfacing the monitor recorder output(s) with a computer system via a multiplexer, observe the precautions in Paragraphs 1-34 through 1-40.

1-34 VOLTAGE MODE INTERFACING

1-35 The output voltage of each voltage-mode recorder output option (see Table 1-1) is limited by the monitor to approximately ±15 Vdc to protect the multiplexer. Therefore, ensure the multiplexer can safely accept this maximum voltage.

1-36 CURRENT MODE INTERFACING

1-37 Ensure the product of the load resistance and the maximum driver current for each current-mode recorder option (see Table 1-1) does not exceed the input voltage limits of the multiplexer.

1-38 The recorder output driver acts as a current sink, thereby developing negative voltages across the load. Ensure the negative polarity is compatible with the multiplexer input requirements.

1-39 MULTIPLEXER SAMPLE TIME

1-40 To reduce switching transients to an acceptable level, the minimum multiplexer sampling time required for any recorder output is 7.5 microseconds. However, certain multiplexers may require longer sampling durations (typically 20 to 30 microseconds) to achieve acceptable reduction of switching transient levels.

SECTION II

MAINTENANCE

2-1 GENERAL

2-2 This section contains procedures for calibration and performance testing, alarm adjustments and alteration of field changeable options. If trouble occurs make certain that the power supply is operational, all field wiring is intact and the transducers are operating normally before testing or replacing the DRV monitor. Monitor installation and removal procedures are given in the Rack Assembly Operation and Maintenance Manual, TW8025700. Soldering or unsoldering of connections on the circuit board should be limited to changing of jumper options. Failure to heed this recommendation could void the guarantee. If replacement of the monitor is required, use the specific part number given in Table 1-1, with all option numbers and any applicable modification numbers. A monitor which is equivalent except for field changeable options can be used as a replacement if the field changeable options are altered appropriately.

2-3 FIELD CHANGEABLE OPTIONS

CAUTION

To prevent damage to circuit board components, do not use excessive heat during soldering.

******

2-4 If one of the field changeable options must be altered, remove the monitor board from the rack to expose the jumper wires as shown in Figure 2-1. To change the alarm timing and mode, or relay selection, unsolder one end of the appropriate jumper wire and resolder it according to Table 2-1.

2-5 After completing the change, mark the revised catalog number on the printed wiring board for future reference.

2-6 ALARM ADJUSTMENT PROCEDURES

CAUTION

The alarm adjustment controls are capable of setpoints as low as 0 mils. If the external alarm circuits are connected during this procedure, improper adjustment could activate the alarms.

******

2-7 The alarm adjustment front panel cover must be removed to gain access to the potentiometers. Refer to Figure 1-3 for switch locations and Figure 2-1

TABLE 2-1. FIELD CHANGEABLE OPTIONS

ALARM TIMING & MODE	JUMPER BETWEEN	FUNCTION	ALERT RELAY SELECT	JUMPER BETWEEN	FUNCTION	DANGER RELAY SELECT	JUMPER BETWEEN	FUNCTION
01	E149-E150 E162-E163 E151-E153 E164-E166 E175-E174* E185-E186* E176-E178* & E187-E189*	ALERT AND DANGER 3 SEC DELAY LATCHING	01	E154-E155	RELAY 1	00	NONE	NONE
02	E149-E150 E162-E163 E151-E152 E164-E165 E175-E174* E185-E186* E176-E177* & E187-E188*	ALERT & DANGER 3 SEC DELAY NON-LATCHING	02	E154-E156	RELAY 2	01	E179-E180*	RELAY 1
03	E149-E148 E162-E161 E151-E153 E164-E166 E174-E173* E185-E184* E176-E178* & E187-E189*	ALERT AND DANGER 1 SEC DELAY LATCHING	03	E154-E157	RELAY 3	02	E179-E181*	RELAY 2
04	E149-E148 E162-E161 E151-E152 E164-E165 E174-E173* E185-E184* E176-E177* & E187-E188*	ALERT AND DANGER 1 SEC NON-LATCHING	04	E154-E158	RELAY 4	03	E179-E182*	RELAY 3
						04	E179-E183*	RELAY 4

* DANGER CIRCUITS ARE OPTIONAL. THESE JUMPERS HAVE NO EFFECT ON MONITOR OPERATION WHEN THE DANGER CIRCUITS ARE NOT INCLUDED.

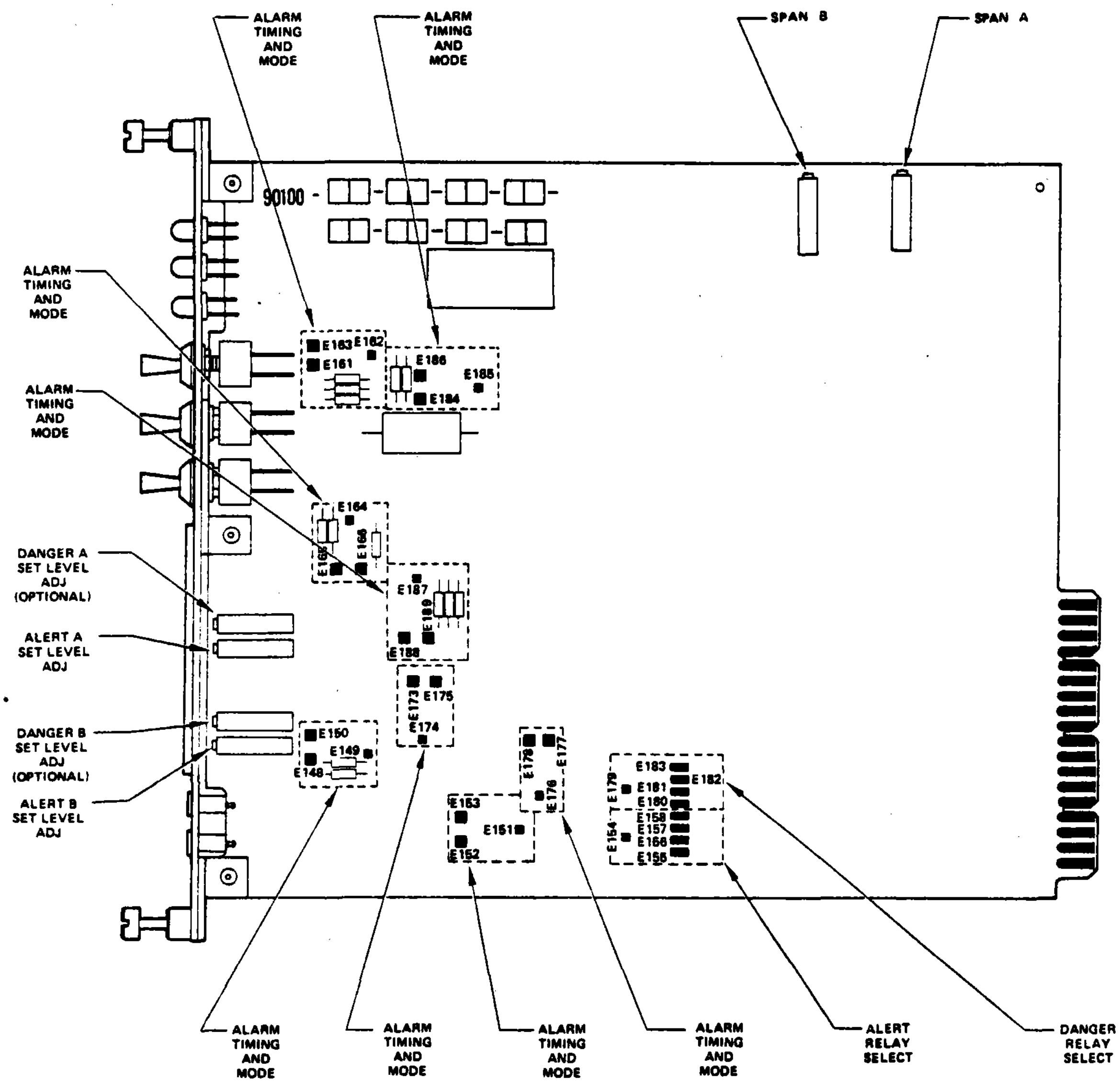


Figure 2-1. DRV Monitor Side View

for alarm adjustment locations. If the danger alarms are not included, the adjustment controls are not installed on the board.

2-8 The alarms are adjusted to the required values by first pressing the appropriate alarm switch toward the proper channel, reading the value indicated by the display and then adjusting the corresponding potentiometer to the value representing the desired alarm vibration.

2-9 PERFORMANCE TESTING AND CALIBRATION PROCEDURES

2-10 Successful completion of the following procedures will verify proper monitor system operation at minimum acceptable standards. To ensure proper calibration, the procedures must be followed in the order given. The recommended maintenance equipment for performing these procedures is given in Table 2-2. The remainder of the testing requires that the monitor be extended from the rack using the extender card.

CAUTION

> To prevent circuit damage when installing the extender card, either disconnect system power or connect the monitor to the extender card before connecting the extender card to the rack bus. Ensure that all connector pins are matched and properly aligned.

******

TABLE 2-2 RECOMMENDED MAINTENANCE EQUIPMENT

RECOMMENDED EQUIPMENT	EQUIPMENT SPECIFICATIONS
Hewlett-Packard	
HP970A Digital Multimeter (DMM) with HP97002A Current Shunt	3-1/2 digit display with: 0 to ±1000 vdc 0 to 1000 vac 0 to 1000 ma dc 0 to 1000 ma ac 0 to 10 megohms
Bently Nevada Corporation TK-3 Test and Calibration Kit with Instruction Manual	Vibration rpm range = 1K to 10K rpm Vibration amplitude range = 0 to 5 mils peak-to-peak Displacement range (spindle micrometer)= 0 to 500 mils
9000 Series Extender Card Part Number 90038	Contains all required test points for performing test and calibration (refer to Table 2-3)

CAUTION

> The preset alarm levels will be exceeded when performing all test and calibration procedures remaining in this manual. Disconnect or bypass all external circuits to avoid a false alarm or machine shutdown.

******

2-11 TRANSDUCER POWER TEST

2-12 If the following test results are not within the limits specified, replace the monitor.

a. Using the DMM, measure the voltage between the SIG 1 and SIG 2 extender card terminals and between the SIG 4 and SIG 5 extender card terminals. The voltage should be between -17.7 and -18.4 volts for the -02 transducer option, and between -23.8 and -24.1 volts for the -01 and -03 transducer options.

b. Disconnect the rear terminal strip proximitor output power connector (V_T) from the channel A and B proximitors.

c. Using the DMM and the current shunt, measure the current between the SIG 1 and the SIG 2 extender card terminals, and between the SIG 4 and the SIG 5 extender card terminals. The current should be between 20 and 33 ma for the -02 transducer option, and between 29 and 43 ma for the -01 and -03 transducer options.

d. Reconnect V_T to the appropriate proximitors.

2-13 TRANSDUCER AND OK CIRCUIT LIMIT TEST

2-14 If the following Steps d through j do not yield results that are within the specified limits, replace the monitor.

NOTE

> Some probes and proximitors are calibrated for use with materials such as aluminum and stainless steel, rather than for common soft steel. Ensure that the TK-3 targets are compatible with the particular probe and proximitor in use. The TK-3 is normally provided with soft steel targets, but special targets are available.

a. Disconnect the probe from the 95-ohm extension cable.

b. Remove the channel A probe from the machine or obtain an equivalent substitute probe.

NOTE

The actual machine probe should be used in lieu of a substitute probe to obtain greater system accuracy.

c. Perform the Calibration Check Procedures that are in the appropriate Probe and Proximitor Operation and Maintenance Manual, TW8019410, TW8019610, or TW8026800, depending on the type used.

NOTE

Use monitor power instead of an external power supply. No external load will be required on the proximitor OUTPUT terminal when the monitor is connected. Bently Nevada Corporation recommends that for future reference the calibration curve should be plotted from data obtained in the preceding step.

d. Rotate the TK-3 spindle micrometer to a gap of 50 mils away from the probe face. The A OK indicator should be illuminated. If the OK circuit latching option is included, press the COMMON RESET switch on the system display module and the A OK indicator should illuminate. If the timed OK/danger defeat option is installed, there will be an 8- to 18-second delay before the OK indicator illuminates.

e. Rotate the spindle micrometer away from the probe face to a point at which the A OK indicator just extinguishes. The DMM indication at the PROX OUT A connector should be between -10.5 and -11.4 volts for 3000 series proximitors (200 mv/mil), between -11.0 and -12.0 volts for 7000 series proximitors (100 mv/mil) and between -16.4 and -17.3 volts for 7200 series proximitors (200 mv/mil).

NOTE

If the timed OK/danger defeat option is included, then perform Step g in lieu of Step f.

f. Slowly rotate the spindle micrometer toward the probe face to a point at which the A OK indicator illuminates. If the OK circuit latching option is included, press and hold the COMMON RESET switch during this step. The DMM indication should be within 0.1 volt of the indication in the preceding step.

g. Slowly rotate the spindle micrometer toward the probe face to a point at which the DMM indication is 0.1 volt below the indication in Step e. The A OK indicator will illuminate after an 8- to 18-second delay.

h. Rotate the spindle micrometer toward the probe face to a point at which the A OK indicator just extinguishes. The DMM indication should be between -2.0 and -2.35 volts for 3000 series proximitors, between -3.9 and -4.5 volts for 7000 series proximitors and between -2.9 and -3.3 volts for 7200 series proximitors.

NOTE

> If the timed OK/danger defeat option is included, then perform Step j in lieu of Step i.

i. Slowly rotate the spindle micrometer away from the probe face to a point at which the A OK indicator illuminates. If the OK circuit latching option is included, press and hold the COMMON RESET switch during this step. The DMM indication should be within 0.1 volt of the indication in the preceding step.

j. Slowly rotate the spindle micrometer away from the probe face to a point at which the DMM indication is 0.1 volt above the indication in Step h. The A OK indicator will illuminate after an 8- to 18-second delay.

2-15 SIGNAL CONDITIONER CALIBRATION

2-16 Successful completion of the following signal conditioner calibration procedure will verify proper operation of the monitor readout circuits. Replace the monitor if this procedure cannot be completed successfully. If the high read option is included in the display module, set the HIGH READ/CHANNEL SELECT switch on the system display module to the CHANNEL SELECT position.

a. Using the dial micrometer supplied with the TK-3, adjust the TK-3 wobulator cross-slide until it is set at the monitor full scale vibration value, or 5 mils (127 micrometers) peak-to-peak, whichever is less.

NOTE

> Refer to the TK-3 Instruction Manual for the procedure of setting the cross-slide, and to Table 1-1 of this manual for the monitor full-scale vibration value.

b. Remove the dial micrometer from the cross-slide and install the channel A probe or substitute probe in the cross-slide.

c. Connect the DMM to PROX OUT A on the monitor front panel and adjust the probe position in the cross-slide until the DMM indication is approximately -6.5 volts for 3000 series proximitors, -7.5 volts for 7000 series proximitors or -9.0 volts for 7200 series proximitors.

d. Press the SIGNAL switch on the monitor front panel to the READ A position. The system display module meter should indicate zero vibration.

e. Connect the DMM to METER OUT A. Set to indicate dc voltage within a range of 0 to -10 vdc.

f. Turn on the TK-3 wobulator and adjust the speed to approximately 6000 rpm.

g. The DMM indication should correspond to the vibration input level set in Step a of this paragraph within about ±5%. If the indication is incorrect, adjust the SPAN A potentiometer (see Figure 2-1).

h. Press the SIGNAL switch to the READ A position. The system display module meter indication should be full scale or 5 mils (127 micrometers) peak-to-peak, as determined by the vibration level set in Step a of this paragraph.

i. If the high read option is included in the display module, set the HIGH READ/CHANNEL SELECT switch to the HIGH READ position. The system display module meter indication should be within 1% of the indication in Step h if no other vibration channel in the system has a higher vibration input. Return the switch to the CHANNEL SELECT position.

j. To check the recorder output, connect the DMM to SIG 7 on the extender card. Adjust the DMM to indicate a dc voltage or current range that is capable of accommodating the recorder output (refer to Option List, Table 1-1, for proper recorder outputs). If the system has remote recorders, each should be disconnected during calibration in order to obtain accurate results. The recorder output should correspond to the meter output value of Step g with an error of less than ±1% of full scale.

2-17 ALARM CIRCUIT TESTS

2-18 The following test procedure includes both the alert and optional danger circuit tests. When the danger circuit is included, perform the entire procedure. If the danger circuit is excluded, omit Steps e through g and continue to Step h. If the alarm levels are set at a value greater than 5 mils (127 micrometers) peak-to-peak, use the Alarm Adjustment Procedures (refer to Paragraph 2-6) to set the alarm levels to a point less than 5 mils peak-to-peak for this test only.

a. With the probe installed as in Paragraph 2-16, set the TK-3 wobulator cross-slide to the center of the disc.

b. If the alarm circuit latching option is included, press the COMMON RESET switch to clear any alarms.

c. Turn on the wobulator and adjust the speed to approximately 6000 rpm. Press the SIGNAL switch to the READ A position. The system display module meter should indicate approximately zero mils or micrometers peak-to-peak.

d. Press and hold the SIGNAL switch to the READ A position during this step. Slowly adjust the cross-slide away from the center of the disc until the system display module meter indicates the alert vibration alarm level. After the specified time delay, the ALERT indicator should illuminate and the alarm relay assigned to the alert circuit should change state. Verify the relay changed state by performing a contact resistance measurement.

e. Press and hold the SIGNAL switch to the READ A position during this step. Slowly adjust the cross-slide away from the center of the disc until the system display module meter indicates the danger vibration alarm level. After the specified time delay (refer to Table 1-1), the DANGER indicator should illuminate and the relay assigned to the danger circuit should change state. Verify that the relay changed state.

NOTE

> If the timed OK/danger defeat option is included, perform Steps f and g, otherwise continue to Step h.

f. Connect a jumper between the SIG 1 and SIG 2 extender card terminals. The A OK and DANGER indicators should extinguish.

g. Disconnect the jumper between SIG 1 and SIG 2. After an 8- to 18-second delay the A OK indicator should illuminate. The DANGER indicator then should illuminate after the specified alarm time delay has elapsed.

h. Restore the channel A probe to the normal machine location. Press the COMMON RESET switch if the alarms are latched on and repeat this procedure for channel B beginning with Paragraph 2-13. Substitute terminals SIG 4 and SIG 5 for SIG 1 and SIG 2, and SIG 9 for SIG 7.

i. When Step h has been completed, restore the channel B probe to the normal machine location. Readjust the alarm set levels as desired if changed for this procedure. Press the COMMON RESET switch if the alarms are latched on and reinstall the monitor in the rack.

TABLE 2-3. EXTENDER CARD TEST POINTS

TERMINAL NAME	SIGNAL DEFINITION
SIG 10	REC B COMMON
SIG 9	REC B OUTPUT
SIG 3	PROX A INPUT
SIG 8	REC A COMMON
SIG 4	PROX B POWER
SIG 5	PROX B COMMON
#2 ALM	ALARM RELAY 2 OUTPUT
TM	(OPTIONAL)
SIG 1	PROX A POWER
SIG 6	PROX B INPUT
SIG 2	PROX A COMMON
SIG 7	REC A OUTPUT
#3 ALM	ALARM RELAY 3 OUTPUT
INHIBIT	INHIBIT SIGNAL (-24 VDC)
-18 V	-18 VOLT INPUT TO MON
+5 V	+5 VOLT INPUT TO MON
(7)	NOT USED
M1	METER DRIVE
#4 ALM	ALARM RELAY 4 OUTPUT
RESET	RESET SIGNAL (-24 VDC)
-V	-29 to -48 VOLTS
L/R COM	LAMP AND RELAY COMMON
+V	+28 TO +49 VOLTS
HI READ	HIGH READ METER DRIVE
M2	NOT USED
OK	OK RELAY DRIVE OUTPUT
#1 ALM	ALARM RELAY 1 OUTPUT
(14)	NOT USED
-24 V	-24 VOLT INPUT TO MON
+V_R	+9.5 TO +15 VOLTS
SIG COM	SIGNAL COMMON

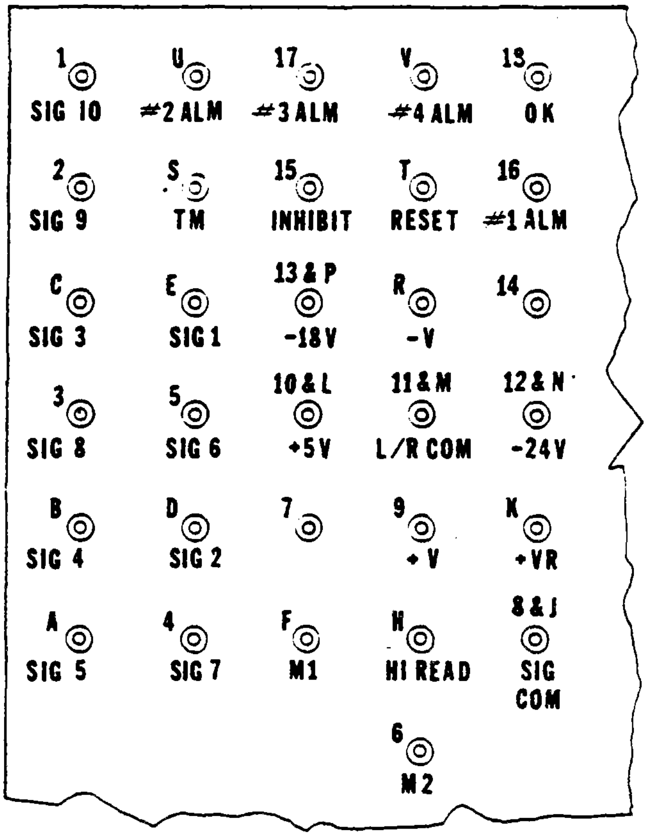


Figure 2-2. Extender Card Terminals

APPENDIX A
OPERATION AND MAINTENANCE MANUAL

3000 SERIES
PROBE AND PROXIMITOR

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

SECTION A-I

GENERAL INFORMATION

A1-1 GENERAL

A1-2 This manual contains four sections that cover the Bently Nevada Corporation 3000 Series Probe and Proximitor combination. Section A-I contains a general description of the manual, general physical and functional descriptions of the equipment, description of the available options, definition of the non-standard terms used in this manual, and the following specifications: electrical, performance, mechanical, and terminals. Section A-II contains receiving inspection, power and signal connections, proximitor installation, probe installation, and initial gap procedures. Section A-III contains calibration check procedures. Section A-IV contains a list of replaceable parts.

A1-3 PHYSICAL DESCRIPTION

A1-4 The 3000 Series Probe and Proximitor system consists of three separate items; a Type 190 or 300 Probe with 50-ohm integral cable and connector, a 95-ohm coaxial extension cable, and a 3000 Series Proximitor as shown in Figure A1-1. These components are required to make proximity measurements. The field wiring descriptions between the proximitor output and the monitor device are covered in the applicable monitoring device manual.

A1-5 PROBE WITH 50-OHM INTEGRAL CABLE AND CONNECTOR

A1-6 The Type 190 or 300 Probe shown in Figure A1-2 is a typical probe used with monitoring systems. The probe is ordered by the user with a specific length of 50-ohm integral cable and connector, and a specific body type. When ordering the probe and cable, the total physical length is defined as the distance measured from the probe tip to the connector end. When compared to the 95-ohm coaxial extension cable, the electrical length of the probe 50-ohm integral cable is approximately double its physical length.

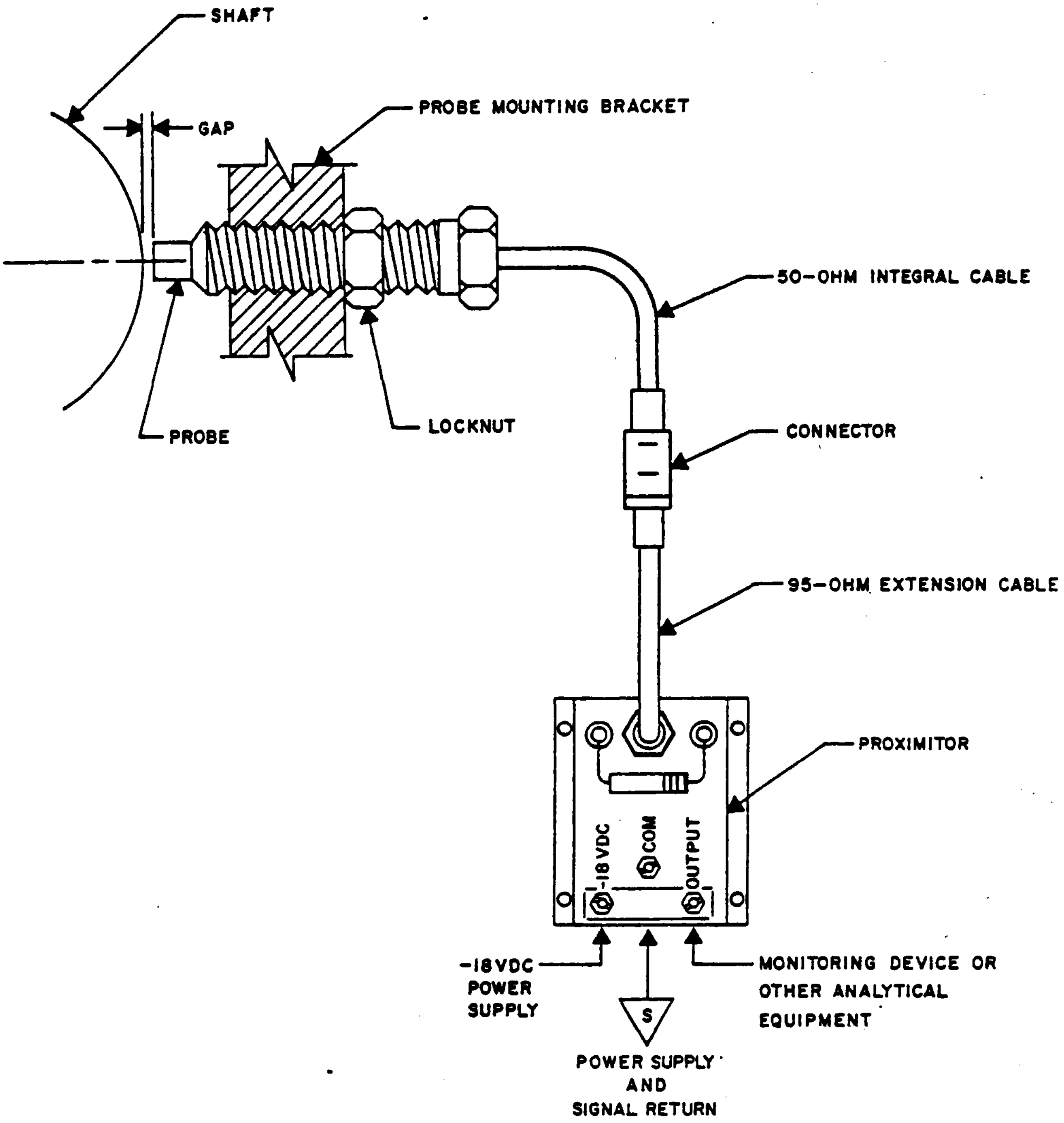


Figure A1-1. 3000 Series Probe and Proximitor Combination

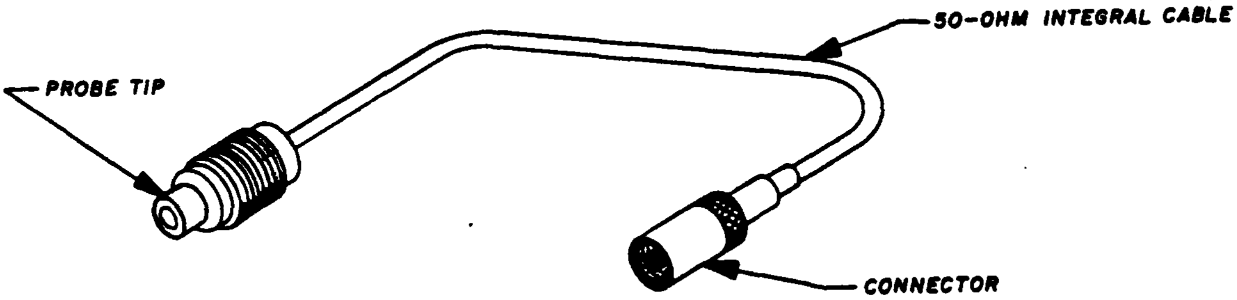


Figure A1-2. Type 190 or 300 Probe

A1-7 95-OHM EXTENSION CABLE

A1-8 The 95-ohm extension cable shown in Figure A1-3 is used to connect the probe with the proximitor with a specific matched electrical length of cable. When ordering the extension cable, the total physical length is approximately equal to the electrical length.

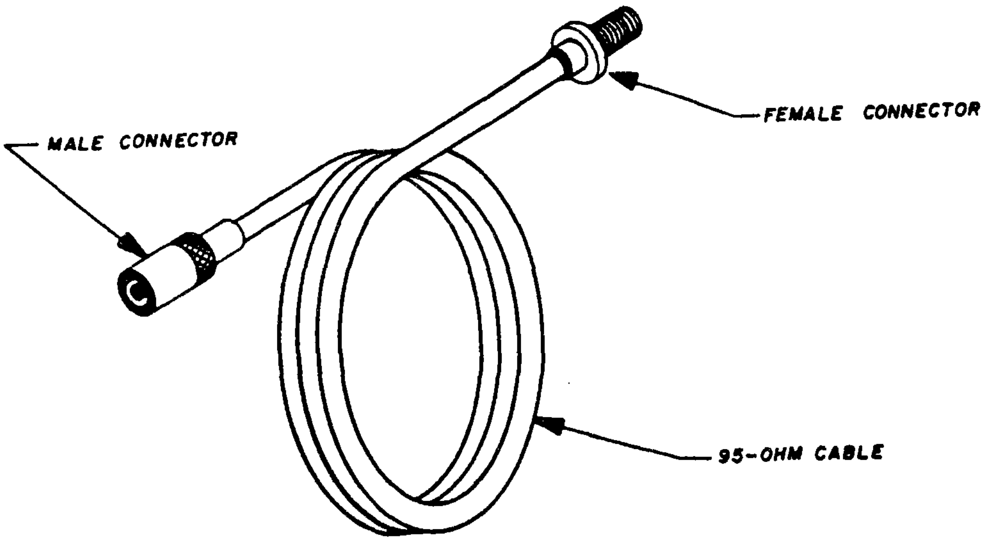


Figure A1-3. 95-ohm Extension Cable

A1-9 3000 SERIES PROXIMITOR

A1-10 The 3000 Series Proximitor shown in Figure A1-4 is used in conjunction with the Type 190 or 300 Probe and 95-ohm extension cable. The Proximitor Catalog Number defines the case configuration, the total electrical length of the combined probe with 50-ohm integral cable and connector plus the 95-ohm coaxial extension cable, and the tip size of the probe used, as shown by the following example:

EXAMPLE:

CATALOG
NUMBER 3115 2800 .190

.190 — Probe tip size
2800 — Proximitor case configuration
3115 — Proximitor series and total cable length in electrical feet (15 feet in this example)

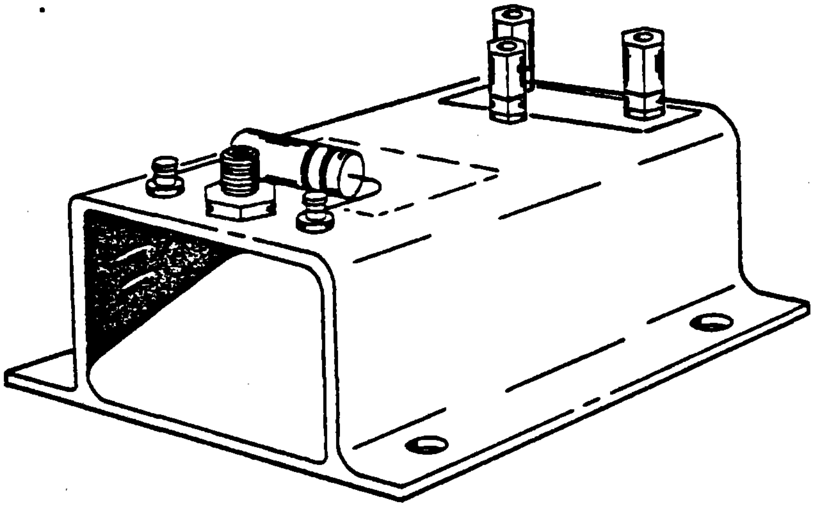


Figure A1-4. 3000 Series Proximitor

A1-11 In the preceding example, the first two digits of the catalog number define the proximitor series. The second two digits define the total cable length in electrical feet. Part of this total length is the probe with 50-ohm integral cable and connector, and part is the 95-ohm coaxial extension cable. If the probe with 50-ohm integral cable and connector is 18 inches long (physical length), the total electrical length is approximately equal to 36 inches (3 feet). Using the preceding number, the total electrical length, 15 feet minus 3 feet (50-ohm cable) equals 12 feet. This is the total electrical and approximate physical length of 95-ohm coaxial extension cable required to match the calibration of the example proximitor catalog number. The total physical length of this cable would be 1-1/2 feet (18 inches 50-ohm cable) plus approximately 12 feet (95-ohm cable), or approximately 13-1/2 feet.

A1-12 FUNCTIONAL DESCRIPTION

A1-13 The functional operation can be divided into two distinct categories; gap measurement (initial gap setting and thrust or eccentricity measurements) and vibration measurement (varying gap measurement). The probe and proximitor covered by this manual are capable of both types of measurements without any modification. The monitoring device must be suited to the measurement application for the required readout.

A1-14 GAP MEASUREMENT

A1-15 The proximitor is always powered by -18 volts from an external source, such as a power supply or monitoring device containing an -18 volts power supply. The proximitor converts the -18 volts into an rf signal that is applied to the probe through the 95-ohm coaxial extension cable, as shown in Figure A1-5. The probe coil radiates the rf signal into the surrounding area as a magnetic field. If there is no conductive material within a specified distance to intercept the magnetic field, there is no power loss in the rf signal. With no power loss in the rf signal, the output signal at the proximitor OUTPUT terminal is maximum (approximately -14 volts). When a conductive material approaches

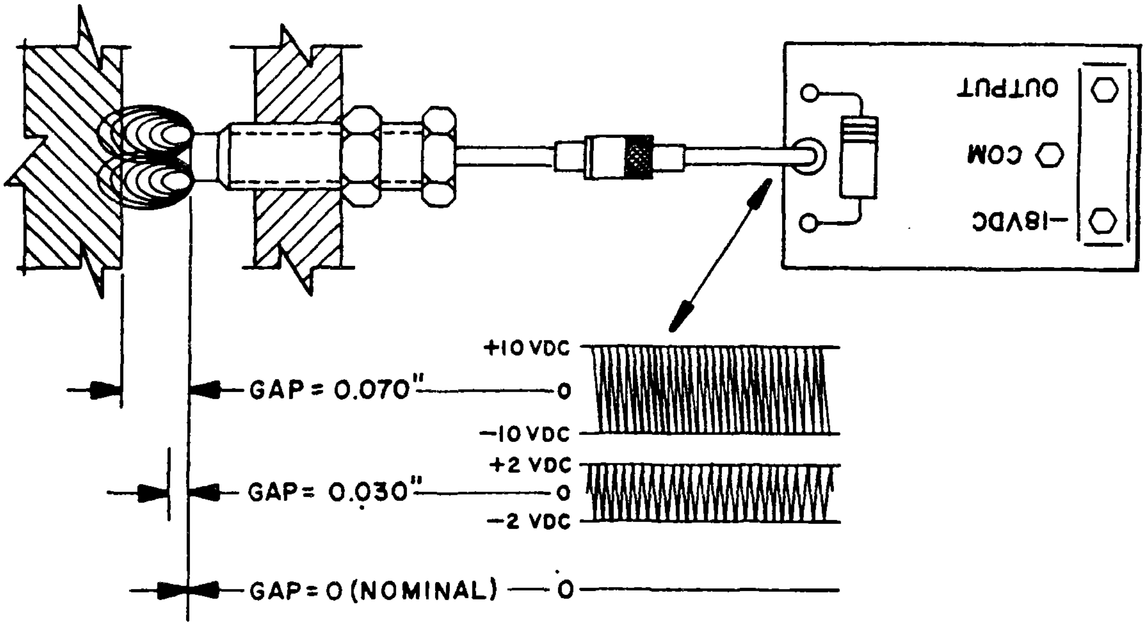


Figure A1-5. Gap Measurement Diagram

the probe tip, eddy currents are generated on the surface of the material, resulting in a power loss in the rf signal. As a power loss is developed in the rf signal, the output signal voltage at the proximitor OUTPUT terminal is reduced proportionately. As the observed conductive surface comes closer to the probe tip, more power is absorbed by the eddy currents on the surface of the material. When the probe is very close to the conductive material surface, nearly all of the power radiated by the probe is absorbed by the material. This is reflected as a maximum power loss of the rf signal, resulting in a minimum dc output signal at the proximitor OUTPUT terminal. The proximitor measures the magnitude of the rf signal, and provides a negative dc output signal proportional to the peaks of the rf signal. Thrust measurements and eccentricity measurements are merely gap measurements at a slow rate of change in the gap.

A1-16 VIBRATION MEASUREMENT

A1-17 If the observed surface is rotating and rapidly changing the gap distance, the rf signal amplitude is not a constant amplitude, but varies in direct proportion to the peak-to-peak movement of the observed surface as shown in Figure A1-6. This peak-to-peak movement of the observed surface causes the rf signal to be amplitude modulated.

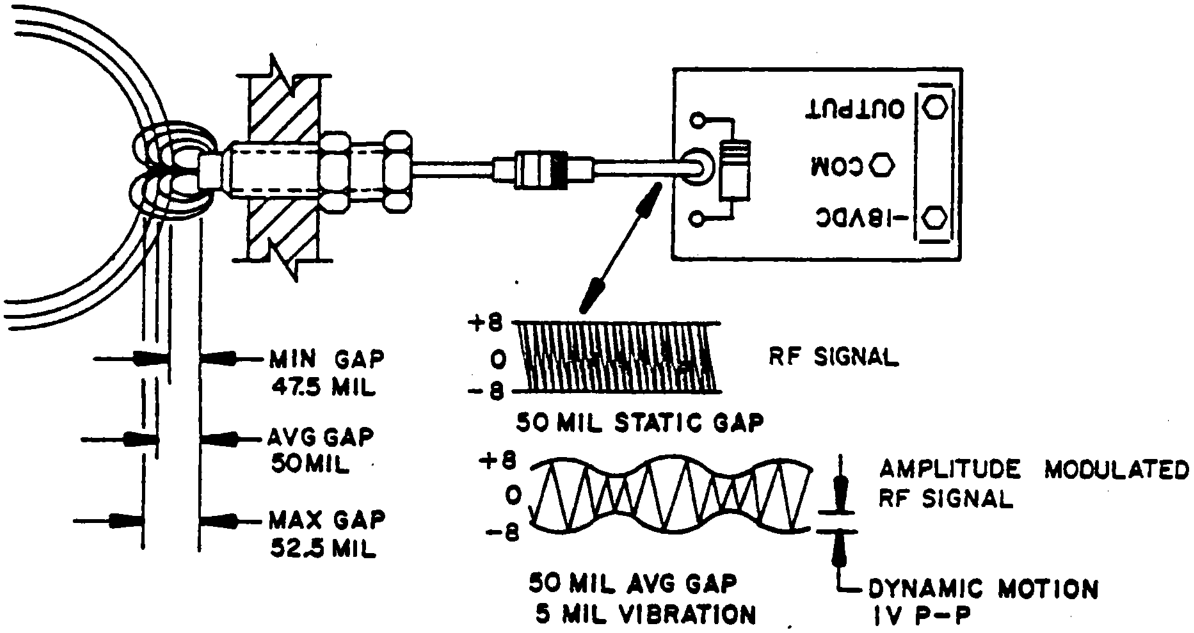


Figure A1-6. Dynamic Motion Measurement Diagram

A1-18 The proximitor detects the modulated rf signal as an ac signal varying around a constant average dc voltage (initial probe gap setting), as shown in Figure A1-7.

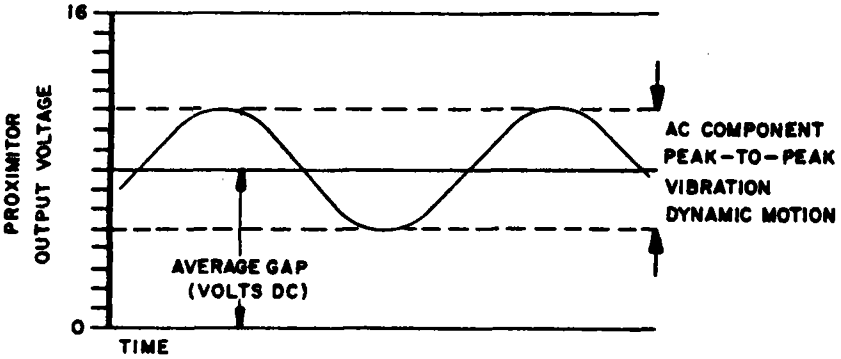


Figure A1-7. AC Component of Motion Measurement

A1-19 If the shaft vibration is 5-mils peak-to-peak, around an initial gap of 50 mils, the average dc voltage of approximately -8.0 volts remains constant, but the ac voltage is one volt peak-to-peak (-7.5 to -8.5 volts) in direct proportion to the shaft vibration (200 mv/mil scale factor), as shown in Figure A1-8. This is the process of radial vibration measurements, whether it is single plane or two plane (X-Y).

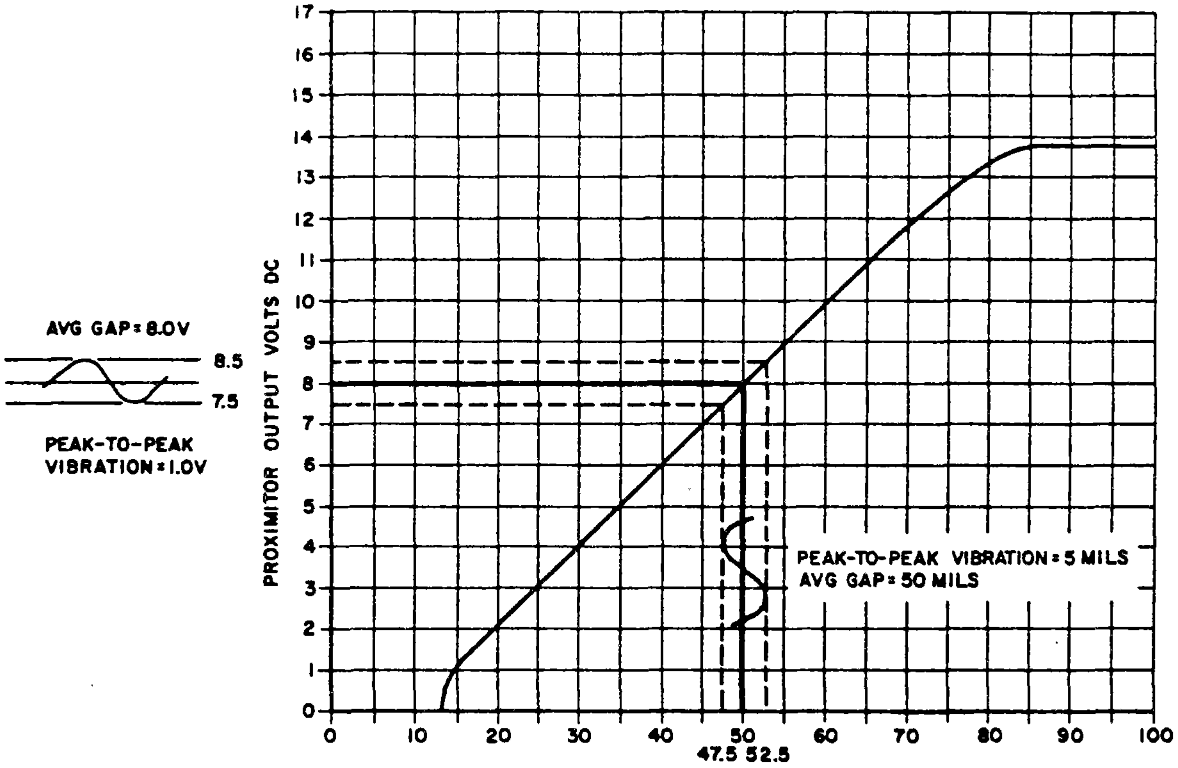


Figure A1-8. 300 Probe Gap Conversion From Mils to Volts - Typical

A1-20 DEFINITION OF TERMS

A1-21 The following terms are used throughout this manual and have the definitions noted for each. Any other definition of these terms does not apply to this manual.

Probe - A proximity measurement device that radiates an rf field into a given area to allow non-contacting measurements of static and varying gaps. The probe in this manual can be either 0.190 or 0.300 inch in diameter.

3000 Series Proximitor - A transducer and rf generating device that drives the probe and converts the probe gap information into a proportionally linear dc output voltage.

50-Ohm Integral Cable - A coaxial cable of specific length that is an integral part of the proximity probe. The cable is the input/output connection for the probe.

95-Ohm Extension Cable - A coaxial cable of specific length that interconnects the probe with 50-ohm integral cable and connector to the proximitor.

Electrical Length - One electrical foot of cable has the same electrical characteristics at low radio frequencies as one physical foot of ideal 95-ohm coaxial cable.

Probe Calibration Curve - A plotted curve of probe gap in mils versus proximitor output in dc voltage, that represents the operating characteristics of the probe, extension cable, and proximitor.

Recommended Initial Gap Voltage - The point on the probe calibration curve that corresponds to the approximate center of the linear operating range. This point may also be expressed in mils, as translated from the probe calibration curve.

Observed Surface - The surface from which the probe is gapped. This surface is also the surface being monitored for gap changes by the probe.

Mechanical Runout - The physical probe-to-observed surface gap variation caused by physical surface imperfections and/or an eccentric shaft.

Electrical Runout - The error signal read by the proximity system that is due to electrical imperfections in shaft surface caused by magnetism, non-uniform hardness, non-uniform composition, etc.

A1-22 SPECIFICATIONS

A1-23 The following specifications define the probe electrical, environmental, and mechanical characteristics; and the proximitor electrical, performance, mechanical and terminal characteristics.

A1-24 PROBE

Electrical

Typical response with different observed material:	See graph, Figure A1-9 for 190 probe or A1-10 for 300 probe

Environmental

Operating Temperature Range:	-45°C (-50°F) to +175°C (+350°F)
Storage Temperature Range:	-45°C (-50°F) to +175°C (+350°F)
Temperature Sensitivity:	See graph, Figure A1-11 for 190 probe or A1-12 for 300 probe
Pressure:	Order P type probe for applications where probe is exposed to differential pressures. P type probe will withstand 500 psi differential pressure at 120°C (250°F)
Humidity:	100% RH If probe is to be submerged, order PG type. PG type will withstand submersion of 500 psi at +175°C (350°F). A 100 mv shift occurs when gap medium is water instead of air
Corrosive Atmosphere:	Generally, atmospheres with a PH of less than 4, or more than 10, will damage the probe

Mechanical

Case Material:	300 Series Stainless steel
Tip Material:	Epoxy resin with anhydride curing
Cable Material:	Teflon jacket and dielectric
Connector Material:	Body - corrosion resistant metal Insulator - teflon
Tip Diameter:	190 Probe = 0.190 inch 300 Probe = 0.300 inch

A1-25 PROXIMITOR

Electrical

Input Power Required	-18.00 volts (-17.70 to -18.5 volts) / milliamps maximum draw. The AC ripple on power source should not exceed 0.020 volts peak-to-peak (AC ripple on input power will be present on the proximitor output.	
DC Output	Proportional to probe average gap distance	
AC Output	Proportional to probe peak-to-peak gap change and frequency of gap change (superimposed on DC output)	
Output Impedance	Approximately 320 ohms	
External Load	10K ohm load across the OUTPUT	
Probe Tip Diameter	Proximitors 31XX-XXXX-190: 0.190 inch Proximitors 31XX-XXXX-300: 0.300 inch	
Probe to Proximitor Calibrated Cable Length	Proximitor Model	Nominal Electrical Cable Length
	3106-XXXX-XXX	6 Feet
	3109-XXXX-XXX	9 Feet
	3115-XXXX-XXX	15 Feet
	3120-XXXX-XXX	20 Feet
Calibration Scale Factor	200 mv/mil ± 5%.	
Operating Range	190 Probe: 15 to 55 Mils 300 Probe: 20 to 70 Mils	
Observed Material	4140 Steel. For typical response with different observed materials, see Figures A1-9 and A1-10	

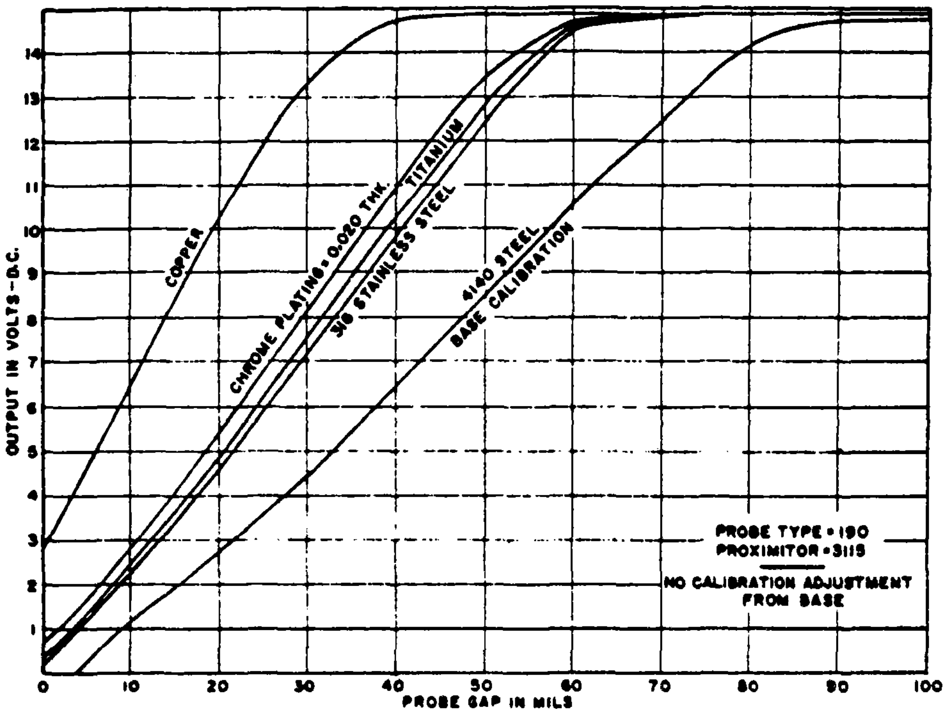


Figure A1-9. Typical Response With Different Observed Materials - 190 Probe

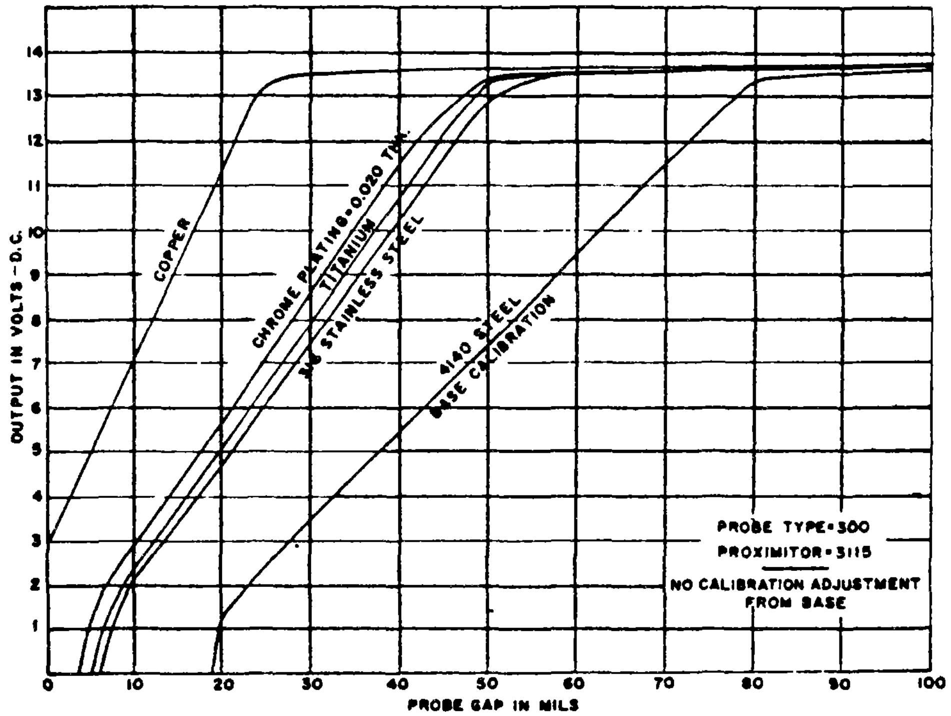


Figure A1-10. Typical Response With Different Observed Material - 300 Probe

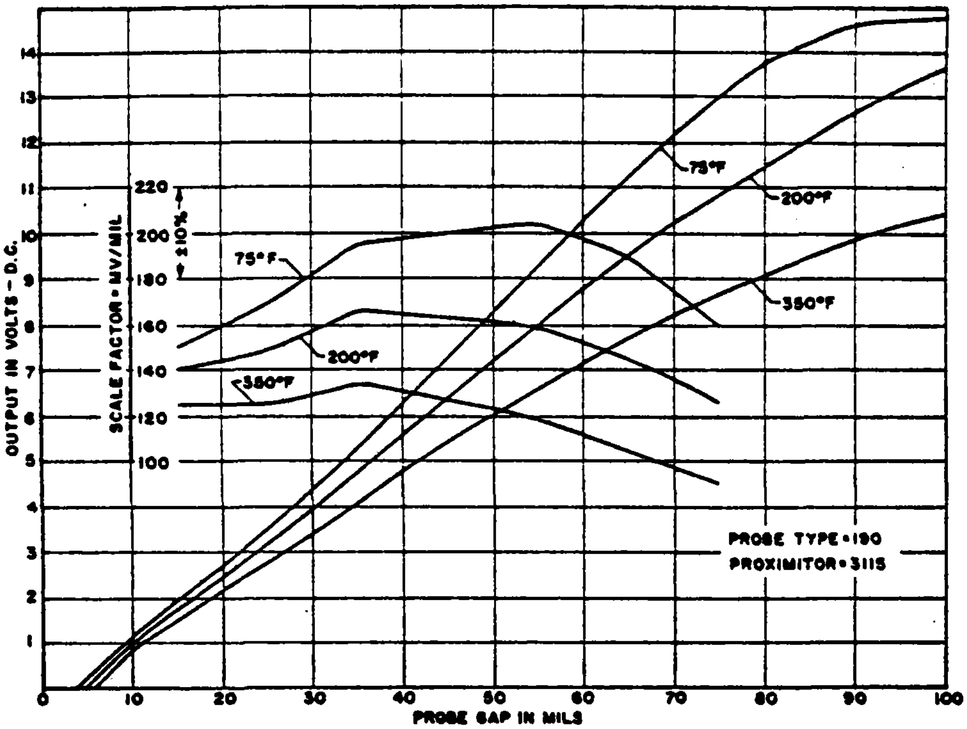


Figure A1-11. 190 Probe Temperature Sensitivity Graph - Typical

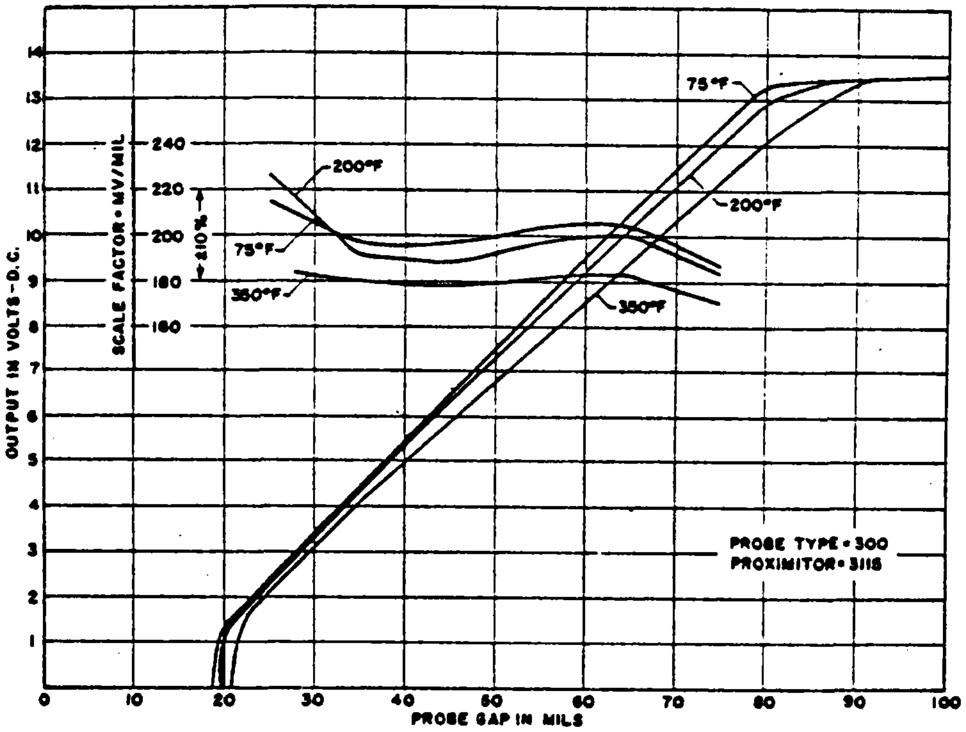


Figure A1-12. 300 Probe Temperature Sensitivity Graph - Typical

Calibration Resistor	Fixed - Factory Calibrated
Output Voltage vs Probe Gap (Typical)	See Figure A1-8
Temperature Effects on Proximitor (Typical)	See Figure A1-14
Power Supply Stability Effects (Typical)	See Figure A1-15
Frequency Response	Flat to 10 KHz

Mechanical Characteristics

Dimensions - Overall and Mounting	See Figure A1-16 Outline Drawing
Weight	5 1/3 ounces
Materials:	
Case	Extruded 6063-T5 Aluminum
Terminals (-18 VDC, COM, OUTPUT)	Brass - Gold Plated, 6-32 thread
Terminal Insulator (-18 VDC, OUTPUT)	Fiberglas
Probe or Cable Connector	Stainless Steel BNJR - Gold Plated
Calibration Resistor Terminals	Brass - Gold Plated
Calibration Terminal Insulator	Teflon
Identification and Calibration Tag	Mylar - Acetate Laminate Finish

Terminals

-18 VDC	Power Input Terminal
COM	Power and Signal Ground Terminal - Grounded to Aluminum Case
OUTPUT	Output Signal Terminal

BNJR Connector	Probe or Cable Connector
Calibration Terminals	Scale Factor Calibration Resistor Terminals - Adjusts mv/mil

A1-26 OPTIONS

A1-27 The available options offered for the 3000 Series Probe and Proximitor combination are the calibrated length of the probe with 50-ohm integral cable and connector and 95-ohm coaxial extension cable. Refer to the example of Paragraph A1-9, 3000 Series Proximitor. Also, probe tip size of 0.190 or 0.300 inch and several probe types are offered for specific applications and environments.

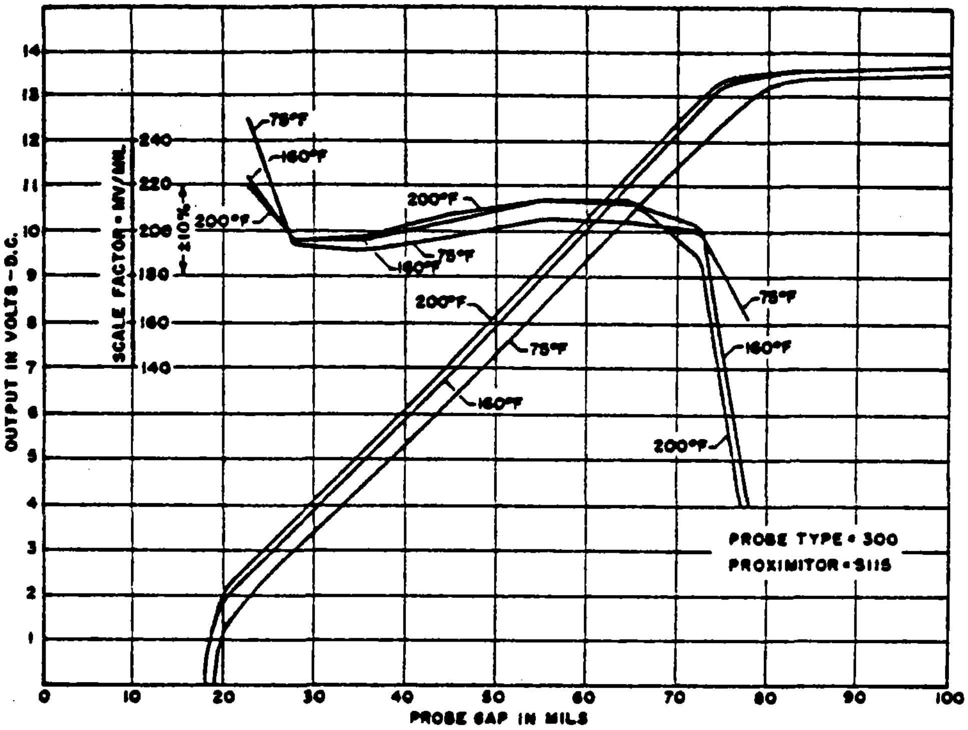


Figure A1-13. Proximitor Temperature Sensitivity Graph - Typical

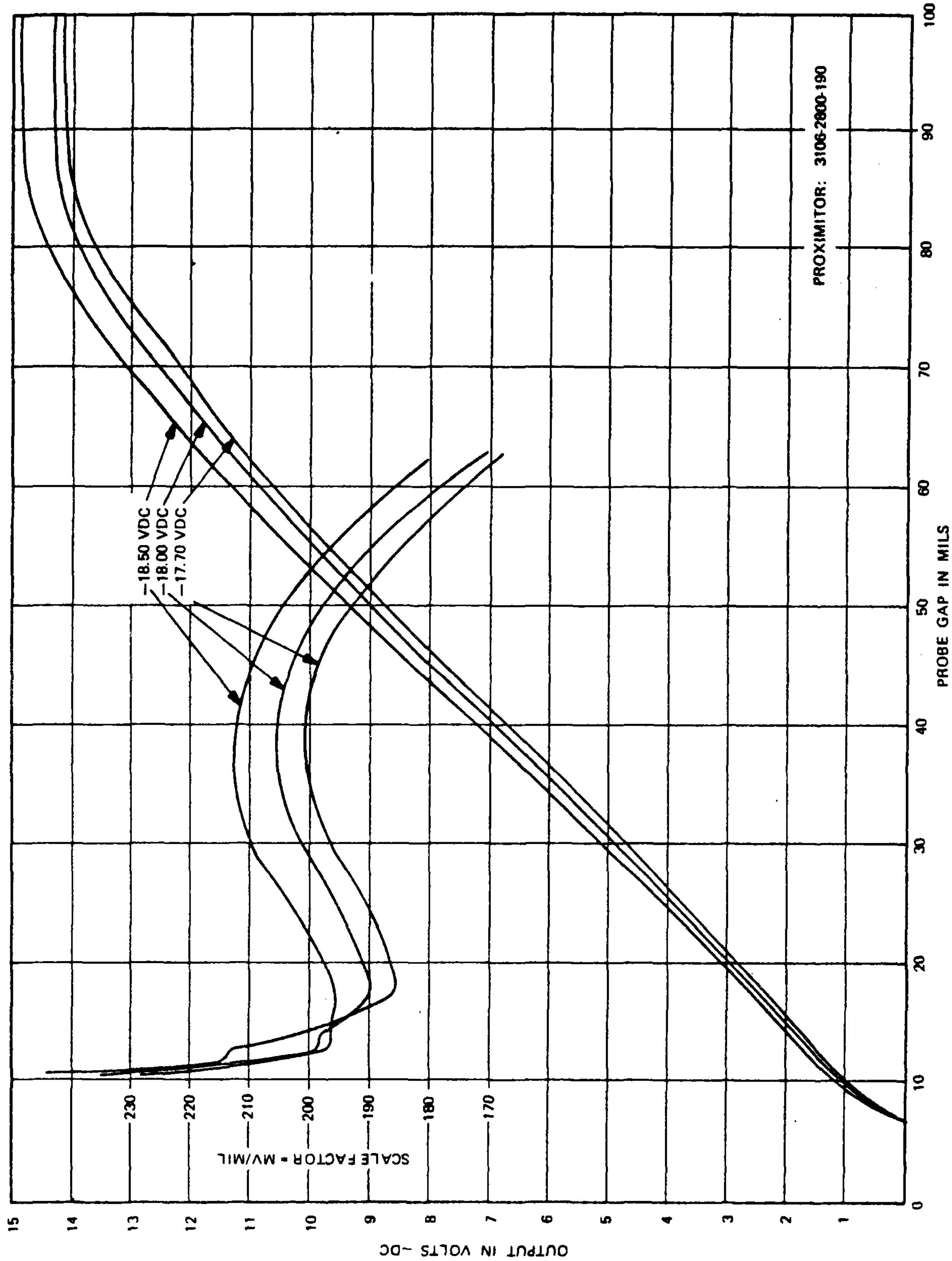


Figure A1-14. Power Supply Stability Effects

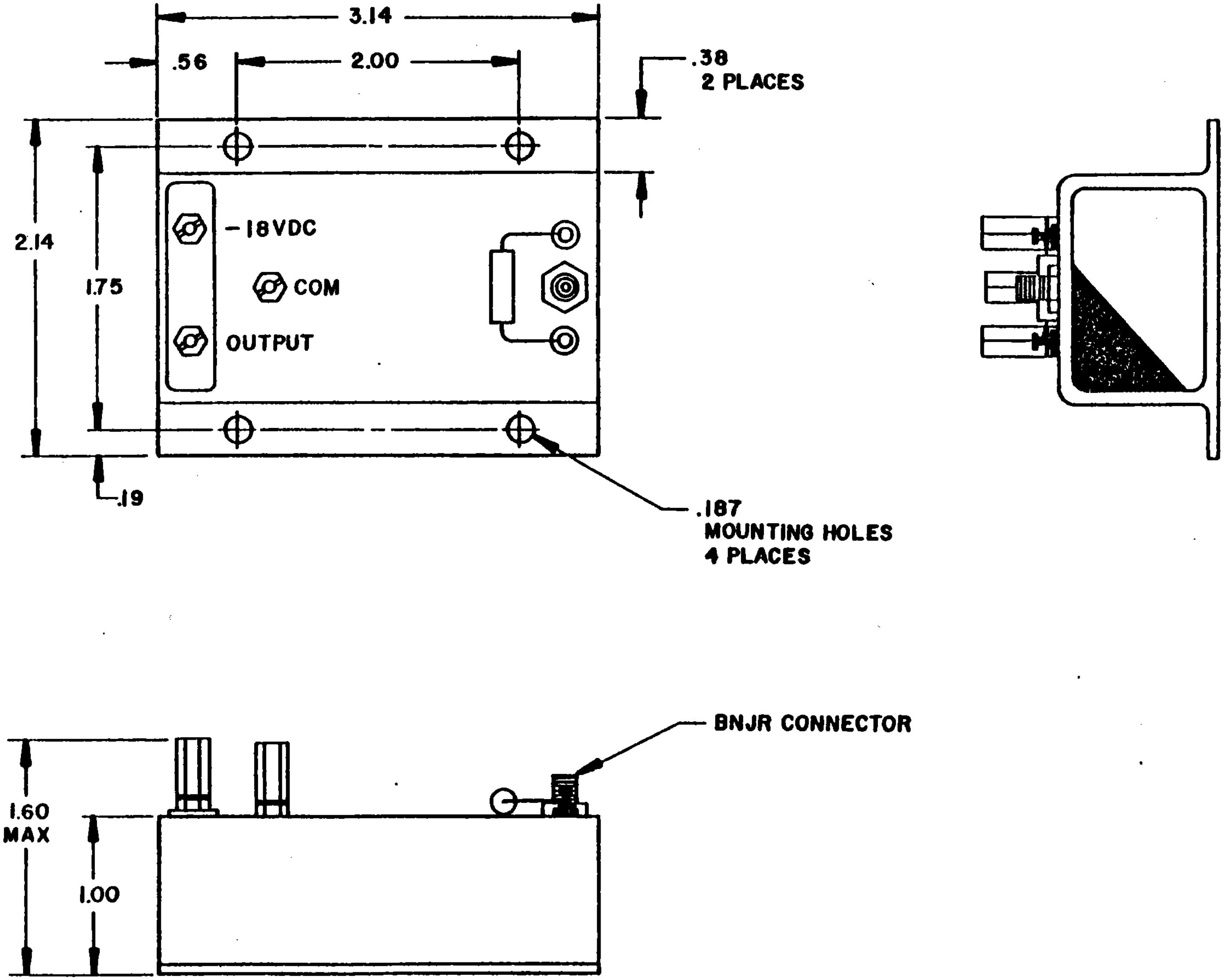


Figure A1-15. Proximitor Outline Drawing.

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SECTION A-II

INSTALLATION

A2-1 GENERAL

A2-2 This section contains receiving inspection, power and signal connections, probe and proximitor mounting considerations, and an initial gap procedure. The exact installation instructions will depend upon the application and machine configuration where the probe and proximitor are to be used.

A2-3 RECEIVING INSPECTION

A2-4 Inspect the probe, extension cable, and proximitor as soon as it is received and unpacked, to determine if any in-transit damage has occurred. All shipping forms and invoices should be retained. If any shipping damage is apparent, file a claim with the carrier and submit a copy to Bently Nevada Corporation. Include the probe and proximitor model and serial numbers with all correspondence. The user will be advised concerning repair or replacement in accordance with the guarantee.

A2-5 POWER AND SIGNAL CONNECTIONS

A2-6 All power and signal connections between the probe and proximitor and between the proximitor and the monitoring device must be made in the field. Figure A2-1 shows the probe connected to the proximitor through the extension cable, and the required power and output signal connections from an external source such as a monitoring device. The power and signal connections between the proximitor and the monitoring device should be made through three-wire shielded cable to avoid erroneous indications due to radiated interference.

A2-7 For specific monitoring applications, using the probe and proximitor described in this manual, refer to the applicable monitoring device manual.

A2-8 PROXIMITOR INSTALLATION

A2-9 The proximitor installation is primarily governed by the length of the extension cable to the probe and the environmental considerations. The proximitors are designed to operate with a specific length of 95-ohm coaxial extension cable connected to a probe that has a 50-ohm integral cable and connector, refer to Section A-I for an explanation of these specific lengths. In general, some provision should be set up for protection from hazardous environments or weather.

A2-10 The 3000 Series Proximitor is not normally affected by vibration, dust, humidity, or most gases. However, it is necessary to mount the proximitor in a location where it is not subjected to temperatures in excess of 65°C (150°F). Temperatures in excess of 65°C (150°F) may cause permanent damage to the proximitor.

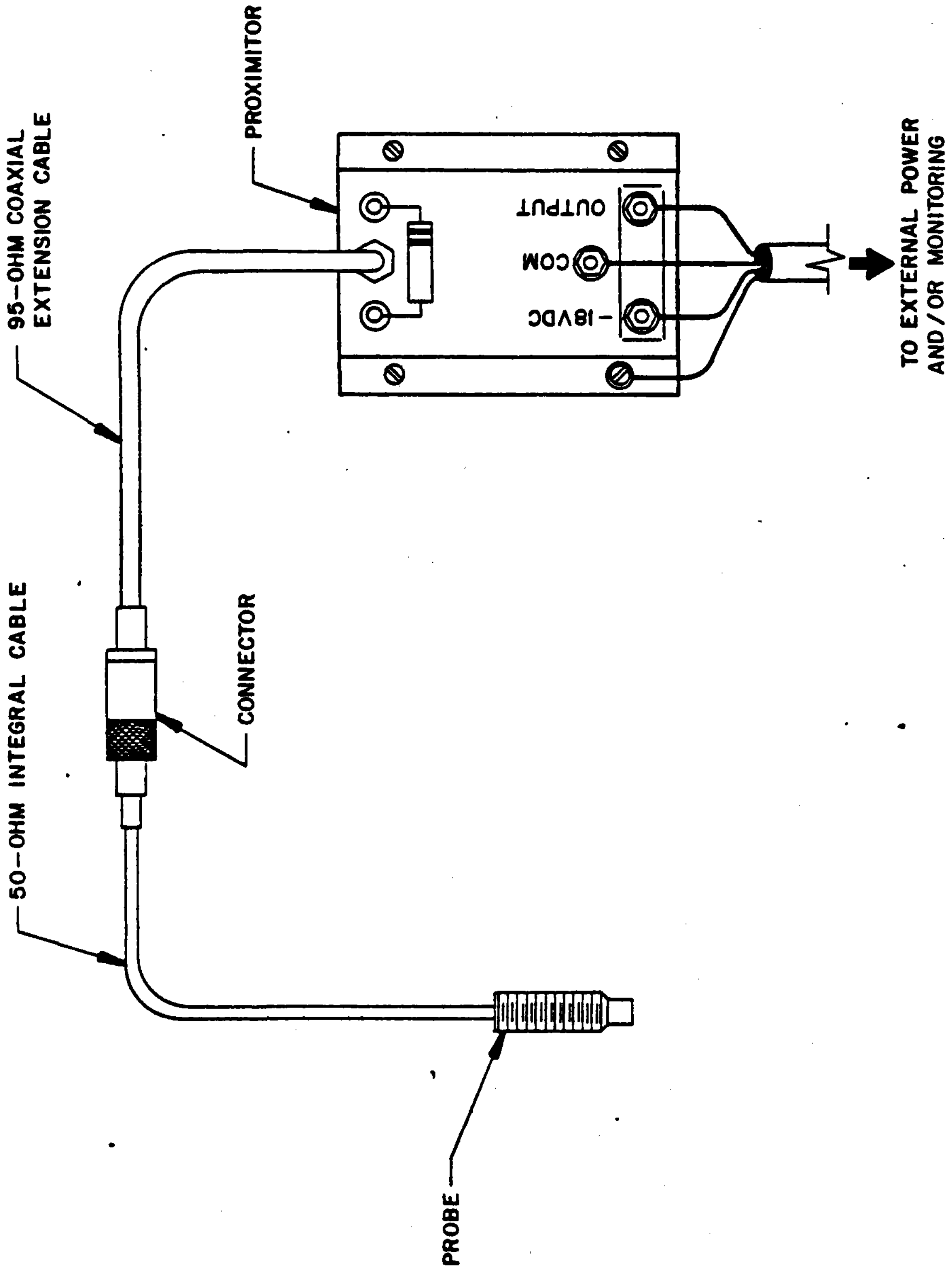

Figure A2-1. Probe and Proximitor Power and Signal Connections

A2-11 PROBE INSTALLATION

A2-12 Standard probes for relative shaft motion measurements may be mounted in any location on or in the machine with the end of the probe facing the surface to be observed. When observing a vibration point, the machine surface should be of bearing type finish to minimize mechanical runout noise. Also, the observed surface should be checked for electrical runout, and if present, the runout should be removed.

A2-13 The probe observes the gap from the probe face to the running shaft. Therefore, for accurate measurements of vibration, the holding structure of the probe must not vibrate at amplitudes or frequencies in the range of the measurements to be made. If a probe cannot be mounted in a solid location on the machine, like a bearing housing, it is necessary to use a beam structure. Make certain the beam structure cannot vibrate appreciably. The resonant vibration frequency of any such mounting structure should be field checked by tapping the structure lightly, and observing the proximitor output on an oscilloscope (the proximitor output is available on the proximitor OUTPUT terminal). The lower frequency limit should not be less than ten times the rpm of the observed surface.

A2-14 When installing the probe, the 50-ohm integral cable and connector should be disconnected and the 50-ohm integral cable should be rotated with the probe as the probe is threaded into the mounting hole. Do not allow twist loads to occur at the probe and the joint of the 50-ohm integral cable as they may cause cable damage. The probe must be securely locked into its mount by a locknut, clamp, or other vibration secure device. Make certain the mounting hole is clear of obstructions. If the observed surface is moving, take care to prevent the probe face from being rubbed by the shaft.

A2-15 Initial probe gap is determined by consulting the typical probe calibration curve shown in Figure A2-2 for 190 tip, A2-3 for 300 tip; or for specific applications, the probe calibration curve shown in the applicable monitoring device manual. In open installations, the gap can be set using a feeler gage or plastic shim, or by observing the proximitor output voltage. The output voltage of the proximitor should be set to correspond to the recommended initial gap voltage indicated by the typical probe calibration curve in Figure A2-2 for 190 tip, A2-3 for 300 tip, or the specific application probe calibration curve in the applicable monitoring device manual. The proximitor output voltage method is useful in blind installations or with the machine running, where feeler gages or shims cannot be used. In blind mounting holes, make certain the probe is observing the shaft by moving the probe in and out to decrease or increase the gap while observing the proximitor output voltage. Decreasing gap will cause decreasing voltage (less negative) and increasing gap will cause increasing voltage (more negative).

A2-16 In the completed installation there should be no metal within a radius from the center of the probe tip equal to the diameter of the probe tip coil (see Figure A2-4). Disregard the diameter of special application items around the probe tip such as shrouds. For example,

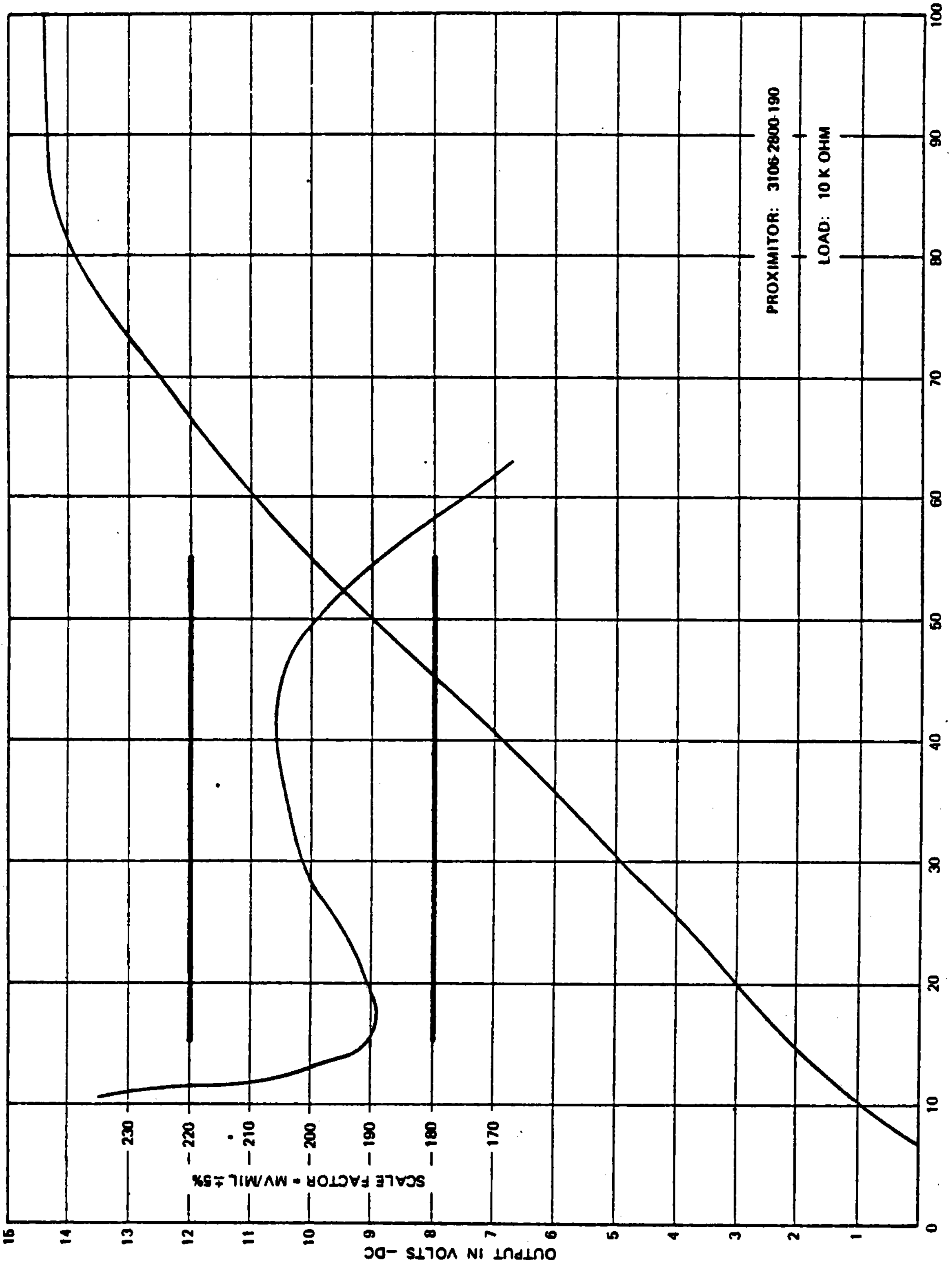

Figure A2-2. Typical Probe Calibration Curve for 190 Tip

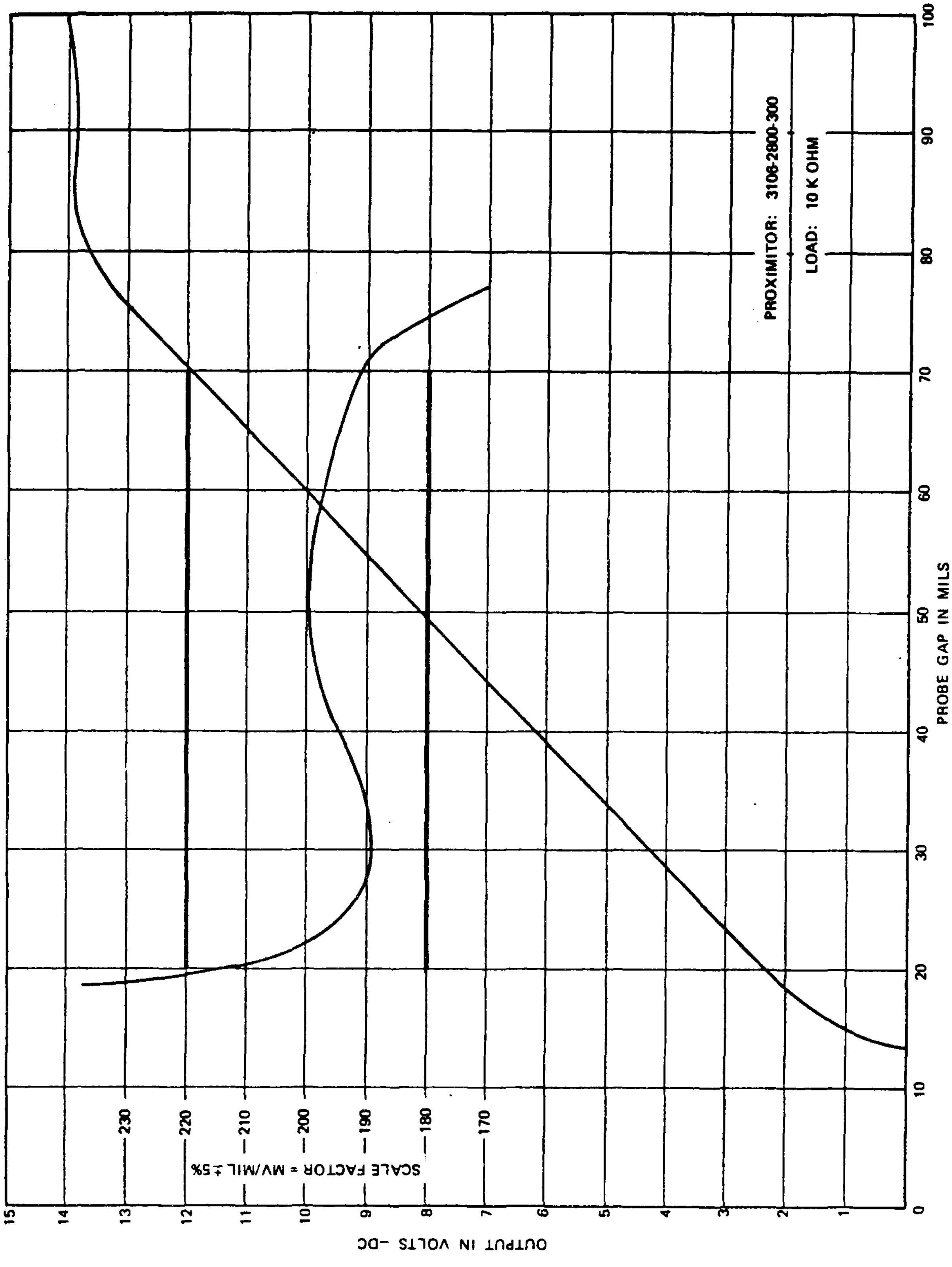

Figure A2-3. Typical Probe Calibration Curve for 300 Tip

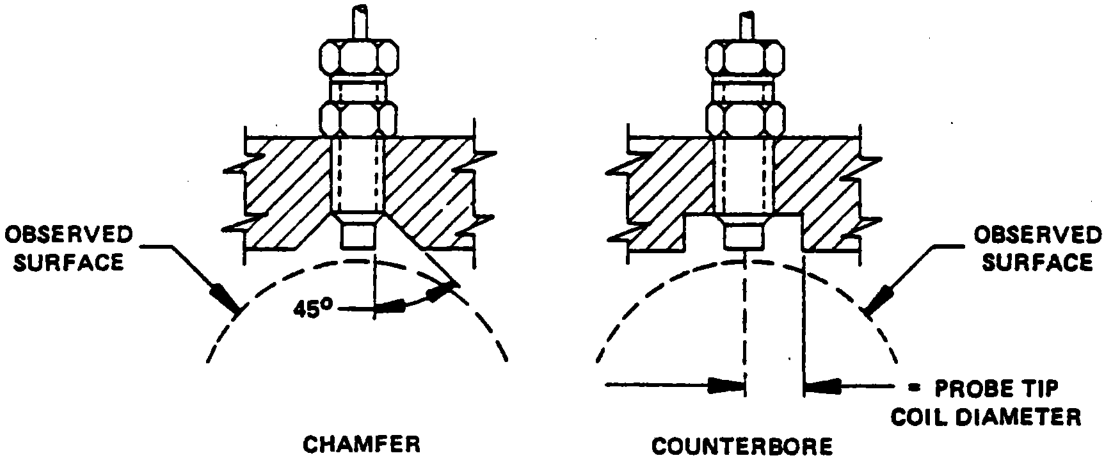

Figure A2-4. Probe Tip Relief Diagram

when installing a 190 probe (0.190-inch tip diameter), no metal other than the observed surface should be within 0.190 inch from the center of the probe tip. However, as much clearance as possible should be maintained. If the minimum required clearance cannot be obtained, contact Bently Nevada Corporation.

A2-17 INITIAL GAP PROCEDURE

A2-18 The following initial gap procedure may be used to set the initial probe operating gap in accordance with the typical probe calibration curve, Figure A2-2 for 190 tip, A2-3 for 300 tip, or a specific probe calibration curve for a specific application. Specific application probe calibration curves will be found in the applicable monitoring device manual. The following procedure will be performed using the Digital Multimeter (DMM) or a direct equivalent. For open installations where the shaft is not rotating, a feeler gage or plastic shim may be used in lieu of this procedure.

a. With the probe installed in its normal mounting, connected to its proximitor in accordance with the instructions in this section, and with all proximitor power connected, connect the DMM between the OUTPUT and COM terminals on the proximitor. Set the DMM to indicate dc voltage.

b. Carefully rotate the probe and its 50-ohm integral cable toward the observed surface; the dc voltage indicated on the DMM will be decreasing in magnitude (approaching zero from a negative voltage).

c. Continue to rotate the probe and the 50-ohm integral cable toward the observed surface until the voltage indicated on the DMM has decreased to some value less than the recommended initial gap voltage on the probe calibration curve being used.

d. Rotate the probe away from the observed surface until the recommended initial gap voltage is reached as indicated on the DMM.

e. Secure the probe. If the 50-ohm integral cable has a twist load from rotation, disconnect it at the 95-ohm coaxial extension cable connector and relieve the twist load before reconnecting. Disconnect the DMM.

SECTION A-III

MAINTENANCE

A3-1 GENERAL

A3-2 This section covers calibration check procedures for the 3000 Series Probe and Proximitor combination. Part of the calibration check procedure is devoted to making a probe and proximitor calibration curve, similar to the typical curve shown in Figure A2-2 for 190 tip, or A2-3 for 300 tip. Table A3-1 lists the equipment recommended to perform the calibration check procedures.

TABLE A3-1. RECOMMENDED MAINTENANCE EQUIPMENT

RECOMMENDED EQUIPMENT	SPECIFICATION
Digital Multimeter (DMM)	3-1/2 digit display minimum, with ohms, ac volts, dc volts as minimum functions
TK-3 Test and Calibration Kit with Instruction Manual	Vibration rpm range = 1K to 10K rpm Displacement range (spindle micrometer) = 0 to 500 mils Vibration amplitude range = 0 to 5 mils peak-to-peak
10K OHM Resistor	

A3-3 CALIBRATION CHECK PROCEDURES

A3-4 The following calibration check procedures will determine if the 3000 Series Probe and Proximitor combination are operating within tolerance.

a. Install the probe in the TK-3 spindle micrometer fixture, assuring the probe tip extends completely through the spindle micrometer mounting fixture.

b. Connect the probe to the proximitor with the proper length extension cable.

c. Connect the power supply -18 volts output between the -18 VDC and COM terminals on the proximitor.

d. Connect the 10K ohm resistor between the OUTPUT and COM terminals on the proximitor.

e. Connect the DMM between the OUTPUT and COM terminals on the proximitor.

f. Set the TK-3 spindle micrometer to 0 mils, and adjust the probe position in the mounting fixture until the probe face just touches the target. The DMM indication should be 0 volts.

g. Set the TK-3 spindle micrometer to 10 mils. The proximitor output voltage should be approximately -2 volts.

h. Measure and record the output voltage from the proximitor at each 10-mil increment as the TK-3 spindle micrometer is rotated away from the probe face, out to a setting of 120 mils.

i. Set the TK-3 spindle micrometer to 200 mils. The proximitor output voltage should be approximately -14 volts.

j. Calculate the response sensitivity between each 10-mil increment from 10 mils to 70 mils.

NOTE

For example, if the voltage at 40 mils is -6.0 volts and the voltage at 30 mils is -4.05 volts, the difference is 1.95 volts or 1950 millivolts. Sensitivity is derived by dividing the voltage by the distance: 1950 mv/10 mils = 195 mv/mil. The sensitivity between any 10-mil increment from 15 mils to 55 mils for a 190 probe, or from 20 mils to 70 mils for a 300 probe should be no less than 180 mv/mil nor greater than 220 mv/mil. If they are not within the specified limits, refer to the Field Wiring Tests, Paragraph A3-5. The voltages recorded in the preceding test may be used to plot a probe calibration curve on graph paper graduated 10 mils per inch for the horizontal scale and 2 volts per inch for the vertical scale. The probe graph should be similar to Figure A2-2 for 190 tip, or A2-3 for 300 tip.

A3-5 FIELD WIRING TESTS

A3-6 The field wiring test procedure need be performed only when the calibration check procedures of Paragraph A3-3 show that the sensitivity between 15 mils and 55 mils for 190 probe, or 20-70 for 300 probe is greater than 180 mv/mil or less than 220 mv/mil. Field wiring includes the probe, probe 50-ohm integral cable and connector, 95-ohm coaxial extension cable, and proximitor. The wiring between the proximitor and the specific monitoring device is covered in the applicable monitoring device manual.

a. Measure regulated proximitor drive voltage (-18 volts) at the proximitor -18 VDC terminal.

b. Measure the probe gap voltage at the proximitor OUTPUT terminal.

c. If voltage indicated in Step b of this paragraph is not satisfactory, disconnect the extension cable at the proximitor (probe remains connected) and measure 4 to 10 ohms between the cable center conductor and cable shield.

NOTE

The approximate resistance of the probe with 50-ohm integral cable and connector is 4 to 10 ohms. The 95-ohm coaxial extension cable resistance is approximately 0.25 ohms per foot. However, the wide variation in resistance of probes with 50-ohm integral cable and connector causes most measurements to be between 4 to 10 ohms, except for those with very long extension cables. The measurement should not be a short or much more than 10 ohms.

d. If ohms reading in Step c of this paragraph is not satisfactory, disconnect the 95-ohm coaxial extension cable from the probe 50-ohm integral cable and connector, and measure 4 to 10 ohms between the probe 50 ohm center conductor and the shield.

e. If all the tests in the preceding Steps of this paragraph are satisfactory, replace the proximitor.

SECTION A-IV

REPLACEABLE PARTS

A4-1 GENERAL

A4-2 This section contains a list of the replaceable parts required to maintain the 3000 Series Probe and Proximitor combination. When ordering either the probe or the extension cable, the cable length must be matched to that being replaced. If replacement of connectors is required, contact the Bently Nevada Corporation factory or field representative to determine the correct part numbers, tools, and replacement procedures.

TABLE A4-1. REPLACEABLE PARTS

QTY	PART NO.	NOMENCLATURE	SPECIAL REMARKS
1	*	Probe with 50-ohm cable	Specify length as measured from probe tip to cable connector end.
1	*	95-ohm coaxial extension cable	Specify length.
1	*	Proximitor	Specify probe size and total electrical cable length.

* When ordering replacement parts, assure that the number on the parts order exactly matches the number stamped or labeled on the part being replaced.

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Sales and Service Centers

UNITED STATES OF AMERICA

FIELD SALES AND SERVICE OFFICES

EASTERN STATES:

J.W. Simpson Company
280 Cayuga Road
Buffalo, **New York** 14225
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633 Trapelo Road, Suite 5
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15 Charles St.
Westwood, **New Jersey** 07675
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J.W. Simpson Company
390 Reed Road
Broomall, **Pennsylvania** 19008
(215) 328-0400
Telex: 831622

J.W. Simpson Company
Wexford Professional Bldg.
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Telex: 18793

Petrovest as
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76-82-86
76-94-46
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(R9/80)

WARRANTY

The following provisions constitute Bently Nevada Corporation's (BNC's) warranty, disclaimer and Buyer's exclusive remedies, all of which, absent specific written waiver by BNC, become part of the contract upon acceptance by BNC.

A. **LIMITED WARRANTY.** Subject to the following terms and conditions, BNC warrants title and guarantees its manufactured standard electronic instrument products to be free from defects in material or workmanship for a period of ten (10) years from the date of shipment from the factory, its standard test equipment, Liquid Crystal Display Units with associated electronics and products having moving mechanical parts for a period of two (2) years from the date of shipment from the factory, and all other products for a period of 90 days from the date of shipment from the factory or as otherwise stated by BNC in each instance of sale:
   1. So long as the products are installed by BNC, its representatives or the user according to BNC's instructions.
   2. So long as the products are serviced and calibrated by BNC, its representatives, or the user according to BNC's instructions.
   3. So long as the products are not used with attachments or modifications which have not been recommended or approved by BNC in writing.
   4. So long as an adequate service and calibration record is maintained.
   5. So long as the defective products, parts or assemblies are returned prepaid to, or repaired by, BNC Product Services or an authorized representative. Repairs performed by BNC Product Service personnel or its representatives include parts and labor for actual repair of warranted items. Cost of travel, subsistence, and labor required to obtain access to the defective item will be for the Buyer's account.

B. **EXCLUSIVE REMEDY.** Buyer's remedy is limited exclusively to repair or replacement, by BNC, of the defective product. All other remedies, statutory or otherwise, are expressly waived by Buyer.

C. **DISCLAIMER.**
   1. THERE IS NO IMPLIED WARRANTY OF MERCHANTABILITY.
   2. THERE IS NO IMPLIED WARRANTY OF FITNESS FOR ANY PARTICULAR PURPOSE.
   3. BNC assumes no liability for, and this warranty does not extend to protection against, incidental or consequential damages suffered by any person or thing as a result of a defect in BNC product, material, design, manufacture or installation.
   4. BNC shall assume no liability for typographical or printing errors in and does not warrant the complete accuracy of installation or service manuals. BNC will notify purchasers immediately upon the ascertainment of such errors.
   5. BNC shall not be responsible for any delay in repair, replacement or delivery to a carrier arising out of acts of the public enemy, fire, flood, or any disaster, labor trouble, acts of a supplier, or occurring without fault of BNC.
   6. BNC shall not be responsible for any damage which shall occur during shipment, nor shall any such damage relieve Buyer of any obligation hereunder.
   7. BNC shall not be liable for consequential or incidental damages or penalties resulting from its failure to perform, or delays in performing, its obligations hereunder unless otherwise agreed in writing by an authorized officer of BNC at the time of accepting the order.
   8. BNC does not warrant and shall not be liable for equipment or instruments supplied by BNC but manufactured by others, beyond the original supplier/manufacturer warranty. BNC shall apply its best efforts to support Buyer's pursuit of such reparations.
   9. This Warranty does not extend to Computer Systems hardware, software or peripheral equipment. These items are exclusively and separately warranted.

D. **WARNING.** BNC has thoroughly tested and inspected its products for their recommended and approved uses. Present technology and expertise reveal no defects in design or manufacture if put to those uses and serviced according to schedule. However, misuse, abuse or modification of BNC products may result in failure or inaccuracy, and will terminate the express warranty contained herein. BNC products require the use of electrical current for their operation. Improper installation, use or service may result in exposure of such current.

BENTLY NEVADA CORPORATION

1 October 1980
The above Warranty supercedes all previous Warranty statements

BENTLY NEVADA CORPORATION

TERMS AND CONDITIONS CONSTITUTING A PART OF ALL QUOTATIONS, PROPOSALS, AND SALES OF BENTLY NEVADA CORPORATION GOODS

1. Acceptance: Offers to purchase are subject to and effective only upon acceptance by BENTLY NEVADA CORPORATION (hereinafter referred to as "BNC") in Minden, Nevada, USA. This quotation and solicitation for orders is limited to the quantities and items specifically mentioned herein and BNC will assume no responsibility for furnishing other equipment or materials shown in any plan or specification. Acceptance of offers to purchase goods by BNC is expressly conditioned upon Buyer's assent to the terms and conditions contained herein, which assent is acknowledged by Buyer upon accepting shipment, and shall prevail as the final expression of the parties in the event of conflict.

2. Prices: Prices are FOB shipping point unless otherwise agreed to in writing by BNC. Prices will remain in effect for sixty (60) days from the date of the quotation. In all other respects, the quotation and solicitation for orders may be withdrawn at any time prior to acceptance by BNC, or the whole may be extended beyond sixty (60) days when confirmed in writing by BNC.

3. Taxes: Liability for all taxes, licenses or other fees imposed by any governmental authority upon the productions, sale, shipment or use of equipment or services covered by this solicitation shall be assumed and paid for by the Buyer and the Buyer shall indemnify BNC against any such liability. Applicable sales or use taxes will be billed by BNC to Buyer unless suitable exemption certificates are furnished by Buyer before acceptance by BNC.

4. Shipment: Shipment shall occur upon delivery of the products or materials by BNC to a carrier at BNC's factory, at which time all risks pass to Buyer. BNC shall attempt to make shipment within the time specified by BNC after its acceptance and/or after the receipt of full data including approved certified prints. Buyer agrees to furnish complete shipping instructions to BNC within a reasonable period of time before the date such shipment is required to be made.

5. Payment: Unless otherwise specified in BNC's quotation and solicitation for offers, payment terms are thirty (30) days net from the date of BNC's invoice payable in United States dollars. Upon BNC's failure to receive payment within thirty (30) days, in addition to any other remedies which BNC may have, it shall have the right and Buyer will permit it to enter the premises where the equipment is installed and repossess equipment or products as to which full payment has not been received. On all currency based transactions, interest of one and one half percent (1 ½ %) per month, eighteen percent (18%) annually will be added to past due accounts.

6. Proprietary Information: The data supplied by BNC is for use in support of BNC manufactured and supplied equipment only. Reproduction for use or use of supplied data for any other purpose is prohibited except with the express permission of BNC.

7. Cancellation and Returned Equipment: Orders may be cancelled or terminated by Buyer only upon BNC's written consent and upon payment of reasonable and proper cancellation charges including factory costs and expenses incurred by BNC in carrying forward the order to the date of BNC's agreement to terminate. If the order or any part thereof has been shipped from the shipping point, the equipment shall be returned only when specifically authorized and credit for this returned equipment shall be determined by BNC after factory inspection and granted only after prior written authorization from BNC has been given. If equipment has been manufactured or outside purchases made by BNC pursuant to orders, prior to receipt of Buyer's hold notice, the equipment shall be held in storage for ten (10) days with no charge. After ten (10) days, storage charges will be levied on the Buyer. The order will be invoiced on the date the equipment was placed in storage. Storage charges will be invoiced after the equipment has been removed from storage.

8. Financial Responsibility of Buyer: If any time before shipment, the financial responsibility of Buyer becomes impaired, or unsatisfactory to BNC, BNC may require cash payment or such other further assurances as it deems necessary be made before shipment, and in the event of bankruptcy or insolvency of the Buyer, or in the event any proceeding is brought by or against Buyer under bankruptcy or insolvency laws, BNC shall be entitled to cancel any order then outstanding and shall receive reimbursement and proper cancellation charges therein. Such termination shall not prejudice BNC's rights to any amounts due under the contract.

9. Tender: In the event of failure or refusal of the Buyer to accept delivery, no physical tender of the products by BNC shall be necessary, but written notice of BNC's readiness and willingness to deliver any quantity of the product at any time specified shall be the equivalent of physical tender thereof.

10. Catalog and Specification Illustrations: The illustrations and engravings in BNC's catalogs and specification sheets are intended to show the general features of the product or materials, but BNC reserves the right to supply products and materials of latest design and manufacture and does not warrant that products will conform to either samples or illustrations. Two Installation and Maintenance Instruction Manuals will be furnished with each system rack and, as applicable, one Instruction or Operation and Maintenance Manual or one set of drawings or microfilm will be provided for other instruments ordered, free of charge. When requested, one sepia and blueline drawing will be provided for each system rack and one blueline drawing or microfilm will be provided for other instruments ordered, free of charge. Additional copies of the above will be provided at extra charge.

11. Assignment: No right or obligation arising under this contract may be assigned or transferred by the Buyer without prior written consent of BNC.

12. Indemnification: Buyer does hereby promise and covenant to indemnify and hold harmless and shall defend BNC from and against all claims, losses and liability of any kind whatsoevr brought by any person or entity, caused in whole or in part by the negligence or willful acts of Buyer, its representatives, agents or employees in connection with the goods furnished hereunde. including, without limitation, the installation, erection, repair, adjustment or operation thereof.

13. Entire Contract: This writing constitutes the entire agreement and understanding between the parties as of the date of acceptance by BNC and shall not thereafter be modified in any way except in writing by an authorized BNC executive

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WARRANTY

The following provisions constitute Bently Nevada Corporation's (BNC's) warranty, disclaimer and Buyer's exclusive remedies, all of which, absent specific written waiver by BNC, become part of the contract upon acceptance by BNC.

A. Limited Warranty. Subject to the following terms and conditions, BNC warrants title and guarantees its standard electronic instrument products to be free from defects in material or workmanship for a period of ten (10) years from the date of shipment from the factory, its standard test equipment, Liquid Crystal Display units with associated electronics and products having moving mechanical parts for a period of two (2) years from the date of shipment from the factory, and all other products for a period of ninety (90) days from the date of shipment from the factory or as otherwise stated by BNC in each instance of sale:

   1. So long as the products are installed by BNC, its representatives or the user according to BNC's instructions.
   2. So long as the products are serviced and calibrated by BNC, its representatives, or the user, according to BNC's instructions.
   3. So long as the products are not used with attachments or modifications which have not been recommended or approved by BNC in writing.
   4. So long as an adequate service and calibration record is maintained.
   5. So long as the defective products, parts or assemblies are returned prepaid to, or repaired by, BNC Product Services or an authorized representative. Repairs performed by BNC Product Service personnel or its representatives include parts and labor for actual repair of warranted items. Cost of travel, subsistence, and labor required to obtain access to the defective item will be for the Buyer's account.

B. Exclusive Remedy. Buyer's remedy is limited exclusively to repair or replacement, by BNC, of the defective product. All other remedies, statutory or otherwise, are expressly waived by Buyer.

C. Disclaimer.

   1. THERE IS NO IMPLIED WARRANTY OF MERCHANTABILITY.
   2. THERE IS NO IMPLIED WARRANTY OF FITNESS FOR ANY PARTICULAR PURPOSE.
   3. BNC assumes no liability for, and this warranty does not extend to protection against, incidental or consequential damages suffered by any person or thing as a result of a defect in BNC product, material, design, manufacture or installation.
   4. BNC shall assume no liability for typographical or printing errors in and does not warrant the complete accuracy of installation or service manuals. BNC will notify purchasers immediately upon the ascertainment of such errors.
   5. BNC shall not be responsible for any delay in repair, replacement or delivery to a carrier arising out of acts of the public enemy, fire, flood, or any disaster, labor trouble, acts of a supplier, or occuring without fault of BNC.
   6. BNC shall not be responsible for any damage which shall occur during shipment, nor shall any such damage relieve Buyer of any obligation hereunder.
   7. BNC shall not be liable for consequential or incidental damages or penalties resulting from its failure to perform, or delays in performing its obligations hereunder unless otherwise agreed in writing by an authorized office of BNC at the time of accepting the order.
   8. BNC does not warrant and shall not be liable for equipment or instruments supplied by BNC but manufactured by others, beyond the original supplier/manufacturer warranty. BNC shall apply its best efforts to support Buyer's pursuit of such reparations.
   9. This Warranty does not extend to Computer Systems hardware, software or peripheral equipment. These items are exclusively and separately warranted.

D. Warning. BNC has thoroughly tested and inspected its products for their recommended and approved uses. Present technology and expertise reveal no defects in design manufacture if put to those uses and serviced according to schedule. However, misuse, abuse or modification of BNC products may result in failure or inaccuracy, and will terminate the express warranty contained herein. BNC products require the use of electrical current for their operation. Improper installation, use or service may result in exposure of such current.

BENTLY NEVADA CORPORATION

1 October 1980
The above Warranty supercedes all previous Warranty statements

YOUNG RADIATOR COMPANY

RACINE, WISCONSIN 53404

INSTALLATION AND MAINTENANCE INSTRUCTIONS FOR YOUNG HEAT EXCHANGERS

INSTALLATION INSTRUCTIONS

Young Radiator Company Heat Exchangers are designed to give the optimum heat transfer rate for given flow conditions. Ordinarily the most viscous fluid is piped to the shell side while the least viscous is piped to the tube side. The shell side of the Exchanger is baffled and therefore the shell fluid is required to make many changes of direction in its travel through the Exchanger. This breaks up the surface film which would otherwise prevent the transfer of heat. The next important consideration in the piping of the fluids to the Exchanger pertains to temperature. A single pass Exchanger should be piped counter flow for greatest heat transfer as this will give the greatest mean temperature difference over the entire length of the Exchanger. True counter flow exists where the two fluids flow in opposite directions in the Exchanger and is possible in the single pass Exchanger only.

In connecting a multi-pass Exchanger, the shell fluid should enter the Exchanger at the same end at which the tube fluid enters.

Strainers

In making up the pipe on the lube oil side of a Heat Exchanger for lubricating oil cooling it is essential to install a strainer on the outlet side of the Heat Exchanger. This is to collect foreign matter which may have entered the Exchanger in shipping and piping, preventing its entry into the engine. Consult your Young Radiator Company representative or write the factory directly for strainer recommendations.

Water Regulating Valves

In the interest of conserving water, a water regulating valve should be installed ahead of the Heat Exchangers in which water is used for cooling another fluid. Normally the regulating valve is temperature controlled and the control bulb for the valve is placed in the stream of fluid being cooled. Consult Young Radiator Company or a reputable manufacturer of this equipment for recommendations.

Pressure Relief Valve

When there is a possibility of surge pressures, above the design pressure of the Heat Exchanger a pressure relief or regulating valve should be installed to protect the Exchanger from bursting pressures. Consult Young Radiator Company factory or a reliable manufacturer of such equipment for recommendations.

SERVICE RECOMMENDATIONS

The Heat Exchanger, when shipped from the factory, is clean and should require no on-the-job cleaning. It is recommended that the Exchanger be inspected thoroughly on both the shell and tube side making sure that no foreign matter entered while in shipment. This inspection can be made without removing the end bonnets of the Exchanger. It is also recommended that the bolts holding the end bonnet to the end casting be checked and pulled down so as to insure tightness. The Exchanger should be mounted solidly in place and the pipe connections made up, being sure that all connections are tight. If the Exchanger is to be stored for any length of time before use, shell and bonnet openings should be kept sealed to prevent the entry of dirt or other foreign matter.

When the Exchanger is first installed, sufficient data should be taken to establish the temperature and pressure drops. Similar data recorded at regular intervals by the operator will serve to detect any accumulation of sediment or scale, and from such data the proper interval between cleanings can be established.

When an Exchanger is disassembled for cleaning, new gaskets should be used upon reassembly. This is important in both the Fixed and Removable Tube Bundle Exchangers.

Care should be taken when removing or handling the tube bundle of a Removable Tube Bundle Exchanger to protect the baffle plates and tubes from being bent or damaged. The result of bent baffle plates is bypassing of fluid with an accompanying decrease in heat transfer rate.

Corrosive and Scale Forming Fluids

In many sections of the country raw water is extremely corrosive or scale forming and should be treated to prevent damage to the Heat Exchanger and to prolong periods between cleanings. Before piping fluids to a Heat Exchanger, they should be analyzed as to what action they will have on the metals in the Exchanger.

If salt water is used as a cooling medium, zinc pencils should be used in the Heat Exchanger on the salt water side to prevent corrosion of the Exchanger. Parts in contact with the salt water should be of Admiralty metal, cast iron, or copper-nickel alloys.

TECHNICAL MANUAL

LESLIE CO. TECHNICAL MANUAL

BINGHAM - WILLAMETTE
P.O. # 1-61656
Portland Or. 97210
LESLIE CO. ORDER NO.
80-0516

OPERATING and MAINTENANCE DATA for ORDERING PARTS

THIS INFORMATION IS ESSENTIAL — When ordering parts for Leslie Regulators, Controllers or Whistles, the following data should accompany each order:

1. Part name and part (REFERENCE NUMBER) from parts list on back of applicable drawing.
2. Quantity of each part.

OR

1. Serial number, Class and Size of Regulators, Controller or Whistle.
2. Part name (See parts list on drawing).
3. Quantity of each part.
4. Marine Representative Listing.

LOCATE OPERATING, MAINTENANCE INSTRUCTIONS AND DRAWINGS FROM INDEX

USE ONLY GENUINE LESLIE PARTS

LESLIE CO., PARSIPPANY, NEW JERSEY 07054

2462 PRINTED IN U.S.A. 278 5M

1.2.23-367

CONTENTS SHEET

ITEM NO.	DESCRIPTION	DWG.NO.	INSTRUCTION
1.0	2" DPUF 1500# BWE Sch. 40 Diaphragm Control Valve Severe Service Valve 7/8" Trim 5 Stage CODE: 03P23A2BLA w/ Bailey Positioner AP21200 Spring Ref. # A35014	106 8868 29	10/0.5.1 10/2.5.1 P88-7
2.0	Electronic Controller 4-20 MA Pressure 0-100 G I & D Output 4-20 MA Single Case	23/1.4.6	23/1.5.1
3.0	1/4" Thd. AF-2 Reducing Valve 3-60 PSIG	301 8029 13	30/1.5.1
9.0	Faichild Model T5100-4 I/F Transducer 4-20 MA Input 3-15 PSIG Output	EA-12817	
10.0	Model F 20CS Annubar 2" 1500# ANSI Flg. Flow Range 0-345 GPM Max. Press. 2493 PSIG @ 325°F. Schedule pipe 160	C-4900	
	System Diagram	SKTLG~~5-8-80~~ ~~REV. 1~~ 2-24-81	

OPERATING and MAINTENANCE DATA

for

ORDERING PARTS

THIS INFORMATION IS ESSENTIAL

WHEN ORDERING PARTS FOR LESLIE REGULATORS, CONTROLLERS OR WHISTLES, THE FOLLOWING DATA SHOULD ACCOMPANY EACH ORDER:

1. PART NAME AND PART (REFERENCE NUMBER) FROM PARTS LIST OF APPLICABLE DRAWING.

2. QUANTITY OF EACH PART.

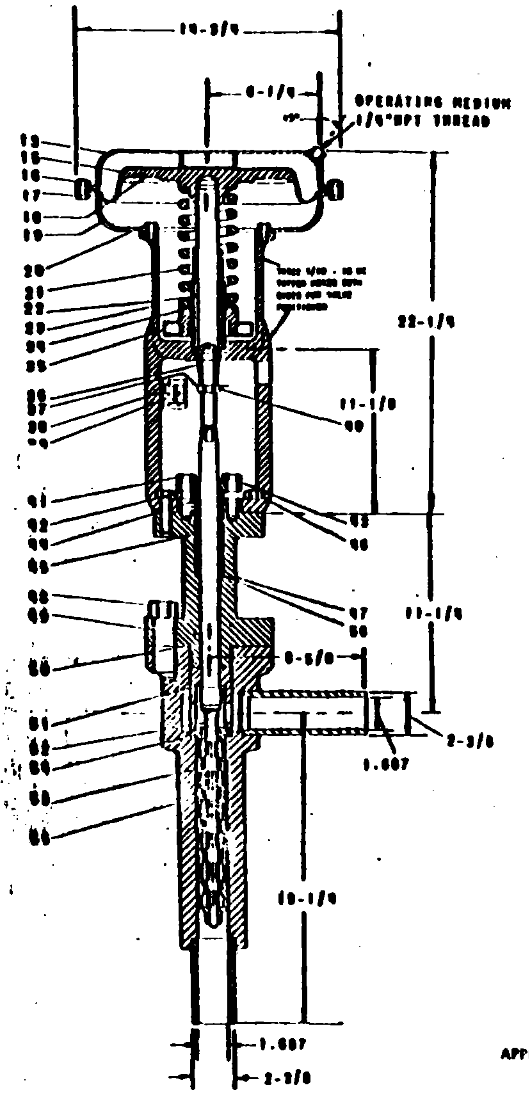
OR

1. SERIAL NUMBER, CLASS AND SIZE OF REGULATORS, CONTROLLER OR WHISTLE.
2. PART NAME (SEE PARTS LIST ON DRAWING).
3. QUANTITY OF EACH PART.
4. MARINE REPRESENTATIVE LISTING.

LOCATE OPERATING, MAINTENANCE INSTRUCTIONS AND DRAWINGS FROM INDEX

USE ONLY GENUINE LESLIE PARTS

MAXIMUM ALLOWABLE AIR PRESSURE IS 60 PSI



APPROX. NET. WT. - 116 LB.

PART NO.	PART NAME	MATERIAL	MATERIAL SPEC.	QTY. PER UNIT	REF. NO.
13	Diaphragm Cover, Compl	Pressed Steel	Commercial	1	37791
15	Diaphragm	Synthetic Rubber	Fairprene	1	37819
16	Nut	Steel	Commercial	16	26585
17	Bolt	Steel	Commercial	16	37797
18	Diaphragm Plate	Cast Iron	ASTM A- 126, Cl . B	1	37843
19	Diaphragm Base	Pressed Steel	Commercial	1	37678
20	Cap Screw	Steel	Commercial	6	23400
21	Actuator Spring	Steel, Plate	AISI 1095	1	See Tag
22	Actuator Stem	Stainless Steel	AISI Type 410	1	57521
23	Yoke	Cast Iron	ASTM A- 126, Cl B	1	57554
34	Washer	Stainless Steel	AISI Type 302	1	24271
35	Spring Adjustor	Cast Iron	ASTM A- 126, Cl. B	1	24274
36	Adjustor Sleeve	Stainless Steel	AISI Type 416	1	37766
37	Travel Indicator	Stainless Steel	AISI Type 302	1	58012
38	Travel Indicator Scale	Aluminum	ASTM B- 221	1	38907
39	Screw	Steel, Cad. Plated	Commercial	2	34728
40	Stem Nut	Steel	ASTM A- 194, Gr.4	1	26584
41	Packing Nut	Steel, Cad Plated	Commercial	2	48830
42	Packing Stud	Steel	ASTM A- 193, Gr. B7	2	42738
43	Packing Flange	Cold Rolled Steel	ASTM A- 108, Gr. 1144	1	57635
44	Packing Follower	Stainless Steel	AISI Type 303	1	30701
45	Packing Set	Molded Rings	Commercial	1	30909
46	Bolt	Steel	ASTM A- 193, Gr. B7	4	36150
47	Bonnet	Carbon Steel	AISI 1020HR	1	66270
48	Nut, Valve Body	Steel	ASTM A194 Gr. 4	6	23371
49	Stud, Valve Body	Steel	ASTM A- 193, Gr. B- 16	6	27142
50	Bonnet Gasket	Stainless Steel	AISI Type 316L	1	52677
51	Seat Retaining Guide	Stainless Steel	ASTM A- 564 Type 630	1	54901
52	Valve Plug, Mark SP Trim	Stainless Steel	ASTM A564 Type 630&Stell	1	66276
53	Seat Chamber, Mark SP Trim	Stainless Steel	AISI Type 410 & Stell.	1	66431
54	Seat Chamber Gasket	Stainless Steel	AISI Type 316L	1	54903
55	Valve Body, SP Trim	Forged Carbon Steel	ASTM A- 181 GR. I L	1	66273
56	Packing Ring	Stainless Steel	AISI Type 302/304	1	30702

NOTE 1 - YOKE, PART NO. 23 IS FURNISHED COMPLETE WITH ADJUSTING SLEEVE, PART NO. 36

Code - 03P23A2BLA

Valve Plug - 7/8 Mark SP Trim

LESLIE CO.

DIAPHRAGM CONTROL VALVE
2" DPUF 1500 LB. BWE SCH. 160
STUB ENDS

DATE	APP'D.	DR'N	DWG NO	106 8868 29 DD REV. 0
6- 18 80	JR	KR		

LESLIE

instructions for

CONTROL VALVES

• INSTALLATION, OPERATION and MAINTENANCE

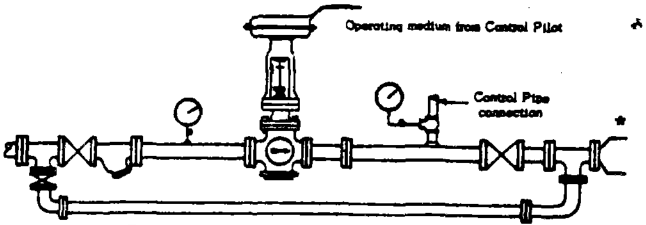
FOR ADDITIONAL CONTROL VALVE DATA CONSULT PROPER INSTRUCTION SECTION BELOW:

- **Where noise is a factor follow recommendations for piping and fittings per 5/0.3.1.**

SECTION I – INSTALLATION •

1. **Valve Position**

   Install control valve in the highest horizontal line of piping, in an accessible location and with arrow on side of valve body in direction of fluid flow. Control valve may be placed in any position, but upright is preferable for ease of maintenance.



• Figure 1 – Typical Installation
*Expand as required for fluid flow.

2. **Problem Preventing Procedures**

   - Provide removal space above, below and around control valve for easy removal of parts during maintenance. See proper Dwg. for dimensions.
   - Blow or flush out pipe lines thoroughly before installing control valve.
   - Protect control valve and following equipment with a *LESLIE SELF-CLEANING STRAINER.*
   - Install stop valves and gauges in inlet and outlet lines to provide means for checking adjustment and operation of equipment.
   - Provide proper inlet and outlet drainage in steam service to prevent water hammer or possible erosion in equipment.
   - Adhere to good piping practice. Install a bypass around the control valve.

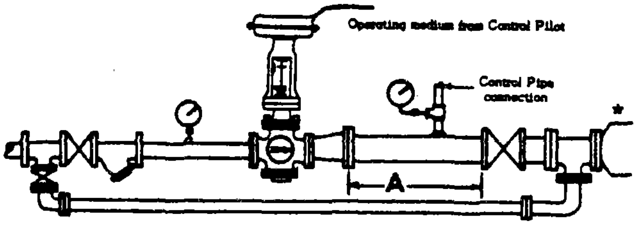
3. Connect operating medium tubing from control pilot, instrument or loading device to diaphragm chamber connection of control valve or to valve positioner, if one is in use.

4. **Important:**

   If control valve is fitted with a Thermo-Isolating bonnet, *do not* lag or insulate bonnet or paint it other than dull black, otherwise its heat emitting efficiency will be impaired and packing will be submitted to excessive temperature.

5. **Recommended Piping for Control of Compressible Fluids at Values of 25% or Less of Inlet Pressure.**

   - Expand outlet pipe to twice control valve inlet pipe size. Use tapered expander.
   - Connect control pipe for control pilot ahead of outlet stop valve and at least 2′ to 3′ downstream from end of expander.
   - Make control pipe connection at least 18″ to 2′ from outlet stop valve, any elbow or other flow direction changing fitting.



• Fig. 2 – Typical Control Valve Station For Control of Compressible Fluids at 25% or Less of Inlet Pressure.
*Expand as required for fluid flow.

NOTE: *Where sensing impulse is taken 2′ to 3′ downstream from control valve (expander), dimension "A" minimum of 6′ to 10′ will provide lowest noise and velocity factors, accurate pressure sensing and reasonable bypass length.*

SECTION II – OPERATION

1. Close inlet and outlet stop valves.
2. Check that control valve responds properly through rated travel in relation to changes in operating pressure on the diaphragm. Rated travel is shown by position of travel indicator on valve stem relative to travel indicator scale on yoke.
3. Manually operate control valves fitted with manual operating devices through rated travel to check freedom of movement.

SECTION IV – ACTUATOR MAINTENANCE, REPLACING DIAPHRAGMS, STEM SEALS, ETC.

FOR ADDITIONAL CONTROL VALVE DATA CONSULT PROPER INSTRUCTION SECTION BELOW:

GENERAL

1. Remove compression on actuator spring by screwing spring adjustor counterclockwise until actuator spring is free.

SIZES 35, 55, 85, 135-DISMANTLING-(See Fig. 3)

Remove bolts/nuts (23/22), upper diaphragm case (20) and old diaphragm (21).

To examine, clean or replace other internal components lift out diaphragm plate (24) assembled with actuator stem (31), actuator spring (28), washer (34) and unscrew spring adjustor from adjustor sleeve (36).

REASSEMBLY

Replace internal parts. Install new diaphragm. In sizes 35, 55 and 85 line up holes with those in lower diaphragm case. In size 135 place bead on diaphragm in recess in lower diaphragm case. Replace upper diaphragm case on diaphragm.

Assemble four bolts and nuts through parts (90° apart). Fingertighten. Assemble balance of bolts/nuts to actuator. Tignten evenly and alternately across diaphragm case. (Before tightening bolts in 35 actuators or where flat stock diaphragm material is used in other sizes as an emergency measure) consult note relating to preforming diaphragms.

SIZES 35R, 55R, 85R & 135R.– DISMANTLING– (See Fig. 4)

Remove bolts/nuts (19/18) and upper diaphragm case (15). Insert rod through holes in yoke (34) and actuator stem (35) to prevent twisting of stem seal (29) when removing self-locking nut (16). (In size 35R use wrench on flats on actuator stem) Remove self-locking nut (16), diaphragm plate (17), diaphragm (20), collar (22) and stem seal (29). Remove stem seal as follows; – *In 35R and 135R Actuators,* remove stud nuts (24) in 135R; capscrews (23) in 35R and disassemble lower diaphragm base (21) from yoke (34). Lift out stem seal. *In 55R and 85R DO NOT* remove lower diaphragm base unless gasket (26) is to be replaced. Stem seal (29) is held in place by seal ring (27) and screws (28). Take out these parts and lift out stem seal.

NOTE: To check actuator spring and other components in size 135R disassemble spacer (33) and lift out parts. In 35R, 55R and 85R parts are taken out from the underside.

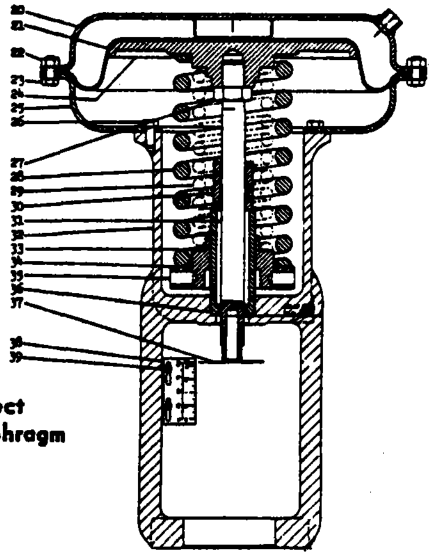


Fig. 3–Direct Acting Diaphragm Actuator

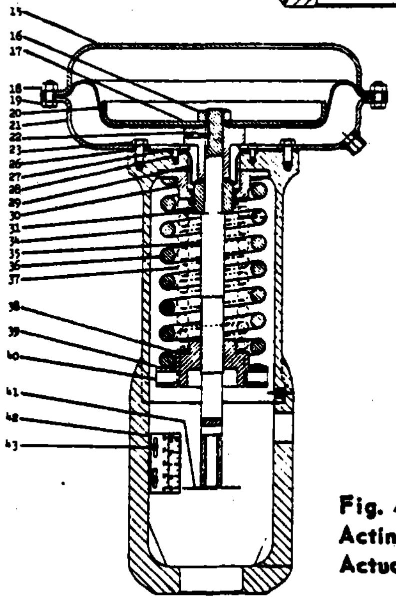


Fig. 4–Reverse Acting Diaphragm Actuator

instructions for
CONTROL VALVES

REASSEMBLY

Reassemble spring adjustor (40), washer (39), actuator spring (36), top spring seat (30) to actuator stem (35) (If they have been removed). Replace assembled parts in yoke (34). Place stem seal collar (31) on actuator stem (35). Reassemble spacer (33) to yoke in 135R. Position stem seal (29) on stem seal collar (22). In sizes 55R, 85R and 135R place bead of stem seal in recess of stem seal collar.

In 35R and 135R actuators reassemble lower diaphragm base (21) to yoke (34). Assemble nuts (24) to spacer studs (32) in 135R. Tighten. *In 35R* insert capscrews (23) through holes in lower diaphragm case and diaphragm and into threads in yoke. Tighten after presetting stem seal as discribed below.

In 55R and 85R actuators replace sealing ring (27) and screws (28). Tighten.

Pre-setting Stem Seal – (55R, 85R, & 135R)

Place collar (22) on stem seal (29) making sure that bead on stem seal enters recess in collar. Reassemble diaphragm (20) over actuator stem (35). Fit center hole in diaphragm around raised face of collar (22). Replace diaphragm plate (17), and self-locking nut (16). *Hold actuator stem steady with rod through yoke and stem (55R, 85R, 135R) or with wrench on flats on actuator stem (35R)* then tighten self-locking nut. Replace upper diaphragm case (15) and bolts/nuts. Tighten as described previously. See Instruction Sheet 10/0.5.8 – for precautions to observe when replacing seals.

Pre-setting Stem Seal – (35R)

Place collar (22) on stem seal (29), assemble self-locking nut (16) to actuator stem (35) and tighten down against parts. Then press actuator stem downward to make stem seal move to taut position. Tighten capscrews and remove self-locking nut (16).

ALL ACTUATORS

Set preload on actuator spring, reassemble actuator to valve body assembly, if it has been removed, adjust valve for rated travel and reconnect operating medium tubing.

SOME IMPORTANT NOTES

FLAT SHEET RUBBER MATERIAL

Flat sheet rubber material may be used in 55(R), 85(R) and 135(R) actuators as emergency replacement material but for guaranteed results it should be replaced at the earliest opportunity with the LESLIE ROLLING ACTION DIAPHRAGM designed specifically for these actuators. When flat material is used in emergency preform as described below.

PREFORMING 35(R) ACTUATOR DIAPHRAGMS

Flat stock material is used for diaphragms in 35(R) actuators. When assembling first fingertighten all diaphragm case bolts. Then compress actuator spring sufficiently to move diaphragm through full travel to the upper or lower diaphragm case (depending on whether actuator is direct or reverse acting). This preforms diaphragm and permits full movement through rated travel without resistance from a taut diaphragm.

TO CHANGE VALVE ACTION FROM NORMALLY OPEN TO NORMALLY CLOSED OR VICE-VERSA.

To reverse the action of a single ported diaphragm control valve it is only necessary to replace the actuator in use with one having the opposite action. A single "D" in the control valve class indicates actuator is "DIRECT ACTING" – Air moves diaphragm downward. A double D ("DD") indicates actuator is "REVERSE ACTING" – Air moves diaphragm upward. *Note:* Final valve action in response to air signal on diaphragm depends on whether valve plug is positioned above or below the seat ring.

PROCEDURE

To change actuator, loosen valve plug stem locknut under travel indicator and turn valve plug stem all the way out of the actuator stem. Remove capscrews securing actuator to bonnet. Replace actuator with one having desired action. Re-insert and tighten capscrews. Reconnect valve plug stem to actuator stem. Adjust actuator spring preload and set valve for rated travel. For more detailed instruction consult general instruction pertaining to the particular type of control valve.

PLAY SAFE! USE ONLY GENUINE LESLIE REPLACEMENT PARTS.

2818 PRINTED IN U.S.A. 776 10M

instructions for

CONTROL VALVES

SINGLE PORTED CONTROL VALVES - 1500 PSIG AND OVER SERIES

[illegible] covers all classes [illegible] Pressure-Cage Trim Control Valves with Diaphragm Actuators.

SECTION III (Cont'd) - MAINTENANCE OF VALVE BODY SUB-ASSEMBLIES

FOR ADDITIONAL CONTROL VALVE DATA CONSULT PROPER INSTRUCTION SECTION BELOW:

INSTALLATION....................SECTION I
OPERATION.......................SECTION II
MAINTENANCE.....................SECTION III
ACTUATOR MAINTENANCE..........SECTION IV

DISMANTLING (Continued)

Prior to dismantling control valve body assembly remove actuator (as described in Steps 1-3) and positioner if one is in use. To remove positioner loosen nut (17) and remove cap screws holding positioner to yoke (11). Slide positioner extension arm away from valve stem.

4. Remove nut (17) from valve plug stem. Loosen stuffing box nuts (22). Remove bonnet nuts (40). Lift bonnet (27), and valve plug (21) off body as a unit. Remove valve plug complete and other parts from bonnet.

5. Take gasket (32) and seat retaining guide (37) from body. Then remove seat ring in the following manner; Insert wooden dowel into seat ring (38). Press sufficiently for dowel to grip seat ring so that it can be lifted out of body. Gasket (39) will follow with seat ring.

   Clean main body thoroughly including gasket faces. Inspect seat ring (38), valve plug complete (21) and seat retaining guide (37). Replace any badly worn or damaged part. Clean all parts to be re-used thoroughly, using suitable solvent and crocus cloth to remove any encrusted material.

6. **Lapping in Valve Plug and Seat Ring**

   A. In Main Body - Return seat ring gasket (39), seat ring (38), to their proper places in valve body (33) making sure that valve seating face of seat ring (38) faces toward bonnet end of body.

   Note: For lapping Mark "P" Trim Type instructions see Page 5 and 6.

   Place a small amount of superfine grinding compound, properly mixed with oil, on seating face of valve plug at several points. Insert valve plug assembly into valve body (33) and in contact with seat ring (38). Place bonnet (27) over valve plug complete and on valve body, using bonnet as guide when lapping inner valve. Lap valve plug complete (21) and seat ring (38) together very lightly and carefully. Just a few turns are sufficient. As lapping progresses, occasionally lift valve plug complete (21) a small distance away from seat ring (38) and rotate 90° to keep lapping compound evenly distributed.

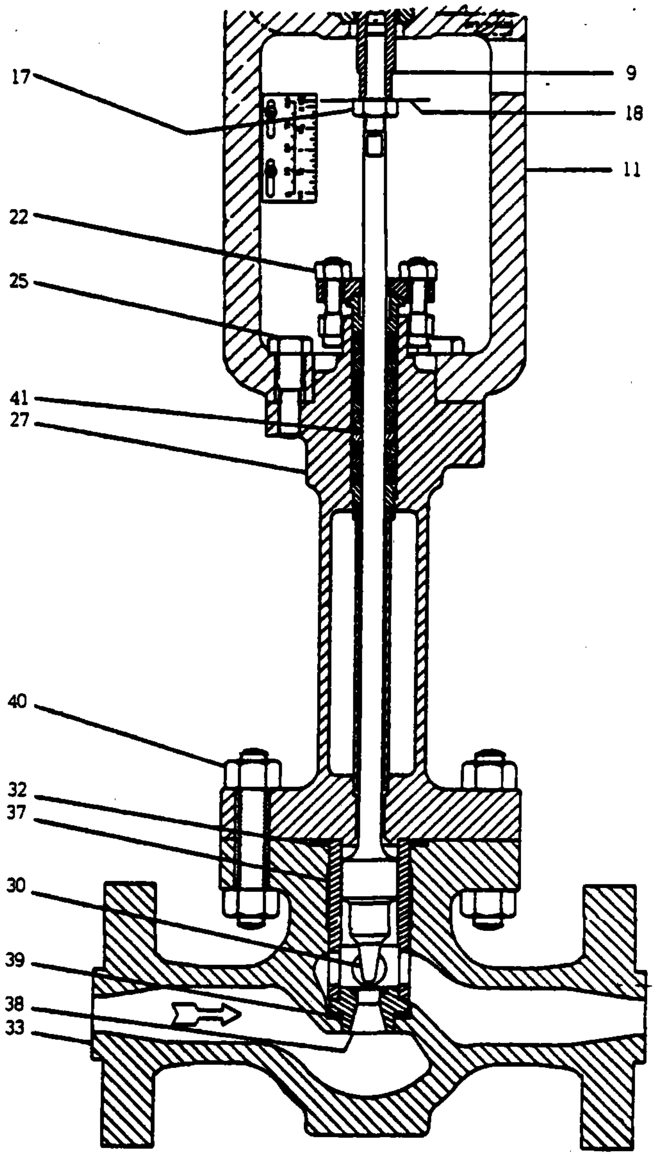


Fig. 3 - DOS, Cage Trim, Socket Weld End Type. May also be butt weld end, Flanged End or 90° Angle Type.

REASSEMBLY

Reassemble spring adjustor (40), washer (39), actuator spring (36), top spring seat (30) to actuator stem (35) (If they have been removed). Replace assembled parts in yoke (34). Place stem seal collar (31) on actuator stem (35). Reassemble spacer (33) to yoke in 135R. Position stem seal (29) on stem seal collar (22). In sizes 55R, 85R and 135R place bead of stem seal in recess of stem seal collar.

In 35R and 135R actuators reassemble lower diaphragm base (21) to yoke (34). Assemble nuts (24) to spacer studs (32) in 135R. Tighten. *In 35R* insert capscrews (23) through holes in lower diaphragm case and diaphragm and into threads in yoke. Tighten after presetting stem seal as discribed below.

In 55R and 85R actuators replace sealing ring (27) and screws (28). Tighten.

Pre-setting Stem Seal – (55R, 85R, & 135R)

Place collar (22) on stem seal (29) making sure that bead on stem seal enters recess in collar. Reassemble diaphragm (20) over actuator stem (35). Fit center hole in diaphragm around raised face of collar (22). Replace diaphragm plate (17), and self-locking nut (16). *Hold actuator stem steady with rod through yoke and stem (55R, 85R, 135R) or with wrench on flats on actuator stem (35R)* then tighten self-locking nut. Replace upper diaphragm case (15) and bolts/nuts. Tighten as described previously. See Instruction Sheet 10/0.5.8 – for precautions to observe when replacing seals.

Pre-setting Stem Seal – (35R)

Place collar (22) on stem seal (29), assemble self-locking nut (16) to actuator stem (35) and tighten down against parts. Then press actuator stem downward to make stem seal move to taut position. Tighten capscrews and remove self-locking nut (16).

ALL ACTUATORS

Set preload on actuator spring, reassemble actuator to valve body assembly, if it has been removed, adjust valve for rated travel and reconnect operating medium tubing.

SOME IMPORTANT NOTES

FLAT SHEET RUBBER MATERIAL

Flat sheet rubber material may be used in 55(R), 85(R) and 135(R) actuators as emergency replacement material but for guaranteed results it should be replaced at the earliest opportunity with the LESLIE ROLLING ACTION DIAPHRAGM designed specifically for these actuators. When flat material is used in emergency preform as described below.

PREFORMING 35(R) ACTUATOR DIAPHRAGMS

Flat stock material is used for diaphragms in 35(R) actuators. When assembling first fingertighten all diaphragm case bolts. Then compress actuator spring sufficiently to move diaphragm through full travel to the upper or lower diaphragm case (depending on whether actuator is direct or reverse acting). This preforms diaphragm and permits full movement through rated travel without resistance from a taut diaphragm.

TO CHANGE VALVE ACTION FROM NORMALLY OPEN TO NORMALLY CLOSED OR VICE-VERSA.

To reverse the action of a single ported diaphragm control valve it is only necessary to replace the actuator in use with one having the opposite action. A single "D" in the control valve class indicates actuator is "DIRECT ACTING" – Air moves diaphragm downward. A double D ("DD") indicates actuator is "REVERSE ACTING" – Air moves diaphragm upward. *Note:* Final valve action in response to air signal on diaphragm depends on whether valve plug is positioned above or below the seat ring.

PROCEDURE

To change actuator, loosen valve plug stem locknut under travel indicator and turn valve plug stem all the way out of the actuator stem. Remove capscrews securing actuator to bonnet. Replace actuator with one having desired action. Re-insert and tighten capscrews. Reconnect valve plug stem to actuator stem. Adjust actuator spring preload and set valve for rated travel. For more detailed instruction consult general instruction pertaining to the particular type of control valve.

If preload adjustment is made with no pressure in valve body, then, when the control valve is placed in operation, additional compression must be placed on the actuator spring to provide valve closure force. With proper adjustment valve will close tightly and will not begin to open until the 3 psig operation pressure is exceeded.

NOTE A - A control valve which has been adjusted to provide 3 psig starting pressure plus valve closure force (with pressure in body) will have a considerably higher starting pressure than 3 psig, when tested at 0 body pressure.

NOTE B - Air pressures quoted are relative. Actual pressures required in operation may vary with pressure drop conditions existing and/or actuator springs used.

ADJUSTING CONTROL VALVE FOR RATED TRAVEL

(Indicator scale shows rated travel of valve)

6. Single Ported Unbalanced Control Valves With Direct Acting Actuators

With valve plug and actuator stem threads engaged as described in "Reassembly", supply 20 psig operating pressure to actuator diaphragm. Valve will move to closed position. Observe travel obtained as shown by travel indicator and indicator scale. Readjust as follows:

- OVERTRAVEL - If travel is too great, loosen stem locknut and turn valve plug stem out of actuator stem the amount necessary to obtain correct travel.
- UNDERTRAVEL - If travel is too short, loosen stem locknut and turn valve plug stem further into actuator stem the amount necessary to obtain correct travel.

7. Positive Compression Force

When correct travel has been obtained reduce operating pressure sufficiently to move valve plug away from seat ring(s). *Then turn valve plug stem one full turn out of actuator stem threads.*

8. Single Ported Unbalanced Control Valves With Reverse Acting Actuators

Loosen stem locknut. Apply air to diaphragm. Turn valve plug stem into actuator stem threads until valve plug is out of contact with seat ring, with air removed from diaphragm. Then turn valve plug stem out of actuator stem threads until valve plug just contacts seat ring again.

Supply sufficient operating pressure to actuator diaphragm to move valve plug away from seat ring. *Then turn valve plug stem one full turn out of actuator stem threads.* Diaphragm plate determines travel. With proper diaphragm plate correct travel will result from adjustment. For under- or over-travel proceed as described above.

9. Positive Closing Force

The *one full turn* toward the seat ring, made after obtaining travel, provides the positive closing force required to obtain tight valve closure in single ported valves. In all cases be sure to make this final adjustment.

10. All Actuators

Tighten stem locknut and travel indicator against actuator stem. Reconnect operating medium tubing from the sensing element or manual loading device to the diaphragm case.

REPLACING OR LAPPING IN MARK "P" TRIM

(Screw Stem Locknut Down to Bottom of Stem Threads)

To remove Mark "P" Trim from main body dismantle actuator from bonnet, remove bonnet nuts then carefully lift bonnet, valve plug and seat retainer out of valve body. CAUTION: Move bonnet directly upward or outward from body (relative to installation) to prevent damage to valve plug. Take out bonnet gasket, throttling orifice chamber, and gasket. Clean all parts. Replace any worn or damaged part.

Lapping in Mark "P" Trim

To lap in Mark "P" trim use a very small amount of superfine lapping compound (no rougher than 20,000 grit) evenly distributed over valve plug seating surface. Insert valve plug in throttling orifice chamber and place seat retaining guide in position on orifice chamber as shown in 4A).

Lap only enough to remove any encrusted material from seating surfaces. A few turns should be sufficient. Lift and rotate valve plug 90° occasionally to keep compound evenly distributed. Remove all traces of lapping compound from parts before reassembling valve.

If either of the seating surfaces is found to be damaged parts should be returned to Leslie Co. for refurbishing.

__NOTE:__ *Although valve plugs and chambers are not essentially matched sets it is always good practice to consider them as such after use, and to replace them in service as units.*

REASSEMBLY

Follow general procedure outlined under "Reassembly" Page 4 making sure that throttling orifice chamber and gasket are properly positioned in body and that seat retaining guide is passed carefully over valve plug stem into position on throttling orifice chamber.

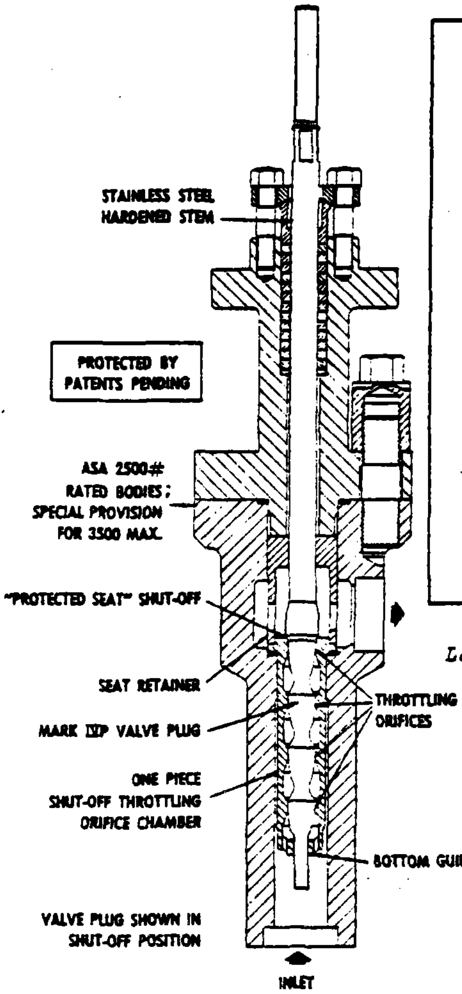


Fig. 4 - Mark "P" Valve Body Assembly.

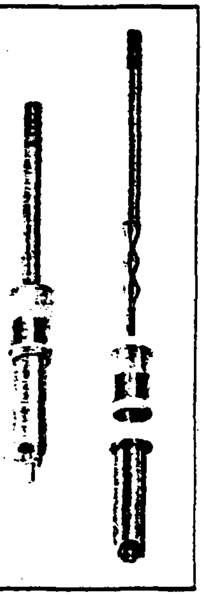
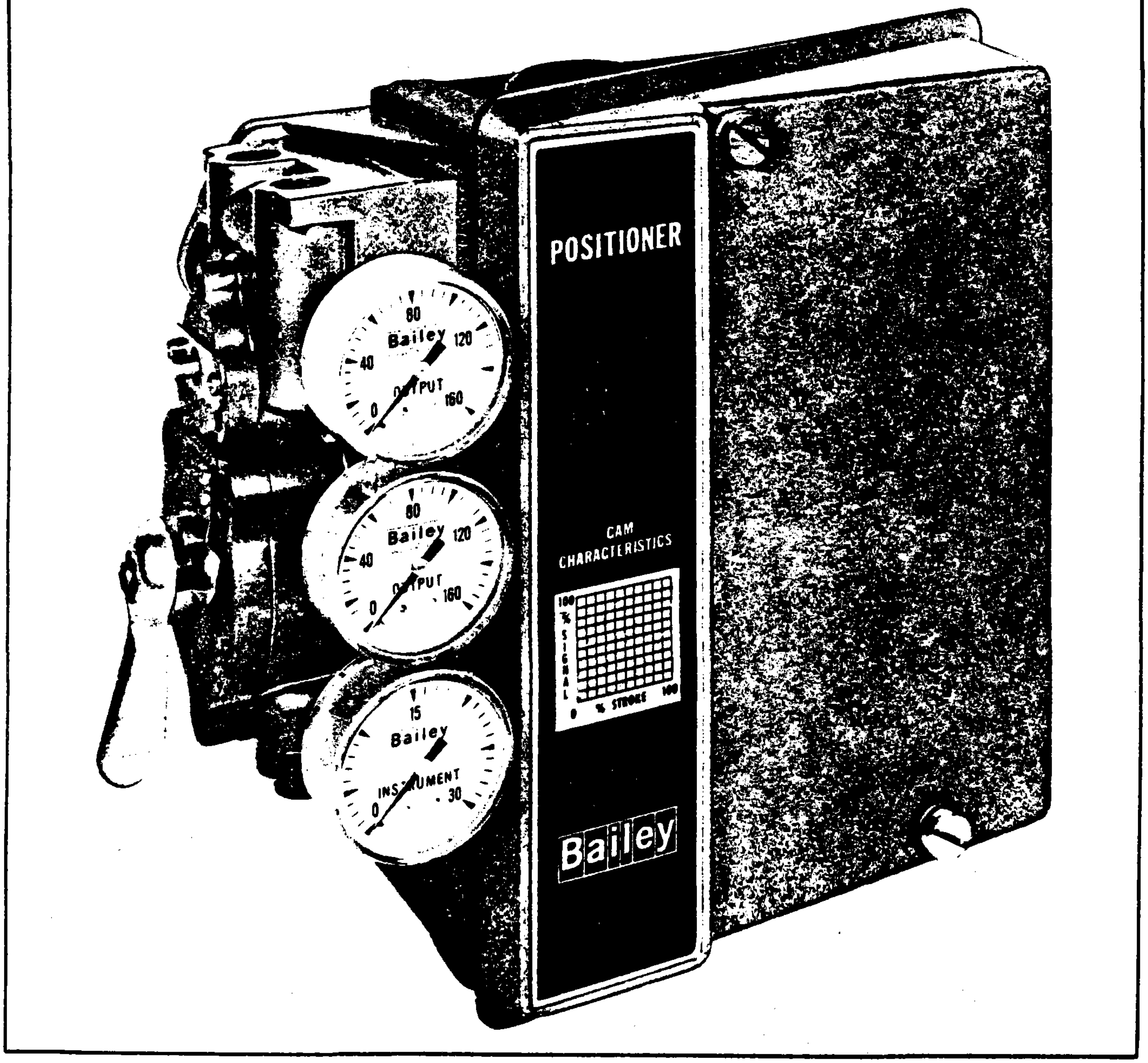


Fig. 4A - Lapping Valve.

Bailey Control Systems	Product Instruction **P88-7**

Characterizable Pneumatic Positioner

Type AP2



Form I-P88-7 Litho in U.S.A. 277

Babcock & Wilcox
Bailey Meter Company, U.S.A.

1.2.23-378

instructions for

CONTROL VALVES

SINGLE PORTED CONTROL VALVES - 1500 PSIG AND OVER SERIES

face. Insert valve plug in throttling orifice chamber and place seat retaining guide in position on orifice chamber as shown in 4A).

Lap only enough to remove any encrusted material from seating surfaces. A few turns should be sufficient. Lift and rotate valve plug 90° occasionally to keep compound evenly distributed. Remove all traces of lapping compound from parts before reassembling valve.

If either of the seating surfaces is found to be damaged parts should be returned to Leslie Co. for refurbishing.

__NOTE__: *Although valve plugs and chambers are not essentially matched sets it is always good practice to consider them as such after use, and to replace them in service as units.*

REASSEMBLY

Follow general procedure outlined under "Reassembly" Page 4 making sure that throttling orifice chamber and gasket are properly positioned in body and that seat retaining guide is passed carefully over valve plug stem into position on throttling orifice chamber.

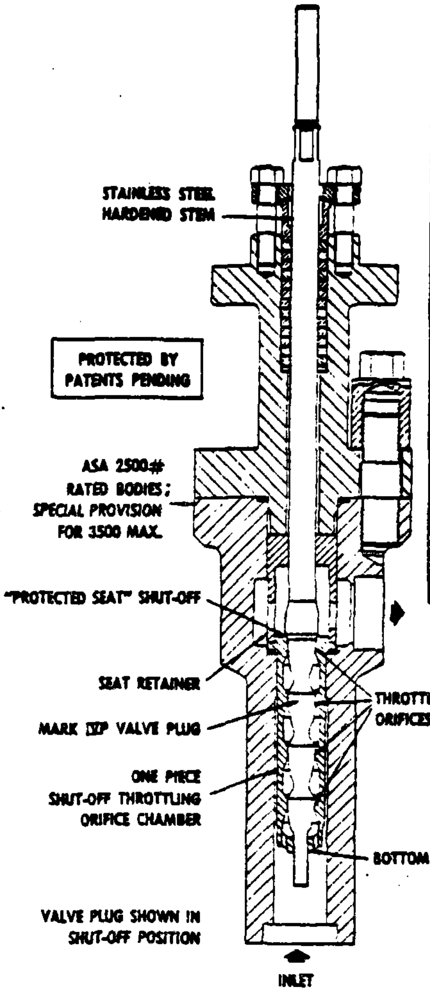


Fig. 4A - Lapping Valve.

Fig. 4 - Mark "P" Valve Body Assembly.

PLAY SAFE! USE ONLY GENUINE LESLIE REPLACEMENT PARTS.

LESLIE CO., PARSIPPANY, NEW JERSEY 07054
1.2.23-379
2758 PRINTED IN U.S.A. 187 SC

WARNING

DO NOT INSTALL, MAINTAIN OR OPERATE THIS EQUIPMENT WITHOUT READING, UNDERSTANDING AND FOLLOWING PROPER Bailey Babcock & Wilcox INSTRUCTIONS AND MANUALS, OTHERWISE INJURY OR DAMAGE MAY RESULT.

INDEX

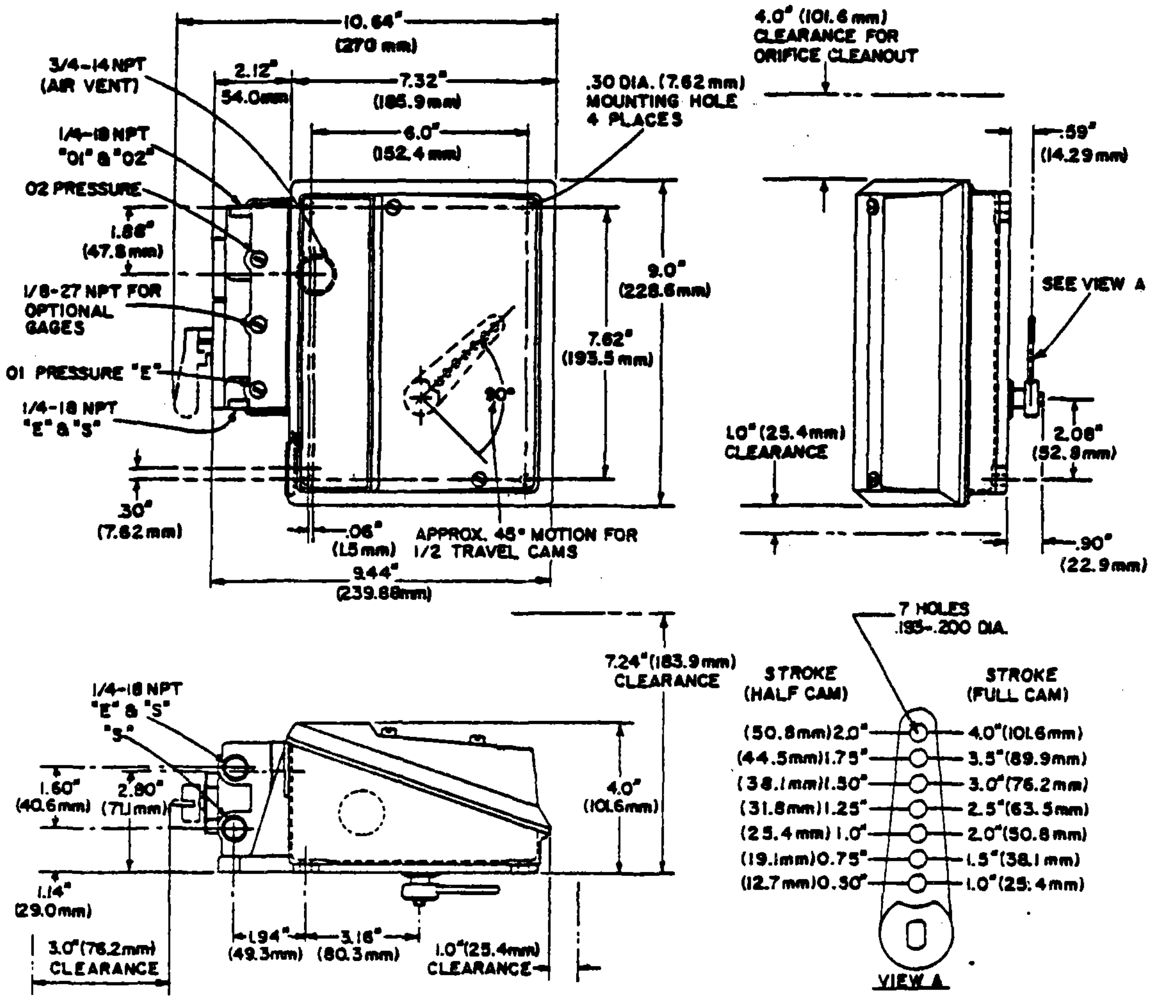


FIGURE 1 - Mounting and External Dimensions of Type AP2 Characterizable Pneumatic Positioner

INSTALLING THE POSITIONER

UNPACKING

1. Check for any obvious damage to shipping carton.

2. Open carton and remove all loose packing.

3. Carefully remove Positioner from carton and inspect for any physical damage which may have occurred during shipping.

4. Remove two cover screws and Positioner cover and examine interior for any loose components, such as nuts, screws, springs, etc. Check data on nameplate (located at right side of cam) for correct Type, Series and Signal Range.

CAUTION: Before mounting or installing Positioner, check nameplate data to make certain Positioner is suitable for application desired. DO NOT AT ANY TIME EXCEED THE RATINGS LISTED ON THE NAMEPLATE.

5. If any damage to Positioner is evident, refer to inside front cover of this Instruction Book. If Positioner appears undamaged, replace cover and proceed with installation instructions.

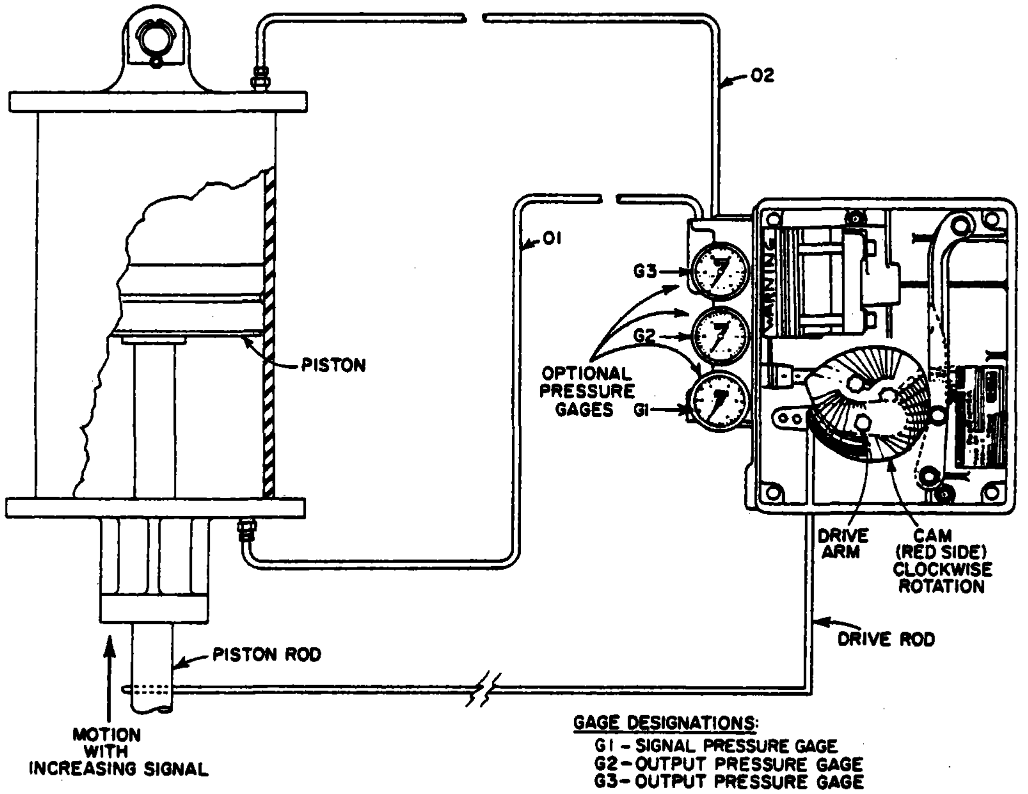
INSTALLATION

The Characterizable Pneumatic Positioner, Type AP2, can be applied to double-acting cylinder applications or single-acting diaphragm actuator applications.

CAUTION: The positioner can be installed in any position with proper recalibration. It should be noted that certain installation methods will not stroke the power operator to a fail-safe condition if the controller fails to send a signal. Bailey Meter Co. strongly recommends that, for increased safety, an installation method be selected to provide a fail-safe mode when loss of controller signal is experienced. Mounting and external dimensions of Type AP2 Positioner are shown in Figure 1.

Double-Acting Cylinder Applications

When the Positioner is applied to a double-acting cylinder assembly, the piston rod is normally connected thru suitable linkage to position a valve, damper or other regulating device. Position of the power operator is normally tied back to the Positioner drive arm thru a drive rod (other tie back methods may be used depending on application). The drive arm is fixed to the positioning cam which is shaped to give a desired characteristic of power operator position versus input demand control signal. Positioner mounting and pneumatic connections must be such that an increasing control signal will extend (stretch) the range spring.



GAGE DESIGNATIONS:
G1 - SIGNAL PRESSURE GAGE
G2 - OUTPUT PRESSURE GAGE
G3 - OUTPUT PRESSURE GAGE

NOTES:
FOR A DOWNWARD MOTION WITH INCREASING SIGNAL, USE BLACK SIDE OF CAM (COUNTER CLOCKWISE ROTATION) AND REVERSE O1 AND O2 CONNECTIONS.

IN ANY INSTALLATION, DIRECTION OF PISTON TRAVEL FOR A GIVEN SIGNAL CHANGE CAN BE REVERSED BY USING OPPOSITE SIDE OF CAM AND SWITCHING O1 AND O2 CONNECTIONS.

FIGURE 2 - Typical Positioner Installation Mounted on Double-Acting Cylinder

In any installation, the direction of piston travel for a given signal change can be reversed by using the opposite side of the cam and reversing the O1 and O2 output connections (Figure 2).

If the Positioner is included with a double-acting cylinder assembly, tubing connections between the Positioner and the power operator would be as illustrated in Figure 2. Pressure gages are optional and are not included unless specified when ordering Positioner.

If it is necessary to complete the pneumatic connections to the Positioner, refer to Product Instruction G18-2 for tubing methods and precautions.

Single-Acting Diaphragm or Spring-Loaded Actuator Applications

When the Positioner is applied to a single-acting actuator assembly, the valve stem is normally connected thru suitable linkage to accurately position an inner valve in response to a control demand signal. Position of the valve stem (or inner valve) is normally tied back to the Positioner thru a drive rod which is attached to the Positioner drive arm. The drive arm is fixed to the positioning cam which is shaped to give a desired characteristic of inner valve position versus input demand control signal. Positioner mounting and pneumatic connections must be such that an increasing control signal will extend (stretch) the range spring.

In any installation, the direction of valve stem travel for a given signal change can be reversed by using the opposite side of the cam, plugging the output connection being used and connecting tubing to the remaining output connection (Figure 3).

If the Positioner is included with a control valve furnished by Bailey Meter Company, it is mounted on the valve yoke and piped to the actuator as illustrated in Figure 3. Pressure gages are optional and are not included unless specified when ordering Positioner.

If it is necessary to complete the pneumatic connections to the Positioner, refer to Product Instruction G18-2 for tubing methods and precautions.

SUPPLY PRESSURE

Supply pressure range is 18 to 150 psi. Because of the minimal effect of supply pressure variations on output positions, a regulated supply is not normally required for either application. However, for single-acting diaphragm actuator applications, a minimum supply pressure of 5 psi over maximum input signal range (20 psi for 3-15 psi unit or 32 psi for 3-27 psi unit) must be maintained.

WARNING: TYPE AP2 POSITIONERS ARE SUITABLE FOR MAXIMUM AIR SUPPLY PRESSURE OF 150 PSIG. ADHERENCE TO THIS LIMITATION WILL ENSURE SATISFACTORY PERFORMANCE. DO NOT SUPPLY PRESSURE TO THE POSITIONER IN EXCESS OF THAT WHICH THE RELATED ACTUATOR OR CYLINDER CAN SAFELY ACCEPT.

NOTE: It is recommended that a filter or dripwell be installed in the supply line to prevent improper operation of the Positioner due to entrained moisture or dirt.

PLACING IN SERVICE

Make the following adjustment checks to insure correct operation of the valve actuator or cylinder assembly and the Positioner before placing in operation.

1. Make certain connecting linkage, brackets and any mounting hardware are secure.

2. Make certain supply, input control signal and output pressure connections are tight. Check for leakage, while under pressure, with soapsuds solution.

3. If optional pressure gages were furnished, make certain gages are installed in correct location for application (Figure 2 or 3) and all connections are tight. Check for leakage, while under pressure, with soapsuds solution.

4. Perform procedures outlined under "Calibrating the Positioner" to check output pressure level adjustment and to set zero and range adjustments for the required application prior to placing the Positioner in service.

NOTE: It is recommended that a position indicator plate be fabricated and installed on valve actuator yoke (or cylinder) and a pointer be installed on valve stem (or piston rod) to indicate full OPEN and full CLOSED travel of power operator (Figure 4).

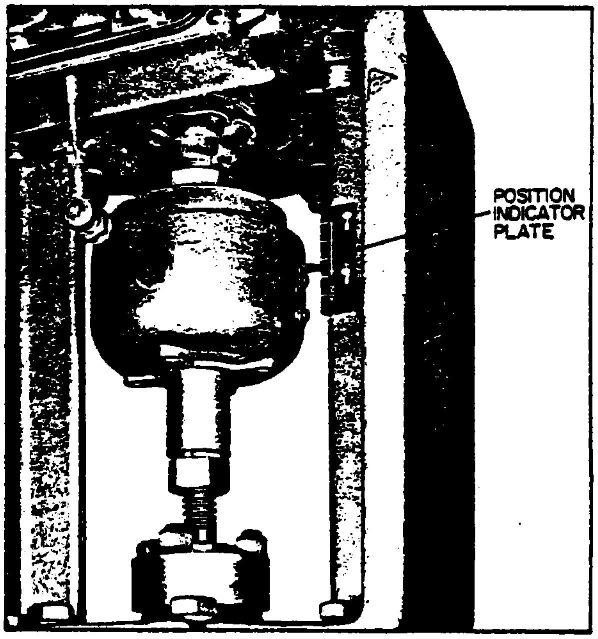


FIGURE 4 - Typical Position Indicator Plate Mounted on Valve Actuator Yoke

ROUTINE SERVICING

1. Once each year, check all air connections for leakage, while under pressure, with a soapsuds solution.

2. Maintain a clean air supply (free of dirt, oil or moisture) to assure satisfactory operation of Positioner. If recommended filter is installed (refer to "Supply Pressure") in supply line, remove and clean if necessary.

3. Whenever power operator is out of service (or when required), remove Positioner output valves as outlined under "Troubleshooting" and clean with an aliphatic hydrocarbon solvent (i.e., gasoline or kerosene).

WARNING: USE SOLVENT IN A WELL-VENTILATED AREA. AVOID PROLONGED OR REPEATED BREATHING OF VAPORS. AVOID PROLONGED OR REPEATED CONTACT WITH SKIN. DO NOT USE NEAR OPEN FLAME.

4. Periodically check orifice and nozzle for deposits and clean if necessary as outlined under "Troubleshooting".

5. Once each year (or when required), check adjustment and calibration of Positioner and power operator as outlined under "Calibrating the Positioner".

6. Also, if Positioner is equipped with optional integral shut off and equalizing valve, clean valve assembly and cavity each year with aliphatic hydrocarbon solvent. Disassemble by removing valve handle and valve retainer (Figure 23, items 16 and 15) and lifting out valve assembly (17). Inspect o-rings (13 and 14) and replace if necessary. Re-lubricate with minimum amount of o-ring lube (Dow Corning No. 4 or equivalent) and reassemble.

NOTE: Be sure same shims are installed between valve assembly (17) and valve retainer (15).

TROUBLESHOOTING

If trouble occurs which is definitely traced to the Positioner, check supply pressure, input and output pressure connections and mechanical linkage adjustments before removing from service. If no obvious defects are noted, refer to "Fault Correction Chart". Locate applicable heading for type of Positioner failure encountered. Correct procedures for checking or replacing various components are listed below.

WARNING: MAKE CERTAIN POSITIONER IS DISCONNECTED FROM SUPPLY PRESSURE SOURCE OR REMOVED FROM SERVICE BEFORE ATTEMPTING ANY REPAIR OR REPLACEMENT PROCEDURES.

CLEANING NOZZLE ORIFICE
(Refer to Figure 5)

NOTE: *Diameter of hole in orifice is approximately 0.016-inch. Dirt or foreign particles could easily be trapped in orifice before reaching nozzle.*

1. An access hole on top of Positioner cover is provided for servicing or cleaning nozzle orifice. Remove pipe plug from nozzle chamber section of relay assembly using a 5/32-inch allen wrench to gain access to orifice.

2. Use a wire approximately 0.015-inch in diameter and remove any dirt or foreign particles obstructing orifice hole.

WARNING: USE EXTREME CARE WHEN CLEANING ORIFICE TO PREVENT SCRATCHING OR ENLARGING ORIFICE HOLE. ENLARGING HOLE COULD AFFECT "GAIN" CHARACTERISTICS OF POSITIONER.

3. Reassemble pipe plug *in nozzle chamber* section of relay assembly.

REPLACING RELAY ASSEMBLY

NOTE: To remove the Positioner from the case, refer to Figure 22 for identification of item numbers listed parenthetically in steps 1 thru 4 only.

1. Remove cam (34) from cam shaft (33).

2. Disconnect range spring (4) from spring retainer (15).

3. If Positioner is equipped with gain suppression accessory kit (items 7 thru 11), remove kit as follows:

a. Remove two screws (9), lockwashers (10) and small washers (11) from base assembly (13).

b. Disassemble retainer (8) and spring (7).

4. Remove two screws (30) from rear of base assembly (13) and carefully remove Positioner assembly (3).

5. To remove signal nut (40), place a 9/16-inch thin head or tappet, open end wrench on hex of signal diaphragm assembly (26) guide to secure guide in position and prevent rotation (Figure 6). With guide held firmly, place a 3/4-inch open end wrench on flats of signal nut (40). Remove signal nut and spring retainer (39) from threaded section of guide.

NOTE: *Spring retainer (39) is loctite sealed into signal nut (40) and should not have to be separated.*

CAUTION: Damage could result to signal diaphragm assembly if guide is not held in position when removing signal nut.

6. Remove tabbed retainer (25) from signal diaphragm assembly (26) guide.

7. Remove screws (46) and lockwashers (47) securing base mainfold assembly (36), relay assembly (27) and manifold assembly (8) in position. (Dowel pins in both ends of relay assembly prevent rotation of assemblies after cap screws have been removed.)

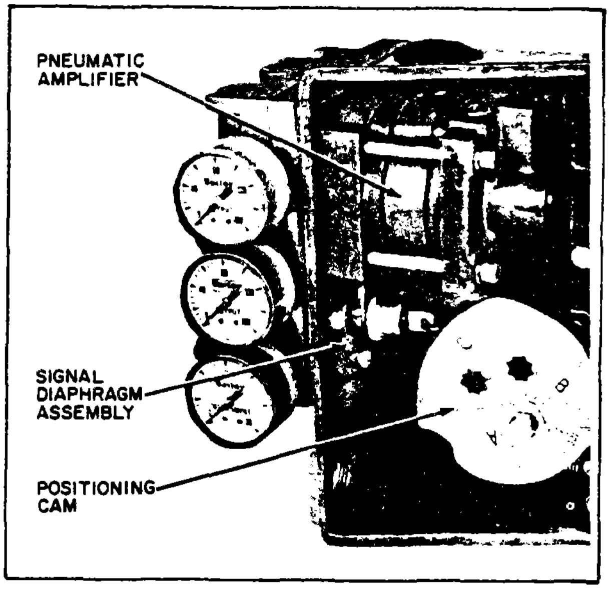


FIGURE 5 - Cleaning Nozzle Orifice

8. Remove base manifold assembly (36)..

9. When removing relay assembly (27), guide vane by hand until vane is clear of signal diaphragm assembly (26) guide.

10. To install new relay assembly, reverse steps 3 thru 9 above. Tighten four screws (46) uniformly in rotation, 70 to 75 in. lb. Wait 15 minutes and retorque screws.

CAUTION: To prevent damage to relay assembly, make certain exposed diaphragms (at each end of relay assembly) are in flat, relaxed position before tightening screws (46). Also, be sure that dowel pins which protrude from each end of relay, enter holes in mating parts before tightening screws.

11. Make a preliminary setting of small slotted set screw in vane assembly so that set screw point lifts vane overtravel hinge end away from vane assembly approximately 1/64".

12. Complete reassembly of relay into Positioner by reversing steps 1 and 2.

13. Recalibrate Positioner for correct application as outlined under "Calibrating the Positioner".

14. Apply minimum input signal pressure. Using a stop watch or watch with a sweep second hand as a timing device, rapidly increase input signal pressure from minimum to maximum while noting the time necessary for piston or valve to stroke from one extreme to the other.

15. Again noting time necessary for piston or valve to stroke from one extreme to the other, rapidly decrease input signal from maximum to minimum.

NOTE: Rate of input signal change should be approximately the same as in step 14.

16. Compare two stroke times. If an undesirable differential exists, adjust small slotted set screw in vane assembly approximately 1/2 turn and re-zero calibration.

17. Repeat steps 14, 15 and 16 until stroke time differential is reduced to within desired limits. At this point supply and exhaust capacities of 01 and 02 output valves are balanced. Apply a drop of Loctite Grade 290 or equivalent to set screw threads.

REPLACING OUTPUT VALVE O1
(Refer to Figure 7)

1. Using slot in end of valve plug (32), remove plug from base manifold assembly (36). (Plug assembled at factory with adjustable sealant on threads.) Plug can be removed by unscrewing until all the threads are exposed. A 3/4-16 UNF hex nut should then be screwed over the plug threads and the plug removed by grasping the nut with pliers. Remove hex nut. Examine o-ring (31) and replace if necessary.

2. Remove valve (28), valve spring (29), washer (30) and o-ring (2) from base manifold assembly (36). Examine o-ring and replace if necessary.

3. Clean valve (28) using an aliphatic hydrocarbon solvent (i.e., gasoline, kerosene, etc.) and visually inspect for damage to seating surfaces. Remove any sealant remaining on valve plug (32) and threads inside base manifold assembly (36). Examine valve seats inside of base manifold assembly for dirt. Clean if necessary.

WARNING: USE SOLVENT IN A WELL-VENTILATED AREA. AVOID PROLONGED OR REPEATED BREATHING OF VAPORS. AVOID PROLONGED OR REPEATED CONTACT WITH SKIN. DO NOT USE SOLVENT NEAR OPEN FLAME.

4. Apply minimum amount of o-ring lubricant (Dow Corning No. 4, or equivalent) to o-ring (2). Assemble valve spring (29), washer (30) and o-ring (2) on valve stem. Install valve (28) subassembly in base manifold assembly (36).

5. Apply small amount of lubricant on o-ring (31) and install on valve plug (32).

6. Apply adjustable seal (Loctite Sealant, Grade No. 242, or equivalent) to threads of valve plug (32) and install in base manifold assembly (36). End of valve plug must be flush with base manifold housing when assembled.

REPLACING OUTPUT VALVE O2
(Refer to Figure 7)

1. Remove as a unit, screw retainer (1), valve cover (3) and valve seat assembly (6) from manifold assembly (8) by removing screws (41) and lockwashers (42).

NOTE: After removing subassembly described in step 1, visually check (or take a quick measurement) of the gap between the bottom side of valve cover (3) and the top of valve seat assembly (6). This procedure is necessary in order to obtain the same approximate dimension when reassembling valve seat assembly and will assist in recalibration of the Positioner after final assembly is completed.

2. To disassemble valve seat assembly (6) from valve cover (3), back off adjustment screw (34) until valve cover can be removed. It is not necessary to remove screw retainer (1) to disassemble valve seat assembly.

3. Examine o-rings (5) and (33). Replace if necessary.

4. If o-ring (2) must be replaced, disassemble screw retainer (1) by removing screws (43) and lockwashers (42). Remove adjustment screw (34) from valve cover (3) and replace o-ring.

5. Clean valve using an aliphatic hydrocarbon solvent (i.e., gasoline or kerosene) and blow dry with air hose. Visually inspect for damage. If valve is damaged, valve seat assembly (6) must be replaced.

WARNING: USE SOLVENT IN A WELL-VENTILATED AREA. AVOID PROLONGED OR REPEATED BREATHING OF VAPORS. AVOID PROLONGED OR REPEATED CONTACT WITH SKIN. DO NOT USE NEAR OPEN FLAME.

6. Examine valve chamber in manifold assembly for dirt and clean if necessary.

7. Apply minimum amount of lubricant (Dow Corning No. 4, or equivalent) to o-rings (2), (5) and (33).

8. Install o-ring (2) on adjustment screw (34), o-ring (5) in valve cover (3) and o-ring (33) on valve seat assembly (6).

9. With notch in valve seat assembly (6) in alignment with dowel pin (4) in valve cover (3), turn in adjustment screw (34) until correct distance is obtained between bottom of valve cover and top of valve seat assembly (refer to NOTE following step 1).

CAUTION: Threads on adjustment screw are very fine pitch. Use care to avoid cross threading.

10. Install valve subassembly in manifold assembly (8). Secure in position using screws (41) and lockwashers (42).

11. If screw retainer (1) was removed, install retainer on valve cover (3) with screws (43) and lockwashers (42).

12. Recalibrate as outlined under "Calibrating the Positioner".

REPLACING SIGNAL DIAPHRAGM ASSEMBLY

(Refer to Figure 8)

NOTE: To remove the Positioner from the case, refer to Figure 22 for identification of item numbers listed parenthetically in steps 1 thru 3 only.

1. Disconnect range spring (4) from spring retainer (15) using needle nose pliers.

2. If Positioner is equipped with optional gain suppression kit (items 7 thru 11), remove kit as follows:

a. Remove two screws (9), lockwashers (10) and small washers (11) from base assembly (13).

b. Disassemble retainer (8) and spring (7).

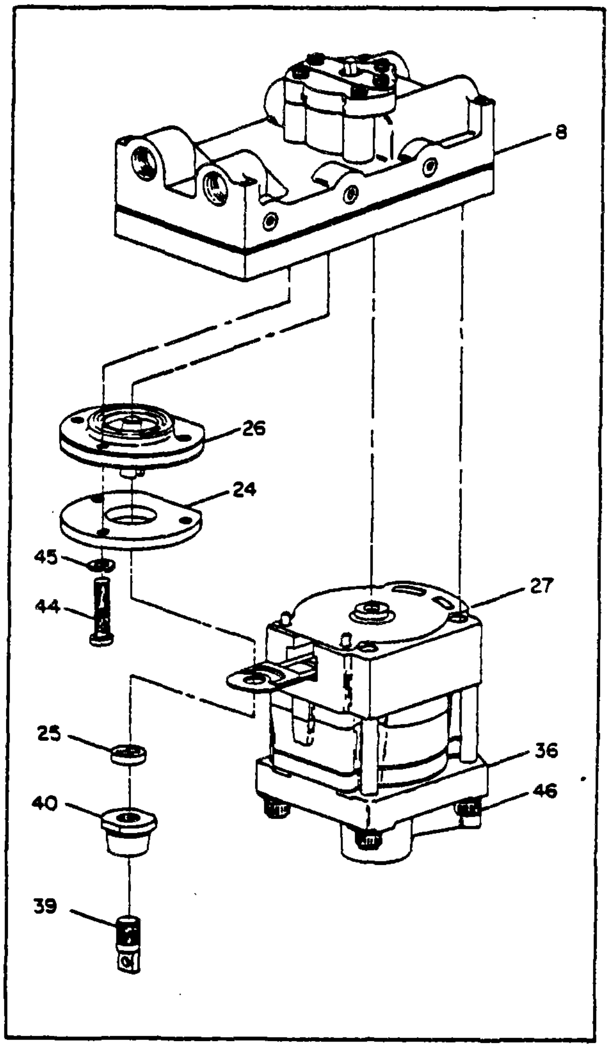


FIGURE 8 - Replacing Signal Diaphragm Assembly

	GAIN SUPPRESSION KIT PART NO. 5327328-1		GAIN SUPPRESSION KIT PART NO. 5327328-2	
APPLICATION	Positioner with Standard Gain (250-300)	Positioner with High Gain (300-400)	Positioner with Standard Gain (250-300)	Positioner with High Gain (300-400)
Cylinders with 50 in.^{3} or less displacement.	X			X
Cylinders with 50 in.^{3} to 200 in.^{3} displacement.		X	Not Required	
Diaphragm actuators with high packing friction.	X			X

TABLE 1 - Suggested Gain Suppression Kit Guide Lines

3. Remove two screws (30) from rear of base assembly (13) and carefully remove Positioner assembly (3).

4. To remove signal nut (40), place a 9/16-inch thin head or tappet,open end wrench on hex of signal diaphragm assembly (26) guide to secure guide in position and prevent rotation. With guide held firmly, place a 3/4-inch open end wrench on flats of signal nut (40). Remove signal nut and spring retainer (39) from threaded section of guide.

CAUTION: Damage could result to signal diaphragm assembly if guide is not held in position when removing signal nut.

5. Remove tabbed retainer (25) from signal diaphragm assembly (26) guide.

6. Loosen four hex socket head cap screws (46) until base manifold assembly (36) and relay assembly (27) can be disassembled from mainfold assembly (8). (Dowel pins in both ends of relay assembly prevent rotation of assemblies after cap screws have been removed.)

CAUTION: To prevent damage to vane of relay assembly, carefully guide relay assembly (27) vane over signal diaphragm guide when separating relay assembly and manifold assembly (8).

7. Remove three screws (44) and disassemble signal cover (24).

8. Remove signal diaphragm assembly (26).

9. To install new signal diaphragm assembly (26), reverse steps 1 thru 8 above. Tighten three screws (44) 25 to 30 in. lb. Tighten four cap screws (46) 70 to 75 in. lb.; uniformly, in rotation. Wait 15 minutes and retorque screws.

INSTALLING OPTIONAL GAIN SUPPRESSION KIT (Refer to Figure 22 and Figure 9)

An optional gain suppression kit is available for Type AP2 Positioner (refer to Table 1). Installing the gain suppression kit might be necessary to control oscillation of the final control element; to reduce sensitivity and prevent overshoot where high packing friction is evident; where oscillation occurs in a rapid rise portion of the cam or to adapt the Positioner to a change in application. The need for gain suppression will vary according to actuator and valve characteristics. If it is necessary to add the gain suppression kit, refer to applications listed in Table 1 and procedure outlined below.

1. Remove cam (Figure 22, item 34) from cam shaft (33).

2. Disconnect range spring (Figure 9, item 4) from spring retainer (15) using needle nose pliers.

3. Install spring (7) over signal nut (45) until spring contacts signal nut flange.

4. Install "bonnet" portion of retainer (8) over spring retainer (15) until retainer (8) secures spring (7) in position.

5. Install screws (9), lockwashers (10) and small washers (11) thru retainer (8) and into Positioner base assembly (13). Do not tighten securely.

6. Reassemble range spring (4) to spring retainer (15).

7. Install cam (Figure 22, item 34) on cam shaft (33).

FAULT CORRECTION CHART

FAULT	PROBABLE CAUSE	CORRECTIVE ACTION
1. Final drive element at one end of stroke and does not respond to input change.	a. Obstruction in orifice leading to nozzle.	a. Check orifice as outlined under "Cleaning Nozzle Orifice".
	b. Relay (amplifier) section leaking internally.	b. Replace as outlined under "Replacing Relay Assembly".
2. Excessive air consumption (exhaust loud).	a. Leakage at joints of manifold assembly, relay assembly or base manifold assembly.	a. Tighten four .250-28 x 4 hex socket head stainless steel cap screws 70 to 75 in. lb.
	b. Improper seating of output valves.	b. Remove valves as outlined under "Replacing Output Valve O1" or "Replacing Output Valve O2". Clean valves and seats. Replace valves if necessary.
3. Oscillation of final drive element.	a. Output pressure level too low.	a. Reset output pressure level adjustment as outlined under "Calibrating the Positioner".
	b. Gain too high.	b. Install optional spring kit as outlined under "Installing Gain Suppression Kit".
	c. Drive arm not securely attached to final drive element.	c. Tighten or correct linkage as necessary.
4. Slow response.	a. Output pressure level too high or too low.	a. Reset output pressure level adjustment as outlined under "Calibrating the Positioner".
	b. Output valves blocked.	b. Remove valves as outlined under "Replacing Output Valve O1" or "Replacing Output Valve O2". Clean valves and ports.
	c. Relay (pneumatic amplifier) assembly not operating correctly.	c. Replace as outlined under "Replacing Relay Assembly".
5. Final drive element at minimum travel stop and will not respond to input change.	a. Signal diaphragm leakage.	a. Tighten three .190-32x1.00 pan head screws to 25-30 in. lb. or replace as outlined under "Replacing Signal Diaphragm Assembly".
6. Uprange zero shift that cannot be adjusted.	a. Signal diaphragm leakage.	a. Tighten three .190-32x1.00 pan head screws to 25-30 in. lb. or replace as outlined under "Replacing Signal Diaphragm Assembly".
7. Full range cannot be obtained with adjustment.	a. Incorrect range spring.	a. Remove range spring and install correct spring for range required.
	b. Signal diaphragm leakage.	b. Tighten three .190-32x1.00 pan head screws to 25-30 in. lb. or replace as outlined under "Replacing Signal Diaphragm Assembly".

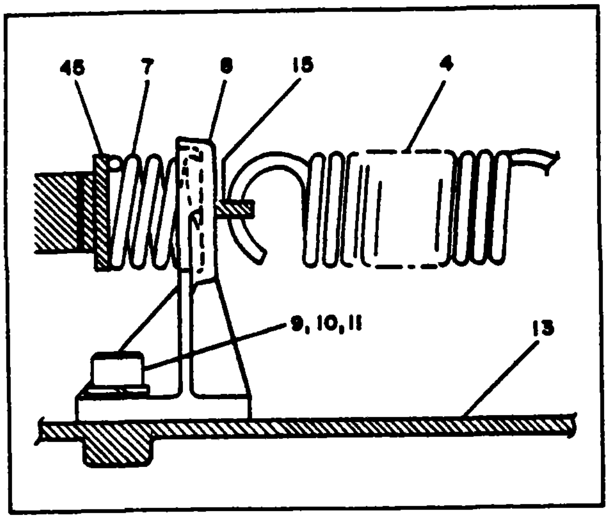


FIGURE 9 - Installing Optional Gain Suppression Kit

8. Position retainer (Figure 9, item 8) on its slotted holes so it is in position to exert a slight, even compression load on spring (7) when cam and signal pressure are at 0%. Tighten screws (9) in this position.

9. Readjust range and zero adjustments as outlined under "Calibrating the Positioner". If unit is unstable or sluggish, retainer (8) can be repositioned in its slotted holes.

10. Check to verify that there is a slight load on spring (7) when unit is pressurized and in a static position.

INSTALLING OPTIONAL HIGH GAIN RANGE SPRING

Two optional high gain range springs are available for Type AP2 Positioner (refer to Table 2). Installation of the high gain range spring is recommended for increasing accuracy on large displacement cylinders or actuators only, where high gain should not affect stability of the final control element. To install high gain range spring, follow procedures outlined below.

1. Remove cam from cam shaft.

2. Disconnect standard gain range spring from threaded adjuster and spring retainer using needle nose pliers. Install new high gain range spring.

3. Install cam on cam shaft.

4. Readjust range and zero adjustments as outlined under "Calibrating the Positioner".

Range Spring Part No.	No. of Coils	Input Signal (psi)	Application
5327330-1	15	3-15	Optional high gain range spring
5327330-2	14	3-27	Optional high gain range spring
		3-15	*Standard gain range spring
5327330-3	11	3-27	*Standard gain range spring

*Standard gain (250-300) range springs are assembled in place and shipped with Positioner.

TABLE 2 - Optional High Gain Range Spring

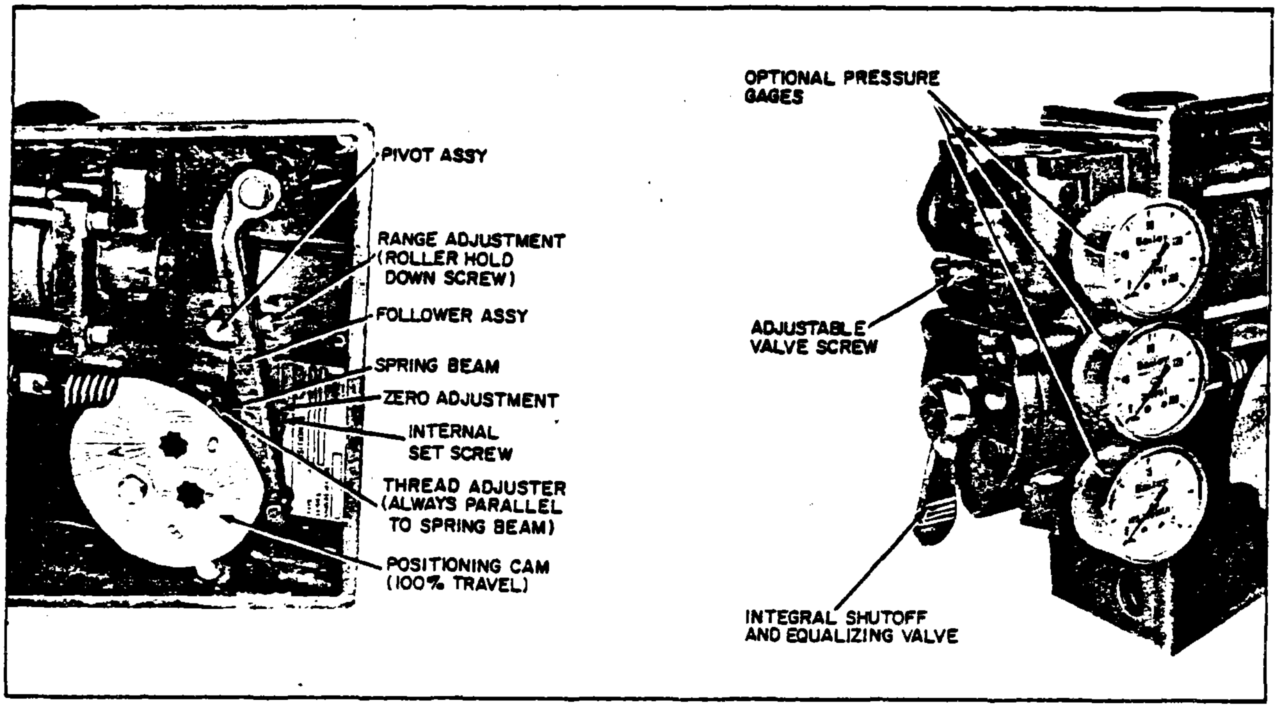


FIGURE 10 - Positioner Adjustments

CALIBRATING THE POSITIONER

Calibration of Type AP2 Characterizable Pneumatic Positioner consists of adjusting the linkage from the power operator so that the positioning cam rotates thru full range for full travel of the piston or valve stem and to adjust (or balance) the output pressure level.

The following adjustments are performed with Positioner mounted on the power operator. These adjustments are specifically for checking operation of the two units prior to adapting the Positioner to a particular application. Once these adjustments have been completed, proceed to "Calibration Adjustments for Particular Applications".

OUTPUT PRESSURE LEVEL ADJUSTMENT

Double-Acting Cylinder Applications

If necessary to change or correct output pressure level of Positioner, follow the procedure outlined below and refer to Figure 10.

1. Use B (straight line) positioning cam which is shipped in place in Positioner assembly.

CAUTION: Make certain correct side of cam (red or black) is facing outward for application desired (Figure 2).

2. Make supply air connections (18 to 150 psig) designated "S" on manifold. Maintain this pressure during adjustments and after Positioner has been placed into service.

WARNING: TYPE AP2 POSITIONERS ARE SUITABLE FOR A MAXIMUM AIR SUPPLY PRESSURE OF 150 PSIG. ADHERENCE TO THIS LIMITATION WILL ENSURE SATISFACTORY PERFORMANCE. DO NOT EXCEED MAXIMUM RECOMMENDED CYLINDER OPERATING PRESSURE.

3. If optional pressure gages are not included, connect customer supplied pressure gages to Positioner output ports O1 and O2 or to 1/8-inch NPT gage ports (Figure 2).

4. Apply midrange signal (9 psi for 3-15 unit or 15 psi for 3-27 unit) with no load on cylinder.

CAUTION: Make certain midrange signal is applied. Output pressure level cannot be adjusted if piston is against travel stop.

5. Turn integral shutoff and equalizing valve (AP2□□1□) to AUTO position.

6. Each output pressure gage should stabilize at approximately 2/3 of supply pressure (O1 gage reading plus O2 gage reading should equal 4/3 of supply pressure).

7. If reading is not correct, turn adjustable valve screw counterclockwise to increase pressure or clockwise to decrease pressure until correct reading is obtained.

NOTE: If oscillation occurs, gain suppression spring kit (available option from Bailey Meter Co., Pt. No. 5327328-☐) must be installed. Refer to "Installing Gain Suppression Spring" for table of spring applications and installation procedure.

Single-Acting Diaphragm Actuator Applications

If necessary to change or correct output pressure level of Positioner, follow procedure outlined below and refer to Figure 10.

1. Use B (straight line) positioning cam which is shipped in place in Positioner assembly.

CAUTION: Make certain correct side of cam (red or black) is facing outward for application desired (Figures 2 and 3).

2. Make supply air connections (18 to 150 psig) designated "S" on manifold. Maintain this pressure during adjustments and after Positioner has been placed in service.

NOTE: For single-acting diaphragm actuator applications, a minimum supply pressure of 5 psi over maximum input signal range (20 psi for 3-15 psi unit or 32 psi for 3-27 psi unit) must be maintained.

WARNING: TYPE AP2 POSITIONERS ARE SUITABLE FOR A MAXIMUM AIR SUPPLY PRESSURE OF 150 PSIG. ADHERENCE TO THIS LIMITATION WILL ENSURE SATISFACTORY PERFORMANCE. DO NOT EXCEED MAXIMUM DESIGN OPERATING PRESSURE OF ACTUATOR.

NOTE: For single acting diaphragm actuators, a minimum supply pressure of 5 psi over maximum input signal range (20 psi for 3-15 psi unit or 32 psi for 3-27 psi unit) must be maintained.

3. If optional pressure gages are not included, connect customer supplied gages to 1/8-inch NPT gage ports in location shown in Figure 3 for application desired.

4. Apply midrange signal (9 psi for 3-15 psi unit or 15 psi for 3-27 psi unit) with no load on actuator.

CAUTION: Make certain midrange signal is applied. Output pressure level cannot be adjusted if valve is against travel stops.

5. If reading on supply gage G3 (Figure 3) does not equal supply pressure being applied, turn adjustable valve screw counterclockwise until supply pressure is obtained. If reading is at supply pressure, turn screw clockwise to decrease pressure; then counterclockwise until full supply pressure is obtained.

NOTE: Supply gage may momentarily drop if large step change is applied.

6. Once supply pressure is obtained, turn adjustable valve screw one (1) full turn counterclockwise.

ZERO AND RANGE ADJUSTMENTS
(Refer to Figure 10)

The range spring assembly applies a proportional feedback force to the input signal diaphragm assembly. A threaded adjuster applies initial tension on the spring and provides a zero adjustment.

Range adjustment of the Positioner is obtained by repositioning a pivot assembly along the cam follower arm. Moving the pivot assembly towards the cam results in a shorter final control element stroke for a given signal change. The opposite holds true for moving the pivot assembly away from the cam.

Double-Acting Cylinder Applications

The adjustment procedure below is based on a direct-acting application as shown in Figure 2. If power operator is being used for a reverse-acting application, note that the movements and positions will be opposite those listed below. Normally, the regulating device (valve, damper, etc.) used in direct-acting applications will be in the CLOSED position when piston is at bottom of cylinder; and the OPEN position when piston is at top of cylinder. Therefore, the words OPEN and CLOSED used below refer to these positions.

Single-Acting Diaphragm Actuator Applications

The adjustment procedure below is based on a direct-acting, top-connected diaphragm actuator as shown in Figure 3. If the power operator is being used for a reverse-acting application, note that the movements and positions will be opposite those listed below. Normally, a control valve used in direct-acting applications will be in the CLOSED position when the valve stem has traveled out of the valve body to its fullest extent; and in the OPEN position when the stem has traveled into the valve body to its fullest extent. Therefore, the words OPEN and CLOSED used below refer to these positions.

NOTE: It is recommended that a position indication plate be installed on the valve actuator yoke (or cylinder) and a pointer be installed on valve stem (or piston rod) to indicate full stroke travel in both directions.

1. Position piston (or valve) to CLOSED position. If cam follower is not at zero mark on positioning cam, disconnect and adjust Positioner drive rod (or other connecting linkage used to tie back to power operator) until Positioner drive arm assumes position which places follower on zero mark. Reconnect drive rod.

2. Set input signal at minimum range value (3 psi for 3-15 psi unit or 3-27 psi unit). Piston (or valve) should remain in CLOSED position.

3. If piston (or valve) begins to move from its CLOSED position, loosen set screw located in recessed hole of knurled adjustment nut and turn zero adjustment (Figure 10) clockwise to increase range spring tension until piston (or valve) returns to a CLOSED position.

4. Increase input signal above minimum range value (3.5 psi for 3-15 unit or 3-27 psi unit). If piston (or valve) does not begin to leave CLOSED position immediately, turn zero adjustment nut (Figure 10) counterclockwise until such movement is obtained. Once zero adjustment is completed, retighten set screw to lock zero adjustment in place.

5. Return to minimum input signal (3 psi). Piston (or valve) should go to CLOSED position.

6. Set input signal at maximum range value (15 psi for 3-15 psi unit or 27 psi for 3-27 psi unit). If piston (or valve) does not move to full OPEN position, loosen roller hold down screw (Figure 10) and slide roller along beam until piston (or valve) reaches full OPEN position. After adjustment, tighten hold down screw firmly in place.

7. Decrease input signal below maximum signal range value (14.5 psi for 3-15 psi unit or 26.5 psi for 3-27 psi unit). If piston (or valve) does not begin to leave full OPEN position immediately, change range adjustment as outlined in step 6 until such movement is obtained.

8. If range adjustment (step 6) was necessary, recheck zero adjustment as outlined in steps 2 thru 5.

CALIBRATION ADJUSTMENTS FOR PARTICULAR APPLICATIONS

The Positioner adjustments described below may be used to improve the operation of the power operator system either by itself or in relation to other systems or parts of a multiple system.

Zero or Suppression Adjustment

By using the zero adjustment (Figure 10) an intitial tension may be imposed upon the range spring so that the piston (or valve) will not begin to move from its minimum position until input signal has increased from 3 psi to any value up to 9 psi (3-15 psi unit) or 15 psi (3-27 psi unit). This adjustment is of value when two or more power operators are to be operated in sequence; where the power operator is equipped with a minimum stop; or where the characteristics of the device which the operator is moving must be matched with that of another regulated device.

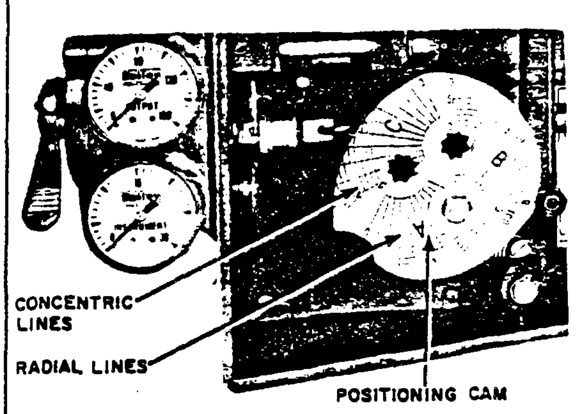


FIGURE 11 - Characterized Cam

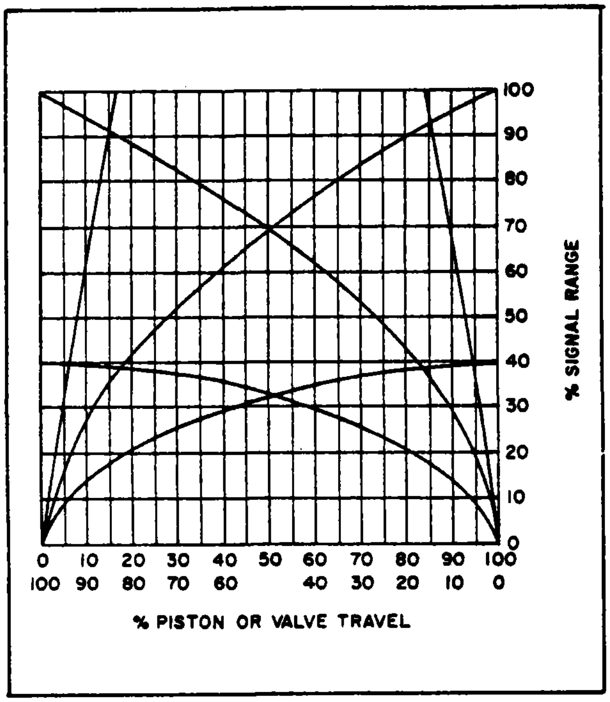


FIGURE 12 - Cam A, Square Root Relation

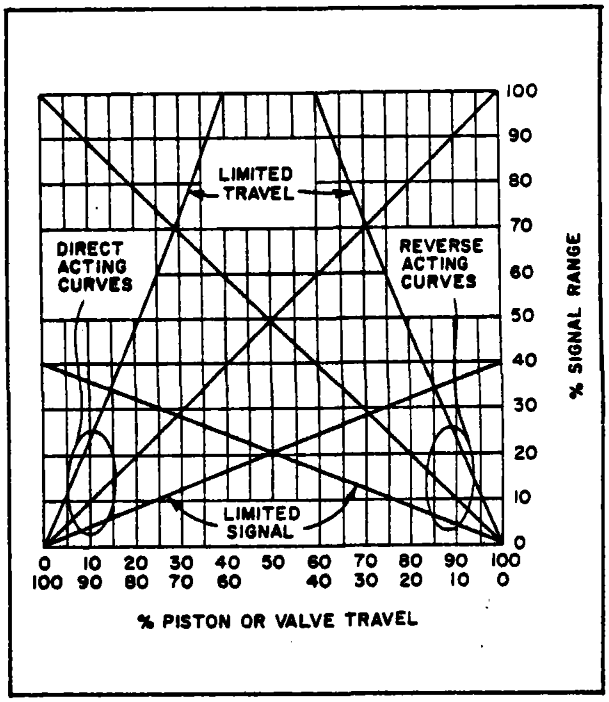


FIGURE 13 - Cam B, Linear Relation

Split Range Adjustment

The range adjustment affords a variation of power operator motion for a given range of control signal pressure. In combination with the zero adjustment described above, full piston (or valve) travel may be obtained for a signal pressure change as small as 6.0 psi (3-15 psi unit). Range adjustments available for each of the three cam variations furnished are shown in Figures 12, 13 and 14. This adjustment is of value when the device being regulated by the power operator is oversized, since the adjustment allows operation of the power operator thru its useful motion for the desired full change in control signal pressure. It is also useful in matching the signal versus position characteristic of the power operator with those of related power devices in the same control system.

Cam Characteristic Adjustment

This adjustment involves selecting or shaping the proper positioning cam in order to obtain that characteristic of piston (or valve) position versus control signal pressure which will afford the desired characteristic of controlled medium versus control signal pressure. The definition of "controlled medium" as applied to this section is the rate of action of that medium (water, air, etc.) being controlled.

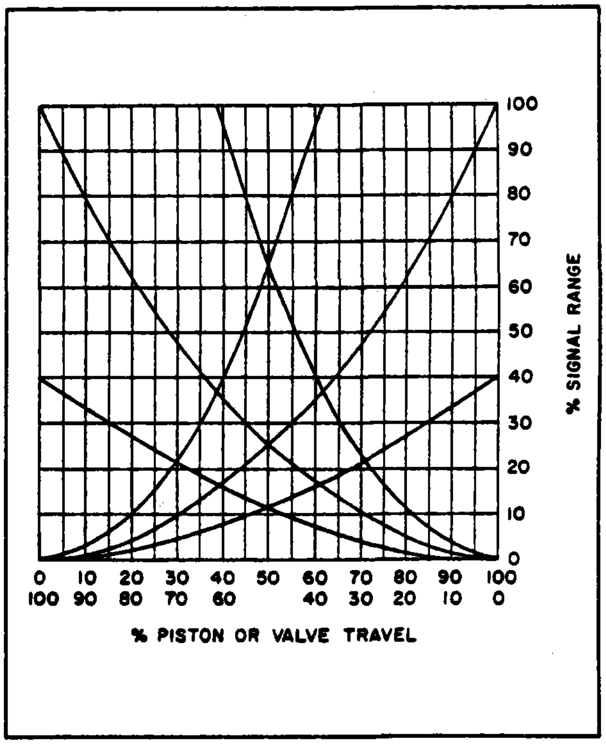


FIGURE 14 - Cam C, Square Relation

CONTROL SIGNAL PRESSURE		
Percent Value	Signal Value (psig)	
	Control System Ranges	
	3-15	3-27
0	3.0	3.0
10	4.2	5.4
20	5.4	7.8
30	6.6	10.2
40	7.8	12.6
50	9.0	15.0
60	10.2	17.4
70	11.4	19.8
80	12.6	22.2
90	13.8	24.6
100	15.0	27.0

TABLE 3 - *Conversion Table for Control System Ranges*

Positioning cams A, B and C (Figure 11) are furnished with each Positioner (the B cam is shipped assembled in place and the A and C cam are included on the same part, but are inactive). The characteristics for which the cams are shaped are listed in Table 4 and are shown in Figures 12, 13 and 14. The figures show a family of curves for each cam, each curve representing a range adjustment when used with that specific cam. Table 3 shows control signal pressure values of the two control system ranges equivalent to the signal range percent values in Figures 12, 13 and 14.

If the system involves a single power operator, it is probable that the B (straight line) cam will be satisfactory. However, one of the other cams may provide a more uniform controlled medium versus signal pressure characteristic, providing stable control over a wide range of operation with a given proportional band adjustment on the controller. For a power operator which is an integral part in a complex control system, the cams provide a selection of characteristics which, when used in conjunction with the range adjustment, should allow close paralleling of the controlled medium versus signal pressure characteristic.

Refer to "Characterized Cams" for selecting or shaping the proper positioning cam for a power operator which is to be part of a complex control system.

Cam Selection

Depending upon nomenclature, the Positioner will be provided with one of two standard 3 lobe cams. The following table is a comparison of possible stroke lengths vs. feedback drive arm hole locations for the Full Stroke - 90° cam and the Half Stroke - 45° cam.

Feedback Arm Hole Position from Cam Shaft	Length of Stroke - Inches	
	Full Stroke - 90° Cam	Half Stroke - 45° Cam
1	1	.5
2	1.5	.75
3	2	1
4	2.5	1.25
5	3	1.5
6	3.5	1.75
7	4	2

CHARACTERIZED CAMS

In order to match the inherent characteristics of the power operator to the final control device, it may be practical to reduce the controlled medium versus piston (or valve) position characteristic of each device in the system to a straight line relationship with regard to control signal pressure. This straight line relationship is established by calibrating the Positioner with respect to the correct positioning cam by the following method.

1. Use B (straight line) cam to determine actual controlled medium versus piston (or valve) characteristic (Figure 15).

2. Determine exact controlled medium versus control signal pressure characteristic desired (Figure 16).

3. Using values determined in steps 1 and 2, plot a curve to determine exact control signal pressure versus piston (or valve) position characteristic (Figure 17).

Positioning Cam, Any Stroke	Piston or Valve Position (P) vs. Control Signal (I)	Figure No.
A	Square Root ($I = \sqrt{P}$)	12
B	Straight Line ($I = P$)	13
C	Square ($I = P2$)	14

TABLE 4 - Positioning Cam Characteristics

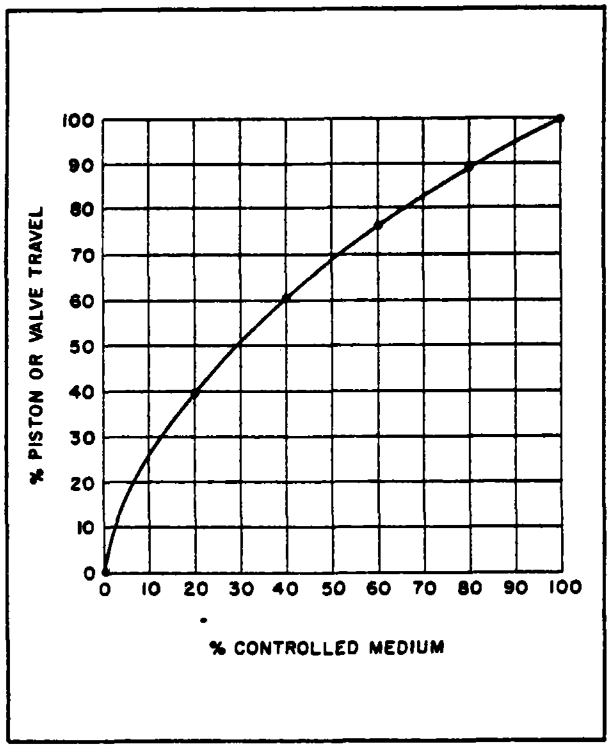


FIGURE 15 - Regulated Device Characteristic

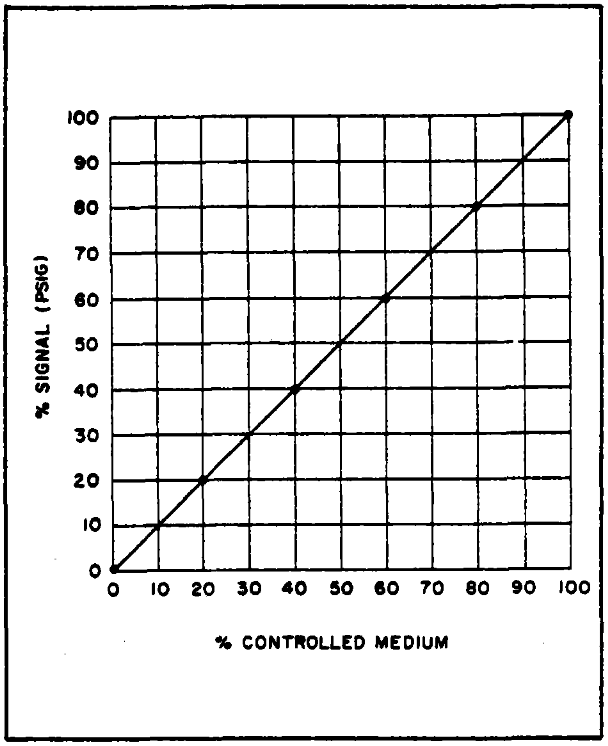


FIGURE 16 - Desired Control

4. Compare curve plotted in step 3 with curves shown in Figures 12, 13 and 14. Select positioning cam whose characteristic most closely matches control signal pressure versus piston (or valve) characteristic plotted in step 3.

5. If necessary, set range and zero adjustments to match control signal pressure versus piston (or valve) characteristic more accurately as outlined under "Zero and Range Adjustments".

6. If required characteristic cannot be obtained using the above procedure, or if a more exact characteristic is required, alter shape of cam as outlined under "Cam Shaping Method".

Cam Shaping Method

To assist in the alteration process, cams are marked with radial lines (index of % piston or valve travel) and concentric lines (index of control signal pressure). The ten concentric lines on the cam correspond to actual control signal pressure values shown in Table 3 for the specific control system signal range being used.

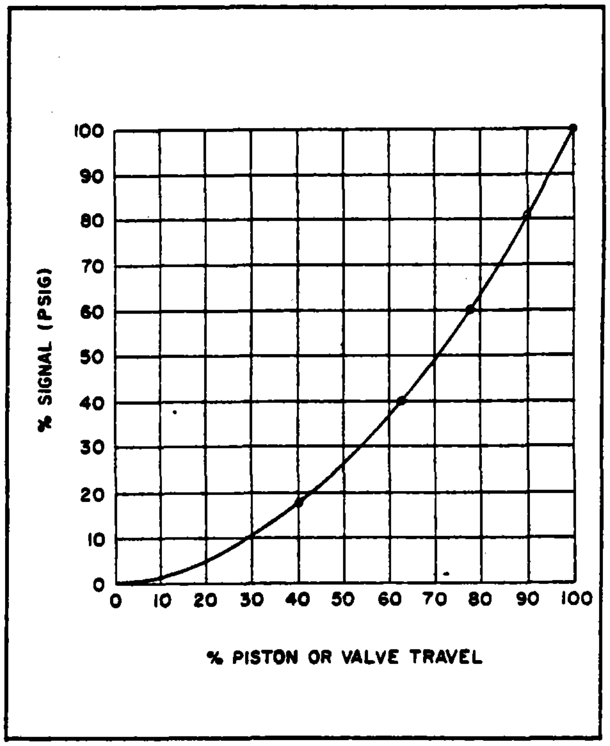


FIGURE 17 - Cam Characteristic

CAUTION: Before cutting any cam, make certain cutting will involve REMOVAL OF CAM MATERIAL, rather than building up of material. For example, if the characteristic plotted lies between the A and B cam (Figure 12 and 13), the A cam should be cut.

1. Use cam selected in step 4 under "Characterized Cams". For each increment of control signal pressure (concentric lines), locate the piston (or valve) position (radial lines) required for specific control signal pressure. Refer to Figure 18 for method of locating these points.

CAUTION: If a cam shape has too steep a rise, there is danger of cam follower becoming locked. Line printed on cam (part no. 5327322-1) indicates the maximum rise which should be cut into the cam. When a cam shape is required that includes such a rise, it is necessary to introduce sufficient angularity in the power operator device drive rod linkage to allow a less radical cam shape.

2. A curve drawn thru points located on cam in step 1 above will be desired cam shape. Either alter cam or cut new cam to this shape.

NOTE: An optional blank cam, Pt. No. 5327322-1 is available from Bailey Meter Company if alteration of the original cam is not desired.

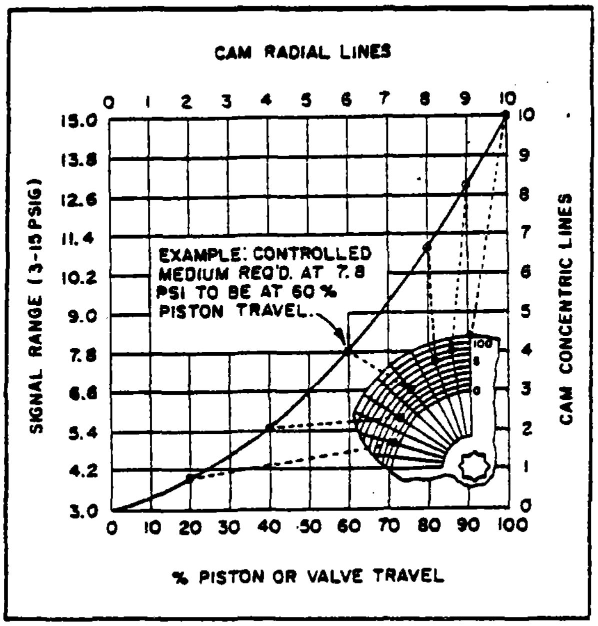


FIGURE 18 - Locating Points for Shaping Positioner Cam for 3-15 psi Unit

Speed Adjustment

When the system involves only a single power operator, a high positioning speed is usually an advantage. In a complex control system, however, it is generally desirable to operate all power devices at the same speed to avoid interaction between units or undesirable process conditions during control pressure changes. If it is necessary to reduce the speed of operation, speed control orifices (0.040") are available as an option from Bailey Meter Company (Pt. No. 5327327-1). These orifices are installed directly into the output ports (O1 and O2) and have 1/4-inch NPT ports for connecting plumbing from the power operator. If orifices are too small, they may be drilled out to obtain desired speed control. Blank orifices (Pt. No. 5327327-2) are also available.

HOW THE POSITIONER OPERATES

The Type AP2 Characterizable Pneumatic Positioner is a two-stage amplification, "push-pull" action, force-balance type control instrument, normally located in the control loop (Figure 19) between the controller and the final control element (valve actuator or cylinder assembly). A pneumatic input (3-15 psig or 3-27 psig) is applied to the Positioner to produce a power operator position which can be characterized for a particular application thru the use of a positioning cam. A mechanical linkage connection to the piston (or valve) stem serves to feed back the actual stem position movement. When the controller calls for the piston (or valve) to change position, the Positioner acts as a pneumatic relay, thru an independent air supply, and changes the piston (or valve) to its new required position.

The Type AP2 Positioner can be applied to double-acting cylinder assemblies where a load is applied to one side of the cylinder while simultaneously unloading the opposite side of the cylinder for a change in controller output. By plugging one of the output connections (unused connection depends on application, Figure 3), the Type AP2 Positioner can also be used with single-acting diaphragm actuators where a load is applied to top or bottom of the acutator for a change in controller output.

PNEUMATIC AMPLIFIER RELAY ASSEMBLY

(Refer to Figure 20 and 21)

The Positioner's pneumatic amplifier is constructed in a "stack" design. Several pneumatic

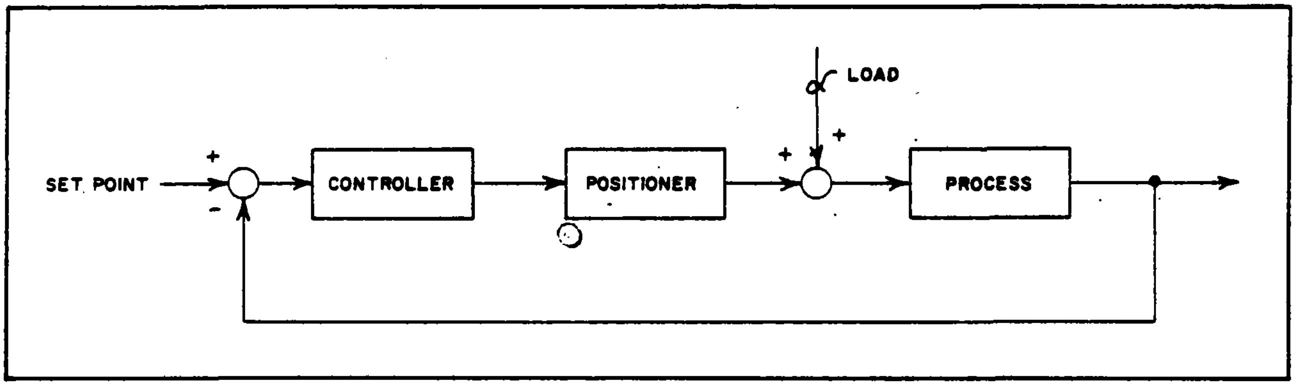


FIGURE 19 - Block Diagram of Type AP2 Positioner Application.

chambers are formed by alternating fabric-reinforced, elastomer diaphragms and aluminum spacers. The outer spacers are secured by stainless steel bolts while the movable center sections are clamped together by flaring the ends of the aluminum guide tubes.

When a change in control signal pressure is applied to the signal diaphragm assembly the distance between the vane and nozzle changes. As the vane moves, the nozzle backpressure will increase or decrease (depending on direction of the signal applied) and the entire relay assembly center structure will displace. Movement of this center structure will open (or close) output valves O1 and O2.

CAM AND LINKAGE

(Refer to Figure 20)

Power operator position is fed back to the Positioner for comparision with the input control signal pressure. The feedback mechanism consists of 1) a drive rod which follows the motion of the power operator; 2) an adjustable, swivel-ended drive arm which is driven by the drive rod; and 3) a cam and shaft which are driven by the adjustable drive arm. The prime function of the cam is to permit characterization of the power operator position versus input control signal pressure.

A series of alternate drive link attachment holes in the Positioner drive arm provides for nominal strokes of 0.50 to 4.00 inches. The drive arm may be repositioned in 45 degree increments with respect to the case (i.e., at midstroke the arm can be at any of eight positions which are parallel to or displaced 45° relative to the sides of the Positioner). One of two cam configurations (45° or 90° rotation) are used, depending upon actuator stroke.

Since the cam, shaft and drive arm move as an assembly, cam motion is 45 or 90 degrees. The cam base circle radius is 1.30 inches and maximum rise is 0.90 inches. In each case a square root cam A, straight line cam B and square cam C are stamped on one blank. The Positioner is shipped with the straight line cam B in position (red side facing out). By flipping the cam over and reversing output connections O1 and O2, a reverse-acting application can be obtained.

SEQUENCE OF OPERATION

NOTE: Because of the variety of applications available with the Type AP2 Positioner, the description below will apply to a double-acting cylinder assembly used in a direct-acting application. The input control signal pressure being applied will be of an increasing nature. Refer to

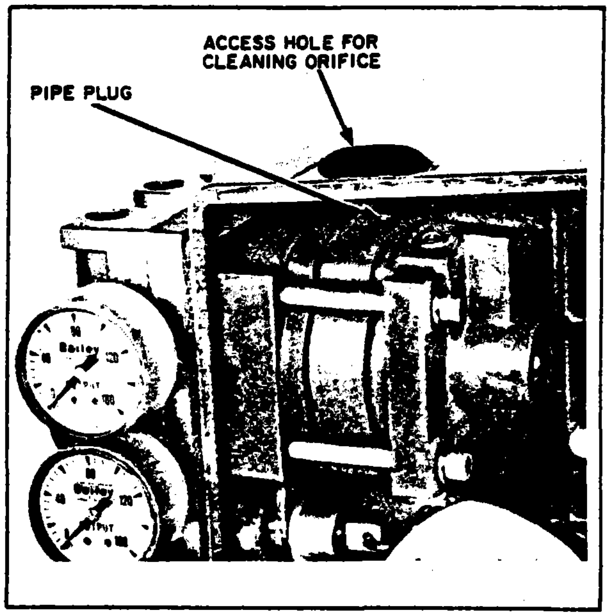


FIGURE 20 - Type AP2 Positioner Components

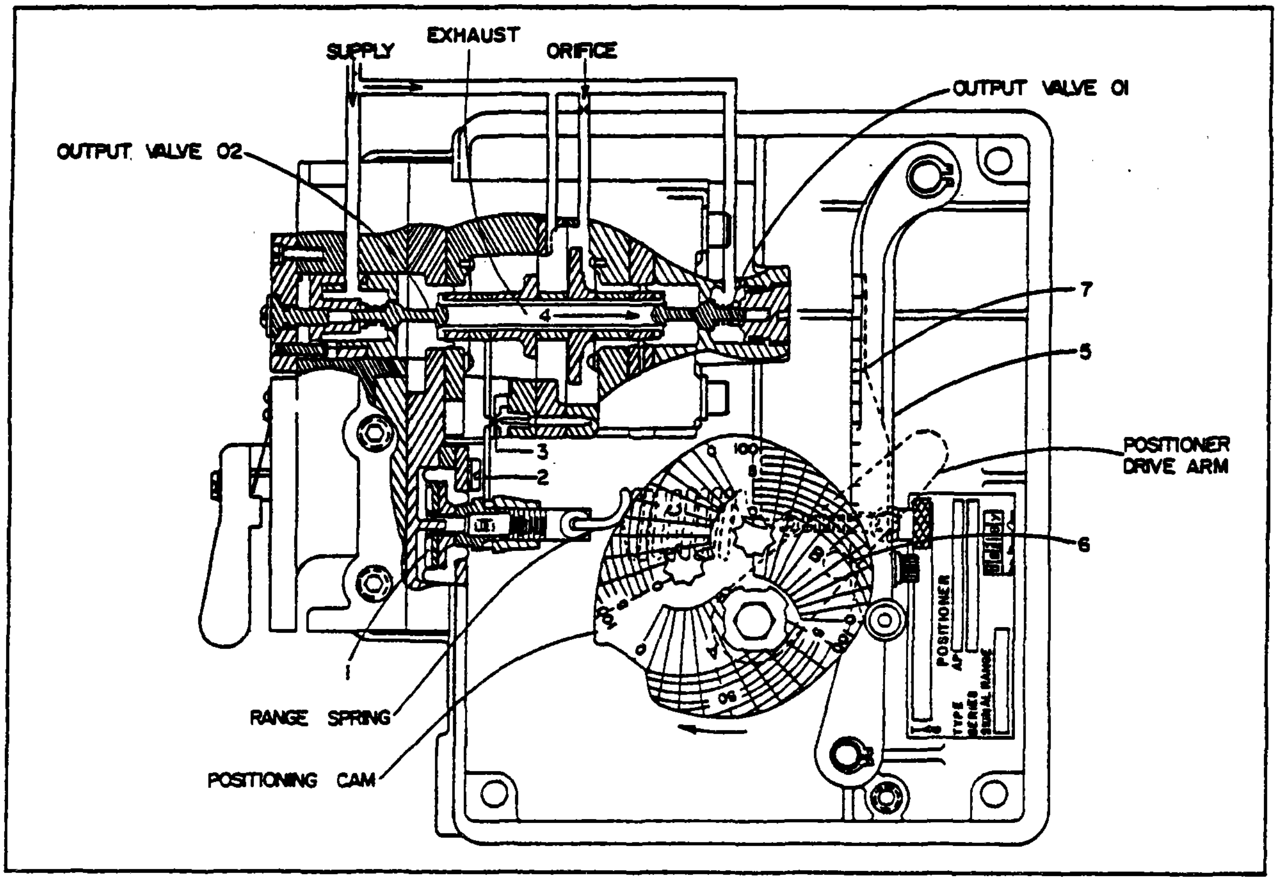


FIGURE 21 - Cutaway View of Type AP2 Positioner

Figure 21 for identification of item numbers listed in parentheses below and as a guide for steps listing direction of movement (clockwise, counterclockwise, right, left, etc.) of various components.

1. The controller sends out an increasing signal to change position of power operator piston.

2. Increase in pressure applied displaces signal diaphragm assembly (1), carrying vane assembly (2) away from nozzle (3).

3. Movement of vane away from nozzle decreases pressure in nozzle backpressure chamber, allowing supply pressure in opposing chamber to exert force on relay diaphragm assembly and move entire center structure (4) to the right.

4. Displacement of relay assembly center structure creates the following reactions:

a. Opens output valve O1 to supply pressure, increasing pressure applied to one side of piston.

b. Opens output valve O2 to atmosphere, causing opposite side of piston to exhaust.

c. Amplifier vane begins to move to the right, initiating a negative internal feedback which decreases tension on range spring and allows vane to move towards nozzle.

5. Piston displaces because of differential pressure across O1 and O2 output ports. Movement of piston is fed back to Positioner by a drive rod which is connected to Positioner drive arm and positioning cam.

6. Cam rotates clockwise and pushes follower assembly (5). Pivot assembly (6), connected to cam follower, then pushes on spring arm (7) which extends (stretches) range spring.

7. As range spring extends, vane assembly is pulled toward nozzle until force exerted by range spring and force exerted on signal diaphragm assembly are equal. When a "balanced" condition is obtained, relay assembly center structure will return to a neutral position closing valves O1 and

O2; nozzle backpressure will again return to 2/3 of supply pressure; and piston position will be in equilibrium with input control signal pressure.

A decreasing input control signal pressure from the controller reverses the sequence above, causing the piston to move in the opposite direction.

For single-acting diaphragm actuators, the sequence of operation is identical to the above example except that one output valve is made inoperative thru a valve adjustment procedure as outlined under "Output Pressure Level Adjustment" for single-acting diaphragm actuators.

INTEGRAL SHUTOFF AND EQUALIZING VALVE, TYPE AP2☐☐1☐

(Double-Acting Cylinder Applications)

If Positioner is equipped with the integral shutoff and equalizing valve, the cylinder assembly may be manually or automatically operated as outlined below. By turning the valve handle to HAND, supply pressure to the cylinder is cut off and O2 and O1 are equalized allowing manual repositioning of the piston.

Transfer from Manual to Automatic Operation

1. Valve handle should be in HAND position.

2. If manual operator does not lock drive cylinder in position:

a. The piston must be positioned from prior knowledge of piston position versus signal or piston may "jump" when transferred to automatic.

b. Turn valve handle to AUTO position.

3. If manual operator locks drive cylinder in position:

a. Switch valve to AUTO position. Drive cylinder will oppose manual operator if drive position and input signal do not correspond.

b. Manually operate drive until load on manual operator decreases. If output pressure gages are installed on Positioner, readings should equalize.

NOTE: If in step 3b it is desired that drive stay in initial position, input signal must be adjusted to correspond with drive position as indicated by the load on manual operator, output pressures or prior knowledge of position versus signal.

Transfer from Automatic to Manual Operation

1. Valve handle should be in AUTO position.

2. If manual operator does not lock drive cylinder in position, press safety latch and switch valve to HAND position. Drive cylinder will move as determined by load if not restrained by hand lever.

3. If manual operator locks drive cylinder in position, transfer mechanism to manual. Press safety latch and turn valve handle to HAND position.

OPTIONAL BYPASS VALVE

(Single-Acting Diaphragm Actuator Applications)

If Positioner is equipped with an optional bypass valve assembly (Figure 25), the actuator may be manually or automatically operated as outlined below. Depending on application, the Positioner may be adjusted for either direct or reverse-acting operation. When applied for direct-acting applications, an increase in control signal pressure will cause an increase in control pressure to the actuator. When applied for reverse-acting applications an increase in control signal pressure will cause a decrease in control pressure to the actuator. Determine the application to which the Positioner is being applied and follow the correct procedure.

NOTE: Supply valve stated in the following procedures is not supplied by Bailey Meter Co.

Direct-Acting Applications

To change from remote control to local manual control:

1. Turn bypass valve to "BYPASS" position.

2. If the Positioner is to be serviced, close supply valve (supply valve not supplied by Bailey Meter Co.).

To change from local manual control to remote control:

1. Open supply valve.

2. Turn bypass valve to "POSITIONER" position.

Operate valves in this sequence to avoid a momentary pressure loss to the diaphragm actuator.

When the valves are set for manual operation, control signal pressure goes to the signal diaphragm assembly and also thru the bypass valve to the actuator. The actuator is supplied with signal pressure directly from the control system.

The final control valve may be positioned either by signal pressure from the control system or preferably, by manual operation of the Selector Station (if used) connected by the control pressure line to the Positioner.

The Positioner cannot normally be transferred from automatic to manual or vice versa without disturbing the control system because the Positioner is usually calibrated to deliver control pressure to the diaphragm actuator which differs from control signal pressure received from the control system.

To manually operate the control valve by handjack.

1. Pick up valve position with handjack.

2. Close supply valve.

3. Position valve using handjack.

Reverse-Acting Applications

WARNING: WHEN ARRANGED FOR REVERSE-ACTING APPLICATIONS, SERIOUS DAMAGE COULD RESULT IF A "BYPASS" VALVE POSITION WERE USED AND CONTROL SIGNAL PRESSURE WERE INTRODUCED DIRECTLY TO THE DIAPHRAGM ACTUATOR. THE CONTROL PRESSURE TO THE ACTUATOR DURING AUTOMATIC OPERATION IS THE OPPOSITE OF CONTROL SIGNAL PRESSURE FROM THE CONTROL SYSTEM TO THE POSITIONER. TO EFFECT A BYPASS ARRANGEMENT, IT IS NECESSARY TO REVERSE THE CONTROL SIGNAL PRESSURE DURING MANUAL OPERATION OF THE POSITIONER. THIS IS NOT PRACTICAL FOR THE SMALL AMOUNT OF TIME THAT THE POSITIONER WOULD BE ON MANUAL DURING NORMAL OPERATION.

To change from remote control to local manual control:

1. Pick up control valve position with handjack.

2. Close supply valve

3. Position valve using handjack.

Position Transmitter Application

The AP2 Positioner may be used as a position transmitter, by generating a pneumatic signal which is a function of an input position. The same combinations of signal ranges and stroke spans are available as are offered in the Positioner application (i.e., 3 to 15 psig and 3 to 27 psig outputs for strokes from 0.5 to 4 inches).

The output signal may be made a square root, linear or square function of the input position thru use of the A, B or C portion of the cam, respectively. Other functions may be created thru special shaping of the cam.

The AP2 may be made to function as a position transmitter by interconnecting the "E" input signal port with the "O2" output port and tapping into this interconnection for the output signal (Figure 26). A plug is placed in the "O1" output port. Position transmitter kit number 5327252-1 (Figure 26) provides the necessary hardware.

A change in input (cam shaft position) causes a deflection of the range spring via the cam and linkage. The resulting unbalance of forces between the signal capsule and the range spring causes a change in the "O2" output which is fed back to the signal capsule.

The signal capsule now acts as a feedback element by opposing the input force from the range spring. When the force from the "O2" pressure in the signal capsule equals the new range spring force the output will stabilize and will represent the desired function of the input position.

Installation

Installation is similar to Positioner installation. The device whose position is to be transmitted should be coupled to the position transmitter's cam shaft so as to cause a 90° rotation of the shaft for full travel of the device (45° for AP2☐1☐ ☐).

For a linear-motion device (e.g. diaphragm actuators) the cam shaft is driven by the drive arm (Figure 22, item 38) and a connecting link (Figure 24, item 7) as in the Positioner application. For a 90° rotation device it may be desirable to couple the cam shaft directly to the device.

The "zero" position of the cam shaft can be adjusted in 45° increments by repositioning the cam on the shaft.

The direction of the transmitted signal can be reversed by reversing the cam. For example, with the red side of the cam facing out, clockwise rotation of the cam, viewed from the front of the unit, will cause an increasing signal. Reversing the cam so that the black side faces out will result in a signal that decreases with clockwise rotation.

Supply Pressure

Maintain a supply pressure, at the "S" connection, 5 psig above the maximum output pressure but not higher than 50 psig.

Output and supply pressure gages may be installed in the positions labeled "G1" and "G2", respectively (Figure 2).

NOTE: The device to which the position transmitter is applied must supply power to operate the transmitter mechanism. Maximum torque to operate a 3 to 15 psi unit with a linear output is approximately 4-1/2 in. lb. Torque may be as high as 25 in. lb. for a square root characteristic and a 3 to 27 psi output with 50% suppression.

Calibrating the Position Transmitter

Output Pressure Level Adjustment

Adjustable valve is set as follows:

1. Connect a pressure gage to "O1" output port or to 1/8 in. NPT port in "G2" position (Figure 2).

2. Position drive at mid-stroke position.

3. Turn adjustable valve screw (Figure 6, item 34) clockwise until "O1" pressure drops below supply pressure. Now turn screw counterclockwise until supply pressure is reached on gage.

4. Turn adjustable valve screw an additional one full turn counterclockwise.

Zero and Span Adjustments

The following description is based upon a 3 to 15 psig output for "0" to 100% travel of the moving device.

1. Install accurate pressure gage at output connection or at connection labeled "G1" (Figure 2).

2. Turn-on air supply.

3. Slowly stroke drive to its "zero" position. Adjust linkage between transmitter and drive such that Transmitter's cam follower is at zero on cam.

CAUTION: In stroking the drive, be certain that the linkage is not overstrained due to maladjustment.

4. Slowly stroke drive to its 100% of travel position, taking care that linkage is free to move at all times, and is not strained due to maladjustment. Adjust pivot position in drive arm (Figure 22, item 38) or other external linkage such that cam follower is at 100% of cam rotation (radial line marked "100" on cam).

5. Repeat steps 3 and 4 until cam follower is at 0% cam when drive is at 0% stroke and 100% cam when drive is at 100% stroke.

6. Move drive to its 0% of stroke position. If output is not 3 psig, loosen set screw located in recessed hole of knurled adjustment nut. Turn nut (while keeping eye-bolt from rotating) until a 3 psig output is achieved. Tighten set screw.

7. Move drive to its 100% of stroke position. If output is not at 15 psig loosen range adjustment hold-down screw (Figure 10). With hold-down screw retightened, slide pivot assembly along follower assembly until a 15 psig output is obtained.

8. Recheck steps 6 and 7 until desired outputs are obtained.

Large adjustments are provided in the zero and range adjustments so large deviations from the above calibration can be obtained.

GENERAL SPECIFICATIONS

TABLE 5

Standard Input Ranges	3-15 and 3-27 psig.
Standard Stroke Range	0.5 in. to 4.0 in. Rotary input 45° and 90°.
Gain*	250 to 300 with 50 psig supply pressure using standard gain range spring. Gain of 400 obtainable using optional high gain range spring. Refer to Table III.
Resolution*	0.1% of output span.
Dead Band*	0.2% of input span
Hysteresis*	0.3% of output span.
Supply Pressure	18 to 150 psig. Minimum supply pressure should be maintained 5.0 psi above maximum required by actuator.
Supply Pressure Effect	Diaphragm Actuators Average effect on actuator position 0.05% per 1.0 psi supply variation, with 50 ± 10 psi supply. Cylinders Negligible
Capacity	Greater than 25 scfm at 75 psig supply (delivery and exhaust).
Air Consumption	Diaphragm Actuators 0.12 scfm at balance with 20 psig supply pressure, typical. 0.25 scfm, maximum. 0.175 scfm at balance with 30 psig supply pressure, typical. 0.35 scfm, maximum. Cylinders 0.5 scfm at balance with 50 psig supply pressure, typical. 1.0 scfm, maximum. 1.5 scfm at balance with 150 psig supply pressure, typical. 3.0 scfm, maximum.
Temperature Limits	–40F to +180F (AP2 □□□0). 0 to +250F (AP2 □□□1). (Determined by material limitation).
Mounting Position Effect	Can be mounted in any position with recalibration.

Vibration	Tested in accordance with MIL STD 167B (ships)
Pneumatic Connections	1/4" NPT on supply, signal and output connections. 1/8" NPT on optional pressure gages.
Size	10.250" x 9.0625" x 4.125". (260.4mm x 230.2mm x 104.8mm).
Weight	9.5 lb (4.3 kg.).
Optional Accessories	PRESSURE GAGES for reading input signal, supply and output pressures. Refer to Table II for part numbers and usage. HIGH GAIN RANGE SPRING available for obtaining a gain factor of 400. Refer to Table III for part numbers. SPEED CONTROL ORIFICES – regulates time constant of Positioner and final control element. Orifices are installed directly into Positioner output ports. Refer to Table IV for part numbers and usage. GAIN SUPPRESSION SPRING for eliminating excessive overshoot of final control element. Refer to Table V for part numbers and usage. POSITIONER MOUNTING KIT for mounting Positioner to direct-or reverse-acting diaphragm actuators only. Refer to Table VI for part numbers. BYPASS VALVE (Pt. No. 5326945-1) for single-acting diaphragm actuator applications. Enables operator to use controller output signal to position actuator directly when servicing Positioner, etc. BLANK CAM (Pt. No. 5327322-1) is available for adapting the Positioner to a particular application if cutting of original cam is not desirable.

*Typical performance characteristics of Positioner mounted on diaphragm actuator (range spring in horizontal position when viewed with cover removed). Actual performance may vary with application.

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.

PRESSURE GAGES TABLE 6

Gage Temperature Range	Range (psig)	Legend*	Gage Part No.
–40F to +160F	0-30	Instrument	5326605-1
	0-160	Supply	5326605-2
	0-160	Output	5326605-3
–40F to +250F	0-30	Instrument	5326605-4
	0-160	Supply	5326605-5
	0-160	Output	5326605-6

*Instrument, Supply and Output gage used on single-acting devices. Instrument and two Output gages used on double-acting devices. There are no provisions for mounting a Supply gage on double-acting devices.

SPEED CONTROL ORIFICE TABLE 8

Orifice Size (in.)	Orifice Part No.
.040"	5327327-1
Blank (drill to suit)	5327327-2

HIGH GAIN RANGE SPRING TABLE 7

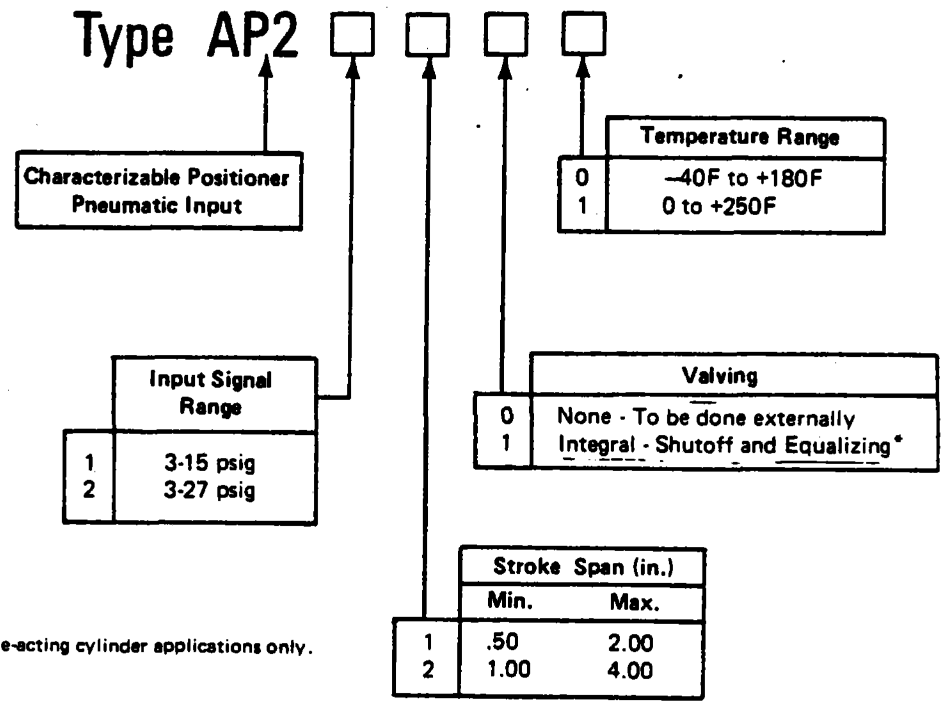
Range Spring Part No.	No. of Coils	Input Signal (psi)	Application
5327330-1	15	3-15	Optional high gain
5327330-2	14	3-27	Optional high gain
		3-15	*Standard gain
5327330-3	11	3-27	*Standard gain

*Standard gain (250-300) range springs are assembled in place and shipped with Positioner.

GAIN SUPPRESSION KIT TABLE 9

Application	Gain Suppression Kit Part No.	
	Std. Gain (250-300)	High Gain (300-400)
Cylinders with 50 in.^{3} or less displacement.	5327328-1	5327328-2
Cylinders with 50 in.^{3} to 200 in.^{3} displacement.	Not Reqd.	5327328-1
Diaphragm actuators with high packing friction.	5327328-1	5327328-2

EXPLANATION OF NOMENCLATURE



Characterizable Positioner Pneumatic Input

Input Signal Range	
1	3-15 psig
2	3-27 psig

Stroke Span (in.)		
	Min.	Max.
1	.50	2.00
2	1.00	4.00

Valving	
0	None - To be done externally
1	Integral - Shutoff and Equalizing*

Temperature Range	
0	−40F to +180F
1	0 to +250F

*For double-acting cylinder applications only.

An "X" as a suffix to TYPE indicates that the Transmitter includes some special feature not covered by the standard Nomenclature.

REPLACEMENT PARTS

Figure 22 is a parts drawing of the Type AP2 Characterizable Pneumatic Positioner. Figure 23 is a parts drawing of the Positioner Assembly.

These figures will normally apply to the unit furnished. However, there may be individual differences in specific assemblies due to:

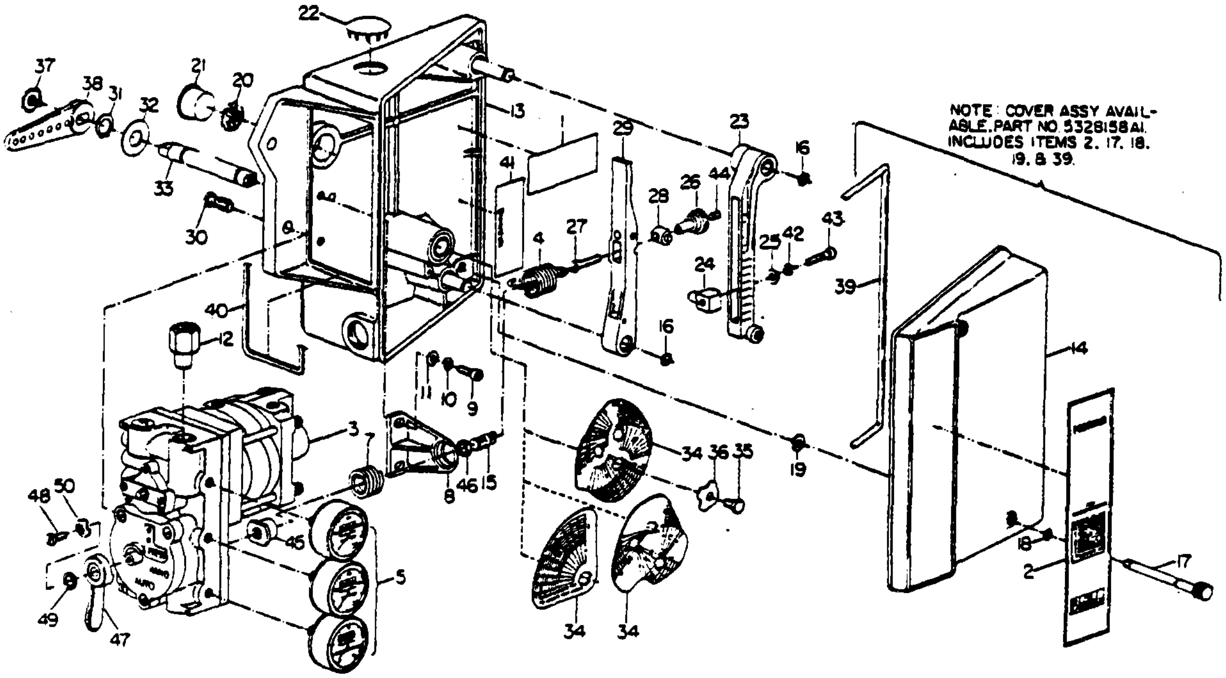
a. Design changes made since the printing of this instruction section.

b. Special design of equipment furnished to make it suitable for special application.

Therefore, when ordering individual parts, assure correct replacement by specifying on the order:

1. Complete nomenclature, code number, part number, series label number and S.O. number of equipment for which parts are desired.

2. The Parts Drawing Number on which each part is illustrated.



NOTE: COVER ASSY AVAILABLE, PART NO. 5328158A1. INCLUDES ITEMS 2, 17, 18, 19, & 39.

ITEM	PART NO.	NAME
1	SEE NOTE	NAMEPLATE
2	SEE NOTE	STYLE PLATE
3	5326600-☐ OR 5328139-☐	POSITIONER RELAY ASSY, SEE PARTS DWG. P88-31
4	SEE TABLE A	RANGE SPRING
5	SEE TABLE B	PRESSURE GAGES (OPTIONAL)
6	SEE TABLE C	GAIN SUPPRESSION KIT (OPTIONAL) INCLUDES ITEMS 7 THRU 11.
7	SEE TABLE D	SPRING
8	5327329-1	RETAINER
9	.250-20x.500	HEX SOC HD STN STL CAP SCR, 2 REQD
10	.250	STN STL REG SPRING LKWASH, 2 REQD
11	19734-18	SMALL WASHER, 2 REQD
12	SEE TABLE E	SPEED CONTROL ORIFICES (OPTIONAL)
13	5327405-2	BASE ASSY
14	5327406-1	COVER
15	197421-1	SPRING RETAINER
16	197164-37	RETAINING RING, 2 REQD
17	197552-1	COVER SCREW, 2 REQD
18	5311428-3	O-RING, 2 REQD
19	198173-16	RETAINING RING, 2 REQD
20	5327419-1	WIRE MESH FILTER
21	1942339-4	CAPLUG
22	19981-12	BUTTON PLUG
23	5327408-1	FOLLOWER ASSY
24	5327440-1	PIVOT ASSY
25	19734-44	SMALL WASHER
26	197423-1	ADJUSTABLE NUT
27	197422-1	EYE BOLT
28	5327332-1	ADJUSTABLE PIVOT
29	5327409-2	SPRING ARM
30	197591-2	PAN HD LONG LOK MACHINE SCR, 2 REQD
31	197164-60	RETAINING RING, 2 REQD
32	19734-45	SMALL WASHER, 2 REQD
33	5326768-1	CAM SHAFT
34	5327239-1	CAM, HALF STROKE (TYPE AP2☐1☐☐ONLY)
	5327240-1	CAM, FULL STROKE (TYPE AP2☐2☐☐ONLY)
	5327322-1	BLANK CAM (OPTIONAL)
35	.250-20x.375	HEX HD STN STL CAP SCR
36	4814-1401-4102	STN STL SHKPRF LKWASH
37	197227-1	SPECIAL HEX HD SEMS SCR
38	5327446-1	DRIVE ARM
39	SEE TABLE F	SEALING CORD (32" REQD)
40	SEE TABLE F	SEALING STRIP (18" REQD)
41	1962883-1	WARNING LABEL
42	.190	STN STL REG SPRING LKWASH
43	.190-32x.875	HEX SOC HD STN STL CAP SCR
44	.190-32x.187	HEX SOC HEADLESS STN STL OVAL POINT SET SCR
45	5327331-1	SIGNAL NUT
46	688460-1	SPECIAL NUT
47	531145981	HANDLE
48	.164-32x.312	LG PAN HD STN STL MACH SCREW
49	.164-32x.312	STN STL TYPE A PLAIN WASHER
50	4808-09-4102	STN STL SHAKEPROOF WASHER

NOTE: SPECIFY ALL INFORMATION ON NAMEPLATE AND STYLE PLATE WHEN ORDERING REPLACEMENT PARTS.

FIGURE 22 - Parts Drawing P88-30,

TABLE A - ITEM 4

RANGE SPRING PART NO.	NO. OF COILS	INPUT SIGNAL (PSI)	APPLICATION
5327330-1	15	3-15	OPTIONAL HIGH GAIN RANGE SPRING
5327330-2	14	3-27	OPTIONAL HIGH GAIN RANGE SPRING
		3-15	STANDARD GAIN RANGE SPRING*
5327330-3	11	3-27	STANDARD GAIN RANGE SPRING*

*STANDARD GAIN (250-300) RANGE SPRINGS ARE ASSEMBLED IN PLACE AND SHIPPED WITH POSITIONER.

TABLE B - ITEM 5

GAGE TEMPERATURE RANGE	RANGE (PSIG)	LEGEND*	GAGE PART NO.
–40F TO +160F	0-30 0-160 0-160	INSTRUMENT SUPPLY OUTPUT	5326605-1 5326605-2 5326605-3
–40F TO +250F	0-30 0-160 0-160	INSTRUMENT SUPPLY OUTPUT	5326605-4 5326605-5 5326605-6

*INSTRUMENT, SUPPLY AND OUTPUT GAGE USED ON SINGLE-ACTING DEVICES. INSTRUMENT AND TWO OUTPUT GAGES USED ON DOUBLE-ACTING DEVICES. THERE ARE NO PROVISIONS FOR MOUNTING A SUPPLY GAGE ON DOUBLE-ACTING DEVICES.

TABLE C - ITEM 6

APPLICATION	GAIN SUPPRESSION KIT PART NO. 5327328-1		GAIN SUPPRESSION KIT PART NO. 5327328-2	
	POSITIONER WITH STANDARD GAIN (250-300)	POSITIONER WITH HIGH GAIN (300-400)	POSITIONER WITH STANDARD GAIN (250-300)	POSITIONER WITH HIGH GAIN (300-400)
CYLINDERS WITH 50 in.^{3} OR LESS DISPLACEMENT.	X			X
CYLINDERS WITH 50 in.^{3} TO 200 in.^{3} DISPLACEMENT.		X	NOT REQUIRED	
DIAPHRAGM ACTUATORS WITH HIGH PACKING FRICTION.	X			X

TABLE D - ITEM 7

SPRING PART NO.	USAGE
5326594-1	INCLUDED IN GAIN SUPPRESSION KIT (ITEM 6) PART NO. 5327328-1
5326594-2	INCLUDED IN GAIN SUPPRESSION KIT (ITEM 6) PART NO. 5327328-2

TABLE E - ITEM 12

OPTIONAL SPEED CONTROL ORIFICE PART NO.	ORIFICE SIZE (IN.)
5327327-1	.040"
5327327-2	BLANK (DRILL TO SUIT)

TABLE F

TYPE	ITEM 39	ITEM 40	MATERIAL
AP2☐☐☐0	6614522-1H	5327724-1H	NEOPRENE
AP2☐☐☐1	6614522-2H	5327724-2H	SILICONE

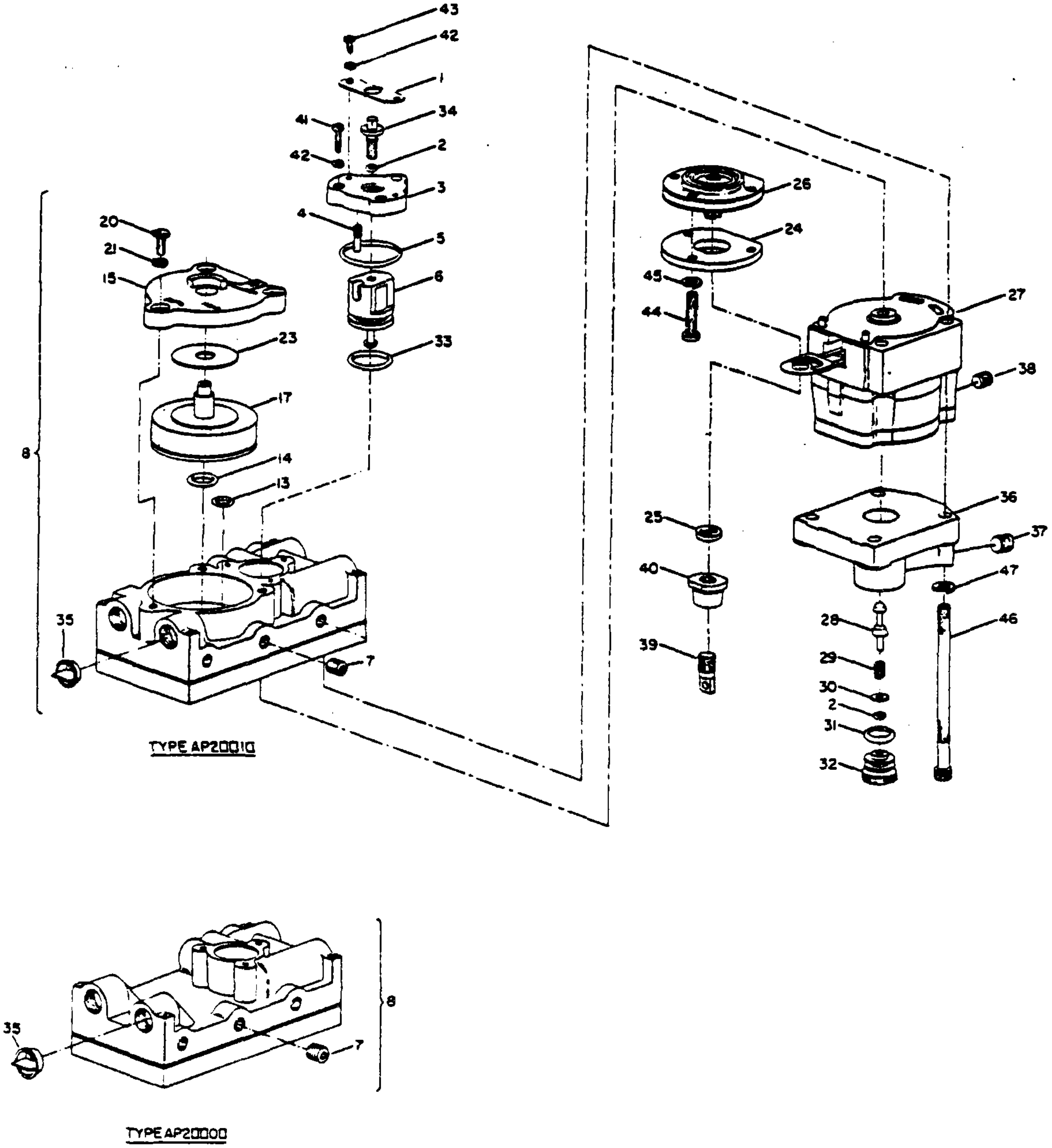


FIGURE 23 - Parts Drawing P88-31,

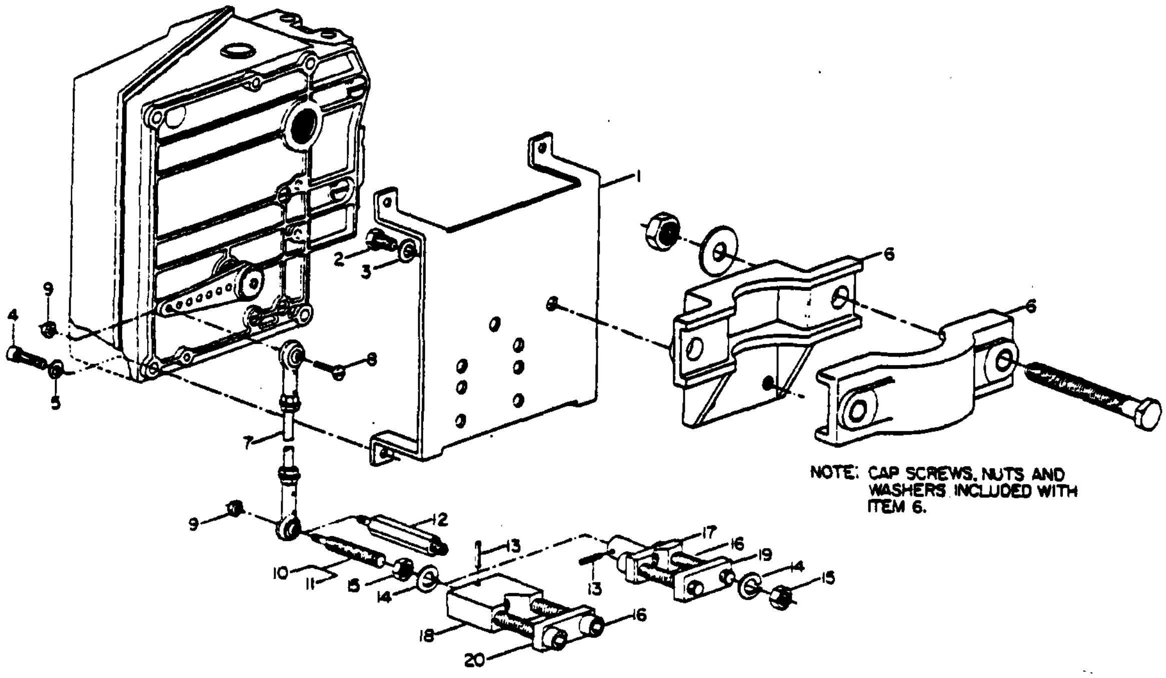
ITEM	PART NO.	NAME
1	5326582-1	SCREW RETAINER
2	SEE TABLE	O-RING, 2 REQD
3	5326783-1	VALVE COVER
4	197553-1	DOWEL PIN
5	SEE TABLE	O-RING
6	SEE TABLE	VALVE SEAT ASSY
7	1951041-2	SOCKET HD PIPE PLUG, 3 REQD
8	5326775-1	MANIFOLD ASSY FOR TYPE AP2☐☐0☐
	5326775-2	MANIFOLD ASSY FOR TYPE AP2☐☐10 ONLY (INCLUDES ITEMS 13 THRU 23, 7, 35)
	5326775-3	MANIFOLD ASSY FOR TYPE AP2☐☐11 ONLY (INCLUDES ITEMS 13 THRU 23, 7, 35)
13	SEE TABLE	O-RING, 2 REQD
14	SEE TABLE	O-RING, 2 REQD
15	5326773-1	VALVE RETAINER ASSY
17	5326792-1	VALVE ASSY
20	.190-32x.500	PAN HD STN STL MACH SCR, 3 REQD
21	.190	STN STL SPRG LKWASH, 3 REQD
23	197562-1	.015" SHIM, AS REQD AT ASSY .020" SHIM, AS REQD AT ASSY .025" SHIM, AS REQD AT ASSY
24	5326593-1	SIGNAL COVER
25	5326778-1	RETAINER
26	SEE TABLE	SIGNAL DIAPHRAGM ASSY
27	SEE TABLE	RELAY ASSEMBLY*
28	5326580-1	VALVE
29	5326599-1	VALVE SPRING
30	19734-20	SMALL WASHER
31	SEE TABLE	O-RING
32	5326781-1	VALVE PLUG
33	SEE TABLE	O-RING
34	5326575-1	ADJUSTMENT SCREW
35	1945750-1	PULL PLUG, 4 REQD
36	5326603-1	BASE MANIFOLD ASSY (INCLUDES ITEM 37)
37	1951041-2	SOCKET HD PIPE PLUG, 2 REQD
38	1951041-3	SOCKET HD PIPE PLUG
39	197421-1	SPRING RETAINER
40	5327331-1	SIGNAL NUT
41	.112-40x.500	FILLISTER HEAD STN STL MACH SCR, 3 REQD
42	.112	STN STL REG SPRING LKWASH, 5 REQD
43	.112-40x.312	PAN HD STN STL MACH SCR, 2 REQD
44	.190-32x1.00	PAN HD MACH SCR, 3 REQD
45	.190	STN STL REG SPRING LKWASH, 3 REQD
46	.250-28x4.00	HEX SOC HEAD STN STL CAP SCR, 4 REQD
47	.250	STN STL REG SPRING LKWASH, 4 REQD

*INCLUDES ITEM 38.

TYPE	RELAY ASSY PART NO.	ITEM 2	ITEM 5	ITEM 6	ITEM 13	ITEM 14	ITEM 26	ITEM 27	ITEM 31	ITEM 33
AP2☐☐00	5326600-5	1951398-1	1951398-5	5326785-1	OMIT	OMIT	5326788-1	5326790-1	1951398-3	1951398-4
AP2☐☐01	5326600-6	1951398-6	1951398-10	5326785-2	OMIT	OMIT	5326788-2	5326790-2	1951398-8	1951398-9
AP2☐☐10	5328139-1	1951398-1	1951398-5	5326785-1	1951398-2	1951398-3	5326788-1	5326790-1	1951398-3	1951398-4
AP2☐☐11	5328139-2	1951398-6	1951398-10	5326785-2	1951398-7	1951398-8	5326788-2	5326790-2	1951398-8	1951398-9

SPARE PARTS KITS TYPE	ITEM 2	ITEM 5	ITEM 6	ITEM 13	ITEM 26	ITEM 28	ITEM 29	ITEM 30	ITEMS 14 & 31	ITEM 33
KIT NO. 258033-5										
AP2☐☐01	1951398-6	1951398-10	5326785-2		5326788-2	5326580-1	5326599-1	19734-20	1951398-8	1951398-9
KIT NO. 258033-6										
AP2☐☐11	1951398-6	1951398-10	5326785-2	1951398-7	5326788-2	5326580-1	5326599-1	19734-20	1951398-8	1951398-9
KIT NO. 258033-7										
AP2☐☐00	1951398-1	1951398-5	5326785-1		5326788-1	5326580-1	5326599-1	19734-20	1951398-3	1951398-4
KIT NO. 258033-8										
AP2☐☐10	1951398-1	1951398-5	5326785-1	1951398-2	5326788-1	5326580-1	5326599-1	19734-20	1951398-3	1951398-4

Positioner Relay Assembly, Pt. No. 5326600-☐ and 5328139-☐



NOTE: CAP SCREWS, NUTS AND WASHERS INCLUDED WITH ITEM 6.

NOTE: SEE TABLE FOR MOUNTING KIT PARTS REQUIRED.

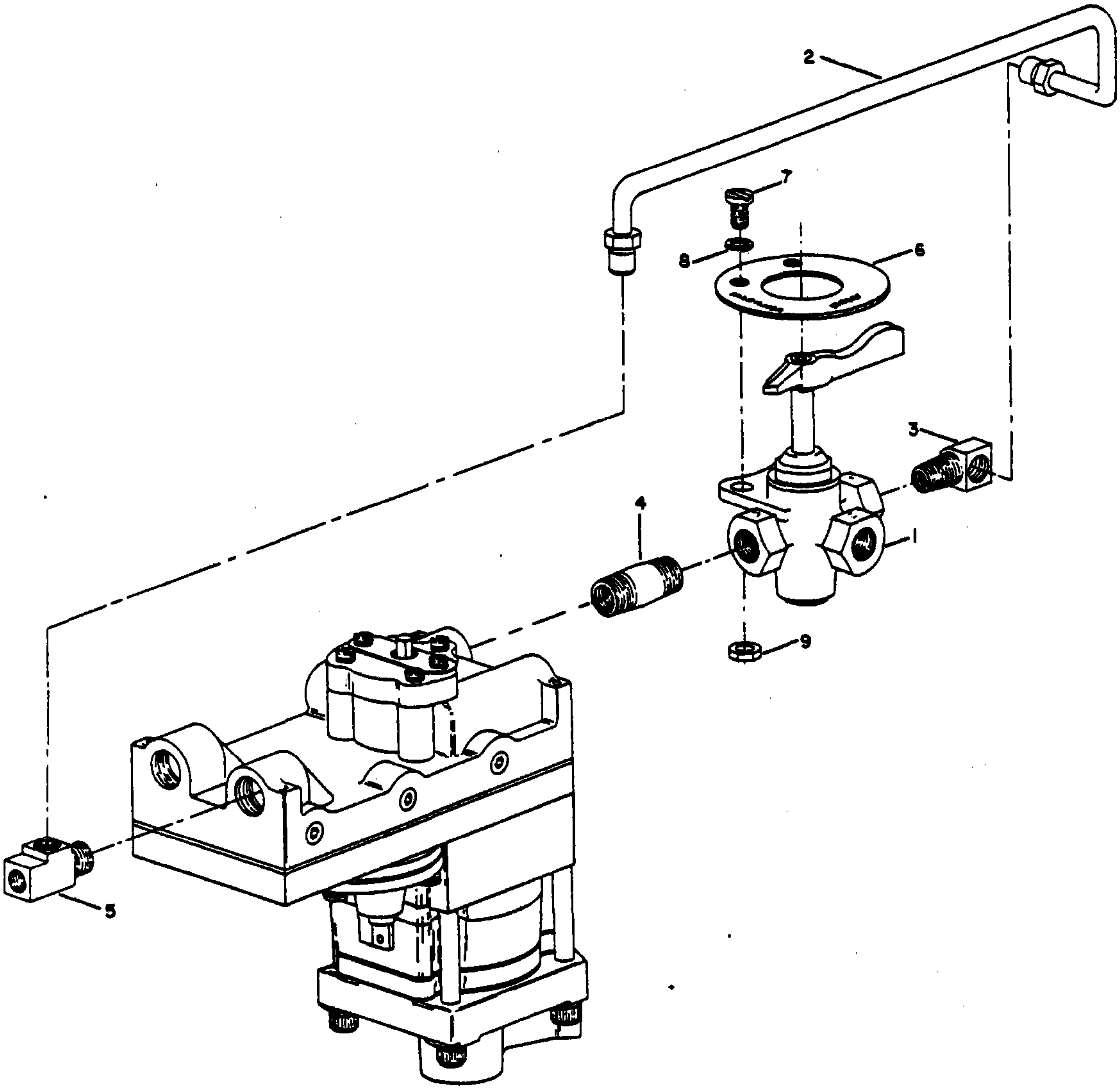
ITEM	PART NO.	NAME	ITEM	PART NO.	NAME	ITEM	PART NO.	NAME
1	5327569-1	POSITIONER MTG BRKT	9	197120A5	STOP NUT, 2 REQD	16	.375-16x1.50	HEX SOC HD CAP SCR, 2 REQD
2	.312-18x.625	HEX SOC HD CAP SCR, 2 REQD	10	5311690-1	ADJUSTABLE STUD (2.687" LG)	17	5311687-2	STEM CLAMP (.375"–.750" DIA)
3	.312	SPRING LKWASH, 2 REQD	11	5311690-2	ADJUSTABLE STUD (3.437" LG)	18	5312483-1	STEM CLAMP (.750"–1.0" DIA)
4	.250-20x1.0	HEX SOC HD CAP SCR, 4 REQD	12	5319500-1	ADJUSTABLE STUD (3.406" LG)	19	5311691-1	CLAMP PLATE (.375"–.750" DIA)
5	.250	SPRING LKWASH, 4 REQD	13	.125x.750	GROOV PIN	20	5312471-1	CLAMP PLATE (.750"–1.0" DIA)
6	SEE NOTE	MTG BRKT (FOR VALVE YOKE WITHOUT MTG BOSS)	14	.375	SPRING LKWASH, 3 REQD			
7	5312449-4	CONNECTING LINK (CUT TO FIT)	15	.375-16	HEX JAM NUT, 3 REQD			
8	.190-32x.188	PAN HD MACH SCR						

NOTE: BRACKET AND ATTACHING HARDWARE NOT INCLUDED IN MOUNTING KIT. IF NECESSARY TO MOUNT POSITIONER ON VALVE YOKE WITHOUT MOUNTING BOSSES, ORDER OPTIONAL MOUNTING BRACKET PT. NO. 5313138-1.

MTG. KIT PART NO.	USAGE	VALVE STEM DIAMETER	ITEM																		
			1	2	3	4	5	7	8	9	10	11	12	13	14	15	16	17	18	19	20
5327321-1	BAILEY	.750"-1.0"	X	X	X	X	X	X	X	X	X			X	X	X	X		X		X
5327321-2	BAILEY	.375"-.750"	X	X	X	X	X	X	X	X	X			X	X	X	X	X		X	
5327321-3	BAILEY	.750"-1.0"	X	X	X	X	X	X	X	X		X		X	X	X	X		*X		X
5327321-4	BAILEY	.375"-.750"	X	X	X	X	X	X	X	X		X		X	X	X	X	X		X	
5327321-5	FISHER	.750"-1.0"	X	X	X	X	X	X	X	X			X								
5327321-6	FISHER	.375"-.750"	X	X	X	X	X	X	X	X			X								

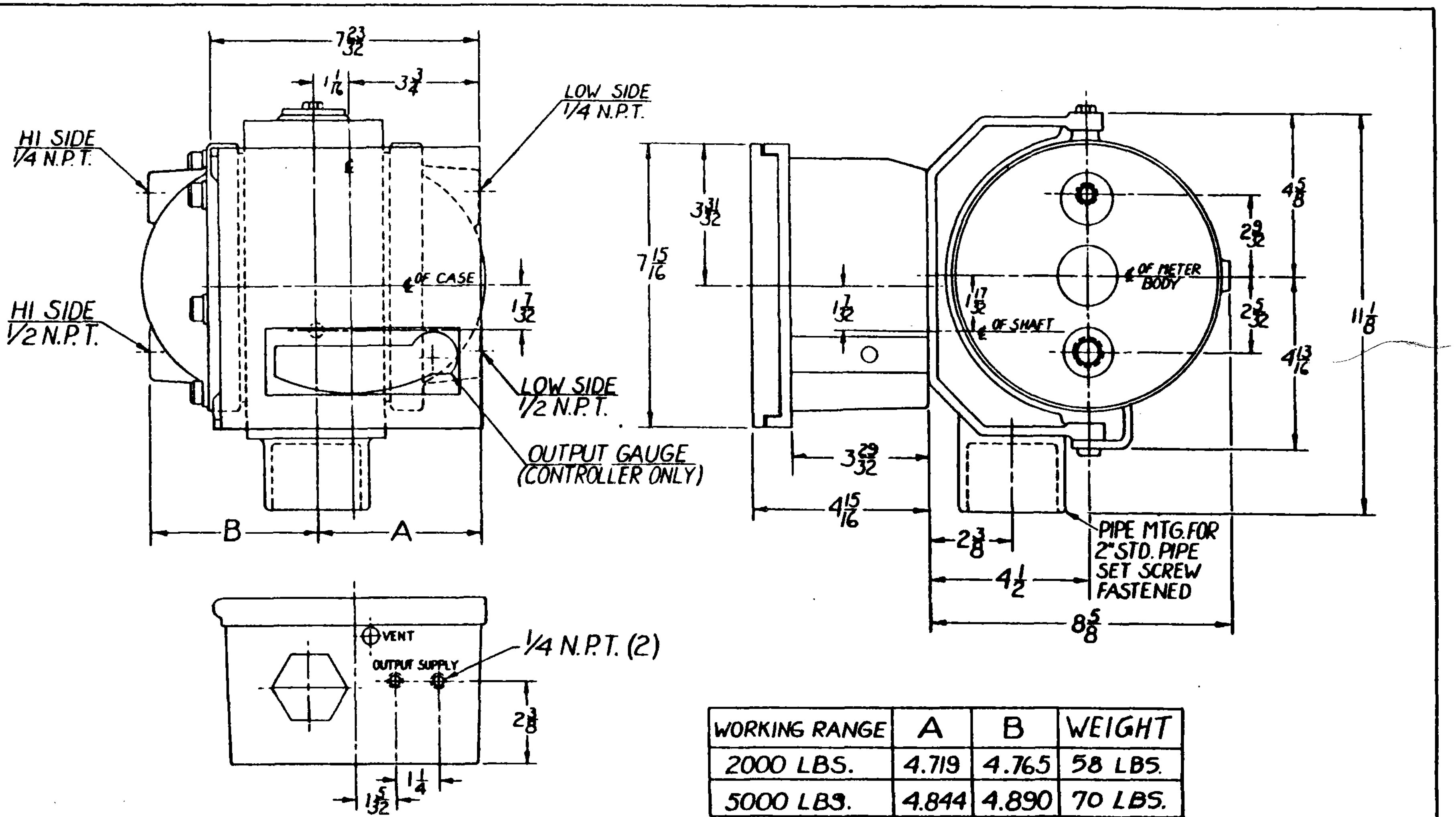
*FOR DIRECT OR REVERSE-ACTING DIAPHRAGM ACTUATOR APPLICATIONS ONLY.

FIGURE 24 - Parts Drawing P88-28, Optional Mounting Kit, Pt. No. 5327321-☐



ITEM	PART NO.	NAME
1	5327226-1	3-WAY VALVE
2	5326946-1	AIRLINE CONNECTION ASSY
3	195159-3	ELBOW CONNECTOR
4	195727-2	BRASS NIPPLE
5	195171-3	WEATHERHEAD TEE
6	1962833-1	DESIGNATION PLATE
7	.190-32x.375	PAN HD MACH SCR, 2 REQD
8	NO. 10	REG SPRING LKWASH, 2 REQD
9	.190-32	HEX NUT, 2 REQD

FIGURE 25 - Parts Drawing P88-24, Optional Bypass Valve Assembly for Single-Acting Diaphragm Actuators, Pt. No. 5326945-1.



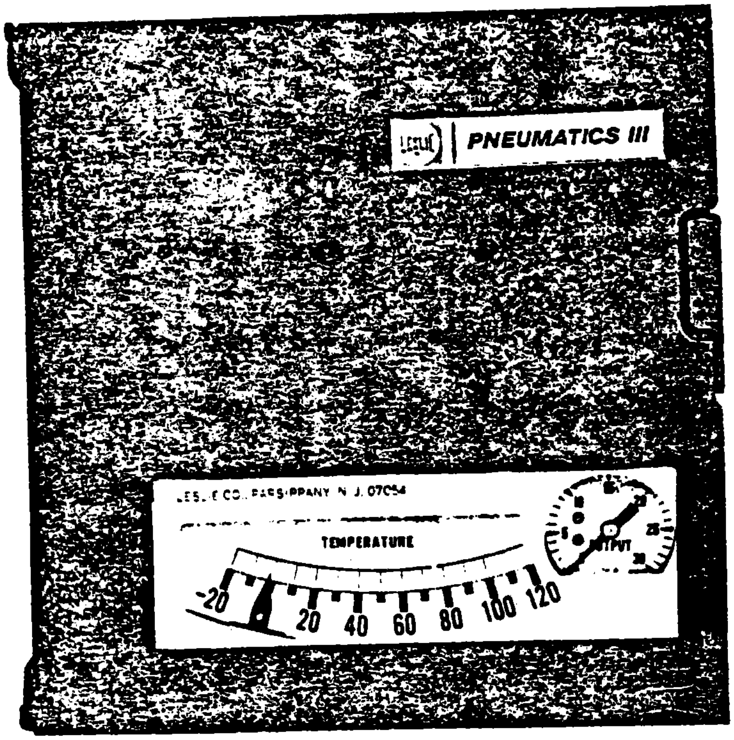
WORKING RANGE	A	B	WEIGHT
2000 LBS.	4.719	4.765	58 LBS.
5000 LBS.	4.844	4.890	70 LBS.

LESLIE CO.
PARSIPPANY NEW JERSEY 07054

OVERALL DIMENSIONS OF PNEUMATICS III
CONTROLLER OR TRANSMITTER WITH
AMERICAN DRI-FLOW METER BODY,
PIPE MTG. ONLY

DATE	APP'D.	D'W'N	DWG. NO.	23/1.4.6
3-19-75	KH	MG		

12.23-411



INSTRUCTIONS FOR INSTALLATION, START-UP, OPERATION AND MAINTENANCE

SERIES 2310

INDICATING PNEUMATIC CONTROLLER

LESLIE

PNEUMATICS III

LESLIE CO., PARSIPPANY, N. J. 07054

Bailey Meter Company, Wickliffe Ohio 44092, a subsidiary of Babcock & Wilcox, U.S.A.

Bailey Meter Australia Pty. Ltd., Regents Park, N.S.W., Australia
Bailey do Brasil, Sao Paulo, Brazil
Bailey Meter GMBH, Mannheim, West Germany

Bailey Meter Company Ltd., Pointe-Claire, Quebec, Canada
Bailey Japan Company, Ltd., Tokyo, Japan
Representatives in Other Principal Cities

TABLE OF CONTENTS

NOTE: This instruction is specific to controllers with 3-15 psi outputs. For 3-27 psi outputs the equivalent values are given in parentheses.

Supply: 20(30) psi
Output Range: 3-15(3-27) psi
Midscale: 9(15) psi

SECTION I GENERAL DESCRIPTION

The Model 2310 Indicating Pneumatic Controller is available with gain, gain-plus-integral, and gain-plus-integral-plus-derivative control modes. Gain is continuously adjustable from .25 to 50 or 2.5 to 100. In integral models a single turn valve provides continuous adjustment from .01 to 85 repeats per minute.

In derivative models a single turn valve provides continuous time adjustment from 0 to 30 minutes.

The instrument consists of three major units: the measuring system, the pointer and error detection mechanism, and the control unit. Any one of these can be removed separately from the case. The control unit contains, in a compact package, the inner valve, gain adjustment, amplifying pilot valve, the feedback bellows and integral and/or derivative mechanisms.

As the measuring element moves with changes in the controlled variable, the relationship between the inner valve and flapper is varied, thus altering the back pressure which in turn is amplified by the self-contained non-bleed type pilot valve, producing the output air pressure to the control valve. These changes in output air pressure also cause changes in the length of the feedback bellows which through a simple lever system tends to restore the original relation between inner valve and flapper. The amount of input and feedback motions to the flapper are adjustable by rotating the cover of the control unit, thus providing gain values of .25 to 50 or 2.5 to 100. A scale and pointer are provided showing values.

To go from Direct Action (output air pressure increasing with an increase in value of measured variable) to Reverse Action (output air pressure decreasing with increase in value of measured variable), it is merely necessary to rotate the cover of the control unit from the Direct portion of the scale to Reverse.

The integral model instrument is similar to the gain model except that a variable restriction is provided which allows the output air pressure to be gradually applied to the inside as well as the outside of the feedback bellows, thus tending to remove the feedback. Integral rates from .01 to 85 repeats per minute are available.

Derivative time is from 0 to 30 minutes. All controllers with derivative action contain a by-pass which allows complete elimination of the derivative response. This is useful for process start-up.

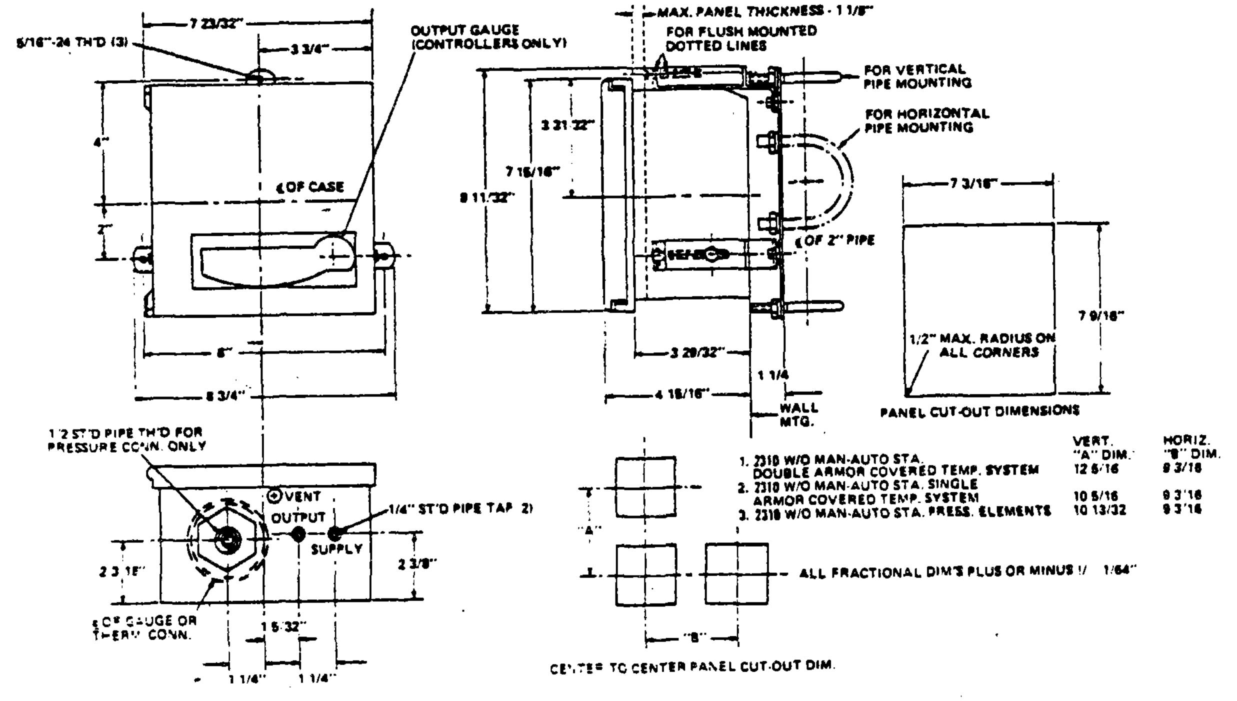


FIGURE 1. OVERALL DIMENSIONS

A. ACCESSORIES

Several variations are available in the instrument which must be specified at the time of ordering. These include provisions for external setpoint adjustment, pneumatically operated setpointer, vented case for gas operation, blowout disk and provisions for pipe mounting or valve mounting. External two-position manual-automatic control stations are also available. Also 30 psi supply on gain and integral models and 60 psi supply on gain model only are available.

SECTION II INSTALLATION

A. MOUNTING

The standard controller may be mounted on a panel or wall. Universal mounting brackets are provided for either location. Choose a place as free as possible from dust, dirt, vibration, corrosive fumes, and extremes of temperature.

For panel mounting, the cut-out dimensions are 7-9/16" high x 7-3/16" wide with square to 1/2" radii corners. (See Figure 1)

Flow meters and differential pressure instruments have a socket for a 2" pipe fitting to permit instrument to be mounted on a floor stand, panel, or wall support.

Remove any string, rubber bands, cardboard guards, etc., that are used for packing and shipping the instrument.

If possible, locate the instrument and all piping where the temperature never goes below freezing. Condensed moisture may freeze in any part, stopping the controller. Insulate the lines if necessary.

B. AIR CONNECTIONS

The air connections, one for supply and one for output, are located on the bottom of the case. Located near them is a bleed vent which must be left open.

Remove and discard all plastic plugs used to close the air connections during shipment. All connections accommodate standard 1/4" pipe fittings.

Make pipe connections according to the piping diagram furnished with these instructions.

C. SUPPLY AIR

It is strongly recommended that the air supply to the controller be clean, dry, and oil free. Air compressors should be equipped with air filters and condensate traps and should be frequently serviced. Most difficulties in air control systems are caused by dirty, wet, or oily air supplies.

The supply air pressure to the standard instrument must be 20 pounds per square inch (psi).

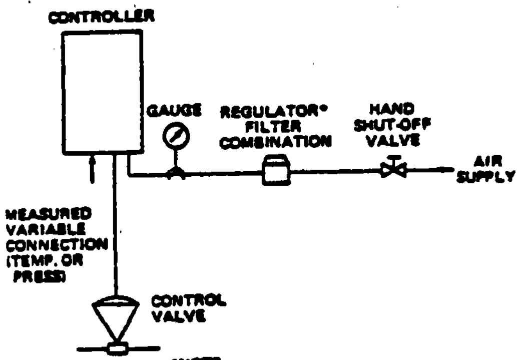
The controller is equipped with a screen type filter in the supply connection. However, it is recommended that a reducing valve and filter be used in the supply line to supply clean 20 psi air to the instrument. A combination unit such as a Leslie Airmate or equivalent may be used instead of the two separate units. This combination unit has a maximum capacity of 6 cubic feet of air per minute at 60 psi supply pressure. Minimum air pressure to the reducer must be not less than 25 psi. Maximum air pressure to the reducer must not exceed 250 psi.

The controller consumes less than 0.1 cubic feet of free air per minute.

The controller is capable of delivering greater than 3.0 CFM and exhausting greater than 4.0 cubic feet of free air per minute.

D. SUPPLY AIR PIPING

A typical installation is shown in Figure 2. Install the supply air lines to slope away from the controller so that condensed moisture cannot drain into the instrument. Connect the instrument supply air line to the top of the main air supply line to prevent condensate from entering.



*NOTE: THE COMBINATION REGULATOR AND FILTER MAY BE REPLACED BY SEPARATE UNITS IF DISIRED.

FIGURE 2. TYPICAL PIPING DIAGRAM

To avoid trouble from pipe scale or rust which occur in iron pipe, it is recommended that 3/8" O.D. annealed copper tubing and compression fittings, or 1/4" brass pipe be used for both supply air and output air lines. Ream the ends of all tubing to remove burrs. Clean scale, rust, dirt, and oil out of all pipe or tubing and low them out thoroughly with . compressed air before installation.

Manual Shut-off Valve. It is recommended that an inexpensive valve be installed in the supply air line, upstream from the reducer, so that the air may be shut off by hand for service to the controller, filter, reducing valve, etc.

E. OUTPUT AIR PIPING

1/4" O.D. copper tubing and compression fittings are recommended for the output air piping on most installations. Where fast response is a critical factor, 3/8" O.D. copper tubing and compression fittings should be used.

Output air lines muct be absolutely air tight to obtain accurate control. Pipe Sealing compound should be used on all threaded connections.

F. CONTROL VALVE

In general, the control valve should be at least one size smaller than the control-agent pipe. This assures that the largest part of the pressure drop through the control-agent supply system will occur at the control valve. Quick opening and disk-type valves should not be used where proportional control is desired.

All standard Leslie controllers which have proportional action are designed for use with final control elements which operate from one end of their stroke to the other through air pressure signals of 3 to 15 psi as recommended by the Industrial Instruments and Regulators Division of the ASME.

G. VALVE BY-PASS CONNECTIONS

Some processes cannot be shut down for service to final control elements; in such cases a suitable by-pass arrangement should be installed.

H. DIRECT AND REVERSE-ACTION ADJUSTMENT

The model 2310 controller can be easily switched from direct to reverse-action control by merely rotating the gain adjustment (control unit cover) to the desired action.

The direction of the controller action is governed by the action of the control valve selected. The controller action must be that which moves the control valve in the proper direction to correct the supply of control agent which will oppose changes in the controlled variable.

1. A Normally Open Valve (direct-acting) is open when there is no air pressure on it and closes with an increase of pressure.

2. A Normally Closed Valve (reverse-acting) is closed when there is no air pressure on it and opens with an increase of pressure.

3. A Direct-Acting Controller increases the output air pressure as the value of the measured variable increases.

4. A Reverse-Acting Controller decreases the output air pressure as the value of the measured variable increases.

The direction of action of the final control element is generally governed by "failsafe" considerations. This means that a control valve should be selected which will move in the safest direction in case of failure of the compressed air supply. What this safe condition is will depend upon conditions of the process concerned.

SECTION III OPERATION

Do not start the controller until the pointer of the instrument indicates that the measuring system is working correctly and accurately. See separate instructions covering the measuring system.

A. STARTING CONTROLLER WITH GAIN ONLY

1. Set the gain at 2. Be sure action is correct (direct or reverse). Turn on the supply air and adjust the reducing valve until the supply air gage reads 20 psi. Adjust the setpoint index to the desired value on the scale. Turn on the control-agent supply to the process, that is, steam, fuel, water, etc. The process is now under automatic control, and the correct gain may be determined as soon as the process has come up to the control point.

2. Adjusting the Gain. Increase the gain in small steps, such as from 2 to 3 to 4 to 5 to 10. If normal load changes to the process are too small or too infrequent during this adjustment period, the effect of load changes can be artificially produced by shifting the setpoint index upscale and downscale about 1/8 inch from the value at which the controller will be used. Allow ample time between each change in the gain for the full effect of the adjustment to be observed (by watching the indicating

CODE

1. Indicating Pointer
2. Coarse Zero Adjustment
3. Span Adjustment
4. Disconnect
5. Linearity Adjustment
6. Indicating Pointer Zero Adjustment
7. Setpoint Index Zero Adjustment
8. Pneumatic Output Adjustment
9. Gain Adjustment
10. Restriction Clearing Button
11. Integral Adjustment
12. Output Pressure Gauge
13. Setpoint Index

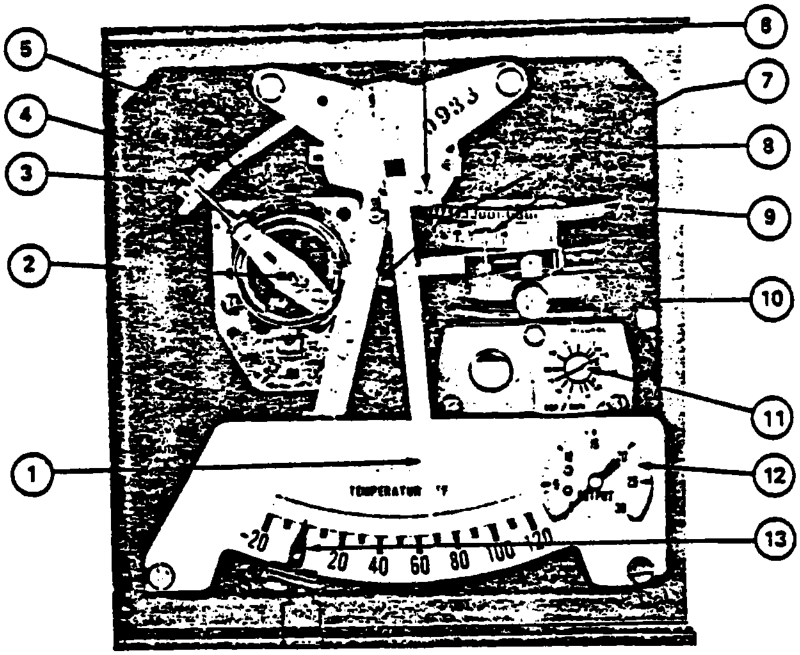


FIGURE 3. INTERIOR VIEW OF CONTROLLER

pointer). In general, the highest gain that will not produce objectionable cycling gives the best control.

B. STARTING CONTROLLER WITH GAIN-PLUS-INTEGRAL ACTION

1. Set the integral rate at the lowest value by turning the integral valve adjustment in a counterclockwise direction.

After setting the integral rate at the lowest value, adjust the gain as in paragraph A2 above.

2. Adjusting the Integral Rate. Increase the integral rate a small amount to .10 (clockwise rotation of adjustment). Wait for the change in integral rate to show up on the scale. The setting of the reset rate will depend on the control characteristics of the individual process and must be determined by slowly adding more integral, one step at a time, until the best control is obtained. In general, use the fastest integral rate that can be applied without increasing instability.

C. STARTING CONTROLLER WITH GAIN-PLUS-INTEGRAL-PLUS-DERIVATIVE ACTION

The procedure for starting three-mode controllers is the same as that for integral models except that the derivative time is established before the integral rate is determined.

1. Turn derivative adjustment to by-pass position.

2. Set the integral rate at the lowest value and adjust gain as in paragraph A2 above.

3. Open derivative valve wide, by turning adjustment in a counterclockwise direction. Adjust the gain as in paragraph A2 above.

4. Adjusting the Derivative Time. Adjust the Derivative valve to .02 time.

Produce small load changes by shifting the setpoint index 1/8 inch upscale and downscale from the desired value. Increase derivative time step by step. After each change in derivative time, wait for the effect of the change to show up on the indicating scale. The purpose of derivative action is to stabilize control on a relatively difficult process. Thus, the best derivative setting must be found for each application. After the correct derivative setting has been found, again try increasing the gain a little. The addition of derivative action usually permits the use of a higher gain value. Derivative action is not required on an easy to control single-capacity process.

5. After the correct derivative time has been found, again try increasing the gain. Next, adjust the integral rate as in paragraph B2.

SECTION IV SERVICE

In discussing service and maintenance, we assume that the measuring system of the controller is working properly. If not, repair it before attempting to service the control system.

A. ROUTINE MAINTENANCE

1. Air-Filter Sump. Moisture, oil and dirt which collect in the bottom of the air-filter sump should be drained out daily. Open the drain valve for a few seconds with the supply air turned on.

2. Lubrication. No lubrication of any sort is required. If the bearings become sticky, clean them with Inhibisol.

B. TROUBLESHOOTING

Unless there is an obvious fault in the air controller, a thorough check of the process, measuring system, and final control element should be made first. The following check list can be used as a guide for the systematic search for possible trouble in the air controller:

1. Symptom. Output air pressure (as shown on the output air gage) is continuously high, regardless of the position of the setpoint index or pointer.

Possible Faults:

The inner valve may be plugged or the restriction screw may not be fully seated--causing high back pressure.

The inner valve can be cleaned by injecting cleaning fluid in the restriction opening. First shut off the air supply, then remove the cleanable restriction assembly, clean inner valve. Reassemble restriction assembly and tighten securely. The effect of turning off supply air can be done by moving the setpoint index to the position of minimum output air pressure.

2. Symptom. Output air pressure (as shown on the output air gage) is continuously low, regardless of the position of the setpoint index or pointer.

Possible Faults:

Control-valve diaphragm is punctured; the output air line leaks; the plunger in the inner valve is jammed, letting air leak out; the restriction may be plugged.

The restriction may be cleaned by simply using the cleanable wire built in the restriction.

3. Symptom (with Integral Action). Slow integral rate cannot be obtained, or resetting occurs even with the integral valve closed.

Possible Fault:

Integral valve may be leaking due to damage, necessitating replacement.

4. Symptom (with Integral Action). Fast integral rate cannot be obtained.

Possible Fault:

Leakage in integral piping or feedback bellows connection; integral valve may be plugged. Remove valve and clean very carefully with cleaning fluid.

C. CONTROLLER ALIGNMENT CHECK (See Fig. 4)

Connect a 20(30) psi air supply to instrument supply connection. Disconnect linearity adjustment (item 5, fig. 3) from span adjustment (item 3, fig. 3) using disconnect (item 4, fig. 3). Move indicating pointer (item 1, fig. 3) to mid-scale and hold with paper clip, tape, etc. NOTE: If output is not connected to process, then output must be plugged off with length of tubing or oscillation may occur.

Proceed to steps 1, 2, 3, or 4 below as required.

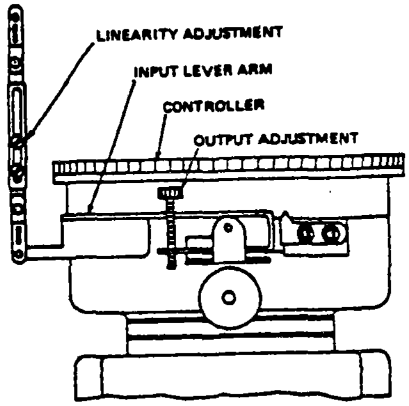


FIGURE 4. CONTROLLER ALIGNMENT

1. On Gain Controllers. Set gain at 2. Move index to coincide with the indicating pointer. Output pressure should be 9 psi. If it is not 9 psi, turn screw (item 8, fig. 3) so that the output is 9 psi. Coarse adjustment of linearity adjustment (fig. 4) may be required.

Next, set gain at 5. Output pressure should be 9 psi ± .5 psi. Set gain at .3. Output pressure should be 9 psi. If output at gain settings of 5 and .3 are not within the above limits, the control unit will have to be recalibrated.

2. On Gain-plus-Integral Controllers. Set gain at 2. Open integral valve wide to 85 rpm and adjust the set-point for 9 psi. Hold for 15 seconds and close integral valve to seal 9 psi in the feedback bellows.

Move the setpoint index to coincide with the indicating pointer. Output pressure should be 9psi. If the output drifts, then the integral valve is not shutting off completely. If the output pressure is not 9 psi after the above procedure, turn screw (item 8, fig.3) so that the output pressure is 9 psi. Coarse adjustment of linearity adjustment (fig. 4) may be necessary.

Next, set gain at 5. Output pressure should be 9 psi ± .5 psi. Set gain at .3. Output pressure should be 9 psi. If output at gain settings of 5 and .3 are not within the above limits, the control unit will have to be recalibrated.

3. On Gain-plus-Integral-plus-Derivative Controllers. Turn derivative adjustment to by-pass position. Proceed as for gain controllers as in paragraph C1 above.

After the above check has been completed, adjust derivative valve to .02 gain at 2. Open derivative valve to 30 and adjust the setpoint to obtain an output of 9.0 psi. After about 15 seconds, with an output of 9.0 psi, close the derivative valve to seal the 9.0 psi pressure in the derivative bellows.

Move the setpoint index to coincide with indicating pointer. Output pressure should be 9 psi. If the output drifts, then the derivative is not shutting off completely. If the output pressure is not 9 psi after the above procedure, turn screw (item 8, fig. 3) so that the output pressure is 9 psi.

Next, set gain at 5. Output pressure should be 9 psi ± .5 psi. Set gain at .3. Output pressure should be 9 psi. If output at gain gettings of 5 and .3 are not within the above limits, the control unit will have to be recalibrated. Then proceed as for integral controllers in paragraph C2.

D. REMOVAL OF CONTROL UNIT

1. Remove indicating scale.

2. Disconnect input lever arm of control unit form the link connected to pointer mounting.

3. Loosen the two control unit mounting screws and lift the control unit out.

E. REPLACING A CONTROL UNIT

1. Remove indicating scale.

2. On temperature models, if the indicating pointer is in the way, disconnect the measuring element link at point 4, fig. 3.

3. Install control unit in case.

CAUTION: Avoid holding control unit by gain adjustment cap when installing unit as this may damage the internal parts of the unit and destroy calibration.

4. Screw the control unit mounting screws in tightly so that control unit is flush against back of case.

5. Connect the link from the pointer mounting to the input lever arm of the control unit. Also reconnect measuring element linkage.

6. Connect a 20 psi supply to instrument supply connection and proceed to check controller alignment as outlined in Section IV, paragraph C.

F. CYCLING CAUSED BY CONTROL VALVE

1. Friction and Lost Motion. Cycling control can be caused by mechanical hysteresis or backlash in the final control element or power unit. A sticking control valve will usually produce a cycling chart record of small amplitude with a distinct time interval between each cycle. Control valves, pneumatic operators, hydraulic cylinders and other final-type elements and power units must be correctly lubricated and adjusted periodically to eliminate friction and lost motion.

2. Wrong Control-Valve Size. In general, the control valve should be one size or more smaller than the control-agent pipe. This assures that the largest part of the pressure drop through the control-agent supply system will occur at the control valve.

Control valves (or other final control elements) should never be completely closed or opened by the controller except during the start up of the process. During normal operation, a valve that is almost always closed is obviously too large, and a valve that is almost always wide open is too small. A control valve is too small only if it cannot pass enough control agent, when wide open, to maintain the variable at the desired value under full load on the process.

SECTION V
CONTROLLERS WITH BATCH INTEGRAL

On automatic start-up, a controller with gain plus integral (reset) response will generally lag for long periods and overshoot the control point. With batch integral added, startup will be fast, but with no overshoot, providing the controller modes are properly tuned.

The batch integral action is accomplished by inserting a small diaphragm actuated valve in the integral system (see fig. 5) which vents the integral pressure to atmosphere when the controller output is 15 psi or more. The valve is designed for a reverse acting controlle only. For direct acting controllers, it

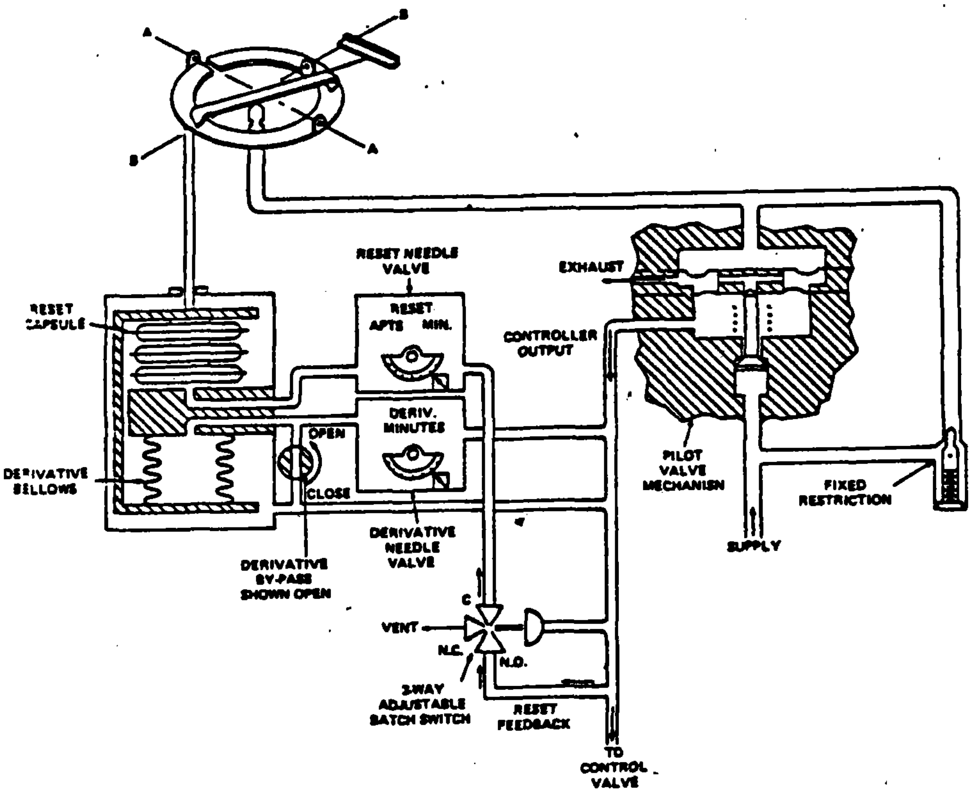


FIGURE 5

would be necessary to inject 20 psi into the integral system (rather than vent it) when the controller output is 3 psi or less.

While figure 5 illustrates a 3-mode controller with batch integral, generally only a 2-mode controller (gain plus batch integral) is used.

On applications where on-stream load changes are not sizeable, very good start-ups without overshoot could also be obtained with gain plus derivative control.

The above features are available on all Leslie Pneumatics III lines.

SECTION VI CALIBRATION OF LINKAGE

A. GENERAL

A link type instrument is one whose pen, pointer or cam follower is driven by a link which connects the pen, pointer or cam follower to the measuring element. The measuring element may be a pressure element, temperature element, manometer shaft, mechanical motion, or any similar device.

Be sure to eliminate all friction before attempting to recalibrate any system. Under bad conditons of high humidity, corrosive fumes, gum vapors, dust laden air, etc., a possible reason for loss of calibration is corroded or dirty bearings in the measuring system. Check for such things as pointer rubbing scale, sticky bearings and binding links and pivots.

B. BASIC ADJUSTMENTS

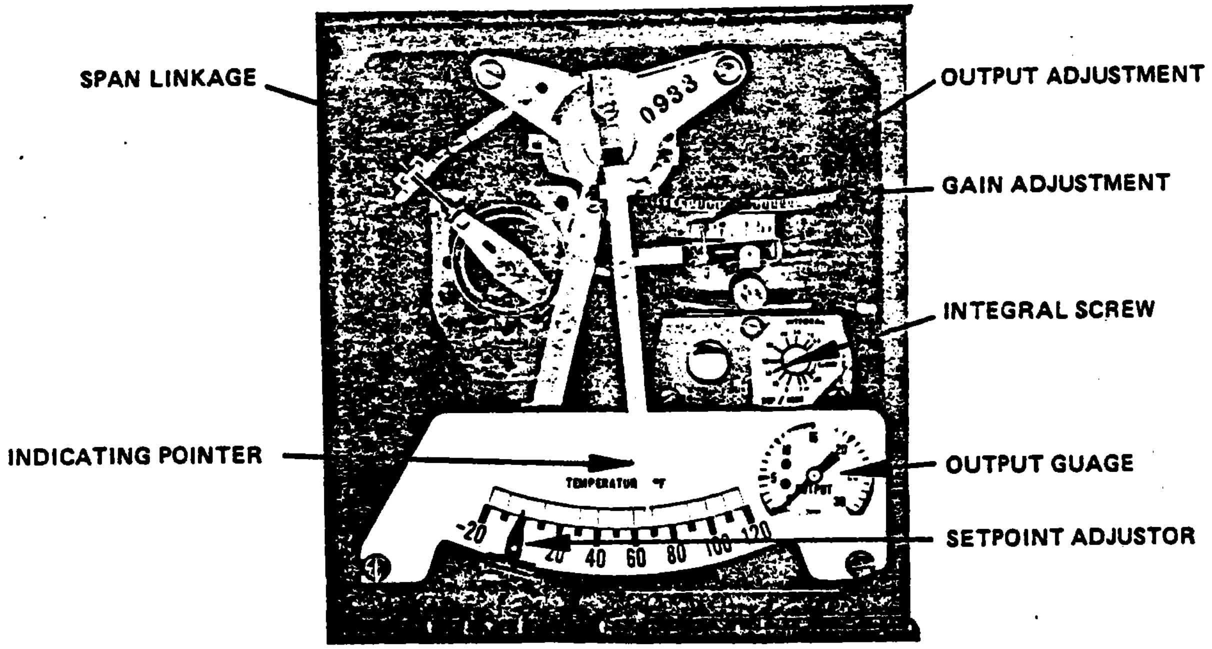
Three adjustments, used singly or in combination are employed in calibrating any link type instrument. These are zero, span and linearity corrections.

1. Zero Adjustment. The zero adjustment shifts the entire scale up or down the same amount. It changes the base point without changing the slope of the curve or its shape.

The fine zero adjustment is made by means of the micrometer adjustment on the pointer. On instruments with an adjusting screw such as item 1, the zero adjustment is made by means of this screw. First loosen slightly locking screws (item 2, fig. 3) to relieve pressure on friction plate and then turn adjusting screw in appropriate direction to zero the pen. Retighten locking screws after any adjustment.

A major zero adjustment is made at the center of rotation of the element by means of a friction plate.

SECTION VII FIELD CALIBRATION OF LINKAGE



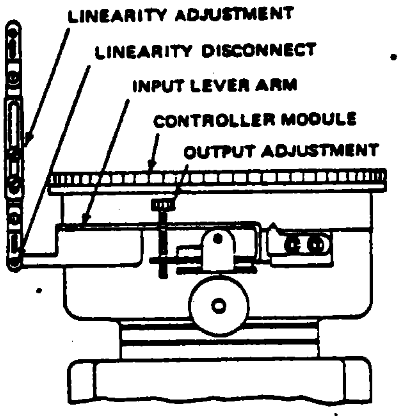
PIII OPERATING INSTRUCTIONS

Adjustment required when changing control module:

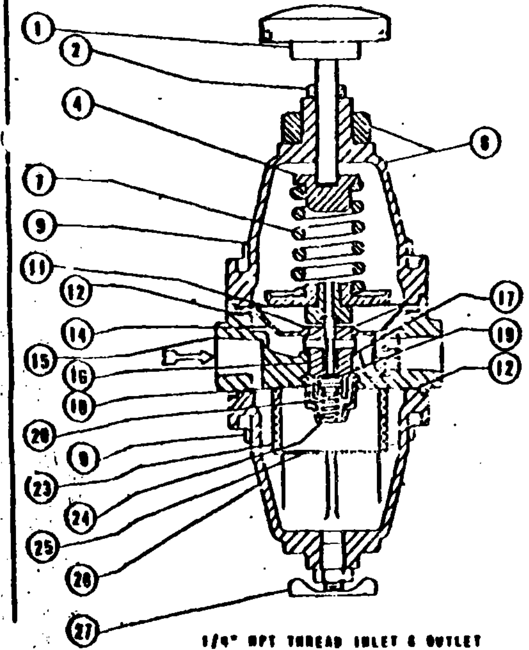
1. Shut off air supply.
2. Plug output connection.
3. Remove scale.
4. Disconnect span linkage.
5. Disconnect linearity linkage on controller.
6. Loosen two screws in back of controller. Back out all the way.
7. Lift module up and out of case.

TO INSTALL

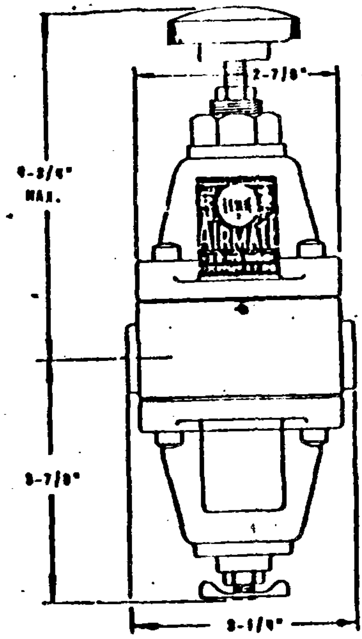
1. Place module in controller case, be sure O-rings are not out of round, cracked or damaged. Secure with two screws.
2. Connect module linearity linkage.
3. Replace scale and adjust gain to 1.
4. Position indicating pointer at 50% and hold in place with tape or paper clip.
5. Set integral adjustment screw at 110.
6. Move set pointer to maximum.
7. Supply air to unit until output guage reads 9# for 30 seconds (or 15 for 3-27 range.
   - 7.1 If controller does not have its own air supply, move set point adjustment and maintain 9# for 30 seconds (15 for 3-27 range).



SPARE PARTS ARE FURNISHED IN KITS ONLY			
AIRMATE KIT NO. C11 9113 03 CONSISTS OF:			
PART NO.	PART NAME	QTY.	REF. NO.
11	DIAPHRAGM COMPLETE	2	56459
12	GASKET	2	52992
14	PITOT PLATE	1	52099
16	VALVE SEAT	2	52676
17	O-RING	2	51162
18	MAIN VALVE COMPLETE	2	54408
20	MAIN VALVE SPRING	2	52706
FILTER KIT NO. 011 9113 02 CONSISTS OF:			
12	GASKET	10	52992
23	FILTER	10	52936



1/4" NPT THREAD INLET & OUTLET



PART NO.	PART NAME	MATERIAL	MATERIAL SPEC.	QTY. PER UNIT	REF. NO.
1	HANDWHEEL, COMPLETE	PHENOLIC & STEEL	COMMERCIAL	1	52690
2	NUT	STEEL, CAD. PLATED	COMMERCIAL	1	24772
4	TOP SPRING SEAT, COMPL.	STEEL, CAD. PLATED	COMMERCIAL	1	20571
7	ADJUSTING SPRING	SPRING STEEL, CAD. PLATED	COMMERCIAL	1	53974
8	ADJUSTING SPR. CASE COMPL (1)	DIE CAST ALUMINUM (NOTE 7)	B85 ALLOY A360	1	52665
9	SCREW, PHILLIPS HEAD	STEEL, CAD. PLATED	COMMERCIAL	8	58661
11	DIAPHRAGM, COMP. (NOTE 6)	SYNTHETIC RUBBER & CELCON	COMMERCIAL	1	56507
12	GASKET	SYNTHETIC RUBBER	COMMERCIAL	2	52992
14	PITOT PLATE	CELCON	COMMERCIAL	1	52099
15	MAIN BODY COMPL. (NOTE 2 & 7)	DIE CAST ALUMINUM	0-05 ALLOY A380	1	54400
16	VALVE SEAT (NOTE 7)	ALUMINUM	0211 ALLOY 2017/2024	1	52676
17	O-RING, VALVE SEAT	SYNTHETIC RUBBER	BUNA N	1	51162
18	MAIN VALVE, COMP. (NOTE 3)	CELCON	COMMERCIAL	1	54408
19	O-RING	POLYURETHANE	COMMERCIAL	1	54450
20	MAIN VALVE SPRING	MUSIC WIRE, CAD. PLATED	COMMERCIAL	1	52706
23	FILTER	RESIN IMPREG. CELLULOSE	COMMERCIAL	1	52936
24	VALVE SPRING RETAINER	CELCON	COMMERCIAL	1	52922
25	FILTER SUPPORT DISC	STAINLESS STEEL	AISI TYPE 302	1	52990
26	FILTER CASE (NOTE 7)	DIE CAST ALUMINUM	0-05 ALLOY A360	1	52921
27	DRAIN COCK	BRASS	ASTM B-16	1	50269

NOTE 1 - ADJUSTING SPRING CASE COMPLETE INCLUDES ONE EACH: SLEEVE, CLIP, FLAT WASHER AND 3/4-16 NUT.
NOTE 2 - MAIN BODY IS FURNISHED COMPLETE WITH VARIABLE PITOT.
NOTE 3 - MAIN VALVE IS FURNISHED COMPLETE WITH O-RING, PART NO. 19.

NOTE 6 - DIAPHRAGM COMPLETE INCLUDES DIAPHRAGM, DIAPHRAGM DISC AND NOZZLE.
NOTE 7 - ALUMINUM IS IRIDITED.

VALVE TO BE TESTED IN ACCORDANCE WITH
LESLIE TEST INSTRUCTION - S.I. 913-148

MAX. INLET PRESSURE - 200 PSI
MAX. TEMPERATURE - 150°F.

APPROX. NET WT. 1 LB. 8 OZ.

1	ALUMINUM MAT'L. SPECS UPDATED	SEB	11/14/78

LESLIE CO.
PARSIPPANY NEW JERSEY 07054

LESLIE - AIRMATE
1/4" CLASS AF-2
RANGE 3-60 PSIG

DATE	APP'D.	DWN	DWG. NO. 301 8029 13 RD
11-14-78	YD	NG	REV. 1

instructions for Small Flow AIRMATE PRESSURE REDUCING VALVES and Air Loaders

CLASSES A-2, AG-2, AF-2, AFG-2, ETC.

INSTALLATION - OPERATION - MAINTENANCE

SECTION I - INSTALLATION

Install as shown in Fig. 1. Use non-corrosive fittings and piping throughout. Use fine wire mesh or poromet filter screen.

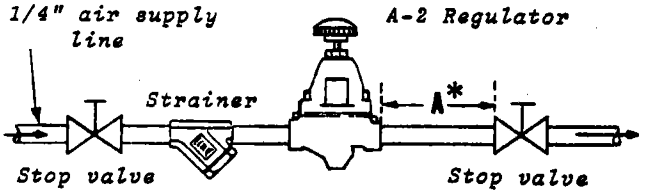


FIG. 1 — INSTALLATION DETAIL

NOTE: Strainer, shown for Class A-2 Types, is not necessary for Filter Type Classes, AF-2.

* *When used with air motors or pulsating equipment, line "A" should be of a sufficient length and diameter to provide a reservoir. On close coupled installations install small reservoir.*

SECTION II - OPERATION

1. Open inlet supply valve to regulator.

   Note: Supply pressure should be at least 5 PSIG above maximum controlled pressure desired.
2. Open outlet stop valve partially.
3. Turn handwheel (1) clockwise to start flow through regulator. Adjust for desired controlled pressure.** Tighten locknut (2). Open outlet stop valve fully.

   ** Turn handwheel clockwise to increase controlled pressure; counterclockwise to decrease.

SECTION III - MAINTENANCE

Dismantling

1. Shut-off air supply. Loosen locknut (2). Relieve all adjusting spring compression.
2. Disassemble adjusting spring case (8), top spring seat (4), adjusting spring (s) (6) and nozzle-diaphragm assembly from main body.
3. Grasp internal rib of aspirator plate (14) (Marked "Lift Here") and lift out of main body. Remove gasket (12).
4. Unscrew valve seat (16) with "O" Ring (17) from main body. Lift out main valve (18), with "O" Ring (19), and main valve spring (20).

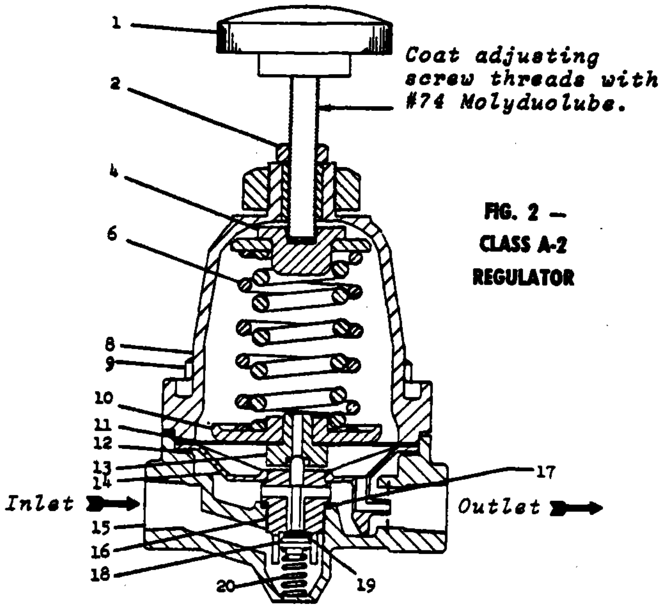


FIG. 2 — CLASS A-2 REGULATOR

Cleaning or replacing parts

Examine and clean all parts. Use an approved detergent (non-injurious to synthetic materials) for cleaning. Blow out all ports and main body with air. Replace any badly worn or damaged part.

PLAY SAFE! USE ONLY GENUINE LESLIE REPLACEMENT PARTS.

8. Set integral to closed.

9. Position set pointer at 50% in line with indicator pointer.

10. Output guage should read 9# (15# for 3-27 range).

11. If it is not 9# (15# for 3-27 range), loosen linearity adjustment screws of module slightly so that linkage can be moved by taping input lever arm until 9# (15# for 3-27) is achieved. For fine adjustment, the output adjustment screw can be adjusted. NOTE: This is a limited adjustment.

12. Now move set point adjustor to 0%. Output should read 3 ± .5.

13. Now move set point adjustor to 100%. OutOutput should be 15 ± 1. (27# for 3-27).

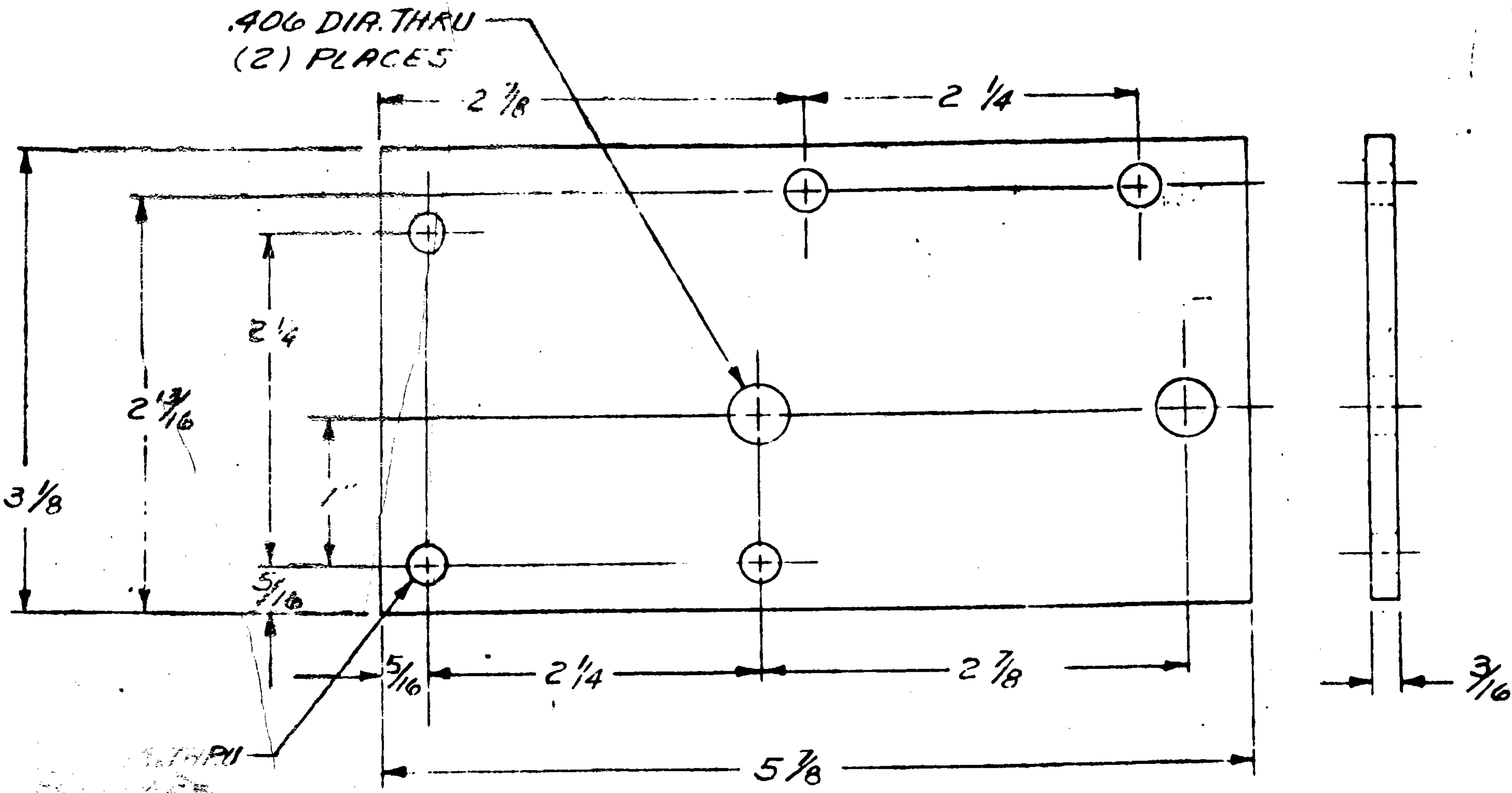
14. It may be necessary to make fine adustments on stream for complete calibration. See 11 output adjusting screw.

LESLIE CO.
Parsippany, New Jersey 07054
Awarded A.S.M.E. (N) and (NPT) Stamp
Approval for Classes 1, 2 and 3 Nuclear Valves.

4470 Printed in USA 678 1½M 2R

NOTE.
1. REMOVE BURRS & BREAK SHARP EDGES.
2. PAINT ~~PER~~ SKC-1891

REV. LET.	REVISION	APP.	CHK. DATE
A	DIM. 2¼ WAS 2.25 (3) PLACES, 2⅞ WAS 2.89 (2) PLACES & 9/32 WAS .281 DIA.	12-20-76	[illegible]



MATERIAL [illegible]
[illegible] BKWN

UNLESS OTHERWISE SPECIFIED

DECIMALS	FRAC-TIONS	ANGLES
XXX	1/64	0° 30'

FAIRCHILD
INDUSTRIAL PRODUCTS DIVISION

1501 FAIRCHILD DRIVE
WINSTON-SALEM, N. C.

MOUNTING
PLATE

CODE IDENT NO. 07282
SCALE FULL
DRAWING NO. EA-12817
REV. A

8. Set integral to closed.

9. Position set pointer at 50% in line with indicator pointer.

10. Output guage should read 9# (15# for 3-27 range).

11. If it is not 9# (15# for 3-27 range), loosen linearity adjustment screws of module slightly so that linkage can be moved by taping input lever arm until 9# (15# for 3-27) is achieved. For fine adjustment, the output adjustment screw can be adjusted. NOTE: This is a limited adjustment.

12. Now move set point adjustor to 0%. Output should read 3 ± .5.

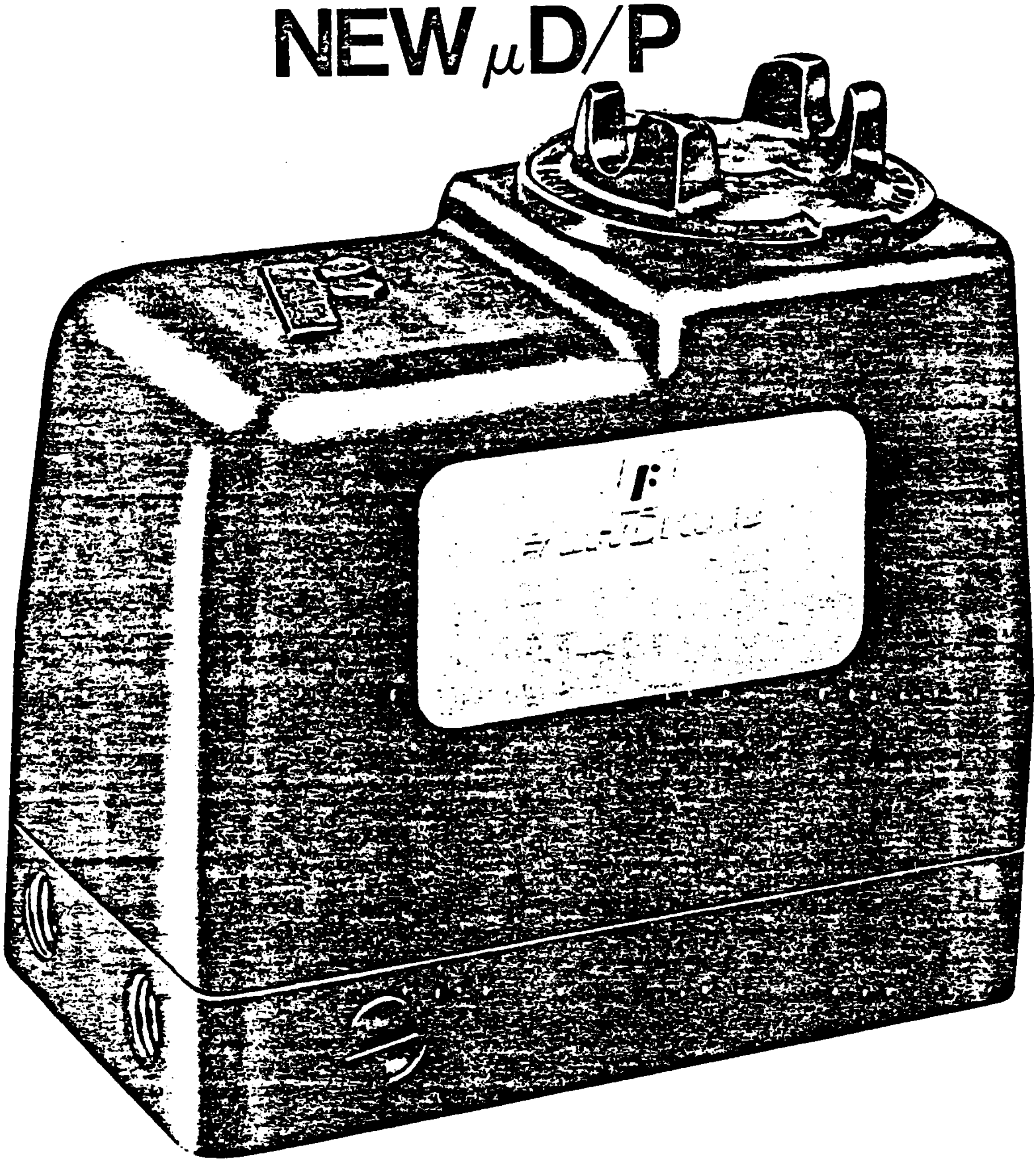
13. Now move set point adjustor to 100%. OutOutput should be 15 ± 1. (27# for 3-27).

14. It may be necessary to make fine adustments on stream for complete calibration. See 11 output adjusting screw.

LESLIE CO.
Parsippany, New Jersey 07054
Awarded A.S.M.E. N and NPT Stamp
Approval for Classes 1, 2 and 3 Nuclear Valves.

4470 Printed in USA 678 1½M 2R

NEW μD/P



Digital to Pressure Transducer

☐ Smallest, lightest, most compact ☐ Resistant to vibrations ☐ Fail safe low ☐ Temperature compensated ☐ Reverse or direct acting ☐ External zero adjustment ☐ Compatible with TTL microprocessor ☐ Active high or low logic

For total control when the pressure's on.

FAIRCHILD
INDUSTRIAL PRODUCTS DIVISION
1501 FAIRCHILD DRIVE WINSTON-SALEM N C 27105
Tel 919-767-8010 Telex 80-6429

Diaphragm replacement

Disassemble nozzle disc assembly consisting of diaphragm disc (10), diaphragm (11) and nozzle (13). Nozzle snaps out of diaphragm disc by finger pressure on diaphragm disc side. Reassemble parts (with curve of disc away from diaphragm). Snap nozzle into place in diaphragm disc.

Integral Filter Types — Class AF-2, etc.

In integral filter types remove filter case (26) from main body. Remove filter (23) and filter support disc (25).

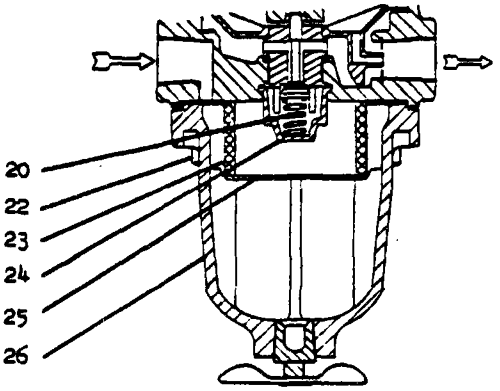


FIG. 3 — PARTIAL ASSEMBLY OF AF-2 TYPE SHOWING ADDITIONAL PARTS IN FILTER ASSEMBLY.

All other parts (except main body) are the same as in A-2 Classes

NOTE: Removal of valve spring retainer (24) in inregral Filter Types is unnecessary unless it is to be replaced. To remove, squeeze sidewalls together to clear groove in main body, then pull. To insert new part, squeeze sidewalls together sufficiently for shoulders to pass through body opening and into groove.

Reassembling

1. Place main valve spring (20) in main body (15). Place "O" Ring (17) in recess of body. Assemble main valve (18), with "O" Ring (19), in valve seat (16). Screw valve seat into main body threads until seating face contacts main body and tighten.

2. Place gasket (12) in recess of main body (15). Insert aspirator plate (14) with aspirator tube in outlet orifice. Snap aspirator plate in place with finger pressure. Place nozzle-diaphragm assembly in main body with diaphragm disc (10) upward. Place adjusting spring(s) (6) and top spring seat (4) on diaphragm disc. Position spring case (8) with handwheel (1) on main body. Insert screws (9) and tighten.

Integral Filter Types — Class AF-2, etc.

In integral filter types place filter support disc (25) and filter (23) in filter case (26). Assemble gasket (12) and filter case to main body. Insert screws (22) and tighten.

3. Readjust regulator as described under "OPERATION".

Maintenance of Loading Panels

Classes P-2, PF-2, etc.

Disconnect tubing at "A". Remove handwheel "B". Take off locknut "C". Remove valve from panel. Follow maintenance Instructions Section III.

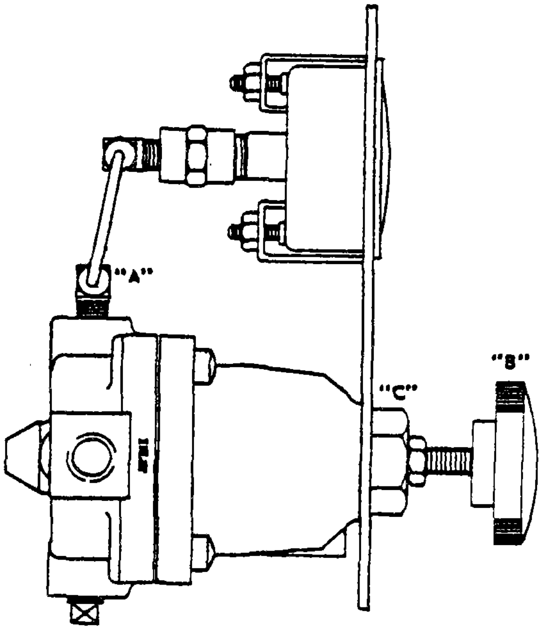
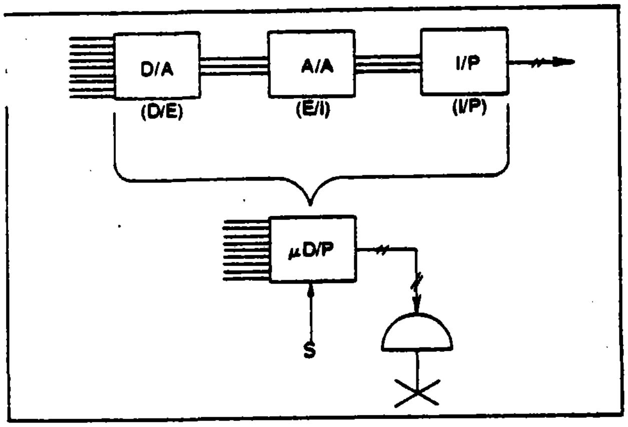


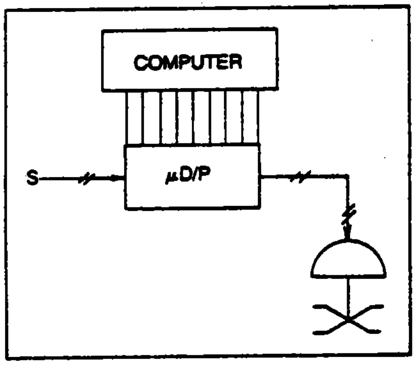
FIG. 4 — CLASS P-2 PANEL LOADER



element. Doing so would eliminate the possibility of errors in the various components, cut maintenance and service cost, and eliminate individual calibration of several different components.

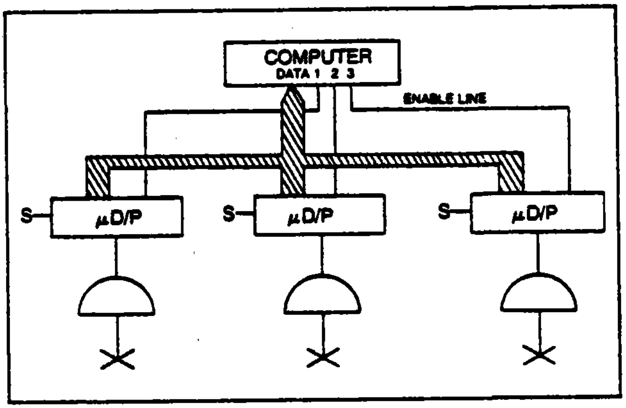
The Fairchild μD/P Transducer.

Fairchild Industrial Products recognized the need for a D/P (Digital/Pneumatic) transducer. And having been a leader in the field of Pneumatic Control for years, they coupled their experience with a new state of the art digital control and are offering a digital to pneumatic transducer which is compatible with TTL level microprocessors. Presently the D/P transducer is being offered in a paralleled wired device that will connect directly to a microprocessor for close coupled control applications. Future expansion of the product line includes serial wiring so that central control room applications can be handled easily and with a minimal amount of wiring.



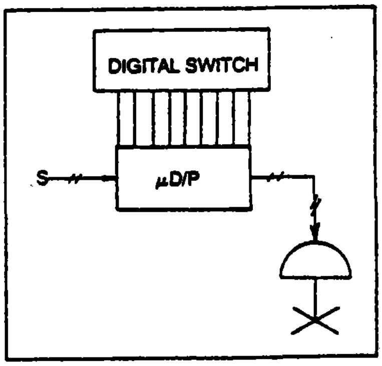
What the μD/P transducer offers the Control Engineer.

More than one D/P transducer can be attached to the same set of nine wires by simply adding an additional wire per unit in the field. We will designate this the enable line. As many as 15 to 20 units can then be put in the field and as the micro decides which unit to control it enables that unit and sets the output. This output will remain drift free at the last point the microprocessor placed it, until the micro again talks to it and sets a new point.



Manual Operation.

The D/P transducer can be completely disconnected from the micro and as long as its independent power supply is on, will remain in the last position placed. This means that in addition to a micro setting the output, an external or manual digital switch could be plugged into a transducer in the field and the output can be changed.



Diaphragm replacement

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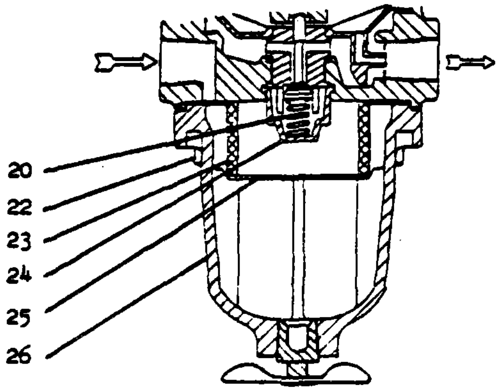

FIG. 3 — PARTIAL ASSEMBLY OF AF-2 TYPE SHOWING ADDITIONAL PARTS IN FILTER ASSEMBLY.

All other parts (except main body) are the same as in A-2 Classes

NOTE: Removal of valve spring retainer (24) in inregral Filter Types is unnecessary unless it is to be replaced. To remove, squeeze sidewalls together to clear groove in main body, then pull. To insert new part, squeeze sidewalls together sufficiently for shoulders to pass through body opening and into groove.

Reassembling

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3. Readjust regulator as described under "OPERATION".

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Classes P-2, PF-2, etc.

Disconnect tubing at "A". Remove handwheel "B". Take off locknut "C". Remove valve from panel. Follow maintenance Instructions Section III.

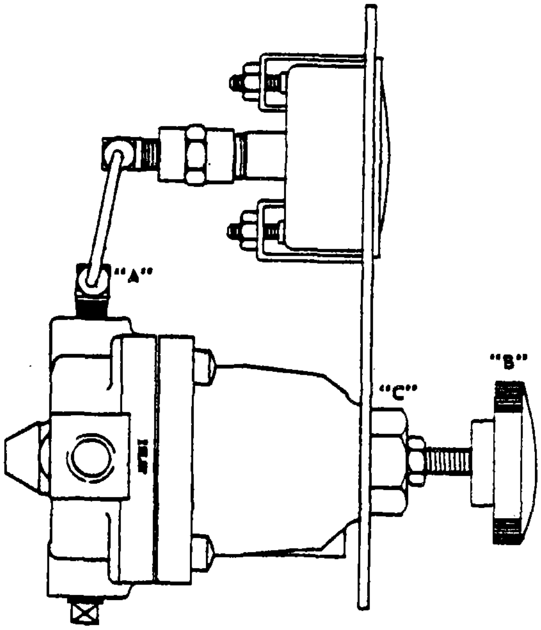
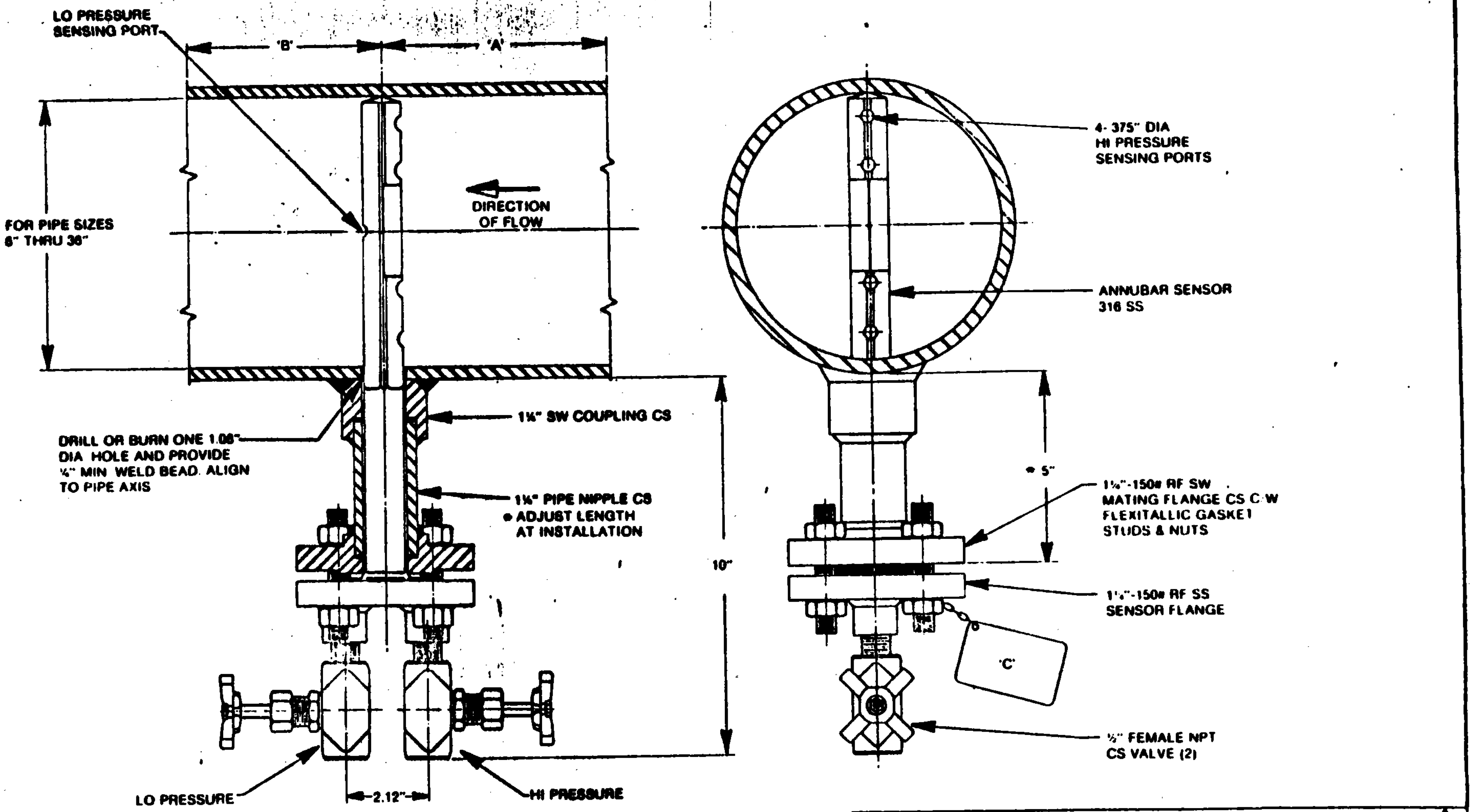


FIG. 4 — CLASS P-2 PANEL LOADER

3138 PRINTED IN U.S.A. 168 2M

1.2.23-432



PROJECT ____________

LOCATION ____________

PIPE SIZE & SCHED ____________

'A' - 7 OR MORE PIPE DIAMETERS ARE RECOMMENDED FOR UPSTREAM SIDE AFTER VALVES, ELBOWS, ETC

'B' - 3 TO 4 PIPE DIAMETERS ARE RECOMMENDED FOR DOWNSTREAM SIDE.

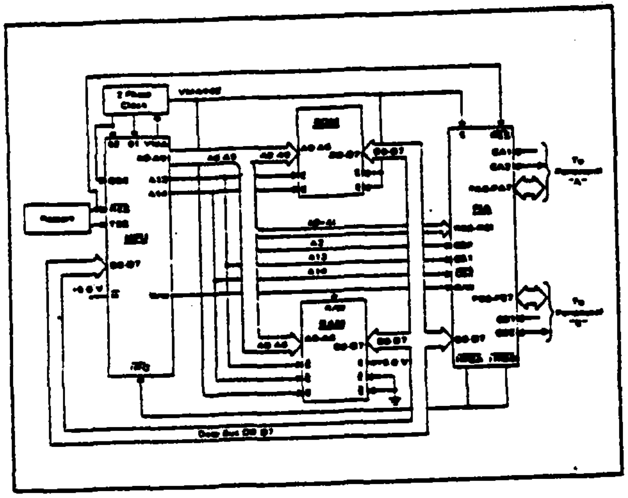
'C' PERMANENT RUSTPROOF METAL TAGS SHOWING MIN., NORM. & MAX. DESIGNED FLOWS, METER READINGS FOR DESIGNED FLOW, TAG NO., LINE SIZE, SERIAL NO. & METERED FLUID.

Dieterich Standard Corporation • Subsidiary of DOVER Corporation

Box 9000 • Boulder, Colorado 80306 USA

ANNUBAR MODEL ANF 75

APPROVAL		LATEST REVISION		
By	Date 3-7-8	Letter	Date	
Drawn by Hilda F	Checked by D Coleman	Date Drawn 5/6/78	Scale N.T.S	C-4900

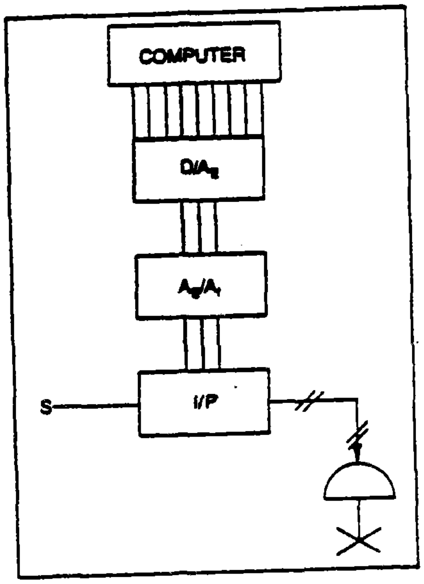


Analog interfacing for microprocessors in the control field.

The microprocessor is the latest thing to enter the process control field. New applications are being discovered everyday. Almost every trade magazine has at least one article on microprocessors and their applications. To utilize the microprocessor in control systems, both digital and analog interface requirements must be met. The digital requirements are not difficult since the microprocessor itself is a digital device. Generally the designer needs only to insure that there is enough I/O available, select the proper drivers, and generate the necessary software. But the analog requirements are a different matter. Some method must be employed to convert the computer digital signal to an analog signal for the final control element.

Digital to analog conversion.

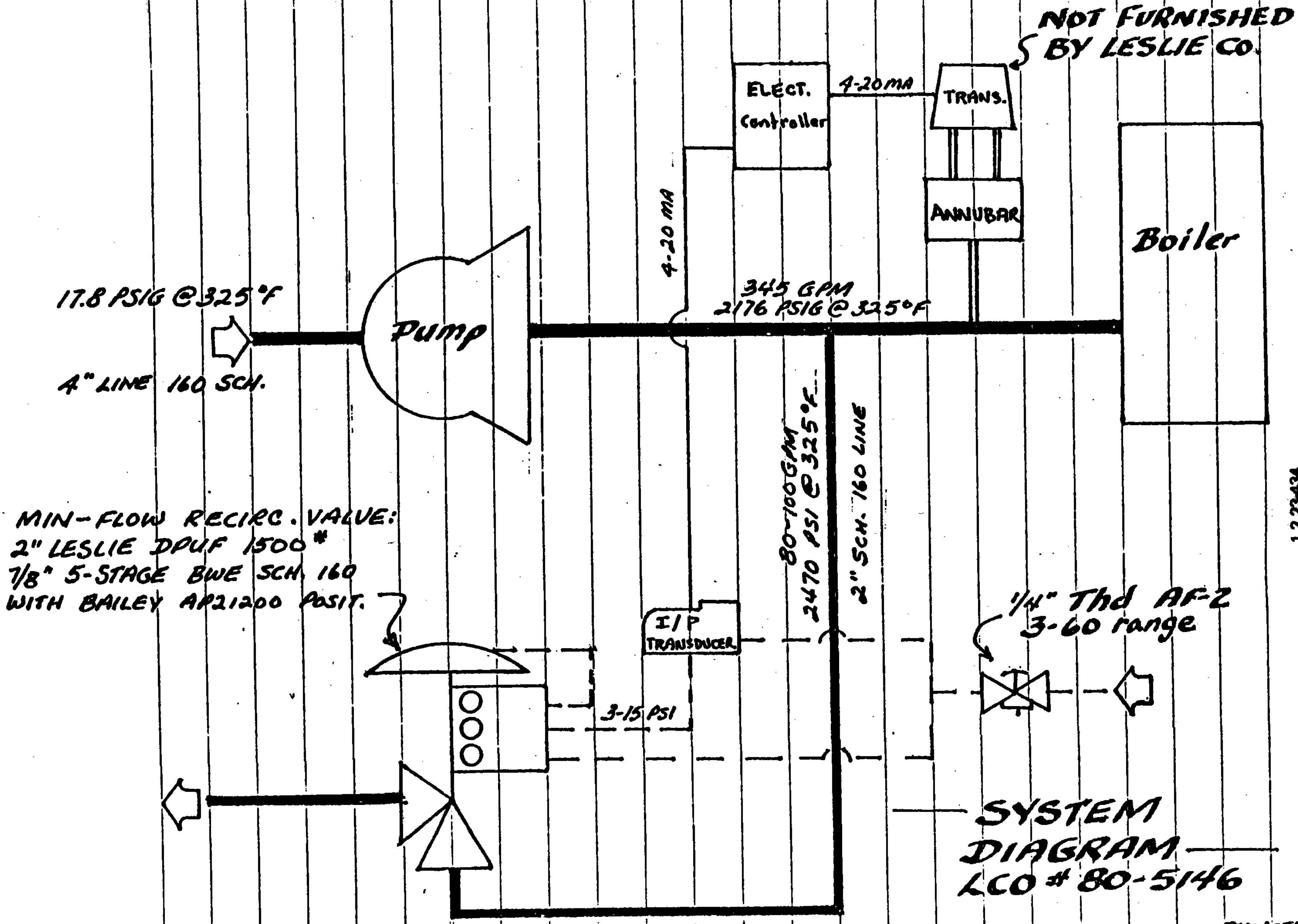
The most common method employed within the past few years to convert digital signals from computers or other digital equipment has been to use three black boxes. One would convert the digital computer signal to a voltage level analog signal. The second would convert the voltage analog signal to a milliamp signal. The third would be a common I/P (Current Pneumatic) transmitter which would convert the milliamp analog signal to a pneumatic 3-15 PSIG signal.



Presently there are over twenty-one firms who have developed plug-in I/O boards for most available single board computers (microprocessors). This is a large step in the right direction, particularly for data acquisition. The method however still requires several conversion steps which are sources of error between the microprocessor and the final control element. The various conversion steps are very costly, running from $150 up to $1,000 for D/A's and A/D's which are still in the electronic or electrical stage and do not include the final step which is the I/P transmitter.

Simplifying the system.

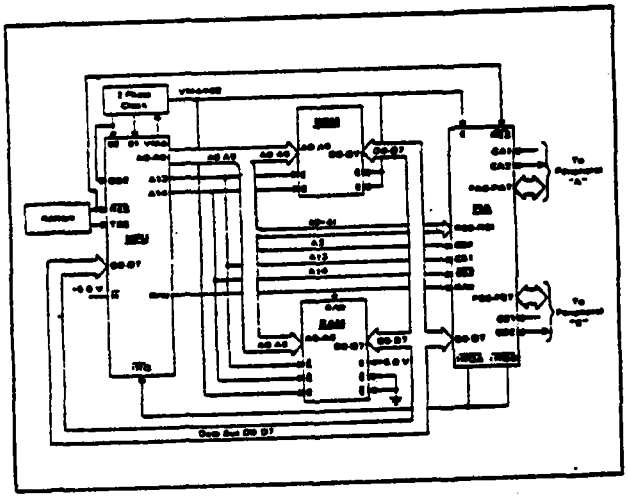
It makes sense to reduce these various steps to one step and one device that would be directly compatible with microprocessors, as well as other digital equipment, and give a 3-15 PSIG pneumatic signal out to a final control



SYSTEM DIAGRAM
LCO # 80-5146

SKTG 2-24-81

REPLACES
SKTLG5-8-80
REV. 1



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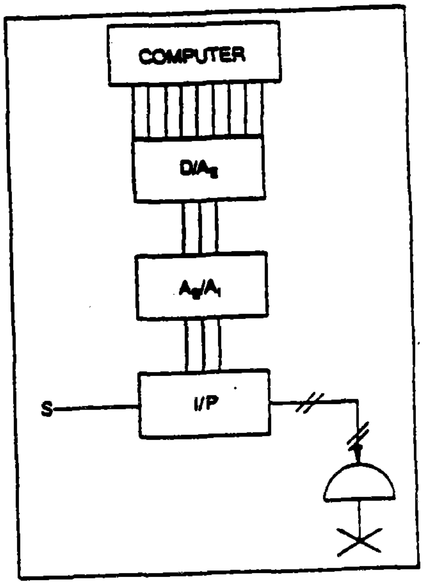

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Simplifying the system.

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REF. 1A995

Bingham-Willamette Company
A DIVISION OF GUY F. ATKINSON COMPANY

DATE: 10-27-81

PORTLAND, OREGON

INSTRUCTION MANUAL SUPPLEMENTS

CUSTOMER: STEARNS-ROGER ENGINEERING CORPORATION

PURCHASE ORDER NO.: 2000 G21700

CHANGE	CONTENTS PAGE (3 SHEETS)	TO: 10-12-81
CHANGE	BASIC KINGSBURY LUBE OIL SYS.	TO: D-1A995-1 REV. D
CHANGE	INJECTION SYS. SCHEMATIC 2 PAGES	TO: A-54924 REV. D
ADD	K'BURY RTD & TERMINAL HEAD MTG. DETAIL DRAWING	TO: B-34899
CHANGE	LESLIE MANUAL	TO: ENCLOSED MANUAL

CONTENTS

(1 of 3)

BINGHAM-WILLAMETTE INFORMATION

CONTENTS
(2 of 3)

VENDOR INFORMATION

BEARING DRAWING	KINGSBURY	NO. 163866
INSTRUCTIONS	KINGSBURY	271-H-66
COUPLING INSTRUCTIONS	THOMAS	DBZ-C
DRIVER	RELIANCE	B-3628-4
ROUTINE TESTS	RELIANCE	RE 1293VV3
CONNECTION DIAGRAM	RELIANCE	416820-55
DATA TRANSMITTAL	RELIANCE	RE 1805ST1
GYROL FLUID DRIVE INSTRUCTIONS	AMERICAN STANDARD	SEC. 1, pp1-25 SEC. 2, pp1-3.1
ORDER BILL OF MATERIAL	AMERICAN STANDARD	78-AD-6271
CROSS SECTION	AMERICAN STANDARD	78-C293
OUTLINE	AMERICAN STANDARD	78-CD-6266
BILL OF MATERIAL	AMERICAN STANDARD	78-146D-6-104CCW 7 SHEETS
INSTALLATION NOTES	AMERICAN STANDARD	78-AD-6270
SPARE PARTS	AMERICAN STANDARD	ONE SHEET
INTERNAL PIPING	AMERICAN STANDARD	78-CD-6273
OIL COOLER	AMERICAN STANDARD	78-CD-6563
CP EXCHANGER PARTS	AMERICAN STANDARD	5-046-08-042-009
CP EXCHANGER DRAWING	AMERICAN STANDARD	5-046-08-042-009
CP EXCHANGER INSTRUCTIONS	AMERICAN STANDARD	PAGE 101
THERMOMETER (ASHCROFT)	AMERICAN STANDARD	SEC. 250-999-H
PROCESS COMMAND CONTROLLER	AMERICAN STANDARD	78-DD-5694
200/400 CONTROL INST.	AMERICAN STANDARD	D-3490
ACTUATOR (JORDAN)	AMERICAN STANDARD	SEC. IM-0422-A
MAG PICKUP (AIRPAX)	AMERICAN STANDARD	SEC. 78-BD-6267
OIL FILTER	HILLIARD	BLTN. HF-11 DWG.DD-431
LUBE SYSTEM INFORMATION	DELAVAL IMO	C3E-A
LUBE PUMP DRIVER	GENERAL ELECTRIC	GEC-1241D

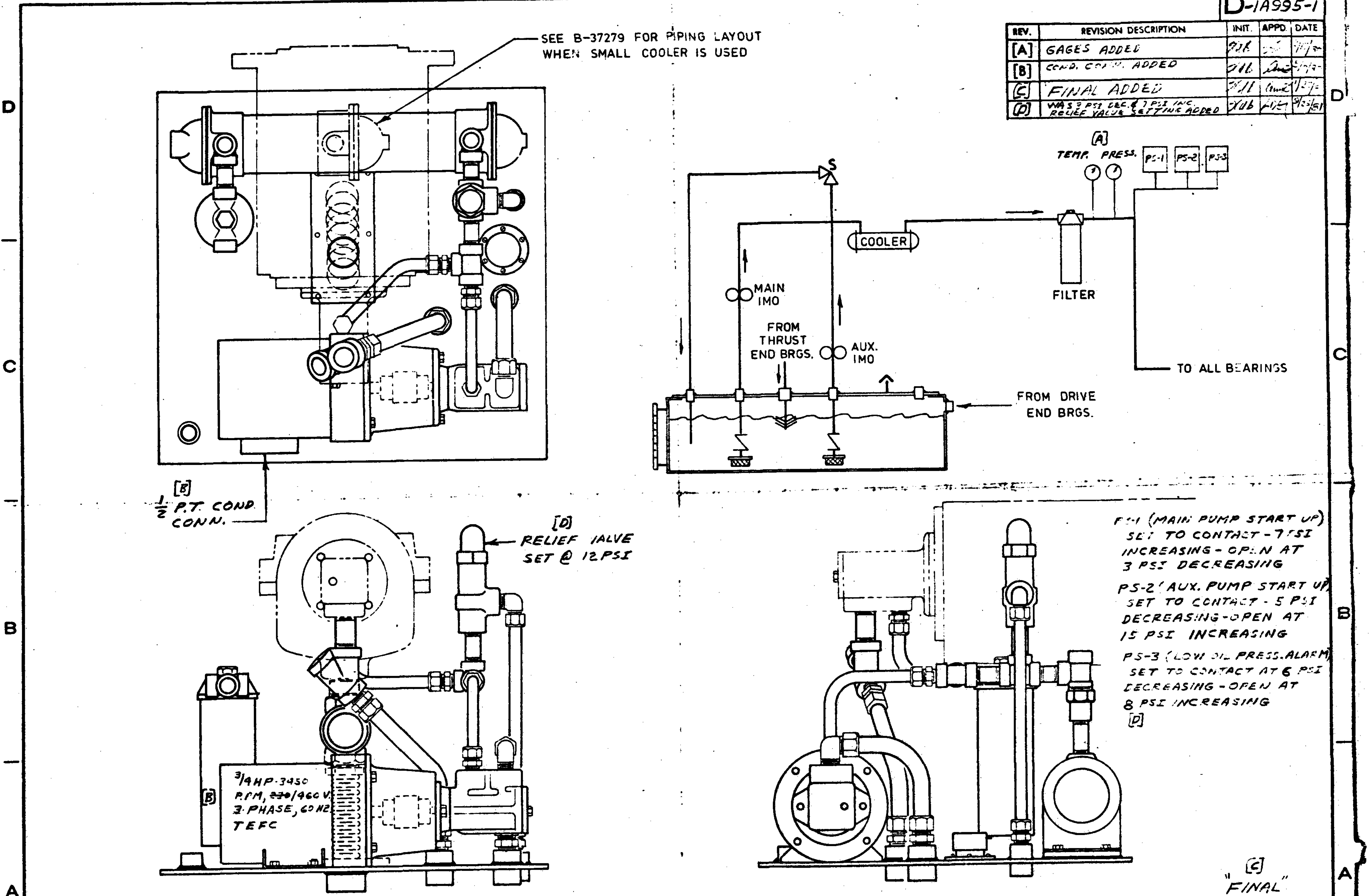
CONTENTS

(3 of 3)

VENDOR INFORMATION CONTINUED

D-1A995-1

REV.	REVISION DESCRIPTION	INIT.	APPD.	DATE
[A]	GAGES ADDED	[illegible]	[illegible]	[illegible]
[B]	COND. CONN. ADDED	[illegible]	[illegible]	[illegible]
[C]	FINAL ADDED	[illegible]	[illegible]	[illegible]
[D]	WAS 3 PSI DEC. & 7 PSI INC. RELIEF VALVE SETTING ADDED	[illegible]	[illegible]	9/25/81



PS-1 (MAIN PUMP START UP) SET TO CONTACT - 7 PSI INCREASING - OPEN AT 3 PSI DECREASING

PS-2 (AUX. PUMP START UP) SET TO CONTACT - 5 PSI DECREASING - OPEN AT 15 PSI INCREASING

PS-3 (LOW OIL PRESS. ALARM) SET TO CONTACT AT 6 PSI DECREASING - OPEN AT 8 PSI INCREASING

[D]

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
GENERAL TOLERANCES:

MACHINING:	FABRICATION:
ANG. ±0°30'	ANG. ±1°0'
LIN. ±.02	LIN. ±.12

S-R #40 VM 700003

Bingham-Willamette Company	PORTLAND, OR. SHREVEPORT, LA.	BASIC KINGSBURY LUBE OIL SYSTEM					D-1A995-1
Bingham-Willamette Ltd.	VANCOUVER, B. C.	REF. D-20443	FIRST USED 1A995	DR. KJB	APPD. [illegible]	DATE: 3/13/80	SCALE: 1"= 4"

REV. D

2 · 1.2.23-440

REV.	REVISION DESCRIPTION	INIT.	APPD.	DATE
[A]	NOTES ADDED	XGB	[illegible]	5/6/80 MR
[B]	FLOW METER ADDED	XAl	DRT	11/7/80 MR

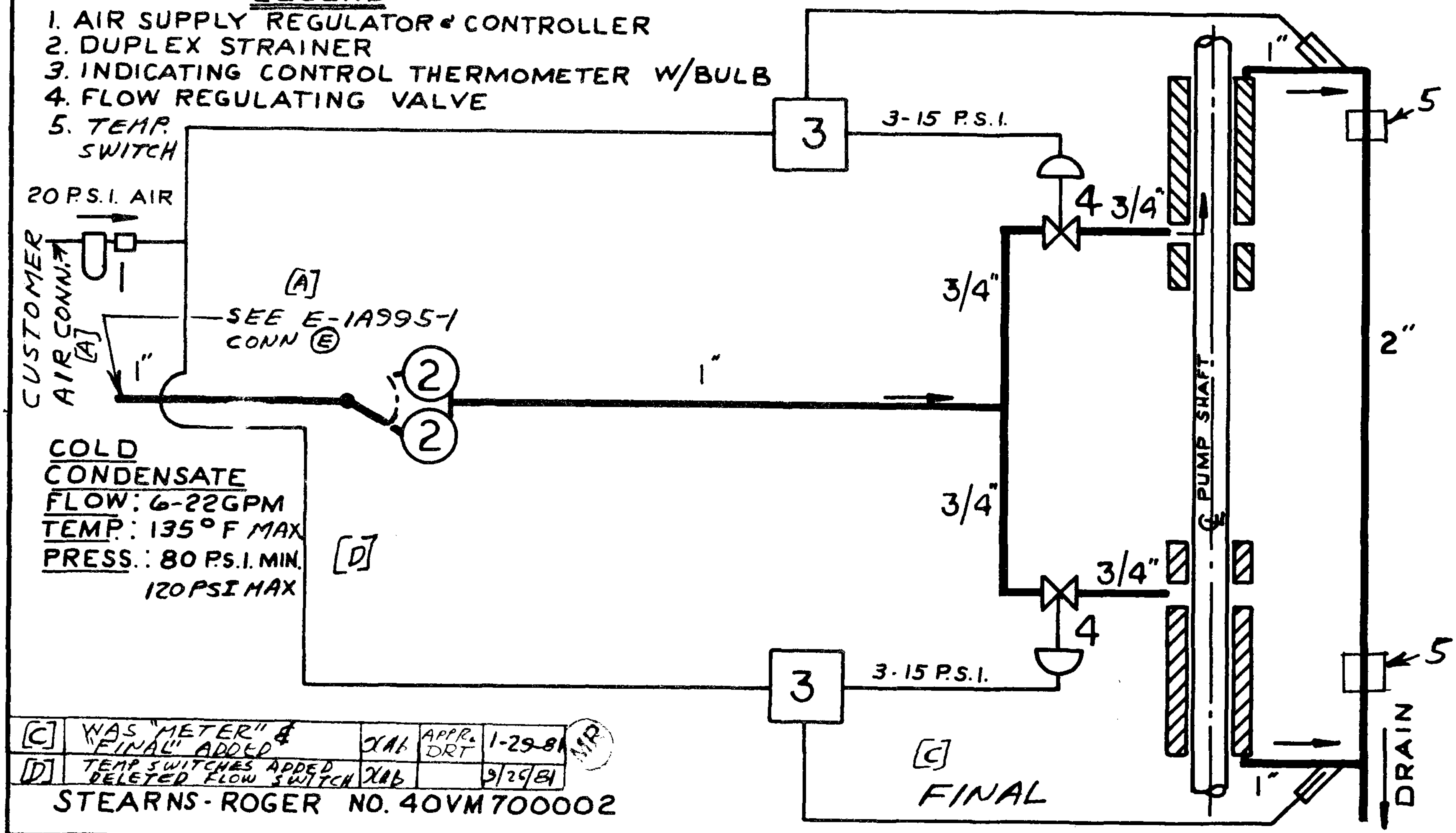
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
GENERAL TOLERANCES:

MACHINING:	FABRICATION:
ANG ±0°30'	ANG. ±1°0'
LIN. ±.02	LIN. ±.12

A-54924

LEGEND

1. AIR SUPPLY REGULATOR & CONTROLLER
2. DUPLEX STRAINER
3. INDICATING CONTROL THERMOMETER W/BULB
4. FLOW REGULATING VALVE
5. TEMP. SWITCH



COLD CONDENSATE
FLOW: 6-22GPM
TEMP: 135° F MAX
PRESS.: 80 P.S.I. MIN.
120 PSI MAX

1.2.23-441

[C]	WAS "METER" & "FINAL" ADDED	XAb	APPR. DRT	1-29-81 MR
[D]	TEMP SWITCHES ADDED DELETED FLOW SWITCH	XAb		9/29/81

STEARNS-ROGER NO. 40VM700002

Bingham-Willamette Company	PORTLAND, OR. SHREVEPORT, LA.	PATT. NO.	INJECTION SYS. SCHEMATIC - TEMP. CONT.
Bingham-Willamette Ltd.	VANCOUVER, B. C.	DR. WM · APPD XGB · DATE: 2-26-80 · SCALE: [illegible] = 12 IN. REF. · USED FIRST 1A995	A-54924 · REV. D

FORM No. 566-1

SH. 1 OF 2

REV.	REVISION DESCRIPTION	INIT.	APPD.	DATE
[A]				
[B]				

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
GENERAL TOLERANCES:

MACHINING:	FABRICATION:
ANG. ±0°30'	ANG. ±1°0'
LIN. ±.02	LIN. ±.12

A-54924
SH 2 OF 2

1.2.23-442

ITEM	DESCRIPTION	IDENTIFICATION
1	AIR SUPPLY REGULATOR	FISHER TYPE 67 FR
2	STRAINER	HAYWARD DUPLEX Nº 5D-1" W/20 MESH BASKETS
3	CONTROLLER	FISHER TYPE 4166R
4	VALVE	FISHER TYPE 513-B-3/4"
5	TEMP. SWITCH	UNITED ELECTRIC TYPE F302-6BS

SETTINGS: SET ITEM Nº 1 TO MAINTAIN 15 PSIG AIR SUPPLY
SET ITEM Nº 3 TO 160°F FOR OUTBOARD LEAK DETECTION

ADDITIONAL COMMENTS: IF SUPPLIED FOR ALARM:
INSTALL TEMPERATURE ALARM SWITCHES IN EACH INDIVIDUAL ATMOSPHERIC DRAIN LINE TO MONITOR OUTBOARD LEAKAGE. SET ALARM SWITCHES TO ACTUATE AT 10°F ABOVE SETTING ITEM Nº 2 (195°F) IF FURNISHED USE SHUTDOWN SWITCHES AT 205° F

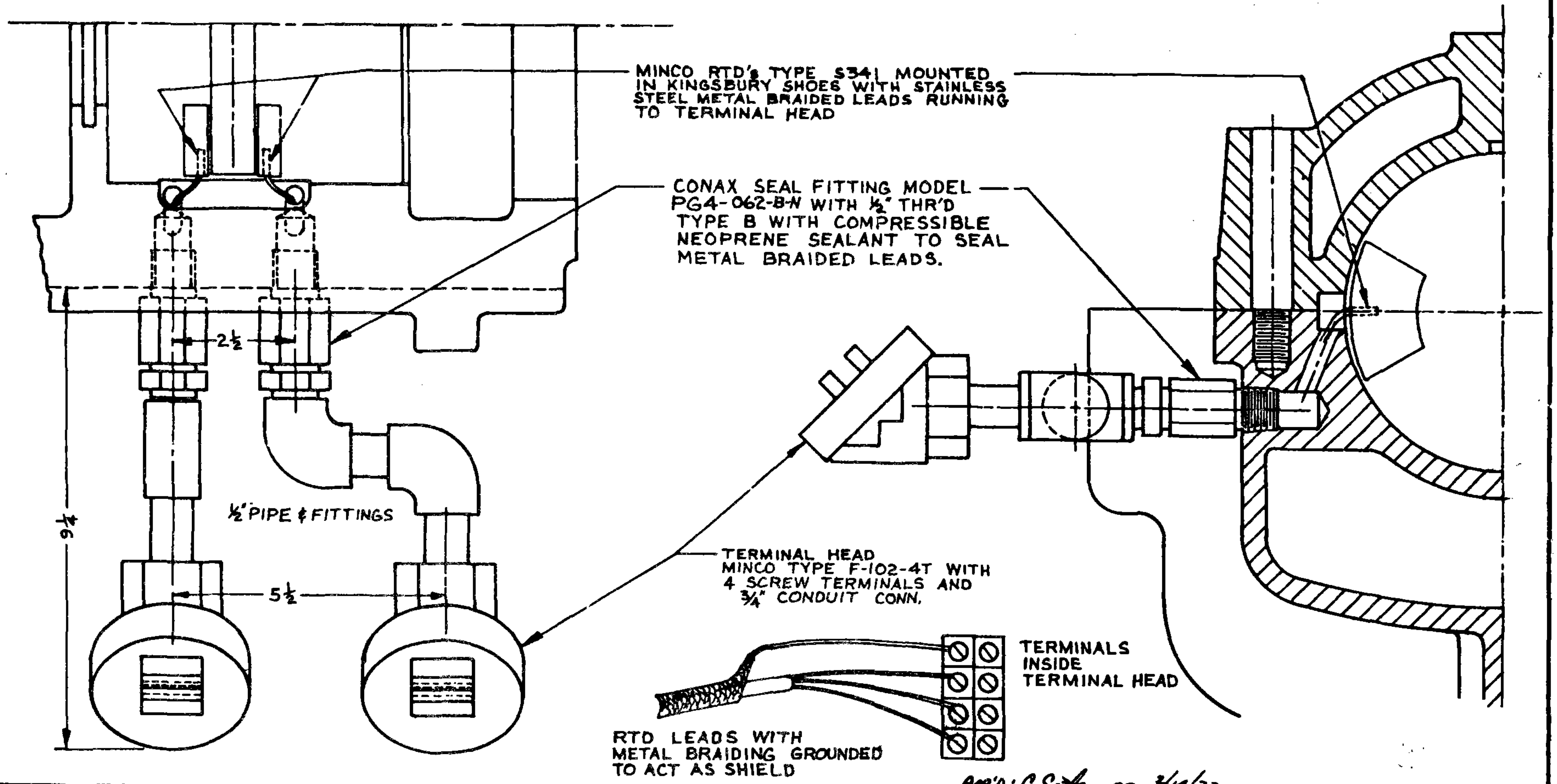
Bingham-Willamette Company	PORTLAND, OR. SHREVEPORT, LA.	PATT. NO.	PARTS IDENTIFICATION
Bingham-Willamette Ltd.	VANCOUVER, B. C.	DR. D.S. APPD. DATE: 9/28/81 SCALE: NONE REF. USED FIRST	A-54924 REV.

FORM No. 566-1

SH 2 OF 2

REV.	REVISION DESCRIPTION	INIT.	APPR.	DATE
[A]	Chg'd neoprene seal size from PG4-125-B-N	WB	LA	
[B]				
[C]				

B-34899



APP'D: C.E. 2/14/77

Bingham-Willamette Company	PORTLAND, OR. SHREVEPORT, LA.	PATT. NO.		K'BURY RTD & TERMINAL HEAD MTG. DETAIL		REV.
Bingham-Willamette Ltd.	VANCOUVER, B. C.	REF. D-18817	FIRST USED 26270681/708	DR. WB CK. LA DATE: 2/14/77 SCALE: 6 = 12 IN.	B-34899	

FORM NO. 867

1.2.23-443

TECHNICAL MANUAL

LESLIE CO. TECHNICAL MANUAL

BINGHAM - WILLAMETTE
P.O. # 1-61656
Portland Or. 97210
LESLIE CO. ORDER NO.
80-0516

OPERATING and MAINTENANCE DATA for ORDERING PARTS

THIS INFORMATION IS ESSENTIAL — When ordering parts for Leslie Regulators, Controllers or Whistles, the following data should accompany each order:

1. Part name and part (REFERENCE NUMBER) from parts list on back of applicable drawing.
2. Quantity of each part.

OR

1. Serial number, Class and Size of Regulators, Controller or Whistle.
2. Part name (See parts list on drawing).
3. Quantity of each part.
4. Marine Representative Listing.

LOCATE OPERATING, MAINTENANCE INSTRUCTIONS AND DRAWINGS FROM INDEX

USE ONLY GENUINE LESLIE PARTS

LESLIE CO., PARSIPPANY, NEW JERSEY 07054

2462 PRINTED IN U.S.A. 278 5M

1.2.23-444

OPERATING and MAINTENANCE DATA

for

ORDERING PARTS

THIS INFORMATION IS ESSENTIAL

WHEN ORDERING PARTS FOR LESLIE REGULATORS, CONTROLLERS OR WHISTLES, THE FOLLOWING DATA SHOULD ACCOMPANY EACH ORDER:

1. PART NAME AND PART (REFERENCE NUMBER) FROM PARTS LIST OF APPLICABLE DRAWING.

2. QUANTITY OF EACH PART.

OR

1. SERIAL NUMBER, CLASS AND SIZE OF REGULATORS, CONTROLLER OR WHISTLE.
2. PART NAME (SEE PARTS LIST ON DRAWING).
3. QUANTITY OF EACH PART.
4. MARINE REPRESENTATIVE LISTING.

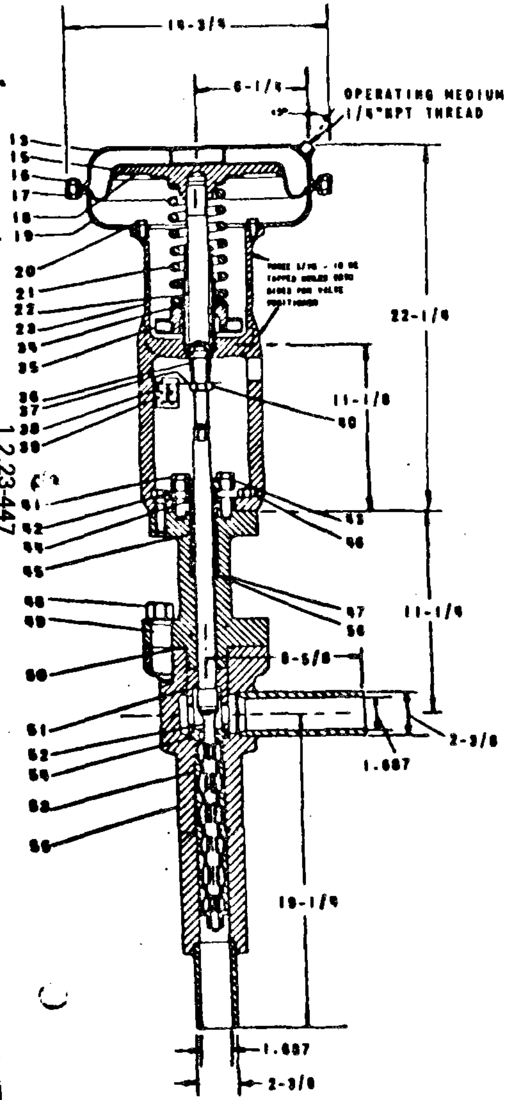
LOCATE OPERATING, MAINTENANCE INSTRUCTIONS AND DRAWINGS FROM INDEX

USE ONLY GENUINE LESLIE PARTS

ITEM NO.	DESCRIPTION	DWG. NO.	INSTRUCTION
1.0	2" DPUF 1500# BWE Sch. 40 Diaphragm Control Valve Severe Service Valve 7/8" Trim 5 Stage CODE: 03P23A2BLA w/Bailey Positioner AP21200 Spring Ref. # A35014	106 8868 29	10/0.5.1 10/2.5.1 P88-7
2.0	Electronic Controller 4-20 MA Pressure 0-100 G I & D Output 4-20 MA Single Case	23/1.4.6	23/1.5.1
3.0	1/4" Thd. AF-2 Reducing Valve 3-60 PSIG	301 8029 13	30/1.5.1
9.0	Fairchild Model 5100B-44 I/P Transducer 4-20 MA Input 3-15 PSIG Output	T5100B	
10.0	Model F 20CS Annubar 2" 1500# ANSI Flg. Flow Range 0-345 GPM Max. Press. 2493 PSIG @ 325° F. Schedule pipe 160	C-4900	
11.0	Rosemont Flow Transmitter Model 1151HP4J12M1,B1 Range 0-50" H_2O, 4-20 MA	1151 HP 50000C	
12.0	Rosemont Power Supply Model #SPS-2011-P		
15.0	Namco Limit Switches	D2400X Chart	
	System Diagram	SKCE-6-3-81-1	
	Electrical Schematic	SKCE-6-3-81-2	

1.2.23-447

MAXIMUM ALLOWABLE AIR PRESSURE IS 60 PSI



APPROX. NET. WT. - 116 LB.

PART NO.	PART NAME	MATERIAL	MATERIAL SPEC.	QTY. PER. UNIT	REF. NO.
13	Diaphragm Cover, Compl	Pressed Steel	Commercial	1	37791
15	Diaphragm	Synthetic Rubber	Fairprene	1	37819
16	Nut	Steel	Commercial	16	26585
17	Bolt	Steel	Commercial	16	37797
18	Diaphragm Plate	Cast Iron	ASTM A- 126, Cl . B	1	37843
19	Diaphragm Base	Pressed Steel	Commercial	1	37678
20	Cap Screw	Steel	Commercial	6	23400
21	Actuator Spring	Steel, Plate	AISI 1095	1	See Tag
22	Actuator Stem	Stainless Steel	AISI Type 410	1	57521
23	Yoke	Cast Iron	ASTM A- 126, Cl. B	1	57554
34	Washer	Stainless Steel	AISI Type 302	1	24271
35	Spring Adjustor	Cast Iron	ASTM A- 126, Cl. B	1	24274
36	Adjustor Sleeve	Stainless Steel	AISI Type 416	1	37766
37	Travel Indicator	Stainless Steel	AISI Type 302	1	58012
38	Travel Indicator Scale	Aluminum	ASTM B- 221	1	38907
39	Screw	Steel, Cad. Plated	Commercial	2	34728
40	Stem Nut	Steel	ASTM A- 194, Gr.4	1	26584
41	Packing Nut	Steel, Cad. Plated	Commercial	2	48830
42	Packing Stud	Steel	ASTM A- 193, Gr. B7	2	42738
43	Packing Flange	Cold Rolled Steel	ASTM A- 108, Gr. 1144	1	57635
44	Packing Follower	Stainless Steel	AISI Type 303	1	30701
45	Packing Set	Molded Rings	Commercial	1	30909
46	Bolt	Steel	ASTM A- 193, Gr. B7	4	36150
47	Bonnet	Carbon Steel	AISI 1020HR	1	66270
48	Nut, Valve Body	Steel	ASTM A194 Gr. 4	6	23371
49	Stud, Valve Body	Steel	ASTM A- 193, Gr. B- 16	6	27142
50	Bonnet Gasket	Stainless Steel.	AISI Type 316L	1	32677
51	Seat Retaining Guide	Stainless Steel	ASTM A- 564 Type 630	1	54901
52	Valve Plug, Mark SP Trim	Stainless Steel	ASTM A564 Type 630&Stell.	1	66276
53	Seat Chamber, Mark SP Trim	Stainless Steel	AISI Type 410 & Stell.	1	66431
54	Seat Chamber Gasket	Stainless Steel	AISI Type 316L	1	54903
55	Valve Body, SP Trim	Forged Carbon Steel	ASTM A- 181 GR.11	1	66273
56	Packing Ring	Stainless Steel	AISI Type 302/304	1	30702

NOTE 1 - YOKE, PART NO. 23 IS FURNISHED COMPLETE
WITH ADJUSTING SLEEVE, PART NO. 36

Code - 03P23A28LA

Valve Plug - 7/8 Mark SP Trim

LESLIE CO.
PARSIPPANY NEW JERSEY 07054

DIAPHRAGM CONTROL VALVE
2" DPUF 1500 LB. BWE SCH. 160
STUB ENDS

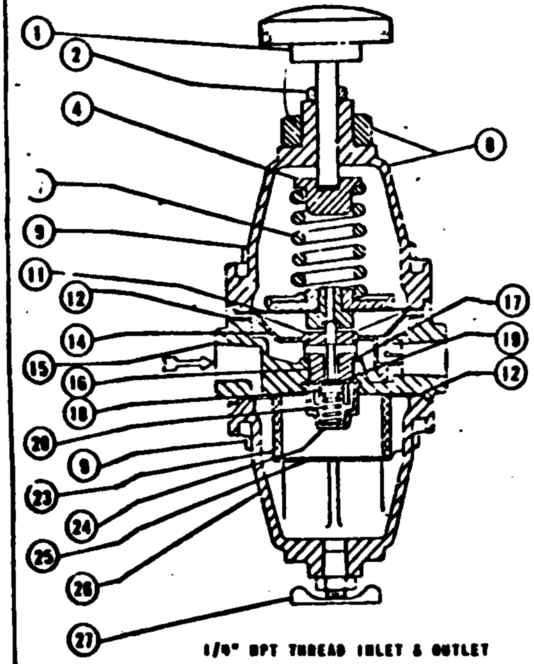
DATE	APP'D.	D'W'N	DWG. NO	106 8868 29 DD REV. 0
6- 18- 80	JR	KR		

SPARE PARTS ARE FURNISHED IN KITS ONLY			
AIRMATE KIT NO. C11 0113 03 CONSISTS OF:			
PART NO.	PART NAME	QTY.	REF. NO.
11	DIAPHRAGM COMPLETE	2	56459
12	GASKET	2	52992
14	PITOT PLATE	1	52899
16	VALVE SEAT	2	52676
17	O-RING	2	51162
18	MAIN VALVE COMPLETE	2	54488
20*	MAIN VALVE SPRING	2	52706
FILTER KIT NO. 011 0113 02 CONSISTS OF:			
12	GASKET	10	52992
23	FILTER	10	52936

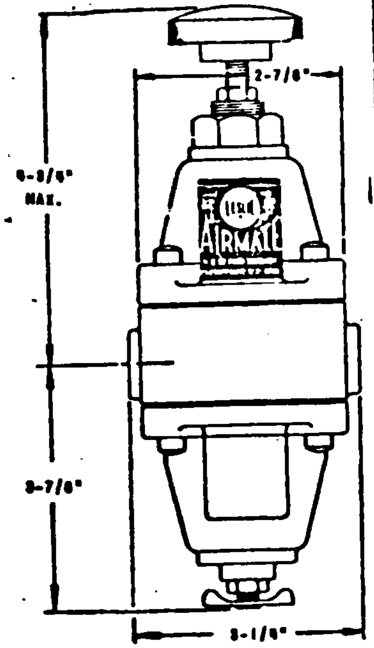
PART NO.	PART NAME	MATERIAL	MATERIAL SPEC.	QTY. PER UNIT	REF. NO.
1	HANDWHEEL, COMPLETE	PHENOLIC & STEEL	COMMERCIAL	1	52650
2	NUT	STEEL, CAD. PLAT.D	COMMERCIAL	1	24772
4	TOP SPRING SEAT, COMPL.	STEEL, CAD. PLATED	COMMERCIAL	1	20571
7	ADJUSTING SPRING	SPRING STEEL, CAD. PLATED	COMMERCIAL	1	33974
8	ADJUSTING SPR. CASE COMPL (1)	DIE CAST ALUMINUM (NOTE 7)	B85 ALLOY A360	1	52665
9	SCREW, PHILLIPS HEAD	STEEL, CAD. PLATED	COMMERCIAL	8	50661
11	DIAPHRAGM, COMP. (NOTE 6)	SYNTHETIC RUBBER & CELCON	COMMERCIAL	1	56507
12	GASKET	SYNTHETIC RUBBER	COMMERCIAL	2	52992
14	PITOT PLATE	CELCON	COMMERCIAL	1	52899
15	MAIN BODY, COMPL. (NOTE 2 & 7)	DIE CAST ALUMINUM	B-85 ALLOY A360	1	54488
16	VALVE SEAT (NOTE 7)	ALUMINUM	B211 ALLOY 2017/2024	1	52676
17	O-RING, VALVE SEAT	SYNTHETIC RUBBER	BUNA N	1	51162
18	MAIN VALVE, COMP. (NOTE 3)	CELCON	COMMERCIAL	1	54488
19	O-RING	POLYURETHANE	COMMERCIAL	1	54458
20	MAIN VALVE SPRING	MUSIC WIRE, CAD. PLATED	COMMERCIAL	1	52706
23	FILTER	RESIN IMPREG. CELLULOSE	COMMERCIAL	1	52330
24	VALVE SPRING RETAINER	CELCON	COMMERCIAL	1	52922
25	FILTER SUPPORT DISC	STAINLESS STEEL	AISI TYPE 302	1	52990
26	FILTER CASE (NOTE 7)	DIE CAST ALUMINUM	B-85 ALLOY A360	1	52921
27	DRAIN COCK	BRASS	ASTM B-16	1	58269

NOTE 1 - ADJUSTING SPRING CASE COMPLETE INCLUDES ONE EACH: SLEEVE, CLIP, FLAT WASHER AND 3/4-16 NUT.
NOTE 2 - MAIN BODY IS FURNISHED COMPLETE WITH VARIABLE PITOT.
NOTE 3 - MAIN VALVE IS FURNISHED COMPLETE WITH O-RING, PART NO. 19.

NOTE 6 - DIAPHRAGM COMPLETE INCLUDES DIAPHRAGM, DIAPHRAGM DISC AND NOZZLE.
NOTE 7 - ALUMINUM IS IRIDITED.



1/4" NPT THREAD INLET & OUTLET



VALVE TO BE TESTED IN ACCORDANCE WITH
LESLIE TEST INSTRUCTION - S.I. 013-T08

MAX. INLET PRESSURE - 200 PSI
MAX. TEMPERATURE - 150°F.

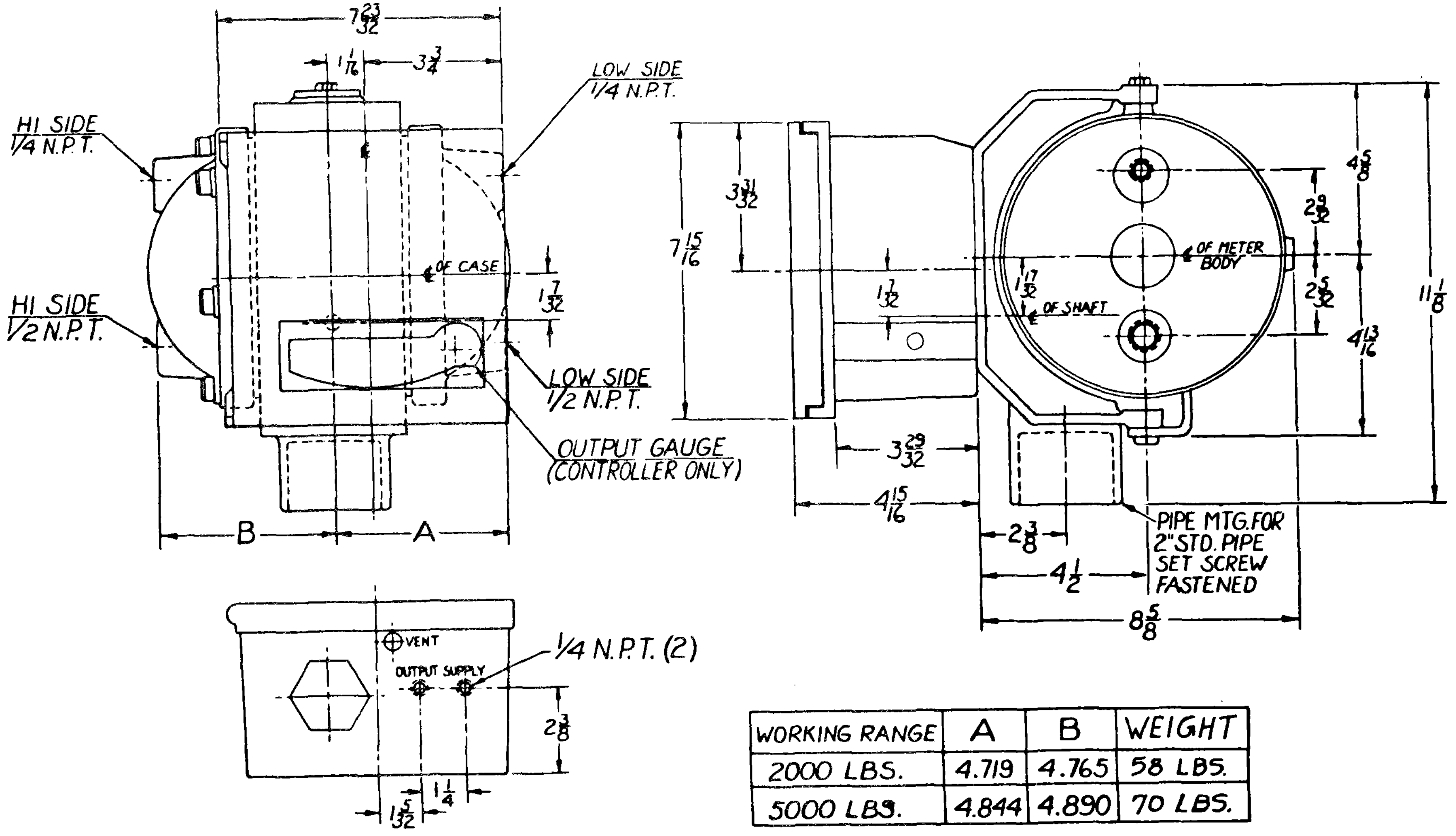
APPROX. NET WT. 1 LB. 8 OZ.

1	ALUMINUM MAT'L. SPECS UPDATED	SeB	11/14/78

LESLIE CO.
PARSIPPANY NEW JERSEY 07054

LESLIE - AIRMATE
1/4" CLASS AF-2
RANGE: 3-60 PSIG

DATE	APP'D.	D'W'N	DWG. NO.
11-14-78	YD	SG	301 8029 13 DD REV. 1



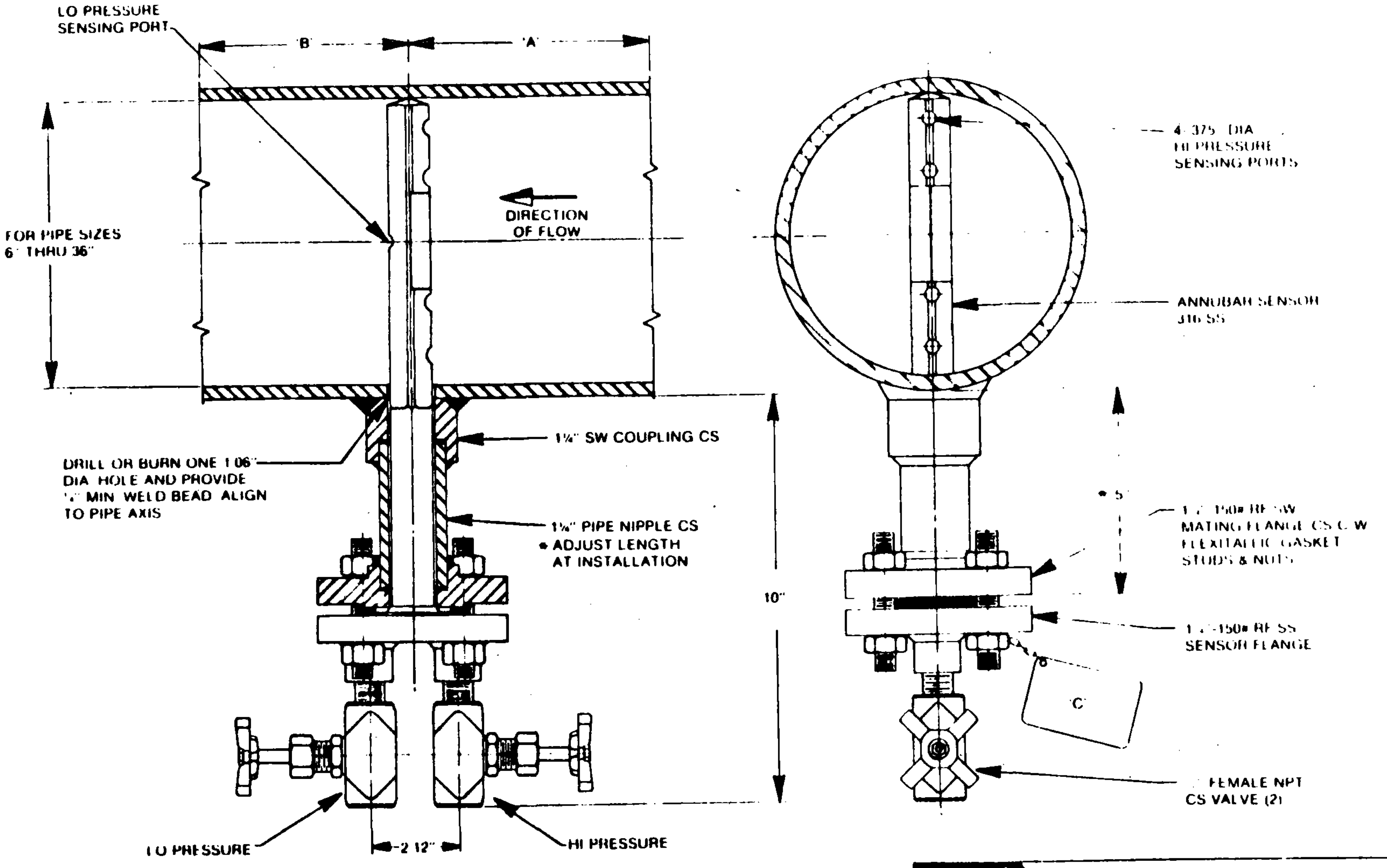
WORKING RANGE	A	B	WEIGHT
2000 LBS.	4.719	4.765	58 LBS.
5000 LBS.	4.844	4.890	70 LBS.

LESLIE CO.
PARSIPPANY NEW JERSEY 07054

OVERALL DIMENSIONS OF PNEUMATICS III
CONTROLLER OR TRANSMITTER WITH
AMERICAN DRI-FLOW METER BODY,
PIPE MTG. ONLY

DATE	APP'D.	D'W'N	DWG. NO.
3-19-75	KH	MG	23/1.4.6

1.2.23-449



PROJECT

LOCATION

PIPE SIZE & SCHED

A 7 OR MORE PIPE DIAMETERS ARE RECOMMENDED FOR UPSTREAM SIDE AFTER VALVES, ELBOWS, ETC.
B 3 TO 4 PIPE DIAMETERS ARE RECOMMENDED FOR DOWNSTREAM SIDE
C PERMANENT RUSTPROOF METAL TAGS SHOWING MIN., NORM. & MAX DESIGNED FLOWS, METER READINGS FOR DESIGNED FLOW, TAG NO., LINE SIZE, SERIAL NO. & METERED FLUID

Dieterich Standard Corporation • Subsidiary of DOVER Corporation
Box 9000 • Boulder Colorado 80306 USA

ANNUBAR MODEL ANF 75

APPROVAL

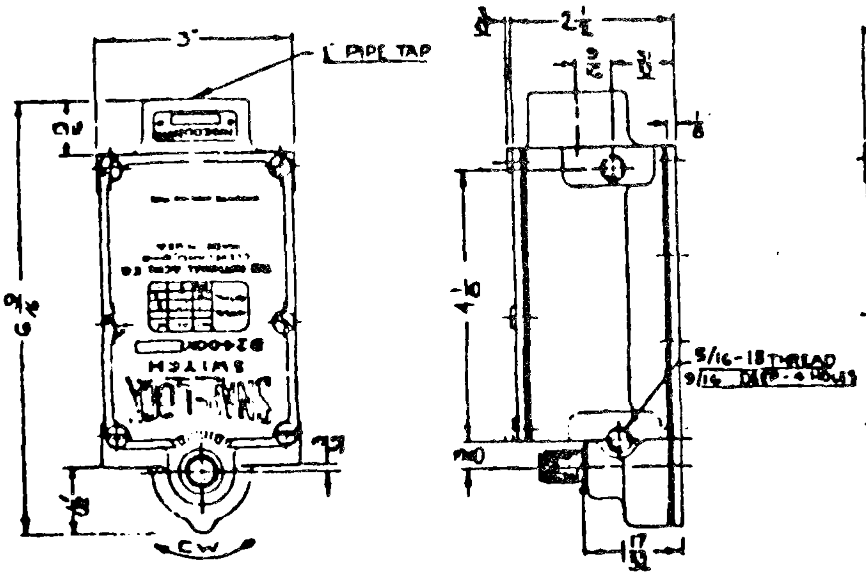
By

Date 3 ' B

Drawn by

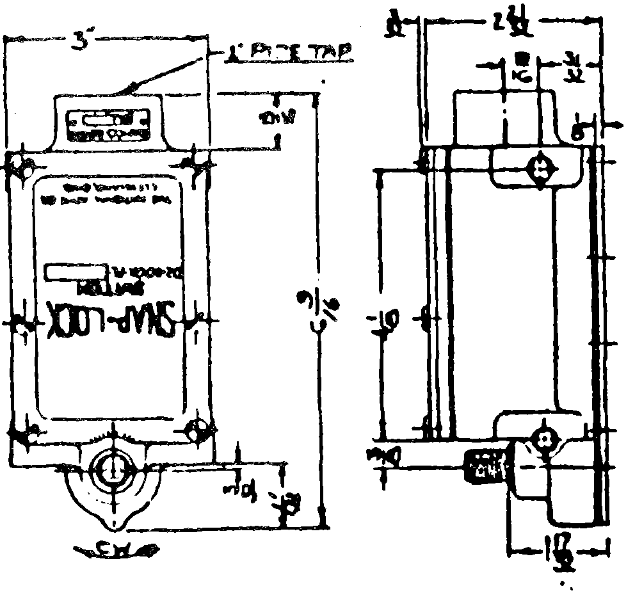
J Coleman

C-4900



STANDARD MTG

TYPE MTG	STANDARD ROTATION "CW"	OPPOSITE ROTATION "CCW"	WITHOUT RETURN SPRING
STANDARD	D2400X	D2400X-SR	D2400X-WS
STYLE 1	D2400X-1	D2400X-1SR	D2400X-1WS
STYLE 2	D2400X-2	D2400X-2SR	D2400X-2WS



STANDARD MTG - WITH PLASTIC COVER

TYPE MTG	STANDARD ROTATION "CW"	OPPOSITE ROTATION "CCW"	WITHOUT RETURN SPRING
STANDARD	D2400X-PL	D2400X-PL-SR	D2400X-PL-WS
STYLE 1	D2400X-PL1	D2400X-PL-1-SR	D2400X-PL-1-WS
STYLE 2	D2400X-PL2	D2400X-PL-2-SR	D2400X-PL-2-WS

SPECIFICATIONS

1. SPRAYTIGHT-PER MIL-E-2036.
2. QUICK MAKE & BREAK ELEC. CONTACTS WHICH ARE LOCKED IN EITHER POS. (OPEN OR CLOSED) & WILL REMAIN SO UNTIL OPERATING PRESSURE IS REMOVED OR EXERTED.
3. DIRECTION OF OPERATION CAN BE ALTERED BY MOVING RETURN SPRING FROM ONE SIDE TO THE OTHER. WITH SPRING REMOVED, SWITCH WILL REMAIN IN EITHER POS. AS ACTUATED.
4. EXTERNAL OPERATING LEVER ADJUSTABLE BY INCREMENTS OF 7½° THROUGH 180°.
5. MOISTURE & FUNGUS PROOF IN ACCORDANCE WITH JAN-1-152.

ELECTRICAL RATINGS

ALTERNATING CURRENT.

VOLTS	AMPS
125V-A.C.	20 ●
250V-A.C.	10 ●
600V-A.C.	5 ●

● POWER FACTOR 75 TO 80%

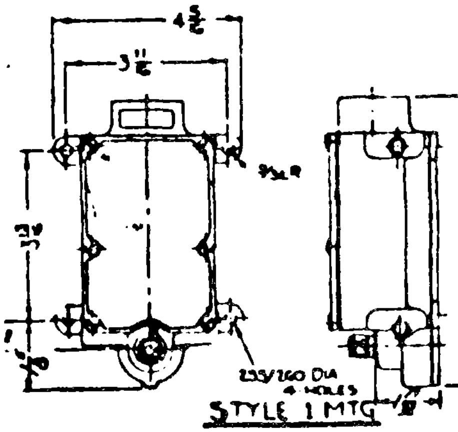
DIRECT CURRENT.

125V-DC.	3.0
250V-DC.	1.5

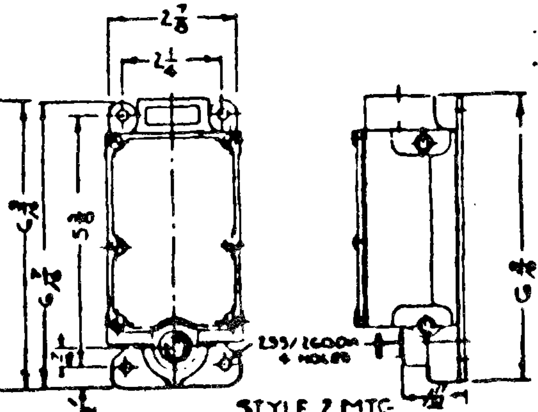
PILOT DUTY.

VOLTS	INRUSH AMP ●●	NORMAL AMP ●●
125V-A.C.	60	6.0
250V-A.C.	30	3.0
480V-A.C.	15	1.5
600V-A.C.	12	1.2

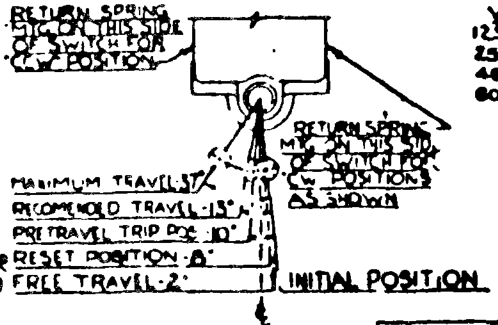
●● POWER FACTOR 35% OR LESS.



STYLE 1 MTG



STYLE 2 MTG



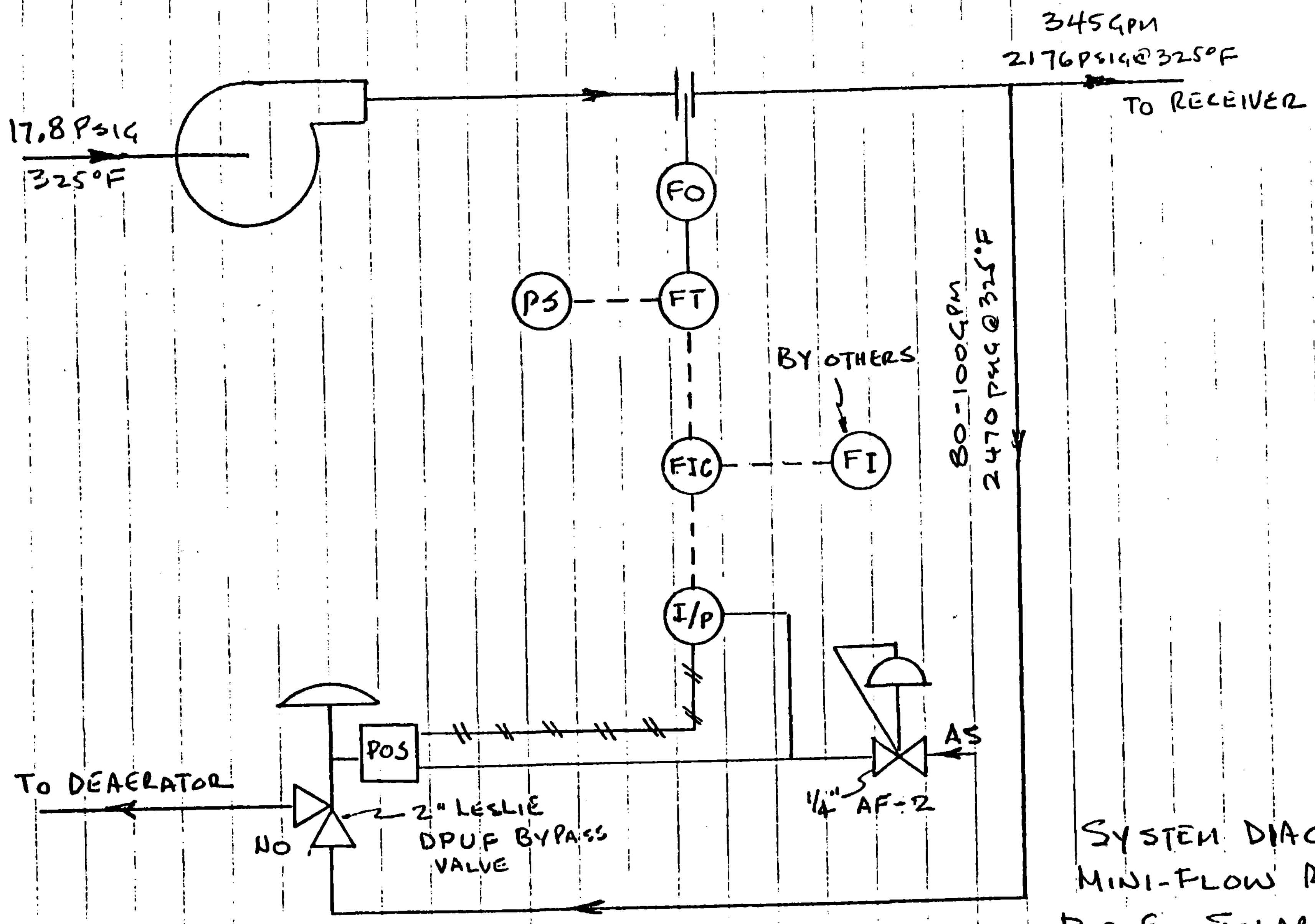
	TORQUE IN. LBS.	
	[illegible]	[illegible]
TORQUE TO TRIP SW.	21	10

FOR REPLACEMENT PARTS SEE REVERSE SIDE.

STANDARD SWITCH

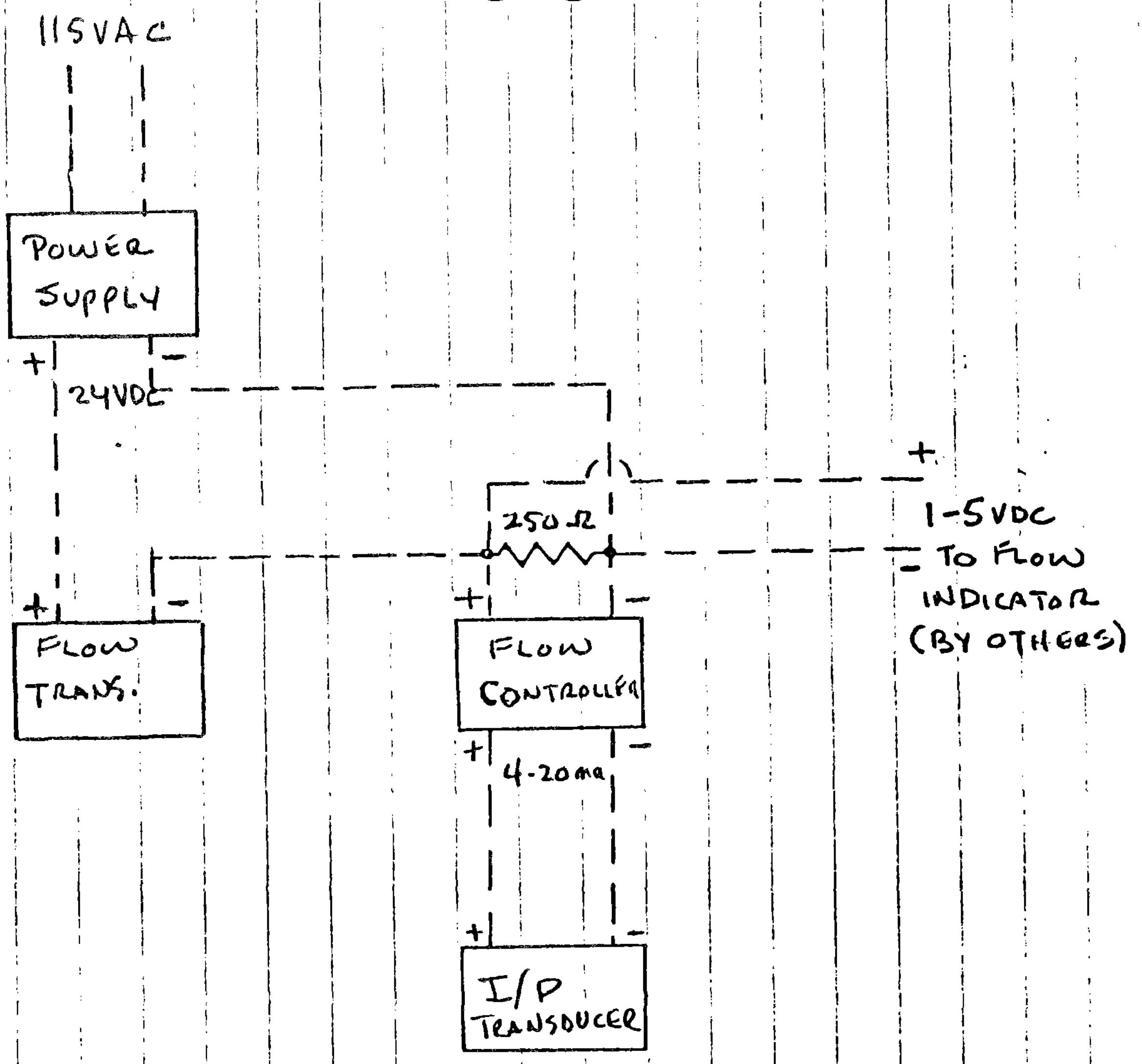
THE NATIONAL ACME CO. CLEVELAND OHIO
ELECTRICAL MANUFACTURING DIVISION
SNAPLOCK LIMIT SWITCH 2-POLE
D2400X CHART

1.2.23-451



SYSTEM DIAGRAM
MINI-FLOW RECIRC
D.O.E. SOLAR ONE
LCO S.O.# 80-5146
SKCE 6-3-81-1

REPLACES SKTG 2-24-81 ;
SKTG 5-8-80



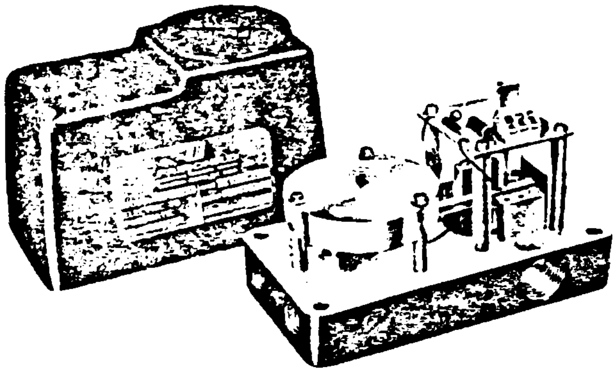
ELECTRICAL SCHEMATIC

MINI-FLOW RECIRC. CONTROL

LCO S.O. * 80-5146

SKCE6-3-81-2

CURRENT to PNEUMATIC
VOLTAGE to PNEUMATIC
TRANSDUCERS



MODEL T5100B Transducer

In a direct acting unit, an increase in the dc milliampere signal to the coil will increase the magnetic field strength around the coil. This increase in flux density, or field strength of the coil, opposes the permanent magnetic field of the magnet; thereby creating a thrust on the coil in a downward direction. The downward movement of the coil moves the beam or flapper closer to the nozzle and restricts the flow of air. The restriction of the flow of air through the nozzle causes a build-up in the output pressure. The change in output pressure is directly proportional to the change in dc current to the coil.

APPLICATION

- Control for emergency process shutdown.
- Operation of air activated valves and first control elements.
- Supply input signal for pneumatic positioners.
- Conversion of electrical outputs from electronic primary measuring devices into pneumatic signals for indication, recording, and control.

MAJOR FEATURES

- Exceptional accuracy
- Four input ranges available
- Compact
- Linearity less than 1/2 of 1% over output span
- Mounting in any position
- Can be changed from direct to reverse acting by simple adjustment.
- Will tolerate more oil or water vapor than competitive units.

Factory Mutual Approval. The Fairchild I/P and E/P Transducers may be purchased as Factory tual approved, Intrinsically Safe for Class I, ision 1, Groups A, B, C, and D and Class II, vision 1, Groups E, F. and G depending upon the model number and barrier used.

Intrinsically safe with barrier models: TI-5100B

Intrinsically safe for Class I, Division 1, Groups C and D (Taylor Instrument Company Barrier No. 113OF/1135F)

(Honeywell, Inc. Barriers 38545-0000-0110-111/ 112-F5B5)

Intrinsically Safe Class I, Division 1, Groups B, C, and D when used with Foxboro SPEC 200 System Models 2AO-V21-FGB, 2AO-V31-FGB, 2AO-VA1-FGB, 2AT-SBU-FGB.

Intrinsically safe for Class I, Division 1, Groups A, B, C, and D (Honeywell, Inc. Barriers 38545-0000-0110-113-F585)

(Measurement Technology LTD Barrier No. MTL 8)

(Leeds & Northup Company Barrier No. 316569 or 316747)

All Fairchild "I" Series Transducers above are dust-ignition proof as approved by factory mutual for Class II, Division 1, Groups E, F, & G when used with any barrier above.

SUBMITTED FOR
FACTORY MUTUAL APPROVAL
IN ACCORD WITH ABOVE

Catalog No.	Range	Pipe Size
Aluminum Cover		
T-5100B-11	1-5ma	1/4" NPT
T-5100B-44	4-20ma 10-50ma	1/4" NPT
T-5100-99	1-9V	1/4" NPT
ptions		
Add after T in catalog number		
Intrinsically Safe	I	

SPECIFICATIONS
MODEL T-5100B

Supply pressure (psig)....20 ± 2

*Output pressure, standard (psig)....3-15

Independent linearity.... ± ¼% F.S.

Terminal based linearity.... ± ½% F.S.

Supply pressure effect (18-22 psig) ....0.3% of span for ± 1 psig change

Shock and vibration.........negligible up to 2G between 5 hz and 200 hz
effect on output pressure

Ambient temperature.... −40°F to 150°F

Temperature coefficient....less than 1% of span/50°F

Hysteresis and repeatability....within 0.1% F.S.

Maximum air consumption....0.16 SCFM

Maximum output capacity....0.15 SCFM

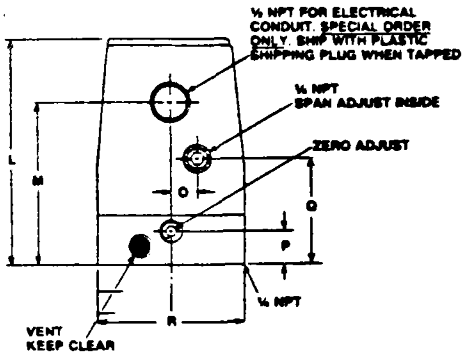
Frequency response.....-3 db @ 20 hz (unloaded)

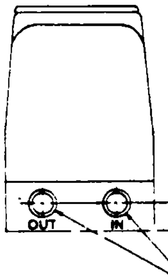
*Other inputs and outputs available on application.

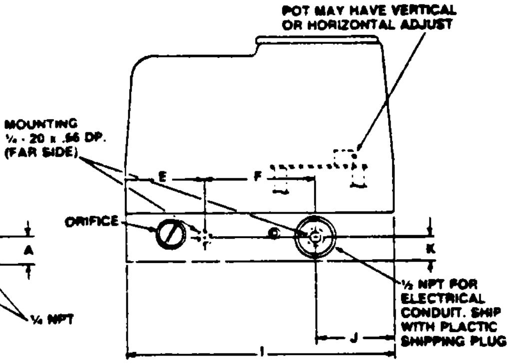
MATERIALS OF CONSTRUCTION

Base	Aluminum Alloy
Orifice	Sapphire
Nozzle	Stainless Steel
PC Board	Fiberglass
Cover	Aluminum

Input Impedance (Nominal)	Input Range
2300	1-5ma
155 78	4-20ma 10-50ma
2740	1-9 volts d-c







LETTER	INCHES
A	.57
B	.75
C	1.50
D	1.50
E	1.63
F	2.25
G	2 03
H	1.84
I	5.50
J	1.40
K	.50
L	4.63
M	3.34
N	2.97
O	.56
P	.67
Q	2.16
R	3.00

T 5100B-11, 44,
CURRENT TO PNEUMATIC TRANSDUCER

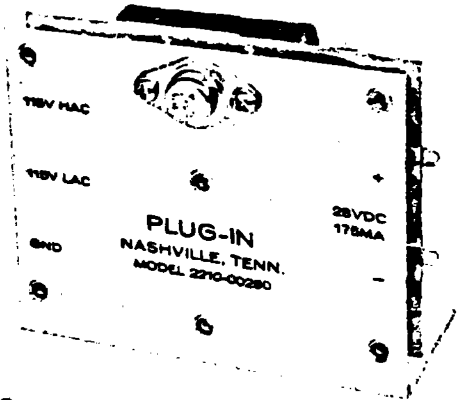
T 5100B-99
VOLTAGE TO PNEUMATIC TRANSDUCER

HOW TO ORDER

Catalog Number T I 5100B 11
Transducer
Option
Intrinsically Safe (I)
Category
Standard Unit 0.15 SCFM

Input	Standard Aluminum Cover
1- 5ma	(11)
4-20ma	(44)
10-50ma	
1- 9	(99)

PLUG-IN™ REGULATED DC POWER SUPPLIES

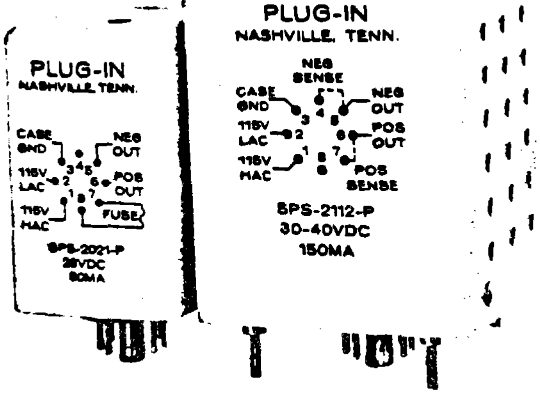


1 to 40 volt outputs

Adjustable voltage

Overcurrent protection

(Automatic or external fuse)



GENERAL

Regulated Plug-In DC power supplies provide highly stable and isolated DC voltage for various industrial, medical, laboratory, ground support and other applications. These models are ideally suited for industrial transducer excitation, current transmitter applications as well as for laboratory use.

The Plug-In types are transistorized and compact, but are repairable. A mating 8-pin octal receptacle for conventional chassis mounting is shipped with each unit. However, the optional screw-down socket with molded barrier strips offers extra convenience and fast installation.

The open construction 2210 series is equally convenient in use and installation. This economical unit is of solid state design, and offers automatic momentary short circuit protection. The line and load regulation and the ripple specifications are less stringent (see ordering table) than for the enclosed models. However, these units are especially designed for low-cost applications where a large number of isolated voltages are required and where electrical specifications are not critical.

Power supplies are available with narrow slot range and with wide range voltage adjustments. Any voltage between 1 and 40 volts is available from at least one of our standard power supplies. The table below shows the model numbers for the most popular voltage ranges between 1 and 40 volts. After determining applicable models, refer to the "Style" table on page 2 for electrical specifications. Duplications exist in some voltage ranges for your selection based on economy, current ratings or electrical specifications.

VOLTAGE/MODEL TABLE

	VOLTAGE									
STYLE	1–6.5	5–9	10	12	15	18	20	24	28	30–40
2210								2210	2210	
A			SPS–2077	SPS–2077	SPS–2078					
B			SPS–2014	SPS–2010	SPS–2018			SPS–2011	SPS–2021	
D	SPS–2055		SPS–2057 SPS–2052	SPS–2057 SPS–2052	SPS–2056 SPS–2074–D	SPS–2054	SPS–2054 SPS–2101	SPS–2101	SPS–2101	SPS–2102
F	SPS–2062	SPS–2063	SPS–2110	SPS–2110 SPS–2120–D	SPS–2110 SPS–2121–D	SPS–2110	SPS–2111	SPS–2111	SPS–2111	SPS–2112

ORDERING INFORMATION

2210

OPEN CIRCUIT CONSTRUCTION

MODEL	DC OUTPUT RATING		REGULATION (mV DC)		RIPPLE (mV RMS)	OUTPUT ADJUST
	VOLTS	CURRENT (mA)	LINE	LOAD		
2210-00280	28	175	±10	20	10	±5%
2210-00240	24	225	±10	20	10	±5%

STYLE "A"

ULTRA COMPACT 0.6 WATT PLUG-IN

MODEL	DC OUTPUT RATING		REGULATION (mV DC)		RIPPLE (mV RMS)	TEMP. COEFF. (%/°F)
	VOLTS	CURRENT (mA)	LINE	LOAD		
SPS-2077-P	9-12.5	0-50	3	6	1.5	0.02
SPS-2078-P	13-16	0-40	3	6	1.5	0.02

STYLE "B"

ECONOMICAL 2 WATT PLUG-IN

MODEL	DC OUTPUT RATING		REGULATION (mV DC)		RIPPLE (mV RMS)	TEMP. COEFF. (%/°F)
	VOLTS	CURRENT (mA)	LINE	LOAD		
SPS-2014-P	10	0-175	±4.5	±9	1	0.03
SPS-2010-P	12	0-175	±6	±12	1	0.03
SPS-2018-P	15	0-125	±6	±12	1	0.03
SPS-2011-P	24	0-90	±5	±12	1	0.025
SPS-2021-P	28	0-80	±6	±14	1	0.025

STYLE "D"

3 WATT PLUG-IN OR SOLDER-HEADER MOUNTING

	MODEL	DC OUTPUT RATING		REGULATION (mV DC)		RIPPLE (mV RMS)	TEMP. COEFF. (%/°F)	MOUNTING STYLE
		VOLTS	CURRENT (mA)	LINE	LOAD			
NARROW ADJUSTMENT RANGE	SPS-2055-P SPS-2055-S	1-6.5	0-300	15	5	1.5	0.03	Plug-In Solder-Header
	SPS-2057-P	9-13	0-200	2	5	0.5	0.02	Plug-In
	SPS-2058-P	13-17	0-175	2	5	0.5	0.02	Plug-In
	SPS-2052-P SPS-2052-S	9-13	0-200	2	5	0.5	0.01	Plug-In Solder-Header
	SPS-2054-P	17-21	0-150	2	5	0.5	0.01	Plug-In
WIDE ADJUSTMENT RANGE	SPS-2101-P	20-30	0-100	10	15	1	0.02	Plug-In
	SPS-2102-P	30-40	0-75	10	15	1	0.02	Plug-In
DUAL VOLTAGE OUTPUT	SPS-2074D-P	±15	0-65	3	6	1	0.02	Plug-In

STYLE "F"

4.5 WATT PLUG-IN OR SOLDER-HEADER MOUNTING

	MODEL	DC OUTPUT RATING		REGULATION (mV DC)		RIPPLE (mV RMS)	TEMP. COEFF. (%/°F)	MOUNTING STYLE
		VOLTS	CURRENT (mA)	LINE	LOAD			
NARROW ADJUSTMENT RANGE	SPS-2062-P SPS-2062-S	1-6.5	0-600 0-800	15	10	1.5	0.03	Plug-In Solder-Header
	SPS-2063-S	5-9	0-600	15	10	1.5	0.03	Solder-Header
WIDE ADJUSTMENT RANGE	SPS-2110-P	10-20	0-200	15	15	1	0.02	Plug-In
	SPS-2111-P	20-30	0-175	15	15	1	0.02	Plug-In
	SPS-2112-P	30-40	0-150	15	15	1	0.02	Plug-In
DUAL VOLTAGE OUTPUT	SPS-2120-P	±12	0-175	5	10	1.5	0.02	Plug-In
	SPS-2121-P	±15	0-150	5	10	1.5	0.02	Plug-In

GENERAL SPECIFICATIONS

Input Voltage
105 to 125 VAC at 50-400 Hz.

Adjustable Output
Voltage adjust potentiometer at the top of all power supplies. (If range is not specified, adjustment is ±5%.)

Floating Output
Positive or negative, output can be grounded, isolated from case and AC line.

DC Isolation
Greater than 100 megohm with 200 VDC applied between output and case.

AC Isolation
Typically 20 picofarad - shield between primary and secondary transformer.

Line Regulation (output voltage variation as input line voltage changes from 105 to 125 VAC)
See ordering table on opposite page.

Load Regulation (output voltage variation due to a change from no load to full rated load current)
See ordering table on opposite page.

Output Impedance
Less than 0.1 ohms (DC to 1KC).

Reverse Current
Fully protected against an application of reverse current.

Remote Sensing
Styles "D" and "F" models have provisions for remoting the point of regulation to the load.

Short Circuit Protection
Electronic protection against accidental short circuit and temporary overloads. (The style "B" has provision for external fusing).

Transient Response
250 mV peak to peak, for a step load change of 10 to 100% for less than 50 millisecond duration. (Not specified for 2210).

Temperature Range
The temperature effect over the usable range of 20°F to 125°F is less than 0.03%/°F. Do not exceed 150°F maximum temperature on base of solder-header styles or permanent damage may result. (Not specified for 2210).

Stability
Long term stability is better than ±0.1% of rated voltage at fixed conditions. Stability is ±0.2% for Style "B" and other models when operating below 9 volts.

PRICING AND DISCOUNTS

The applicable price list is P50000. All models listed on the current price list are stocked at our Nashville plant. Most styles delivered from stock in quantities to 25 pieces F.O.B., Nashville, Tennessee. Prices and specifications on all models are subject to change without notice. When ordering, specify model number and quantity of each item.

Quantity discount schedule follows:

QUANTITY	DISCOUNT
1-9	Base Price
10-24	Base Price Times 0.96
25-49	Base Price Times 0.92
50-99	Base Price Times 0.88
100-199	Base Price Times 0.84

WARRANTY

We warrant our power supplies to be free from defects in workmanship and/or material and to function satisfactorily when properly installed, operated and maintained in accordance with instructions and specifications for a period of 6 months. The warranty becomes effective on the date of shipment.

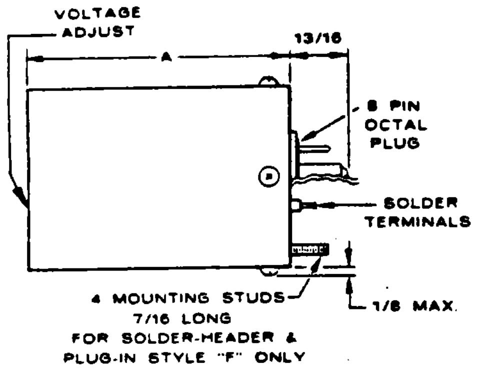
This warranty does not extend to any of our products which have been subject to misuse, neglect, accident, or improper installation or application; nor shall it extend to units which have been repaired or substantially altered by persons other than authorized personnel.

We will, in no way, be liable for damage to other equipment caused by failure or malfunction of equipment built by us.

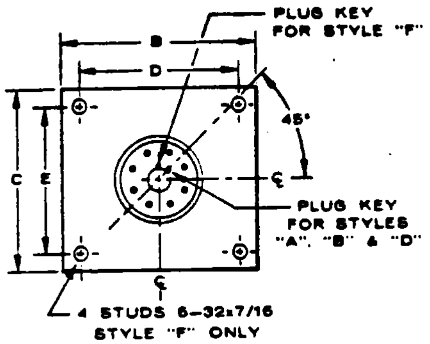
REPAIR POLICY

The warranty obligation is limited to repairing or adjusting of the power supply or parts thereof upon authorized return to the factory, transportation prepaid. Repair or replacement of such equipment, which upon examination proves to be defective due to materials or workmanship, will be completed at no charge and reshipped F.O.B. Nashville. Any power supply returned beyond the time limit warranty, or due to misuse, etc., will be repaired (repair price is approximately half price) or if not repairable, can be replaced at the current price.

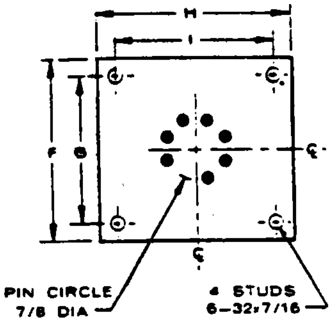
OUTLINE DRAWINGS



ALL STYLES - SIDE VIEW



PLUG-IN STYLES "A", "B", "D" & "F" BOTTOM VIEW



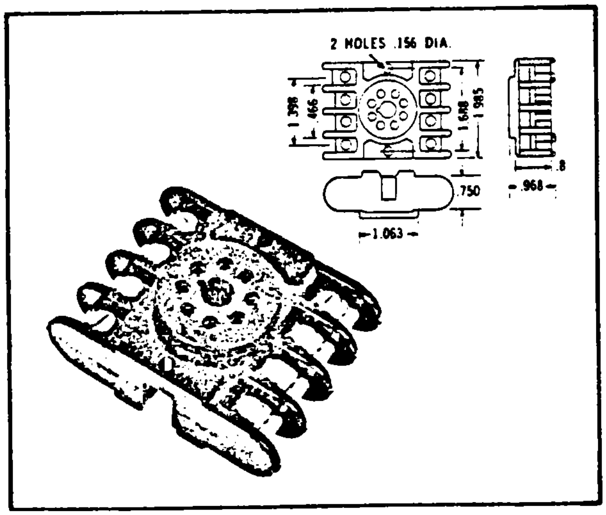
SOLDER-HEADER STYLE "D" BOTTOM VIEW

STYLE	DIMENSIONS, PLUG-IN MODELS									WEIGHT LBS.
	A	B	C	D	E	F	G	H	I	
"A"	2-1/2	1-7/16	1-7/16							3/8
"B"	3	2	2							1/2
"D"	3-1/8	2-1/4	2-1/8			2-1/8	1-1/2	2-1/4	1-1/2	1
"F"	3-15/16	3-1/16	2-15/16	1-7/8	2-9/32					2

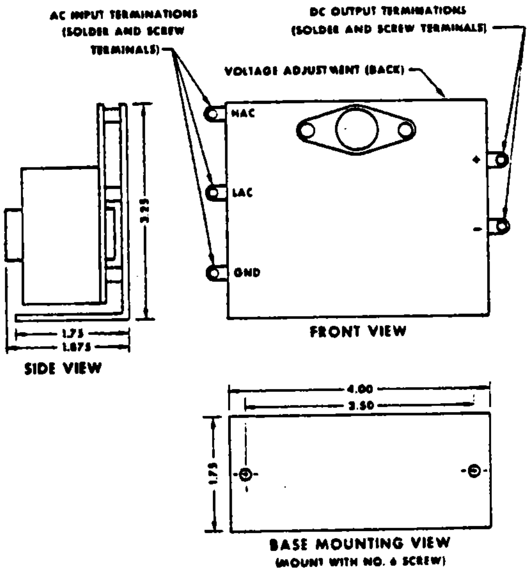
SCREW-DOWN SOCKET WITH MOLDED BARRIER STRIPS

Part Number: N0012-00170

This Amphenol Model 146-104 socket can be used to connect plug-in power supplies into a circuit without soldering. Both mounting and terminal connection problems are quickly solved by using this socket. The socket can be mounted above or below the chassis. Voltage rating is 1250 volts RMS at 5 amp. Mounting screws are not supplied.



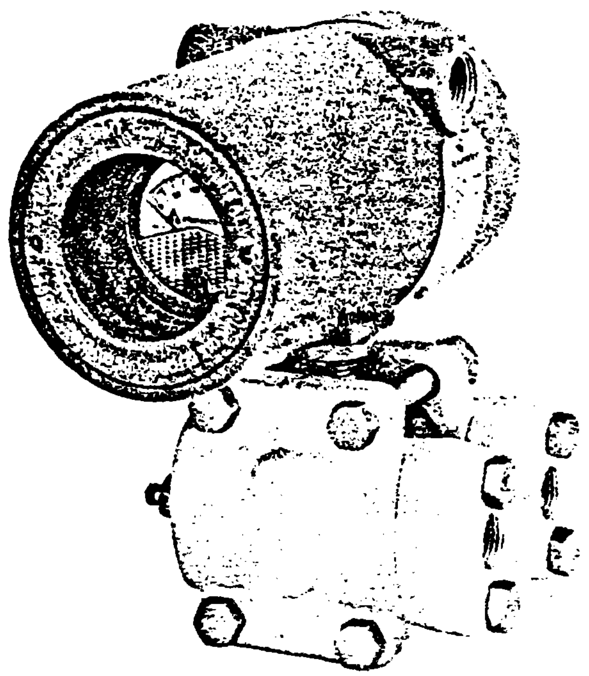
2210 OUTLINE



®Rosemount

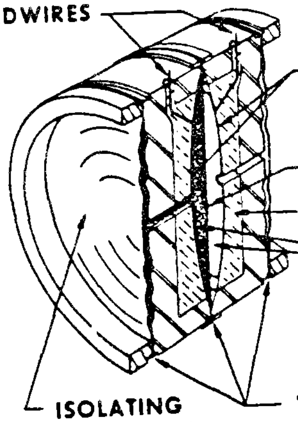
(Replaces PDS 2197)

MODEL 1151HP ALPHALINE DIFFERENTIAL PRESSURE TRANSMITTER FOR HIGH LINE PRESSURES



4500 psi operating pressure
6750 psi test pressure
Ranges from 25" H_2O to 300 psid
Compatible with any 2-wire system
0.25% accuracy
On 4-20 mA output:

- *Up to 600% elevation or 500% suppression*
- *Adjustable damping*



THE δ-CELL

FEATURES

The ALPHALINE® Differential Pressure Transmitter* now provides accurate differential measurement for line pressures up to 4500 psi. Confident application in high line pressure systems is assured with static pressure protection to 6750 psi and full overpressure protection to 4500 psi without damage to the transmitter. Direct electronic sensing with the completely sealed δ-CELL™ capacitance sensing element eliminates mechanical force transfer and the associated problems with vibration and shock.

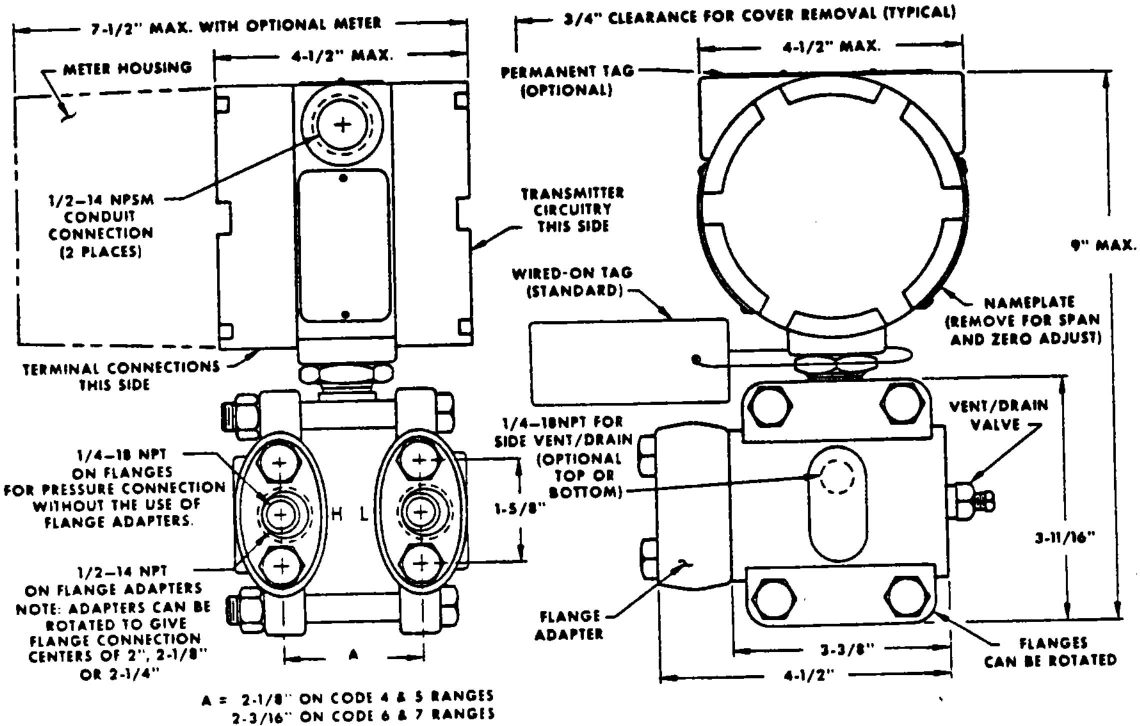
Installation and commissioning are simplified by compact design, 2-wire system compatibility, external span and zero adjustments and explosion-proof, weather-proof construction. Wiring terminals and electronics are in separate compartments, so the electronics remain sealed during installation. Reverse polarity protection keeps wiring mishaps from costing money. Maintenance costs are reduced by the use of solid state plug-in printed circuit boards which are interchangeable among all Rosemount 1151 transmitters.

OPERATION

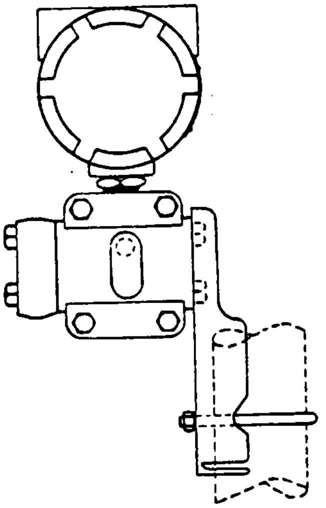
Process pressure is transmitted through isolating diaphragms and silicone oil fill fluid to a sensing diaphragm in the center of the δ-CELL. The sensing diaphragm functions as a spring element which deflects in response to differential pressure across it. The displacement of the sensing diaphragm, a maximum motion of 0.004 inches, is proportional to the differential pressure. The position of the sensing diaphragm is detected by capacitor plates on both sides of the sensing diaphragm. The differential capacitance between the sensing diaphragm and the capacitor plates is converted electronically to a 2-wire, 4-20 mADC or 10-50 mADC signal.

Rosemount

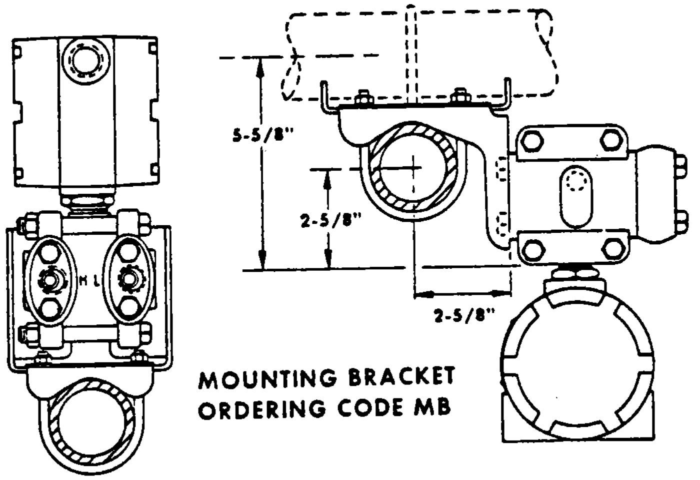
Dimensional Drawings



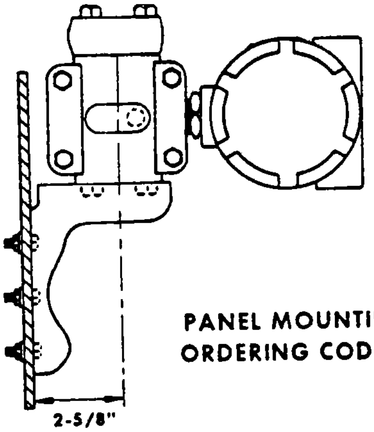
OPTIONAL MOUNTING BRACKETS
SHOWN IN TYPICAL MOUNTING CONFIGURATIONS



FLAT MOUNTING BRACKET
ORDERING CODE FB



MOUNTING BRACKET
ORDERING CODE MB



PANEL MOUNTING BRACKET
ORDERING CODE PB

1.2.23-462

Functional Specifications

Service

Liquid, gas or vapor.

Ranges

0-25/150" H_2O
0-125/750" H_2O
0-17/100 psid
0-50/300 psid

Outputs

4-20 mADC or 10-50 mADC.

Power Supply

External power supply required.
4-20 mADC: Up to 45 VDC.
Transmitter operates on 12 VDC with no load.
10-50 mADC: Up to 85 VDC.
Transmitter operates on 30 VDC with no load.

Load Limitations

See Figure 1.

Indication

Optional meter with 1-3/4" scale. Indication accuracy is ±2%.

Hazardous Locations

Explosion proof: Approved by Factory Mutual for Class I, Division 1, Groups B*, C and D; Class II, Division 1, Groups E, F and G; and Class III, Division 1. Certification by Canadian Standards Association (CSA) for Class I, Groups C and D available as an option. **Intrinsically safe:** FM or CSA certification optional for Class I, Division 1, Groups B, C and D when used with listed barrier systems.

Span and Zero

Continuously adjustable externally.

Zero Elevation and Suppression

Regardless of output specified, zero elevation and suppression must be such that neither the span nor the upper or lower range value, exceed 100% of the upper range limit.
4-20 mADC Maximum zero elevation: 600% of calibrated span. Maximum zero suppression: 500% of calibrated span.
10-50 mADC Range 4 or 5 maximum elevation or suppression: 150% of span. Range 6 or 7 maximum elevation or suppression: 50% of span.

Temperature Limits

−20°F to +200°F Amplifier operating.
−40°F to +220°F Sensing element operating.
−60°F to +250°F Storage.

Static Pressure and Overpressure Limits

Maximum rated static line pressure (operating): 4500 psig.
Maximum static line pressure (without damage): 150% of rated (6750 psig). 4500 psig pressure on either side without damage to the transmitter. 10,000 psig proof pressure on flanges.

Humidity Limits

0-100% RH.

Volumetric Displacement

Less than 0.01 cubic inches.

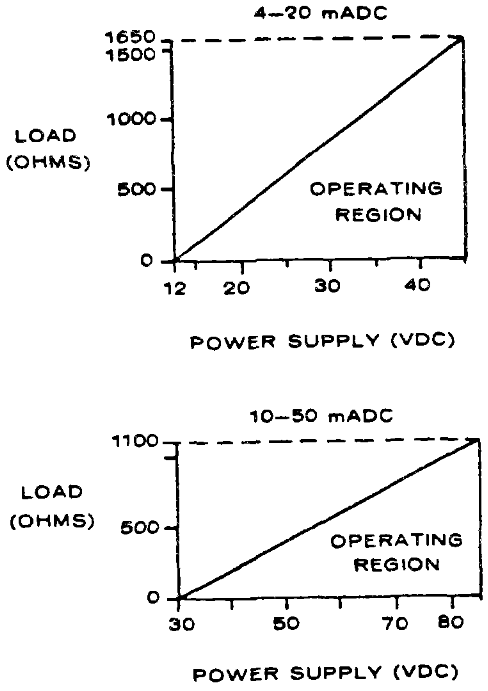
Damping

4-20 mADC: Time constant continuously adjustable between 0.2 and 1.67 seconds.
10-50 mADC: Time constant fixed at 0.2 second for ranges 4 and 5, and 0.1 second for ranges 6 and 7.

Turn-on Time

2 seconds. No warmup required.

FIGURE 1
LOAD LIMITATIONS



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*Optional meter not approved for Group B.

Performance Specifications

(ZERO BASED SPANS, REFERENCE CONDITIONS)

Accuracy

±0.25% of calibrated span. Includes combined effects of linearity, hysteresis and repeatability.

Dead Band

None

Stability

±0.25% of upper range limit for six months.

Temperature Effect

At Maximum Span (e.g. 0-100 psid for 0-17/100 psid range)

Zero Error: ±0.5% of span per 100°F. Total effect including span and zero errors: ±1.0% of span per 100°F.

At Minimum Span (e.g. 0-17 psid for 0-17/100 psid range)

Zero Error: ±3.0% of span per 100°F. Total effect including span and zero errors: ±3.5% of span per 100°F.

Overpressure Effect

Overpressure of 4500 psi will cause a zero shift of
less than ±1.0% of upper range (Range 4)
less than ±2.0% of upper range (Range 5)
less than ±5.0% of upper range (Range 6, 7)

Static Pressure Effect

Zero Error: ±2.0% of upper range limit for 4500 psi.

Span Error: −1.0±0.25% of reading per 1000 psi. This is a systematic error which can be calibrated out for a particular pressure before installation.

Vibration Effect

±0.05% of upper range limit per g to 200 Hz in any axis.

Power Supply Effect

Less than 0.005% of output span per volt.

Load Effect

No load effect other than the change in power supplied to the transmitter.

Mounting Position Effect

Zero shift of up to 1" H_2O which can be calibrated out. No span effect. No effect in plane of diaphragm.

Physical Specifications

Materials of Construction†

Isolating Diaphragms and Drain/Vent Valves:
316SS.

Process Flanges and Adapters:
Cadmium Plated Carbon Steel or 316SS.

Wetted O-Rings:
VITON.

Fill Fluid:
Silicone Oil.

Bolts:
Cadmium Plated Carbon Steel.

Electronics Housing:
Low-copper aluminum (NEMA4)

Paint:
Polyester-Epoxy.

Process Connections

1/4 NPT on flanges. 1/2 NPT with adapters.

Electrical Connections

1/2-inch conduit with screw terminals and integral test jacks compatible with miniature banana plugs (Pomona 2944, 3690 or equal).

Weight

12 pounds excluding options.

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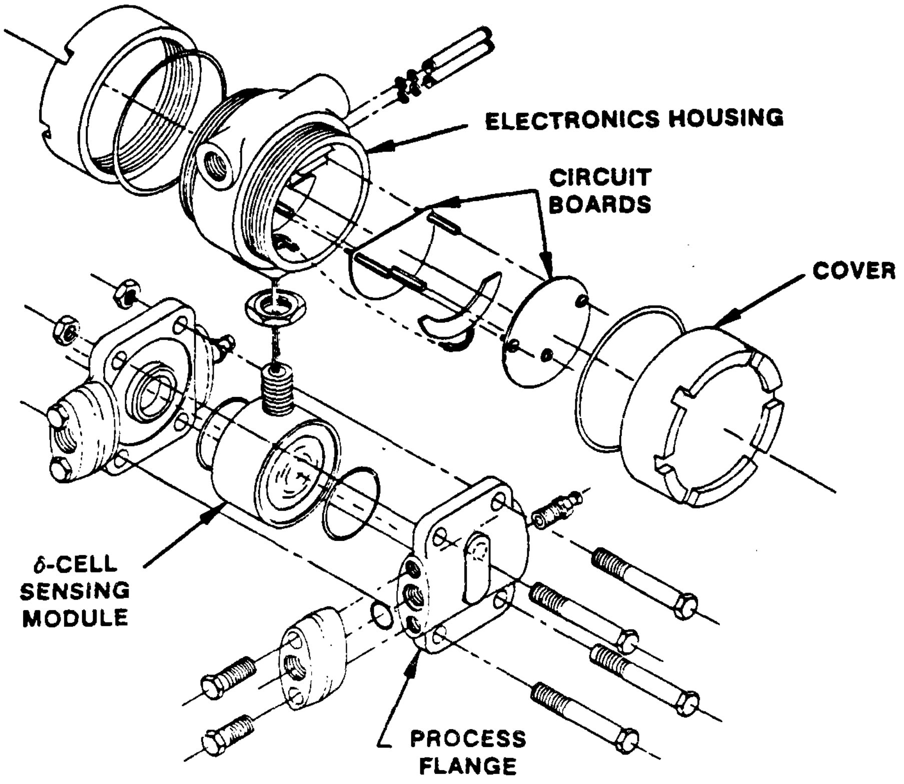
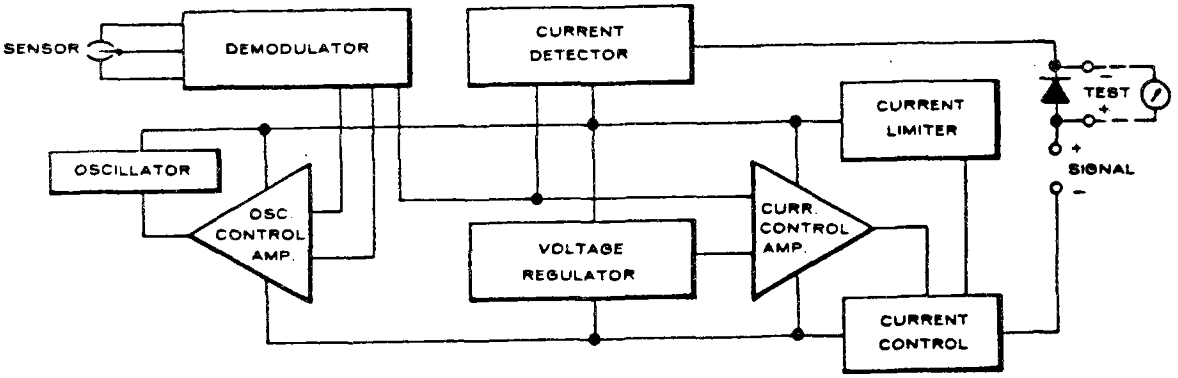
†VITON is a DuPont trademark.
Terminology per SAMA Standard PMC20.1-1973

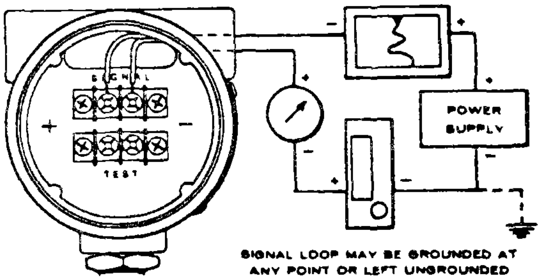
Typical Model 1151 Pressure Transmitter Assembly



Electrical Block Diagram



Wiring Connections



SIGNAL LOOP MAY BE GROUNDED AT ANY POINT OR LEFT UNGROUNDED

STANDARD ACCESSORIES All Models are shipped with flange adapters, vent/drain valves and one instruction manual per shipment.

TAGGING ALPHALINE Differential Pressure Transmitters will be tagged in accordance with customer requirements. All tags are stainless steel.

CALIBRATION Transmitters are factory calibrated to customer's specified range. If calibration is not specified, transmitters are calibrated at maximum range. Calibration is at ambient temperature and pressure.

Ordering Information

MODEL	
1151HP	ALPHALINE DIFFERENTIAL PRESSURE TRANSMITTER

CODE	RANGES
4	0-25 to 0-150 inches H_2O (0-635 to 0-3810 mm H_2O)
5	0-125 to 0-750 inches H_2O (0-3175 to 0-19,050 mm H_2O)
6	0-17 to 0-100 psid (0-1.2 to 0-7.0 kg/cm²)
7	0-50 to 0-300 psid (0-3.5 to 0-21 kg/cm²)

CODE	OUTPUT
E	4-20 mADC w/adjustable damping
B	10-50 mADC w/fixed damping

	MATERIALS OF CONSTRUCTION		
CODE	FLANGES AND ADAPTERS	DRAIN/VENT VALVES	ISOLATING DIAPHRAGMS
12	Cadmium Plated C.S.	316SS	316SS
22	316SS	316SS	316SS

CODE	OPTIONS
LM	Linear Meter, 0-100% scale
SM	Square Root Meter, 0-10 scale
MB	Optional Mounting Bracket for Mounting to 2" Pipe
PB	Optional Mounting Bracket for Panel Mounting
FB	Optional Flat Mounting Bracket for Mounting to 2" Pipe
D1	Side Vent/Drain, Top
D2	Side Vent/Drain, Bottom
CE	Canadian Standards Association (CSA) Explosion Proof Certification for Class I, Groups C and D; Class II, Groups E, F and G; Class III; (Encl. IV).

INTRINSIC SAFETY APPROVAL (All Are Used With Output Code E)

	AGENCY	BARRIER MANUFACTURER	BARRIER MODEL	CLASS I, DIV. 1, GROUPS B	C	D
F1	FM	Foxboro	2AI-12V-FGB, 2AI-13V-FGB	X	X	X
F2	FM	Taylor	124S1134, 124S1144 124S931, 124S932 124S1254, 124S1264	X	X X X	X X X
F3	FM	Westinghouse	75SB01 56FC12	X	X X	X X
F4	FM	Leeds & Northrup	316509, 316747	X	X	X
F5	FM	Fischer & Porter	805H023U01, 805H027U01 805H027U02	 X	X X	X X
F6	FM	Fisher Controls	AC302		X	X
F7	FM	Honeywell	38545-XXXX-0110 -113-F5B5 -111/112-F5B5	 X	 X X	 X X
C1	CSA	Any CSA Approved < 30V & > 120Ω			X	X
C2	CSA	Foxboro	2AI-13V-CBG, 2AI-12V-CBG	X	X	X
C3	CSA	Fisher Controls	AC302		X	X

1151HP	4	E	22	LM, MB	← COMPLETED DESIGN SPECIFICATION

OPTIONAL THREE-VALVE MANIFOLDS (Packaged Separately)

Part No. 1151-150-1:** 3-Valve Manifold, Carbon Steel (Anderson, Greenwood and Co., M4AVC)

Part No. 1151-150-2:** 3-Valve Manifold, 316SS (Anderson, Greenwood and Co., M4AVS)

**Available only for range codes 4 and 5.

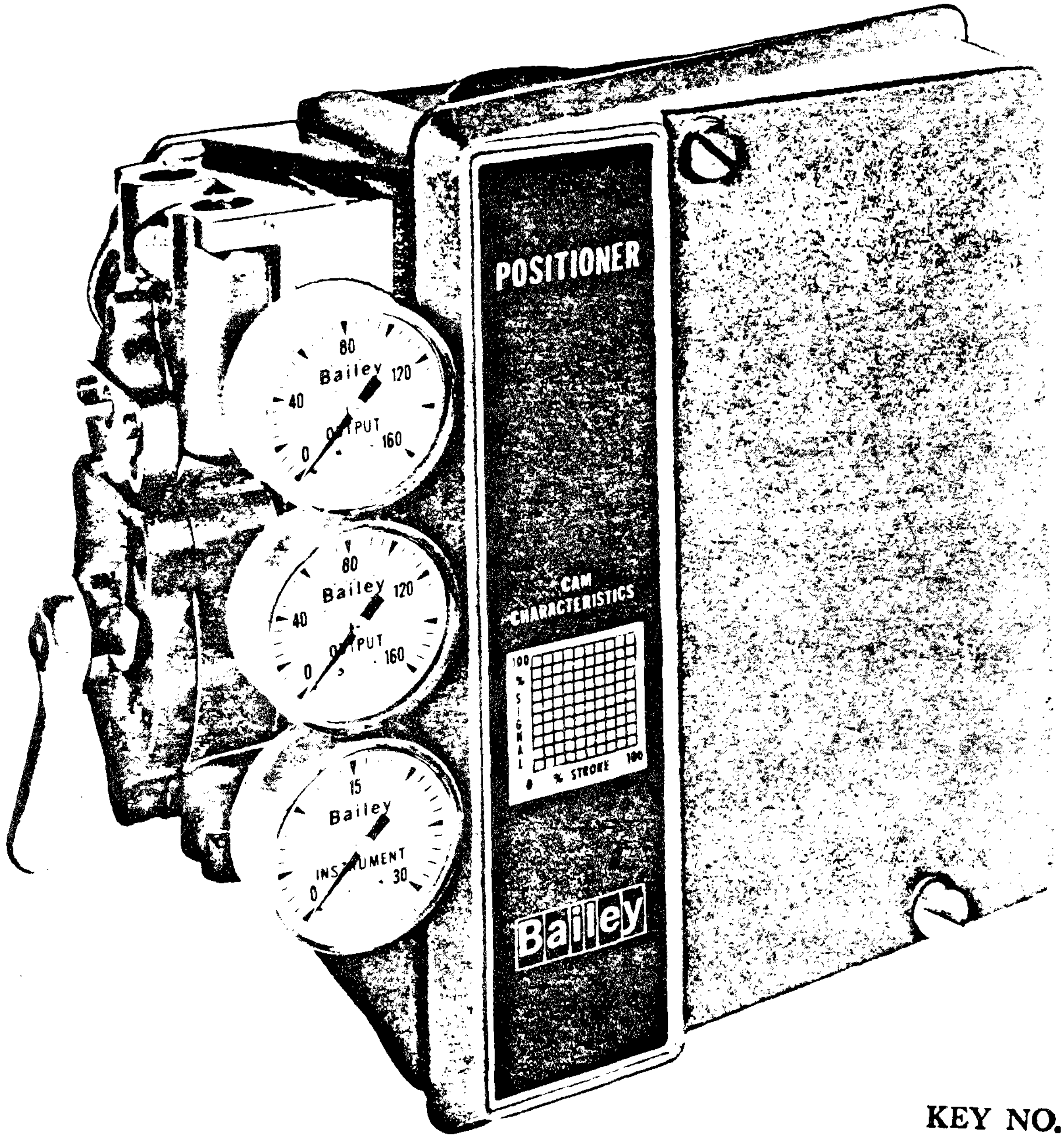
Rosemount Inc. POST OFFICE BOX 35129 MINNEAPOLIS, MINNESOTA 55435
PHONE: (612) 941-5560 TWX: 910-576-3103 TELEX: 29-0183 CABLE: ROSEMOUNT

Bailey Control Systems

Product Instruction
P88-7

Characterizable Pneumatic Positioner

Type AP2



KEY NO. 43

Babcock & Wilcox
Bailey Meter Company, U.S.A.

Form I-P88-7 Litho in U.S.A. 277

1.2.23-467

WARNING

DO NOT INSTALL, MAINTAIN OR OPERATE THIS EQUIPMENT WITHOUT READING, UNDERSTANDING AND FOLLOWING PROPER Bailey Babcock & Wilcox INSTRUCTIONS AND MANUALS, OTHERWISE INJURY OR DAMAGE MAY RESULT.

INDEX

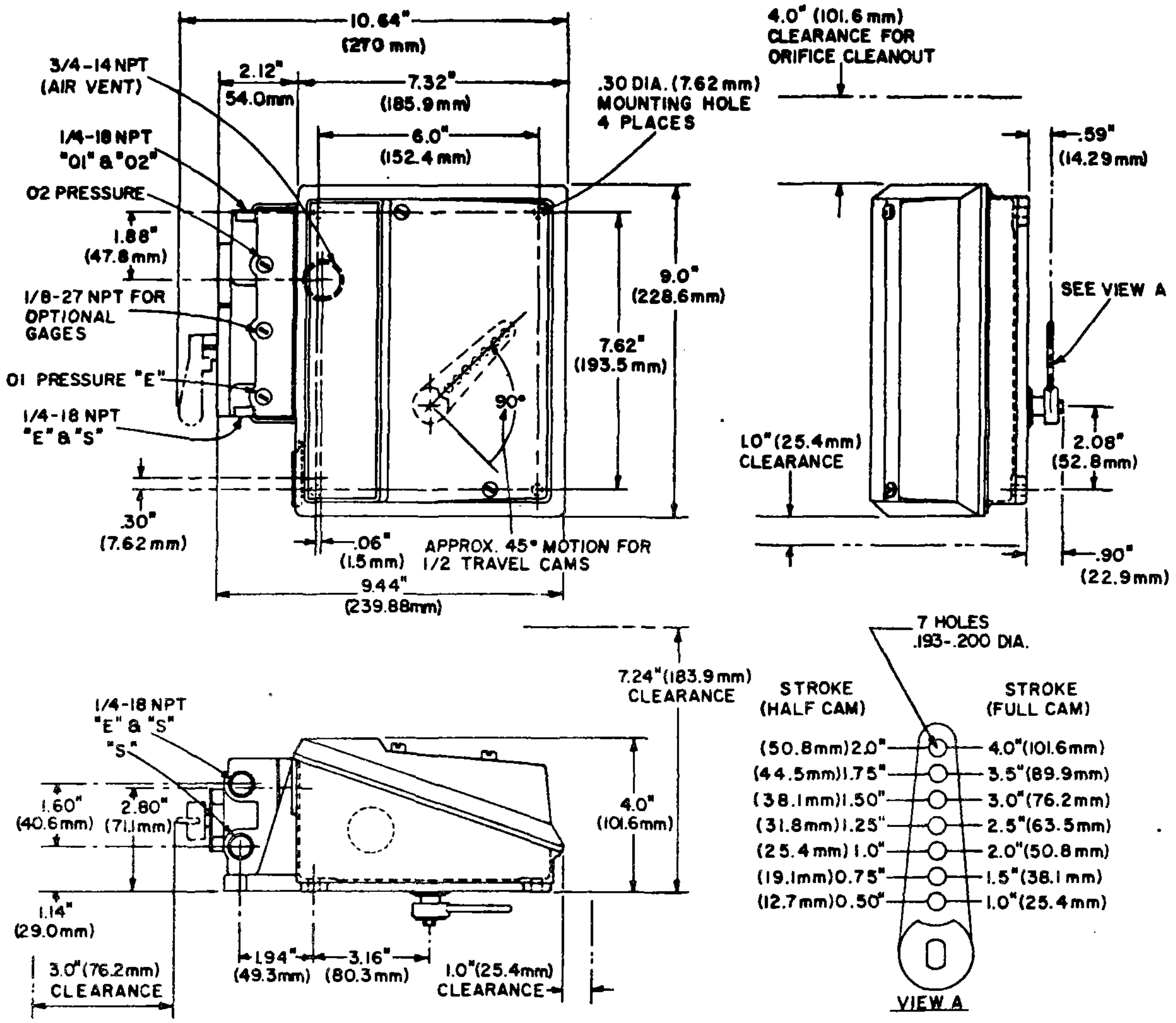


FIGURE 1 - Mounting and External Dimensions of Type AP2 Characterizable Pneumatic Positioner

INSTALLING THE POSITIONER

UNPACKING

1. Check for any obvious damage to shipping carton.

2. Open carton and remove all loose packing.

3. Carefully remove Positioner from carton and inspect for any physical damage which may have occurred during shipping.

4. Remove two cover screws and Positioner cover and examine interior for any loose components, such as nuts, screws, springs, etc. Check data on nameplate (located at right side of cam) for correct Type, Series and Signal Range.

CAUTION: Before mounting or installing Positioner, check nameplate data to make certain Positioner is suitable for application desired. DO NOT AT ANY TIME EXCEED THE RATINGS LISTED ON THE NAMEPLATE.

5. If any damage to Positioner is evident, refer to inside front cover of this Instruction Book. If Positioner appears undamaged, replace cover and proceed with installation instructions.

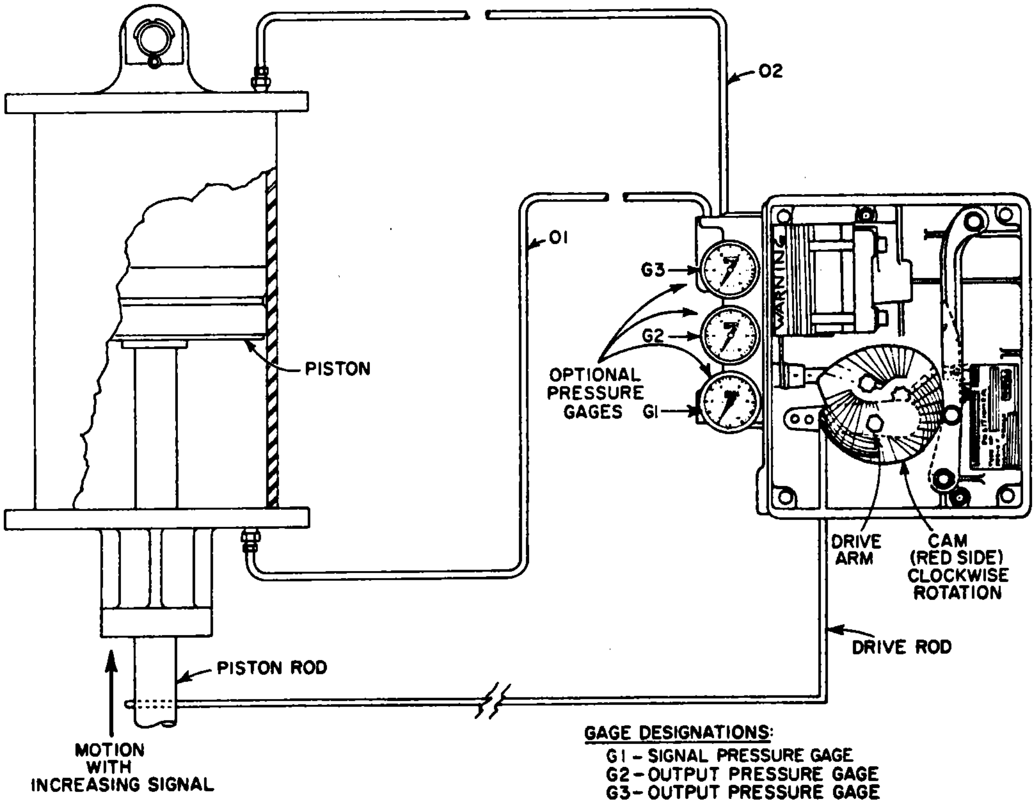
INSTALLATION

The Characterizable Pneumatic Positioner, Type AP2, can be applied to double-acting cylinder applications or single-acting diaphragm actuator applications.

CAUTION: The positioner can be installed in any position with proper recalibration. It should be noted that certain installation methods will not stroke the power operator to a fail-safe condition if the controller fails to send a signal. Bailey Meter Co. strongly recommends that, for increased safety, an installation method be selected to provide a fail-safe mode when loss of controller signal is experienced. Mounting and external dimensions of Type AP2 Positioner are shown in Figure 1.

Double-Acting Cylinder Applications

When the Positioner is applied to a double-acting cylinder assembly, the piston rod is normally connected thru suitable linkage to position a valve, damper or other regulating device. Position of the power operator is normally tied back to the Positioner drive arm thru a drive rod (other tie back methods may be used depending on application). The drive arm is fixed to the positioning cam which is shaped to give a desired characteristic of power operator position versus input demand control signal. Positioner mounting and pneumatic connections must be such that an increasing control signal will extend (stretch) the range spring.



GAGE DESIGNATIONS:
G1 - SIGNAL PRESSURE GAGE
G2 - OUTPUT PRESSURE GAGE
G3 - OUTPUT PRESSURE GAGE

NOTES:
FOR A DOWNWARD MOTION WITH INCREASING SIGNAL, USE BLACK SIDE OF CAM (COUNTER CLOCKWISE ROTATION) AND REVERSE O1 AND O2 CONNECTIONS.

IN ANY INSTALLATION, DIRECTION OF PISTON TRAVEL FOR A GIVEN SIGNAL CHANGE CAN BE REVERSED BY USING OPPOSITE SIDE OF CAM AND SWITCHING O1 AND O2 CONNECTIONS.

FIGURE 2 - Typical Positioner Installation Mounted on Double-Acting Cylinder

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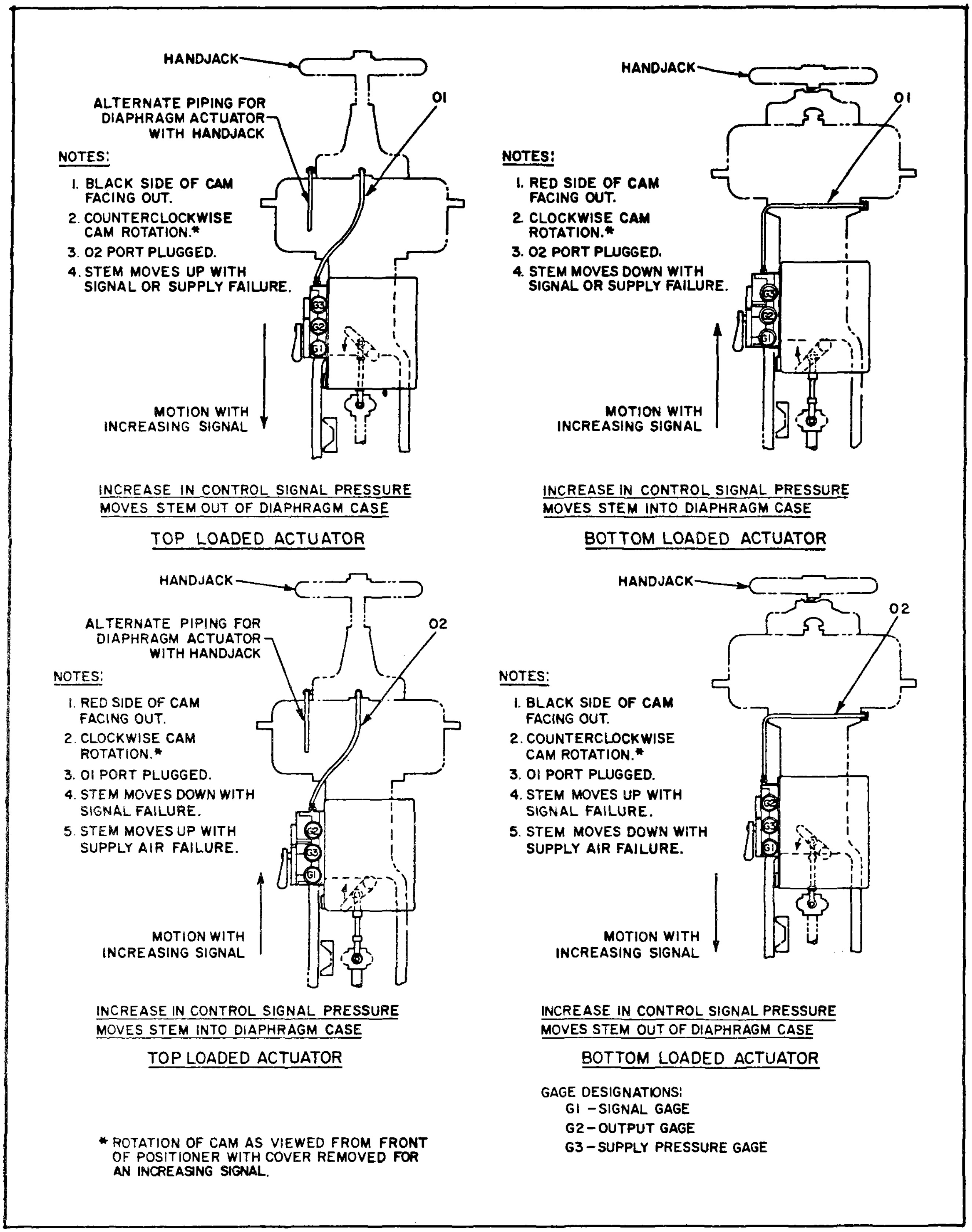


NOTES:

1. BLACK SIDE OF CAM FACING OUT.
2. COUNTERCLOCKWISE CAM ROTATION.*
3. 02 PORT PLUGGED.
4. STEM MOVES UP WITH SIGNAL OR SUPPLY FAILURE.

INCREASE IN CONTROL SIGNAL PRESSURE MOVES STEM OUT OF DIAPHRAGM CASE

TOP LOADED ACTUATOR

NOTES:

1. RED SIDE OF CAM FACING OUT.
2. CLOCKWISE CAM ROTATION.*
3. 02 PORT PLUGGED.
4. STEM MOVES DOWN WITH SIGNAL OR SUPPLY FAILURE.

INCREASE IN CONTROL SIGNAL PRESSURE MOVES STEM INTO DIAPHRAGM CASE

BOTTOM LOADED ACTUATOR

NOTES:

1. RED SIDE OF CAM FACING OUT.
2. CLOCKWISE CAM ROTATION.*
3. 01 PORT PLUGGED.
4. STEM MOVES DOWN WITH SIGNAL FAILURE.
5. STEM MOVES UP WITH SUPPLY AIR FAILURE.

INCREASE IN CONTROL SIGNAL PRESSURE MOVES STEM INTO DIAPHRAGM CASE

TOP LOADED ACTUATOR

NOTES:

1. BLACK SIDE OF CAM FACING OUT.
2. COUNTERCLOCKWISE CAM ROTATION.*
3. 01 PORT PLUGGED.
4. STEM MOVES UP WITH SIGNAL FAILURE.
5. STEM MOVES DOWN WITH SUPPLY AIR FAILURE.

INCREASE IN CONTROL SIGNAL PRESSURE MOVES STEM OUT OF DIAPHRAGM CASE

BOTTOM LOADED ACTUATOR

* ROTATION OF CAM AS VIEWED FROM FRONT OF POSITIONER WITH COVER REMOVED FOR AN INCREASING SIGNAL.

GAGE DESIGNATIONS:
G1 – SIGNAL GAGE
G2 – OUTPUT GAGE
G3 – SUPPLY PRESSURE GAGE

FIGURE 3 - Typical Positioner Installation Mounted on Single-Acting Diaphragm Actuator

1.2.23-471

In any installation, the direction of piston travel for a given signal change can be reversed by using the opposite side of the cam and reversing the O1 and O2 output connections (Figure 2).

If the Positioner is included with a double-acting cylinder assembly, tubing connections between the Positioner and the power operator would be as illustrated in Figure 2. Pressure gages are optional and are not included unless specified when ordering Positioner.

If it is necessary to complete the pneumatic connections to the Positioner, refer to Product Instruction G18-2 for tubing methods and precautions.

Single-Acting Diaphragm or Spring-Loaded Actuator Applications

When the Positioner is applied to a single-acting actuator assembly, the valve stem is normally connected thru suitable linkage to accurately position an inner valve in response to a control demand signal. Position of the valve stem (or inner valve) is normally tied back to the Positioner thru a drive rod which is attached to the Positioner drive arm. The drive arm is fixed to the positioning cam which is shaped to give a desired characteristic of inner valve position versus input demand control signal. Positioner mounting and pneumatic connections must be such that an increasing control signal will extend (stretch) the range spring.

In any installation, the direction of valve stem travel for a given signal change can be reversed by using the opposite side of the cam, plugging the output connection being used and connecting tubing to the remaining output connection (Figure 3).

If the Positioner is included with a control valve furnished by Bailey Meter Company, it is mounted on the valve yoke and piped to the actuator as illustrated in Figure 3. Pressure gages are optional and are not included unless specified when ordering Positioner.

If it is necessary to complete the pneumatic connections to the Positioner, refer to Product Instruction G18-2 for tubing methods and precautions.

SUPPLY PRESSURE

Supply pressure range is 18 to 150 psi. Because of the minimal effect of supply pressure variations on output positions, a regulated supply is not normally required for either application. However, for single-acting diaphragm actuator applications, a minimum supply pressure of 5 psi over maximum input signal range (20 psi for 3-15 psi unit or 32 psi for 3-27 psi unit) must be maintained.

WARNING: TYPE AP2 POSITIONERS ARE SUITABLE FOR MAXIMUM AIR SUPPLY PRESSURE OF 150 PSIG. ADHERENCE TO THIS LIMITATION WILL ENSURE SATISFACTORY PERFORMANCE. DO NOT SUPPLY PRESSURE TO THE POSITIONER IN EXCESS OF THAT WHICH THE RELATED ACTUATOR OR CYLINDER CAN SAFELY ACCEPT.

NOTE: It is recommended that a filter or dripwell be installed in the supply line to prevent improper operation of the Positioner due to entrained moisture or dirt.

PLACING IN SERVICE

Make the following adjustment checks to insure correct operation of the valve actuator or cylinder assembly and the Positioner before placing in operation.

1. Make certain connecting linkage, brackets and any mounting hardware are secure.

2. Make certain supply, input control signal and output pressure connections are tight. Check for leakage, while under pressure, with soapsuds solution.

3. If optional pressure gages were furnished, make certain gages are installed in correct location for application (Figure 2 or 3) and all connections are tight. Check for leakage, while under pressure, with soapsuds solution.

4. Perform procedures outlined under "Calibrating the Positioner" to check output pressure level adjustment and to set zero and range adjustments for the required application prior to placing the Positioner in service.

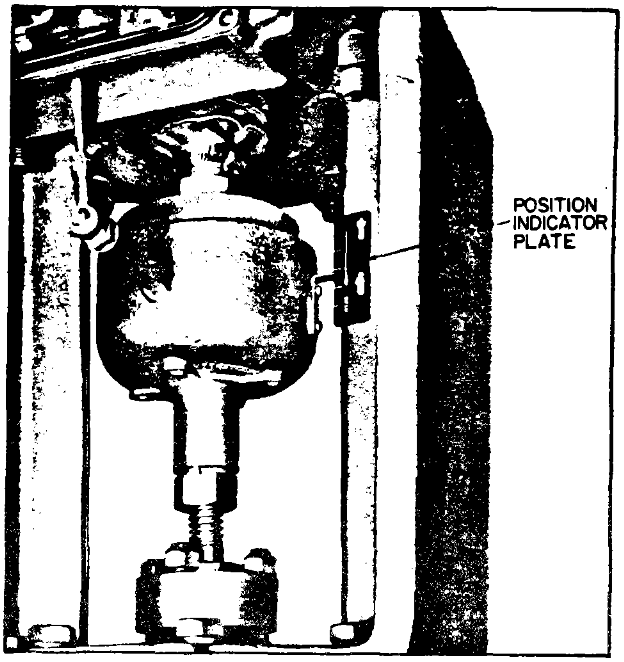


FIGURE 4 - Typical Position Indicator Plate Mounted on Valve Actuator Yoke

NOTE: It is recommended that a position indicator plate be fabricated and installed on valve actuator yoke (or cylinder) and a pointer be installed on valve stem (or piston rod) to indicate full OPEN and full CLOSED travel of power operator (Figure 4).

ROUTINE SERVICING

1. Once each year, check all air connections for leakage, while under pressure, with a soapsuds solution.

2. Maintain a clean air supply (free of dirt, oil or moisture) to assure satisfactory operation of Positioner. If recommended filter is installed (refer to "Supply Pressure") in supply line, remove and clean if necessary.

3. Whenever power operator is out of service (or when required), remove Positioner output valves as outlined under "Troubleshooting" and clean with an aliphatic hydrocarbon solvent (i.e., gasoline or kerosene).

WARNING: USE SOLVENT IN A WELL-VENTILATED AREA. AVOID PROLONGED OR REPEATED BREATHING OF VAPORS. AVOID PROLONGED OR REPEATED CONTACT WITH SKIN. DO NOT USE NEAR OPEN FLAME.

4. Periodically check orifice and nozzle for deposits and clean if necessary as outlined under "Troubleshooting".

5. Once each year (or when required), check adjustment and calibration of Positioner and power operator as outlined under "Calibrating the Positioner".

6. Also, if Positioner is equipped with optional integral shut off and equalizing valve, clean valve assembly and cavity each year with aliphatic hydrocarbon solvent. Disassemble by removing valve handle and valve retainer (Figure 23, items 16 and 15) and lifting out valve assembly (17). Inspect o-rings (13 and 14) and replace if necessary. Re-lubricate with minimum amount of o-ring lube (Dow Corning No. 4 or equivalent) and reassemble.

NOTE: Be sure same shims are installed between valve assembly (17) and valve retainer (15).

TROUBLESHOOTING

If trouble occurs which is definitely traced to the Positioner, check supply pressure, input and output pressure connections and mechanical linkage adjustments before removing from service. If no obvious defects are noted, refer to "Fault Correction Chart". Locate applicable heading for type of Positioner failure encountered. Correct procedures for checking or replacing various components are listed below.

WARNING: MAKE CERTAIN POSITIONER IS DISCONNECTED FROM SUPPLY PRESSURE SOURCE OR REMOVED FROM SERVICE BEFORE ATTEMPTING ANY REPAIR OR REPLACEMENT PROCEDURES.

CLEANING NOZZLE ORIFICE

(Refer to Figure 5)

NOTE: Diameter of hole in orifice is approximately 0.016-inch. Dirt or foreign particles could easily be trapped in orifice before reaching nozzle.

1. An access hole on top of Positioner cover is provided for servicing or cleaning nozzle orifice. Remove pipe plug from nozzle chamber section of relay assembly using a 5/32-inch allen wrench to gain access to orifice.

2. Use a wire approximately 0.015-inch in diameter and remove any dirt or foreign particles obstructing orifice hole.

WARNING: USE EXTREME CARE WHEN CLEANING ORIFICE TO PREVENT SCRATCHING OR ENLARGING ORIFICE HOLE. ENLARGING HOLE COULD AFFECT "GAIN" CHARACTERISTICS OF POSITIONER.

3. Reassemble pipe plug in nozzle chamber section of relay assembly.

REPLACING RELAY ASSEMBLY

NOTE: To remove the Positioner from the case, refer to Figure 22 for identification of item numbers listed parenthetically in steps 1 thru 4 only.

1. Remove cam (34) from cam shaft (33).

2. Disconnect range spring (4) from spring retainer (15).

3. If Positioner is equipped with gain suppression accessory kit (items 7 thru 11), remove kit as follows:

a. Remove two screws (9), lockwashers (10) and small washers (11) from base assembly (13).

b. Disassemble retainer (8) and spring (7).

4. Remove two screws (30) from rear of base assembly (13) and carefully remove Positioner assembly (3).

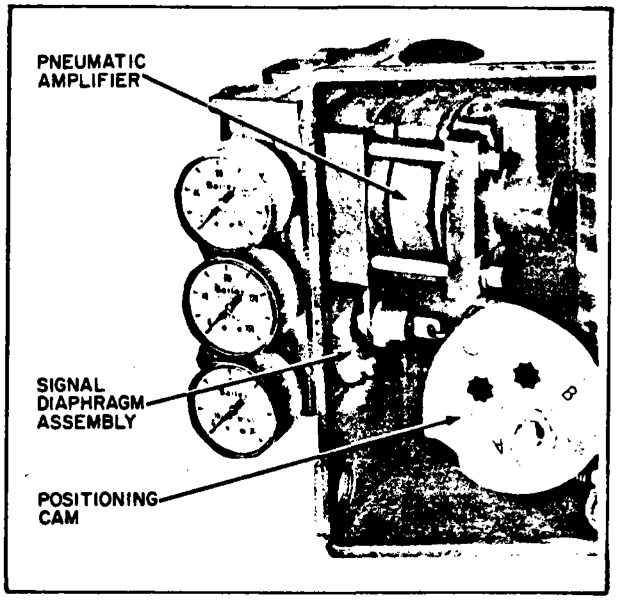
5. To remove signal nut (40), place a 9/16-inch thin head or tappet, open end wrench on hex of signal diaphragm assembly (26) guide to secure guide in position and prevent rotation (Figure 6). With guide held firmly, place a 3/4-inch open end wrench on flats of signal nut (40). Remove signal nut and spring retainer (39) from threaded section of guide.

NOTE: Spring retainer (39) is loctite sealed into signal nut (40) and should not have to be separated.

CAUTION: Damage could result to signal diaphragm assembly if guide is not held in position when removing signal nut.

6. Remove tabbed retainer (25) from signal diaphragm assembly (26) guide.

7. Remove screws (46) and lockwashers (47) securing base mainfold assembly (36), relay assembly (27) and manifold assembly (8) in position. (Dowel pins in both ends of relay assembly prevent rotation of assemblies after cap screws have been removed.)



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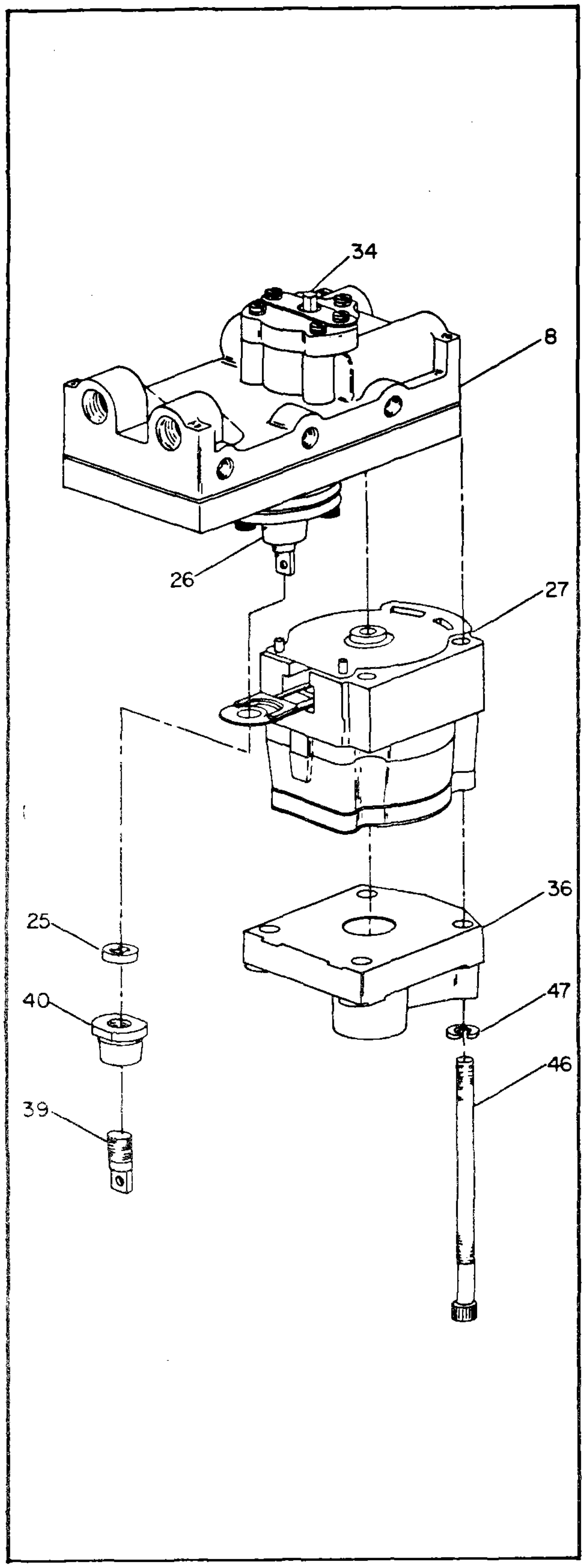


FIGURE 6 - Replacing Relay Assembly

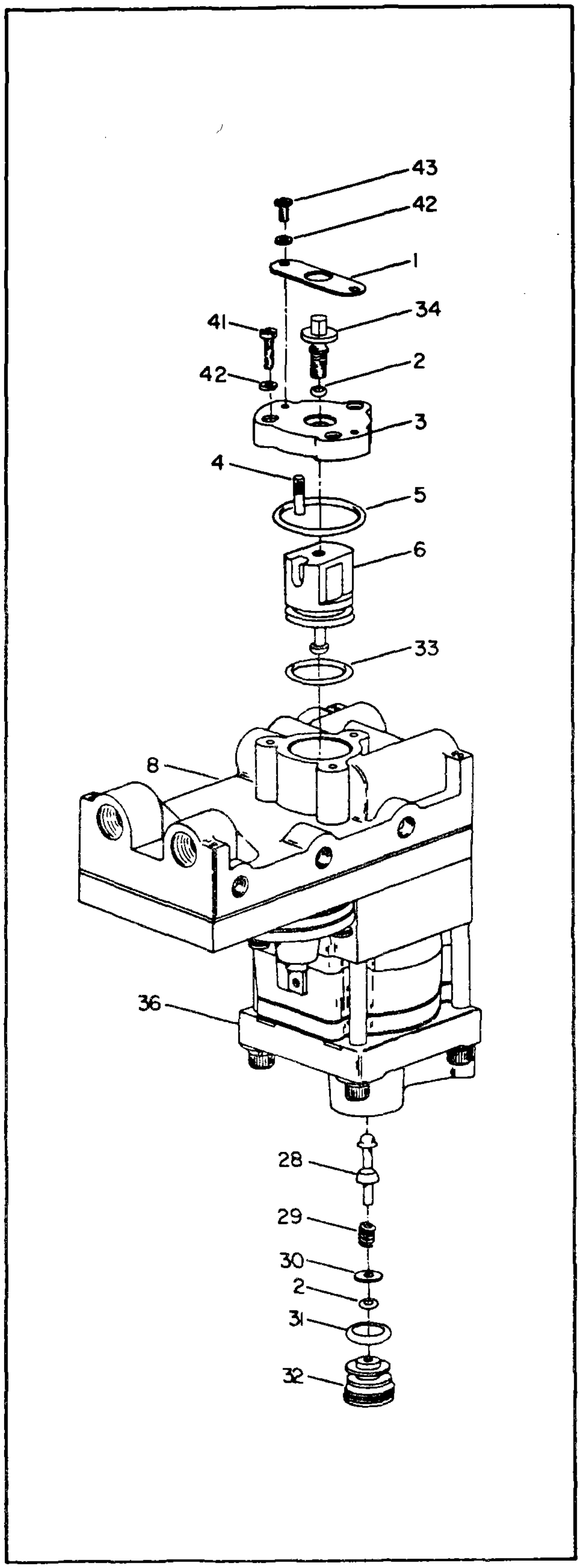


FIGURE 7 - Replacing Output Valves

8. Remove base manifold assembly (36).

9. When removing relay assembly (27), guide vane by hand until vane is clear of signal diaphragm assembly (26) guide.

10. To install new relay assembly, reverse steps 3 thru 9 above. Tighten four screws (46) uniformly in rotation, 70 to 75 in. lb. Wait 15 minutes and retorque screws.

CAUTION: To prevent damage to relay assembly, make certain exposed diaphragms (at each end of relay assembly) are in flat, relaxed position before tightening screws (46). Also, be sure that dowel pins which protrude from each end of relay, enter holes in mating parts before tightening screws.

11. Make a preliminary setting of small slotted set screw in vane assembly so that set screw point lifts vane overtravel hinge end away from vane assembly approximatelv 1/64".

12. Complete reassembly of relay into Positioner by reversing steps 1 and 2.

13. Recalibrate Positioner for correct application as outlined under "Calibrating the Positioner".

14. Apply minimum input signal pressure. Using a stop watch or watch with a sweep second hand as a timing device, rapidly increase input signal pressure from minimum to maximum while noting the time necessary for piston or valve to stroke from one extreme to the other.

15. Again noting time necessary for piston or valve to stroke from one extreme to the other, rapidly decrease input signal from maximum to minimum.

NOTE: Rate of input signal change should be approximately the same as in step 14.

16. Compare two stroke times. If an undesirable differential exists, adjust small slotted set screw in vane assembly approximately 1/2 turn and re-zero calibration.

17. Repeat steps 14, 15 and 16 until stroke time differential is reduced to within desired limits. At this point supply and exhaust capacities of 01 and 02 output valves are balanced. Apply a drop of Loctite Grade 290 or equivalent to set screw threads.

REPLACING OUTPUT VALVE 01

(Refer to Figure 7)

1. Using slot in end of valve plug (32), remove plug from base manifold assembly (36). (Plug assembled at factory with adjustable sealant on threads.) Plug can be removed by unscrewing until all the threads are exposed. A 3/4-16 UNF hex nut should then be screwed over the plug threads and the plug removed by grasping the nut with pliers. Remove hex nut. Examine o-ring (31) and replace if necessary.

2. Remove valve (28), valve spring (29), washer (30) and o-ring (2) from base manifold assembly (36). Examine o-ring and replace if necessary.

3. Clean valve (28) using an aliphatic hydrocarbon solvent (i.e., gasoline, kerosene, etc.) and visually inspect for damage to seating surfaces. Remove any sealant remaining on valve plug (32) and threads inside base manifold assembly (36). Examine valve seats inside of base manifold assembly for dirt. Clean if necessary.

WARNING: USE SOLVENT IN A WELL-VENTILATED AREA. AVOID PROLONGED OR REPEATED BREATHING OF VAPORS. AVOID PROLONGED OR REPEATED CONTACT WITH SKIN. DO NOT USE SOLVENT NEAR OPEN FLAME.

4. Apply minimum amount of o-ring lubricant (Dow Corning No. 4, or equivalent) to o-ring (2). Assemble valve spring (29), washer (30) and o-ring (2) on valve stem. Install valve (28) subassembly in base manifold assembly (36).

5. Apply small amount of lubricant on o-ring (31) and install on valve plug (32).

6. Apply adjustable seal (Loctite Sealant, Grade No. 242, or equivalent) to threads of valve plug (32) and install in base manifold assembly (36). End of valve plug must be flush with base manifold housing when assembled.

REPLACING OUTPUT VALVE 02

(Refer to Figure 7)

1. Remove as a unit, screw retainer (1), valve cover (3) and valve seat assembly (6) from manifold assembly (8) by removing screws (41) and lockwashers (42).

NOTE: After removing subassembly described in step 1, visually check (or take a quick measurement) of the gap between the bottom side of valve cover (3) and the top of valve seat assembly (6). This procedure is necessary in order to obtain the same approximate dimension when reassembling valve seat assembly and will assist in recalibration of the Positioner after final assembly is completed.

2. To disassemble valve seat assembly (6) from valve cover (3), back off adjustment screw (34) until valve cover can be removed. It is not necessary to remove screw retainer (1) to disassemble valve seat assembly.

3. Examine o-rings (5) and (33). Replace if necessary.

4. If o-ring (2) must be replaced, disassemble screw retainer (1) by removing screws (43) and lockwashers (42). Remove adjustment screw (34) from valve cover (3) and replace o-ring.

5. Clean valve using an aliphatic hydrocarbon solvent (i.e., gasoline or kerosene) and blow dry with air hose. Visually inspect for damage. If valve is damaged, valve seat assembly (6) must be replaced.

WARNING: USE SOLVENT IN A WELL-VENTILATED AREA. AVOID PROLONGED OR REPEATED BREATHING OF VAPORS. AVOID PROLONGED OR REPEATED CONTACT WITH SKIN. DO NOT USE NEAR OPEN FLAME.

6. Examine valve chamber in manifold assembly for dirt and clean if necessary.

7. Apply minimum amount of lubricant (Dow Corning No. 4, or equivalent) to o-rings (2), (5) and (33).

8. Install o-ring (2) on adjustment screw (34), o-ring (5) in valve cover (3) and o-ring (33) on valve seat assembly (6).

9. With notch in valve seat assembly (6) in alignment with dowel pin (4) in valve cover (3), turn in adjustment screw (34) until correct distance is obtained between bottom of valve cover and top of valve seat assembly (refer to NOTE following step 1).

CAUTION: Threads on adjustment screw are very fine pitch. Use care to avoid cross threading.

10. Install valve subassembly in manifold assembly (8). Secure in position using screws (41) and lockwashers (42).

11. If screw retainer (1) was removed, install retainer on valve cover (3) with screws (43) and lockwashers (42).

12. Recalibrate as outlined under "Calibrating the Positioner".

REPLACING SIGNAL DIAPHRAGM ASSEMBLY
(Refer to Figure 8)

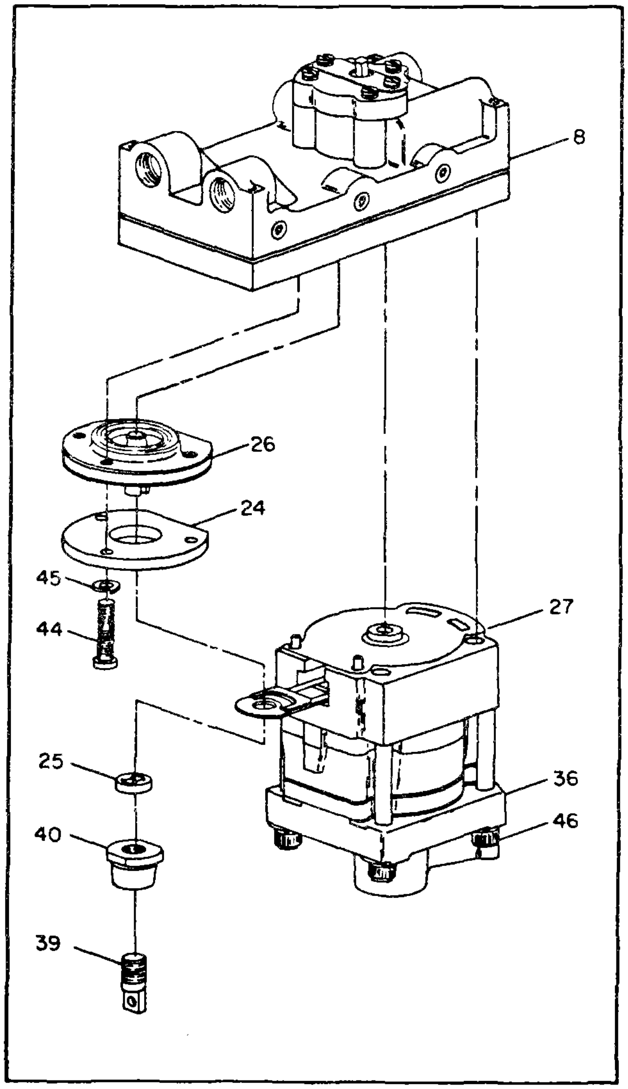
NOTE: To remove the Positioner from the case, refer to Figure 22 for identification of item numbers listed parenthetically in steps 1 thru 3 only.

1. Disconnect range spring (4) from spring retainer (15) using needle nose pliers.

2. If Positioner is equipped with optional gain suppression kit (items 7 thru 11), remove kit as follows:

a. Remove two screws (9), lockwashers (10) and small washers (11) from base assembly (13).

b. Disassemble retainer (8) and spring (7).



1.2.23-477 FIGURE 8 - Replacing Signal Diaphragm Assembly

	GAIN SUPPRESSION KIT PART NO. 5327328-1		GAIN SUPPRESSION KIT PART NO. 5327328-2	
APPLICATION	**Positioner with Standard Gain (250-300)**	**Positioner with High Gain (300-400)**	**Positioner with Standard Gain (250-300)**	**Positioner with High Gain (300-400)**
Cylinders with 50 in.^{3} or less displacement.	X			X
Cylinders with 50 in.^{3} to 200 in.^{3} displacement.		X	**Not Required**	
Diaphragm actuators with high packing friction.	X			X

TABLE 1 - Suggested Gain Suppression Kit Guide Lines

3. Remove two screws (30) from rear of base assembly (13) and carefully remove Positioner assembly (3).

4. To remove signal nut (40), place a 9/16-inch thin head or tappet.open end wrench on hex of signal diaphragm assembly (26) guide to secure guide in position and prevent rotation. With guide held firmly, place a 3/4-inch open end wrench on flats of signal nut (40). Remove signal nut and spring retainer (39) from threaded section of guide.

CAUTION: Damage could result to signal diaphragm assembly if guide is not held in position when removing signal nut.

5. Remove tabbed retainer (25) from signal diaphragm assembly (26) guide.

6. Loosen four hex socket head cap screws (46) until base manifold assembly (36) and relay assembly (27) can be disassembled from mainfold assembly (8). (Dowel pins in both ends of relay assembly prevent rotation of assemblies after cap screws have been removed.)

CAUTION: To prevent damage to vane of relay assembly, carefully guide relay assembly (27) vane over signal diaphragm guide when separating relay assembly and manifold assembly (8).

7. Remove three screws (44) and disassemble signal cover (24).

8. Remove signal diaphragm assembly (26).

9. To install new signal diaphragm assembly (26), reverse steps 1 thru 8 above. Tighten three screws (44) 25 to 30 in. lb. Tighten four cap screws (46) 70 to 75 in. lb.; uniformly, in rotation. Wait 15 minutes and retorque screws.

INSTALLING OPTIONAL GAIN SUPPRESSION KIT (Refer to Figure 22 and Figure 9)

An optional gain suppression kit is available for Type AP2 Positioner (refer to Table 1). Installing the gain suppression kit might be necessary to control oscillation of the final control element; to reduce sensitivity and prevent overshoot where high packing friction is evident; where oscillation occurs in a rapid rise portion of the cam or to adapt the Positioner to a change in application. The need for gain suppression will vary according to actuator and valve characteristics. If it is necessary to add the gain suppression kit, refer to applications listed in Table 1 and procedure outlined below.

1. Remove cam (Figure 22, item 34) from cam shaft (33).

2. Disconnect range spring (Figure 9, item 4) from spring retainer (15) using needle nose pliers.

3. Install spring (7) over signal nut (45) until spring contacts signal nut flange.

4. Install "bonnet" portion of retainer (8) over spring retainer (15) until retainer (8) secures spring (7) in position.

5. Install screws (9), lockwashers (10) and small washers (11) thru retainer (8) and into Positioner base assembly (13). Do not tighten securely.

6. Reassemble range spring (4) to spring retainer (15).

7. Install cam (Figure 22, item 34) on cam shaft (33).

FAULT CORRECTION CHART

FAULT	PROBABLE CAUSE	CORRECTIVE ACTION
1. Final drive element at one end of stroke and does not respond to input change.	a. Obstruction in orifice leading to nozzle.	a. Check orifice as outlined under "Cleaning Nozzle Orifice".
	b. Relay (amplifier) section leaking internally.	b. Replace as outlined under "Replacing Relay Assembly".
2. Excessive air consumption (exhaust loud).	a. Leakage at joints of manifold assembly, relay assembly or base manifold assembly.	a. Tighten four .250-28 x 4 hex socket head stainless steel cap screws 70 to 75 in. lb.
	b. Improper seating of output valves.	b. Remove valves as outlined under "Replacing Output Valve O1" or "Replacing Output Valve O2". Clean valves and seats. Replace valves if necessary.
3. Oscillation of final drive element.	a. Output pressure level too low.	a. Reset output pressure level adjustment as outlined under "Calibrating the Positioner".
	b. Gain too high.	b. Install optional spring kit as outlined under "Installing Gain Suppression Kit".
	c. Drive arm not securely attached to final drive element.	c. Tighten or correct linkage as necessary.
4. Slow response.	a. Output pressure level too high or too low.	a. Reset output pressure level adjustment as outlined under "Calibrating the Positioner".
	b. Output valves blocked.	b. Remove valves as outlined under "Replacing Output Valve O1" or "Replacing Output Valve O2". Clean valves and ports.
	c. Relay (pneumatic amplifier) assembly not operating correctly.	c. Replace as outlined under "Replacing Relay Assembly".
5. Final drive element at minimum travel stop and will not respond to input change.	a. Signal diaphragm leakage.	a. Tighten three .190-32x1.00 pan head screws to 25-30 in. lb. or replace as outlined under "Replacing Signal Diaphragm Assembly".
6. Uprange zero shift that cannot be adjusted.	a. Signal diaphragm leakage.	a. Tighten three .190-32x1.00 pan head screws to 25-30 in. lb. or replace as outlined under "Replacing Signal Diaphragm Assembly".
7. Full range cannot be obtained with adjustment.	a. Incorrect range spring.	a. Remove range spring and install correct spring for range required.
	b. Signal diaphragm leakage.	b. Tighten three .190-32x1.00 pan head screws to 25-30 in. lb. or replace as outlined under "Replacing Signal Diaphragm Assembly".

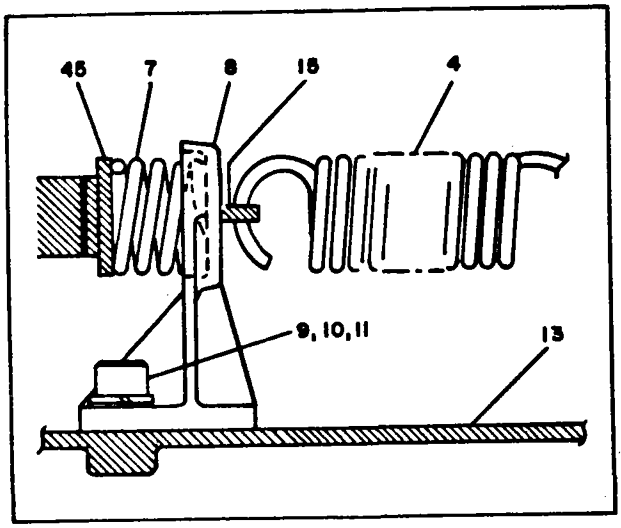


FIGURE 9 - Installing Optional Gain Suppression Kit

8. Position retainer (Figure 9, item 8) on its slotted holes so it is in position to exert a slight, even compression load on spring (7) when cam and signal pressure are at 0%. Tighten screws (9) in this position.

9. Readjust range and zero adjustments as outlined under "Calibrating the Positioner". If unit is unstable or sluggish, retainer (8) can be repositioned in its slotted holes.

10. Check to verify that there is a slight load on spring (7) when unit is pressurized and in a static position.

INSTALLING OPTIONAL HIGH GAIN RANGE SPRING

Two optional high gain range springs are available for Type AP2 Positioner (refer to Table 2). Installation of the high gain range spring is recommended for increasing accuracy on large displacement cylinders or actuators only, where high gain should not affect stability of the final control element. To install high gain range spring, follow procedures outlined below.

1. Remove cam from cam shaft.

2. Disconnect standard gain range spring from threaded adjuster and spring retainer using needle nose pliers. Install new high gain range spring.

3. Install cam on cam shaft.

4. Readjust range and zero adjustments as outlined under "Calibrating the Positioner".

Range Spring Part No.	No. of Coils	Input Signal (psi)	Application
5327330-1	15	3-15	Optional high gain range spring
5327330-2	14	3-27	Optional high gain range spring
		3-15	*Standard gain range spring
5327330-3	11	3-27	*Standard gain range spring

*Standard gain (250-300) range springs are assembled in place and shipped with Positioner.

TABLE 2 - Optional High Gain Range Spring

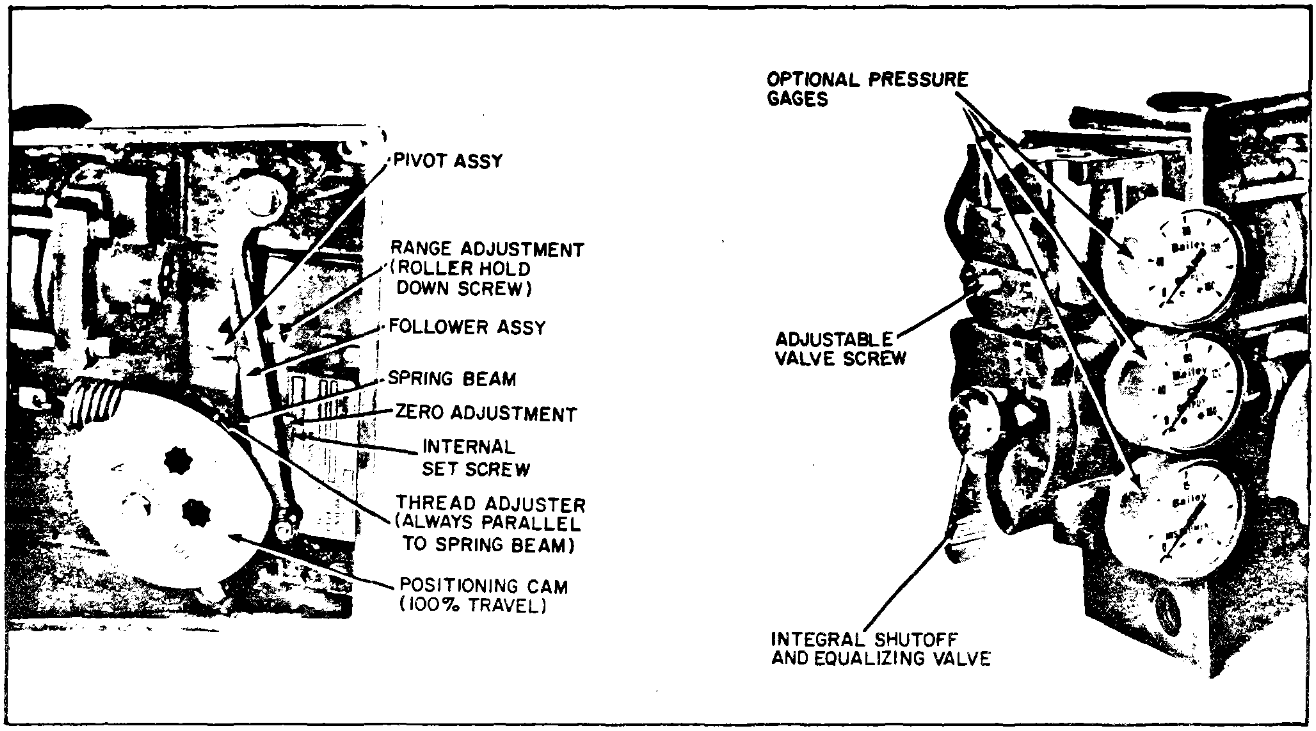


FIGURE 10 - Positioner Adjustments

CALIBRATING THE POSITIONER

Calibration of Type AP2 Characterizable Pneumatic Positioner consists of adjusting the linkage from the power operator so that the positioning cam rotates thru full range for full travel of the piston or valve stem and to adjust (or balance) the output pressure level.

The following adjustments are performed with Positioner mounted on the power operator. These adjustments are specifically for checking operation of the two units prior to adapting the Positioner to a particular application. Once these adjustments have been completed, proceed to "Calibration Adjustments for Particular Applications".

OUTPUT PRESSURE LEVEL ADJUSTMENT

Double-Acting Cylinder Applications

If necessary to change or correct output pressure level of Positioner, follow the procedure outlined below and refer to Figure 10.

1. Use B (straight line) positioning cam which is shipped in place in Positioner assembly.

CAUTION: Make certain correct side of cam (red or black) is facing outward for application desired (Figure 2).

2. Make supply air connections (18 to 150 psig) designated "S" on manifold. Maintain this pressure during adjustments and after Positioner has been placed into service.

WARNING: TYPE AP2 POSITIONERS ARE SUITABLE FOR A MAXIMUM AIR SUPPLY PRESSURE OF 150 PSIG. ADHERENCE TO THIS LIMITATION WILL ENSURE SATISFACTORY PERFORMANCE. DO NOT EXCEED MAXIMUM RECOMMENDED CYLINDER OPERATING PRESSURE.

3. If optional pressure gages are not included, connect customer supplied pressure gages to Positioner output ports O1 and O2 or to 1/8-inch NPT gage ports (Figure 2).

4. Apply midrange signal (9 psi for 3-15 unit or 15 psi for 3-27 unit) with no load on cylinder.

CAUTION: Make certain midrange signal is applied. Output pressure level cannot be adjusted if piston is against travel stop.

5. Turn integral shutoff and equalizing valve (AP2☐☐1☐) to AUTO position.

6. Each output pressure gage should stabilize at approximately 2/3 of supply pressure (O1 gage reading plus O2 gage reading should equal 4/3 of supply pressure).

7. If reading is not correct, turn adjustable valve screw counterclockwise to increase pressure or clockwise to decrease pressure until correct reading is obtained.

NOTE: If oscillation occurs, gain suppression spring kit (available option from Bailey Meter Co., Pt. No. 5327328-☐) must be installed. Refer to "Installing Gain Suppression Spring" for table of spring applications and installation procedure.

Single-Acting Diaphragm Actuator Applications

If necessary to change or correct output pressure level of Positioner, follow procedure outlined below and refer to Figure 10.

1. Use B (straight line) positioning cam which is shipped in place in Positioner assembly.

CAUTION: Make certain correct side of cam (red or black) is facing outward for application desired (Figures 2 and 3).

2. Make supply air connections (18 to 150 psig) designated "S" on manifold. Maintain this pressure during adjustments and after Positioner has been placed in service.

NOTE: For single-acting diaphragm actuator applications, a minimum supply pressure of 5 psi over maximum input signal range (20 psi for 3-15 psi unit or 32 psi for 3-27 psi unit) must be maintained.

WARNING: TYPE AP2 POSITIONERS ARE SUITABLE FOR A MAXIMUM AIR SUPPLY PRESSURE OF 150 PSIG. ADHERENCE TO THIS LIMITATION WILL ENSURE SATISFACTORY PERFORMANCE. DO NOT EXCEED MAXIMUM DESIGN OPERATING PRESSURE OF ACTUATOR.

NOTE: For single acting diaphragm actuators, a minimum supply pressure of 5 psi over maximum input signal range (20 psi for 3-15 psi unit or 32 psi for 3-27 psi unit) must be maintained.

3. If optional pressure gages are not included, connect customer supplied gages to 1/8-inch NPT gage ports in location shown in Figure 3 for application desired.

4. Apply midrange signal (9 psi for 3-15 psi unit or 15 psi for 3-27 psi unit) with no load on actuator.

CAUTION: Make certain midrange signal is applied. Output pressure level cannot be adjusted if valve is against travel stops.

5. If reading on supply gage G3 (Figure 3) does not equal supply pressure being applied, turn adjustable valve screw counterclockwise until supply pressure is obtained. If reading is at supply pressure, turn screw clockwise to decrease pressure; then counterclockwise until full supply pressure is obtained.

NOTE: Supply gage may momentarily drop if large step change is applied.

6. Once supply pressure is obtained, turn adjustable valve screw one (1) full turn counterclockwise.

ZERO AND RANGE ADJUSTMENTS
(Refer to Figure 10)

The range spring assembly applies a proportional feedback force to the input signal diaphragm assembly. A threaded adjuster applies initial tension on the spring and provides a zero adjustment.

Range adjustment of the Positioner is obtained by repositioning a pivot assembly along the cam follower arm. Moving the pivot assembly towards the cam results in a shorter final control element stroke for a given signal change. The opposite holds true for moving the pivot assembly away from the cam.

Double-Acting Cylinder Applications

The adjustment procedure below is based on a direct-acting application as shown in Figure 2. If power operator is being used for a reverse-acting application, note that the movements and positions will be opposite those listed below. Normally, the regulating device (valve, damper, etc.) used in direct-acting applications will be in the CLOSED position when piston is at bottom of cylinder; and the OPEN position when piston is at top of cylinder. Therefore, the words OPEN and CLOSED used below refer to these positions.

Single-Acting Diaphragm Actuator Applications

The adjustment procedure below is based on a direct-acting, top-connected diaphragm actuator as shown in Figure 3. If the power operator is being used for a reverse-acting application, note that the movements and positions will be opposite those listed below. Normally, a control valve used in direct-acting applications will be in the CLOSED position when the valve stem has traveled out of the valve body to its fullest extent; and in the OPEN position when the stem has traveled into the valve body to its fullest extent. Therefore, the words OPEN and CLOSED used below refer to these positions.

NOTE: It is recommended that a position indication plate be installed on the valve actuator yoke (or cylinder) and a pointer be installed on valve stem (or piston rod) to indicate full stroke travel in both directions.

1. Position piston (or valve) to CLOSED position. If cam follower is not at zero mark on positioning cam, disconnect and adjust Positioner drive rod (or other connecting linkage used to tie back to power operator) until Positioner drive arm assumes position which places follower on zero mark. Reconnect drive rod.

2. Set input signal at minimum range value (3 psi for 3-15 psi unit or 3-27 psi unit). Piston (or valve) should remain in CLOSED position.

3. If piston (or valve) begins to move from its CLOSED position, loosen set screw located in recessed hole of knurled adjustment nut and turn zero adjustment (Figure 10) clockwise to increase range spring tension until piston (or valve) returns to a CLOSED position.

4. Increase input signal above minimum range value (3.5 psi for 3-15 unit or 3-27 psi unit). If piston (or valve) does not begin to leave CLOSED position immediately, turn zero adjustment nut (Figure 10) counterclockwise until such movement is obtained. Once zero adjustment is completed, retighten set screw to lock zero adjustment in place.

5. Return to minimum input signal (3 psi). Piston (or valve) should go to CLOSED position.

6. Set input signal at maximum range value (15 psi for 3-15 psi unit or 27 psi for 3-27 psi unit). If piston (or valve) does not move to full OPEN position, loosen roller hold down screw (Figure 10) and slide roller along beam until piston (or valve) reaches full OPEN position. After adjustment, tighten hold down screw firmly in place.

7. Decrease input signal below maximum signal range value (14.5 psi for 3-15 psi unit or 26.5 psi for 3-27 psi unit). If piston (or valve) does not begin to leave full OPEN position immediately, change range adjustment as outlined in step 6 until such movement is obtained.

8. If range adjustment (step 6) was necessary, recheck zero adjustment as outlined in steps 2 thru 5.

CALIBRATION ADJUSTMENTS FOR PARTICULAR APPLICATIONS

The Positioner adjustments described below may be used to improve the operation of the power operator system either by itself or in relation to other systems or parts of a multiple system.

Zero or Suppression Adjustment

By using the zero adjustment (Figure 10) an intitial tension may be imposed upon the range spring so that the piston (or valve) will not begin to move from its minimum position until input signal has increased from 3 psi to any value up to 9 psi (3-15 psi unit) or 15 psi (3-27 psi unit). This adjustment is of value when two or more power operators are to be operated in sequence; where the power operator is equipped with a minimum stop; or where the characteristics of the device which the operator is moving must be matched with that of another regulated device.

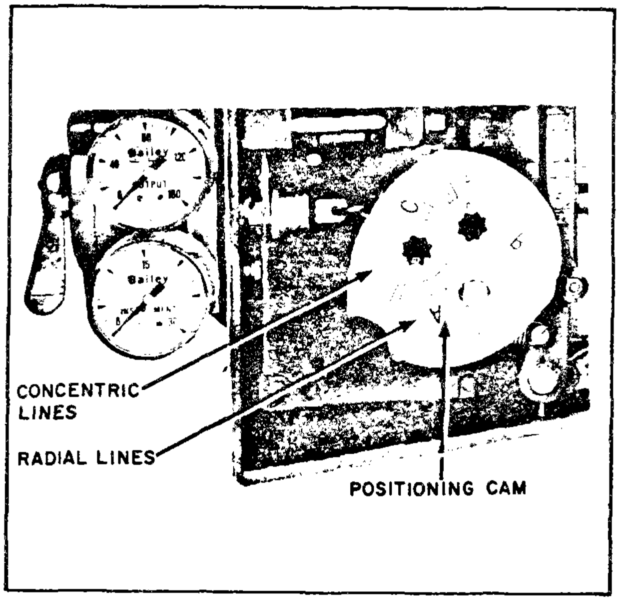


FIGURE 11 - Characterized Cam

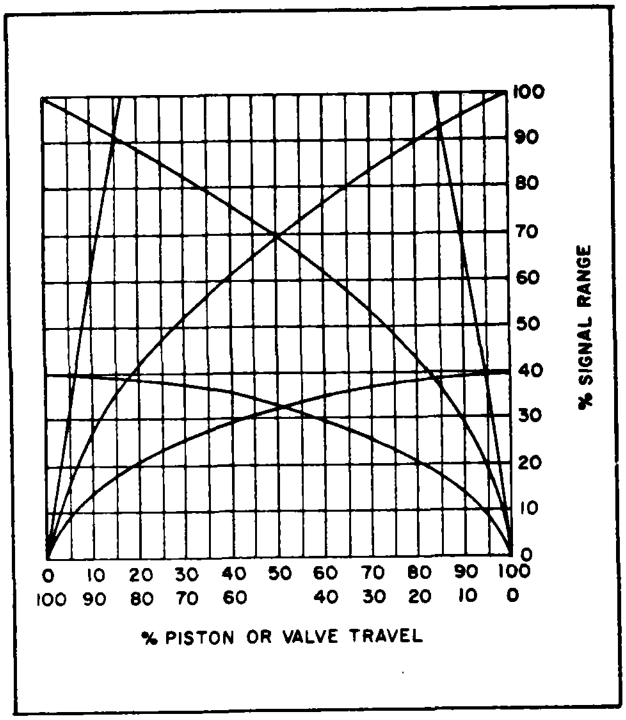


FIGURE 12 - Cam A, Square Root Relation

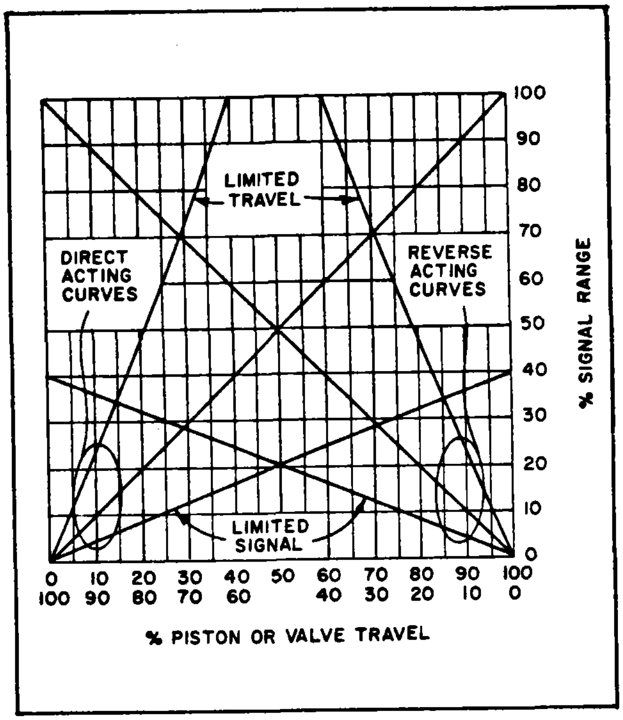


FIGURE 13 - Cam B, Linear Relation

Split Range Adjustment

The range adjustment affords a variation of power operator motion for a given range of control signal pressure. In combination with the zero adjustment described above, full piston (or valve) travel may be obtained for a signal pressure change as small as 6.0 psi (3-15 psi unit). Range adjustments available for each of the three cam variations furnished are shown in Figures 12, 13 and 14. This adjustment is of value when the device being regulated by the power operator is oversized, since the adjustment allows operation of the power operator thru its useful motion for the desired full change in control signal pressure. It is also useful in matching the signal versus position characteristic of the power operator with those of related power devices in the same control system.

Cam Characteristic Adjustment

This adjustment involves selecting or shaping the proper positioning cam in order to obtain that characteristic of piston (or valve) position versus control signal pressure which will afford the desired characteristic of controlled medium versus control signal pressure. The definition of "controlled medium" as applied to this section is the rate of action of that medium (water, air, etc.) being controlled.

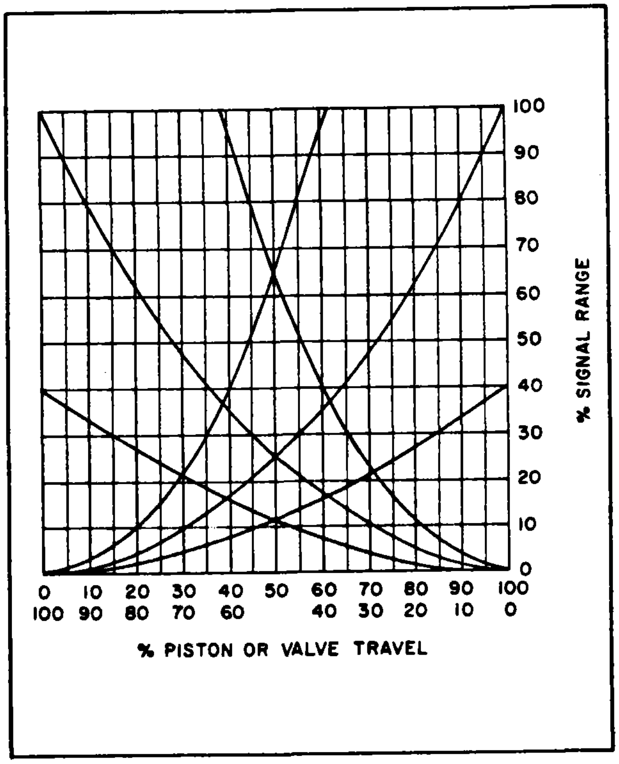


FIGURE 14 - Cam C, Square Relation

CONTROL SIGNAL PRESSURE		
Percent Value	Signal Value (psig)	
	Control System Ranges	
	3-15	3-27
0	3.0	3.0
10	4.2	5.4
20	5.4	7.8
30	6.6	10.2
40	7.8	12.6
50	9.0	15.0
60	10.2	17.4
70	11.4	19.8
80	12.6	22.2
90	13.8	24.6
100	15.0	27.0

TABLE 3 - Conversion Table for Control System Ranges

Positioning cams A, B and C (Figure 11) are furnished with each Positioner (the B cam is shipped assembled in place and the A and C cam are included on the same part, but are inactive). The characteristics for which the cams are shaped are listed in Table 4 and are shown in Figures 12, 13 and 14. The figures show a family of curves for each cam, each curve representing a range adjustment when used with that specific cam. Table 3 shows control signal pressure values of the two control system ranges equivalent to the signal range percent values in Figures 12, 13 and 14.

If the system involves a single power operator, it is probable that the B (straight line) cam will be satisfactory. However, one of the other cams may provide a more uniform controlled medium versus signal pressure characteristic, providing stable control over a wide range of operation with a given proportional band adjustment on the controller. For a power operator which is an integral part in a complex control system, the cams provide a selection of characteristics which, when used in conjunction with the range adjustment, should allow close paralleling of the controlled medium versus signal pressure characteristic.

Refer to "Characterized Cams" for selecting or shaping the proper positioning cam for a power operator which is to be part of a complex control system.

Cam Selection

Depending upon nomenclature, the Positioner will be provided with one of two standard 3 lobe cams. The following table is a comparison of possible stroke lengths vs. feedback drive arm hole locations for the Full Stroke - 90° cam and the Half Stroke - 45° cam.

Feedback Arm Hole Position from Cam Shaft	Length of Stroke - Inches	
	Full Stroke - 90° Cam	Half Stroke - 45° Cam
1	1	.5
2	1.5	.75
3	2	1
4	2.5	1.25
5	3	1.5
6	3.5	1.75
7	4	2

CHARACTERIZED CAMS

In order to match the inherent characteristics of the power operator to the final control device, it may be practical to reduce the controlled medium versus piston (or valve) position characteristic of each device in the system to a straight line relationship with regard to control signal pressure. This straight line relationship is established by calibrating the Positioner with respect to the correct positioning cam by the following method.

1. Use B (straight line) cam to determine actual controlled medium versus piston (or valve) characteristic (Figure 15).

2. Determine exact controlled medium versus control signal pressure characteristic desired (Figure 16).

3. Using values determined in steps 1 and 2, plot a curve to determine exact control signal pressure versus piston (or valve) position characteristic (Figure 17).

Positioning Cam, Any Stroke	Piston or Valve Position (P) vs. Control Signal (I)	Figure No.
A	Square Root ($I = \sqrt{P}$)	12
B	Straight Line ($I = P$)	13
C	Square ($I = P^2$)	14

TABLE 4 - Positioning Cam Characteristics

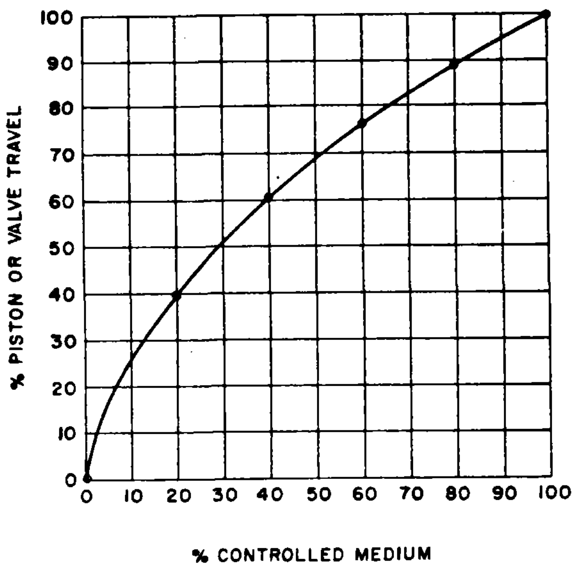


FIGURE 15 - Regulated Device Characteristic

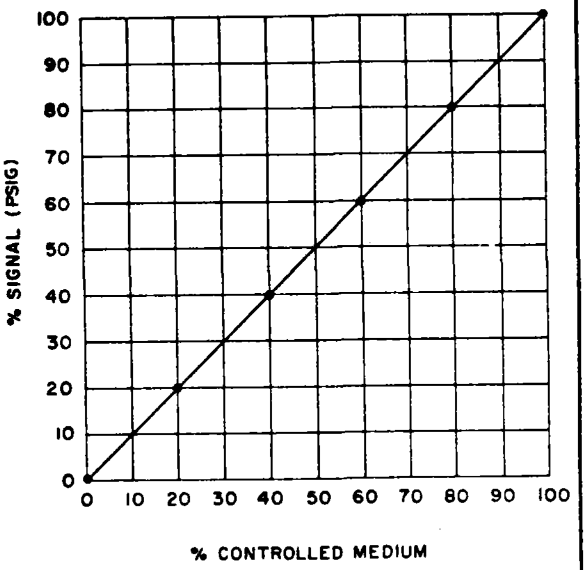


FIGURE 16 - Desired Control

4. Compare curve plotted in step 3 with curves shown in Figures 12, 13 and 14. Select positioning cam whose characteristic most closely matches control signal pressure versus piston (or valve) characteristic plotted in step 3.

5. If necessary, set range and zero adjustments to match control signal pressure versus piston (or valve) characteristic more accurately as outlined under "Zero and Range Adjustments".

6. If required characteristic cannot be obtained using the above procedure, or if a more exact characteristic is required, alter shape of cam as outlined under "Cam Shaping Method".

Cam Shaping Method

To assist in the alteration process, cams are marked with radial lines (index of % piston or valve travel) and concentric lines (index of control signal pressure). The ten concentric lines on the cam correspond to actual control signal pressure values shown in Table 3 for the specific control system signal range being used.

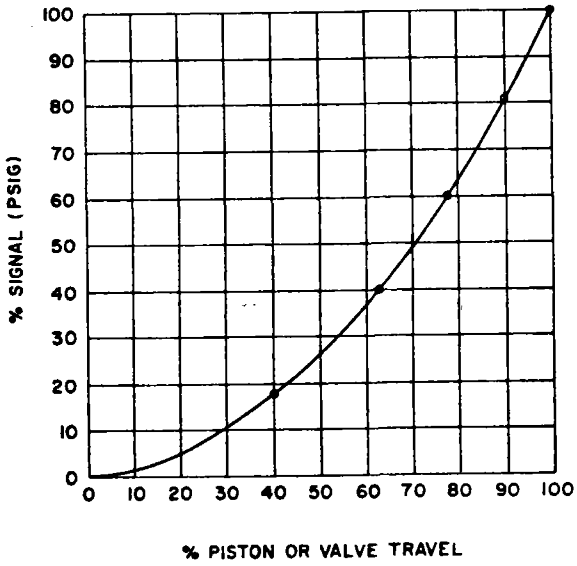


FIGURE 17 - Cam Characteristic

CAUTION: Before cutting any cam, make certain cutting will involve REMOVAL OF CAM MATERIAL, rather than building up of material. For example, if the characteristic plotted lies between the A and B cam (Figure 12 and 13), the A cam should be cut.

1. Use cam selected in step 4 under "Characterized Cams". For each increment of control signal pressure (concentric lines), locate the piston (or valve) position (radial lines) required for specific control signal pressure. Refer to Figure 18 for method of locating these points.

CAUTION: If a cam shape has too steep a rise, there is danger of cam follower becoming locked. Line printed on cam (part no. 5327322-1) indicates the maximum rise which should be cut into the cam. When a cam shape is required that includes such a rise, it is necessary to introduce sufficient angularity in the power operator device drive rod linkage to allow a less radical cam shape.

2. A curve drawn thru points located on cam in step 1 above will be desired cam shape. Either alter cam or cut new cam to this shape.

NOTE: An optional blank cam, Pt. No. 5327322-1 is available from Bailey Meter Company if alteration of the original cam is not desired.

Speed Adjustment

When the system involves only a single power operator, a high positioning speed is usually an advantage. In a complex control system, however, it is generally desirable to operate all power devices at the same speed to avoid interaction between units or undesirable process conditions during control pressure changes. If it is necessary to reduce the speed of operation, speed control orifices (0.040") are available as an option from Bailey Meter Company (Pt. No. 5327327-1). These orifices are installed directly into the output ports (O1 and O2) and have 1/4-inch NPT ports for connecting plumbing from the power operator. If orifices are too small, they may be drilled out to obtain desired speed control. Blank orifices (Pt. No. 5327327-2) are also available.

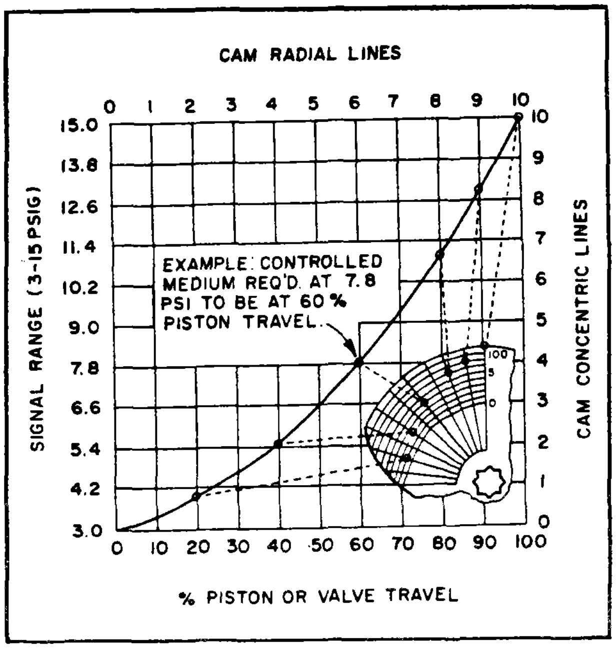


FIGURE 18 - Locating Points for Shaping Positioner Cam for 3-15 psi Unit

HOW THE POSITIONER OPERATES

The Type AP2 Characterizable Pneumatic Positioner is a two-stage amplification, "push-pull" action, force-balance type control instrument, normally located in the control loop (Figure 19) between the controller and the final control element (valve actuator or cylinder assembly). A pneumatic input (3-15 psig or 3-27 psig) is applied to the Positioner to produce a power operator position which can be characterized for a particular application thru the use of a positioning cam. A mechanical linkage connection to the piston (or valve) stem serves to feed back the actual stem position movement. When the controller calls for the piston (or valve) to change position, the Positioner acts as a pneumatic relay, thru an independent air supply, and changes the piston (or valve) to its new required position.

The Type AP2 Positioner can be applied to double-acting cylinder assemblies where a load is applied to one side of the cylinder while simultaneously unloading the opposite side of the cylinder for a change in controller output. By plugging one of the output connections (unused connection depends on application, Figure 3), the Type AP2 Positioner can also be used with single-acting diaphragm actuators where a load is applied to top or bottom of the acutator for a change in controller output.

PNEUMATIC AMPLIFIER RELAY ASSEMBLY
(Refer to Figure 20 and 21)

The Positioner's pneumatic amplifier is constructed in a "stack" design. Several pneumatic

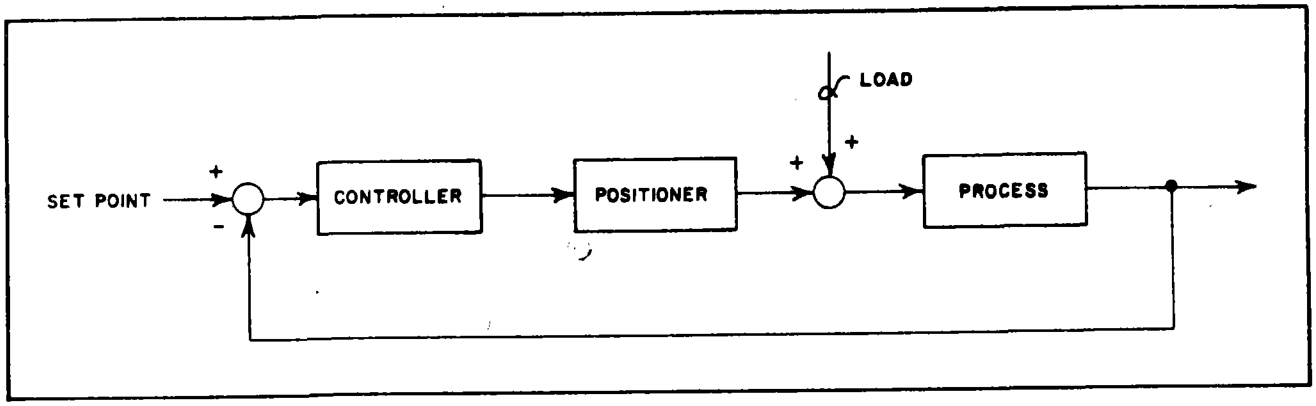


FIGURE 19 - Block Diagram of Type AP2 Positioner Application.

chambers are formed by alternating fabric-reinforced, elastomer diaphragms and aluminum spacers. The outer spacers are secured by stainless steel bolts while the movable center sections are clamped together by flaring the ends of the aluminum guide tubes.

When a change in control signal pressure is applied to the signal diaphragm assembly the distance between the vane and nozzle changes. As the vane moves, the nozzle backpressure will increase or decrease (depending on direction of the signal applied) and the entire relay assembly center structure will displace. Movement of this center structure will open (or close) output valves O1 and O2.

CAM AND LINKAGE

(Refer to Figure 20)

Power operator position is fed back to the Positioner for comparision with the input control signal pressure. The feedback mechanism consists of 1) a drive rod which follows the motion of the power operator; 2) an adjustable, swivel-ended drive arm which is driven by the drive rod; and 3) a cam and shaft which are driven by the adjustable drive arm. The prime function of the cam is to permit characterization of the power operator position versus input control signal pressure.

A series of alternate drive link attachment holes in the Positioner drive arm provides for nominal strokes of 0.50 to 4.00 inches. The drive arm may be repositioned in 45 degree increments with respect to the case (i.e., at midstroke the arm can be at any of eight positions which are parallel to or displaced 45° relative to the sides of the Positioner). One of two cam configurations (45° or 90° rotation) are used, depending upon actuator stroke.

Since the cam, shaft and drive arm move as an assembly, cam motion is 45 or 90 degrees. The cam base circle radius is 1.30 inches and maximum rise is 0.90 inches. In each case a square root cam A, straight line cam B and square cam C are stamped on one blank. The Positioner is shipped with the straight line cam B in position (red side facing out). By flipping the cam over and reversing output connections O1 and O2, a reverse-acting application can be obtained.

SEQUENCE OF OPERATION

NOTE: Because of the variety of applications available with the Type AP2 Positioner, the description below will apply to a double-acting cylinder assembly used in a direct-acting application. The input control signal pressure being applied will be of an increasing nature. Refer to

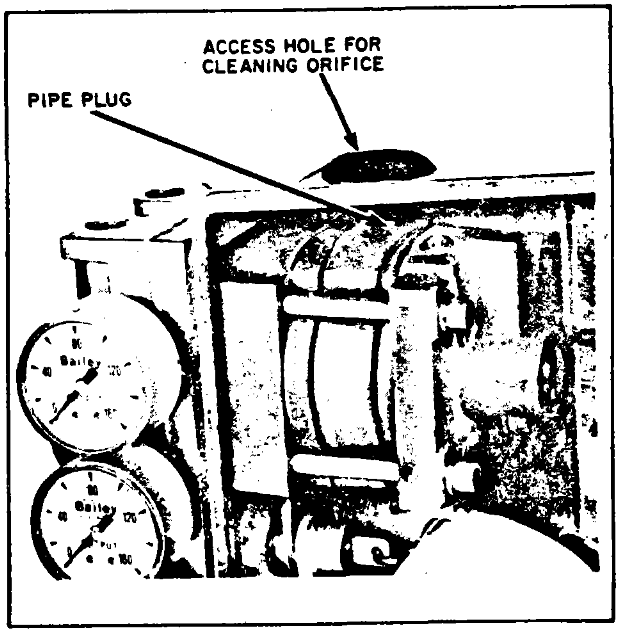


FIGURE 20 - Type AP2 Positioner Components

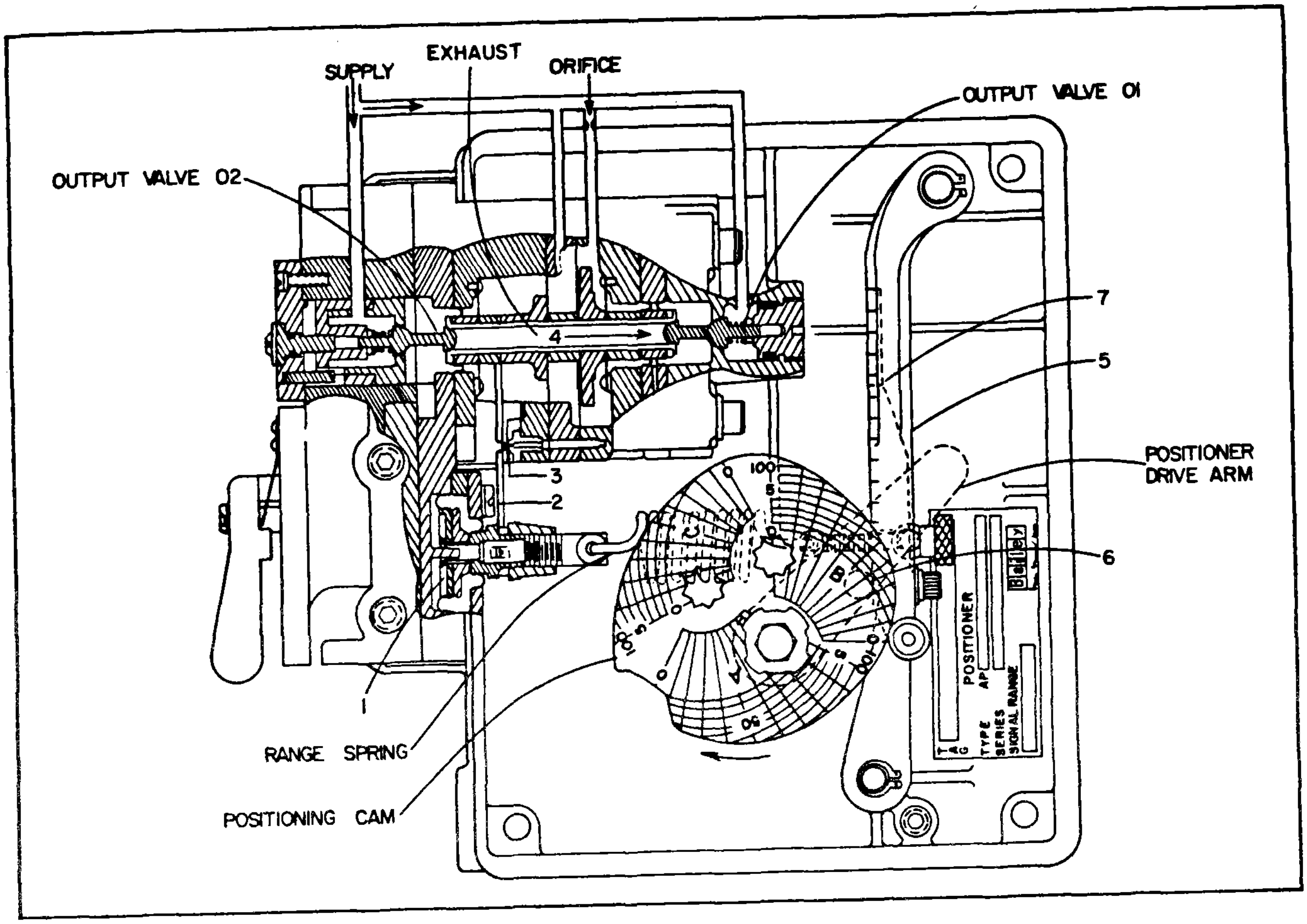


FIGURE 21 - Cutaway View of Type AP2 Positioner

Figure 21 for identification of item numbers listed in parentheses below and as a guide for steps listing direction of movement (clockwise, counterclockwise, right, left, etc.) of various components.

1. The controller sends out an increasing signal to change position of power operator piston.

2. Increase in pressure applied displaces signal diaphragm assembly (1), carrying vane assembly (2) away from nozzle (3).

3. Movement of vane away from nozzle decreases pressure in nozzle backpressure chamber, allowing supply pressure in opposing chamber to exert force on relay diaphragm assembly and move entire center structure (4) to the right.

4. Displacement of relay assembly center structure creates the following reactions:

a. Opens output valve O1 to supply pressure, increasing pressure applied to one side of piston.

b. Opens output valve O2 to atmosphere, causing opposite side of piston to exhaust.

c. Amplifier vane begins to move to the right, initiating a negative internal feedback which decreases tension on range spring and allows vane to move towards nozzle.

5. Piston displaces because of differential pressure across O1 and O2 output ports. Movement of piston is fed back to Positioner by a drive rod which is connected to Positioner drive arm and positioning cam.

6. Cam rotates clockwise and pushes follower assembly (5). Pivot assembly (6), connected to cam follower, then pushes on spring arm (7) which extends (stretches) range spring.

7. As range spring extends, vane assembly is pulled toward nozzle until force exerted by range spring and force exerted on signal diaphragm assembly are equal. When a "balanced" condition is obtained, relay assembly center structure will return to a neutral position closing valves O1 and

O2; nozzle backpressure will again return to 2/3 of supply pressure; and piston position will be in equilibrium with input control signal pressure.

A decreasing input control signal pressure from the controller reverses the sequence above, causing the piston to move in the opposite direction.

For single-acting diaphragm actuators, the sequence of operation is identical to the above example except that one output valve is made inoperative thru a valve adjustment procedure as outlined under "Output Pressure Level Adjustment" for single-acting diaphragm actuators.

INTEGRAL SHUTOFF AND EQUALIZING VALVE, TYPE AP2☐☐1☐

(Double-Acting Cylinder Applications)

If Positioner is equipped with the integral shutoff and equalizing valve, the cylinder assembly may be manually or automatically operated as outlined below. By turning the valve handle to HAND, supply pressure to the cylinder is cut off and O2 and O1 are equalized allowing manual repositioning of the piston.

Transfer from Manual to Automatic Operation

1. Valve handle should be in HAND position.

2. If manual operator does not lock drive cylinder in position:

a. The piston must be positioned from prior knowledge of piston position versus signal or piston may "jump" when transferred to automatic.

b. Turn valve handle to AUTO position.

3. If manual operator locks drive cylinder in position:

a. Switch valve to AUTO position. Drive cylinder will oppose manual operator if drive position and input signal do not correspond.

b. Manually operate drive until load on manual operator decreases. If output pressure gages are installed on Positioner, readings should equalize.

NOTE: If in step 3b it is desired that drive stay in initial position, input signal must be adjusted to correspond with drive position as indicated by the load on manual operator, output pressures or prior knowledge of position versus signal.

Transfer from Automatic to Manual Operation

1. Valve handle should be in AUTO position.

2. If manual operator does not lock drive cylinder in position, press safety latch and switch valve to HAND position. Drive cylinder will move as determined by load if not restrained by hand lever.

3. If manual operator locks drive cylinder in position, transfer mechanism to manual. Press safety latch and turn valve handle to HAND position.

OPTIONAL BYPASS VALVE

(Single-Acting Diaphragm Actuator Applications)

If Positioner is equipped with an optional bypass valve assembly (Figure 25), the actuator may be manually or automatically operated as outlined below. Depending on application, the Positioner may be adjusted for either direct or reverse-acting operation. When applied for direct-acting applications, an increase in control signal pressure will cause an increase in control pressure to the actuator. When applied for reverse-acting applications an increase in control signal pressure will cause a decrease in control pressure to the actuator. Determine the application to which the Positioner is being applied and follow the correct procedure.

NOTE: Supply valve stated in the following procedures is not supplied by Bailey Meter Co.

Direct-Acting Applications

To change from remote control to local manual control:

1. Turn bypass valve to "BYPASS" position.

2. If the Positioner is to be serviced, close supply valve (supply valve not supplied by Bailey Meter Co.).

To change from local manual control to remote control:

1. Open supply valve.

2. Turn bypass valve to "POSITIONER" position.

Operate valves in this sequence to avoid a momentary pressure loss to the diaphragm actuator.

When the valves are set for manual operation, control signal pressure goes to the signal diaphragm assembly and also thru the bypass valve to the actuator. The actuator is supplied with signal pressure directly from the control system.

The final control valve may be positioned either by signal pressure from the control system or preferably, by manual operation of the Selector Station (if used) connected by the control pressure line to the Positioner.

The Positioner cannot normally be transferred from automatic to manual or vice versa without disturbing the control system because the Positioner is usually calibrated to deliver control pressure to the diaphragm actuator which differs from control signal pressure received from the control system.

To manually operate the control valve by handjack.

1. Pick up valve position with handjack.
2. Close supply valve.
3. Position valve using handjack.

Reverse-Acting Applications

WARNING: WHEN ARRANGED FOR REVERSE-ACTING APPLICATIONS, SERIOUS DAMAGE COULD RESULT IF A "BYPASS" VALVE POSITION WERE USED AND CONTROL SIGNAL PRESSURE WERE INTRODUCED DIRECTLY TO THE DIAPHRAGM ACTUATOR. THE CONTROL PRESSURE TO THE ACTUATOR DURING AUTOMATIC OPERATION IS THE OPPOSITE OF CONTROL SIGNAL PRESSURE FROM THE CONTROL SYSTEM TO THE POSITIONER. TO EFFECT A BYPASS ARRANGEMENT, IT IS NECESSARY TO REVERSE THE CONTROL SIGNAL PRESSURE DURING MANUAL OPERATION OF THE POSITIONER. THIS IS NOT PRACTICAL FOR THE SMALL AMOUNT OF TIME THAT THE POSITIONER WOULD BE ON MANUAL DURING NORMAL OPERATION.

To change from remote control to local manual control:

1. Pick up control valve position with handjack.
2. Close supply valve
3. Position valve using handjack.

Position Transmitter Application

The AP2 Positioner may be used as a position transmitter, by generating a pneumatic signal which is a function of an input position. The same combinations of signal ranges and stroke spans are available as are offered in the Positioner application (i.e., 3 to 15 psig and 3 to 27 psig outputs for strokes from 0.5 to 4 inches).

The output signal may be made a square root, linear or square function of the input position thru use of the A, B or C portion of the cam, respectively. Other functions may be created thru special shaping of the cam.

The AP2 may be made to function as a position transmitter by interconnecting the "E" input signal port with the "O2" output port and tapping into this interconnection for the output signal (Figure 26). A plug is placed in the "O1" output port. Position transmitter kit number 5327252-1 (Figure 26) provides the necessary hardware.

A change in input (cam shaft position) causes a deflection of the range spring via the cam and linkage. The resulting unbalance of forces between the signal capsule and the range spring causes a change in the "O2" output which is fed back to the signal capsule.

The signal capsule now acts as a feedback element by opposing the input force from the range spring. When the force from the "O2" pressure in the signal capsule equals the new range spring force the output will stabilize and will represent the desired function of the input position.

Installation

Installation is similar to Positioner installation. The device whose position is to be transmitted should be coupled to the position transmitter's cam shaft so as to cause a 90° rotation of the shaft for full travel of the device (45° for AP2☐1☐ ☐).

For a linear-motion device (e.g. diaphragm actuators) the cam shaft is driven by the drive arm (Figure 22, item 38) and a connecting link (Figure 24, item 7) as in the Positioner application. For a 90° rotation device it may be desirable to couple the cam shaft directly to the device.

The "zero" position of the cam shaft can be adjusted in 45° increments by repositioning the cam on the shaft.

The direction of the transmitted signal can be reversed by reversing the cam. For example, with the red side of the cam facing out, clockwise rotation of the cam, viewed from the front of the unit, will cause an increasing signal. Reversing the cam so that the black side faces out will result in a signal that decreases with clockwise rotation.

Supply Pressure

Maintain a supply pressure, at the "S" connection, 5 psig above the maximum output pressure but not higher than 50 psig.

Output and supply pressure gages may be installed in the positions labeled "G1" and "G2", respectively (Figure 2).

NOTE: The device to which the position transmitter is applied must supply power to operate the transmitter mechanism. Maximum torque to operate a 3 to 15 psi unit with a linear output is approximately 4-1/2 in. lb. Torque may be as high as 25 in. lb. for a square root characteristic and a 3 to 27 psi output with 50% suppression.

Calibrating the Position Transmitter

Output Pressure Level Adjustment

Adjustable valve is set as follows:

1. Connect a pressure gage to "O1" output port or to 1/8 in. NPT port in "G2" position (Figure 2).

2. Position drive at mid-stroke position.

3. Turn adjustable valve screw (Figure 6, item 34) clockwise until "O1" pressure drops below, supply pressure. Now turn screw counterclockwise until supply pressure is reached on gage.

4. Turn adjustable valve screw an additional one full turn counterclockwise.

Zero and Span Adjustments

The following description is based upon a 3 to 15 psig output for "0" to 100% travel of the moving device.

1. Install accurate pressure gage at output connection or at connection labeled "G1" (Figure 2).

2. Turn-on air supply.

3. Slowly stroke drive to its "zero" position. Adjust linkage between transmitter and drive such that Transmitter's cam follower is at zero on cam.

CAUTION: In stroking the drive, be certain that the linkage is not overstrained due to maladjustment.

4. Slowly stroke drive to its 100% of travel position, taking care that linkage is free to move at all times, and is not strained due to maladjustment. Adjust pivot position in drive arm (Figure 22, item 38) or other external linkage such that cam follower is at 100% of cam rotation (radial line marked "100" on cam).

5. Repeat steps 3 and 4 until cam follower is at 0% cam when drive is at 0% stroke and 100% cam when drive is at 100% stroke.

6. Move drive to its 0% of stroke position. If output is not 3 psig, loosen set screw located in recessed hole of knurled adjustment nut. Turn nut (while keeping eye-bolt from rotating) until a 3 psig output is achieved. Tighten set screw.

7. Move drive to its 100% of stroke position. If output is not at 15 psig loosen range adjustment hold-down screw (Figure 10). With hold-down screw retightened, slide pivot assembly along follower assembly until a 15 psig output is obtained.

8. Recheck steps 6 and 7 until desired outputs are obtained.

Large adjustments are provided in the zero and range adjustments so large deviations from the above calibration can be obtained.

GENERAL SPECIFICATIONS

Standard Input Ranges	3-15 and 3-27 psig.
Standard Stroke Range	0.5 in. to 4.0 in. Rotary input 45 and 90 .
Gain*	250 to 300 with 50 psig supply pressure using standard gain range spring. Gain of 400 obtainable using optional high gain range spring. Refer to Table III.
Resolution*	0.1% of output span.
Dead Band*	0.2% of input span
Hysteresis*	0.3% of output span.
Supply Pressure	18 to 150 psig. Minimum supply pressure should be maintained 5.0 psi above maximum required by actuator.
Supply Pressure Effect	Diaphragm Actuators Average effect on actuator position 0.05% per 1.0 psi supply variation, with 50 ± 10 psi supply. Cylinders Negligible
Capacity	Greater than 25 scfm at 75 psig supply (delivery and exhaust).
Air Consumption	Diaphragm Actuators 0.12 scfm at balance with 20 psig supply pressure, typical. 0.25 scfm, maximum. 0.175 scfm at balance with 30 psig supply pressure, typical. 0.35 scfm, maximum. Cylinders 0.5 scfm at balance with 50 psig supply pressure, typical. 1.0 scfm, maximum. 1.5 scfm at balance with 150 psig supply pressure, typical. 3.0 scfm, maximum.
Temperature Limits	−40F to +180F (AP2 ☐☐☐0). 0 to +250F (AP2 ☐☐☐1). (Determined by material limitation).
Mounting Position Effect	Can be mounted in any position with recalibration.

TABLE 5

Vibration	Tested in accordance with MIL STD 167B (ships)
Pneumatic Connections	1/4" NPT on supply, signal and output connections. 1/8" NPT on optional pressure gages.
Size	10.250" x 9.0625" x 4.125". (260.4mm x 230.2mm x 104.8mm).
Weight	9.5 lb (4.3 kg.).
Optional Accessories	PRESSURE GAGES for reading input signal, supply and output pressures. Refer to *Table II for part numbers and usage.* HIGH GAIN RANGE SPRING available for obtaining a gain factor of 400. Refer to Table III for part numbers. SPEED CONTROL ORIFICES – regulates time constant of Positioner and final control element. Orifices are installed directly into Positioner output ports. Refer to Table IV for part numbers and usage. GAIN SUPPRESSION SPRING for eliminating excessive overshoot of final control element. Refer to Table V for part numbers and usage. POSITIONER MOUNTING KIT for mounting Positioner to direct-or reverse-acting diaphragm actuators only. Refer to *Table VI for part numbers.* BYPASS VALVE (Pt. No. 5326945-1) for single-acting diaphragm actuator applications. Enables operator to use controller output signal to position actuator directly when servicing Positioner, etc. BLANK CAM (Pt. No. 5327322-1) is available for adapting the Positioner to a particular application if cutting of original cam is not desirable.

*Typical performance characteristics of Positioner mounted on diaphragm actuator (range spring in horizontal position when viewed with cover removed). Actual performance may vary with application.

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.

PRESSURE GAGES — TABLE 6

Gage Temperature Range	Range (psig)	Legend*	Gage Part No.
−40F to +160F	0-30	Instrument	5326605-1
	0-160	Supply	5326605-2
	0-160	Output	5326605-3
−40F to +250F	0-30	Instrument	5326605-4
	0-160	Supply	5326605-5
	0-160	Output	5326605-6

*Instrument, Supply and Output gage used on single-acting devices. Instrument and two Output gages used on double-acting devices. There are no provisions for mounting a Supply gage on double-acting devices.

SPEED CONTROL ORIFICE — TABLE 8

Orifice Size (in.)	Orifice Part No.
.040"	5327327-1
Blank (drill to suit)	5327327-2

HIGH GAIN RANGE SPRING — TABLE 7

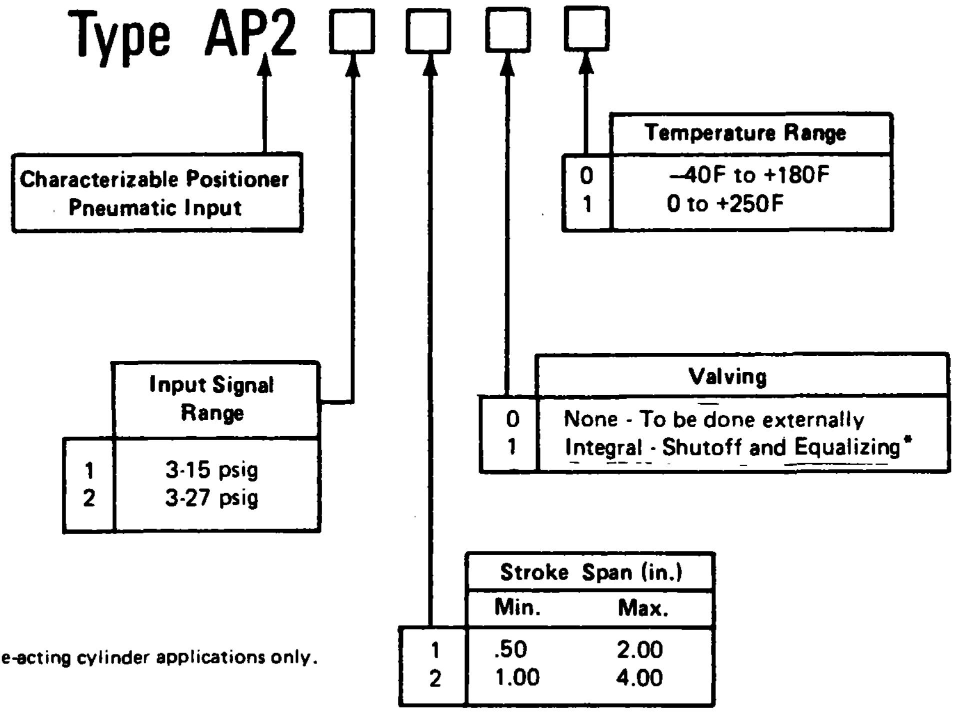
Range Spring Part No.	No. of Coils	Input Signal (psi)	Application
5327330-1	15	3-15	Optional high gain
5327330-2	14	3-27	Optional high gain
		3-15	*Standard gain
5327330-3	11	3-27	*Standard gain

*Standard gain (250-300) range springs are assembled in place and shipped with Positioner.

GAIN SUPPRESSION KIT — TABLE 9

Application	Gain Suppression Kit Part No.	
	Std. Gain (250-300)	High Gain (300-400)
Cylinders with 50 in.^{3} or less displacement.	5327328-1	5327328-2
Cylinders with 50 in.^{3} to 200 in.^{3} displacement.	Not Reqd.	5327328-1
Diaphragm actuators with high packing friction.	5327328-1	5327328-2

EXPLANATION OF NOMENCLATURE



Type AP2 □ □ □ □

Characterizable Positioner Pneumatic Input

	Input Signal Range
1	3-15 psig
2	3-27 psig

	Stroke Span (in.)	
	Min.	**Max.**
1	.50	2.00
2	1.00	4.00

	Valving
0	None - To be done externally
1	Integral - Shutoff and Equalizing*

	Temperature Range
0	–40F to +180F
1	0 to +250F

*For double-acting cylinder applications only.

An "X" as a suffix to TYPE indicates that the Transmitter includes some special feature not covered by the standard Nomenclature.

REPLACEMENT PARTS

Figure 22 is a parts drawing of the Type AP2 Characterizable Pneumatic Positioner. Figure 23 is a parts drawing of the Positioner Assembly.

These figures will normally apply to the unit furnished. However, there may be individual differences in specific assemblies due to:

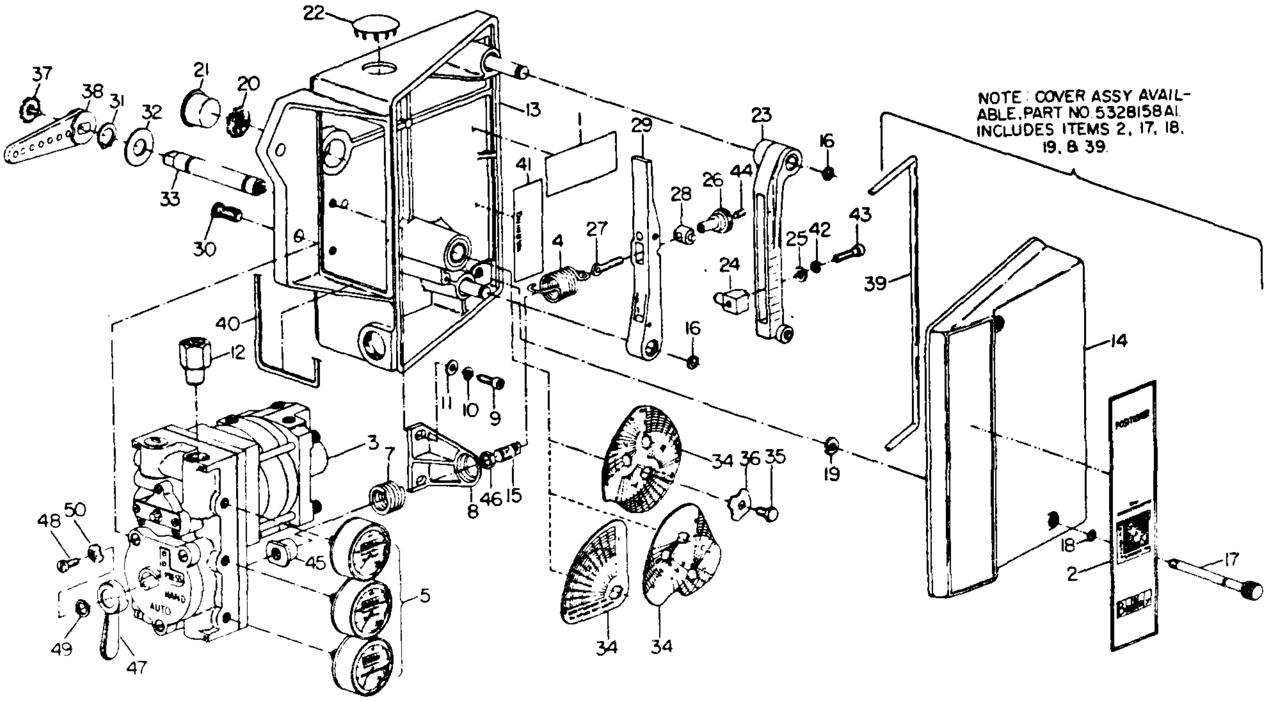
a. Design changes made since the printing of this instruction section.

b. Special design of equipment furnished to make it suitable for special application.

Therefore, when ordering individual parts, assure correct replacement by specifying on the order:

1. Complete nomenclature, code number, part number, series label number and S.O. number of equipment for which parts are desired.

2. The Parts Drawing Number on which each part is illustrated.


NOTE: COVER ASSY AVAILABLE, PART NO. 5328158AI. INCLUDES ITEMS 2, 17, 18, 19, & 39.

ITEM	PART NO.	NAME
1	SEE NOTE	NAMEPLATE
2	SEE NOTE	STYLE PLATE
3	5326600-□ OR 5328139-□	POSITIONER RELAY ASSY, SEE PARTS DWG. P88-31
4	SEE TABLE A	RANGE SPRING
5	SEE TABLE B	PRESSURE GAGES (OPTIONAL)
6	SEE TABLE C	GAIN SUPPRESSION KIT (OPTIONAL) INCLUDES ITEMS 7 THRU 11.
7	SEE TABLE D	SPRING
8	5327329-1	RETAINER
9	.250-20x.500	HEX SOC HD STN STL CAP SCR, 2 REQD
10	.250	STN STL REG SPRING LKWASH, 2 REQD
11	19734-18	SMALL WASHER, 2 REQD
12	SEE TABLE E	SPEED CONTROL ORIFICES (OPTIONAL)
13	5327405-2	BASE ASSY
14	5327406-1	COVER
15	197421-1	SPRING RETAINER
16	197164-37	RETAINING RING, 2 REQD
17	197552-1	COVER SCREW, 2 REQD
18	5311428-3	O-RING, 2 REQD
19	198173-16	RETAINING RING, 2 REQD
20	5327419-1	WIRE MESH FILTER
21	1942339-4	CAPLUG
22	19981-12	BUTTON PLUG
23	5327408-1	FOLLOWER ASSY
24	5327440-1	PIVOT ASSY
25	19734-44	SMALL WASHER
26	197423-1	ADJUSTABLE NUT
27	197422-1	EYE BOLT
28	5327332-1	ADJUSTABLE PIVOT
29	5327409-2	SPRING ARM
30	197591-2	PAN HD LONG LOK MACHINE SCR, 2 REQD
31	197164-50	RETAINING RING, 2 REQD
32	19734-45	SMALL WASHER, 2 REQD
33	5326766-1	CAM SHAFT
34	5327239-1	CAM, HALF STROKE (TYPE AP2 □ 1□□ ONLY)
	5327240-1	CAM, FULL STROKE (TYPE AP2□2□□ONLY)
	5327322-1	BLANK CAM (OPTIONAL)
35	.250-20x.375	HEX HD STN STL CAP SCR
36	4814-1401-4102	STN STL SHKPRF LKWASH
37	197227-1	SPECIAL HEX HD SEMS SCR
38	5327445-1	DRIVE ARM
39	SEE TABLE F	SEALING CORD (32" REQD)
40	SEE TABLE F	SEALING STRIP (18" REQD)
41	1962883-1	WARNING LABEL
42	.190	STN STL REG SPRING LKWASH
43	.190-32x.875	HEX SOC HD STN STL CAP SCR
44	.190-32x.187	HEX SOC HEADLESS STN STL OVAL POINT SET SCR
45	5327331-1	SIGNAL NUT
46	668460-1	SPECIAL NUT
47	5311459B1	HANDLE
48	.164-32x.312	LG PAN HD STN STL MACH SCREW
49	.164-32x.312	STN STL TYPE A PLAIN WASHER
50	4808-09-4102	STN STL SHAKEPROOF WASHER

NOTE: SPECIFY ALL INFORMATION ON NAMEPLATE AND STYLE PLATE WHEN ORDERING REPLACEMENT PARTS.

FIGURE 22 - Parts Drawing P88-30,

TABLE A - ITEM 4

RANGE SPRING PART NO.	NO. OF COILS	INPUT SIGNAL (PSI)	APPLICATION
5327330-1	15	3-15	OPTIONAL HIGH GAIN RANGE SPRING
5327330-2	14	3-27	OPTIONAL HIGH GAIN RANGE SPRING
		3-15	STANDARD GAIN RANGE SPRING*
5327330-3	11	3-27	STANDARD GAIN RANGE SPRING*

*STANDARD GAIN (250-300) RANGE SPRINGS ARE ASSEMBLED IN PLACE AND SHIPPED WITH POSITIONER.

TABLE B - ITEM 5

GAGE TEMPERATURE RANGE	RANGE (PSIG)	LEGEND*	GAGE PART NO.
–40F TO +160F	0-30 0-160 0-160	INSTRUMENT SUPPLY OUTPUT	5326605-1 5326605-2 5326605-3
–40F TO +250F	0-30 0-160 0-160	INSTRUMENT SUPPLY OUTPUT	5326605-4 5326605-5 5326605-6

*INSTRUMENT, SUPPLY AND OUTPUT GAGE USED ON SINGLE-ACTING DEVICES. INSTRUMENT AND TWO OUTPUT GAGES USED ON DOUBLE-ACTING DEVICES. THERE ARE NO PROVISIONS FOR MOUNTING A SUPPLY GAGE ON DOUBLE-ACTING DEVICES.

TABLE C - ITEM 6

APPLICATION	GAIN SUPPRESSION KIT PART NO. 5327328-1		GAIN SUPPRESSION KIT PART NO. 5327328-2	
	POSITIONER WITH STANDARD GAIN (250-300)	POSITIONER WITH HIGH GAIN (300-400)	POSITIONER WITH STANDARD GAIN (250-300)	POSITIONER WITH HIGH GAIN (300-400)
CYLINDERS WITH 50 in.^{3} OR LESS DISPLACEMENT.	X			X
CYLINDERS WITH 50 in.^{3} TO 200 in.^{3} DISPLACEMENT.		X	NOT REQUIRED	
DIAPHRAGM ACTUATORS WITH HIGH PACKING FRICTION.	X			X

TABLE D - ITEM 7

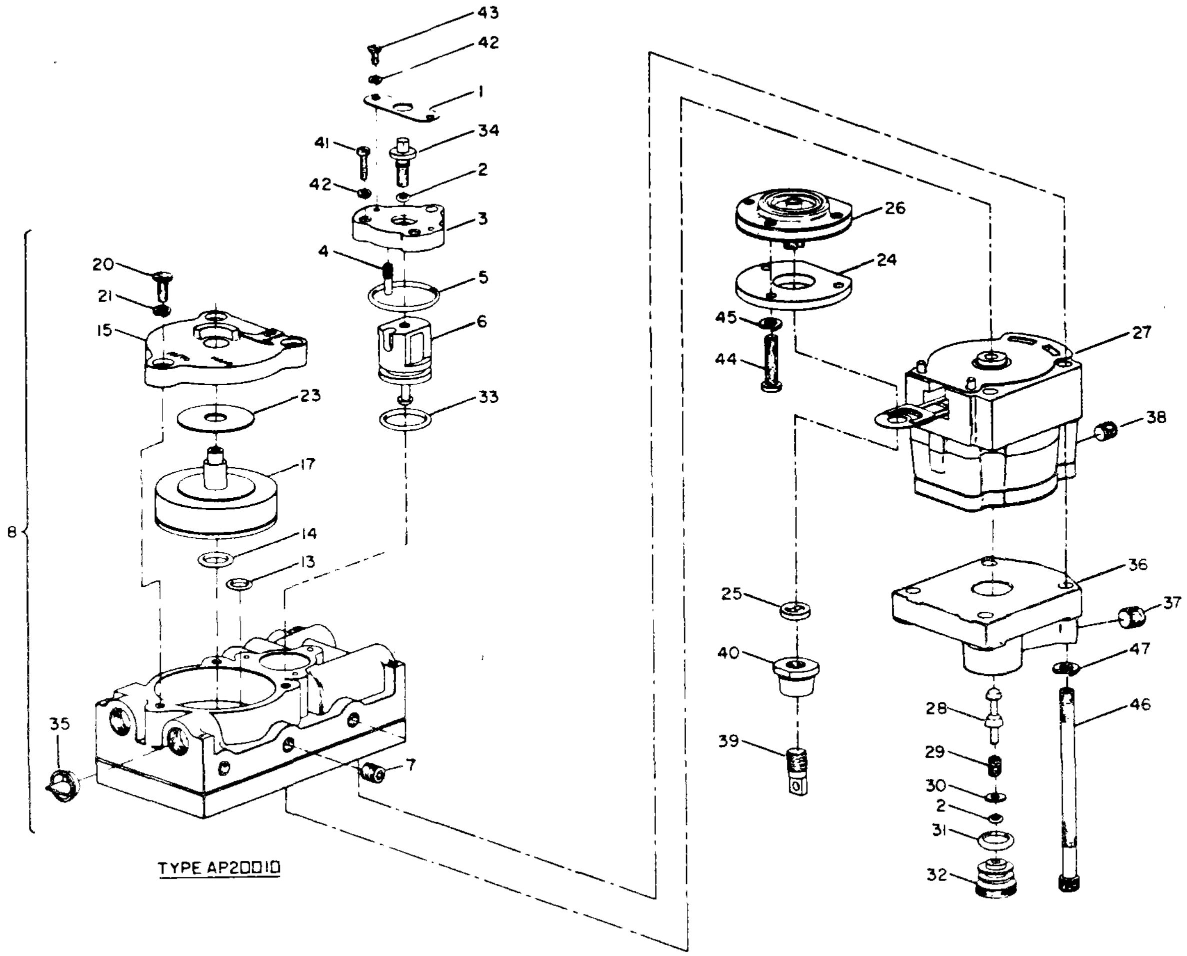
SPRING PART NO.	USAGE
5326594-1	INCLUDED IN GAIN SUPPRESSION KIT (ITEM 6) PART NO. 5327328-1
5326594-2	INCLUDED IN GAIN SUPPRESSION KIT (ITEM 6) PART NO. 5327328-2

TABLE E - ITEM 12

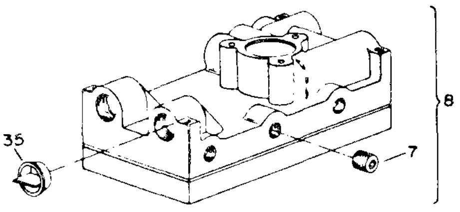
OPTIONAL SPEED CONTROL ORIFICE PART NO.	ORIFICE SIZE (IN.)
5327327-1	.040"
5327327-2	BLANK (DRILL TO SUIT)

TABLE F

TYPE	ITEM 39	ITEM 40	MATERIAL
AP2☐☐☐0	6614522-1H	5327724-1H	NEOPRENE
AP2☐☐☐1	6614522-2H	5327724-2H	SILICONE



TYPE AP20010



TYPE AP20000

FIGURE 23 - Parts Drawing P88-31,

ITEM	PART NO.	NAME
1	5326582-1	SCREW RETAINER
2	SEE TABLE	O-RING, 2 REQD
3	5326783-1	VALVE COVER
4	197553-1	DOWEL PIN
5	SEE TABLE	O-RING
6	SEE TABLE	VALVE SEAT ASSY
7	1951041-2	SOCKET HD PIPE PLUG, 3 REQD
8	5326775-1	MANIFOLD ASSY FOR TYPE AP2☐☐0☐
	5326775-2	MANIFOLD ASSY FOR TYPE AP2☐☐10 ONLY (INCLUDES ITEMS 13 THRU 23, 7, 35)
	5326775-3	MANIFOLD ASSY FOR TYPE AP2☐☐11 ONLY (INCLUDES ITEMS 13 THRU 23, 7, 35)
13	SEE TABLE	O-RING, 2 REQD
14	SEE TABLE	O-RING, 2 REQD
15	5326773-1	VALVE RETAINER ASSY
17	5326792-1	VALVE ASSY
20	.190-32x.500	PAN HD STN STL MACH SCR, 3 REQD
21	.190	STN STL SPRG LKWASH, 3 REQD
23	197562-1	.015" SHIM, AS REQD AT ASSY .020" SHIM, AS REQD AT ASSY .025" SHIM, AS REQD AT ASSY
24	5326593-1	SIGNAL COVER
25	5326778-1	RETAINER
26	SEE TABLE	SIGNAL DIAPHRAGM ASSY
27	SEE TABLE	RELAY ASSEMBLY*
28	5326580-1	VALVE
29	5326599-1	VALVE SPRING
30	19734-20	SMALL WASHER
31	SEE TABLE	O-RING
32	5326781-1	VALVE PLUG
33	SEE TABLE	O-RING
34	5326575-1	ADJUSTMENT SCREW
35	1945750-1	PULL PLUG, 4 REQD
36	5326603-1	BASE MANIFOLD ASSY (INCLUDES ITEM 37)
37	1951041-2	SOCKET HD PIPE PLUG, 2 REQD
38	1951041-3	SOCKET HD PIPE PLUG
39	197421-1	SPRING RETAINER
40	5327331-1	SIGNAL NUT
41	.112-40x.500	FILLISTER HEAD STN STL MACH SCR, 3 REQD
42	.112	STN STL REG SPRING LKWASH, 5 REQD
43	.112-40x.312	PAN HD STN STL MACH SCR, 2 REQD
44	.190-32x1.00	PAN HD MACH SCR, 3 REQD
45	.190	STN STL REG SPRING LKWASH, 3 REQD
46	.250-28x4.00	HEX SOC HEAD STN STL CAP SCR, 4 REQD
47	.250	STN STL REG SPRING LKWASH, 4 REQD

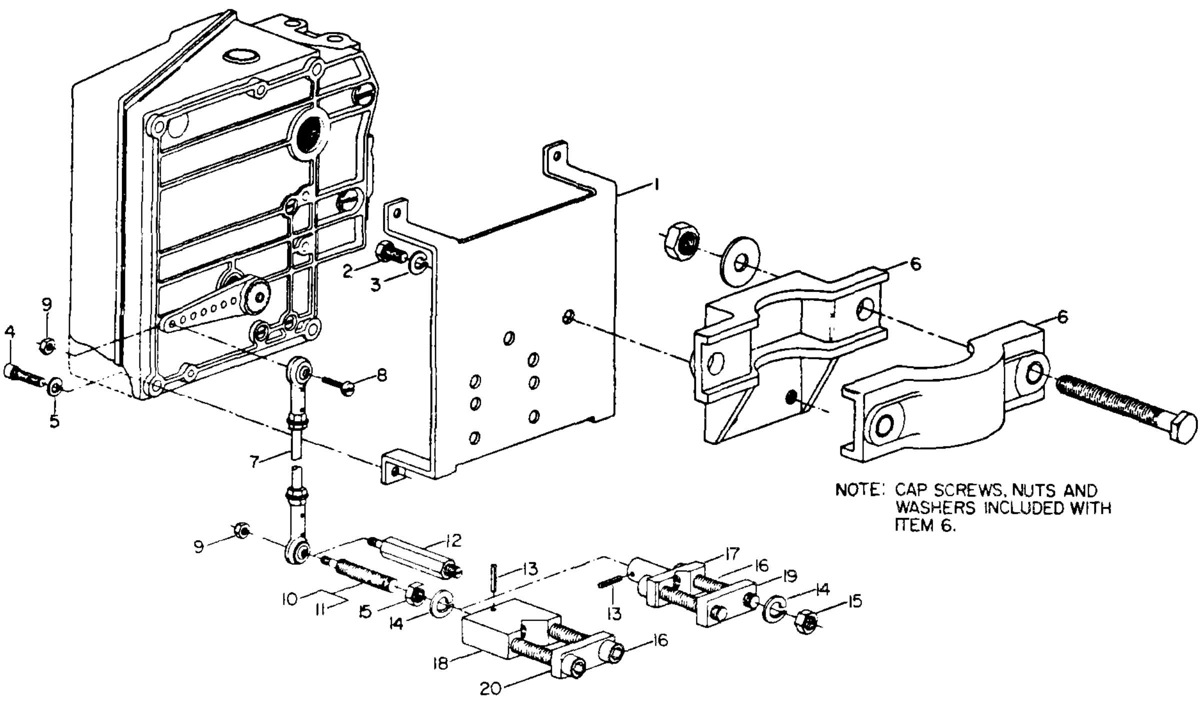
*INCLUDES ITEM 38.

TYPE	RELAY ASSY PART NO.	ITEM 2	ITEM 5	ITEM 6	ITEM 13	ITEM 14	ITEM 26	ITEM 27	ITEM 31	ITEM 33
AP2☐☐00	5326600-5	1951398-1	1951398-5	5326785-1	OMIT	OMIT	5326788-1	5326790-1	1951398-3	1951398-4
AP2☐☐01	5326600-6	1951398-6	1951398-10	5326785-2	OMIT	OMIT	5326788-2	5326790-2	1951398-8	1951398-9
AP2☐☐10	5328139-1	1951398-1	1951398-5	5326785-1	1951398-2	1951398-3	5326788-1	5326790-1	1951398-3	1951398-4
AP2☐☐11	5328139-2	1951398-6	1951398-10	5326785-2	1951398-7	1951398-8	5326788-2	5326790-2	1951398-8	1951398-9

SPARE PARTS KITS

TYPE	ITEM 2	ITEM 5	ITEM 6	ITEM 13	ITEM 26	ITEM 28	ITEM 29	ITEM 30	ITEMS 14 & 31	ITEM 33
KIT NO. 258033-5										
AP2☐☐01	1951398-6	1951398-10	5326785-2		5326788-2	5326580-1	5326599-1	19734-20	1951398-8	1951398-9
KIT NO. 258033-6										
AP2☐☐11	1951398-6	1951398-10	5326785-2	1951398-7	5326788-2	5326580-1	5326599-1	19734-20	1951398-8	1951398-9
KIT NO. 258033-7										
AP2☐☐00	1951398-1	1951398-5	5326785-1		5326788-1	5326580-1	5326599-1	19734-20	1951398-3	1951398-4
KIT NO. 258033-8										
AP2☐☐10	1951398-1	1951398-5	5326785-1	1951398-2	5326788-1	5326580-1	5326599-1	19734-20	1951398-3	1951398-4

Positioner Relay Assembly, Pt. No. 5326600-☐ and 5328139-☐



NOTE: CAP SCREWS, NUTS AND WASHERS INCLUDED WITH ITEM 6.

NOTE: SEE TABLE FOR MOUNTING KIT PARTS REQUIRED.

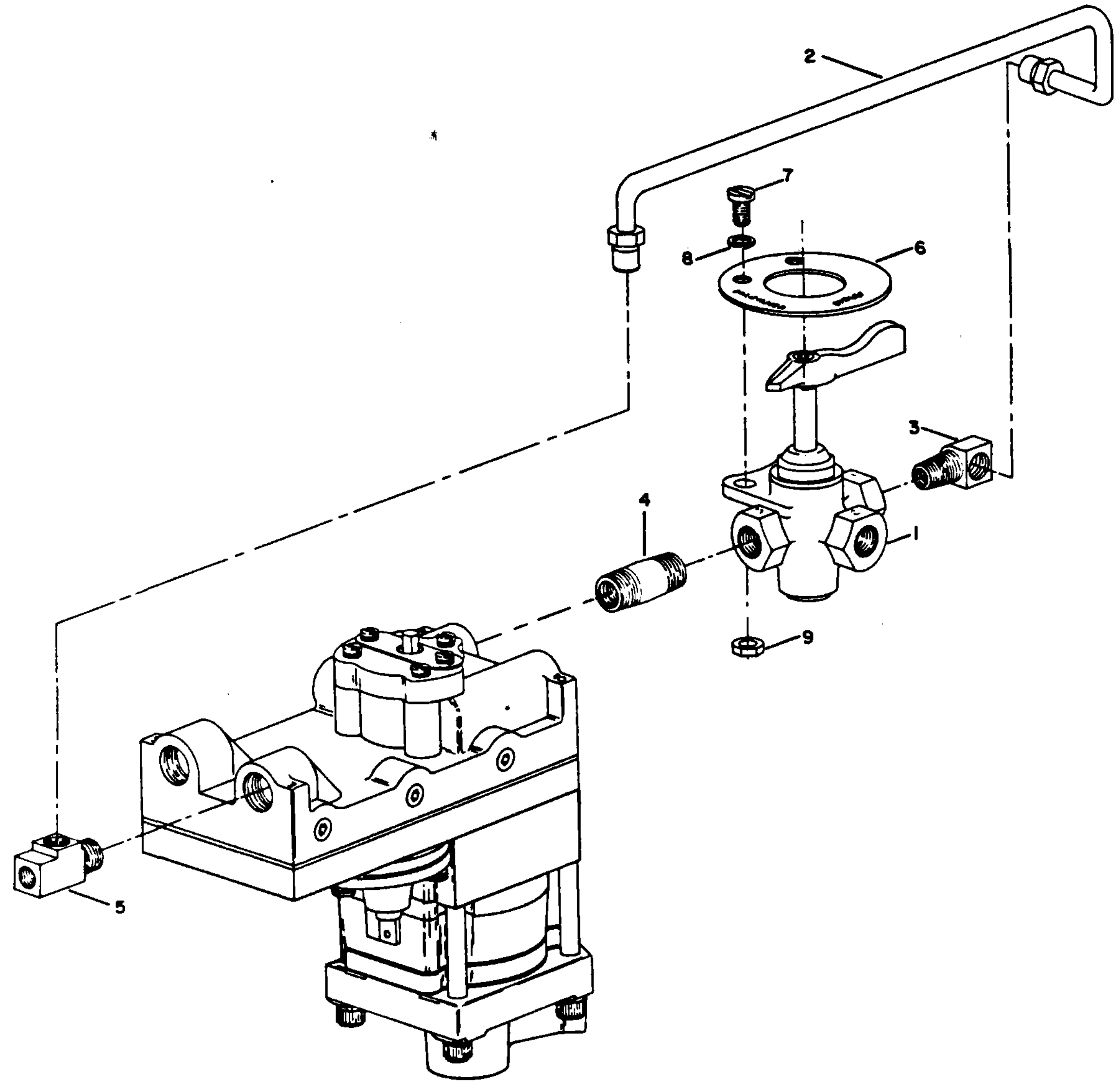
ITEM	PART NO.	NAME
1	5327569-1	POSITIONER MTG BRKT
2	.312-18x.625	HEX SOC HD CAP SCR, 2 REQD
3	.312	SPRING LKWASH, 2 REQD
4	.250-20x1.0	HEX SOC HD CAP SCR, 4 REQD
5	.250	SPRING LKWASH, 4 REQD
6	SEE NOTE	MTG BRKT (FOR VALVE YOKE WITHOUT MTG BOSS)
7	5312449-4	CONNECTING LINK (CUT TO FIT)
8	.190-32x.188	PAN HD MACH SCR
9	197120A5	STOP NUT, 2 REQD
10	5311690-1	ADJUSTABLE STUD (2.687" LG)
11	5311690-2	ADJUSTABLE STUD (3.437" LG)
12	5319500-1	ADJUSTABLE STUD (3.406" LG)
13	.125x.750	GROOV PIN
14	.375	SPRING LKWASH, 3 REQD
15	.375-16	HEX JAM NUT, 3 REQD
16	.375-16x1.50	HEX SOC HD CAP SCR, 2 REQD
17	5311687-2	STEM CLAMP (.375"–.750" DIA)
18	5312483-1	STEM CLAMP (.750"–1.0" DIA)
19	5311691-1	CLAMP PLATE (.375"–.750" DIA)
20	5312471-1	CLAMP PLATE (.750"–1.0" DIA)

NOTE: BRACKET AND ATTACHING HARDWARE NOT INCLUDED IN MOUNTING KIT. IF NECESSARY TO MOUNT POSITIONER ON VALVE YOKE WITHOUT MOUNTING BOSSES, ORDER OPTIONAL MOUNTING BRACKET PT. NO. 5313138-1.

MTG. KIT PART NO.	USAGE	VALVE STEM DIAMETER	ITEM																	
			1	2	3	4	5	7	8	9	10	11	12	13	14	15	16	17	18	19	20
5327321-1	BAILEY	.750"-1.0"	X	X	X	X	X	X	X	X	X			X	X	X	X		X		X
5327321-2	BAILEY	.375"-.750"	X	X	X	X	X	X	X	X	X			X	X	X	X	X		X	
5327321-3	BAILEY	.750"-1.0"	X	X	X	X	X	X	X	X		X		X	X	X	X		*X		X
5327321-4	BAILEY	.375"-.750"	X	X	X	X	X	X	X	X		X		X	X	X	X	X		X	
5327321-5	FISHER	.750"-1.0"	X	X	X	X	X	X	X	X			X								
5327321-6	FISHER	.375"-.750"	X	X	X	X	X	X	X	X			X								

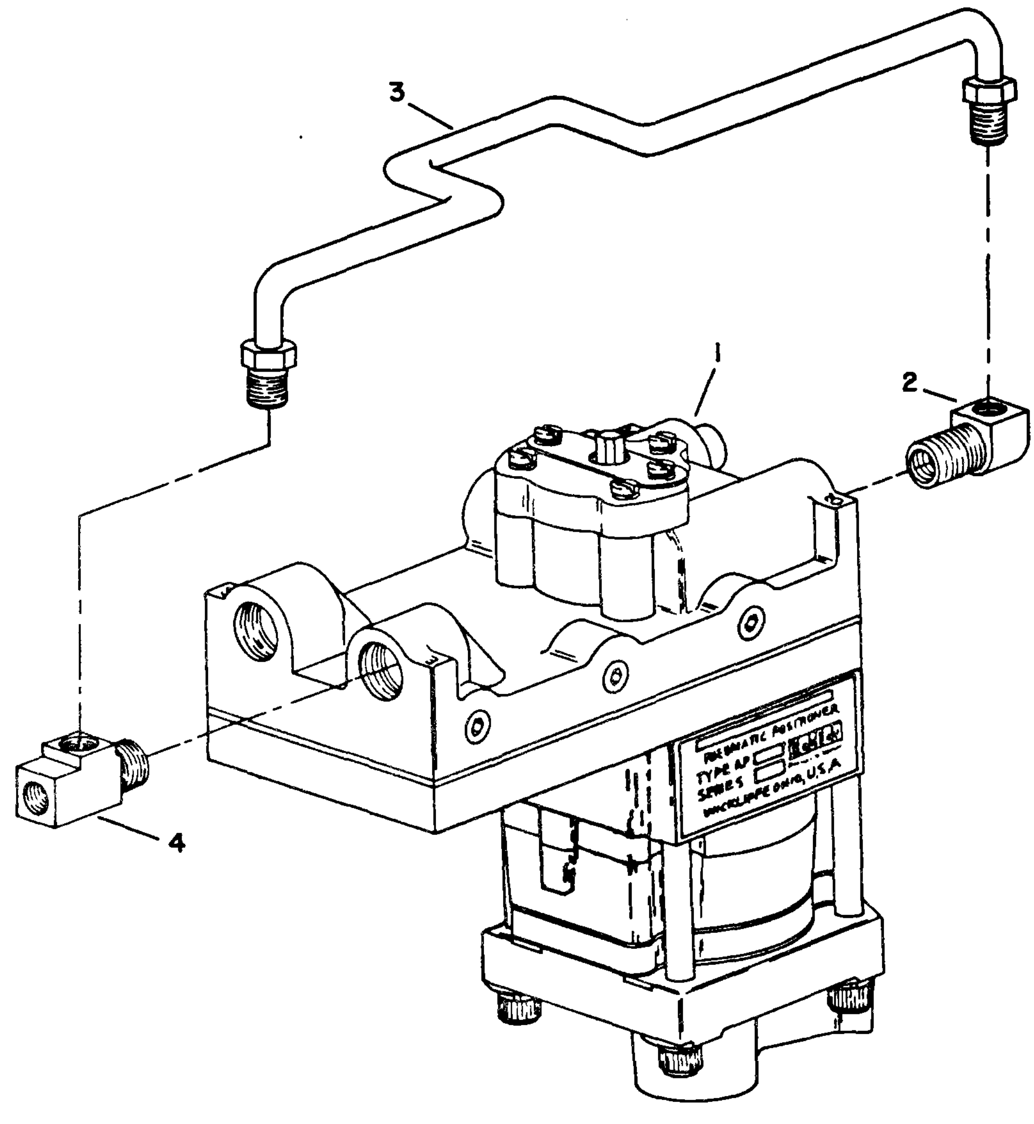
*FOR DIRECT OR REVERSE-ACTING DIAPHRAGM ACTUATOR APPLICATIONS ONLY.

FIGURE 24 - Parts Drawing P88-28, Optional Mounting Kit, Pt. No. 5327321-☐



ITEM	PART NO.	NAME	ITEM	PART NO.	NAME	ITEM	PART NO.	NAME
1	5327226-1	3-WAY VALVE	5	195171-3	WEATHERHEAD TEE	8	NO. 10	REG SPRING LKWASH, 2 REQD
2	5326946-1	AIRLINE CONNECTION ASSY	6	1962833-1	DESIGNATION PLATE	9	.190-32	HEX NUT, 2 REQD
3	195159-3	ELBOW CONNECTOR	7	.190-32x.375	PAN HD MACH SCR, 2 REQD			
4	195727-2	BRASS NIPPLE						

FIGURE 25 - Parts Drawing P88-24, Optional Bypass Valve Assembly for Single-Acting Diaphragm Actuators, Pt. No. 5326945-1.



KIT NO. 5327252-1

ITEM	PART NO.	NAME
1	1951421-2	PIPE PLUG
2	1951187-3	ELBOW CONNECTOR
3	5327236-1	AIRLINE ASSY
4	195171-6	WEATHERHEAD TEE

Figure 26- Parts Drawing P88-32, Optional Position Transmitter Conversion Kit, Pt. No. 5327252-1

26/3.5.1.
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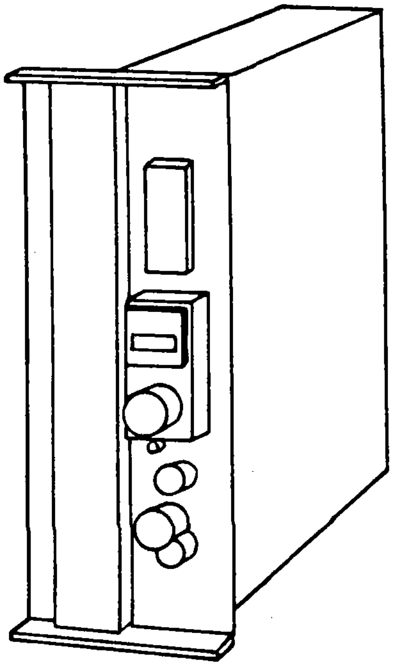
ELECTRONIC PROCESS CONTROLLER
MODEL 2620



INSTRUCTIONS FOR INSTALLATION
START-UP, OPERATION AND MAINTENANCE

ELECTRONICS

LESLIE CO., PARSIPPANY, N. J. 07054

TABLE OF CONTENTS

SECTION 1 – INTRODUCTION

1.0 GENERAL

The Model 2620 Controller, shown in figure 1–1, is a primary control instrument, designed with solid state circuits, to provide extended troublefree operation within the working range of a closed-loop control application. Control applications include temperature, pressure, speed, force, position or any process control parameter that can be measured or controlled electrically.

Three operational control modes are provided:

Setpoint	Closed-loop process level is confined to preset level of setpoint control on the Model 2620
Remote program	Closed-loop process level is controlled by a remote variable controlled by a remote variable control
Manual	Open-loop process level is a direct function of the MANUAL control dial setting

In the set point control mode, a sensor generates a feedback signal which is compared with the setpoint level corresponding to the dial setting of the SETPOINT control. The resulting difference signal is applied to the final control circuits as a command level to provide a corresponding process adjustment to bring the process within the setpoint range setting (zero differential).

In the remote program mode of operation a remote potentiometer is used in place of the local setpoint control to provide a variable control level.

In the manual mode a MANUAL control dial on the controller is adjusted to provide a constant control signal to provide a constant output command level. The process level is a direct function of the MANUAL control setting (0 to 100%).

1.1 CHARACTERISTICS AND SPECIFICATIONS

The characteristics and specifications of the 2620 Controller are listed in Table 1–1.

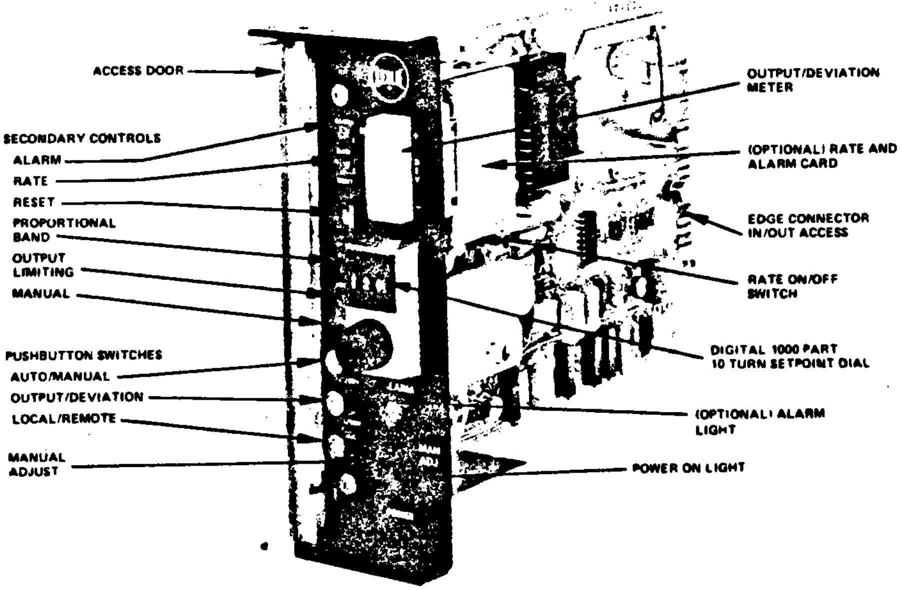


FIGURE 1-1 MODEL 2620 TEMPERATURE CONTROLLER

TABLE 1-1 2620 SPECIFICATIONS

INPUT TYPES

- Thermocouple — Accepts directly; has internal cold junction compensation and burnout protection that is selectable for upscale, downscale or none.
- Resistance Bulb Thermometers — RTD inputs for 3 wire platinum wound elements accepted directly.
- Millivolt, Voltage or Current — Selected ranges available to accept industry standards from process transmitters.

INPUT IMPEDANCES

- Thermocouples — 100 ohms.
- Voltages — <100mv: 100K.
  >100mv: 10K.
- Currents — 2500/High end of span in ma.

MINIMUM PRACTICAL SPANS

- Thermocouples and Millivolts — At least 10 mv change over process span.
- Currents — At least 0.1ma change over process span.
- RTD's — 60Ω minimum R, with △ R the greater of 10Ω or 10% of minimum R.

MAXIMUM ZERO SUPPRESSION

- 50% of high end value.

COMMON MODE REJECTION

- Better than 120 db at 60 Hz (1,000,000:1).
- Common mode not to exceed 120 VAC or 150 VDC.

NORMAL MODE REJECTION

- Better than 40 db at 60 Hz (100:1). Normal mode not to exceed 2 times input span.

LOCAL SETPOINT

- 3 Digit Setpoint, 10-turn, dial, 1000 parts.
- Accuracy:
  Calibrated to ± ½ % span.
  Linearity ¼ % of span.
  Repeatability ½ digit or 0.05% of span.

STANDARD OUTPUTS

- Current output 4-20 ma into 500 ohms maximum.
- Voltage output 0-5 volts into 500 ohms minimum.

OPTIONAL OUTPUT

- Internal Distributed Zero Cross Fired solid state relay power controller rated 120 volts at 10 amps.

OUTPUT LIMITING

- In Auto mode only, adjustable output limiting settable 10-100% not functional in Manual mode.

CONTROL MODE SETTINGS

- Proportioning Bandwidth 5-400% of span.
- Reset in 10 steps — off and 0.05-20 repeats/minute.
- Rate adjustable 0.1-1.5 minutes with on/off switch.

DEVIATION/OUTPUT METER

- Displays deviation from setpoint ±10% input span, or percent controller output.

DEVIATION ALARM (OPTIONAL)

- Red alarm light and 1A, 120 VAC selectable NC or NO contact.
- High only, low only or high and low.
- Adjustable 1 to 10% input span.

CONTROL SENSITIVITY

- A 1 microvolt change at input will provide a measurable output change.

RESPONSE TIME

- Less than 30 milliseconds to reach 63% of final.

ENVIRONMENTAL LIMITS

- Operating 40 to 140°F at 90% RH (noncondensing).
- Storage −40 to +160°F at 90% RH (noncondensing).
- Vibration 1G maximum.

STABILITY

- Ambient Temperature — A change in ambient from 80 degrees F, ±40 degrees will result in a control point change less than ±.02% of span per 1 degree F ambient change, or:
  Thermocouple and Voltage Input: ±3 microvolts/degree F, whichever is larger.
  100 Ohm RTD Input: ±.075 ohm / degree F, whichever is larger.
- Line Voltage—A change in line voltage from 120V, +10-15%, will result in a control point change less than ±.1% of span or:
  Thermocouple and Voltage Input:
  ±20 microvolts, whichever is larger.
  100 Ohm RTD Input: ±.2 ohm, whichever is larger.
- Long Term — With line and ambient being constant, control point drift over 25-hour period to be less than ±.1% of span or:
  Thermocouple and Voltage Input:
  30 microvolts, whichever is larger.
  100 Ohm RTD Input: ±.2 ohm, whichever is larger.

POWER

- 120/240 VAC, 50/60 Hz.
- Controller only 10 VA and unfused.

WEIGHT

• 2620	3 Lbs.	1.36 kg
• Single Case	3 Lbs.	1.36 kg
• 6 Unit frame	16 Lbs.	7.26 kg

SECTION 2 – INSTALLATION

2.1 GENERAL

Model 2620 Controllers are supplied in either single-unit or multi-unit housings. The single-unit housings can be mounted on any sheet metal panel; the multi-unit housing, which can hold up to six of the pluggable controller assemblies, is designed to bolt directly into a standard 19-inch electronics rack. Preparations for mounting the controllers, and the electrical connections required, are described in the following paragraphs.

2.2 SINGLE-UNIT PANEL MOUNTING

Mounting one or more single-unit housings in a sheet metal panel requires preparation of a cut-out for separate mounting of each unit in the panel, as shown in Figure 2-1. The pluggable controller assembly can be withdrawn from the housing to facilitate installation. The assembly can then be reinserted into the housing by aligning the edges of the printed-circuit card in the slotted nylon guides at the top and bottom of the housing.

2.3 MULTI-UNIT RACK MOUNTING

The multi-unit housing, shown in Figures 2-2 and 2-3, has four holes in its front mounting flange matching the spacing of mounting holes in the frame of standard 19-inch electronics racks (5-3/4 inches, center-to-center). Insert the housing at the desired level in the rack and secure it in position with mounting hardware. Controllers can then be plugged into the housing to complete the mechanical installation.

2.4 STANDARD ELECTRICAL CONNECTIONS

All standard electrical connections to each 2620 Controller are made to its individual printed circuit board connector mounted at the rear of its housing, whether it is in a single-unit or a multi-unit configuration. The connector screw terminals accept between 30 and 12 gauge wire stripped to expose 3/8" of lead. After insertion into a terminal, each wire is secured in position by tightening the associated set-screw, as indicated in Figure 2–4. Figure 2–5 shows the system connections.

FIGURE 2-1

SINGLE CASE

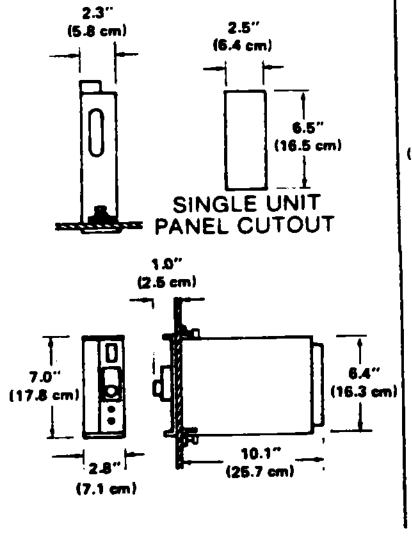
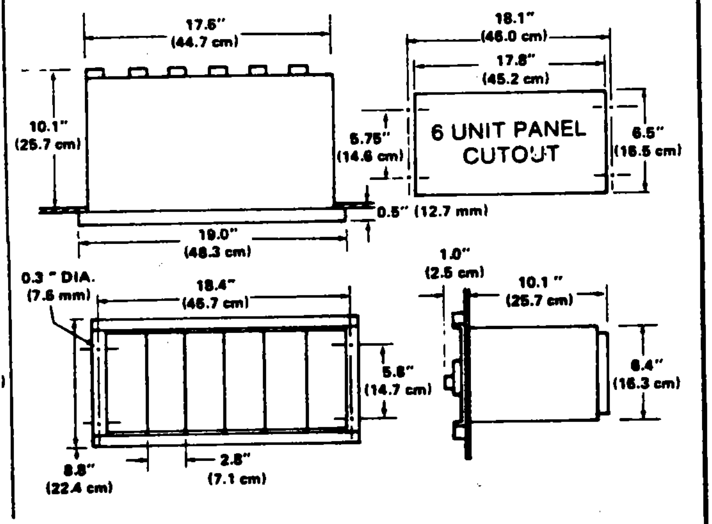


FIGURE 2-2

MULTI-UNIT PANEL
6 UNIT RACK MOUNTING FRAME



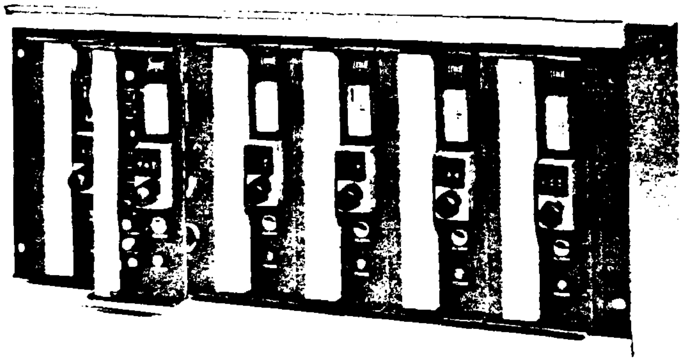


FIGURE 2-3 2620 MULTI-UNIT CONFIGURATION

2.4.1 Line Connections

The 2620 Controller can operate on either 120 or 240 VAC 60 Hz input power. However, operation on 240 VAC requires that the dual primary windings on the internal power transformer be wired in series rather than in parallel, as is normal for 120 VAC operation. To accomplish this change, two printed wiring paths must be cut open and a jumper must be installed as shown on schematic drawing D47081. Also, if an internal solid-state relay (SSR) rated at 120 VAC is installed in the controller, it must be replaced with a unit rated for 240 VAC operation.

When an internal SSR is not installed, AC high connects to either terminal 18 or terminal 19; AC common connects either to terminal 15 or 16. (See figure 2-5)

When an internal SSR is installed, AC high and common connect as described above, but terminal 18 must be jumpered to terminal 19, and terminal 15 must be jumpered to terminal 16 with 16-gauge stranded wire so that the 5 ampere current handling capability of each terminal is not exceeded when full current is applied to a load. Also, line wire in this case should be 16-gauge stranded, minimum, to handle the 10-ampere input current.

Note that line voltage to the controller should come from the same source that supplies the external solid-state relay so that the controller can properly compensate for variations in line voltage applied to the load.

2.4.2 Load Connections

No load connections are made to the controller unless an internal SSR is installed, in which case the high side of the load connects to either terminal 21 or terminal 22, which must be jumpered together. The low side of the load connects to either terminal 15 or 16, whichever is not occupied by the AC common input line; be sure 15 or 16, whichever is not occupied by the AC common input line; be sure 15 is jumpered to 16. All load wiring must also be 16-gauge stranded, minimum.

2.4.3 Sensor Connections

Sensor leads connect to terminals 1 and 4 on the PCB connector. The negative lead connects to terminal 1; the positive lead connects to terminal 4.

NOTE

An up/down burnout protection resistor is provided to protect thermocouple, voltage on current inputs. The resistor is supplied from the factory in the up (UP) position. If downscale protection is required move to the down (DN) position. In RTD applications resistor R-1 in the down (DN) position is used for lead resistance compensation.

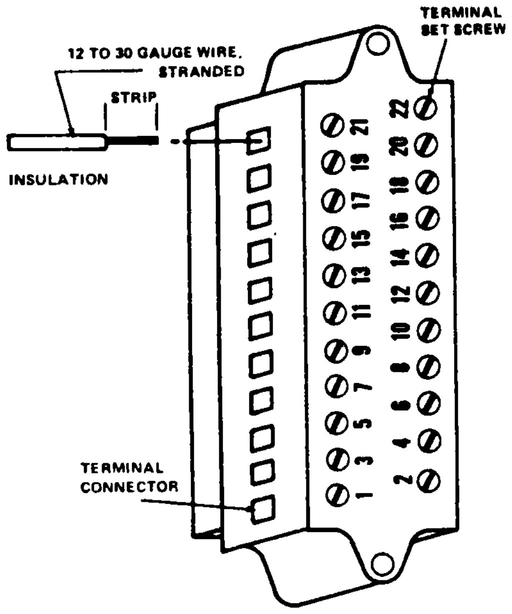


FIGURE 2-4

ELECTRICAL CONNECTION TO PCB CONNECTOR

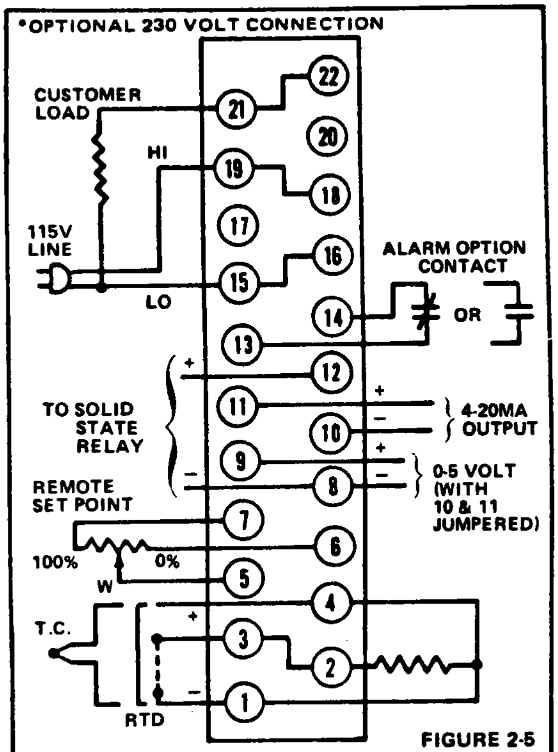


FIGURE 2-5

SYSTEM INTERCONNECTIONS

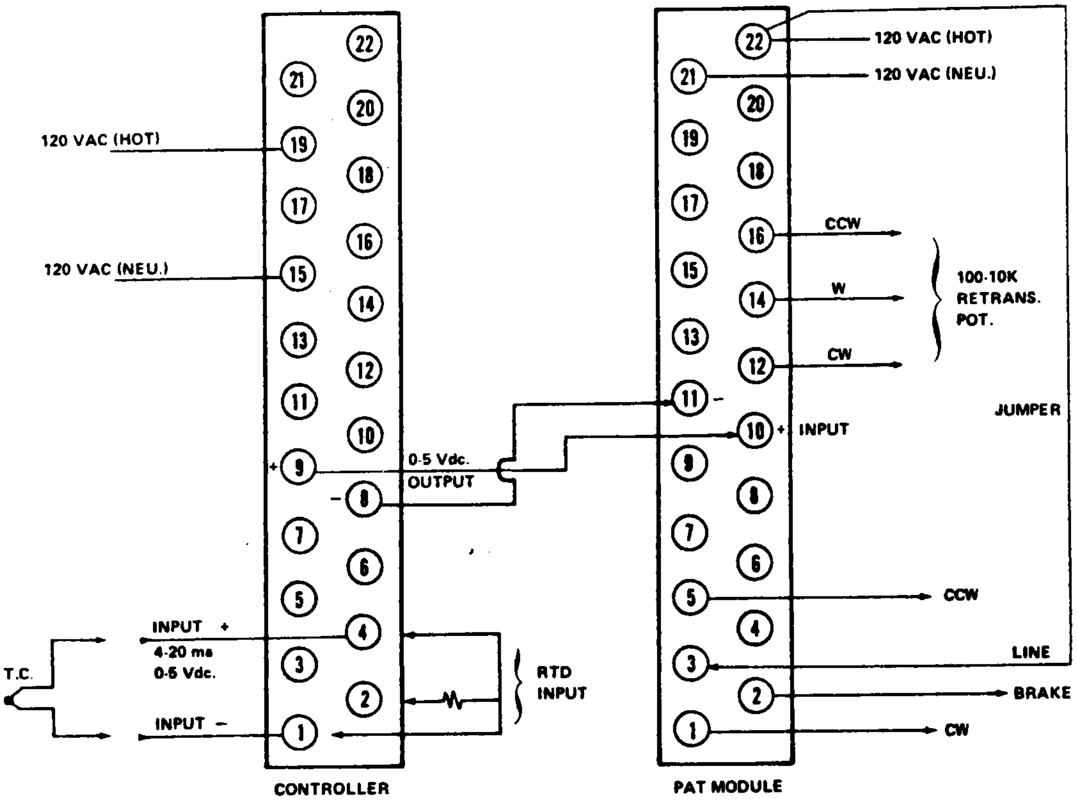


FIGURE 2-6

TYPICAL INTERCONNECTIONS BETWEEN CONTROLLER & PAT MODULE

Thermocouple extension wire should be twisted tightly together and kept isolated from the line and load wiring to prevent noise pickup or undesirable coupling. Also note that calibration of the controller is based on a 10-ohm thermocouple lead-wire resistance.

2.4.4 Remote Setpoint Connections

The three leads from a remote 1K ohm setpoint potentiometer, or from the ouput potentiometer of an external programming device, such as a Research, Inc. DATA-TRAK programmer, connect to the controller as follows:

Clockwise lead - terminal 7
Wiper lead - terminal 5
Counterclockwise lead - terminal 6

2.4.5 External Solid State Relay Drive Connections

The control signal lead to an external solid state relay connect to terminal 12; the signal return lead connects to terminal 8 (common).

2.4.6 Auxiliary Output Control Signal Connections

Two auxiliary output signals are available from the 2620 for controlling devices that require either a 0 to 5 volt or a 4 to 20 milliampere control signal. The 0 to 5 volt connections are made to terminals 8 (ground) and 9 (+out). Note that when this control signal is used, terminals 10 and 11 must be jumpered together to activate the internal amplifier circuit.

The 4 to 20 milliampere signal connections are made to terminals 10 (-) and 11 (+). Note the terminals are factory-supplied with a jumper which must be removed prior to use of this output.

2.4.7 Alarm Relay Connections

External connections to the alarm relay contacts are made to terminals 13 and 14. Depending on the requirements of any given application, an internal jumper can be installed to provide connection to either the normally-closed or normally-open contacts of the relay. Note that the contacts of this relay are rated at 1 ampere, 120 VAC' resistive.

2.4.8 Alarm Indicator Diodes

The alarm indicator is provided with removable diodes for hi, low or hi/lo operation. These diodes are located on the 2620 circuit board and are removed to provide the following indications:

Hi/Lo – Both diodes in place
Hi – Remove diode CR13
Lo – Remove diode CR12

SECTION 3 – OPERATION

3.0 GENERAL

This section includes a functional description of the controls and indicators used during normal operation of the controller and provides general instructions for their use. Controls used only for adjustment and calibration are described in Section 4.

3.1 OPERATING CONTROLS AND INDICATORS

Operating controls and indicators are listed in Table 3-1 and shown in Figure 3-1. Note that the controls and indicators on the right-hand half of the front panel are permanently exposed; the remaining controls are accessed by pivoting out the hinged handle on the left half of the panel.

3.2 OPERATING PROCEDURES

Operating procedures for the 2620 Controller in manual and automatic modes are presented in the following paragraphs. It is assumed that the controller is installed in a process control system as described in Section 2 and that power is applied to the controller.

3.3 MANUAL OPERATING MODE

Place the 2620 in manual mode by pressing the A/M pushbutton until it locks in the "in" postion.

The MAN control pot adjusts the magnitude of the control signal sent to the external solid state switch, irrespective of sensor signal or LIMIT control setting. Rotation of this control from fully counterclockwise to fully clockwise causes from zero to maximum power to be applied to the load.

Although the sensor feedback signal has no influence over load power in manual mode, it can be used to provide an accurate measurement of process parameter in the following manner:

1. Press the O/D switch to its D (in) position.
2. Rotate the setpoint control until panel meter nulls.
3. Read setpoint dial.

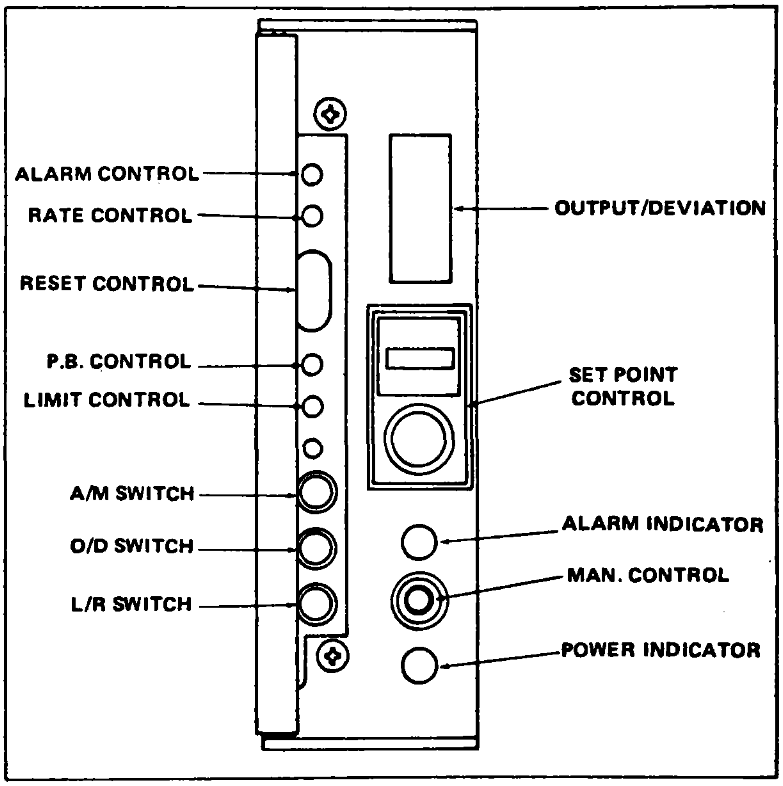


FIGURE 3-1 OPERATING CONTROLS AND INDICATORS

TABLE 3-1 OPERATING CONTROLS AND INDICATORS

NAME	TYPE	FUNCTION
ALARM	Indicator	When lighted, indicates that the controlled process parameter is not within the selected upper and lower alarm limits within the proportional band of control.
SET POINT	Potentiometer with 10-turn logging dial	Selects the desired setpoint level.
OUTPUT/DEVIATION METER	Null indicating	Indicates either the magnitude of the control signal sent to the solid state relay, or any deviation of the controlled process parameter above or below the setpoint level (selectable with O/D pushbutton).
ALARM	Potentiometer	Adjusts the alarm limits to any desired level from 1 to 10% of input signal span.
RATE	Potentiometer	Adjusts the amount of rate action from .1 to 1.5 minutes added to proportional control to aid control stability.
RESET	10-position rotary switch	Adjusts reset action from .05 to 20 repeats per minute in 9 discrete steps. In 0 position reset action is off.
P.B. (Proportional Band)	Potentiometer	Adjusts the width of the proportional control band from 5 to 200% of the span of the input signal.
LIMIT	Potentiometer	Adjusts the limit of the output power applied to the load.
MAN (Manual)	Potentiometer	Adjusts output command level from 0 to 100% of span in manual operating mode.
A/M (Automatic/ Manual)	Pushbutton Switch (Maintained)	Selects either automatic or manual operating modes. (A=out; M=in.).
O/D (Output/ Deviation)	Pushbutton Switch (Maintained)	Selects between the output control signal and process parameter deviation for magnitude display on the panel meter. (0=out; D=in.)
L/R (Local/ Remote)	Pushbutton Switch (Maintained)	Selects between the internal (local) setpoint control or remote setpoint control for establishing setpoint levels.(L=out; R=in.)

3.4 AUTOMATIC OPERATING MODE

Automatic operating mode is entered when the A/M pushbutton on the front panel is pressed and released to its A (out) position.

Closed-loop process control is accomplished in the automatic mode through comparison between a sensor feedback signal and a setpoint level. Any difference between these signals is amplified and used to control the level of the control signal in a manner that tends to reduce the difference to zero.

The command signal is generated either by the setpoint control on the front panel, or by an external setpoint control, depending on the selected setting of the L/R (local/remote) switch. Ther procedures that are performed in adjusting a system to a closed-loop control process in the automatic mode are described in the following paragraphs in the order they are normally performed.

3.4.1 LIMIT Adjustment

The setting of the LIMIT control determines the upper limit to the output signal from the controller.

The rate of change of a sensor output is a basic parameter that influences adjustment of other controls that provide responsive, stable system operation. Therefore, if limiting action is desired, the following procedure should be performed before other adjustments are made:

1. Turn the LIMIT control fully counterclockwise to limit load power to 20% of its maximum value. Ensure that the RATE control is fully counterclockwise, and that the RESET switch is in off position (0).

2. Turn the P.B. control fully counterclockwise to establish the narrowest possible proportional band of control.

3. Set the O/D switch to its O position to display the magnitude of the output signal on the panel meter.

4. Adjust the setpoint control to a temperature output command level sufficiently higher than its current setting such that the process control parameter can not rise to within the proportional band during the limit adjustment. This is to prevent normal automatic reduction of load power within the proportional band from interacting with the limit adjustment which would introduce an adjustment error.

5. The magnitude of the output signal displayed on the panel meter has a linear relationship with applied load power, which at this time indicates 20% of maximum. Adjust the LIMIT control clockwise until the panel meter displays a value corresponding to an output.

After the initial limit adjustment has been made, shift the setpoint upward and monitor the panel meter. The output indication should go no higher than the selected limiting level.

Widen the proportional band by turning the P.B. control to approximately its center setting. Switch the panel meter to display deviation, and adjust the setpoint control to the normal process level.

After the process has stabilized somewhat lower than the setpoint level (indicated by stable negative deviation on the panel meter), the P.B., RATE, and RESET controls are adjusted for optimum system operation.

Note that the optimum settings of the P.B., RATE, and RESET controls depend on the electrical and physical characteristics of all components in the system as a group.

In view of the numerous variables involved, a general rather than a specific adjustment procedure for each of these controls is provided in the following paragraphs.

3.4.2 Proportional Band Adjustment

The P.B. control setting establishes the amount of proportional output control signal for a given difference between setpoint and input signal. Clockwise rotation of the control increases the output signal for a given difference, thus narrowing the band of proportional control, which provides tighter control of process parameter.

The P.B. control should be set to a point where system oscillations occur in response to small shifts in setpoint level, and then turned down until the oscillations stop.

3.4.3 Reset Action Adjustment

Reset action is used to cancel out the proportional droop of the process parameter below the setpoint level caused by system losses. Introduce reset action by switching the RESET control from 0 to the highest position that produces just a slight amount of system overshoot with repeated changes of the setpoint level. Begin trial adjustment at midrange (position 5). Note that the panel meter is zero.

3.4.4 Rate Action Adjustment

Rate action improves system response and prevents transient overshoot. Turn the RATE control slightly clockwise from its zero position to introduce rate action. Rate adjustment always causes some system perturbation; therefore, changes in setting should be small, and the operator must wait for the system to settle before making additional adjustments. Excessive rate action is characterized by system oscillations of a higher frequency than those produced by an excessively narrow proportional band. Proper rate action results in better damped system response.

Rate action can be increased as long as overshoot decrease with small shifts in the setpoint level.

3.4.5 Alarm Control Adjustment

The alarm control setting establishes the deviation limits at which the ALARM indicator is on the the alarm control relay is energized. The ALARM adjust control is adjustable to provide a maximum of 10% of the span.

Keeping the process control feedback level constant, either by disconnecting the output signal or removing the final control element, turn the setpoint dial until the DEVIATION meter nulls. Note the setpoint level, increase (or decrease) the setpoint control to the desired deviation limit (maximum of 10% of span). Adjust the ALARM control counterclockwise until the ALARM indicator is on.

NOTE:

External connection to the alarm relay contacts, terminals 13 and 14, can be normally open or normally closed when the ALARM indicator is on. Install a jumper on RATE/ALARM PCB Assembly to provide the required contact operation.

SECTION 4 – MAINTENANCE AND CALIBRATION

4.0 GENERAL

The 2620 temperature controller is engineered to provide extended trouble-free service with minimum maintenance. Normal maintenance consists of keeping the unit free of dust or other contamintants. However, due to normal component aging or failure, it might be necessary to make re-adjustments or locate and replace faulty components. The physical location on the 2620 printed circuit board of test points and adjustment and calibration procedures are called out on Figure 4-1. The equipment required for the checking and calibration procedures includes a digital voltmeter with 10 microvolt resolution, a precision millivolt source, an AC voltmeter, and card extender.

4.1 CHECKOUT AND ADJUSTING PROCEDURES

The following checks can be used to determine if specific areas in the controller circuits are in need of adjustment or repair. All checks and adjustments made in automatic mode must be made with the internal setpoint control selected (L/R switch in L (local) position).

4.1.1 Power Supply Voltage Checks

1) Measure voltage across capacitor C11; should read between -23 and -28 VDC.

2) Measure voltage across capacitor C12; should read between +23 and +28 VDC.

3) Measure voltage across capacitor C9; should read +15 ± .5VDC.

4) Measure voltage across capacitor C10; should read -15 ± .5 VDC.

4.1.2 Panel Meter Check

1) Check mechanical zero of meter with power off. Adjust balance spring if necessary after removing tape from access hole in side of meter. Replace tape to prevent dust from entering the meter movement after completing adjustment.

2) Connect a current source to the input terminals (1 (–) and 4 (+). Switch the panel meter to display deviation (O/D switch in D position), and apply power to the 2620.

3) Turn the setpoint dial to midrange (500 dial divisions), and raise the input signal until the meter nulls.

4) Increase the setpoint setting to 600; with this 10% (±1%) difference between the input signal the setpoint level, the meter should read full scale.

4.1.3 Proportional, Integral, Derivative (PID) Amplifier Check

The following checks are made in automatic operating mode with a voltmeter scaled for 0 to 10 VDC connected across diode CR1.

4.1.3.1 Reset Check

1) Turn the RESET switch to zero, and center the setpoint dial at 500.

2) Adjust input signal for a reading of -1 volt across diode CR1.

3) Turn the RESET switch to 9; the voltage across CR1 should go more negative at a rate of 1 volt every 3 seconds.

4) Turn the RESET switch back to 0 and then to 1; the voltage across CR1 should go more negative very slowly — at a rate of 50 millivolts per minute.

4.1.3.2 Reset Lockout Check

1) Turn the LIMIT control fully clockwise and switch RESET to position 9.

2) Monitor voltage across diode CR1; voltage should slowly move toward -6 volts, but just before reaching this level, it should jump back to approximately -5 volts. The cycle should then repeat.

4.1.3.3. Limit Check

1) Turn reset off and turn the proportional band (P.B.) control fully counterclockwise.

2) Adjust input signal for -5 volts across diode CR1.

3) Turn LIMIT control from fully clockwise to fully counterclockwise; the voltage across diode CR1 should go from -5 volts to about -1 volt (80% limiting).

4.1.3.4 Rate Check

1) Turn LIMIT control fully clockwise, switch RESET off, and turn RATE and P.B. controls fully counterclockwise.

2) Adjust input signal for -1 volt across diode CR1.

3) Turn RATE control fully clockwise and jumper pin 4 and pin 6 on RATE/ALARM board; voltage across CR1 should go to zero.

4) Release jumper; voltage across CR1 should drop to about -8 volts and then settle back to -1 volt.

4.1.4 Manual Control And Auxiliary Output Control Signal Check

The following checks are made in manual operating mode (A/M switch in M position).

4.1.4.1 Manual Control Check

1) Turn MANual control fully counterclockwise; voltage across diode CR1 should be less than +1 volt.

2) Turn MANual control fully clockwise; voltage across CR1 should be between -5 and -6 volts.

4.1.4.2 Auxiliary Output Control Signal Check

1) Connect a milliammeter, capable of measuring 20MA, between terminals 10 (−) and 11 (+) on the printed circuit board (PCB) connector after removing jumper.

2) Adjust the MANual control for -5 volts across diode CR1; the milliammeter should read 20 MA ± 1 MA.

3) Read the voltage between terminals 8 and 9 on the PCB connector; the voltage should measure 5 volts ± .25 volts.

4) Adjust the MANual control for zero volts across diode CR1. The output should measure zero volts between terminals 8 (output common) and 9 (+), and the milliammeter should read 4 MA ± 1 MA.

4.2 AMPLIFIER BALANCE AND INPUT CALIBRATION

4.2.1 Amplifier Null Balances Adjustment

1) Connect a voltmeter between the wiper of the ZERO trimpot (P$) and common, and adjust P4 for a 0 ± .1 volt on the wiper.

2) Turn the GAIN trimpot fully clockwise, remove the voltmeter lead from the wiper of P4, and jumper the wiper to common. Also, jumper the junction of resistors R30 and R31 to common.

3) Turn setpoint control to 000.

4) Connect a voltmeter between pin 4 and common on the RATE/ALARM board, and adjust the A1 NULL trimpot for a 0 volt ± 10 millivolt reading on the meter.
5) Remove jumpers.

6) Jumper pin 6 on the RATE/ALARM board to common.

7) Turn the P.B. control fully counterclockwise.

8) Connect a voltmeter between the LIMIT control (P8 /resistor R2) junction and common.

9) Adjust A2 NULL trimpot (P7) for a 0 volt ±10 millivolt reading on the meter.

10) Remove jumper.

4.2.2 Input Calibration

Calibration of the input consists of compensator trimpot (P2) adjustment, offset calibration, zero adjustment, span adjustment and gain adjustment. These procedures vary somewhat depending on the type of sensor to be used. The following procedures for compensator trimpot adjustments and offset calibration are provided for thermocouple (temperature sensing) inputs. For pressure, force, time etc. the setpoint values will be made according to compensator and offset voltage range chart supplied in place of table 4-1.

4.2.2.1 Compensator Trimpot (P2) Adjustment (Temperature Sensors)

1) Measure the temperature at the input terminals with a thermometer. (Tape thermometer to PCB connector and allow reading to stabilize).

2) Look up in Table 4-1 the compensator voltage required for the sensor type at the measured temperature.

3) Connect a voltmeter between terminals 1 and 6 on th PCB connector, and adjust P2 for the proper millivoltage.

4.2.2.2 Offset Calculation Procedure (Temperature Sensors)

1) Measure the temperature at the input terminals with a therometer (Tape thermometer to PCB connector and allow reading to stablize).

2) Look up in Table 4-1 the offset voltage for the measured ambient temperature required for the thermocouple type, and subtract this value from the table values for the range specified. Use the new values for the following calibration procedures.

4.2.2.3 Zero Adjustment

1) Turn the setpoint control to 000.

2) Connect a millivoltage source to the input terminals (1 (–) and 4 (+).

3) Adjust millivoltage input to the low calibration value calculated in 4.3.2.2.

4) Connect a voltmeter between pin 4 on the RATE/ALARM board and common, and adjust the ZERO trimpot (P4) for a 0-volt ± 10 millivolt reading on the meter.

5) Leave meter connected for span adjustment.

4.2.2.4 Span Adjustment

1) Turn the setpoint control to 999.

2) Increase millivoltage input to the high calibration value calculated in 4.3.2.2.

3) Adjust the SPAN trimpot (P5) for a 0 volt ± 10 millivolt reading on the meter.

4) Repeat 4.3.2.3 and 4.3.2.4.

5) Leave meter connected for gain adjustment.

4.2.2.5 Gain Adjustment

1) Set millivoltage input to high calibration value calculated in 4.3.2.2.

2) Turn setpoint to 000.

3) Adjust the GAIN trimpot (P6) for an 8 volt, ±1- millivolt reading on the meter.

4.2.3 Alarm Check

1) Turn setpoint to 500 and adjust input signal until meter nulls.

2) Connect a voltmeter between pins 4 (+) and 1 (–) on the RATE/ALARM board and adjust P12 ALARM trimpot fully counterclockwise.

3) Turn the setpoint control clockwise until ALARM indicator is on. The voltmeter should read +.08 volts.

4) Turn the setpoint control counterclockwise, past 500, until the ALARM indicator is on. The voltmeter should read less than -.08 volts.

5) Turn the setpoint control back to 500.

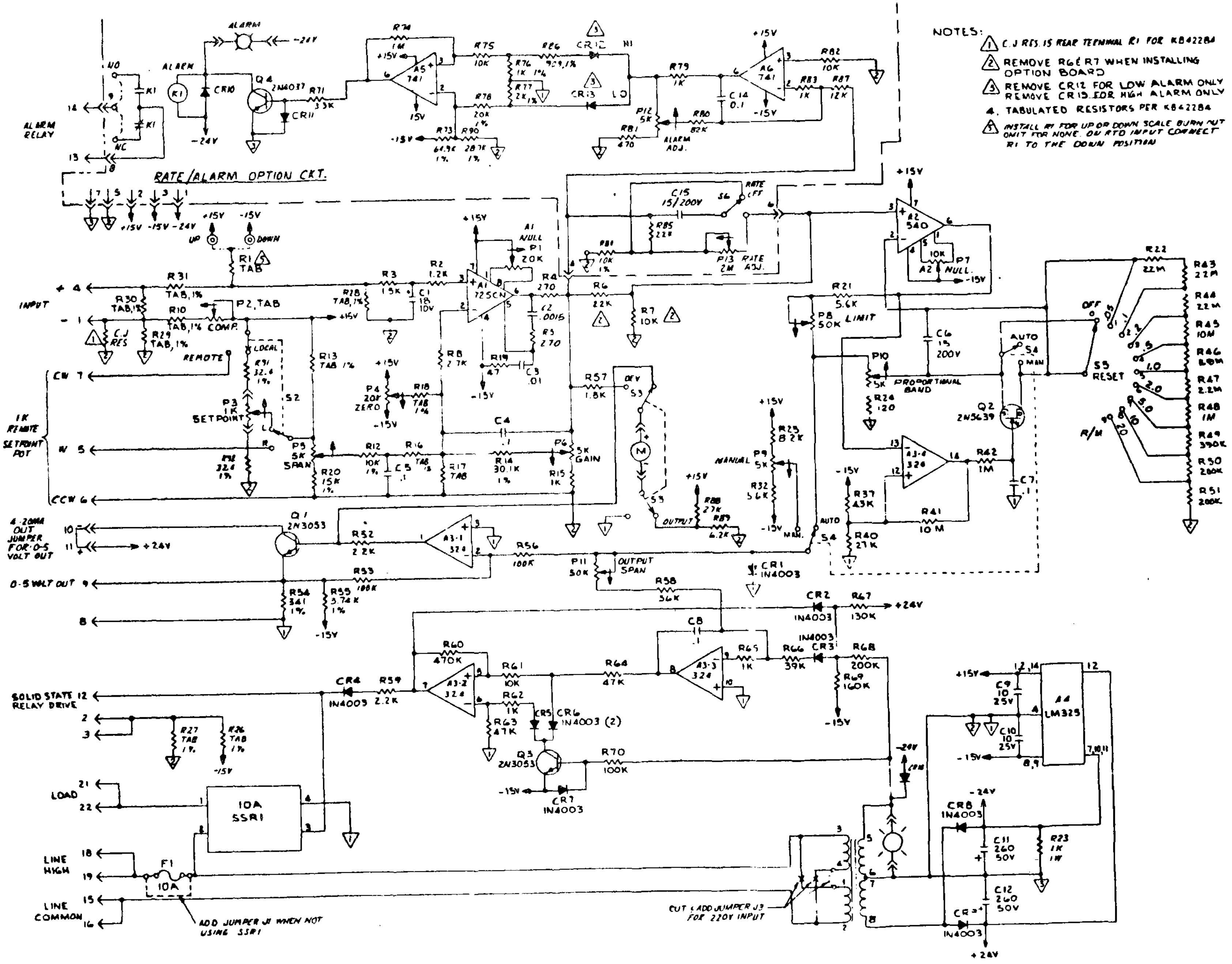
6) Adjust P12 ALARM trimpot fully clockwise.

7) Turn the setpoint clockwise until the ALARM indicator is on. The voltmeter should read .8 ±.1 volt.

8) Turn the setpoint control counterclockwise, past 500, until the ALARM indicator is on. The voltmeter should read between -.7 to -1.2 volts.

CALIBRATION TEMP. F		69	70	71	72	73	74	75	76	77	78	79	80	81
THERMOCOUPLE TYPE		MILLIVOLTAGE												
J	Comp	12.9	12.9	12.9	13.0	13.0	13.0	13.0	13.1	13.1	13.1	13.2	13.2	13.2
	offset	1.048	1.076	1.105	1.134	1.162	1.191	1.220	1.248	1.277	1.306	1.335	1.363	1.392
K	Comp	10.2	10.2	10.3	10.3	10.3	10.3	10.4	10.4	10.4	10.4	10.4	10.5	10.5
	offset	.821	.843	.865	.888	.910	.933	.955	.978	1.000	1.023	1.045	1.068	1.090
R	Comp	1.67	1.68	1.68	1.68	1.69	1.69	1.69	1.70	1.70	1.70	1.71	1.71	1.71
	offset	.114	.118	.121	.124	.127	.131	.134	.137	.141	.144	.147	.150	.154
S	Comp	1.67	1.68	1.68	1.69	1.69	1.69	1.69	1.70	1.70	1.70	1.71	1.71	1.71
	offset	.116	.119	.123	.126	.129	.129	.136	.139	.142	.146	.149	.152	.156
T	Comp	10.1	10.1	10.2	10.2	10.2	10.2	10.3	10.3	10.3	10.3	10.3	10.4	10.4
	offset	.812	.834	.857	.879	.902	.924	.947	.969	.992	1.014	1.037	1.060	1.082
E	Comp	13.70	13.73	13.77	13.80	13.84	13.87	13.90	13.94	13.97	14.00	14.04	14.07	14.11
	offset	1.225	1.259	1.292	1.326	1.360	1.394	1.427	1.461	1.495	1.529	1.563	1.597	1.631
MV	Comp	--	--	--	--	--	10 mv	--	--	--	---	---	--	--
	offset	--	--	--	--	--	0 mv	--	--	--	--	--	--	--
W,B	Comp	--	--	--	--	--	10 mv	--	---	--	--	--	--	--
	offset	--	--	--	--	--	0 mv	--	--	--	--	--	--	--
W 3	Comp	2.59	2.60	2.60	2.61	2.61	2.62	2.62	2.63	2.63	2.64	2.64	2.65	2.65
	offset	.203	.209	.215	.221	.227	.233	.239	.244	.250	.256	.262	.268	.274
W 5	Comp	3.34	3.35	3.36	3.37	3.37	3.38	3.39	3.39	3.40	3.41	3.42	3.42	3.43
	offset	.243	.250	.258	.265	.272	.280	.287	.294	.302	.309	.316	.323	.331
Platinel II	Comp	7.74	7.75	7.77	7.79	7.81	7.82	7.84	7.86	7.88	7.89	7.91	7.93	7.95
	offset	.626	.643	.661	.678	.696	.713	.730	.748	.765	.783	.800	.818	.835

TABLE 4-1 COMPENSATION AND OFFSET MILLIVOLTAGES



NOTES:

1. C.J RES. IS REAR TERMINAL R1 FOR KB42284
2. REMOVE R6 & R7 WHEN INSTALLING OPTION BOARD
3. REMOVE CR12 FOR LOW ALARM ONLY
   REMOVE CR13 FOR HIGH ALARM ONLY
4. TABULATED RESISTORS PER KB42284
5. INSTALL R1 FOR UP OR DOWN SCALE BURN OUT OMIT FOR NONE. ON RTD INPUT CONNECT R1 TO THE DOWN POSITION

FIGURE 4-1
SCHEMATIC DIAGRAM

Electronic Temperature/Pressure And Power Controller

Multi-Loop

Series 2620

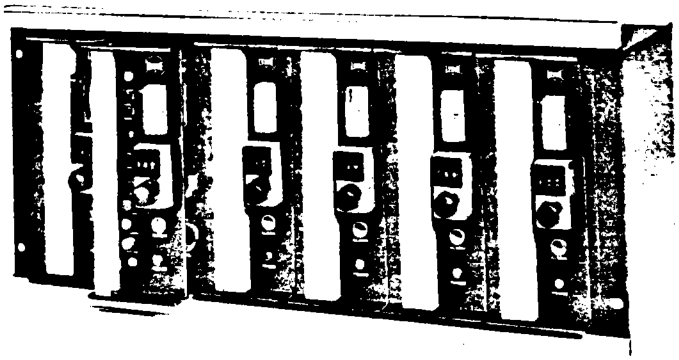
PRODUCT DATA 26/3.1.2

DESCRIPTION

The basic 2620 instrument is a two-mode controller featuring a proportional band and reset (with anti-reset wind-up). The optional plug-in module adds a third control mode —(rate)and deviation alarm. Selected spans are available and dedicate the unit to use with thermo-couple, RTD, voltage or milliamp input. The setpoint is direct-set by using the appropriate portion of a 10-turn 1000 point dial.

The combination meter reads ±10% of the input span deviation, or by switch selection, 0-100% of the controller output to the final control device.

All secondary controls are under a closed access door and include: Proportioning Bandwidth, Reset, Rate, Alarm and Output Limiting.



The alternate action pushbutton switches allow selection of Auto / Manual Control and the Output/Deviation Meter.

The basic controller provides two outputs: 0-5 VDC and 4-20 milliamp proportioning. 120/240 VAC positioning for direct control of electric actuators is available with drive module.

Power Controller options available provide internally mounted 120/240 volt 10 amp capacities. High density packaging is in 6-unit multiples in a 19" rack mounting frame or optional single- or dual-unit panel mounting case. For local mounting, rear terminal covers are available.

All input/output terminations are provided through a barrier strip-terminated edge connector, providing plug-in serviceability.

FEATURES

- Compact high density design using the latest state-of-the-art electronics and controller technology
- Versatile Inputs:
  Thermocouple Millivolts
  RTD Milliamps
- Versatile Outputs:
  Direct solid state 10A power (optional)
  Proportioning control (current or voltage)
- Plug-in chassis for rapid replacement
- Full front panel controls:
  Digital 1000-part setpoint dial
  Secondary controls under a closed access door
  Deviation/output metering
  Auto/Manual transfer
- Multiple 6-channel 19" rack mounting frame
- Optional single or dual channel mounting case

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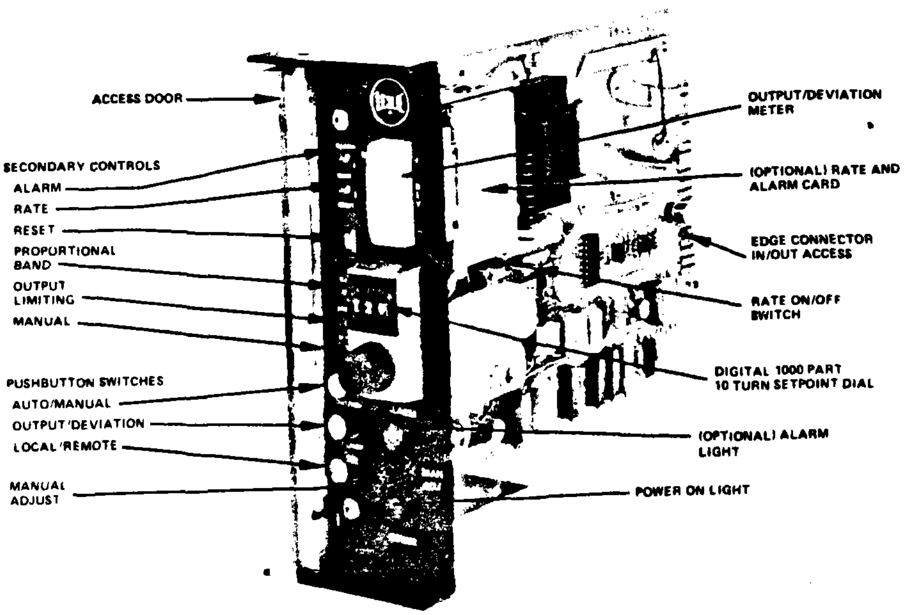
LESLIE CO., PARSIPPANY, N. J. 07054

Awarded A.S.M.E. (N) and (NPT) Stamp
Approval for Classes 1, 2 and 3 Nuclear Valves.



2620 SPECIFICATIONS

INPUT TYPES

- Thermocouple — Accepts directly; has internal cold junction compensation and burnout protection that is selectable for upscale, downscale or none.
- Resistance Bulb Thermometers — RTD inputs for 3 wire platinum wound elements accepted directly.
- Millivolt, Voltage or Current — Selected ranges available to accept industry standards from process transmitters.

INPUT IMPEDANCES

- Thermocouples — 100 ohms.
- Voltages — <100mv: 100K.
  >100mv: 10K.
- Currents — 2500/High end of span in ma.

MINIMUM PRACTICAL SPANS

- Thermocouples and Millivolts — At least 10 mv change over process span.
- Currents — At least 0.1ma change over process span.
- RTD's — 60Ω minimum R, with △ R the greater of 10Ω or 10% of minimum R.

MAXIMUM ZERO SUPPRESSION

- 50% of high end value.

COMMON MODE REJECTION

- Better than 120 db at 60 Hz (1,000,000:1).
- Common mode not to exceed 120 VAC or 150 VDC.

NORMAL MODE REJECTION

- Better than 40 db at 60 Hz (100:1). Normal mode not to exceed 2 times input span.

LOCAL SETPOINT

- 3 Digit Setpoint, 10-turn, dial, 1000 parts.
- Accuracy:
  Calibrated to ±½ % span.
  Linearity ¼ % of span.
  Repeatability ½ digit or 0.05% of span.

STANDARD OUTPUTS

- Current output 4-20 ma into 500 ohms maximum.
- Voltage output 0-5 volts into 500 ohms minimum.

OPTIONAL OUTPUT

- Internal Distributed Zero Cross Fired solid state relay power controller rated 120 volts at 10 amps.

OUTPUT LIMITING

- In Auto mode only, adjustable output limiting settable 10-100% not functional in Manual mode.

CONTROL MODE SETTINGS

- Proportioning Bandwidth 5-400% of span.
- Reset in 10 steps — off and 0.05-20 repeats/minute.
  — optional.
- Rate adjustable 0.1-1.5 minutes with on/off switch.

DEVIATION/OUTPUT METER

- Displays deviation from setpoint ±10% input span, or percent controller output.

DEVIATION ALARM (OPTIONAL)

- Red alarm light and 1A, 120 VAC selectable NC or NO contact.
- High only, low only or high and low.
- Adjustable 1 to 10% input span.

CONTROL SENSITIVITY

- A 1 microvolt change at input will provide a measurable output change.

RESPONSE TIME

- Less than 30 milliseconds to reach 63% of final.

ENVIRONMENTAL LIMITS

- Operating 40 to 140°F at 90% RH (noncondensing).
- Storage −40 to +160°F at 90% RH (noncondensing).
- Vibration 1G maximum.

STABILITY

- Ambient Temperature — A change in ambient from 80 degrees F, ±40 degrees will result in a control point change less than ±.02% of span per 1 degree F ambient change, or:
  Thermocouple and Voltage Input: ±3 microvolts/degree F, whichever is larger.
  100 Ohm RTD Input: ±.075 ohm / degree F, whichever is larger.
- Line Voltage—A change in line voltage from 120V, +10-15%, will result in a control point change less than ±.1% of span or:
  Thermocouple and Voltage Input:
  ±20 microvolts, whichever is larger.
  100 Ohm RTD Input: ±.2 ohm, whichever is larger.
- Long Term — With line and ambient being constant, control point drift over 25-hour period to be less than ±.1% of span or:
  Thermocouple and Voltage Input:
  30 microvolts, whichever is larger.
  100 Ohm RTD Input: ±.2 ohm, whichever is larger.

POWER

- 120/240 VAC, 50/60 Hz.
- Controller only 10 VA and unfused.

WEIGHT

• 2620	3 Lbs.	1.36 kg
• Single Case	3 Lbs.	1.36 kg
• 6 Unit frame	16 Lbs.	7.26 kg

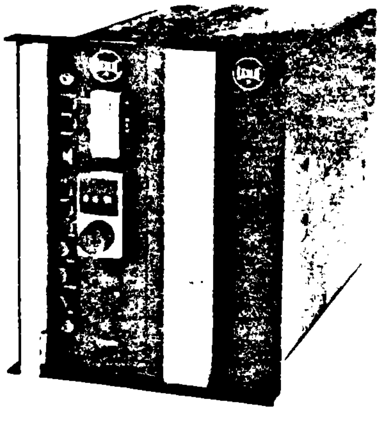
DIMENSIONS

- See back page.

Available Option
Series 2620
Motor Actuator Drive Module

DESCRIPTION

The Motor Actuator Drive Module is used to interface with electric valve operators. The Module accepts a position feedback signal from a potentiometer in the actuator. This signal is compared with the process controller output. If an error exists, the circuitry provides dual relay contacts (drive-open or drive-closed) which are selectively closed, depending on the direction of the error. This causes the drive motor to move the valve stem. When properly positioned, the potentiometer feedback matches the input signal and the relay contacts open. Thus, the valve opening is proportional to the output of the process controller. Any change of input will produce a change in valve position as needed to maintain control of the process.



FEATURES

- Heavy-Duty Contacts
- Long Life
- Electrically Trimmed Zero and Span
- ½ to 5% Adjustable Deadband

26/3.1.2

SPECIFICATIONS

POWER

- 120 VAC (jumper selectable 240 VAC). +10/-15%; 50/60 Hz; 5 VA.

INPUTS

- Command signals 0-5 VDC into 47K ohm (jumper selectable 4-20 ma into 250 ohm).
- Accepts position feedback from retransmit potentiometer, any value 100-10,000 ohms (0-1,000 ohms standard).

OUTPUTS

- Dual motor contacts (CW & CCW drive).
- Brake release contact.
- Rated 120 VAC at 5A, surge-suppressed 28 VDC at 5A.

ADJUSTMENTS

- Deadband ½ to 5% input span.
  Zero trim: ±10%.
  Span trim: ±10%.

ENVIRONMENTAL

- Storage temperature: −40/160°F.
- Operating temperature: −40/125°F.
- RH to 90% non-condensing.

DIMENSIONAL

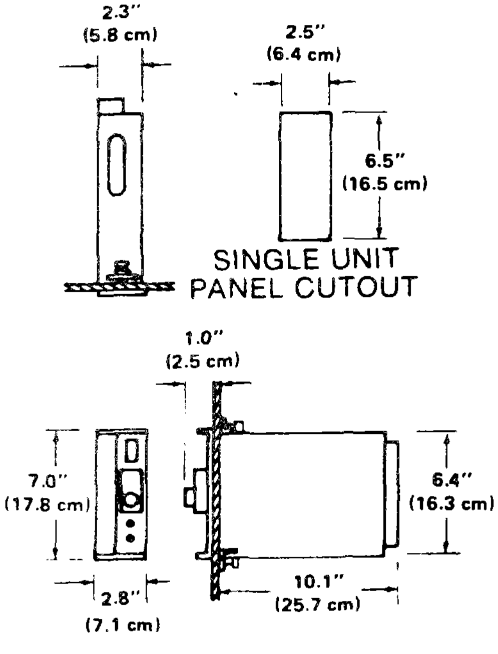
- See outlines 2620 series.
- The Motor Actuator Drive Module requires an additional slot in the mounting case.

WEIGHT

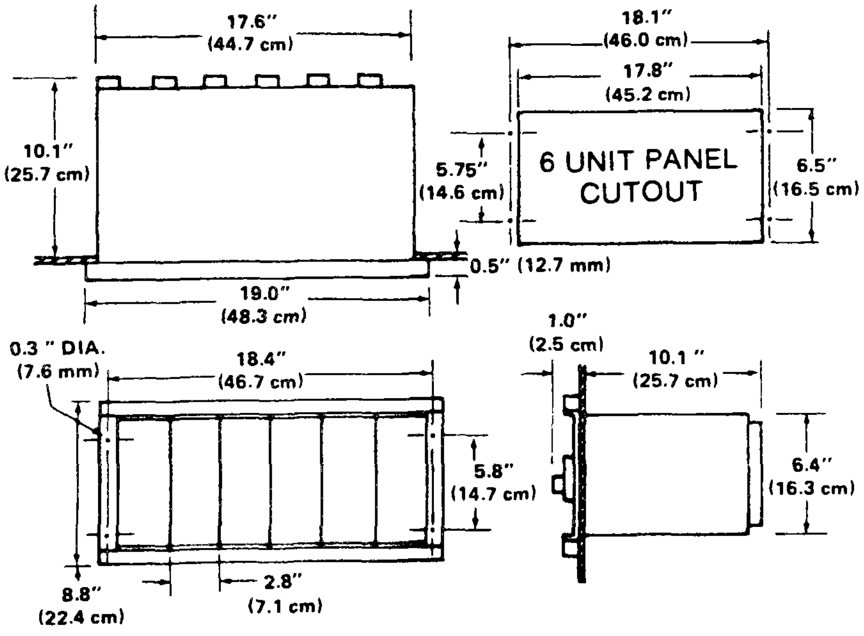
- 2 lbs. (.91 kg) 2½ lbs. shipping (1.13 kg)

DIMENSIONS

SINGLE CASE



MULTI-UNIT PANEL
6 UNIT RACK MOUNTING FRAME



(Double case is approximately double the width of the single case.)

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5652 Printed in the U S A 578 6M 'R

instructions for Small Flow AIRMATE
PRESSURE REDUCING VALVES
and Air Loaders
CLASSES A-2, AG-2, AF-2, AFG-2, ETC.

INSTALLATION - OPERATION - MAINTENANCE

SECTION I - INSTALLATION

Install as shown in Fig. 1. Use non-corrosive fittings and piping throughout. Use fine wire mesh or poromet filter screen.

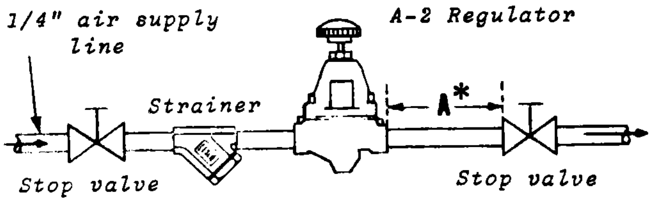


FIG. 1 — INSTALLATION DETAIL

NOTE: Strainer, shown for Class A-2 Types, is not necessary for Filter Type Classes, AF-2.

* *When used with air motors or pulsating equipment, line "A" should be of a sufficient length and diameter to provide a reservoir. On close coupled installations install small reservoir.*

SECTION II - OPERATION

1. Open inlet supply valve to regulator.

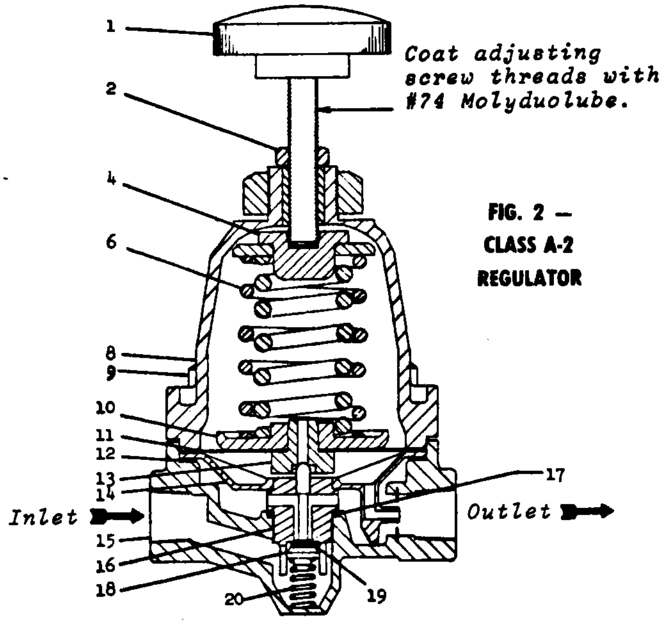
   Note: Supply pressure should be at least 5 PSIG above maximum controlled pressure desired.

2. Open outlet stop valve partially.
3. Turn handwheel (1) clockwise to start flow through regulator. Adjust for desired controlled pressure.** Tighten locknut (2). Open outlet stop valve fully.

   ** Turn handwheel clockwise to increase controlled pressure; counterclockwise to decrease.

SECTION III - MAINTENANCE
Dismantling

1. Shut-off air supply. Loosen locknut (2). Relieve all adjusting spring compression.
2. Disassemble adjusting spring case (8), top spring seat (4), adjusting spring (s) (6) and nozzle-diaphragm assembly from main body.
3. Grasp internal rib of aspirator plate (14) (Marked "Lift Here") and lift out of main body. Remove gasket (12).
4. Unscrew valve seat (16) with "O" Ring (17) from main body. Lift out main valve (18), with "O" Ring (19), and main valve spring (20).



Coat adjusting screw threads with #74 Molyduolube.

FIG. 2 — CLASS A-2 REGULATOR

Cleaning or replacing parts

Examine and clean all parts. Use an approved detergent (non-injurious to synthetic materials) for cleaning. Blow out all ports and main body with air. Replace any badly worn or damaged part.

PLAY SAFE! USE ONLY GENUINE LESLIE REPLACEMENT PARTS.

LESLIE CO., PARSIPPANY, NEW JERSEY 07054

Diaphragm replacement

Disassemble nozzle disc assembly consisting of diaphragm disc (10), diaphragm (11) and nozzle (13). Nozzle snaps out of diaphragm disc by finger pressure on diaphragm disc side. Reassemble parts (with curve of disc away from diaphragm). Snap nozzle into place in diaphragm disc.

Integral Filter Types — Class AF-2, etc.

In integral filter types remove filter case (26) from main body. Remove filter (23) and filter support disc (25).

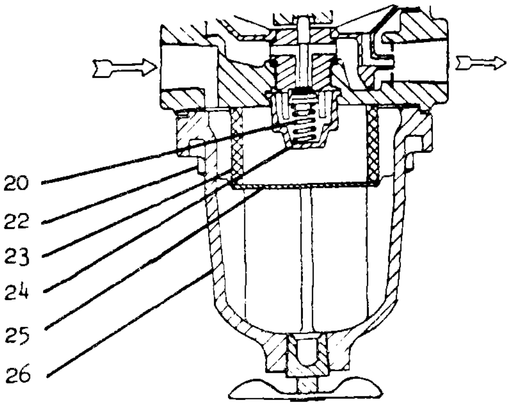


FIG. 3 — PARTIAL ASSEMBLY OF AF-2 TYPE SHOWING ADDITIONAL PARTS IN FILTER ASSEMBLY.

All other parts (except main body) are the same as in A-2 Classes

NOTE: Removal of valve spring retainer (24) in inregral Filter Types is unnecessary unless it is to be replaced. To remove, squeeze sidewalls together to clear groove in main body, then pull. To insert new part, squeeze sidewalls together sufficiently for shoulders to pass through body opening and into groove.

Reassembling

1. Place main valve spring (20) in main body (15). Place "O" Ring (17) in recess of body. Assemble main valve (18), with "O" Ring (19), in valve seat (16). Screw valve seat into main body threads until seating face contacts main body and tighten.

2. Place gasket (12) in recess of main body (15). Insert aspirator plate (14) with aspirator tube in outlet orifice. Snap aspirator plate in place with finger pressure. Place nozzle-diaphragm assembly in main body with diaphragm disc (10) upward. Place adjusting spring(s) (6) and top spring seat (4) on diaphragm disc. Position spring case (8) with handwheel (1) on main body. Insert screws (9) and tighten.

Integral Filter Types — Class AF-2, etc.

In integral filter types place filter support disc (25) and filter (23) in filter case (26). Assemble gasket (12) and filter case to main body. Insert screws (22) and tighten.

3. Readjust regulator as described under "OPERATION".

Maintenance of Loading Panels

Classes P-2, PF-2, etc.

Disconnect tubing at "A". Remove handwheel "B". Take off locknut "C". Remove valve from panel. Follow maintenance Instructions Section III.

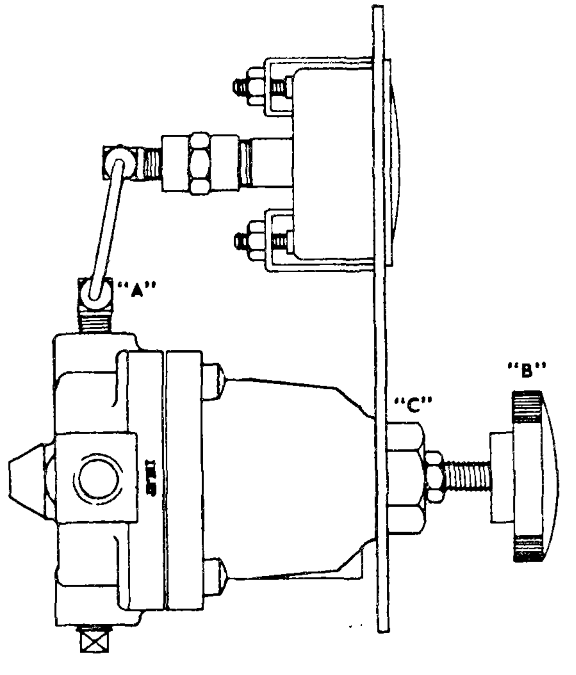


FIG. 4 — CLASS P-2 PANEL LOADER

LESLIE ®

instructions for CONTROL VALVES

SINGLE PORTED CONTROL VALVES - 1500 PSIG AND OVER SERIES

This instruction covers all classes of High Pressure-Cage Trim Control Valves with Diaphragm Actuators.

SECTION III (Cont'd) - MAINTENANCE OF VALVE BODY SUB-ASSEMBLIES

FOR ADDITIONAL CONTROL VALVE DATA CONSULT PROPER INSTRUCTION SECTION BELOW:

INSTALLATION..................SECTION I
OPERATION....................SECTION II
MAINTENANCE..................SECTION III
ACTUATOR MAINTENANCE.........SECTION IV

DISMANTLING (Continued)

Prior to dismantling control valve body assembly remove actuator (as described in Steps 1-3) and positioner if one is in use. To remove positioner loosen nut (17) and remove cap screws holding positioner to yoke (11). Slide positioner extension arm away from valve stem.

4. Remove nut (17) from valve plug stem. Loosen stuffing box nuts (22). Remove bonnet nuts (40). Lift bonnet (27), and valve plug (21) off body as a unit. Remove valve plug complete and other parts from bonnet.

5. Take gasket (32) and seat retaining guide (37) from body. Then remove seat ring in the following manner; Insert wooden dowel into seat ring (38). Press sufficiently for dowel to grip seat ring so that it can be lifted out of body. Gasket (39) will follow with seat ring.

   Clean main body thoroughly including gasket faces. Inspect seat ring (38), valve plug complete (21) and seat retaining guide (37). Replace any badly worn or damaged part. Clean all parts to be re-used thoroughly, using suitable solvent and crocus cloth to remove any encrusted material.

6. Lapping in Valve Plug and Seat Ring

A. In Main Body - Return seat ring gasket (39), seat ring (38), to their proper places in valve body (33) making sure that valve seating face of seat ring (38) faces toward bonnet end of body.

Note: For lapping Mark "P" Trim Type instructions see Page 5 and 6.

Place a small amount of superfine grinding compound, properly mixed with oil, on seating face of valve plug at several points. Insert valve plug assembly into valve body (33) and in contact with seat ring (38). Place bonnet (27) over valve plug complete and on valve body, using bonnet as guide when lapping inner valve. Lap valve plug complete (21) and seat ring (38) together very lightly and carefully. Just a few turns are sufficient. As lapping progresses, occasionally lift valve plug complete (21) a small distance away from seat ring (38) and rotate 90° to keep lapping compound evenly distributed.

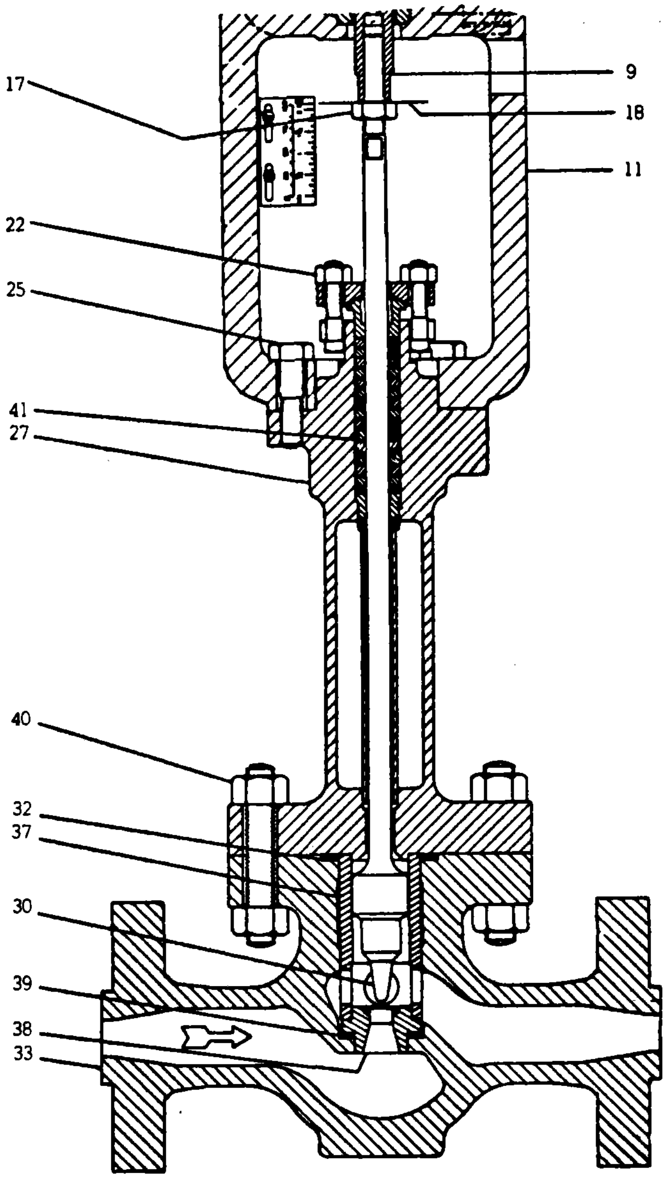


Fig. 3 - DOS, Cage Trim, Socket Weld End Type. May also be butt weld end, Flanged End or 90° Angle Type.

B. Alternate Method - Using holding Device.

Assemble components as shown in Fig. 4 and follow lapping procedure described under "A".

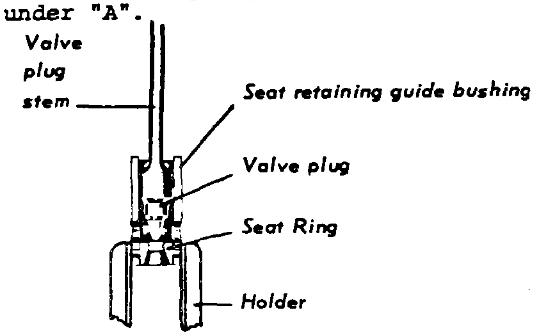


Fig. 4 - Place seat ring in a suitable holding device (that will not distort seat ring). Position seat retaining guide on seat ring. (In the case of "I" Trim - Classes DIS, etc. - be sure to assemble the valve plug guide and throttling sector in their respective positions before lapping, regardless of procedure followed).

NOTE: *Very little lapping is required with cage type trim; a few turns should be sufficient. When lapping is completed remove all traces of lapping compound.*

REASSEMBLY

1. Install internal components in valve body before assembling bonnet to body. Place rod in valve body and down through body bridge to prevent seat ring or gasket from falling into body throat when assembling.

   Place new gasket (39) in recess in Valve body. Follow with seat ring (38), with valve plug seating face toward bonnet end of body. Position seat retaining guide (37) on seat ring. Insert Valve plug in valve body.

NOTE: *With "I" type trim assemble throttling sector (35) and valve plug guide (36) on shoulder of valve plug disc and pass threaded end of valve plug stem through seat retaining guide before inserting parts in valve body.*

Direct window throttling end or seat retaining guide toward valve plug disc and engage keyways of valve plug guide and seat retaining guide with their respective keys.

2. Place new body gasket (32) in valve body recess. Place bonnet (27) in position on valve body (33) moving it carefully down over valve plug stem. Insert bolts through bonnet and valve body flanges. Attach nuts (40). Tighten nuts evenly and firmly on alternating sides, making sure that bonnet pulls down evenly into contact with valve body flange face. Assemble actuator to bonnet (27).* Insert cap screws (25) and tighten. Place locknut (17) on stem threads and turn down on threads a little more than one half way. Position travel indicator (18). Screw stem no less than one diameter on valve stem nor more than one half way into upper stem (9).

**Reassemble positioner to actuator, if positioner is in use.*

HOW TO MAKE PRELOAD ADJUSTMENT

3. Adjusting Actuator Spring Preload (Starting Pressure)

- Connect controlled air line to diaphragm case.
- Supply 3 psig air pressure to actuator diaphragm.
- Compress actuator spring until travel indicator begins to move when air pressure is raised above 3 psig.
- TO COMPRESS ACTUATOR SPRING SCREW SPRING ADJUSTOR UPWARD

NOTE: *Alternately add compression and check starting pressure by raising air pressure slightly above 3 psig until correct adjustment is attained. After each check return air pressure to 3 psig.*

4. Single Ported Unbalanced Control Valves With Direct Acting Actuators (DOS Etc.)

Actuator spring preload adjustment can be made either with or without pressure in valve body. Once correct compression is made no further adjustment is necessary.

5. Single Ported Unbalanced Control Valves With Reverse Acting Actuators – Spring Closing Classes.

In a single ported unbalanced control valve (reverse acting actuator), the valve plug is closed against upward fluid thrust by actuator spring force. Total compression placed on actuator spring must be sufficient to provide the 3 psig preload plus force required to close the valve.

instructions for

CONTROL VALVES

SINGLE PORTED CONTROL VALVES - 1500 PSIG AND OVER SERIES

If preload adjustment is made with no pressure in valve body, then, when the control valve is placed in operation, additional compression must be placed on the actuator spring to provide valve closure force. With proper adjustment valve will close tightly and will not begin to open until the 3 psig operation pressure is exceeded.

NOTE A - A control valve which has been adjusted to provide 3 psig starting pressure plus valve closure force (with pressure in body) will have a considerably higher starting pressure than 3 psig, when tested at 0 body pressure.

NOTE B - Air pressures quoted are relative. Actual pressures required in operation may vary with pressure drop conditions existing and/or actuator springs used.

ADJUSTING CONTROL VALVE FOR RATED TRAVEL

(Indicator scale shows rated travel of valve)

6. Single Ported Unbalanced Control Valves With Direct Acting Actuators

With valve plug and actuator stem threads engaged as described in "Reassembly", supply 20 psig operating pressure to actuator diaphragm. Valve will move to closed position. Observe travel obtained as shown by travel indicator and indicator scale. Readjust as follows:

- OVERTRAVEL - If travel is too great, loosen stem locknut and turn valve plug stem out of actuator stem the amount necessary to obtain correct travel.
- UNDERTRAVEL - If travel is too short, loosen stem locknut and turn valve plug stem further into actuator stem the amount necessary to obtain correct travel.

7. Positive Compression Force

When correct travel has been obtained reduce operating pressure sufficiently to move valve plug away from seat ring(s). *Then turn valve plug stem one full turn out of actuator stem threads.*

8. Single Ported Unbalanced Control Valves With Reverse Acting Actuators

Loosen stem locknut. Apply air to diaphragm. Turn valve plug stem into actuator stem threads until valve plug is out of contact with seat ring, with air removed from diaphragm. Then turn valve plug stem out of actuator stem threads until valve plug just contacts seat ring again.

Supply sufficient operating pressure to actuator diaphragm to move valve plug away from seat ring. *Then turn valve plug stem one full turn out of actuator stem threads.* Diaphragm plate determines travel. With proper diaphragm plate correct travel will result from adjustment. For under- or overtravel proceed as described above.

9. Positive Closing Force

The *one full turn* toward the seat ring, made after obtaining travel, provides the positive closing force required to obtain tight valve closure in single ported valves. In all cases be sure to make this final adjustment.

10. All Actuators

Tighten stem locknut and travel indicator against actuator stem. Reconnect operating medium tubing from the sensing element or manual loading device to the diaphragm case.

REPLACING OR LAPPING IN MARK "P" TRIM

(Screw Stem Locknut Down to Bottom of Stem Threads)

To remove Mark "P" Trim from main body dismantle actuator from bonnet, remove bonnet nuts then carefully lift bonnet, valve plug and seat retainer out of valve body. CAUTION: Move bonnet directly upward or outward from body (relative to installation) to prevent damage to valve plug. Take out bonnet gasket, throttling orifice chamber, and gasket. Clean all parts. Replace any worn or damaged part.

Lapping in Mark "P" Trim

To lap in Mark "P" trim use a very small amount of superfine lapping compound (no rougher than 20,000 grit) evenly distributed over valve plug seating surface. Insert valve plug in throttling orifice chamber and place seat retaining guide in position on orifice chamber as shown in 4A).

Lap only enough to remove any encrusted material from seating surfaces. A few turns should be sufficient. Lift and rotate valve plug 90° occasionally to keep compound evenly distributed. Remove all traces of lapping compound from parts before reassembling valve.

If either of the seating surfaces is found to be damaged parts should be returned to Leslie Co. for refurbishing.

<u>NOTE:</u> *Although valve plugs and chambers are not essentially matched sets it is always good practice to consider them as such after use, and to replace them in service as units.*

REASSEMBLY

Follow general procedure outlined under "Reassembly" Page 4 making sure that throttling orifice chamber and gasket are properly positioned in body and that seat retaining guide is passed carefully over valve plug stem into position on throttling orifice chamber.

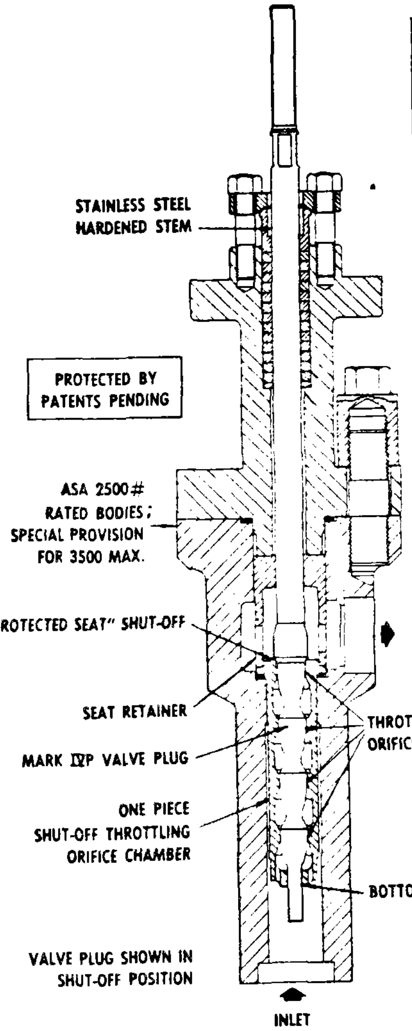


Fig. 4 - Mark "P" Valve Body Assembly.

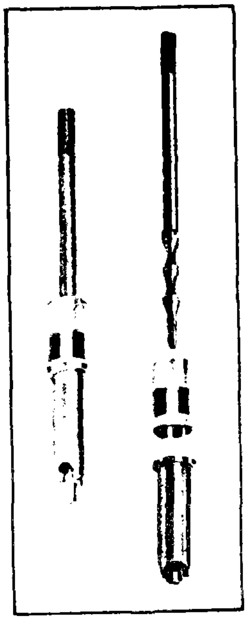


Fig. 4A - Lapping Valve.

instructions for

CONTROL VALVES

• INSTALLATION, OPERATION and MAINTENANCE

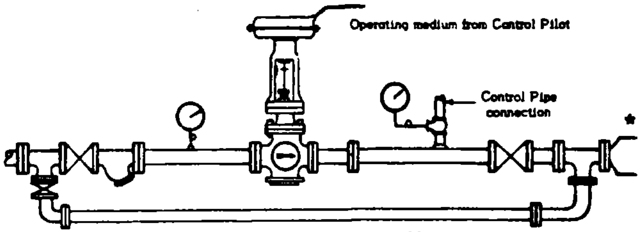
FOR ADDITIONAL CONTROL VALVE DATA CONSULT PROPER INSTRUCTION SECTION BELOW:

- **Where noise is a factor follow recommendations for piping and fittings per 5/0.3.1.**

SECTION I – INSTALLATION •

1. **Valve Position**

   Install control valve in the highest horizontal line of piping, in an accessible location and with arrow on side of valve body in direction of fluid flow. Control valve may be placed in any position, but upright is preferable for ease of maintenance.



• **Figure 1 – Typical Installation**
*Expand as required for fluid flow.

2. **Problem Preventing Procedures**

   - Provide removal space above, below and around control valve for easy removal of parts during maintenance. See proper Dwg. for dimensions.
   - Blow or flush out pipe lines thoroughly before installing control valve.
   - Protect control valve and following equipment with a *LESLIE SELF-CLEANING STRAINER.*
   - Install stop valves and gauges in inlet and outlet lines to provide means for checking adjustment and operation of equipment.
   - Provide proper inlet and outlet drainage in steam service to prevent water hammer or possible erosion in equipment.
   - Adhere to good piping practice. Install a bypass around the control valve.

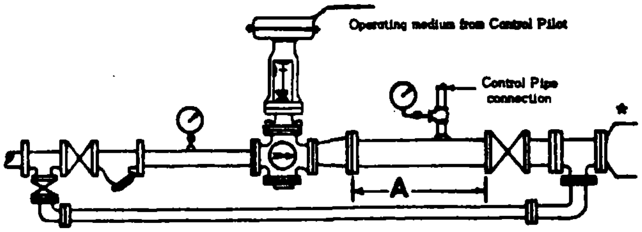
3. Connect operating medium tubing from control pilot, instrument or loading device to diaphragm chamber connection of control valve or to valve positioner, if one is in use.

4. **Important:**

   If control valve is fitted with a Thermo-Isolating bonnet, *do not* lag or insulate bonnet or paint it other than dull black, otherwise its heat emitting efficiency will be impaired and packing will be submitted to excessive temperature.

5. **Recommended Piping for Control of Compressible Fluids at Values of 25% or Less of Inlet Pressure.**

   - Expand outlet pipe to twice control valve inlet pipe size. Use tapered expander.
   - Connect control pipe for control pilot ahead of outlet stop valve and at least 2' to 3' downstream from end of expander.
   - Make control pipe connection at least 18" to 2' from outlet stop valve, any elbow or other flow direction changing fitting.



• **Fig. 2 – Typical Control Valve Station For Control of Compressible Fluids at 25% or Less of Inlet Pressure.**
*Expand as required for fluid flow.

NOTE: Where sensing impulse is taken 2' to 3' downstream from control valve (expander), dimension "A" minimum of 6' to 10' will provide lowest noise and velocity factors, accurate pressure sensing and reasonable bypass length.

SECTION II – OPERATION

1. Close inlet and outlet stop valves.
2. Check that control valve responds properly through rated travel in relation to changes in operating pressure on the diaphragm. Rated travel is shown by position of travel indicator on valve stem relative to travel indicator scale on yoke.
3. Manually operate control valves fitted with manual operating devices through rated travel to check freedom of movement.

4. Place control valve in operation in accordance with instructions furnished with control pilot or other operating device.

SECTION III – MAINTENANCE

To reduce maintenance time refer to proper drawing and follow steps shown below for applicable maintenance operation.

PROPOSED MAINTENANCE	FOLLOW STEPS
TO RENEW VALVE PLUG STEM PACKING	SECTION III
TO DISMANTLE CONTROL VALVE–INSPECT PARTS–REPLACE OR REGRIND VALVE PLUG/SEAT RING(S)	SECTION III DISMANTLING
TO REASSEMBLE CONTROL VALVE	SECTION III REASSEMBLY
TO PRELOAD ADJUSTING SPRING: SET RATED TRAVEL	SECTION III REASSEMBLY 3 THRU 10
TO REPLACE DIAPHRAGM AND/OR STEM SEAL	SECTION IV
TO CHANGE VALVE ACTION NORMALLY OPEN TO NORMALLY CLOSED OR VICE-VERSA	SECTION IV

RENEWING VALVE PLUG STEM PACKING

Renew valve plug stem packing if control valve has been in service beyond normal maintenance and packing shows signs of wear. Wear will be indicated by leakage which cannot be corrected by minor tightening of packing flange.

Where LESLIE "LUBRISOFT" packing is in use, additional packing rings can be installed to overcome minor leakage without dismantling the control valve or breaking valve plug connection.

TO INSTALL A COMPLETE SET OF PACKING

1. Disassemble control valve as far as necessary for the work required (See "DISMANTLING"). Remove old packing. Clean valve plug stem and packing box thoroughly. Polish valve plug stem with crocus cloth. Use approved, non-residue forming solvent for cleaning. Wipe dry with clean cloth.

2. Insert a new set of packing in packing box in the order shown on the *packing wrapper* Packing wrapper contains complete installation instructions and a photograph of an installed set of packing. Each wrapper shows the order in which the various pieces of packing are to be inserted in the particular valve in which they are to be used.

3. After packing is installed, assemble packing follower, packing box flange and bolts to bonnet. Tighten bolts as shown in instruction on wrapper.

DISMANTLING

1. Close inlet and outlet stop valves. Operate system on bypass, if necessary.

2. Shut off operating medium and relieve pressure from diaphragm by disconnecting tubing at diaphragm case.

3. **Remove Actuator From Valve Body Assembly**

   Loosen valve plug stem nut. Use wrench on flats of valve plug stem and turn valve plug stem out of actuator stem threads until it is disengaged. (In large control valves support valve plug stem to prevent valve plug from suddenly falling downward as valve plug stem clears actuator stem). Take travel indicator off valve plug stem.

   Remove capscrews holding actuator to bonnet and lift actuator off bonnet.

instructions for

CONTROL VALVES

SECTION IV – ACTUATOR MAINTENANCE, REPLACING DIAPHRAGMS, STEM SEALS, ETC.

FOR ADDITIONAL CONTROL VALVE DATA CONSULT PROPER INSTRUCTION SECTION BELOW:

GENERAL

1. Remove compression on actuator spring by screwing spring adjustor counterclockwise until actuator spring is free.

SIZES 35, 55, 85, 135-DISMANTLING-(See Fig. 3)

Remove bolts/nuts (23/22), upper diaphragm case (20) and old diaphragm (21).

To examine, clean or replace other internal components lift out diaphragm plate (24) assembled with actuator stem (31), actuator spring (28), washer (34) and unscrew spring adjustor from adjustor sleeve (36).

REASSEMBLY

Replace internal parts. Install new diaphragm. In sizes 35, 55 and 85 line up holes with those in lower diaphragm case. In size 135 place bead on diaphragm in recess in lower diaphragm case. Replace upper diaphragm case on diaphragm.

Assemble four bolts and nuts through parts (90° apart). Fingertighten. Assemble balance of bolts/nuts to actuator. Tighten evenly and alternately across diaphragm case. (Before tightening bolts in 35 actuators or where flat stock diaphragm material is used in other sizes as an emergency measure) consult note relating to preforming diaphragms.

SIZES 35R, 55R, 85R & 135R.– DISMANTLING– (See Fig. 4)

Remove bolts/nuts (19/18) and upper diaphragm case (15). Insert rod through holes in yoke (34) and actuator stem (35) to prevent twisting of stem seal (29) when removing self-locking nut (16). (In size 35R use wrench on flats on actuator stem) Remove self-locking nut (16), diaphragm plate (17), diaphragm (20), collar (22) and stem seal (29). Remove stem seal as follows; – *In 35R and 135R Actuators,* remove stud nuts (24) in 135R; capscrews (23) in 35R and disassemble lower diaphragm base (21) from yoke (34). Lift out stem seal. *In 55R and 85R DO NOT* remove lower diaphragm base unless gasket (26) is to be replaced. Stem seal (29) is held in place by seal ring (27) and screws (28). Take out these parts and lift out stem seal.

NOTE: To check actuator spring and other components in size 135R disassemble spacer (33) and lift out parts. In 35R, 55R and 85R parts are taken out from the underside.

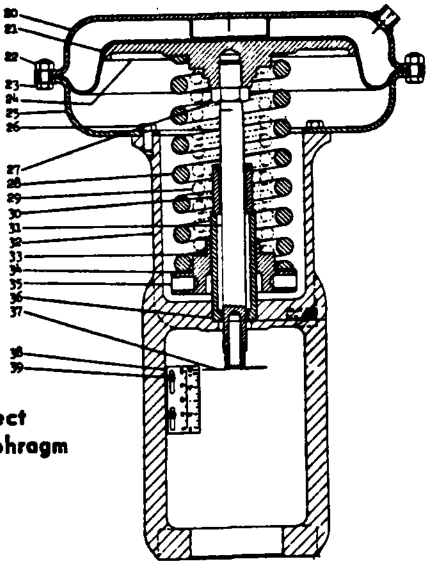


Fig. 3–Direct Acting Diaphragm Actuator

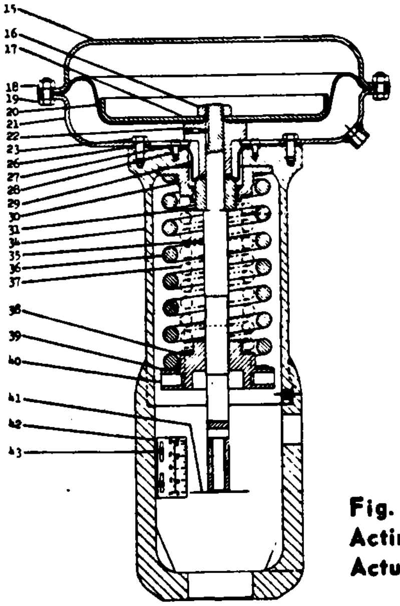


Fig. 4–Reverse Acting Diaphragm Actuator

REASSEMBLY

Reassemble spring adjustor (40), washer (39), actuator spring (36), top spring seat (30) to actuator stem (35) (If they have been removed). Replace assembled parts in yoke (34). Place stem seal collar (31) on actuater stem (35). Reassemble spacer (33) to yoke in 135R. Position stem seal (29) on stem seal collar (22). In sizes 55R, 85R and 135R place bead of stem seal in recess of stem seal collar.

In 35R and 135R actuators reassemble lower diaphragm base (21) to yoke (34). Assemble nuts (24) to spacer studs (32) in 135R. Tighten. *In 35R* insert capscrews (23) through holes in lower diaphragm case and diaphragm and into threads in yoke. Tighten after presetting stem seal as discribed below.

In 55R and 85R actuators replace sealing ring (27) and screws (28). Tighten.

Pre-setting Stem Seal – (55R, 85R, & 135R)

Place collar (22) on stem seal (29) making sure that bead on stem seal enters recess in collar. Reassemble diaphragm (20) over actuator stem (35). Fit center hole in diaphragm around raised face of collar (22). Replace diaphragm plate (17), and self-locking nut (16). *Hold actuator stem steady with rod through yoke and stem (55R, 85R, 135R) or with wrench on flats on actuator stem (35R)* then tighten self-locking nut. Replace upper diaphragm case (15) and bolts/nuts. Tighten as described previously. See Instruction Sheet 10/0.5.8 – for precautions to observe when replacing seals.

Pre-setting Stem Seal – (35R)

Place collar (22) on stem seal (29), assemble self-locking nut (16) to actuator stem (35) and tighten down against parts. Then press actuator stem downward to make stem seal move to taut position. Tighten capscrews and remove self-locking nut (16).

ALL ACTUATORS

Set preload on actuator spring, reassemble actuator to valve body assembly, if it has been removed, adjust valve for rated travel and reconnect operating medium tubing.

SOME IMPORTANT NOTES

FLAT SHEET RUBBER MATERIAL

Flat sheet rubber material may be used in 55(R), 85(R) and 135(R) actuators as emergency replacement material but for guaranteed results it should be replaced at the earliest opportunity with the LESLIE ROLLING ACTION DIAPHRAGM designed specifically for these actuators. When flat material is used in emergency preform as described below.

PREFORMING 35(R) ACTUATOR DIAPHRAGMS

Flat stock material is used for diaphragms in 35(R) actuators. When assembling first fingertighten all diaphragm case bolts. Then compress actuator spring sufficiently to move diaphragm through full travel to the upper or lower diaphragm case (depending on whether actuator is direct or reverse acting). This preforms diaphragm and permits full movement through rated travel without resistance from a taut diaphragm.

TO CHANGE VALVE ACTION FROM NORMALLY OPEN TO NORMALLY CLOSED OR VICE-VERSA.

To reverse the action of a single ported diaphragm control valve it is only necessary to replace the actuator in use with one having the opposite action. A single "D" in the control valve class indicates actuator is "DIRECT ACTING" – Air moves diaphragm downward. A double D ("DD") indicates actuator is "REVERSE ACTING" – Air moves diaphragm upward. *Note:* Final valve action in response to air signal on diaphragm depends on whether valve plug is positioned above or below the seat ring.

PROCEDURE

To change actuator, loosen valve plug stem locknut under travel indicator and turn valve plug stem all the way out of the actuator stem. Remove capscrews securing actuator to bonnet. Replace actuator with one having desired action. Re-insert and tighten capscrews. Reconnect valve plug stem to actuator stem. Adjust actuator spring preload and set valve for rated travel. For more detailed instruction consult general instruction pertaining to the particular type of control valve.

1.2.23-533

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REPLACE	CONTENTS (2 of 2) 6-4-81	WITH CONTENTS (2 of 2) 11-25-81
ADD	TEMPERATURE CONTROLLERS II FISHER	FORM 5115

CONTENTS
(1 of 2)

CONTENTS
(2 of 2)

VENDOR INFORMATION CONTINUED

FISHER® Controls

Instruction Manual

4156 and 4166 Series *Wizard*® II Temperature Controllers

Form 5115, October 1978

INTRODUCTION

Scope of Manual

This instruction manual provides installation, operating, maintenance, and parts information for the 4156 and 4166 Series **Wizard**® II temperature controllers. Refer to separate instruction manuals for information regarding the control valve, actuator, and accessories.

Description

The 4156 and 4166 Series instruments are pneumatic temperature controllers that use a temperature bulb immersed in the process fluid to increase or decrease pressure in a Bourdon tube as the temperature of the process fluid increases or decreases. The controller output is a pneumatic signal that operates a final control element to reduce deviation between the process temperature and an operator-adjusted set point.

Specifications

Specifications for the 4156 and 4166 Series are listed in table 1.

INSTALLATION

Controller Mounting

The controllers are normally mounted with the case cover vertical as shown in figure 1. If the controller is to be installed in any other position, be sure that the opening in the vent (key 15, figure 12) is facing downward. For panel mounting, cut a hole in the panel surface using the dimensions shown in figure 2. Remove cap screws (key 252, figure 2), brackets (key 251, figure 2), and vent (key 15, figure 12). Slide the controller into the cutout and re-attach the brackets. Tighten the cap screw located in the center of each bracket to draw the case snugly and evenly around the panel. Re-install the vent unless the vent connection is to be piped away.

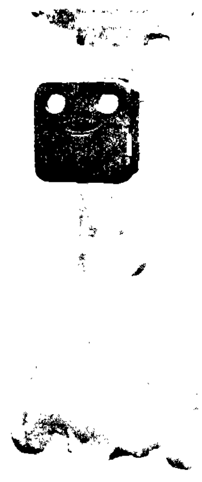

Figure 1. Controller Yoke-mounted on Actuator of Control Valve

For wall mounting, drill four holes in the wall using the dimensions shown in figure 2. Mounting holes in the bracket are 11/32-inch (8.7 mm) diameter holes. Back out the cap screw located in the center of each bracket. If the capillary tube is to run through the wall, drill a hole in the wall large enough to accept the temperature bulb (see figure 3 for bulb dimensions). See figure 2 for the location of the capillary tube connection in the back of the case.

Table 1. Specifications

AVAILABLE CONFIGURATIONS	See table 2
INPUT SIGNAL	**Type**: Temperature between 0°F (−18°C) and 1000°F (538°C). See table 4 for available ranges **Minimum Span***: 100F° (56C°) **Maximum Span***: 1000F° (538C°)
OUTPUT SIGNAL	**Proportional or Proportional-Plus-Reset Ranges**: ■ 3 to 15 psig (0.2 to 1 bar) or ■ 6 to 30 psig (0.4 to 2 bar) **On-Off Ranges**: ■ 0 (off) and 20 (on) psig (0 and 1.4 bar) or ■ 0 (off) and 35 (on) psig (0 and 2.4 bar) **Action**: Field reversible between ■ Direct (increasing sensed temperature increases output pressure) or ■ Reverse (increasing sensed temperature decreases output pressure)—(an R is suffixed to the type number of a construction specified for reverse action)
SUPPLY PRESSURE REQUIREMENT	See table 3
OPERATIVE SUPPLY PRESSURE LIMIT	See table 3
ALLOWABLE SUPPLY OVERPRESSURE	See table 3
STEADY-STATE AIR CONSUMPTION	See table 3
MAXIMUM ALLOWABLE PRESSURE IN CLOSED VESSEL (FOR TEMPERATURE BULB)	3/8-inch (9.7 mm) Temperature Bulb: 1000 psi (69 bar) 9/16-inch (14.3 mm) Temperature Bulb: 500 psig (34.5 bar)
PROPORTIONAL BAND* FOR PROPORTIONAL OR PROPORTIONAL-PLUS-RESET CONTROLLERS	Full output pressure change adjustable over per cent of sensing element temperature range as follows: Proportional—■ 3 to 100% [3 to 15 psig (0.2 to 1 bar)] or ■ 6 to 100% [6 to 30 psig (0.4 to 2 bar)] Proportional-Plus-Reset—■ 6 to 200% [3 to 15 psig (0.2 to 1 bar)] or ■ 12 to 200% [6 to 30 psig (0.4 to 2 bar)]
RECOMMENDED DIFFERENTIAL GAP FOR ON-OFF CONTROLLERS	Full output pressure change adjustable over 15 to 100% of sensing element temperature range
TEMPERATURE SETTING ACTION	Continuously adjustable to position proportional band or differential gap of less than 100% anywhere within sensing element temperature range
PERFORMANCE	**Repeatability***: 0.5% of sensing element temperature range **Dead Band* (Except On-Off Controllers†)**: 0.1% of proportional band or span **Time Constant of Temperature Bulb**: 9 to 18 seconds (bare bulb in agitated liquid) **Resonant Frequency**: Unaffected at usual motor and turbine speeds
RESET ADJUSTMENT (4166 SERIES ONLY)	Reset* is continuously adjustable from 0.01 to over 74 minutes per repeat (from 100 to under 0.0135 repeats per minute)
AMBIENT OPERATIVE TEMPERATURES	**Standard Construction**: −40 to 160°F (−40 to 71°C) **High-Temperature Construction**: 0°F to 250°F (−18 to 121°C)
AMBIENT TEMPERATURE OPERATING INFLUENCE	Controlled pressure varies only ±1.5% of sensing element rating for each 50F° (28C°) change in ambient temperature
APPROXIMATE WEIGHT	18 pounds (8.1 kg)

*These terms are defined in ISA Standard S51.1-1976.
† Adjustable differential gap of on-off controllers is equivalent to an adjustable dead band.

Table 2. Available Configurations and Type Numbers

CONTROL MODE		TYPE NUMBER
Proportional-Plus-Reset Control	Standard	4166
	With anti-reset windup	4166F
Proportional Only Control	Available with or without remote set point	4156
On-Off Control		4156S

Provide four suitable bolts or screws to attach the bracket to the wall. Mount the controller to the bracket using four cap screws (key 252, figure 2).

For pipestand mounting, attach spacer spools and mounting plate (keys 228 and 213, figure 2) to the controller with cap screws, lock washers, and nuts (keys

March 1979

Errata Sheet for

4156 and 4166 Series Wizard II Temperature Controllers Instruction Manual

Form 5115 October 1978

This errata sheet adds to the instruction manual information on a washer that is a new part of the reset restriction valve and is shown as key 258 on figure 1 of this errata. If this washer is not used, damage to the reset restriction valve may result.

1. Page 15 -- Change step 5 to read: Remove the washer (key 258), the scratch valve (key 253), plate (key 252), and O-rings (key 171).

2. Page 16 -- Change step 2 to read: Replace the plate and scratch valve (key 253) and washer (key 258) in the body (key 251).

3. Page 21 -- Add the following information to the Reset Restriction Valve Assembly parts list:

258	Washer	16A1775 X012

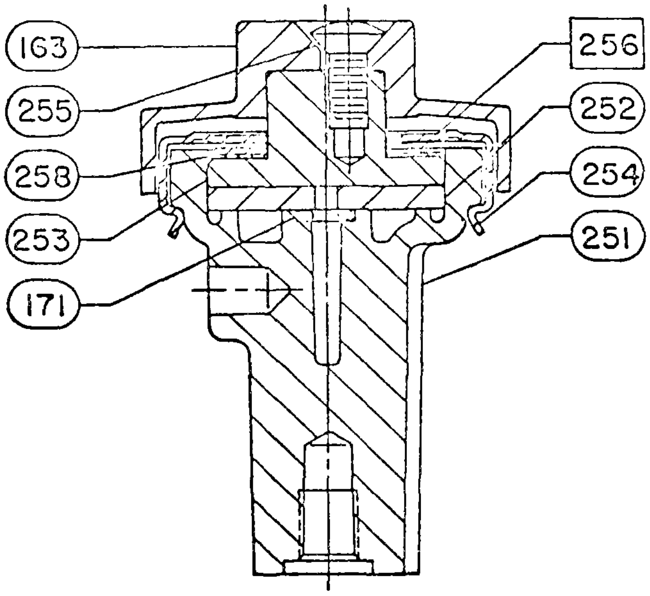

Figure 1. Reset Restriction Valve Assembly

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Fisher Controls Company

Fisher Controls Company, Marshalltown, Iowa 50158

Table 3. Supply Pressure Data

OUTPUT SIGNAL RANGE		NORMAL OPERATING SUPPLY PRESSURE[1]		OPERATIVE SUPPLY PRESSURE LIMIT[2]		ALLOWABLE SUPPLY OVER-PRESSURE[2,3]		STEADY-STATE AIR CONSUMPTION SCFH OF AIR [6]	
Psig	Bar	Psig	Bar	Psig	Bar	Psig	Bar	Min[4]	Max[5]
3 to 15 or 0 & 20 (On-Off)	0.2 to 1.0 or 0 & 1.4 (On-Off)	20	1.4	45	3.1	100	7	4.2	27
6 to 30 or 0 & 35 (On-Off)	0.4 to 2.0 or 0 & 2.4 (On-Off)	35	2.4	45	3.1	100	7	7	42

[1] If this pressure is exceeded, control stability may be impaired.
[2] If this pressure is exceeded, controller output may increase to a pressure equal to supply pressure and remain there until supply pressure is reduced. The high output pressure may overpressure equipment being operated by the controller.
[3] If this pressure is exceeded, damage to the controller may result.
[4] At proportional band setting of 0 or 10.
[5] At proportional band setting of 5.
[6] At 60°F, 14.7 psia. Multiply by 0.0268 to convert to normal cubic meters per hour (0°C, 1.01325 bar absolute).

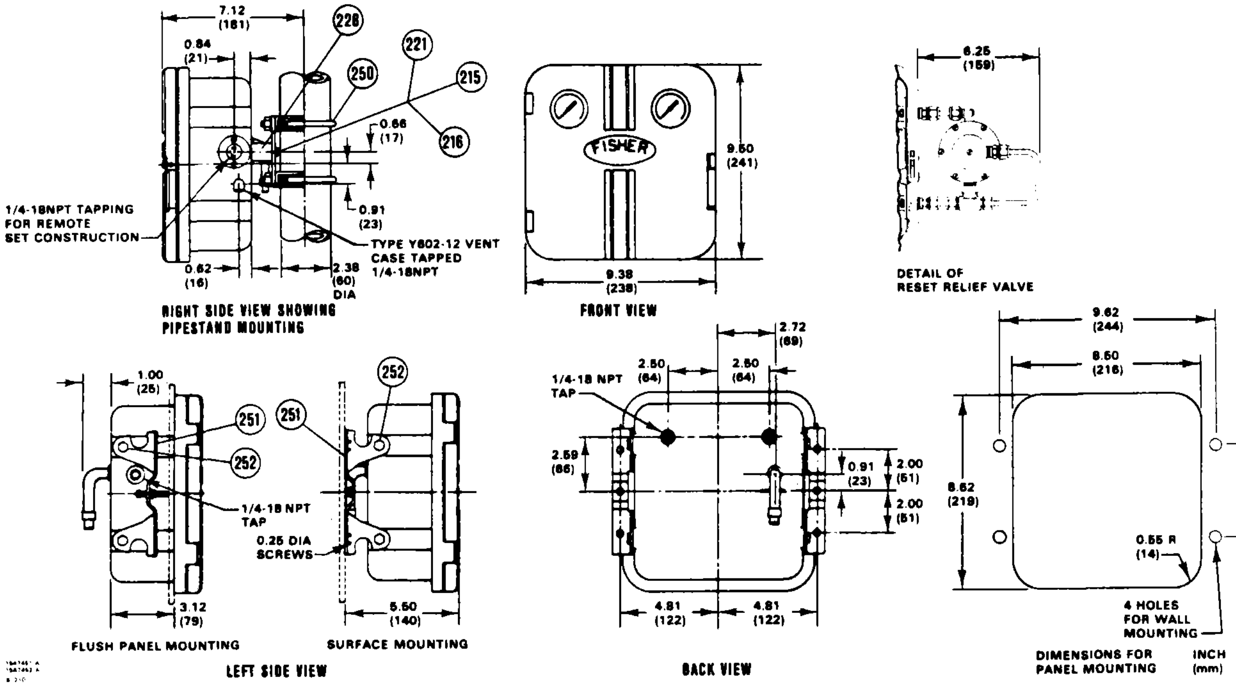


Figure 2. Panel, Wall, and Pipestand Mounting

Table 4. Available Temperature Ranges of Thermal Element Assembly*

RANGE			
°F	°C	°F	°C
0 to 100 50 to150 100 to 200	−18 to 38 10 to 66 38 to 93	200 to 400 0 to 300 0 to 400	93 to 204 −18 to 149 −18 to 204
0 to 200 50 to 200 50 to 250 100 to 300	−18 to 93 10 to 93 10 to 121 38 to 149	0 to 600 0 to 800 0 to 1000	−18 to 316 −18 to 427 −18 to 538

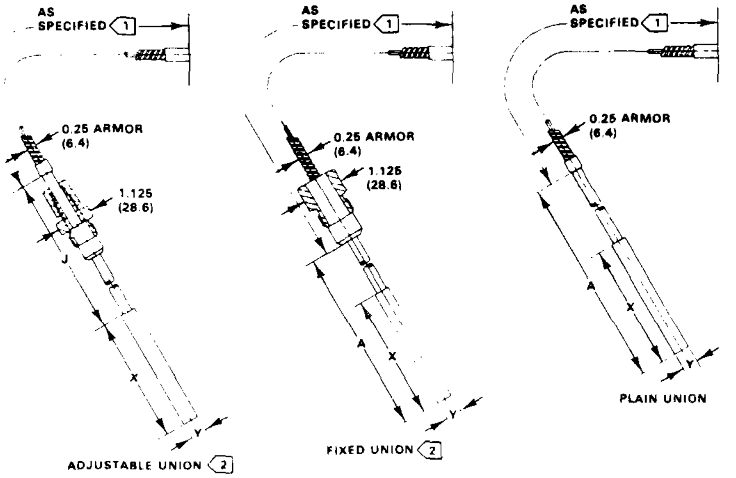
*Class III B per SAMA Standard RC 6-10-1963

215, 221, and 216, figure 2). Attach the controller to a 2-inch (nominal) pipe with pipe clamps (key 250, figure 2).

Controllers specified for mounting on a control valve actuator will be mounted at the factory. If the controller is ordered separately for installation on a control valve actuator, mount the unit per the following instructions.

Mounting parts for various actuator types and sizes vary. Two typical actuator-mounted installations are shown in figure 4; see the "Parts List" section for parts required for the specific actuator type and size involved. Attach spacer spools and mounting plate (keys 228 and 213, figure 4) to the controller with cap screws, lock washers, and nuts (keys 215, 221, and 216; figure 4). Attach the mounting bracket to the actuator yoke with cap screws (key 222, figure 4) and, if needed, spacer spools. On some designs, the mounting bracket is to be attached to the actuator diaphragm casing rather than the yoke.

SAMA STYLE	TEMPERATURE RANGES		DIMENSION					
			A or J		X		Y	
	°F	°C	In.	mm	In.	mm	In.	mm
Adjustable Union	0 to 100 through 200 to 400 0 to 400 through 0 to 1000	−18 to 38 through 93 to 204 −18 to 204 through −18 to 538	17.50 23.00	445 584	5.70 7.00	145 178	0.38 0.56	10 14
Fixed Union	0 to 100 through 200 to 400 0 to 400 through 0 to 1000	−18 to 38 through 93 to 204 −18 to 204 through −18 to 538	7.90 11.25	200 286	5.70 7.00	145 178	0.38 0.56	10 14
Plain Union	0 to 100 through 200 to 400 0 to 400 through 0 to 1000	−18 to 38 through 93 to 204 −18 to 204 through −18 to 538	23.25 30.00	590 762	5.70 7.00	145 178	0.38 0.56	10 14



NOTES

1 AVAILABLE IN 5-FOOT (1.5 METER), 10-FOOT (3 METER), AND 15-FOOT (4.5 METER) LENGTHS. MINIMUM BENDING RADIUS IS 1 INCH (25 mm).

2 USED WITH EITHER A BUSHING OR THERMOWELL CONNECTION PARTS PER SAMA RC8-10-1963

INCH
(mm)

Figure 3. Temperature Bulb Dimensions

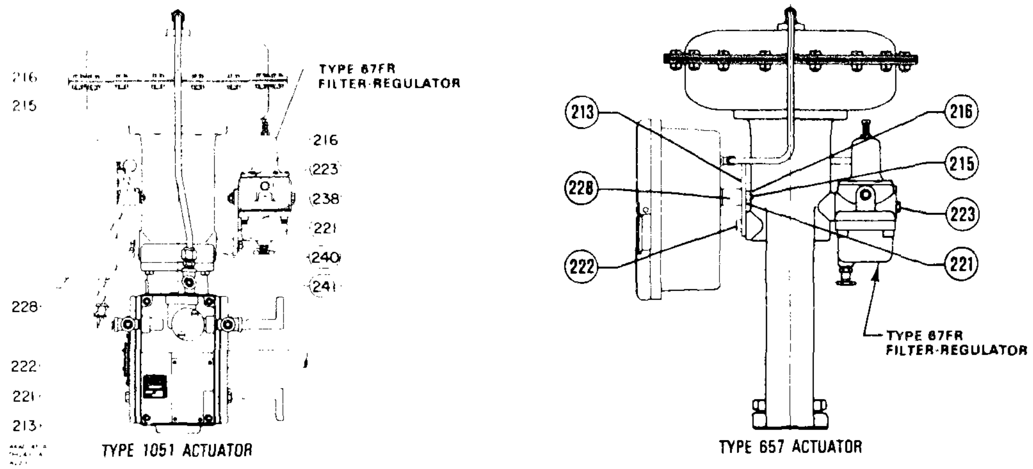
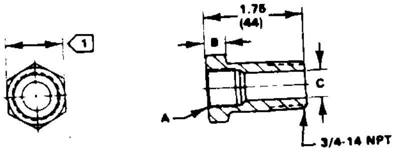


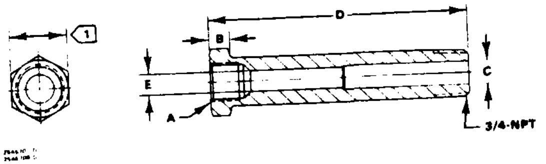
Figure 4. Actuator Mounting



TEMPERATURE BULB DIA		DIMENSION				
		A*	B		C	
In.	mm		In.	mm	In.	mm
3/8	10	1/2-14 NPSM	0.44	11	0.44	11
9/16	14	1-20 UNEF	0.75	19	0.63	16

*Seat area per SAMA Standard RC 17-10-1963

BUSHINGS WITHOUT LAG



TEMPERATURE BULB DIA		DIMENSION								
		A*	B		C		D		E	
In.	mm		In.	mm	In.	mm	In.	mm	In.	mm
3/8	10	1/2-14 NPSM	0.44	11	0.47	12	4.44	113	0.44	11
9/16	14	1-20 UNEF	0.75	19	0.66	17	4.75	121	0.63	16

*Seat area per SAMA RC-17-10-1963

BUSHINGS WITH 3-INCH (76 mm) LAGGING

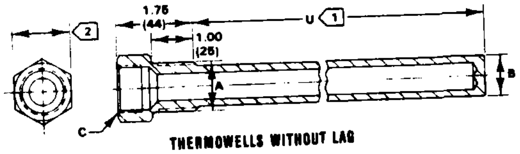
INCH
(mm)

NOTES:
1 1-1/8 INCH HEX FOR 3/8-INCH TEMPERATURE BULB;
1-1/4 INCH HEX FOR 9/16-INCH TEMPERATURE BULB

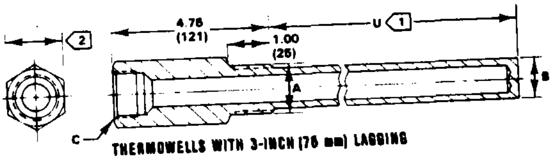
Figure 5. Bushing Dimensions

Temperature Bulb Diameter		Dimension					
		A	B		C	U (Insertion Length)	
In.	mm		In.	mm		In.	mm
3/8	10	1/2-14 NPT 3/4-14 NPT	0.63 0.77	16 20	1/2-14 NPSM-2B*	7.5 10.5 16	191 267 406
9/16	14	3/4-14 NPT	0.88	22	1-20 UNEF-2B*	7.5† 10.5 16 24	191† 267 406 559

*Seat area per SAMA Standard RC 17-10-1963.
† Lagged only



THERMOWELLS WITHOUT LAG



THERMOWELLS WITH 3-INCH (76 mm) LAGGING

NOTES:
1 TOLERANCES FOR THIS DIMENSION ARE AS FOLLOWS:
±0.06 IN. (1.5 mm) WHEN LENGTH IS 12 IN. (305 mm) OR LESS
±0.125 IN. (3.2 mm) WHEN LENGTH IS GREATER THAN 12 IN. (305 mm)
2 1-1/8 INCH HEX FOR 3/8-INCH TEMPERATURE BULB;
1-1/4 INCH HEX FOR 9/16-INCH TEMPERATURE BULB

INCH
(mm)

Figure 6. Thermowell Dimensions

Piping

All pressure connections on 4156 and 4166 Series instruments are 1/4-inch 18 NPT female. Use 1/4-inch or 3/8-inch pipe or tubing for supply, output, and remote set point piping. Use 1/2-inch pipe for the remote vent pipe, if one is required. Locations of pressure connections are shown in figure 2.

Process Temperature

Process temperature is sensed by a temperature bulb immersed in the process fluid. When the temperature bulb is to be used within a closed vessel, bushings are available to fit the bulb to the vessel. The bushing (dimensions are shown in figure 5) penetrates the vessel and the temperature bulb screws into the bushing. Or, if the process pressure exceeds the limitations of the temperature bulb, or if the process fluid is corrosive, a thermowell (dimensions are shown in figure 6) penetrates the vessel and the temperature bulb screws into the thermowell. Table 5 lists process pressure ratings for thermowells. Table 6 lists velocity ratings for thermowells for process fluid velocities such as encountered if the thermowell is mounted in a pipe.

With the controller case mounted so that the temperature bulb will reach the process, screw the temperature bulb into the bushing or thermowell.

Table 5. Maximum Process Pressures for Thermowells

THERMOWELL SIZE	BULB SIZE		MATERIAL	TEMPERATURE °F (°C)											
				70 (21)		200 (93)		400 (204)		600 (316)		800 (427)		1000 (538)	
	In.	mm		Psig	Bar	Psig	Bar	Psig	Bar	Psig	Bar	Psig	Bar	Psig	Bar
1/2 NPT	0.38	9.7	Brass	2810	193.9	2530	174.6	440	30.4	. . .	. . .	. . .	. . .	. . .	. . .
			Carbon Steel	3160	218.0	3040	209.8	2900	200.1	2770	191.1	2110	145.6	. . .	. . .
			304 SST	4120	284.3	3740	258.1	3400	234.6	3280	226.3	3180	219.4	2750	189.8
			316 SST	4120	284.3	4120	284.3	3850	265.7	3760	259.4	3680	253.9	3080	212.5
			Monel	3820	263.6	3530	243.6	3250	224.3	3210	221.5	3130	215.9	. . .	. . .
3/4 NPT	0.38	9.7	Brass	5000	345.0	4200	289.8	1000	69.0	. . .	. . .	. . .	. . .	. . .	. . .
			Carbon Steel	5200	358.8	5000	345.0	4800	331.2	4600	317.4	3500	241.5	. . .	. . .
			304 SST	7000	483.0	6200	427.8	5600	386.4	5400	372.6	5200	358.8	4500	310.5
			316 SST	7000	483.0	7000	483.0	6400	441.6	6200	427.8	6100	441.6	5100	351.9
			Monel	6500	448.5	6000	414.0	5400	372.6	5300	365.7	5200	358.8	. . .	. . .
3/4 NPT	0.56	14.3	Carbon Steel	2310	159.4	2030	140.1	1900	131.1	1820	125.6	1430	98.7	. . .	. . .
			304 SST	3470	239.4	3080	212.5	2520	173.9	2430	167.7	1850	127.7	1630	112.5
			316 SST	3470	239.4	3470	239.4	3240	223.6	3150	217.4	3100	213.9	2600	179.4
			Monel	3070	211.8	2510	173.2	2460	169.7	2410	166.3	2150	148.4	. . .	. . .

Table 6. Maximum Process Fluid Velocities for Thermowells*

THERMOWELL SIZE	TEMPERATURE BULB SIZE		MATERIAL	INSERTION LENGTH† IN. (mm)							
				7.5 (191)		10.5 (267)		16 (406)		24 (610)	
	In.	mm		Ft/s	m/s	Ft/s	m/s	Ft/s	m/s	Ft/s	m/s
1/2 NPT	0.38	9.2	Brass	38	11.6	19	5.8	8	2.4	. . .	. . .
			Carbon Steel	48	14.6	25	7.6	11	3.4	. . .	. . .
			304 SST/316 SST	50	15.2	26	7.9	11	3.4	. . .	. . .
			Monel	48	14.6	24	7 3	11	3.4	. . .	. . .
3/4 NPT	0.38	9.2	Brass	54	16.5	27	8.2	12	3.7	. . .	. . .
			Carbon Steel	69	21.0	35	10.7	15	4.6	. . .	. . .
			304 SST/316 SST	72	21.9	37	11.3	16	4.9	. . .	. . .
			Monel	68	20.7	35	10.7	15	4.6	. . .	. . .
3/4 NPT	0.56	14.3	Carbon Steel	97	29 6	49	14.9	21	6.4	10	3.0
			304 SST/316 SST	100	30.5	51	15.5	22	6.7	10	3.0
			Monel	95	28.9	49	14.9	21	6.4	9	2.7

*For gas, air, or steam. Values may be lower for liquids

†This is the "U" dimension in figure 6

WARNING

Thermowell must be able to withstand the effects of process velocity, and pressure (see tables 5 and 6). Failure to the thermowell may result in personal injury or equipment damage due to escaping process fluid.

If the temperature bulb is to be installed in pipe, process velocity is an important consideration. Install the bulb where the process temperature is to be measured, keeping in mind the velocity limitations as described in table 6. Tapered thermowells, built to withstand even greater process velocities are also available.

Vent

WARNING

If a hazardous gas is being used as the supply pressure medium, provide adequate ventilation to prevent a hazardous accumulation of the gas. Remove vent (key 15, figure 12) and install a vent pipe to a remote location where the vented gas can be safely exhausted.

The vent (key 15, figure 12) or the end of a remote vent pipe must be protected against the entrance of all foreign matter that could plug the vent. Check the vent periodically to be certain it has not become plugged.

Remote Set Point

If the controller is equipped with remote set point adjustment capability, connect the remote set point panel loader or regulator to the connection on the same side of the controller as the cover latch (see figure 2 for location).

The panel loader or regulator used for remote set point adjustment must have an adjustable output of 3 to 15 psig (0.2 to 1.0 bar) for a controller output signal range of 3 to 15 psig (0.2 to 1.0 bar) and 6 to 30 psig (0.4 to 2.0 bar) for a controller output signal range of 6 to 30 psig (0.4 to 2.0 bar).

Supply Pressure

Supply pressure must be clean, dry air or non-corrosive gas. Use a suitable supply pressure regulator to reduce the supply pressure source to 20 psig (1.4 bar) for an output signal range of 3 to 15 psig (0.2 to 1.0 bar) and to 35 psig (2.4 bar) for an output signal range of 6 to 30 psig (0.4 to 2.0 bar).

WARNING

> If the normal operating supply pressure (see table 3) is exceeded, control and stability may be impaired. If the operative supply pressure is exceeded, controller output may increase to a pressure equal to supply pressure; the increased output pressure will remain equal to supply pressure until supply pressure is reduced. The high output pressure may overpressure equipment being operated by the controller.
>
> If the allowable supply overpressure is exceeded, damage to the controller may result.
>
> Overpressuring any of the system components could cause personal injury, equipment damage, and fire or explosion hazard due to venting of hazardous supply pressure medium. To avoid such injury or damage, provide suitable overpressure protection devices to protect all system components from overpressure.

CALIBRATION

Initial Steps

Before calibrating, complete these three initial steps; then, continue with the calibration steps given below for the specific type of instrument.

1. Connect supply pressure source to the supply pressure regulator and be sure that the regulator is delivering the proper supply pressure to the controller.

2. Connect the output connection to a suitable pressure gauge.

3. Provide a means of varying the temperature surrounding the temperature bulb, through the range of the bulb to simulate the process temperature. Or, if the process temperature can be varied through all or part of the bulb range (or through the two desired switching points for on-off controllers), monitor the process temperature and use it for calibration.

Proportional Controllers—Local Set Point

1. After completing the initial steps above, rotate the proportional band knob to 1.5 (15 percent proportional band).

2. Rotate the temperature setting knob to the lower limit.

3. With the temperature bulb at the low temperature of its range, loosen set screw (key 58, figure 16) and carefully rotate nozzle (key 59, figure 16) until controller output is between 8 and 10 psig (0.5 and 0.7 bar) for a 3 to 15 psig (0.2 to 1.0 bar) output signal range, and between 16 and 20 psig (1.0 and 1.4 bar) for a 6 to 30 psig (0.4 to 2.0 bar) output signal range. Carefully tighten set screw.

4. Bring the temperature bulb to the upper limit of its range. Rotate the temperature setting dial to maximum. Controller output should now be the same value as noted in step 3.

Note

> If it is not possible to provide a temperature equal to the upper range limit of the temperature bulb use any temperature that is available within the range. Then, rotate the temperature setting knob to the setting that corresponds to the temperature of the temperature bulb. Controller output pressure should now be the same value as noted in step 3.

If the output signal pressure is not within the limits noted in step 3, loosen two screws (key 70, figure 16) and carefully move the calibration adjustor (key 55, figure 16) to the right to decrease output pressure for direct-acting controllers (increase for reverse-acting) or to the left to increase output pressure for direct-acting controllers (decrease for reverse-acting). Tighten the screws. Then, repeat steps 3 and 4.

5. Proceed to the "Startup" section.

Proportional Controllers—Remote Set Point

1. After completing the initial steps above, connect an adjustable pressure source to the remote set point connection on the controller (see figure 2). The source must be adjustable from 3 to 15 psig (0.2 to 1.0 bar) for a 3 to 15 psig (0.2 to 1.0 bar) output signal range, and from 6 to 30 (0.4 to 2.0 bar) for a 6 to 30 psig (0.4 to 2.0 bar) output signal range.

2. Rotate the proportional band knob to 1.5 (15 percent proportional band).

3. Rotate the temperature setting knob to maximum for direct-acting controllers and to minimum for reverse-acting controllers. Adjust the remote set point signal pressure as follows.

3 to 15 psig (0.2 to 1.0 bar) output signal: 15 psig (1.0 bar) for direct-acting controllers and 3 psig (0.2 bar) for reverse-acting controllers.

6 to 30 psig (0.4 to 2.0 bar) output signal: 30 psig (2.0 bar) for direct-acting controllers and 6 psig (0.4 bar) for reverse-acting controllers.

4. With the temperature bulb at the low temperature of its range, loosen set screw (key 58, figure 16) and carefully rotate nozzle (key 59, figure 16) until controller output is between 8 and 10 psig (0.5 and 0.7 bar) for a 3 to 15 psig (0.2 to 1.0 bar) output signal range and between 15 and 20 psig (1.0 and 1.4 bar) for a 6 to 30 psig (0.4 to 2.0 bar) output signal range. Tighten set screw.

5. Bring the temperature bulb to the upper limit of its range. Change the remote set point pressure to the opposite end of the 3 to 15 psig (0.2 to 1.0 bar) or 6 to 30 psig (0.4 to 2.0 bar) range. Controller output should now be the same value as noted in step 4.

Note

> If it is not possible to provide a temperature equal to the upper range limit of the temperature bulb, use any temperature that is available within the range. Then, adjust the remote set point pressure to the value that corresponds to the temperature applied to the temperature bulb (e.g., mid-range of the remote set point pressure range corresponds to mid-range of the temperature bulb range). Keep in mind that the remote set point pressure decreases the set point of direct-acting controllers and increases the set point of reverse-acting controllers.
>
> Controller output pressure should now be the same value as noted in step 4.

If the output signal pressure is not within the limits noted in step 4, loosen two screws (key 70, figure 16) and carefully move the calibration adjustor (key 55, figure 16) to the right to decrease output pressure for direct-acting controllers (increase for reverse-acting), or to the left to increase output pressure for direct-acting controllers (decrease for reverse-acting). Tighten the screws. Then, repeat steps 4 and 5.

6. Proceed to the "Startup" section.

Proportional-Reset Controllers

1. After completing the initial steps above, rotate the reset knob to 0.01 minutes per repeat.

2. Rotate the proportional band knob to zero.

3. Bring the temperature bulb to the low temperature of its range.

4. Rotate the temperature setting knob until controller output pressure is between 8 and 10 psig (0.5 to 0.7 bar) for a 3 to 15 psig (0.2 to 1.0 bar) output signal range and between 16 and 20 psig (1.0 and 1.4 bar) for a 6 to 30 psig (0.4 to 2.0 bar) output signal. The temperature setting knob should be at or near the lowest temperature.

5. If it is not possible to rotate the temperature setting knob to minimum without controller output pressure exceeding the limits stated in step 4, loosen set screw (key 58, figure 16) and carefully rotate the nozzle (key 59, figure 16) until controller output pressure is within the limits in step 4 while the pressure setting knob is at minimum. Carefully tighten the set screw.

6. Bring the temperature bulb to the upper limit of its range. Rotate temperature setting knob until controller output pressure is within the limits noted in step 4. The temperature setting knob should be at or near the maximum setting.

Note

> If it is not possible to provide a temperature equal to the upper range limit of the sensing element, use any temperature that is available within the temperature bulb range. Then, rotate the temperature setting knob until controller output pressure is within the limits noted in step 4. The temperature setting knob should be at or near a setting equal to the process temperature.

If it is not possible to rotate the temperature setting knob to a setting that equals the temperature of the temperature bulb without exceeding the limits noted in step 4, loosen two screws (key 70, figure 16) and carefully move the calibration adjustor (key 55, figure 16) to the right to decrease output pressure with direct-acting controllers (increase with reverse-acting) or to the left to increase output pressure with direct-acting controllers (decrease with reverse-acting). Tighten the screws. Then, repeat steps 3 through 6.

7. Rotate the proportional band knob to 10 (200 percent proportional band); then proceed to the "Startup" section.

On-Off Controllers

1. Convert the on-off controller to a proportional controller by disconnecting the proportional tubing (key 36, figure 16) from the bellows frame (key 49, figure 16) and reinstalling the tubing into the other connection in the bellows frame (refer to figure 10 for assistance). Do not invert the reversing block.

2. Calibrate the controller by following the "Initial Steps" and "Proportional Controllers—Local Set Point" portions of this section.

3. Return the proportional tubing to the original location.

4. Set the on-off controller switching points per the following section.

Setting On-Off Controller Switching Points

If difficulty is encountered in setting the switching points, calibrate by following the "On-Off Controllers" section before proceeding.

1. After completing the "Initial Steps" portion of this section, refer to figure 7 to determine the proportional band dial setting required for the differential gap desired.

As an example, assume that a 0 to 100°F (−18 to 38°C) temperature bulb is being used and the controller is to switch from zero to full supply pressure at a process temperature of 80°F (27 °C) with rising process temperature and from full supply pressure to zero at 20°F (−7°C) with falling process temperature. (This is a direct-acting controller.) The differential gap is:

$$\frac{80°\text{F} - 20°\text{F}}{100°\text{F}} \times 100 = 60\%$$

$$\left(\frac{27°\text{C} - (-7°\text{C})}{56°\text{C}} \times 100 = 60\%\right)$$

From figure 7, the proportional band dial setting should be approximately 4.5; rotate the proportional band knob to 4.5.

2. Move the temperature setting knob to the temperature at which controller output is to switch from zero to full supply pressure with rising process temperature for direct-acting controllers or with falling process temperature for reverse-acting controllers. In the above example, this temperature would be 80°F (27°C). If the example were for a reverse-acting controller, this switching temperature would be 20°F (−7°C).

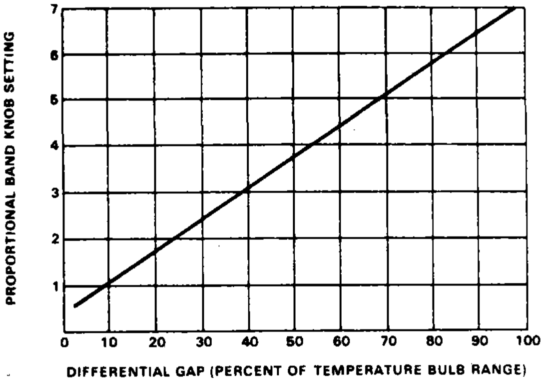


Figure 7. Differential Gap Adjustment for On-Off Controllers

3. Increase temperature at the temperature bulb while monitoring the output pressure gauge. Controller output pressure should switch from zero to full supply pressure as the upper switching point is reached with rising temperature for direct-acting controllers and as the lower switching point is reached with falling temperature for reverse-acting controllers. Loosen set screw (key 58, figure 16) and carefully rotate the nozzle (key 59, figure 16) until the above conditions are met. Then carefully tighten set screw.

4. Vary the process temperature to the lower switching point on direct-acting controllers or to the upper switching point on reverse-acting controllers.

Controller output pressure should switch from full supply pressure back to zero as the lower switching point is reached with falling temperature for direct-acting controllers and as the upper switching point is reached with rising temperature for reverse-acting controllers. It may be necessary to rotate the proportional band knob to broaden or narrow the differential gap. Repeat steps 3 and 4 after changing the position of the proportional band knob.

5. Proceed to the "Startup" section.

OPERATING INFORMATION

This section includes descriptions of adjustments, and instructions for starting the controller.

Adjustments

Set Point

For proportional and proportional-reset controllers, the set point (temperature setting) is the temperature at which it is desired to maintain the process. The temperature setting dial (key 139, figure 16) is graduated in temperature units. The graduations on the dial are approximate indications of the controller set point. When making adjustments, do not rely solely on the dial setting; monitor the process temperature to be sure the desired set point is attained. With proportional-reset controllers, the temperature setting dial will reflect the controller set point if the controller is accurately calibrated.

For on-off controllers, the temperature setting adjustment determines the upper switching point for direct-acting controllers and the lower switching point for reverse-acting controllers. This is the process temperature at which controller output will switch from zero to full supply pressure with rising process temperature for direct-acting controllers and with falling process temperature for reverse-acting controllers.

To adjust the set point on controllers without remote set point capability, open controller cover and locate the temperature setting assembly (see figure 16). Move the pointer clockwise to increase and counterclockwise to decrease the set point.

Remote Set Point

On controllers with remote set point adjustment capability, the set point is adjusted by varying the pressure to the remote set point connection (key 147, figure 14). Increasing the remote set point signal pressure will decrease controller set point for direct-acting controllers and will increase controller set point for reverse-acting controllers.

Proportional Band

For proportional and proportional-reset controllers, the proportional band adjustment determines the amount of change in the process temperature required to change the controller output signal from one limit of the output signal range to the other limit (without the effect of reset action).

Proportional band is expressed as a percent of the temperature bulb range. That is, with a proportional band of 100 percent, a process temperature change equal to the temperature bulb span would change controller output from one limit to the other. With a proportional band of 50 percent, a process temperature change equal to half the temperature bulb range would change controller output from one limit to the other.

For on-off controllers, the proportional band adjustment determines the width of the differential gap (the difference between the process temperature at which controller output will switch from zero to full supply pressure and from full supply pressure to zero). The relationship between the proportional band dial setting and the differential gap is shown in figure 7.

On the proportional-only controllers, the proportional band dial is graduated from 0 to 10 with a setting of "10" representing 100 percent. On proportional-plus-reset controllers, the dial is graduated from 0 to 200 percent.

To adjust the proportional band, open controller cover and locate the proportional band adjustment (see figure 12). Rotate the knob counterclockwise to broaden or clockwise to narrow the proportional band.

Reset

On proportional-reset controllers, the reset adjustment determines the time in minutes required for reset action to produce a change in output pressure equal to a change that has occurred due to proportional action.

To adjust reset action, open the controller cover and locate the reset restriction valve (see figure 15). Rotate the knob clockwise to increase or counterclockwise to decrease the minutes per repeat. Increasing the minutes per repeat provides a slower reset action.

Anti-Reset Windup (Optional)

The valve is located outside the controller case as shown in figure 13, and is set at the factory to relieve at a 5 psi (0.35 bar differential) difference between reset bellows pressure and proportional bellows pressure. The valve can be adjusted to relieve from 2 to 7 psi (0.14 to 0.48 bar, differential).

The relief valve can be reversed to relieve on either rising controller output pressure or falling controller output pressure. If the arrow on the relief valve points toward the bottom of the controller case as shown in figure 13, the valve will relieve on falling output pressure. If the arrow points in the opposite direction, the valve will relieve on rising output pressure. If desired, the valve can be removed and re-installed with the arrow pointing in the opposite direction to change the relief action.

Pre-Startup

Be sure that the controller has been calibrated as described in the "Calibration" section before performing the startup procedures.

Startup

Proportional Controllers

This procedure applies to controllers with either local or remote set point except where indicated.

1. Be sure that the supply pressure regulator is delivering the proper supply pressure to the controller.

2. For controllers with local set point, move the temperature setting knob to the desired set point.

For controllers with remote set point:

a. Rotate the temperature setting knob to the maximum setting for direct-acting controllers and to minimum for reverse-acting controllers.

b. Connect an adjustable pressure source to the remote set point connection on the controller (see figure 2). The remote set point mechanism operates on a pressure range of 3 to 15 psig (0.2 to 1.0 bar) for a 3 to 15 psig (0.2 to 1.0 bar) output signal range and 6 to 30 psig (0.4 to 2.0 bar) for a 6 to 30 psig (0.4 to 2.0 bar) signal range.

c. Adjust the remote set point pressure to the value that is to produce the desired set point. For a set point equal to the mid-point of the temperature bulb range, the remote set point pressure must be equal to the mid-point of the remote set point signal range. If the remote set point mechanism was calibrated using a remote set point signal range of 3 to 15 psig (0.2 to 1.0 bar), a remote set point pressure of 9 psig (0.6 bar) would produce a set point equal to the mid-point of the temperature bulb range. Keep in mind that the remote set point mechanism is reverse-acting. That is, increasing remote set point pressure decreases the set point of direct-acting controllers and increases the set point of reverse-acting controllers.

3. Rotate the proportional band knob to 1.5 (15 percent proportional band).

4. With the controller adjusted to the desired set point, broaden the proportional band, if necessary, until stable control is obtained. In general, the narrowest proportional band setting that does not produce cycling will provide the best control.

Note

Proportional band adjustment will affect the set point. After adjusting the proportional band, re-zero as follows. For units with local set point, loosen the set screw (key 58, figure 16) and carefully rotate the nozzle (key 59, figure 16) until the steady-state process pressure equals the temperature setting knob reading. Then, carefully tighten the set screw. For units with remote set point, rotate the temperature setting knob until the steady-state process pressure corresponds to the remote set point pressure.

5. To ensure that the optimum proportional band setting has been obtained, create a load upset by momentarily changing the set point. If cycling reoccurs, broaden the proportional band until stability is attained.

Proportional-Reset Controllers

1. Be sure that the supply pressure regulator is delivering the proper supply pressure to the controller.

2. Rotate the temperature setting knob to the desired set point.

3. Rotate the proportional band dial knob to 200 percent proportional band.

4. Rotate the reset dial until it is near the maximum setting (approximately 74 minutes per repeat).

5. With the controller set near the desired control point, narrow the proportional band until a cycling condition exists. Then broaden the proportional band slightly until stable control is obtained. For controllers with reset, adjustment of the proportional band does not affect the set point if the controller is accurately calibrated.

6. Rotate the reset knob to obtain the fastest reset time without introducing cycling control.

7. To ensure that the optimum proportional band and reset rate settings have been obtained, create a load upset by momentarily changing the set point adjustment. If cycling reoccurs, broaden the proportional band slightly and repeat the load upset until stability is attained.

In general, the narrowest proportional band and fastest reset rate settings that will not produce cycling will provide the best control.

PRINCIPLE OF OPERATION

Thermal Element Assembly

All the **Wizard** II temperature controllers accept, as an input, the process temperature that is sensed by a temperature bulb immersed in the process fluid. The temperature bulb, a capillary tube, a Bourdon tube, and a temperature gauge calibrated for the appropriate temperature range, form a closed system referred to as the thermal element assembly. The capillary tube connects the temperature bulb to the Bourdon tube and the temperature gauge (both are inside the controller case).

The operation of gas-filled temperature bulbs is based on Charles' Law which says that if the volume of a given weight of gas is kept constant, *the pressure of the gas will vary* directly with the absolute temperature. Temperature bulbs used with the **Wizard** II controllers contain gas-filled charcoal that emits gas as the process temperature increases and absorbs gas as the process cools. Thus an increased process temperature builds pressure within the Bourdon tube, and decreasing temperature diminishes it.

Because the volume of the temperature bulb is much larger than the volume of the capillary tube, temperature errors caused by the ambient temperature of the capillary tube are negligible.

Proportional-Only Controllers

Supply pressure is connected to the pressure-balanced relay (with its double diaphragm assembly) and bleeds through the fixed orifice before escaping through the nozzle. The nozzle pressure registers on the large relay diaphragm and the loading pressure (controller output pressure) registers on the small relay diaphragm (see figures 8 and 9).

A pressure change within the Bourdon tube (reflecting a change in process temperature) changes its radius of arc slightly and moves the flapper (part of the beam) toward or away from the nozzle. An increased process temperature with direct action, or a decreased temperature with reverse action, restricts flow through the nozzle enough to increase the loading in the large diaphragm and open the inlet end of the relay valve.

With the inlet end of the relay valve open, more supply pressure is directed toward increasing the loading pressure on the control device. A decreased process temperature with direct action, or increased temperature with reverse action increases the flow through the nozzle enough to bleed off pressure on the large relay diaphragm. The decreased pressure on the large diaphragm opens the exhaust portion of the relay valve and allows loading pressure to be bled away from the control device.

Moving the set point control moves the bar holding the nozzle (notice how the bar rides on a cam that rotates with the control knob) and changes the proximity of the nozzle to the flapper. When the process temperature changed, the flapper moved with respect to the nozzle. Now, changing the set point moves the nozzle with respect to the flapper. With a direct-acting controller, moving the set point control clockwise to increase the set point temperature moves the nozzle away from the flapper, and counterclockwise movement moves the nozzle nearer the flapper.

Notice that a portion of the output pressure is fed back to the proportional bellows. If an increase in process temperature occurs, flow through nozzle is restricted and the loading pressure increases. Part of the loading pressure is fed to the bellows, backing the flapper away from the nozzle and decreasing the effect the change in temperature has on the system.

More specifically, pressure on the proportional bellows equalizes the relay diaphragm pressure differential. The relay valve maintains a new loading pressure according to the change in sensed temperature. The amount of output pressure fed to the proportional bellows can be adjusted with the proportional band control and is part of the controller tuning procedure to provide optimum control.

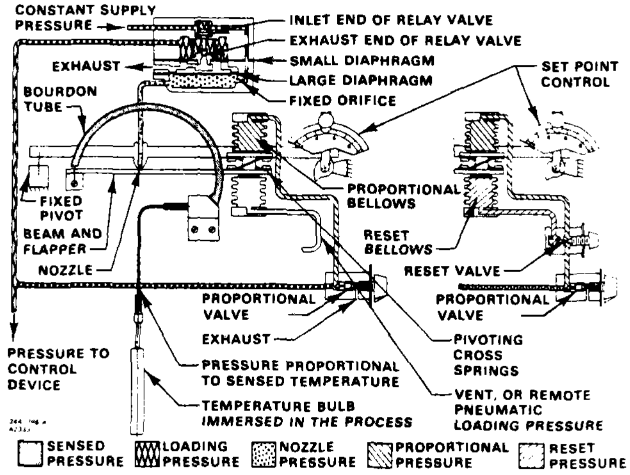


Figure 8. Operational Schematic of Direct-acting 4156 Series Controller

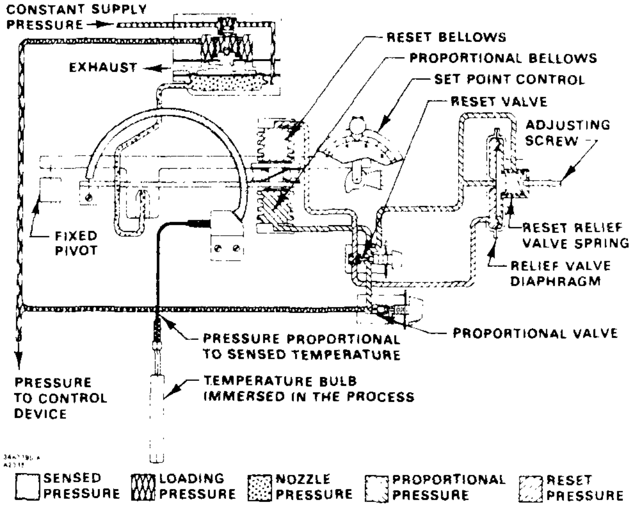


Figure 9. Operational Schematic of Reverse-acting 4166 Series Controller With Anti-Reset Windup

Proportional-Reset Controllers

The basic action of the proportional reset controllers (see figure 9) is the same as described for the proportional-only controller, except that loading pressure is fed back to the reset bellows as well as to the proportional bellows as shown in the right of figure 9. As long as the process temperature is at set point, pressure in both bellows is equal. When a process change occurs, proportional action moves the flapper away from the nozzle to minimize the controller response to the change (as described in the "Proportional-Only Controller" section). This is because even though the feedback pressure is applied to both bellows, pressure to the reset bellows must first pass through a time delay—the reset valve. Once pressure reaches the reset bellows, it opposes the proportional pressure and moves the flapper back closer to the nozzle, starting another pressure buildup throughout the system. The buildup continues until the process temperature is returned to set point, and the pressures in the two bellows are once again equal. The reset control introduces variable time delay and is calibrated in minutes per repeat, which is the number of times the effect of proportional action is repeated per unit time by the reset action. Like proportional action, reset is adjusted during tuning as required by the particular process.

Now that both proportional action and reset action are working together, how does the controller respond to a process temperature change? First, proportional action reduces the controller gain to avoid instability. Then, reset action takes over and gradually increases the gain to return the process temperature to the set point.

Controllers With Anti-Reset Windup

Proportional-reset controllers are available with an optional anti-reset windup valve (see figure 9). With this valve, proportional pressure registers rapidly on the spring side of the relief valve diaphragm as well as in the proportional bellows, and reset pressure registers on the opposite side of the relief valve diaphragm. As long as temperature changes are slow enough for normal proportional and reset action, the relief valve spring will keep the relief valve diaphragm from opening. However, a large or rapid increase in process temperature will cause the relay to exhaust loading pressure from the control device rapidly, and also from the proportional system and spring side of the relief diaphragm. If this decrease on the spring side of this diaphragm is greater that the relief valve spring setting, the diaphragm will move off the relief valve orifice and permit the reset pressure on the opposite side of the relief valve diaphragm to bleed rapidly into the proportional system. The action can be reversed to relieve on decreasing pressure.

On-Off Controllers

With on-off controllers (the Type 4156S), feedback pressure does not counteract the change in flapper position, as it does in proportional controllers, but rather reinforces the change. The feedback pressure is piped through the proportional valve to the bellows below the beam and flapper (as shown in figure 8 for direct action). As the loading pressure increases, the feedback moves the flapper even closer to the nozzle, rapidly increasing the loading pressure to the upper range limit. With falling loading pressure, the bellows pressure is reduced, moving the flapper away from the nozzle, rapidly decreasing the loading pressure to zero. The difference between the process temperature at which the controller output is zero and the temperature at which the output is maximum is the differential gap. The width of the gap is adjustable with the proportional control; the mid-point of the gap is adjustable with the set point control.

MAINTENANCE

If the installation includes a Type 67FR filter-regulator, periodically open the drain on the filter-regulator to drain accumulated moisture. Also, push the cleaner wire (key 89, figures 17 and 18) on the relay to clean the relay orifice. Check the opening of the vent (key 15, figure 12) or the opening of the remote vent pipe, if one is used. In either case, the vent must not become plugged. Clean if necessary.

Instructions are given below for changing controller action, changing output signal range, replacing the thermal element, and relay and reset valve repair. If it is necessary to replace the controller sub-assembly, use the appropriate steps of the "Changing Output Signal Range" instructions.

After performing any of the maintenance operations in this section, calibrate the controller per the "Calibration" section.

WARNING

The following maintenance procedures require taking the controller out of service. To avoid personal injury and damage to the process system, provide some temporary means of control to the process before taking the instrument out of service.

Replacing the Thermal Element

Unless noted otherwise, key numbers refer to figure 16.

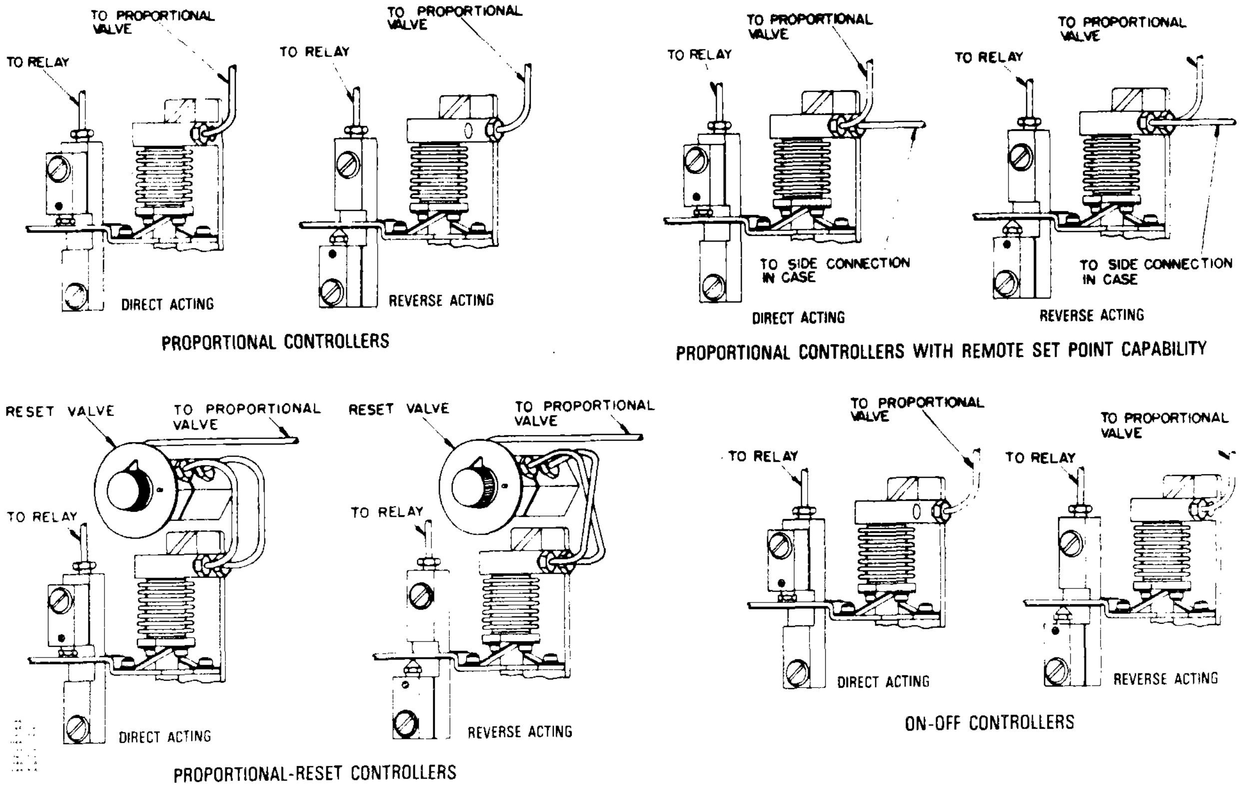


Figure 10. Tubing Connections for Direct- and Reverse-acting Controllers

Removal

1. Shut off supply pressure to the controller and remove the temperature bulb from the process.

2. Open the cover. Remove machine screws (key 73 and 74, figure 16; key 31, figure 15). Remove machine screw (key 77) that holds link (key 42) in place; take care not to lose the bearing.

3. Lift the Bourdon tube and process temperature gauge (these are part of the thermal element assembly) away from the case, withdrawing the capillary tube and temperature bulb through the opening in the rear of the case.

Installation

1. Install the thermal element assembly by feeding the temperature bulb and capillary tube through the opening at the rear of the case. Position the Bourdon tube and process temperature gauge and install and tighten machine screws (key 73 and 74, figure 16; key 31, figure 15). Install the connecting link (key 42) with machine screw (key 77).

2. Proceed to the "Calibration" section.

Changing Action

Use the numbered steps below to change from direct action (increasing temperature produces increasing output pressure) to reverse action (increasing temperature produces decreasing output pressure) or vice versa. Changing action is accomplished by reversing the positions of the bellows tubing and nozzle.

It is also possible to change from proportional-only action to on-off action or vice versa by changing the position of proportional tubing. Use the numbered steps below but do not change the position of the nozzle (omit step 6).

1. Shut off supply pressure to the controller.

2. Open cover and locate the two bellows (key 41, figure 16) and reversing block assembly (key 56, figure 16).

3. Refer to figure 10 and locate the appropriate view for the controller in question. Note the new tubing and reversing block positions for action desired.

4. Disconnect the proportional tubing (key 36, figure 12) from bellows frame (key 49, figure 16). For proportional-reset controllers or controllers with remote set point

capability, also disconnect reset tubing (key 166, figure 15) or remote set tubing (key 152, figure 14) from the bellows frame.

5. Re-connect the tubing to the opposite bellows frame connection from which the tubing was removed (refer to figure 10 to be sure the tubing is properly installed).

6. Unscrew reversing block screw and sealing screw (keys 72 and 71, figure 16), invert the assembly, and re-install it so that the nozzle is on the opposite side of the beam (key 60, figure 16) from which it was removed (refer to figure 10 to be sure the reversing block is properly installed). Re-install sealing screw in the hole from which the reversing block screw was removed.

7. Proceed to the "Calibration" section.

Changing Output Signal Range

Use the following steps to convert from a 3 to 15 psig (0.2 to 1.0 bar) to a 6 to 30 psig (0.4 to 2.0 bar) output signal range or vice versa. When changing output signal, also be sure to change supply pressure. Supply pressure should be 20 psig (1.4 bar) for a 3 to 15 psig (0.2 to 1.0 bar) output signal range and 35 psig (2.4 bar) for a 6 to 30 psig (0.4 to 2.0 bar) output signal range.

Key numbers used in this procedure are shown in figure 16 except where indicated.

Note

If the controller sub-assembly is to be replaced, perform steps 1 through 3 and 7, 8, and 10.

1. Shut off supply pressure to the controller and remove the temperature bulb from the process.

2. Open the cover. Remove machine screws (key 73 and 74, figure 16; key 31, figure 15). Remove machine screw (key 77) that holds link (key 42) in place; take care not to lose the bearing. Lift the Bourdon tube and process temperature gauge (these are part of the thermal element assembly) away from the case, withdrawing the capillary tube and temperature bulb through the opening in the rear of the case.

3. Disconnect tubing from bellows frame (key 49) and calibration adjuster (key 55). Remove machine screws (key 28, figure 12) and remove the sub-assembly from the case.

4. Unscrew machine screws (key 50) from each end of the bellows frame (key 49).

5. Compress the bellows so that the end of the bellows and beam can be removed from the end of the bellows frame and unscrewed from the stud that connects the bellows.

6. With the stud that connects the two bellows in place in the spacer (key 52), screw the new bellows onto the stud. Install new gaskets (key 38) on each bellows. Compress the bellows and install the end of the bellows into the recesses in the bellows frame. With the beam parallel with the mounting plate (key 32), secure bellows frame with machine screws (key 50).

7. Replace sub-assembly in the case and secure with machine screws (key 28, figure 12). Re-connect all tubing. Refer to figure 10 for proper tubing connections.

8. Install the thermal element by feeding the temperature bulb and capillary tube through the opening at the rear of the case so that the bulb and tube protrude from the rear of the case. Position the Bourdon tube and process temperature gauge and install and tighten machine screws (key 73 and 74, figure 16; key 31, figure 15). Install the connecting link (key 42) with machine screw (key 77). If the beam is not horizontal or the link in tension, adjust by bending the cross springs (key 53) slightly.

9. Unscrew output gauge (key 13) and install new gauge with correct range.

10. Proceed to "Calibration" section.

Reset Restriction Valve Repair (Types 4166 or 4166F only)

Unless otherwise noted, key numbers refer to figure 19.

Removal and Disassembly

1. Remove the three pieces of tubing (keys 36 and 165, figure 15) from the reset restriction valve.

2. At the back of the case, remove the machine screw that is directly behind the reset valve. Lift the valve out of the case.

3. Remove machine screw (key 255) from the valve and remove the knob (key 163).

4. Gently pry up the fingers of the spring retainer (key 254) that is held between the detent under one of the four lugs on the valve body (key 251) and rotate the retainer until it clears all four lugs. Then remove the retainer.

5. Remove the scratch valve (key 253), plate (key 252) and O-rings (key 171).

6. Carefully clean the polished surfaces of the scratch valve and plate with a solvent. Inspect the O-rings and replace if necessary.

CAUTION

When cleaning the scratch valve and plate, take care not to scratch the polished surfaces.

Assembly and Installation

1. Replace the O-rings (key 171).

CAUTION

When replacing the plate (key 252) in the following step, ensure that the polished side faces up.

2. Replace the plate and the scratch valve (key 253) in the body (key 251).

3. Push the spring retainer (key 254) over the body and rotate until the retainer is secured on all four lugs.

4. Replace the knob (key 163) and the machine screw (key 255).

5. Place the reset valve inside the case and align the hole in the end of the valve body with the hole in the back of the case. Secure the body with the machine screw.

6. Replace the tubing (keys 36 and 165, figure 15) to the reset valve.

Relay Repair

Relay Replacement

Key numbers used in this procedure are shown in figure 12 except where indicated.

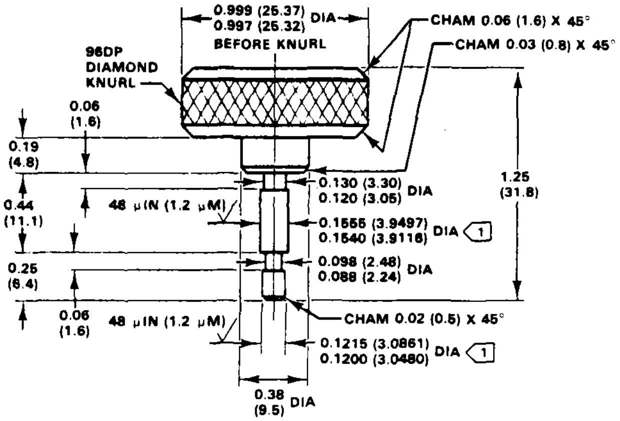
1. Shut off supply pressure line to the controller.

2. Open the cover and disconnect tubing (key 35) from the relay.

3. Unscrew the output gauge (key 13).

4. To remove the relay assembly, unscrew two machine screws located behind the relay on the back of the case.

5. Remove the relay gasket (key 7).



1 THESE DIAMETERS MUST BE CONCENTRIC WITHIN 0.001 INCHES (0.025 MILLIMETERS).

INCH
(mm)

Figure 11. Relay Alignment Tool (Part Number 15A3519 X012)

6. The relay may now be disassembled for cleaning or parts replacement, or a new relay may be installed as a replacement. Refer to the instructions below for relay disassembly. If a new relay is being installed, continue with the next step.

7. Attach the replacement relay and new relay gasket with machine screws inserted through the back of the case. Reinstall the output gauge. Proceed to the "Calibration" section.

Relay Disassembly

Although the alignment tool shown in figure 11 is not required for assembly of the relay, use of the tool will prevent excessive air consumption and dead band. If low air consumption and minimum dead band are required, make or purchase the alignment tool before disassembling the relay. Key numbers used in the following procedure are shown in figure 17 for standard relays and in figure 18 for high-temperature relays except where indicated.

1. Remove relay from the controller or transmitter case by following steps 1 through 5 of the "Relay Replacement" section.

2. Unscrew the orifice assembly (key 88). Remove the O-ring (key 90) from the orifice assembly.

3. Unscrew and remove machine screws (key 96) and, for standard relays, the washers (key 98).

4. Remove the casing assembly (key 85), diaphragm (key 91), and, for high-temperature relays, the gasket (key 100).

5. Remove spacer ring, diaphragm assembly, and relay spring (keys 84, 86, and 92). For high-temperature relays, also remove gasket (key 99).

6. Unscrew machine screws (key 97) and remove spring plate, gasket, spring, and valve plug (keys 95, 94, 93 and 87).

7. Use the following steps to assemble the relay.

Relay Assembly

Key numbers used in this procedure are shown in figure 17 for standard relays and in figure 18 for high-temperature relays.

1. Inspect the diaphragms and gaskets; furnish new parts as needed. The diaphragm assembly (key 86) must be replaced as an assembly. Furnish a new valve plug (key 87) and springs (keys 92 and 93) if these parts are corroded. Inspect valve seats. One seat is located in the diaphragm assembly (key 86), and the other seat is located in the relay body (key 83). Replace diaphragm assembly or relay body if necessary.

2. Clean all parts, including the primary restriction (key 88), thoroughly.

3. For high-temperature relays, install gasket (key 99) on the relay body (key 83). Be sure the hole in the gasket is in line with the flow passage in the relay body.

4. Install spring (key 92) into the relay body. Install diaphragm assembly, spacer, and diaphgram (keys 86, 84, and 91) onto the relay body. For high-temperature relays, also install gasket (key 100). Be certain all flow passages line up with the flow passage in the relay body.

5. Install the relay casing (key 85) such that the flow passage into the casing will be in line with the flow passage through the diaphragms, spacer ring, and relay body and that the lugs on the casing, spacer, and body will be in line.

6. Install screws (key 96) and, for standard relays, washers (key 98) but do not tighten the screws.

7. If an optional alignment tool (figure 11) is to be used, insert the smaller end of the tool into the opening in the relay body. If the tool does not engage the hole in the diaphragm assembly, move the relay parts slightly to reposition the diaphragm assembly so that the alignment tool engages the hole in the diaphragm assembly. Do not remove the alignment tool until the relay screws have been tightened.

8. Tighten the relay screws (key 96) evenly. Remove alignment tool if one was used.

9. Install valve plug, spring, gasket, and cover plate (keys 87, 93, 94, and 95). Secure with machine screws (key 97).

10. Install O-ring (key 90) on the restriction assembly (key 88). Install restriction assembly into the relay casing.

11. Attach the relay assembly and a new relay gasket (key 7, figure 12) with machine screws inserted through the back of the controller or transmitter case. Re-install the output or supply gauge.

12. Proceed to the "Calibration" section.

PARTS ORDERING

Whenever corresponding with the sales representative about this equipment, mention the serial number of the unit. The serial number can be found on the nameplate (key 22, figure 12). When ordering replacement parts, also state the complete eleven-character part number of each part required as found in the following parts list.

PARTS LIST

4156 and 4166 Series Controllers

Key	Description	Part Number
	Proportional Band and Span Adjustment Assembly†	10A9122 X032
	Controller Sub-Assembly	
	Brass Bellows:	
	3 to 15 psig (0.2 to 1 bar)	25A5660 X0A2
	6 to 30 psig (0.4 to 2 bar)	25A5660 X0B2
	SST Bellows:	
	3 to 15 psig (0.2 to 1 bar)	25A5660 X0C2
	6 to 30 psig (0.4 to 2 bar)	25A5660 X0D2
1	Case, aluminum	
	4156, 4156S & 4166	4H2699 08012
	4156 w/remote set	1H3802 08012
	4166 F	1U5774 08012
2	Cover, aluminum	4H2684 08012
4	Relay Base, zinc	3H2885 44012
5*	Relay Base Gasket, neoprene	1H2887 03012
7*	Relay Gasket, neoprene	1C8974 03012
10*	Gasket, neoprene	1C3286 03012
13	Output Gauge	
	0-30 psig	12A5447 X012
	0-60 psig	12A5449 X012
	0-2 kg/cm^2	12A5452 X012
	0-4 kg/cm^2	12A5453 X012
	0-200 kPa	12A4791 X012
	0-400 kPa	12A4797 X012

*Recommended spare part.

†Available as an assembly only; included parts not available separately.

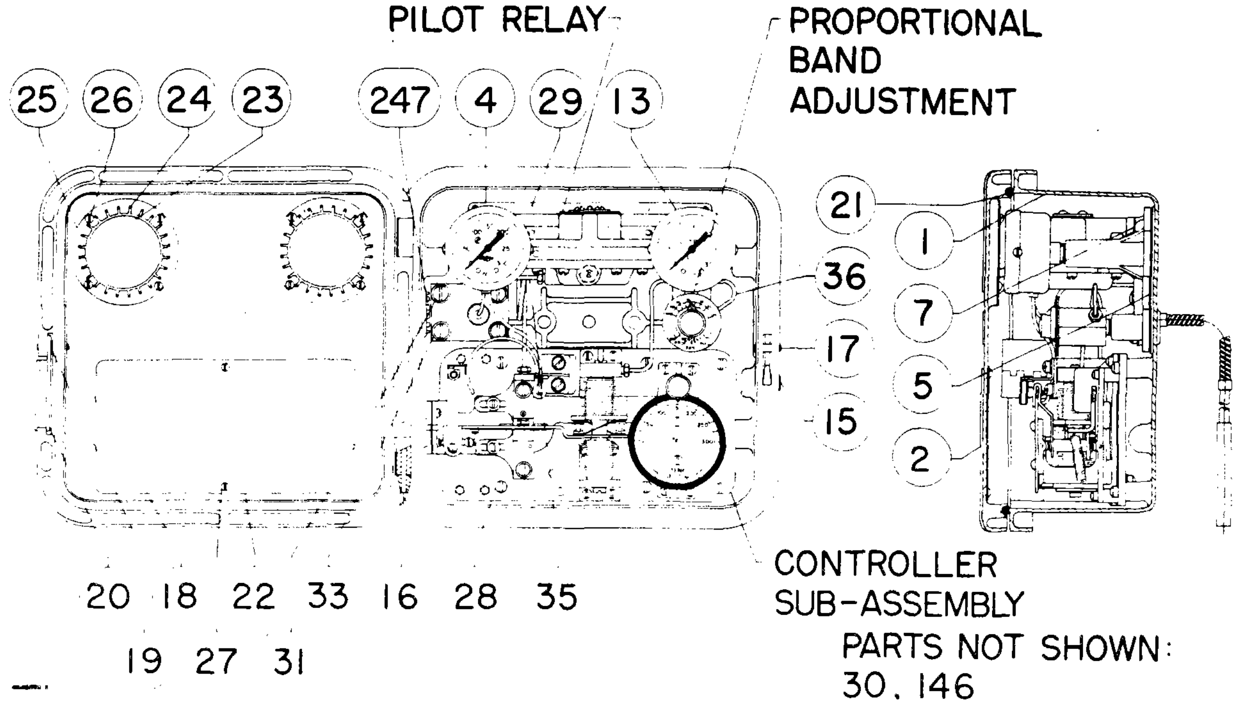


Figure 12. Proportional Controller Assembly

Key	Description	Part Number
	Dual scale	
	0-30 psig & 0-200 kPa	13A6016 X012
	0-60 psig & 0-400 kPa	13A6018 X012
15	Vent Ass'y	EMY602X1-A12
16	Roll Pin, SST (2 req'd)	1H2888 28992
17	Groove Pin, steel Zn pl	1H2890 28992
18	Groove Pin, steel Zn pl	1H2891 28992
19	Spring Washer, steel pl	1H2889 28982
20	Cover Latch, steel Cd pl	1H2886 28982
21*	Cover Gasket, nitrile	1J4075 06432
22	Instruction Plate, aluminum	
	For psig	15A5683 X012
	For kPa	15A5686 X012
	For kg/cm^2	15A5685 X012
23	Gauge Glass (2 req'd)	0T0192 06042
24	Gasket, noeprene (2 req'd)	0T0191 04082
25	Retaining Ring, steel Cd pl (2 req'd)	1A4658 28992
26	Machine Screw, steel pl (8 req'd)	1A5120 28982
27	Self Tapping Screw, steel pl (2 req'd)	1C9419 28982
28	Machine Screw, steel pl (6 req'd)	1A3321 28982
29	Machine Screw, steel pl (17 req'd)	1H5269 28982
30	Machine Screw, steel pl (2 req'd) (not shown)	1H5271 28982
31	Machine Screw, steel pl (4 req'd)	1A6849 28992
32	Mounting Plate, steel (not shown)	2H2651 25012
33	Lockwasher, steel pl (4 req'd)	1C2256 28982
35	Relay Tubing Ass'y	
	Copper	1H2759 000A2
	SST	1H6861 000A2
36	Compensator Tubing Ass'y	
	Type 4156	
	Copper	1H2753 000A2
	SST	1H6864 000A2
	Type 4166	
	Copper	1H2757 000A2
	SST	1H6870 000A2
37*	Mounting Plate Gasket, neoprene (not shown)	1H2654 03012
38*	Gasket, neoprene (2 req'd)	1D3970 03012
41	Bellows Ass'y	
	Types 4156 & 4156S	
	Brass	
	3-15 psig (0.2—1.0 bar)	14A5726 X012
	6-30 psig (0.4—2.0 bar)	14A5726 X032
	SST	
	3-15 psig (0.2—1.0 bar)	14A5726 X022
	6-30 psig (0.4—2.0 bar)	14A5726 X042
	Types 4166 & 4166F	
	Brass	
	3-15 psig (0.2—1.0 bar)	14A5725 X012
	6-30 psig (0.4—2.0 bar)	14A5726 X052
	SST	
	3-15 psig (0.2—1.0 bar	14A5725 X022
	6-30 psig (0.4—2.0 bar)	14A5726 X062
42	Connecting Link, SST	15A5688 X012
43	Machine Screw, steel pl (4 req'd)	1C8969 28982
44*	O-Ring, nitrile	1E2226 06992
45	Link Bearing, 440 SST HT (2 req'd)	1L3795 46202
46	Mounting Bracket, aluminum	25A5695 X012
47	Pressure Adjustment Spacer, aluminum (2 req'd) (not shown)	1H2652 24092
48	Rotary Shaft Spring, SST (not shown)	1J4234 37022
49	Bellows Frame, aluminum	2H2653 08012
50	Bellows Screw, steel Cd pl (2 req'd)	1D3976 14022
51	Bellows Stud, brass (not shown)	1H2658 14012
52	Spacer, zinc	1H2659 44012

*Recommended spare part.

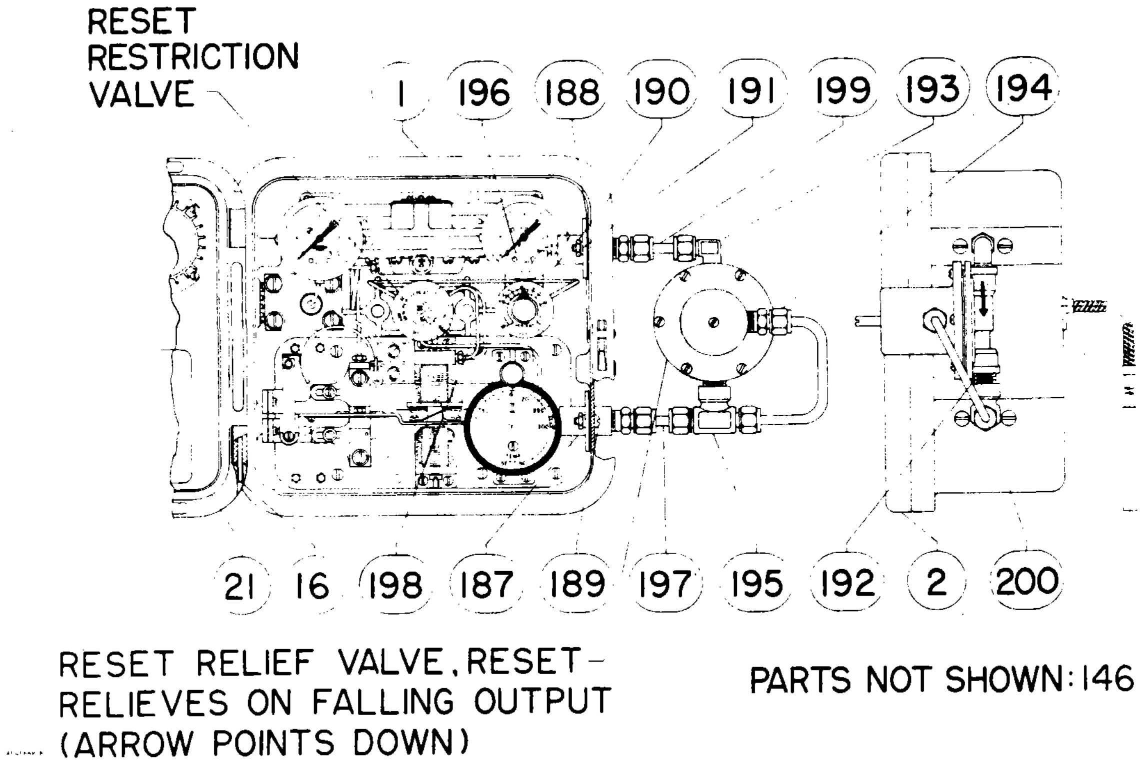


Figure 13. Proportional-Plus-Reset Controller With Differential Relief Valve

Key	Description	Part Number
53	Cross Spring, SST (2 req'd)	1H2660 37032
54	Pressure Set Arm, steel Cd pl	1H2661 25072
55	Calibration Adjustor, zinc	2H2662 44012
56	Reversing Block Ass'y, alum/SST	14A5743 X012
57*	O-Ring, nitrile (3 req'd)	1D6875 06992
58	Set Screw, steel pl	1H2666 28982
59	Nozzle, 416 SST	1U6391 35132
60	Beam, steel Cd pl	1H2668 25072
61	Flapper, Invar†	1H2669 41132
62	Flexure Strip Base, steel Cd pl	1C8977 25082
63	Flexure Strip, 302 SST spring temp	1C8978 36012
64	Flexure Strip Nut, steel Cd pl (2 req'd)	1C8975 25082
65	Washer, steel (2 req'd)	1E8730 28992
66	Washer, steel pl (4 req'd)	1H2671 28982
67	Washer, steel pl (4 req'd)	1H2672 28982
68	Machine Screw, steel pl	1B2751 28992
69	Machine Screw, steel pl (4 req'd)	1C8990 28982
70	Machine Screw, steel pl (8 req'd)	1A5733 28982
71*	Sealing Screw, 416 SST	14A5721 X012
72	Reversing Block Screw, 416 SST	24A5720 X012
74	Machine Screw, steel pl (4 req'd)	1H2676 28982
75	Machine Screw, steel pl (4 req'd)	1H2678 28982
76	Machine Screw, steel pl (4 req'd)	1B2776 28992
77	Machine Screw, steel pl (2 req'd)	1A3319 28982
78	Adjustment Frame, zinc (not shown)	2C8957 44012
79	Adjustment Shaft Ass'y (not shown)	1H2681 000A2
80	Bearing Pin, brass (2 req'd) (not shown)	1C9131 14012
81	Machine Screw, steel pl (2 req'd) (not shown)	1A5120 28982

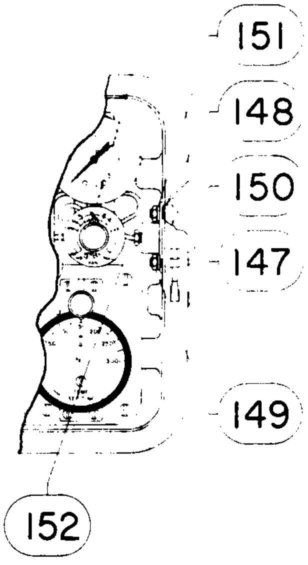


Figure 14. Parts Required for Remote Setpoint Adjustment

*Recommended spare part
† Trademark of Carpenter Technology Corp

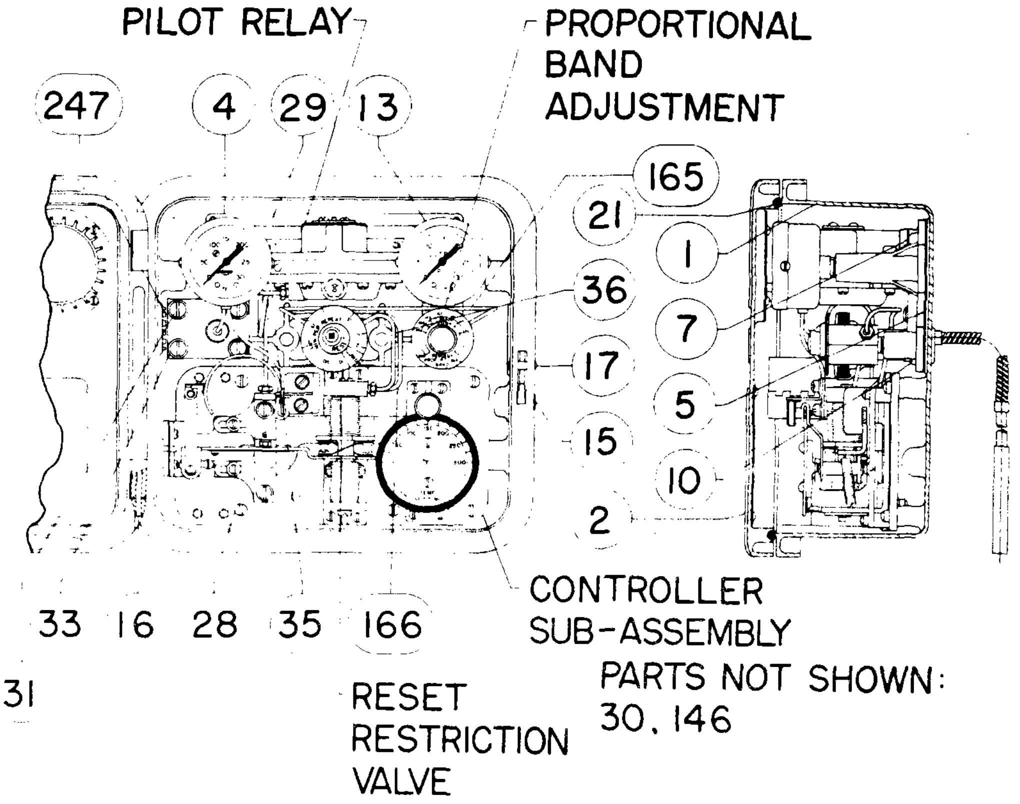
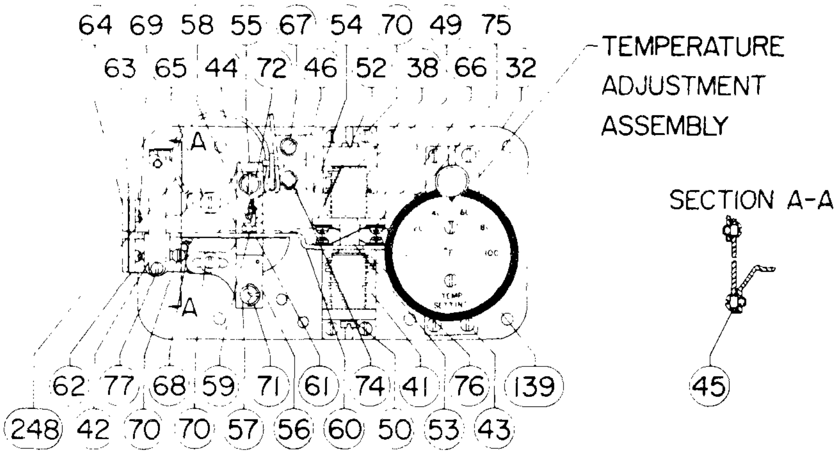


Figure 15. Proportional-Reset Controller



PARTS NOT SHOWN:
37, 47, 48 & 51

Figure 16. Controller Sub-assembly

Key	Description	Part Number
82	Set Screw, steel (2 req'd) (not shown)	1B4556 28992
139	Dial, aluminum	
	0-100°F	15A5670 X012
	50-150°F	15A5677 X012
	0-200°F	15A5671 X012
	50-200°F	15A5678 X012
	100-200°F	15A5680 X012
	50-250°F	15A5679 X012
	0-300°F	15A5672 X012
	100-300°F	15A5681 X012
	0-400°F	15A5673 X012
	200-400°F	15A5682 X012
	0-600°F	15A5674 X012
	0-800°F	15A5675 X012
	0-1000°F	15A5676 X012
146	Pipe Plug, steel pl (not shown)	1E8231 28982
147	Connection, brass (Type 4156 w/remote set only)	1H3803 14012
148*	Gasket, neoprene (Type 4156 w/remote set only)	1H3804 03012
149	Nut, steel pl (2 req'd) (Type 4156 w/remote set only)	1A8396 28982
150	Screw, steel pl (2 req'd) Type 4156 w/remote set only)	1A6370 28982

*Recommended spare part

Key	Description	Part Number
151	Lockwasher, steel pl (2 req'd) (Type 4156 w/remote set only)	1H2672 28982
152	Remote Tubing Ass'y	
	Copper	1H3805 000A2
	SST	1H6872 X00A2
165	Reset Tubing Ass'y (Types 4166 & 4166F)	
	Copper	1H2966 000A2
	SST	1H6866 000A2
166	Compensator Tubing Ass'y (Types 4166 & 4166F)	
	Copper	1H2755 000A2
	SST	1H6868 000A2

Note

Key Nos. 187 thru 200 are for Type 4166F only.

Key	Description	Part Number
187	Connection, brass (2 req'd)	1H3803 14012
188*	Gasket, neoprene (2 req'd)	1H3804 03012
189	Machine Screw, steel pl (4 req'd)	1A6370 28982
190	Hex Nut, steel pl (4 req'd)	1A8396 28982
191	Lockwasher, steel pl (4 req'd)	1H2672 28982
192	Pipe Nipple, brass	1B6782 18992
193	Elbow, brass	1J3936 18992
194	Connector, brass (3 req'd)	1J2309 18992
195	Tee, brass	1U5780 18992
196	Tubing Ass'y	1U5779 X00A2
197	Connector Tubing, copper	1U5782 17012
198	Tubing Ass'y, copper	1U5776 X00A2
199	Reset Tubing, copper	1U5781 17012
200	Equalizer Tubing, copper	1U5783 17012
247	Diaphragm Button Plug, steel pl	1K1631 24152
248	Temperature Element	See following table

Relay Assembly

Key	Description	Part Number
	Relay Assembly (for included parts, see following list)	
	Standard	10A9095 X0A2
	SST trim	10A9095 X022
83	Relay Body	
	Zinc/brass (std)	2H2693 000B2
	Zinc/SST	2H2693 X0012
84	Spacer Ring, zinc	2K4404 44012
85	Diaphragm Casing Ass'y	
	Zinc/steel	1C9369 000A2
86*	Diaphragm Ass'y	
	Std	1C9370 000A2
	SST trim	1C9370 X0032
87	Valve plug	
	Brass	0Y0617 14012
	SST	0Y0617 X0022
88*	Orifice Ass'y, alum/sapphire	1H8264 000A2
89	Core Ass'y	1E2303 000A2
90	O-Ring, nitrile	1D6875 06992
91*	Top Diaphragm, nitrile	1L5556 02042
92	Relay Spring, steel Cd pl	1C8961 27012
93	Valve Spring, SST	0X0836 37022
94*	Plate Gasket, neoprene	1H2696 03012
95	Spring Plate, steel Cd pl	1H2697 25072
96	Machine Screw, steel pl (6 req'd)	1H3294 28992
97	Machine Screw, steel pl (4 req'd)	1A3319 28982
98	Washer, steel pl (6 req'd)	1P8261 28982

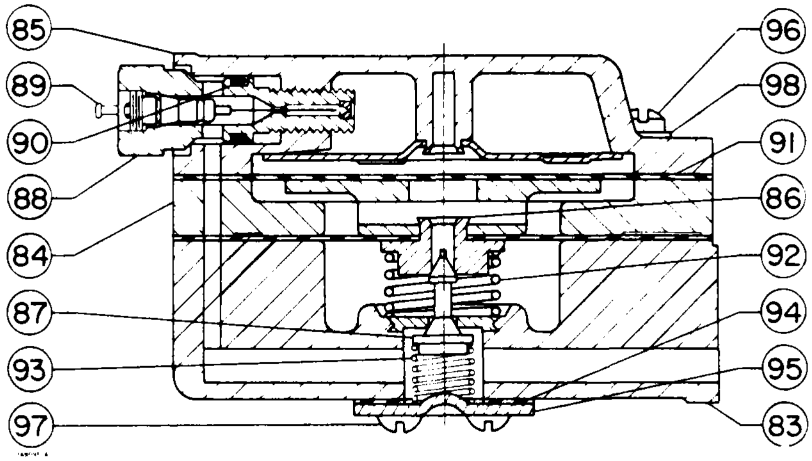


Figure 17. Standard Relay Assembly

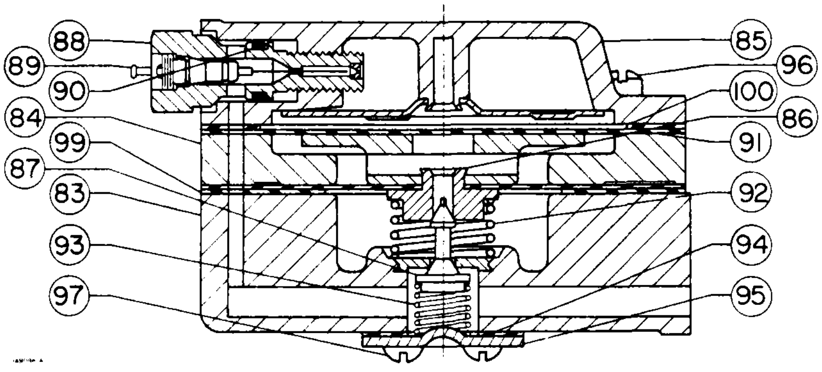


Figure 18. High-Temperature Relay Assembly

Reset Restriction Valve Assembly

Key	Description	Part Number
	Assembly (for included parts available see following list)	
	Standard (4166)	15A8138 X012
	Standard (4166F)	15A8140 X012
	High Temperature (4166)	15A8138 X022
	High Temperature (4166F)	15A8140 X012
162	Machine Screw	1H5270 28982
163	Knob	35A8130 X012
171*	O-Ring	15A8133 X012
251	Body	
	Type 4166	25A8125 X012
	Type 4166F	25A8126 X012
252	Valve Plate	15A8127 X012
253	Scratch Valve	35A8128 X012
254	Retainer Spring	35A8129 X012
255	Machine Screw	15A8131 X012

*Recommended spare part.

Pipestand Mounting Parts

Key	Description	Part Number
213	Mounting Plate, steel	3N9757 25092
215	Machine Screw, steel pl (2 req'd)	1C6392 28982
216	Hex Nut, steel (2 req'd)	1C3328 28982
221	Lockwasher, steel (2 req'd)	1C2257 28982
228	Spacer Spool, steel (2 req'd)	1C5590 24092
250	Clamp, steel (2 req'd)	1P4270 28982
251	Bracket Ass'y, steel (2 req'd)	1H2892 000A2
252	Cap Screws, steel pl (4 req'd)	1B8480 24052
249	Bushing,	
	No lag extension	
	3/8-In. (10 mm) bulb diameter	
	Brass ENC	25A5707 X022
	316 SST	25A5707 X012
	9/16-In. (14 mm) bulb diameter	
	316 SST	25A5705 X012
	3-In. (76 mm) lag extension	
	3/8-In. (10 mm) bulb diameter	
	Brass ENC	25A5708 X022
	316 SST	25A5708 X012
	9/16-In. (14 mm) bulb diameter	
	316 SST	25A5706 X012
250	Thermowells	See following tables

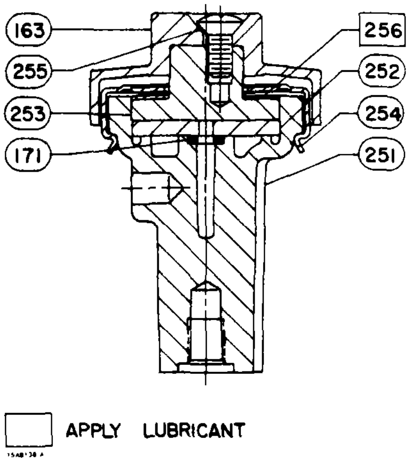


Figure 19. Reset Restriction Valve Assembly

4156 & 4166 Series

Key 250, Thermowell for 3/8-inch (10 mm) Temperature Bulb

MATERIAL	NO LAG EXTENSION			3 IN. (76.2 mm) LAG EXTENSION		
	7-1/2 In. (191 mm)	10-1/2 In. (267 mm)	16 In. (406 mm)	7-1/2 In. (191 mm)	10-1/2 In. (267 mm)	16 In. (406 mm)
1/2 In. NPT						
Brass	25A7358 X022	25A7358 X042	25A7358 X062	25A7359 X022	25A7359 X042	25A7359 X062
316 SST	25A7358 X012	25A7358 X032	25A7358 X052	25A7359 X012	25A7359 X032	25A7359 X052
C-1018 Stl.	25A7358 X072	25A7358 X102	25A7358 X132	25A7359 X072	25A7359 X102	25A7359 X132
304 SST	25A7358 X082	25A7358 X112	25A7358 X142	25A7359 X082	25A7359 X112	25A7359 X142
R-Monel	25A7358 X092	25A7358 X122	25A7358 X152	25A7359 X092	25A7359 X122	25A7359 X152
3/4 In. NPT						
Brass	25A7356 X022	25A7356 X042	25A7356 X062	25A7357 X022	25A7357 X042	25A7357 X062
316 SST	25A7356 X012	25A7356 X032	25A7356 X052	25A7357 X012	25A7357 X032	25A7357 X052
C-1018 Stl.	25A7356 X072	25A7356 X102	25A7356 X132	25A7357 X072	25A7357 X102	25A7357 X132
304 SST	25A7356 X082	25A7356 X112	25A7356 X142	25A7357 X082	25A7357 X112	25A7357 X142
R-Monel	25A7356 X092	25A7356 X122	25A7356 X152	25A7357 X092	25A7357 X122	25A7357 X152

Key 250, Thermowell for 9/16-Inch (14 mm) Temperature Bulb

MATERIAL	3/4 IN. NPT			
	7-1/2 In. (191 mm)	10-1/2 In. (267 mm)	16 In. (406 mm)	24 In. (559 mm)
No Lag Extension				
316 SST	...	25A7354 X012	25A7354 X022	25A7354 X032
C-1018 Stl.	...	25A7354 X042	25A7354 X072	25A7354 X102
304 SST	...	25A7354 X052	25A7354 X082	25A7354 X112
R-Monel	...	25A7354 X062	25A7354 X092	25A7354 X122
3 In. (76.2 mm) Lag Extension				
316 SST	25A7355 X012	25A7355 X022	25A7355 X032	25A7355 X042
C-1018 Stl.	25A7355 X052	25A7355 X082	25A7355 X112	25A7355 X142
304 SST	25A7357 X062	25A7355 X092	25A7355 X122	25A7355 X152
R-Monel	25A7355 X072	25A7355 X102	25A7355 X132	25A7355 X162

FISHER Controls

WORLDWIDE MANUFACTURING, SALES, SERVICE

Fisher Controls Company

Fisher Controls Company, Marshalltown, Iowa.

Key 248, Temperature Element

TEMP RANGE °F (°C)	CAPILLARY LENGTH		
	5 Ft. (1.5 M)	10 Ft. (3 M)	15 Ft. (4.5 M)
Plain Bulb			
0-100 (−18 to 44)	35A5692 X012	35A5692 X022	35A5692 X032
0-200 (−18 to 93)	35A5692 X042	35A5692 X052	35A5692 X062
0-300 (−18 to 149)	35A5692 X252	35A5692 X262	35A5692 X272
0-400 (−18 to 204)	35A5689 X012	35A5689 X022	35A5689 X032
0-600 (−18 to 316)	35A5689 X042	35A5689 X052	35A5689 X062
0-800 (−18 to 427)	35A5689 X072	35A5689 X082	35A5689 X092
0-1000 (−18 to 538)	35A5689 X012	35A5689 X112	35A5689 X122
50-150 (10 to 66)	35A5692 X072	35A5692 X082	35A5692 X092
50-200 (10 to 93)	35A5692 X102	35A5692 X112	35A5692 X122
50-250 (10 to 121)	35A5692 X132	35A5692 X142	35A5692 X152
100-200 (38 to 93)	35A5692 X162	35A5692 X172	35A5692 X182
100-300 (38 to 149)	35A5692 X192	35A5692 X202	35A5692 X212
200-400 (93 to 204)	35A5692 X222	35A5692 X232	35A5692 X242
Fixed Union Bulb			
0-100 (−18 to 43)	35A5693 X012	35A5693 X022	35A5693 X032
0-200 (−18 to 93)	35A5693 X042	35A5693 X052	35A5693 X062
0-300 (−18 to 149)	35A5693 X252	35A5693 X262	35A5693 X272
0-400 (−18 to 204)	35A5690 X012	35A5690 X022	35A5690 X032
0-600 (−18 to 316)	35A5690 X042	35A5690 X052	35A5690 X062
0-800 (−18 to 427)	35A5690 X072	35A5690 X082	35A5690 X092
0-1000 (−18 to 538)	35A5690 X102	35A5690 X112	35A5690 X122
50-150 (10 to 66)	35A5693 X072	35A5693 X082	35A5693 X092
50-200 (10 to 93)	35A5693 X012	35A5693 X112	35A5693 X122
50-250 (10 to 121)	35A5693 X132	35A5693 X142	35A5693 X152
100-200 (38 to 93)	35A5693 X162	35A5693 X172	35A5693 X182
100-300 (38 to 149)	35A5693 X192	35A5693 X202	35A5693 X212
200-400 (93 to 204)	35A5693 X222	35A5693 X232	35A5693 X242
Adjustable Union Bulb			
0-100 (−18 to 44)	35A5694 X012	35A5694 X022	35A5694 X032
0-200 (−18 to 93)	35A5694 X042	35A5694 X052	35A5694 X062
0-300 (−18 to 149)	35A5694 X252	35A5694 X262	35A5694 X272
0-400 (−18 to 204)	35A5691 X012	35A5691 X022	35A5691 X032
0-600 (−18 to 316)	35A5691 X042	35A5691 X052	35A5691 X062
0-800 (−18 to 427)	35A5691 X072	35A5691 X082	35A5691 X092
0-1000 (−18 to 538)	35A5691 X102	35A5691 X112	35A5691 X122
50-150 (10 to 66)	35A5694 X072	35A5694 X082	35A5694 X092
50-200 (10 to 93)	35A5694 X102	35A5694 X112	35A5694 X122
50-250 (10 to 121)	35A5694 X132	35A5694 X142	35A5694 X152
100-200 (38 to 93)	35A5694 X162	35A5694 X172	35A5694 X182
100-300 (38 to 149)	35A5694 X192	35A5694 X202	35A5694 X212
200-400 (93 to 204)	35A5694 X222	35A5694 X232	35A5694 X242

REF 1A995

Bingham-Willamette Company
A DIVISION OF GUY F. ATKINSON COMPANY

DATE: 11-25-81

PORTLAND, OREGON

INSTRUCTION MANUAL SUPPLEMENTS

CUSTOMER: STEARNS-ROGER ENGINEERING CORPORATION

PURCHASE ORDER NO.: 2000 C21700

REPLACE	CONTENTS (2 of 2) 6-4-81	WITH CONTENTS (2 of 2) 11-25-81	
ADD	TEMPERATURE CONTROLLERS II FISHER		FORM 5115

CONTENTS
(2 of 2)

VENDOR INFORMATION CONTINUED

1.2.36 BCS Fluid Receiver Pump

1.2.36.1 Identification

Tag Number	Description
P-201	BSC Fluid Receiver Pump with Tag No.s E-201 & 202 Heat Exchangers Included

1.2.36.2 Description

Pump 201

Manufacturer:	Aurora Pump Aurora, Illinois 60542
Part Number:	Model 134, 04 Series

Motor

Manufacturer:	Marathon Electric Wausau, WI 54401
Part Number:	1/2 H.P. Induction Motor, Frame 56

Heat Exchanger

Manufacturer:	Young Radiator Co. Racine, Wisconsin 53404
Part Number:	OCH-41

1.2.36.3 Vendor

DECO Engineering Products, Inc.
Des Moines, IA

1.2.36.4 Procurement Specification

DOE Spec 40M700-6S, CP 9

1.2.36.5 Piping Connection

DOE Dwg No. 40P2005131901, CP 9

1.2.36.6 Operation/Maintenance

See Aurora Pump Manual, Section 6
and Young Type "OCH" Oil Coolers
Installation and Maintenance Instruction (following)

Solar I Power Plant
Daggett, CA.
Spec. JD 40.140-1
Waldinger Corp. CM-0100-059

AURORA® PUMPS

INSTRUCTION MANUAL
REPAIR
MODEL 134-135 (04-05 SERIES)

6

SERVICE

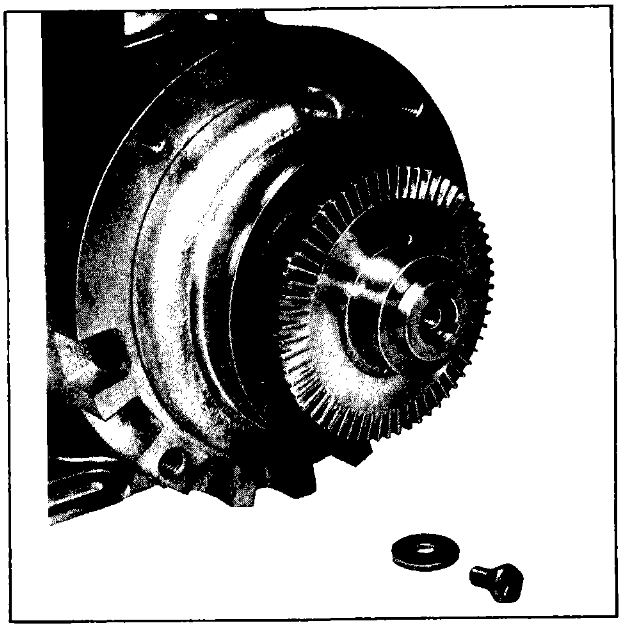
Your Aurora pump requires no maintenance other than periodic inspection and occasional cleaning. The intent of inspection is to prevent breakdown, thus obtaining optimum service life. The pump is lubricated by the liquid being pumped and therefore does not require periodic lubrication. The motor, however may require lubrication, in which case, the motor manufacturer's recommendation should be followed.

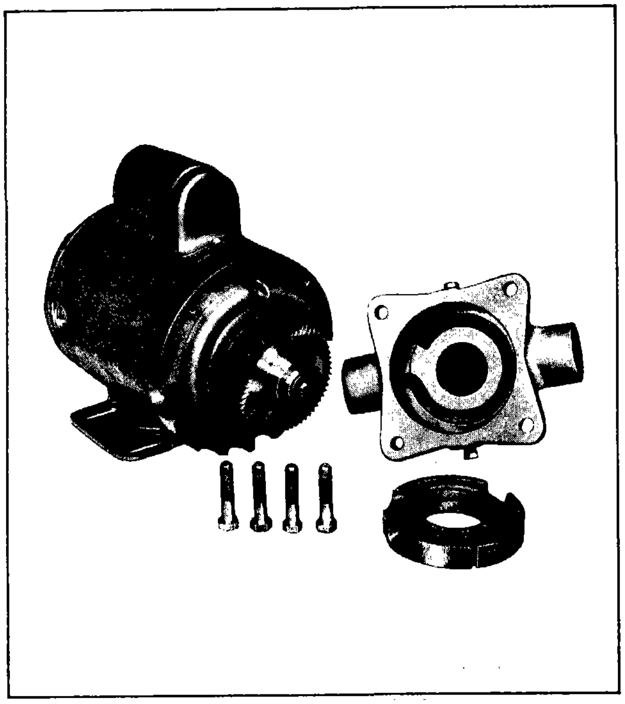
REPAIRS

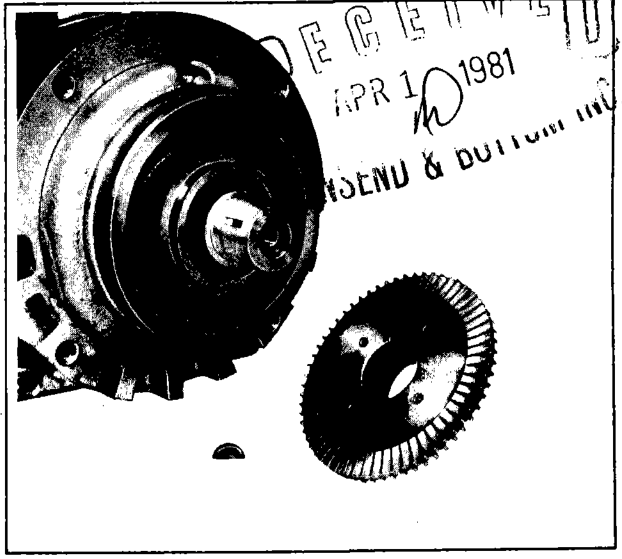
The pump may be disassembled using the illustrations and text provided. Although complete disassembly is covered, it will seldom be necessary to completely disassemble your Aurora pump.

The illustrations accompanying the disassembly instructions show the pump at various stages of disassembly. The illustrations are intended to aid in the correct identification of the parts mentioned in the text.

Inspect removed parts at disassembly to determine their reusability. Cracked castings should never be reused. All packing and gaskets should be replaced with new ones at reassembly simply as a matter of economy; they are much less expensive to replace routinely than to replace as the need occurs. In general it is economical to return to the manufacturer for repair only the motor and motor controller.


Impeller screw and washer removed.


Pump casing and outer ring removed.


Impeller and key removed.

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AURORA, ILLINOIS

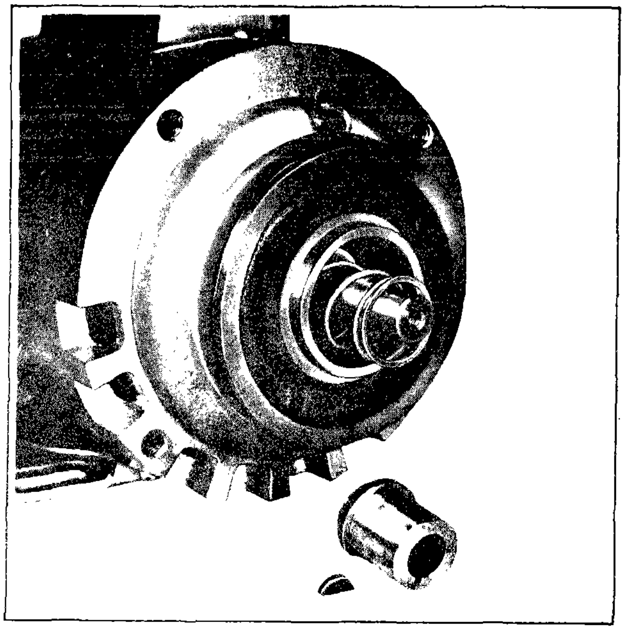
Disassembly. Disassemble only what is needed to make repairs or accomplish inspection.

Disassembling the Model 134 and 135 pumps (See Figure 3).

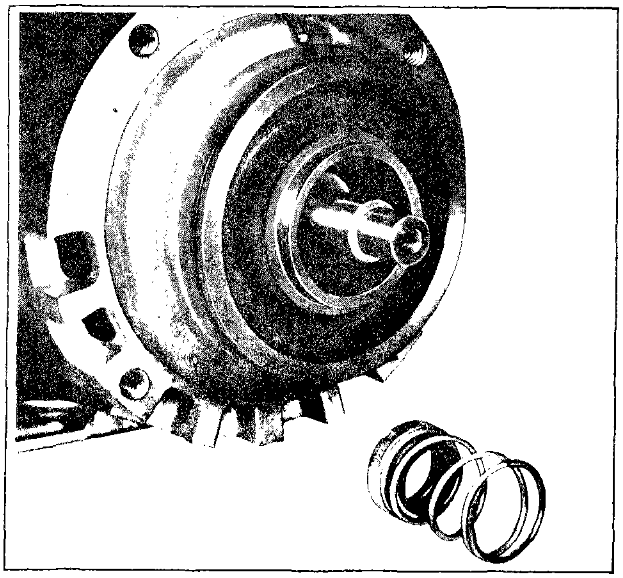
1. Remove the four screws (2) and separate the casing (6) from the motor bracket (19, 20).

2. Remove the two plugs (3), screws (4), and nameplate (5) only if replacement is necessary. Remove pin (15).

3. Remove outer ring (7).



Sleeve and key removed from shaft.



Mechanical seal and spring removed.

4. Remove screw (8) and washer (9) and remove impeller (10) with key (13) from impeller sleeve.

5. Remove impeller sleeve (12) with key (11) from shaft.

6. Carefully remove the mechanical seal (14). The stationary portion of the seal may be removed in Step 9.

CAUTION

The mechanical seal (see Figure 1) is a precision product and must be treated as such. During removal great care must be taken to avoid dropping any part of the seal. Take particular care not to scratch the lapped faces on the washer or the sealing seat. Do not put a seal back into service until the sealing faces of the washer and seat have been relapped or replaced.

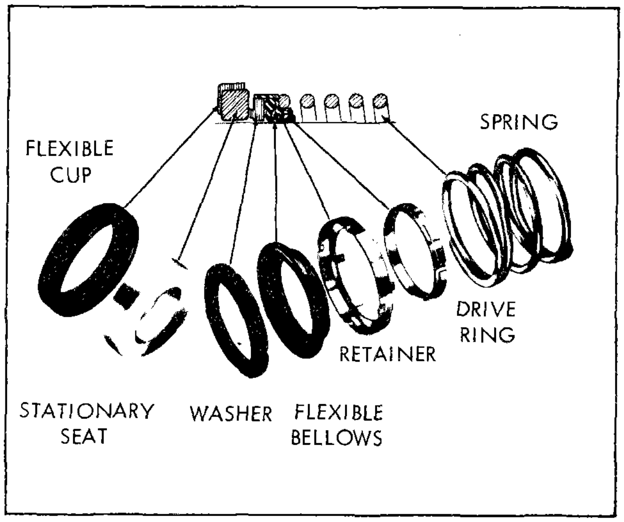


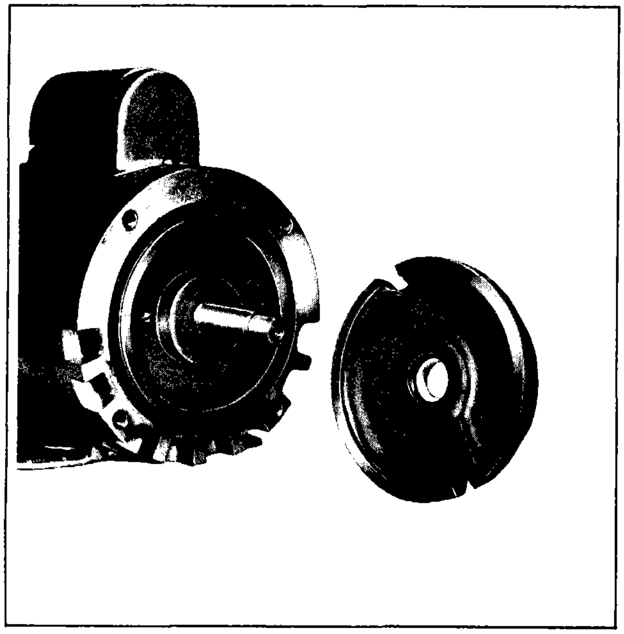
Figure 1. Mechanical Seal

7. Remove inner ring (16).

8. Gasket (17) may be removed from bracket if replacement is necessary.

9. Remove the four screws (18) (Model 135, 1-1/8 inch shaft only). Motor bracket with stationary portion of seal may now be removed by applying a steady force separating bracket and motor.

Reassembly. Clean and inspect all parts thoroughly prior to reassembly. Replace gasket. Check that all mating surfaces are free of nicks and burrs.



Bracket removed.

Inspect the impeller hub carefully for signs of excessive wear. Proceed to reassemble the pump as follows: (See Figure 3)

1. Position the motor bracket (19, 20) on the motor and secure with screws (18). Tighten screws evenly. (Screws used on 135 Series, 1-1/8 inch shaft only).

2. Attach nameplate (5) with screws (4), and replace plugs (3) if these were removed.

NOTE

> The mechanical seal (14) cannot be installed as an assembly; the seal seat must be properly in place before the balance of parts can be added.

3. Thoroughly inspect the seal cavity in the motor bracket, checking for burrs or nicks which could damage the seat of the mechanical seal (14). Apply a film of liquid dishwashing detergent to the seal seat and install, taking care to seat it evenly and squarely.

NOTE

> If it is not possible to insert seat with fingers, place cardboard protecting ring, furnished with seal, over lapped face of seat and press into place with a piece of tubing having end cut square. Tubing should be slightly larger than the diameter of the shaft. Remove cardboard ring after the seat has been firmly seated.

4. Apply a film of liquid dishwashing detergent to allow remaining seal parts to be pushed onto shaft. Check the proper sequence of assembly as shown in Figure 1.

5. Position gasket (17) on the motor bracket (19, 20) and gradually slip into its groove.

6. Install inner ring (16).

7. Replace shaft key (11) and impeller sleeve (12). Be sure spring of mechanical seal is properly positioned on back side of impeller sleeve.

8. Slip on impeller (10). Line up impeller keyway with key (13) so that key is not pushed out of keyway when the impeller is replaced. Secure impeller with washer (9) and screw (8).

9. Place the pin (15) and outer ring (7) in casing (6); slide casing into position over motor bracket (19, 20) being careful not to damage gasket (17).

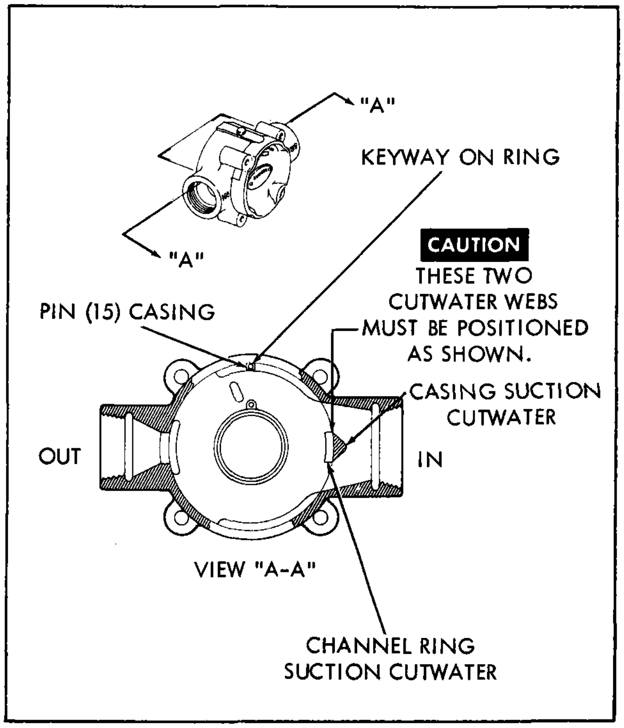


Figure 2. Model 134-135 Installing Inner and Outer Rings in Casing

Attach casing with screws (2). (See Figure 2 for proper positioning of inner and outer rings in casing.)

10. Replace pipe plug (3), and install nameplate (5) and attach with screws (4), if these were removed.

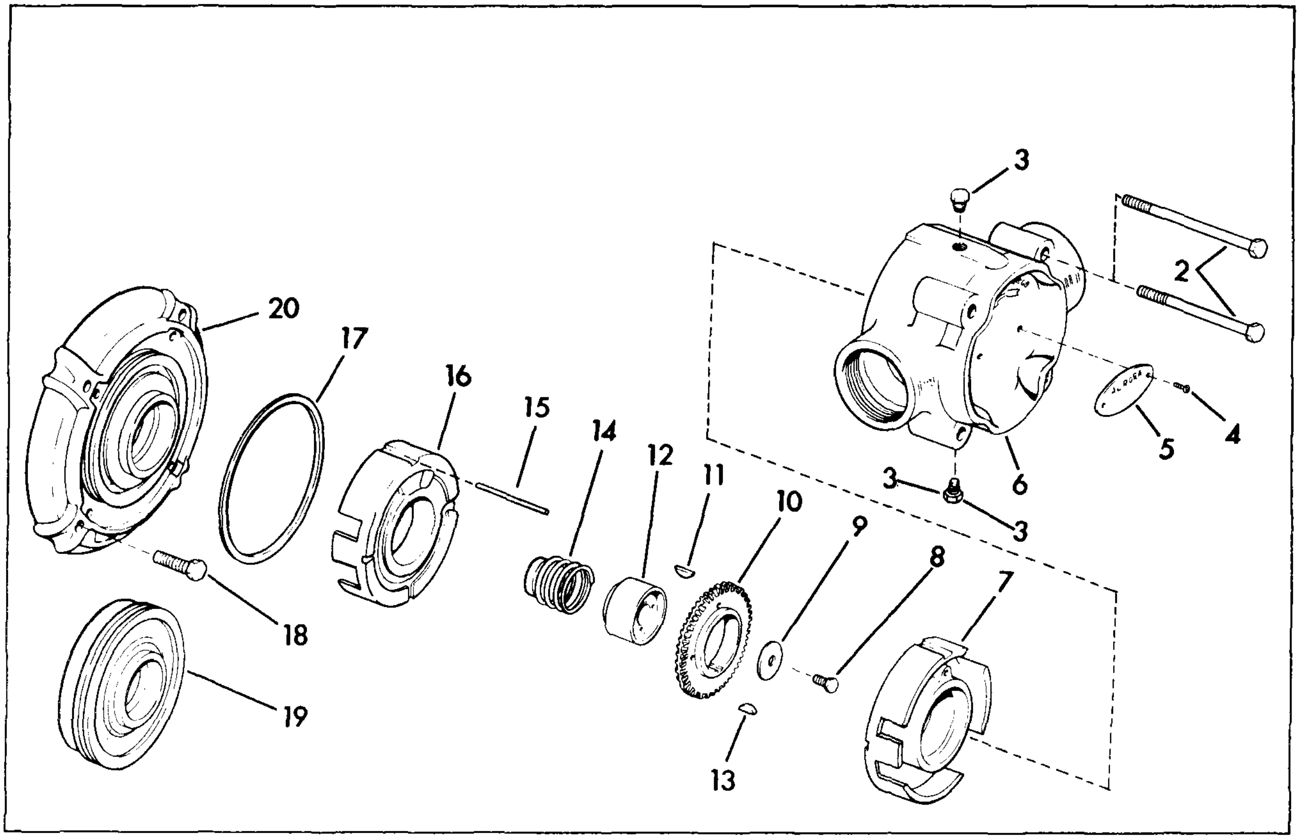


Figure 3. 134 and 135 Series Pump Exploded View

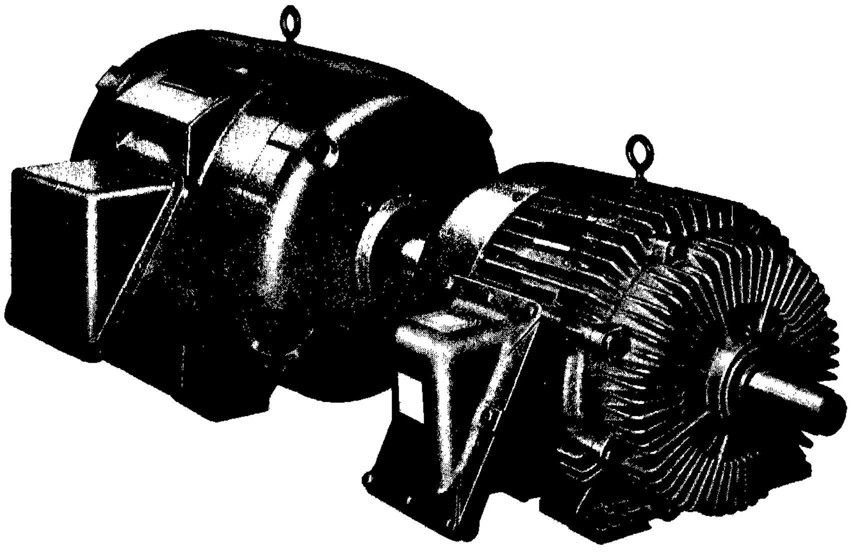
List of Parts For Model 134-135

2. Capscrew
3. Pipe Plug
4. Drive Screw
5. Nameplate
6. Casing
7. Outer Ring
8. Capscrew
9. Washer
10. Impeller
11. Key
12. Sleeve
13. Key
14. Seal
15. Pin
16. Inner Ring
17. Gasket
18. Capscrew
19. Bracket
20. Bracket

Solar I Power Plant
Daggett, CA.
Spec. JF16.02.02
Waldinger Corp.
CM-0100.059

MARATHON® ELECTRIC

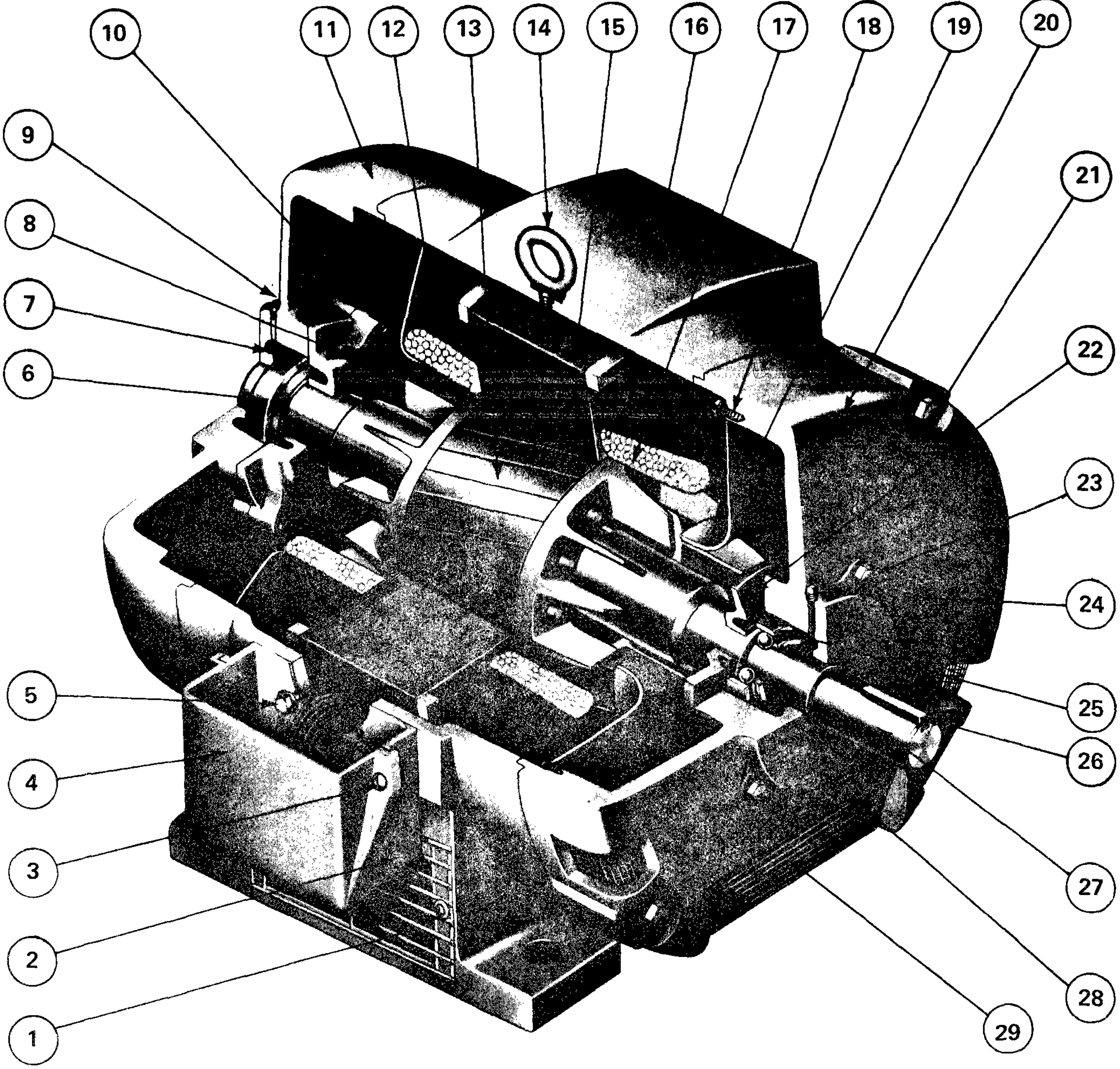
STANDARD INDUCTION MOTORS



INSTALLATION, OPERATION, AND MAINTENANCE INSTRUCTIONS

1-2.38-6

TYPICAL CUTAWAY VIEW OF A MARATHON DESIGNED, DRIPPROOF, HORIZONTAL INTEGRAL HORSEPOWER MOTOR & PARTS DESCRIPTION 364 THRU 445 FRAME SIZE



ITEM	DESCRIPTION	ITEM	DESCRIPTION	ITEM	DESCRIPTION
1.	** Frame Vent Screen	11.	Bracket O.P.E.	21.	Bracket Holding Bolt
2.	Conduit Box Bottom	12.	Baffle Plate O.P.E.	22.	Inner Bearing Cap P.E.
3.	Conduit Box Top-Holding Screw	13.	Rotor Core	23.	Inner Bearing Cap Bolt
4.	Conduit Box Top	14.	Lifting Eye Bolt	24.	Grease Plug
5.	Conduit Box Bottom-Holding Bolt	15.	Stator Core	25.	*Ball Bearing P.E.
6.	*Ball Bearing O.P.E.	16.	Frame	26.	Shaft Extention Key
7.	Pre-loading Spring	17.	Stator Winding	27.	Shaft
8.	Inner Bearing Cap O.P.E.	18.	Baffel Plate Holding Screw	28.	Drain Plug (grease)
9.	Grease Plug	19.	Baffle Plate P.E.	29.	** Bracket Screen
10.	Inner Bearing Cap Bolt	20.	Bracket P.E.		

P.E. = Pulley End

O.P.E. = Opposite Pulley End

* = Bearing Numbers are shown on motor nameplate when requesting information or parts always give complete motor description, model and serial numbers.

** = Bracket and frame screens are optional.

WARNING

These instructions must be followed to ensure safe and proper installation, operation and maintenance of the motor. They should be brought to the attention of all persons who install, operate or maintain this equipment.

GENERAL INFORMATION

Marathon Electric motors are all fully factory tested and inspected before shipment. Frequently the most likely cause of troubles may occur in either (1) shipment, (2) improperly matched power supply, or (3) failure to follow the installation precautions. These instructions are intended as a guide to eliminate these causes before they are overlooked.

ACCEPTANCE

Check carefully for any damage that may have occurred in transit. If any damage or shortage is discovered, do not accept until an appropriate notation on the freight bill is made. Any damage discovered after receipt of equipment should be immediately reported to the carrier.

WARNING

Failure to follow instructions and safe electrical procedures could result in serious injury or fatality. Disconnect all power before servicing. Install and ground per local and national codes. Consult qualified personnel with any questions or services required.

INSTALLATION

UNCRATING

After uncrating, check further that no apparent damage has been incurred in handling. See that the motor shaft and armature turn freely.

EXPOSURE

Check to determine that the motor has not been exposed to dirt, grit, or excessive moisture in either shipment (without protection) or storage before installation. Motors in storage should have shafts turned over once each month to redistribute grease in bearings.

Never start a motor which has been wet without having it thoroughly dried.

The measure of insulation resistance (see operation) is a good dampness test. Clean the motor of any dirt or grit.

SAFETY

Eyebolts or lifting lugs are intended only for lifting the motor and factory motor-mounted standard accessories. These lifting provisions should never be used when lifting or handling the motor and other equipment (i.e.) pumps, gear boxes, fans (or other driven equipment) as a single unit.

Eyebolt lifting capacity rating is based on a lifting alignment coincident with the eyebolt centerline. Eyebolt capacity reduces as deviation from this alignment increases.

Motors should be installed, protected and fused in accordance with latest issue of National Electrical Code, NEMA Standard Publication No. MG 2 and local requirements.

Frames and accessories of motors should be grounded in accordance with National Electrical Code (NEC) Article 430. For general information on grounding refer to NEC Article 250.

Rotating parts such as pulleys, couplings, external fans, unusual shaft extensions should be permanently guarded against accidental contact with clothing or body extremities.

WARNING

Disconnect power before working on motor driven equipment. Motors with automatic thermal protectors will automatically restart when the protector cools. Do not use motors with automatic thermal protectors in applications where automatic restart will be hazardous to personnel or equipment.

WARNING

Motors with manual thermal protectors may start unexpectedly after protector trips. If manual protector trips, disconnect motor from power line. After protector cools (five minutes or more) it can be reset and power may be applied to motor.

THERMAL PROTECTOR INFORMATION

A space on nameplate will be stamped or not be stamped to indicate:

1. Motor is thermally protected
2. Motor is not thermally protected
3. Motor is with overheat protective device

For examples, refer to paragraphs below:

1. Motors equipped with built-in thermal protection have "THERMALLY PROTECTED" stamped on the nameplate. Thermal protectors open the motor circuit electrically when the motor overheats or is overloaded. The protector cannot be reset until the motor cools. If the protector is automatic, it will reset itself. If the protector is manual, press the red button to reset.
2. Motors without thermal protection have nothing stamped on nameplate about thermal protection.
3. Motors that are provided with overheat protective device that does not open the motor circuit directly, nameplate will be stamped "WITH OVERHEAT PROTECTIVE DEVICE".
   A. Motors with this type of "Overheat Protective Device" have protector leads brought out in the motor conduit box marked "P1" and "P2". These leads are intended for connection in series with the stop button of a 3-wire pilot circuit of a magnetic controller connected to a motor, as in Figure 1.
   B. The load controlled by the above "Overheat Protective Device" cannot exceed the values shown in the chart below.

AC VOLTS	VOLT–AMP RATINGS	AC VOLTS	VOLT–AMP RATINGS
120	360	208	360
240	360	480	360
600	360		

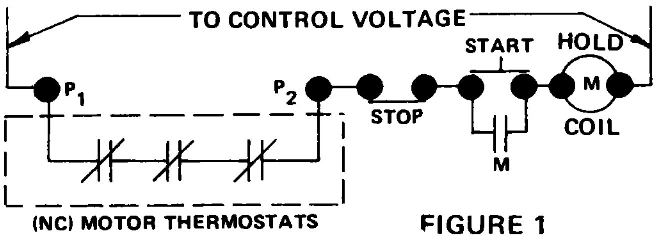
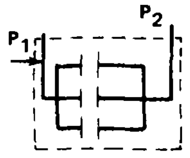


FIGURE 1



N/O MOTOR THERMOSTATS

Normally Open (N/O) Motor Thermostats are used in conjunction with controls installed by Original Equipment Manufacturers.

FIGURE 1A

LOCATION

In selecting a location for the unit, first consideration should be given to ventilation. It should be far enough from walls or other objects to permit a free passage of air.

The motor should never be placed in a room with a hazardous process, or where flammable gasses or combustible material may be present unless it is specifically designed for this type of service.

1. Dripproof motors are intended for use where atmosphere is relatively clean, dry and non-corrosive.
   a. When atmosphere is worse than above request approval of motor for use intended.
2. Totally enclosed motors may be installed where dirt, moisture and corrosion are present, or in outdoor locations.
3. Explosion proof motors are built for use in hazardous locations as indicated by Underwriters' label on motor. Consult your local governmental inspection agency for guidance.

The ambient temperature of the air surrounding the motor should not exceed 40° C or 104° F unless the motor has been especially designed for high ambient temperature applications. The free flow of air around the motor should not be obstructed.

FLOOR MOUNTING

Motors should be provided with a firm, rigid foundation, with the plane of four mounting stud pads flat within .010" for 56 to 210 frame; .015" from 250 through 680 frame. This may be accomplished by shims under the motor feet. For special isolation mounting, contact a Marathon Electric sales representative.

Before connecting motor to the load by belt drive or direct coupling, verify manually that the rotor turns freely and does not rub.

V-BELT DRIVE

1. Align sheaves carefully to avoid axial thrust on motor bearing. The drive sheave on the motor should be centered on the shaft extension.
2. When adjusting belt tension by pulling on the feet make sure *the motor is secured by all mounting bolts before tightening* belts.
3. Adjust belt tension to belt manufacturers recommendations.
4. Sheaves should be in accordance to NEMA Spec. MG-1 or as approved by the manufacturer for a specific application.

DIRECT CONNECTED DRIVE

Flexible or solid shaft couplings must be properly aligned for satisfactory operation. On flexible couplings, the clearance between the ends of the shafts should be in accordance with the coupling manufacturer's recommendations or NEMA standards for end play and limited travel in coupling.

ANGULAR MISALIGNMENT and RUN-OUT between direct connected shafts will cause increased bearing loads and vibration even when the connection is made by means of a flexible coupling.

To check for ANGULAR MISALIGNMENT, clamp the dial indicator to one coupling hub and place the finger or button of the indicator against the finished face of the other hub as shown in diagram 1. Set the dial at zero.

Rotate one shaft, keeping the indicator button at the reference mark on the coupling hub, and note the reading on the indicator dial at each revolution.

ANGULAR MISALIGNMENT OF THE SHAFTS MUST NOT EXCEED A TOTAL INDICATOR READING OF .002 INCH FOR EACH INCH OF DIAMETER OF THE COUPLING HUB.

After the shafts have been checked for angular misalignment and are parallel within the limits specified in the preceding paragraph, check the shaft for RUN-OUT to assure concentricity of the shafts. Clamp the indicator button on the machined diameter of the other hub as shown in diagram II. Set the dial at zero.

Rotate one shaft, keeping the indicator button at the reference mark on the hub and note the reading on the indicator dial at each revolution.

TOTAL RUN-OUT BETWEEN THE HUBS SHOULD NOT EXCEED .002 INCH.

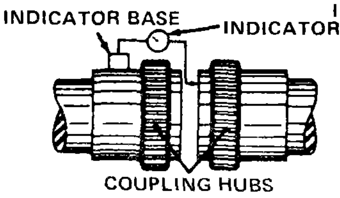


DIAGRAM 1

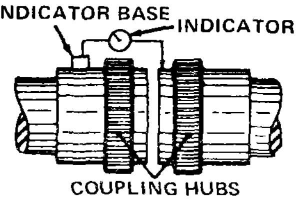


DIAGRAM 2

Rotating parts such as couplings, external fans, unusual shaft extensions should be permanently guarded against accidental contact with clothing or body extremities.

ELECTRICAL CONNECTIONS

1. All wiring, fusing, and grounding must comply with National Electrical Codes and local requirements.
2. To determine proper wiring, rotation and voltage connections, refer to the information and diagram on the nameplate, separate connection plate or decal. If the plate or decal has been removed, make inquires of the manufacturer.
3. Use the proper size of line current protection and motor controls as required by the National Electrical Code and local codes. Recommended use is 125% of full load amps as shown on the nameplate for motors with 40° C ambient and a service factor over 1.0. Recommended use is 115% of full load amps as shown on the nameplate for all other motors. Do not use protection with larger capacities than recommended. All three phase motors must have all three phases protected.

CHANGING ROTATION

1. The key must be removed from the motor shaft before starting. Keep hands and clothing away from rotating parts.
2. Before the motor is used as a power source for equipment, determine the proper rotation of the driven unit.
3. Before applying a load to the motor, determine that the motor and driven unit are in the same rotation sequence.
4. Checking rotation can be done by jogging or bumping by applying power to the motor leads for a short period of time, enough to just get motor shaft to rotate a slight amount to observe shaft rotating direction.
5. Three phase - interchange any two (2) of the line leads with *the motor lead connections shown on the nameplate,* separate connection plate or decal.

PART WINDING STARTING

On those motors used for part winding starting, the elapsed time on the first step should be kept as short as possible and should not exceed 5 seconds. It is recommended that this time be limited to 2 seconds.

OPERATION

BEFORE INITIAL STARTING

1. If a motor has become damp in shipment or in storage, it is advisable to measure insulation resistance of the stator winding.

$$\text{Minimum Insulation Valve in Megohms} = \frac{\text{Rated Voltage}}{1000} + 1$$

2. If insulation resistance is low, dry out the moisture in one of the following ways:
   a. Bake in oven at temperature not more than 90° C (194° F) until insulation resistance is practically constant.
   b. Enclose motor with canvas or similar covering, leaving a hole at the top for moisture to escape, and insert heating units or lamps.
   c. Pass a current at low voltage (rotor locked) through the stator winding. Increase the current gradually until the winding temperature, measured with a thermometer, reaches 90° C (194° F). Do not exceed this temperature.
3. See that voltage and frequency stamped on motor and control nameplates correspond with that of the power line.
4. Check all connections to the motor and control with the wiring diagram.
5. Be sure rotor turns freely and does not rub when disconnected from the load. Any foreign matter in the air gap should be removed.
6. Leave the motor disconnected from the load for the initial start; it is desirable to operate the motor without load for about one hour to test for any localized heating in bearings and windings. Check for proper rotation.

COLLECTOR RINGS (Wound Rotor Motors Only)

The collector rings are sometimes slushed at the factory to protect them while in stock and during shipment. The brushes have been fastened in a raised position. Before putting the motor into service, the slushing should be removed with carbon tetrachloride or some other cleaning fluid that will not attack insulation; the rings polished with fine sandpaper; and the brushes should be set down on the collector surface. Keep the rings clean and maintain their polished surfaces. Ordinarily, the rings will require only occasional wiping with a piece of canvas or non-linting cloth. Do not let dust or dirt accumulate between the collector rings.

BRUSHES (Wound Rotor Motors Only)

See that the brushes move freely in the holders and at the same time make firm, even contact with the collector rings. The pressure should be between 2 and 3 pounds per square inch of brush surface.

When installing new brushes, fit them carefully to the collector rings. Be sure that the copper pigtail conductors are securely fastened to, and make good contact with, the brushholders.

ALLOWABLE VOLTAGE AND FREQUENCY RANGE

If voltage and frequency are within the following range, motors will operate, but with somewhat different characteristics than obtained with correct nameplate values.

1. Voltage: Within 10% above or below the value stamped on the nameplate.
2. Frequency: Within 5% above or below the value stamped on the nameplate.
3. Voltage and Frequency together: Within 10% (providing frequency above is less than 5%) above or below values stamped on the nameplate.

CLEANLINESS

Keep both the interior and exterior of the motor free from dirt, water, oil and grease. Motors operating in dirty places should be periodically disassembled and thoroughly cleaned.

CONDENSATION DRAIN PLUGS

If motor is totally enclosed fan cooled or non ventilated and is equipped with automatic drain plugs, they should be free of oil, grease, paint, grit and dirt so they don't clog up.

LUBRICATION

This motor has been properly lubricated at the time of manufacture and is not necessary to lubricate at time of installation. If the motor has been in storage for a period of six months or greater, relubricate before starting.

To lubricate:

1. Stop motor
2. Wipe clean all grease fittings. (Filler and drain.)
3. Remove filler and drain plugs. A and B (See figure 2.)
4. Free drain hole of any hard grease (use piece of wire if necessary).
5. Add Grease* using a low pressure grease gun.
6. Start motor and let run for approximately 30 minutes.
7. Stop motor, wipe off any drained grease, and replace filler and drain plugs.
8. Motor is ready for operation.

* The amount of grease added is very important. Only enough grease should be added to replace the grease used by the bearing. Too much grease can be as harmful as insufficient grease. Every four years (every year in the case of severe duty) motors with open bearings should be thoroughly cleaned, washed and repacked with grease. The quantity of grease is important. The grease cavity should be filled 1/3 to 1/2 full. Too much grease is as detrimental as insufficient grease. (See figures 3, 4, 5.)

NOTE

If lubrication instructions are shown on motor, they will supersede this general instruction.

FIGURE 2

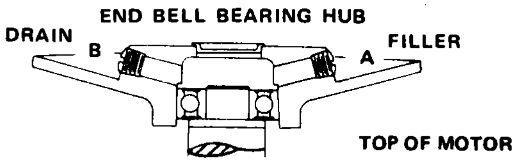


FIGURE 3

RECOMMENDED GREASES

INSULATION CLASS SHOWN ON NAMEPLATE	GREASE DESIGNATION	GREASE SUPPLIER
B	Alvania #2	Shell Oil Company or equivalent
F	Chevron SRI-2	Standard Oil of California or equivalent

FIGURE 4

RELUBRICATION PERIOD

Frame Size @ 900, 1200 & Var. Speed	Relub. Period @ Std. Conditions (8 hr./day, normal to light loading 100° F max. amb.)	Severe Conditions	Extreme Conditions
140–180	4.5 Years	18 Months	9 Months
210–280	4 Years	16 Months	8 Months
320–400	3.5 Years	14 Months	7 Months
440–508	3.0 Years	12 Months	6 Months
510	2.5 Years	11½ Months	6 Months
Frame Size @ 1800 RPM	**Std. Conditions**	**Severe Conditions**	**Extreme Conditions**
140–180	3 Years	1 Year	6 Months
210–280	2.5 Years	10½ Months	5½ Months
320–400	2.0 Years	9 Months	4½ Months
440–508	1.5 Years	8 Months	4 Months
510	1 Years	6 Months	3½ Months
All Motors over 1800 RPM	6 Months	3 Months	3 Months

For roller bearings: Divide above times by 3.

STANDARD CONDITIONS: Eight hours per day, normal or light loading, clean 100° F maximum ambient.

SEVERE CONDITIONS: Twenty-four hours per day operation, or shock loadings, vibration, or in dirt or dust at 100° to 150° F ambient.

EXTREME CONDITIONS: Heavy shock or vibration, dirt or dust at 100° to 150° F ambient.

WARNING

Disconnect power before working on motor driven equipment. Motors with automatic thermal protectors will automatically restart when the protector temperature drops sufficiently. Do not use motors with automatic thermal protectors in applications where automatic restart will be hazardous to personnel or equipment.

TROUBLES

If trouble is experienced in the operation of the motor, make sure that:

1. The bearings are in good condition and operating properly.
2. There is no mechanical obstruction to prevent rotation in the motor or in the driven load.
3. The air gap is uniform.
4. All bolts and nuts are tightened securely.
5. Proper connection to drive machine or load has been made.

In checking for electrical troubles, be sure that:

1. The line voltage and frequency correspond to the voltage and frequency stamped on the nameplate of the motor.
2. The voltage is actually available at motor terminals.
3. The fuses and other protective devices are in proper condition.
4. All connections and contacts are properly made in the circuits between the control apparatus and motor.

Never attempt to measure the temperature rise of a motor by hand. Temperature rise **must** be measured by thermometer, resistance, or by imbedded detector or thermocouple.

CAUTION

1. Do not perform any maintenance or service on this motor before disconnecting the power source.
2. Discharge all capacitors before servicing motor.
3. Always keep hands and clothing away from moving parts.
4. Electrical repairs should be performed by trained and qualified personnel only.
5. Failure to follow instructions and safe electrical procedures could result in serious injury.
6. If safety guards are required, be sure the guards are in use.

FIGURE 5

AMOUNT OF GREASE REQUIRED WHEN REGREASING

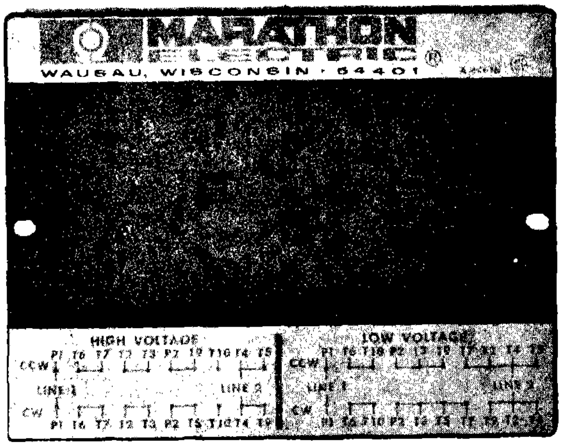
BEARING NUMBER	AMOUNT (IN.^{3})	APPROX. EQUIV. TEASPOONS	BEARING NUMBER	AMOUNT (IN.^{3})	APPROX. EQUIV. TEASPOONS
203	.15	.5 Tsp.	222	3.0	10.0 Tsp.
205	.27	.9 Tsp.	307	.53	1.8 Tsp.
206	.34	1.1 Tsp.	308	.66	2.2 Tsp.
207	.43	1.4 Tsp.	309	.81	2.7 Tsp.
208	.52	1.7 Tsp.	310	.97	3.2 Tsp.
209	.61	2.0 Tsp.	311	1.14	3.8 Tsp.
210	.72	2.4 Tsp.	312	1.33	4.4 Tsp.
212	.95	3.1 Tsp.	313	1.54	5.1 Tsp.
213	1.07	3.6 Tsp.	314	1.76	5.9 Tsp.
216	1.49	4.9 Tsp.	316	2.24	7.4 Tsp.
219	2.8	7.2 Tsp.	318	2.78	9.2 Tsp.

These instructions do not cover all details or variations in equipment nor provide for every possible condition to be met in connection with installation, operation or maintenance. Should additional information be desired for the purchaser's purposes, the matter should be referred to the nearest Marathon Electric Manufacturing Corp. sales office listed on the back page.

MOTOR TROUBLE SHOOTING CHART

Your motor service and any trouble shooting must be handled by qualified persons who have proper tools and equipment.

TROUBLE	CAUSE	WHAT TO DO
Motor fails to start	Blown fuses	Replace fuses with proper type and rating.
	Overload trips	Check and reset overload in starter.
	Improper power supply	Check to see that power supplied agrees with motor nameplate and load factor.
	Improper line connections	Check connections with diagram supplied with motor.
	Open circuit in winding or control switch	Indicated by humming sound when switch is closed. Check for loose wiring connections. Also see that all control contacts are closing.
	Mechanical failure	Check to see if motor and drive turn freely. Check bearings and lubrication
	Short circuited stator	Indicated by blown fuses. Motor must be rewound.
	Poor stator coil connection	Remove end bells, locate with test lamp.
	Rotor defective	Look for broken bars or end rings.
	Motor may be overloaded	Reduce load.
Motor stalls	One phase may be open	Check lines for open phase.
	Wrong application	Change type or size. Consult manufacturer.
	Overload motor	Reduce load.
	Low motor voltage	See that nameplate voltage is maintained. Check connection.
	Open Circuit	Fuses blown, check overload relay, stator and pushbuttons.
Motor runs and then dies down	Power failure	Check for loose connections to line, to fuses and to control.
Motor does not come up to speed	Not applied properly	Consult supplier for proper type.
	Voltage too low at motor terminals because of line drop.	Use higher voltage on transformer terminals or reduce load. Check connections. Check conductors for proper size.
	Starting load too high	Check that load motor is supposed to carry at start.
	Broken rotor bars or loose rotor	Look for cracks near the rings. A new rotor may be required as repairs are usually temporary.
	Open primary circuit	Locate fault with testing device and repair.
Motor takes too long to accelerate	Excess loading	Reduce load.
	Poor circuit	Check for high resistance
	Defective squirrel cage rotor	Replace with new rotor.
	Applied voltage too low	Get power company to increase power tap.
Wrong rotation	Wrong sequence of phases	Reverse connections at motor or at switchboard.
Motor overheats while running under load	Overloaded	Reduce load.
	Frame or bracket vents may be clogged with dirt and prevent proper ventilation of motor.	Open vent holes and check for a continuous stream of air from the motor.
	Motor may have one phase open	Check to make sure that all leads are well connected.
	Grounded coil	Locate and repair
	Unbalanced terminal voltage	Check for faulty leads, connections and transformers.
Motor vibrates after corrections have been made.	Motor misaligned	Realign.
	Weak support	Strengthen base
	Coupling out of balance	Balance coupling.
	Driven equipment unbalanced	Rebalance driven equipment.
	Defective ball bearing	Replace bearing.
	Bearings not in line	Line up properly.
	Balancing weights shifted	Rebalance motor.
	Polyphase motor running single phase	Check for open circuit.
	Excessive end play	Adjust bearing or add washer.
Unbalanced line current on polyphase motors during normal operation.	Unequal terminal volts	Check leads and connections.
	Single phase operation	Check for open contacts.
Scraping noise	Fan rubbing air shield	Remove interference.
	Fan striking insulation	Clear fan.
	Loose on bedplate	Tighten holding bolts.
Noisy operation	Airgap not uniform	Check and correct bracket fits or bearing.
	Rotor unbalance	Rebalance.
Hot bearings general	Bent or sprung shaft	Straighten or replace shaft.
	Excessive belt pull	Decrease belt tension.
	Pulleys too far away	Move pulley closer to motor bearing.
	Pulley diameter too small	Use larger pulleys.
	Misalignment	Correct by realignment of drive.
Hot bearings ball	Insufficient grease	Maintain proper quantity of grease in bearing.
	Deterioration of grease or lubricant contaminated	Remove old grease, wash bearings thoroughly in kerosene and replace with new grease.
	Excess lubricant	Reduce quantity of grease, bearing should not be more than ½ filled.
	Overloaded bearing	Check alignment, side and end thrust.
	Broken ball or rough races	Replace bearing, first clean housing thoroughly.



FOR RENEWAL PARTS

When ordering parts for repair or spares, give description and state quantity of parts desired, together with the complete nameplate data: rating, model and serial number of the motor and all data.

Sales and Service Assistance

California
ANAHEIM
625 South Euclid Suite 15
Anaheim, CA 92802
Phone: (714) 956-7111

SAN LEANDRO
14441 Griffith Street
San Leandro, CA 94577
Phone: (415) 357-7620

Connecticut
HARTFORD
49 North Gate
Simsbury, CT 06070
Phone: (203) 658-9835

Illinois
CHICAGO
680 Greenleaf Avenue
Elk Grove Village, IL 60007
Phone: (312) 593-6500

Indiana
INDIANAPOLIS
4518 North Hillside
Indianapolis, IN 46205
Phone: (317) 253-6465
253-5354

Louisiana
NEW ORLEANS
336 N. Jefferson
Davis Parkway
New Orleans, LA 70119
Phone: (504) 482-2089

Minnesota
MINNEAPOLIS
8700 West 36th Street
Minneapolis, MN 55426
Phone: (612) 935-8424

Missouri
ST. LOUIS
1887 Cedar Mill Drive
Chesterfield, MO 63017
Phone: (312) 593-6500

New York
SYRACUSE
Room 173 Pickard Building
5858 East Molloy Road
Syracuse, NY 13211
Phone: (315) 454-0994
454-3130

Ohio
CINCINNATI
9319 Cincinnati-Columbus Rd.
West Chester, OH 45069
Phone (513) 777-7990

CLEVELAND
20800 Center Ridge Rd-Suite 400
Cleveland, OH 44116
Phone: (216) 331-2910
331-1081

Pennsylvania
ALLENTOWN
P.O. Box 2206
Allentown, PA 18001
Phone: (215) 837-1866

South Carolina
GREENVILLE
100 Executive Center Drive
Greenville, SC 29615
Phone: (803) 288-8991
288-8990

Tennesse
NASHVILLE
1040 Murfreesboro Road
Suite 207
Nashville, TN 37217
Phone: (615) 242-3321
242-3322
255-8281

Texas
DALLAS
1366 Exchange Drive
Richardson, TX 75080
Phone: (214) 699-0251

HOUSTON
4502 Mossygate Rd.
Spring, TX 77373
Phone: (713) 350-3277

Washington
SPOKANE
Electro-Power Corp.
North 104 Madelia
P.O. Box 2983
Spokane, WA 99220
Phone: (509) 535-2931

MARATHON ELECTRIC®
100 E. Randolph Street
Wausau, WI 54401
Phone: (715) 675-3311

3CS Cooling

Woldinger
Sub

INSTALLATION AND MAINTENANCE INSTRUCTIONS
YOUNG TYPE "OCH" OIL COOLERS

I. GENERAL

A. IMMEDIATELY AFTER REMOVING FROM SHIPPING CONTAINER AND BEFORE INSTALLING OIL COOLER, INSPECT CAREFULLY FOR CONCEALED DAMAGE FROM SHIPPING. IF ANY DAMAGE IS FOUND, FILE CLAIM WITH THE CARRIER.

B. TYPE "OCH" OIL COOLERS ARE DESIGNED AND MANUFACTURED FOR MAXIMUM EFFICIENCY AT OPERATING PRESSURES UP TO 300 PSI MAXIMUM AT 400 F MAXIMUM IN AN AMBIENT TEMPERATURE OF 104 F MAXIMUM WITH STANDARD MOTORS.

II. INSTALLATION

A. AVOID LOCATING COOLER IN A CORROSIVE ATMOSPHERE AS RAPID DETERIORATION OF CASING, COOLING ELEMENT, FAN AND MOTOR MAY TAKE PLACE RESULTING IN SHORTENED LIFE AND UNNECESSARY REPLACEMENT EXPENSE.

B. IF COOLER IS TO UTILIZE WASTE HEAT FOR SPACE HEATING, IT SHOULD BE MOUNTED 7 TO 14 FEET ABOVE THE FLOOR FOR PROPER HEAT DISTRIBUTION.

C. COOLER MAY BE SUSPENDED FROM 1/2-13 UNC TAPPED HOLES IN TOP BY THREADED RODS, OR MAY BE BASE-MOUNTED FROM 1/2-13 UNC TAPPED HOLES IN BOTTOM. IN EITHER CASE, MOUNT FOR HORIZONTAL AIR FLOW TO MAINTAIN PROPER COOLING OF FAN MOTOR AND VENTING OF INTERNAL PASSAGES.

D. PIPING SHOULD BE SIZED BASED ON DESIGN FLOW AND PRESSURE DROP REQUIREMENTS AND NOT ON OIL COOLER SUPPLY AND RETURN CONNECTION SIZES.

A STRAINER OR FILTER LOCATED AHEAD OF THE COOLER OR THE HEAT SOURCE, DEPENDING ON THE TYPE OF SERVICE, SHOULD BE INSTALLED TO TRAP SCALE, DIRT OR SLUDGE THAT MAY BE PRESENT IN PIPING AND EQUIPMENT, OR THAT MAY ACCUMULATE FROM OIL BREAKDOWN. A THERMOSTATIC OR SPRING LOADED BY-PASS RELIEF VALVE INSTALLED AHEAD OF THE COOLER WILL BE FOUND HELPFUL TO HASTEN WARM-UP AND RELIEVE THE SYSTEM OF EXCESSIVE PRESSURES, AS WELL AS TO CONTROL THE OIL TEMPERATURE IN CERTAIN INSTALLATIONS. THESE ACCESSORIES SHOULD BE CONSIDERED IN THE ORIGINAL HEAT REJECTION AND PIPING COMPUTATIONS.

FIGURE 1, PAGE 3 SHOWS TYPICAL ONE PASS COOLER CONNECTIONS FOR HIGH OIL FLOWS. FIGURE 2, SHOWS TYPICAL TWO PASS COOLER CONNECTIONS FOR LOW OIL FLOWS.

E. CONNECT MOTOR TO POWER SUPPLY FOR VOLTAGE AND FREQUENCY (HERTZ) ON MOTOR NAMEPLATE ONLY, AND ACCORDING TO DIAGRAM FURNISHED WITH MOTOR. CONNECT TWO-SPEED SWITCH WHEN FURNISHED, ACCORDING TO DIAGRAM INCLUDED WITH TWO-SPEED SWITCH. BEFORE TURNING ON ELECTRIC POWER, ROTATE FAN BY HAND, MAKING SURE IT HAS PROPER CLEARANCE AND HAS NOT BEEN DAMAGED. TURN ON ELECTRIC POWER. MAKE

SURE FAN IS ROTATING COUNTERCLOCKWISE (LOOKING DOWN THE AIR STREAM) AND DRAWING AIR OVER THE MOTOR, THROUGH THE HEATING ELEMENT AND OUT THE LOUVERS OR DISCHARGE OPENING.

IF MOTOR IS TO BE PROTECTED AGAINST OVERCURRENT THROUGH MOTOR STARTER OR OTHER OVERCURRENT DEVICE, SELECT OVERCURRENT RELAYS OR HEATERS BASED ON ACTUAL MEASURED CURRENT DRAW OF MOTOR ON COMPLETED INSTALLATION. <u>DO NOT USE NAMEPLATE AMPERES</u>. (MOTOR LOAD ON THIS COOLER IS BASED ON ACTUAL SAFE TEMPERATURE TEST OF MOTOR).

III. MAINTENANCE

A. <u>LUBRICATION</u>: LUBRICATE MOTOR ACCORDING TO INSTRUCTIONS FURNISHED WITH MOTOR.

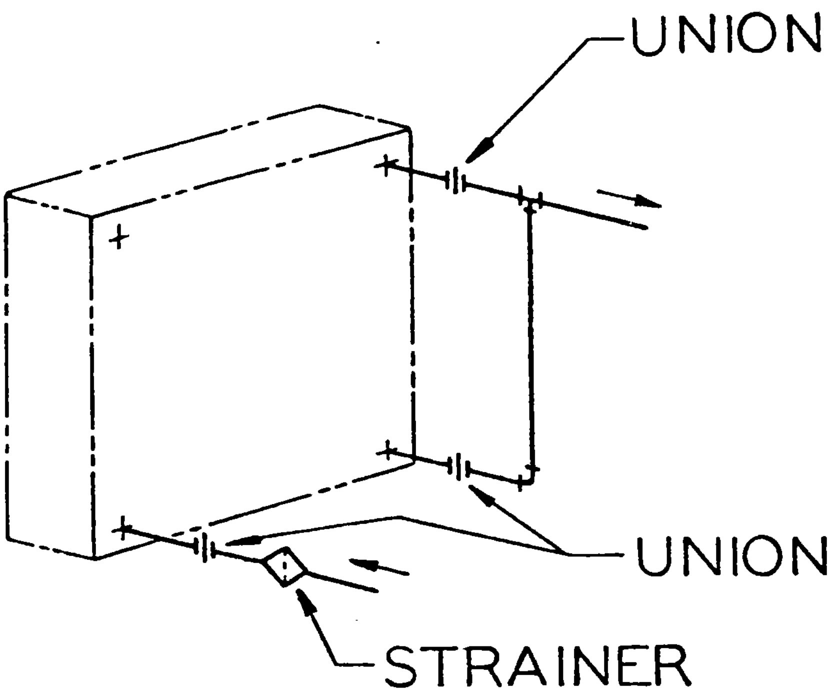
B. <u>EXTERNAL CLEANING</u>: DIRT ON COOLING ELEMENT FINS REDUCES AIR FLOW AND COOLING CAPACITY. DIRT ON FAN BLADES REDUCES AIR OUTPUT AND MAY THROW FAN OUT OF BALANCE AND OVERLOAD MOTOR. DIRT ON MOTOR REDUCES MOTOR VENTILATION AND COOLING, CAUSING OVERHEATING AND POSSIBLE BURN-OUT.

AT LEAST ONCE EACH YEAR, REMOVE DUST AND GREASY DEPOSITS FROM COOLING ELEMENT FINS, MOTOR, FAN BLADES AND FAN SHROUD. USE A STIFF BRUSH OR AIR NOZZLE FOR LOOSE DIRT AND NONINFLAMMABLE SOLVENT WITH BRUSH FOR SOLID DEPOSITS. DO NOT BEND OR DAMAGE COOLING ELEMENT FINS. CARE MUST BE TAKEN NOT TO DAMAGE FAN BLADES AS A RESULTING OUT-OF-BALANCE CONDITION MAY CAUSE VIBRATION, DAMAGE TO MOTOR BEARINGS, AND POSSIBLE MOTOR BURN-OUT DUE TO OVERHEATING.

C. <u>INTERNAL CLEANING</u>: ONCE A YEAR, PIPING SHOULD BE DISCONNECTED AND A DEGREASING AGENT OR FLUSHING OIL CIRCULATED THROUGH THE UNIT TO REMOVE SLUDGE FROM TURBULATORS AND INTERNAL TUBE SURFACES TO RETURN THE UNIT TO FULL CAPACITY. A THOROUGH CLEANING OF THE ENTIRE SYSTEM IN THE SAME MANNER IS PREFERABLE TO AVOID CARRY OVER FROM UNCLEANED PIPING, PUMP AND ACCESSORIES. IF THIS IS DONE, FILTER OR STRAINER SHOULD BE REMOVED AND NECESSARY ADJUSTMENT OR REMOVAL OF BY-PASS VALVE EFFECTED. REGULAR CLEANING OR REPLACEMENT OF FILTER OR STRAINER WILL HELP MAINTAIN A CLEAN AND EFFICIENTLY OPERATING SYSTEM.

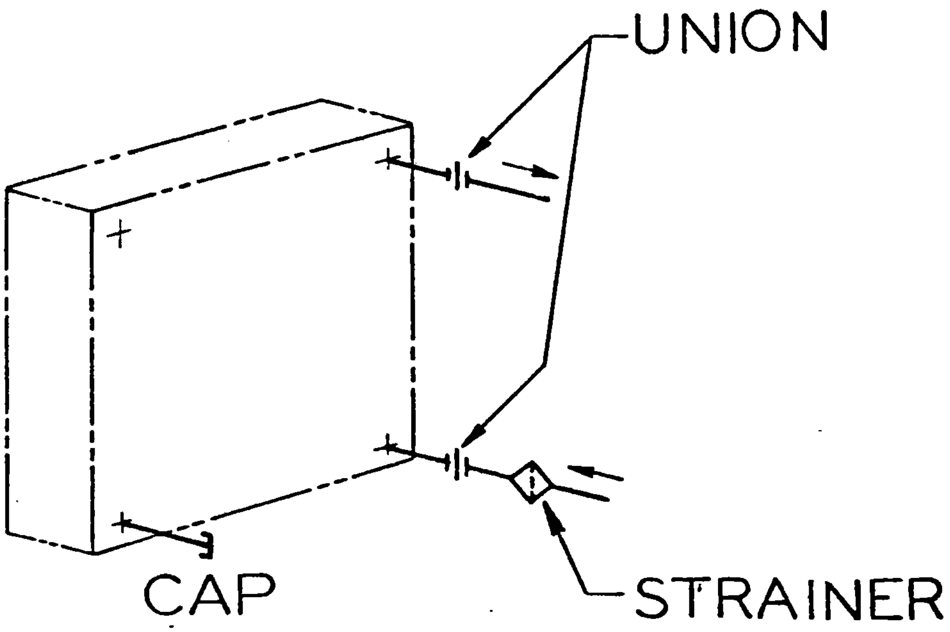
D. <u>SERVICE</u>: WHEN ORDERING REPLACEMENT PARTS OR MAKING INQUIRY REGARDING SERVICE, ALWAYS MENTION MODEL NUMBER, SERIAL NUMBER, AND "YOUNG" ORDER NUMBER ON WHICH COOLER WAS ORIGINALLY FURNISHED. ANY REFERENCE TO THE MOTOR MUST CARRY FULL MOTOR NAMEPLATE DATA.

YOUNG RADIATOR COMPANY
GENERAL OFFICES: RACINE, WISCONSIN 53404 U.S.A.
PLANTS AT: RACINE, WISCONSIN AND MATTOON, ILLINOIS



TYPICAL ONE PASS CONNECTIONS
FIGURE 1

AM-8427



TYPICAL TWO PASS CONNECTIONS
FIGURE 2

AM-8428

ONE AND TWO PASS OIL FLOW

SPECIFICATIONS

TUBES: STEEL

FINS: ALUMINUM

TURBULATORS: STEEL

MANIFOLDS: TUBULAR STEEL

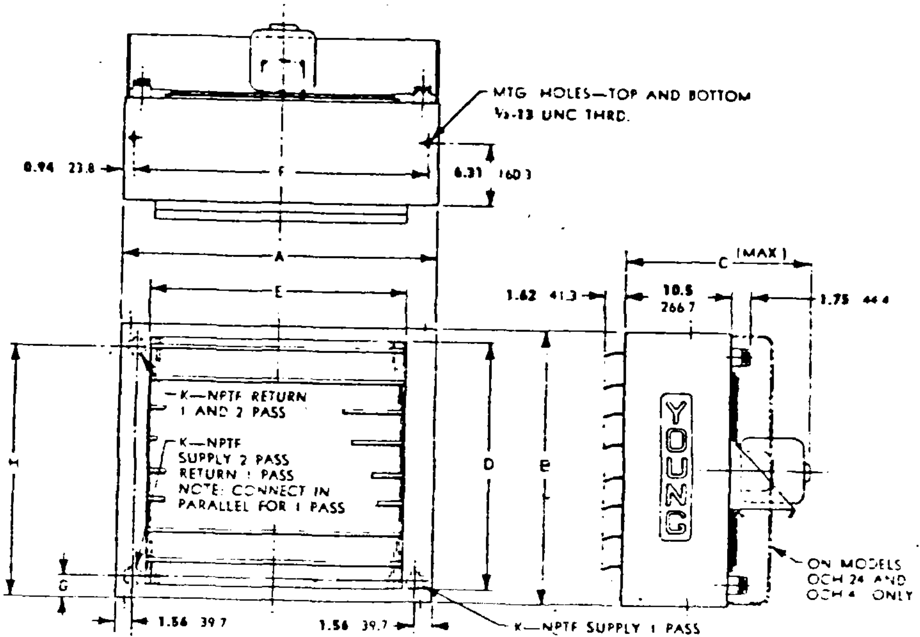
HOUSING: HEAVY GAGE STEEL

HOUSING FINISH: GRAY GLOSS ENAMEL

HARDWARE FINISH: ZINC PLATED

WORK PRESS: 300 PSI 2100 kPa @ 400 F 205C

TEST PRESS: 450 PSI 3100 kPa



CM-9140

ALL DIMENSIONS ARE INCHES MILLIMETRES

DIMENSION	MODEL															
	OCH-24		OCH-41		OCH-55		OCH-91		OCH-130		OCH-174		OCH-257		OCH-360	
A	14.81	376.2	19.00	482.6	20.38	517.5	23.81	604.8	26.81	681.0	31.62	803.3	33.81	858.8	41.62	1057.3
B	11.81	300.0	13.12	333.4	15.75	400.0	18.38	466.7	23.62	600.1	27.56	700.1	30.19	766.8	36.75	933.4
C	13.94	354.0	14.44	366.7	22.00	558.8	22.00	558.8	22.00	558.8	22.00	558.8	23.50	596.9	23.50	596.9
D	9.19	233.4	10.50	266.7	13.12	333.4	15.75	400.0	21.00	533.4	24.94	633.4	27.56	700.1	34.12	866.8
E	8.31	211.1	12.50	317.5	13.88	352.4	17.19	436.6	20.19	512.8	25.12	638.2	27.31	693.7	35.12	892.2
F	12.94	328.6	17.12	435.0	18.50	469.9	21.81	554.0	24.81	630.2	29.75	755.6	31.94	811.2	39.75	1009.6
G	2.12	54.0	2.12	54.0	2.12	54.0	2.19	55.6	2.19	55.6	2.19	55.6	2.19	55.6	2.19	55.6
H	9.81	249.2	11.00	279.4	13.62	346.1	16.19	411.2	21.44	544.5	25.38	644.5	28.00	711.2	34.56	877.9
K	1.00	25.4	1.00	25.4	1.00	25.4	1.25	31.8	1.25	31.8	1.25	31.8	1.25	31.8	1.25	31.8

SCHEDULE OF UNITS

ITEM	QTY	MODEL	CAPACITY				MOTOR				
			Btuh	gpm OIL	ENT OIL TEMP F	AMB AIR TEMP F	HP	RPM	PHASE	HERTZ	VOLTS
01	2	OCH-41					1/8	1725	3	60	230/460
							Totally Enclosed Air Over				
							42" Dia. Frame				

RECEIVED
DEC 22 1980

DIMENSION DRAWING

JOB

LOCATION TOWNSEND & BOTTUM INC.

ARCH. ENGR

CUSTOMER The Waldinger Corp.

ADDRESS P.O.Box 1612,DesMoines, Iowa

CUSTOMER ORDER CM-0100-034

YOUNG ORDER B-190343

TITLE
OCH OIL COOLERS

YOUNG RADIATOR CO.
RACINE, WISCONSIN 53404

DATE 12/12/80
BY DJL
DRAWING NO. 275941

10-31-74

Form 289

1.3 FANS

Equipment Number	Description	Maintenance Section	P&ID Dwg. Number
FA-901	Cooling tower fan	1.3.2	5163154
FA-902	Cooling tower fan	1.3.2	5163154
FA-903	Cooling tower fan	1.3.2	5163154
FA-906&907	Air Compressor after Cooling Fan	1.3.3	5133309

1.4 AIR COMPRESSOR

Equipment Number	Description	Maintenance Section	P&ID Dwg. Number
CP-901	Service & inst. air compressor	1.4.1	5163162
CP-902	Service & inst. air compressor	1.4.1	5163162

1.5 BLOWERS

Equipment Number	Description	Maintenance Section	P&ID Dwg. Number
FA-301	UMU Vapor Blower	1.5.1	5163147 5132196
FA-302	UMU Air Blower	1.5.2	5163147 5132196
FA-904	Turbine Lagging Blower	1.1.1*	
FA-905(A,B,C&D)	Turbine Lagging Blower	1.1.1*	

*Furnished W/Turbine Generator

1. 5 BLOWERS

1. 5. 1 UMU VAPOR BLOWER

1. 5. 1.1

Identification Tag Number	Description
FA-301	UMU VAPOR BLOWER

1. 5. 1.2 Description

Manufacturer : Eclipse Inc., Rockford, Illinois 61103

Part Number : HB-3314-1/2

Specification No. : None

Material :

Weight :

1. 5. 1.3 Prescribed Service

Hydrocarbon Vapors, Ullage Tank Fumes

1. 5. 1.4 Vendor

Hirt Combustion Engineers, 931 So. Maple Ave., Montebello, CA 90640

1. 5. 1.5 Special Cautions

See Eclipse Information Guide K-74 (following)

1. 5. 1.6 Periodic Service

None

1. 5. 1.7 Parts List

None

1. 5. 1.8 Special Tools

None

1. 5. 1.9 Maintenance Instructions

See Eclipse Information Guide K-74 (following)

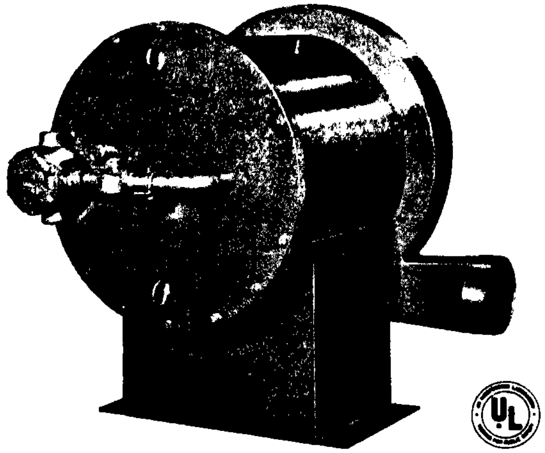
1. 5. 1.10 Acceptance Tests

None

FA-301

K-74
Information Guide
Rev. 1/80

ECLIPSE INFORMATION GUIDE
HERMETIC GAS BOOSTERS
SERIES HB



Eclipse Hermetic Gas Boosters are used for pumping any gas or gas/air mixture, which is not corrosive to aluminum or steel, when an increase in pressure is required. They deliver gas at any volume, within the capacity range of the booster, with a relatively constant pressure. The discharge pressure is the total of the booster pressure plus incoming gas pressure.

The design of Hermetic Boosters permits the motor and rotor to be enclosed in an airtight, steel housing. No shaft seal is required, thus eliminating any possibility of shaft seal leakage, a problem experienced on many gas booster designs. Motor and rotor are easily accessible by unbolting the cover plate and sliding the entire motor and rotor assembly out of the housing. During any disassembly, be careful NOT to disturb the wiring conduit or terminal box position. This will break the gas seal and result in gas leakage. These boosters are UL listed when handling natural or manufactured gas.

1.0 INSTALLATION

1.1 Install booster in accessible location on a level concrete floor or other substantial mounting pad.

1.2 Be sure the top of booster housing is perfectly level to avoid excessive wear of motor bearings.

1.3 Booster should be bolted to mounting pad through mounting holes provided in booster base. If desired, vibration pads may be installed under base.

1.4 If mounted rigid to mounting pad, be careful not to spring booster base when bolting down. Shim properly before tightening mounting bolts.

1.5 When installing booster, be sure that enough space is left between the Terminal Box and the nearest obstruction to allow removal of the internal assembly for maintenance purposes. The space required is equal to the distance between the End Plate on the Terminal Box side and the Front Housing Cover.

1.6 DO NOT DISTURB WIRING CONDUIT OR TERMINAL BOX POSITION. This will break the gas seal and result in gas leakage. If resealing is necessary, it should be done by Eclipse factory authorized personnel only.

1.7 As a precautionary measure, Eclipse recommends that a second U.L. listed sealing unilet and pipe nipple be installed directly upstream of the junction unilet (see Figure 4). This additional installation should be done on the job site by a qualified electrical contractor.

2.0 PIPING FIGURE 1

2.1 Hermetic boosters are available in various outlet positions so that a minimum number of bends in the piping is required. Bottom horizontal discharge and standard rotation (CCW as viewed from motor side) is supplied unless otherwise specified by the customer on his order.

2.2 To prevent leakage of gas, excessive power consumption, and possible hazard, the use of rigid piping is recommended. Solid pipe connections (threaded or flanged) should be used at booster inlet and outlet. Make sure all fittings are tight. Check lines for leakage.

2.3 DO NOT use the booster to support the piping. Use suitable brackets or hangers. Place booster as close as possible to appliance to avoid unnecessary piping pressure losses.

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OF ECLIPSE INC.
ROCKFORD, ILLINOIS 61103 (815) 877-3031
IN CANADA: ECLIPSE FUEL ENGINEERING CO. OF CANADA, LTD. DON MILLS, ONTARIO

2.4 **Use sufficiently large size piping from booster to appliance to avoid excessive pressure losses. Avoid sharp bends and pipe constrictions.**

2.5 NOTE: **Maximum test or inlet pressure must not exceed 5 p.s.i.g.**

TYPICAL THREE VALVE BYPASS ARRANGEMENT

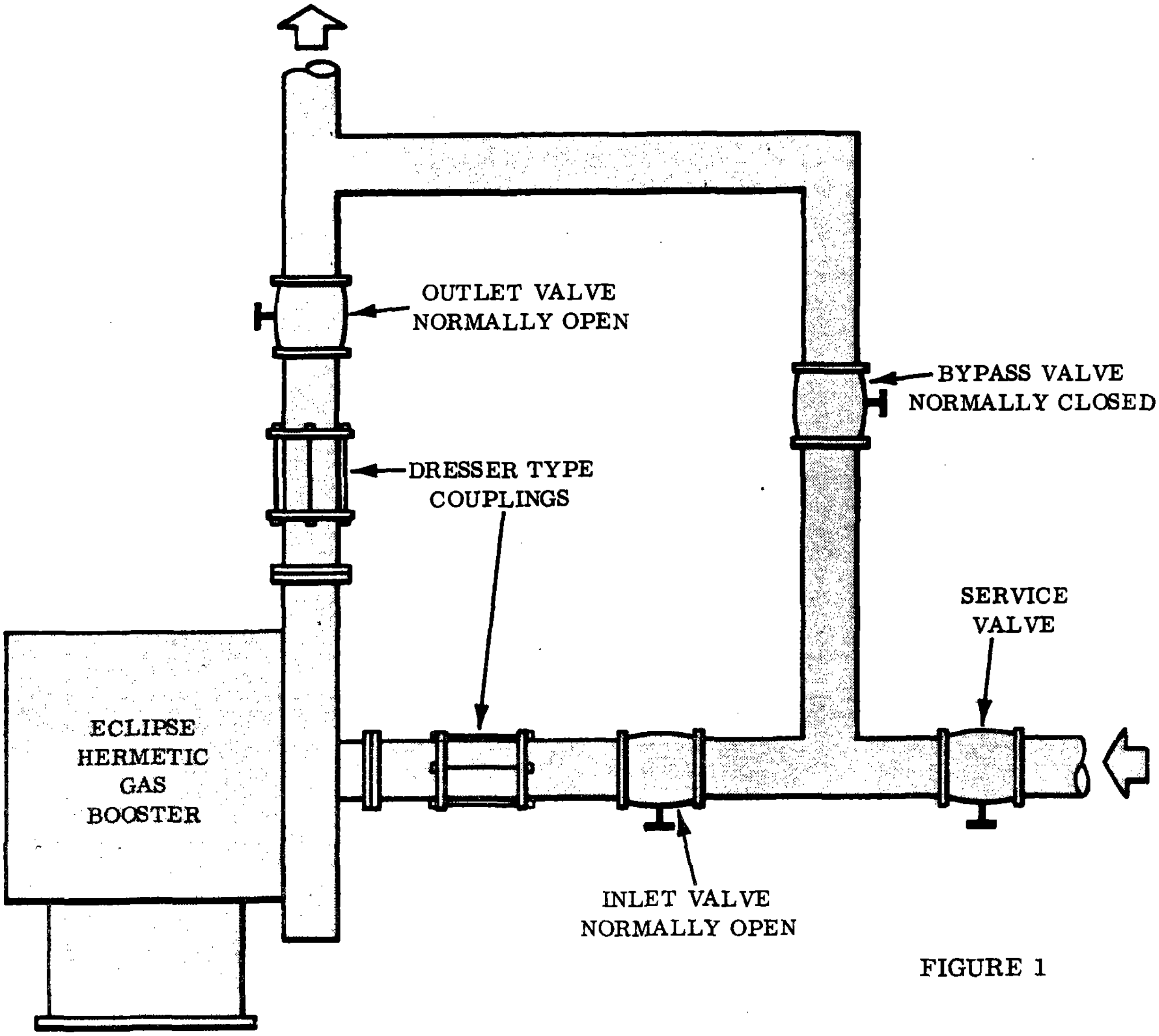


FIGURE 1

3.0 ELECTRICAL CHARACTERISTICS

3.1 Before making any electrical connections, check the electrical characteristics of circuit against those of the motor to make certain they are the same. See Specifications on booster nameplate. (Refer FIGURE 2).

3.2 Because of the wide variety of local electrical codes and regulations covering motor starters, switches and controls, it is recommended that a reliable electrical contractor be engaged to supply the proper starter or switch and to make the necessary electrical connections.

3.3 The motors used on all Eclipse Hermetic Gas Boosters are U.L. Listed Class 1, Group D, explosion-proof. When wiring booster motor, it is essential that it be properly protected against overload and excessive heat conditions. (Refer to FIGURE 5 for suggested wiring.)

3.4 Make sure that heating elements in motor starter are correct for power requirements.

3.5 Check to make sure fan is rotating in the proper direction, i.e., with the blades traveling toward the outlet. This can be determined by removing the 1" pipe plug from the booster end plate, momentarily starting the motor and observing fan rotation. Replace plug after the fan rotation has been determined. (Refer FIGURE 2).

4.0 MAINTENANCE

4.1 Keep motor properly lubricated per motor manufacturer's recommendations. The life of the booster depends largely upon proper care of the motor.

4.2 The entire internal assembly is easily removed from the booster for inspection and/or maintenance of motor and rotor. (Refer FIGURE 3).

4.2.1 Before disassembling, make sure gas, air and electricity have been shut off.

4.2.2 Remove end plate bolts and carefully slide out entire internal assembly. Be careful not to damage or upset balance of rotor.

4.2.3 CAUTION: Anytime the Eclipse Hermetic Gas Booster is disassembled, care should be taken when reassembling to be certain it is properly resealed against leakage. It is recommended a spare flange gasket be available for use when booster is reassembled.

4.2.4 DO NOT DISTURB WIRING CONDUIT OR TERMINAL BOX POSITION. This will break the gas seal and result in gas leakage.

4.3 Contact your local Eclipse sales office for any required assistance and for recommended spare parts.

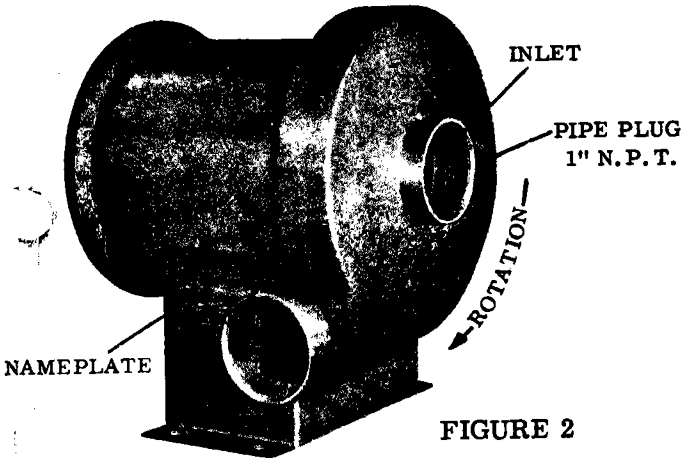


FIGURE 2

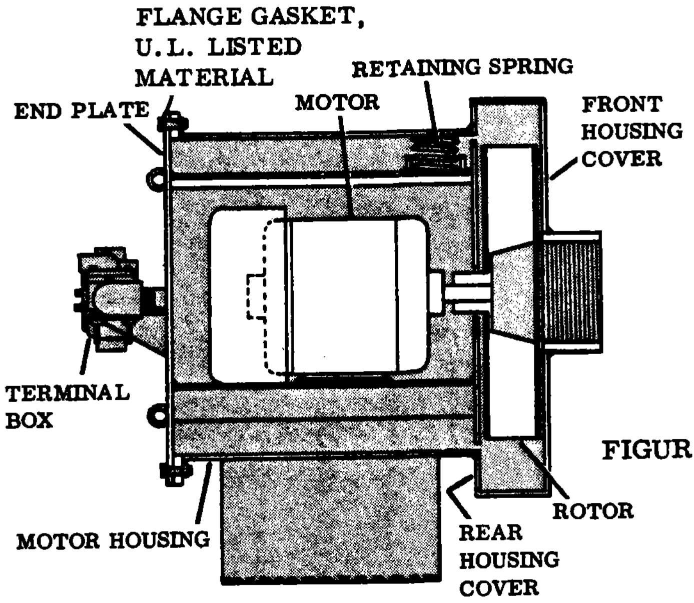


FIGURE 3

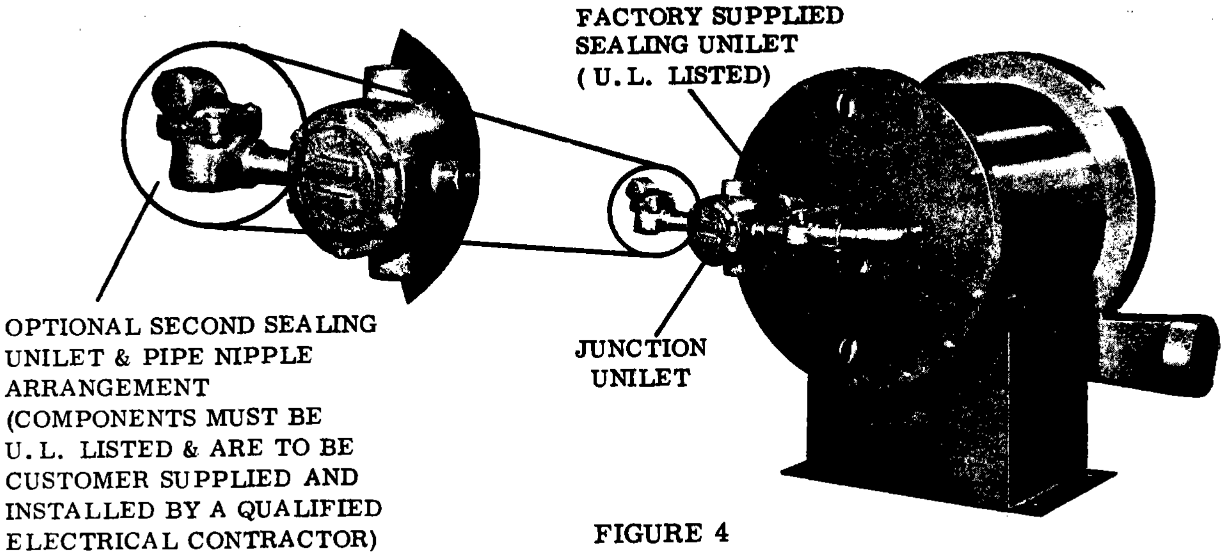
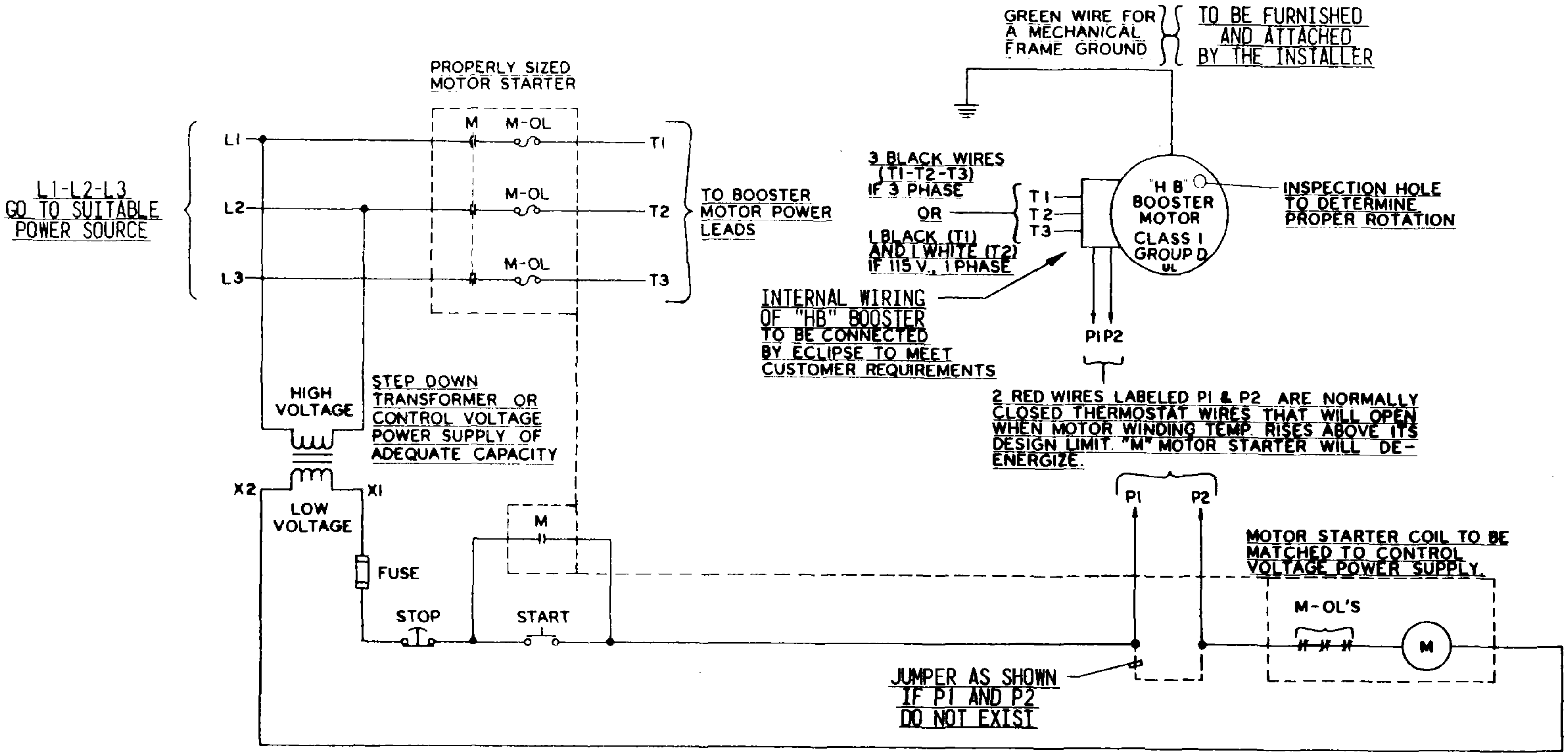


FIGURE 4

FIGURE 5



J.I.C. COLORCODE
WHITE — GROUNDED CIRCUIT CONDUCTOR.
YELLOW — INTERLOCK CONTROL CIRCUIT WIRED FROM AN EXTERNAL SOURCE.
BLACK — LINE VOLTAGE POWER LEADS.
RED — ALTERNATING CURRENT CONTROL WIRES.
BLUE — DIRECT CURRENT CONTROL WIRES.
GREEN — SAME AS FOR N.E.C.

N.E.C. WIRE COLORCODE
WHITE — IS THE "DESIGNATED" CONDUCTOR.
GREEN — FRAME (GROUND) BONDING WIRE.

1 THIS IS "SUGGESTED" WIRING ONLY!!!

2 ECLIPSE INC. WILL INTERNALLY WIRE ONLY THE "HB" BOOSTER FOR THE SPECIFIED VOLTAGE AND BRING OUT TO A TERMINATION BOX THE MINIMUM NUMBER OF NECESSARY CONNECTING WIRES.

3 SOME MOTOR MANUFACTURERS DO NOT FURNISH THERMOSTATS IN THEIR CLASS 1, GROUP D MOTORS. IN WHICH CASE P1 AND P2 DO NOT EXIST AND ECLIPSE INC. CANNOT WIRE THEM NOR CAN ANY INSTALLER. THEREFORE WIRE P1 OR P2 INTO ANY CONTROL CIRCUIT AS SHOWN.

4 WIRING AND INSTALLATION TO CONFORM WITH NATIONAL AND LOCAL ELECTRICAL CODES. ALL WIRING AND EQUIPMENT EXTERNAL TO ECLIPSE HERMETIC BOOSTER TO BE FURNISHED BY OTHERS UNLESS OTHERWISE SPECFIED.

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ECLIPSE COMBUSTION DIVISION
OF ECLIPSE INC.
ROCKFORD, ILLINOIS 61103 (815) 877-3031
IN CANADA: ECLIPSE FUEL ENGINEERING CO. OF CANADA, LTD, DON MILLS, ONTARIO
1.5.1-5

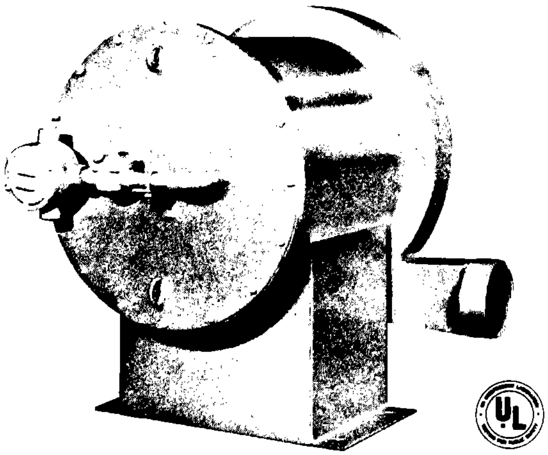
Litho in U.S.A.

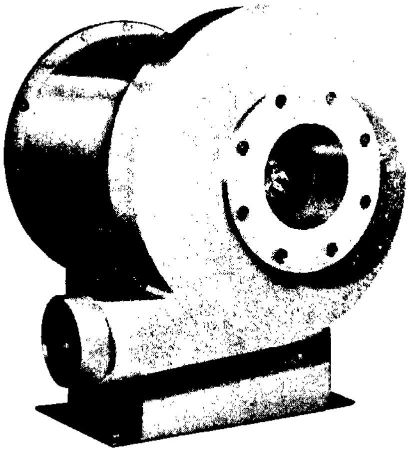
[illegible]

K-74
Bulletin
Rev. 2/80

ECLIPSE HERMETIC GAS BOOSTERS

SERIES HB





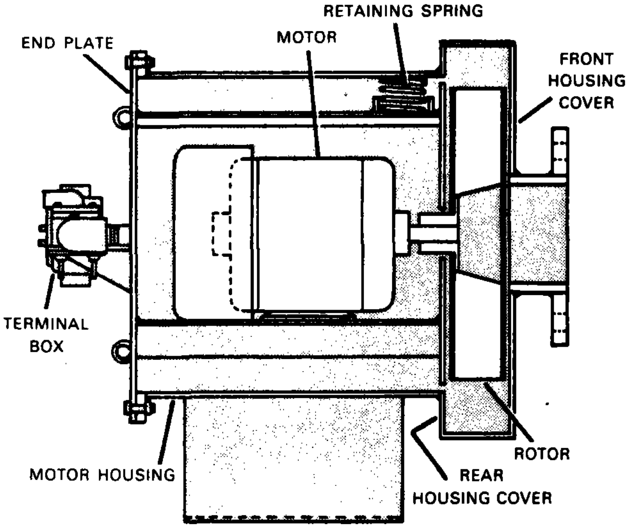
Eclipse Hermetic Gas Boosters are used for pumping any gas or gas/air mixture, which is not corrosive to aluminum or steel, when an increase in pressure is required. They deliver gas at any volume, within the capacity range of the booster, with a relatively constant pressure. The discharge pressure is the total of the booster pressure plus incoming gas pressure.

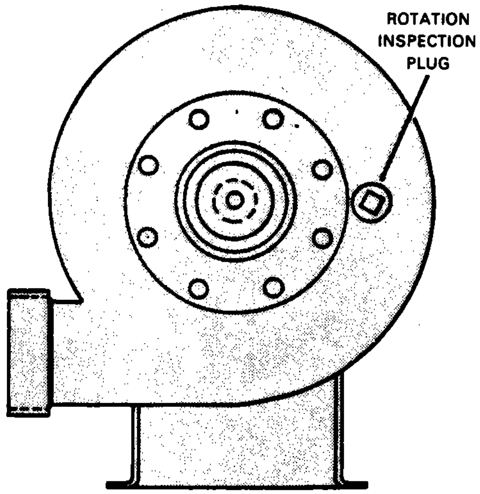
DESIGN FEATURES

The design of Hermetic Boosters permits the motor and rotor to be enclosed in an airtight, steel housing. No shaft seal is required, thus eliminating any possibility of shaft seal leakage, a problem experienced on many gas booster designs. Motor and rotor are easily accessible by unbolting the cover plate and sliding the entire motor and rotor assembly out of the housing.

Sealed electrical connections are made through explosion proof conduit, and an explosion proof junction box is provided. Standard shaft, Class 1, Group D, explosion proof motors are used as standard. These boosters are UL listed when handling natural or manufactured gases.

Hermetic Boosters are available in either standard rotation (CCW as viewed from the side opposite the suction inlet) or counter standard rotation. Four different outlet positions are available on all Hermetic Boosters (see K-74A Specification Sheet). Rotor rotation can be checked on initial start-up by simply removing the pipe plug on the front housing cover.





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IN CANADA: ECLIPSE FUEL ENGINEERING CO. OF CANADA, LTD. DON MILLS, ONTARIO

CAPACITIES

CATALOG NUMBER	MOTOR H. P.	AIR - 1.0 SP. GR.		NAT. GAS - 0.65 SP. GR.		PROPANE/AIR - 1.28 SP. GR.	
		CFH	OSI	CFH	OSI	CFH	OSI
HB-3412-1/3	1/3	4,800	6	6,000	3.9	3,700	7.6
HB-3412-1/2	1/2	6,000	6	9,000	3.7	4,600	7.6
HB-4412-1/2	1/2	8,600	6	12,000	3.9	6,700	7.6
HB-4412-3/4	3/4	14,000	6	20,000	3.5	10,000	7.6
HB-4412-1	1	16,000	5.3	----	---	14,000	7.6
HB-6812-1	1	20,200	6	30,000	3.9	15,000	7.6
HB-6812-1-1/2	1-1/2	40,000	6	44,000	3.9	30,000	7.6
HB-3314-1/3	1/3	----	---	3,600	5.2	----	---
HB-3314-1/2	1/2	3,600	8	5,400	5.2	2,700	10
HB-4414-3/4	3/4	10,700	8	13,000	4.2	7,500	10
HB-4414-1	1	----	---	----	---	9,000	10
HB-4614-3/4	3/4	----	---	12,000	5.2	----	---
HB-4614-1	1	12,000	8	18,000	5.2	9,000	10
HB-4614-1-1/2	1-1/2	21,000	8	21,000	5.2	15,000	10
HB-4615-3/4	3/4	7,700	10	11,500	6.5	6,000	12
HB-4615-1	1	15,300	10	15,300	6.5	11,000	12
HB-6615-1-1/2	1-1/2	----	---	28,000	6.5	----	---
HB-6615-2	2	28,000	10	35,000	6.5	21,000	12
HB-4617-1	1	----	---	15,000	7.8	----	---
HB-4617-1-1/2	1-1/2	15,000	12	18,000	7.3	11,000	15
HB-6617-2	2	19,000	12	25,000	7.8	14,000	15
HB-6617-3	3	32,000	12	35,000	7.8	24,000	15
HB-8817-5	5	55,000	12	80,000	7.8	40,000	15
HB-4619-1-1/2	1-1/2	8,850	16	13,000	10	6,600	20
HB-4619-2	2	12,250	16	18,000	10	9,000	20
HB-6619-3	3	21,500	16	27,000	10	16,000	20
HB-6619-5	5	41,200	16	49,000	10	30,000	20
HB-8819-7-1/2	7-1/2	57,000	16	70,000	10	42,000	20
HB-8819-10	10	70,000	16	----	---	52,000	20
HB-4623-3	3	8,000	24	11,600	15.6	6,000	30
HB-4623-5	5	22,600	24	29,500	15.6	16,800	30
HB-6623-7-1/2	7-1/2	37,000	24	40,000	15.6	27,000	30
HB-6623-10	10	42,000	24	47,000	14.9	35,000	30
HB-8823-15	15	85,000	24	87,000	15.6	60,000	30
HB-8823-20	20	100,000	22	100,000	14.3	85,000	30
HB-4628-5	5	6,000	32	12,000	20	4,500	40
HB-4628-7-1/2	7-1/2	17,700	32	24,000	20	13,000	40
HB-4628-10	10	28,000	32	28,000	20	20,000	40
HB-8828-10	10	32,000	32	40,000	20	24,000	40
HB-8828-15	15	53,000	32	63,000	20	40,000	40
HB-8828-20	20	78,000	32	90,000	20	60,000	40

NOTE: Boosters are for use with any gas not corrosive to aluminum or steel. For capacities and pressures of gases with specific gravities other than those listed, consult factory.

For Dimensions & Specifications, see K-74-A Specification Sheet.

ECLIPSE COMBUSTION DIVISION
OF ECLIPSE INC.
ROCKFORD, ILLINOIS 61103 (815) 877-3031
IN CANADA: ECLIPSE FUEL ENGINEERING CO. OF CANADA, LTD. DON MILLS, ONTARIO

Litho in U.S.A.

1.5.2 UMU AIR BLOWER

1.5.2.1

Identification Tag Number	Description
FA-302	UMU Air Blower

1.5.2.2 Description

Manufacturer : Aladdin Industries Inc., 703 Murfreesboro Road,
Nashville, TN 37210

Part Number :

Specification No. : None

Material :

Weight : 500 lb.

1.5.2.3 Prescribed Service

Air, 1500 CFM, 4 In. SP, 2050 RPM, 1.79 BHP

1.5.2.4 Vendor

Hirt Combustion Engineers, 931 So. Maple Ave., Montebello, CA 90640

1.5.2.5 Special Cautions

None

1.5.2.6 Periodic Service

None

1.5.2.7 Parts List

None

1.5.2.8 Special Tools

None

1.5.2.9 Maintenance Instructions

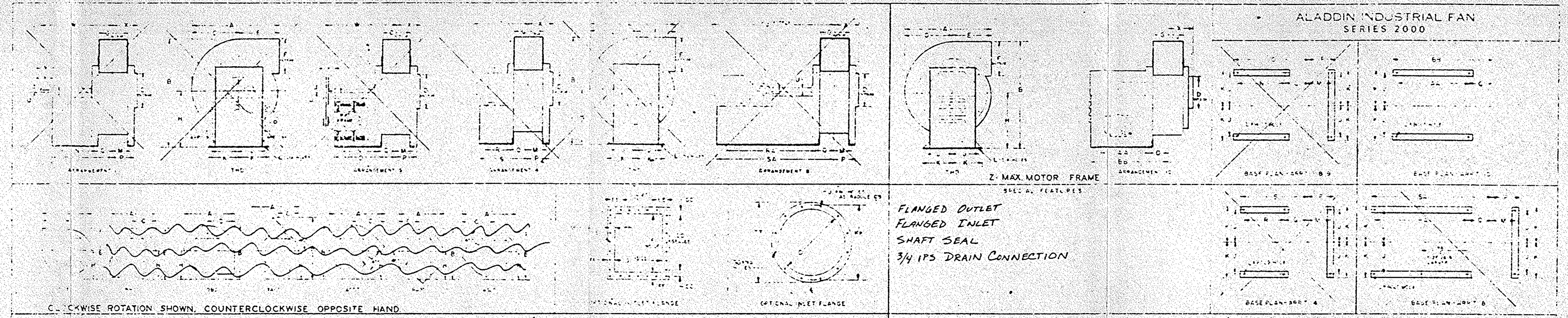
None

1.5.2.10 Acceptance Tests

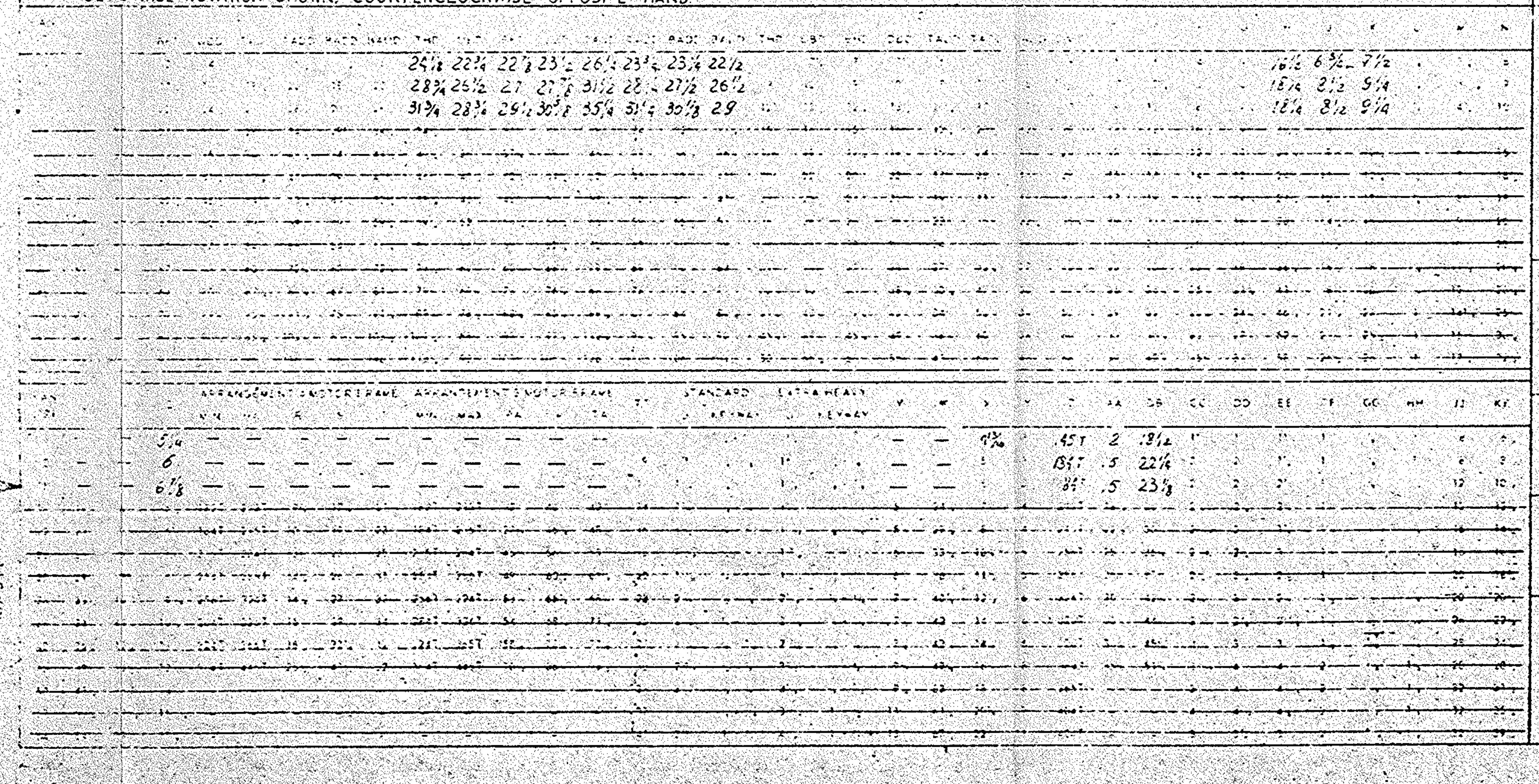
None

F-302

ALADDIN INDUSTRIAL FAN
SERIES 2000



FLANGED OUTLET
FLANGED INLET
SHAFT SEAL
3/4 IPS DRAIN CONNECTION



ITEM NO.	QUANTITY
1	1

FAN SPECIFICATIONS

TYPE INDUSTRIAL SIZE 15 ARRANGEMENT 10 TYPE WHEEL MR HEAVY DUTY WHEEL ___ STD DUTY WHEEL ✓

ROTATION CW DISCHARGE UB MOTOR POSITION ___ TYPE BEARINGS BALL

HEAVY DUTY HOUSING ___ EXTRA HEAVY SHAFT ___

STD DUTY HOUSING ✓ STD DUTY SHAFT ✓ FLANGED OUTLET ✓ FLANGED INLET ✓

DUTY

CFM 1500 OV 3400 SP 4 RPM 2050 TS 8385 BHP 1.79 TEMP °F 70°

MOTOR SPECIFICATIONS

MAKE ___ TYPE ___ FRAME ___ HP ___

RPM ___ VOLTS ___ PHASE ___ CYCLE ___ BEARINGS ___

ENCLOSURE ___ BY OTHERS

DRIVE SPECIFICATIONS

MAKE ___ FAN SHEAVE ___ BORE ___ MOTOR SHEAVE ___ BORE ___

BELTS ___ BY OTHERS ___ DRIVE CENTERS ___

MOTOR CONTROL

PROJECT ___ LOCATION MONTEBELLO, CALIF.

CUSTOMER HIRT COMBUSTION PURCHASE ORDER 1276-5542

ENGINEER ___ REPRESENTATIVE J.D. SALES Co.

DATE 10-28-80 BY C Shulenberger

DRAWING NO 462-2-10671-L

1,5,2-3

Aladdin
AIR HANDLING EQUIPMENT

CHARACTERISTIC CURVES

FAN TYPE "MR" INDUSTRIAL
SERIES 2000
WIDTH SISW
SIZES 9 THRU 22

FAN SIZE	BASIC VALUES			
	RPM	CFM	SP	BHP
9	5000	1 082	9.88	1.74
12	4000	2 304	12.1	4.55
15	3000	3 698	11.3	6.82
19	2000	4 521	7.55	5.55
22	2000	7 482	10.6	12.9

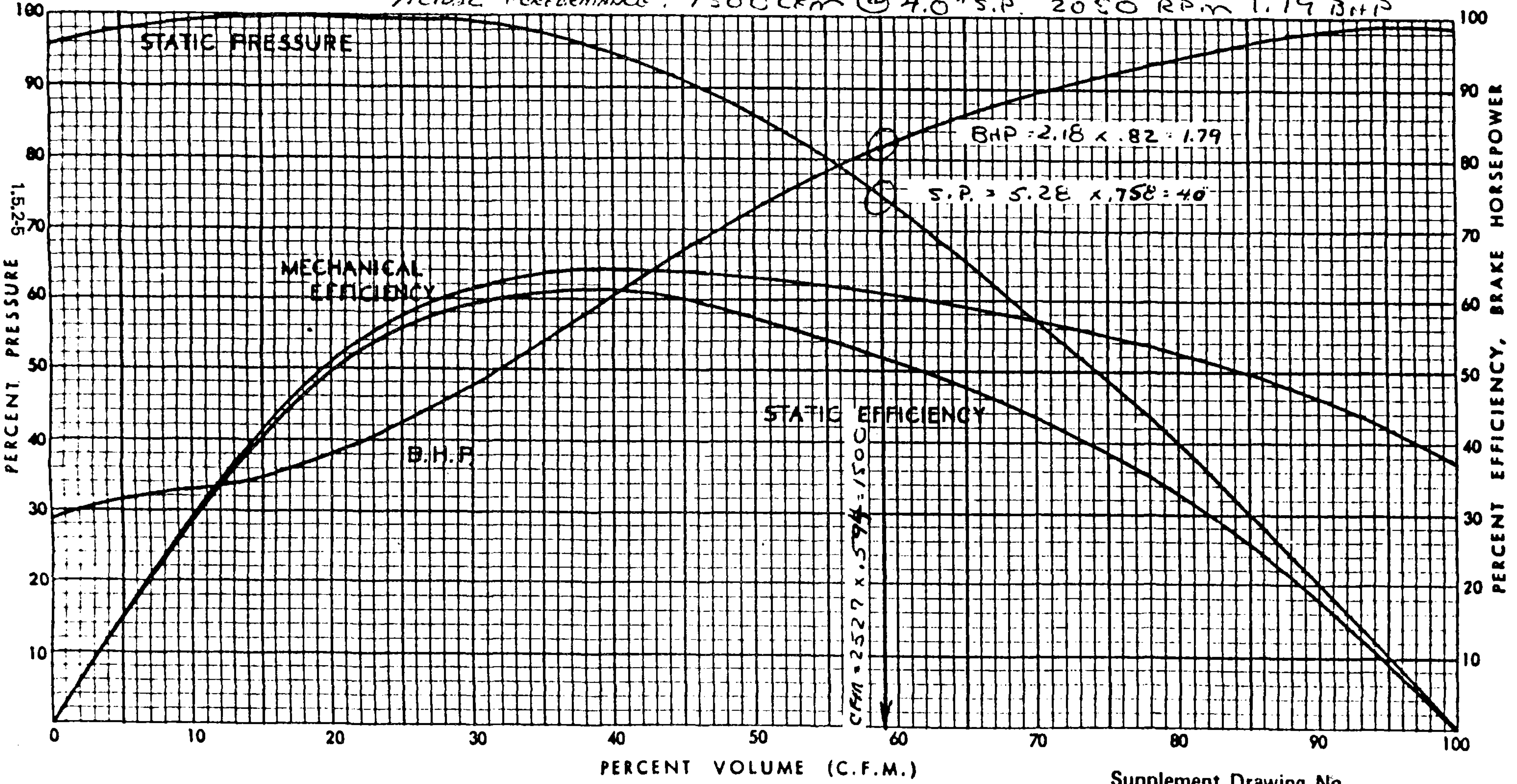
The characteristic curves are for all fan sizes shown and the basic values apply for 100% of the chart scale at RPM listed. At actual RPM, determine 100% scale values of chart as follows:

$$\frac{\text{ACTUAL RPM}}{\text{BASIC RPM}} = R \qquad \begin{array}{l} \text{CFM} = \text{BASIC CFM} \times R \\ \text{SP} = \text{BASIC SP} \times (R)^2 \\ \text{BHP} = \text{BASIC BHP} \times (R)^3 \end{array}$$

FAN SIZE	100% VALUES AT ACTUAL CONDITIONS			
	RPM	CFM	SP	BHP
15	2050	2527	5.28	2.18

462- 21/23

Actual Performance: 1500 CFM @ 4.0" S.P. 2050 RPM 1.79 BHP



Supplement Drawing No. ____________

Equipment Number	Description	Maintenance Section	P&ID Dwg. Number
PR-901	Turbine lube oil centrifuge	1.6.1	G. E. lube oil

Aladdin
AIR HANDLING EQUIPMENT

CHARACTERISTIC CURVES

FAN TYPE "MR" INDUSTRIAL
SERIES 2000
WIDTH SISW
SIZES 9 THRU 22

FAN SIZE	BASIC VALUES			
	RPM	CFM	SP	BHP
9	5000	1 082	9.88	1.74
12	4000	2 304	12.1	4.55
15	3000	3 698	11.3	6.82
19	2000	4 521	7.55	5.55
22	2000	7 482	10.6	12.9

The characteristic curves are for all fan sizes shown and the basic values apply for 100% of the chart scale at RPM listed. At actual RPM, determine 100% scale values of chart as follows:

$$\frac{\text{ACTUAL RPM}}{\text{BASIC RPM}} = R \qquad \begin{aligned} \text{CFM} &= \text{BASIC CFM} \times R \\ \text{SP} &= \text{BASIC SP} \times (R)^2 \\ \text{BHP} &= \text{BASIC BHP} \times (R)^3 \end{aligned}$$

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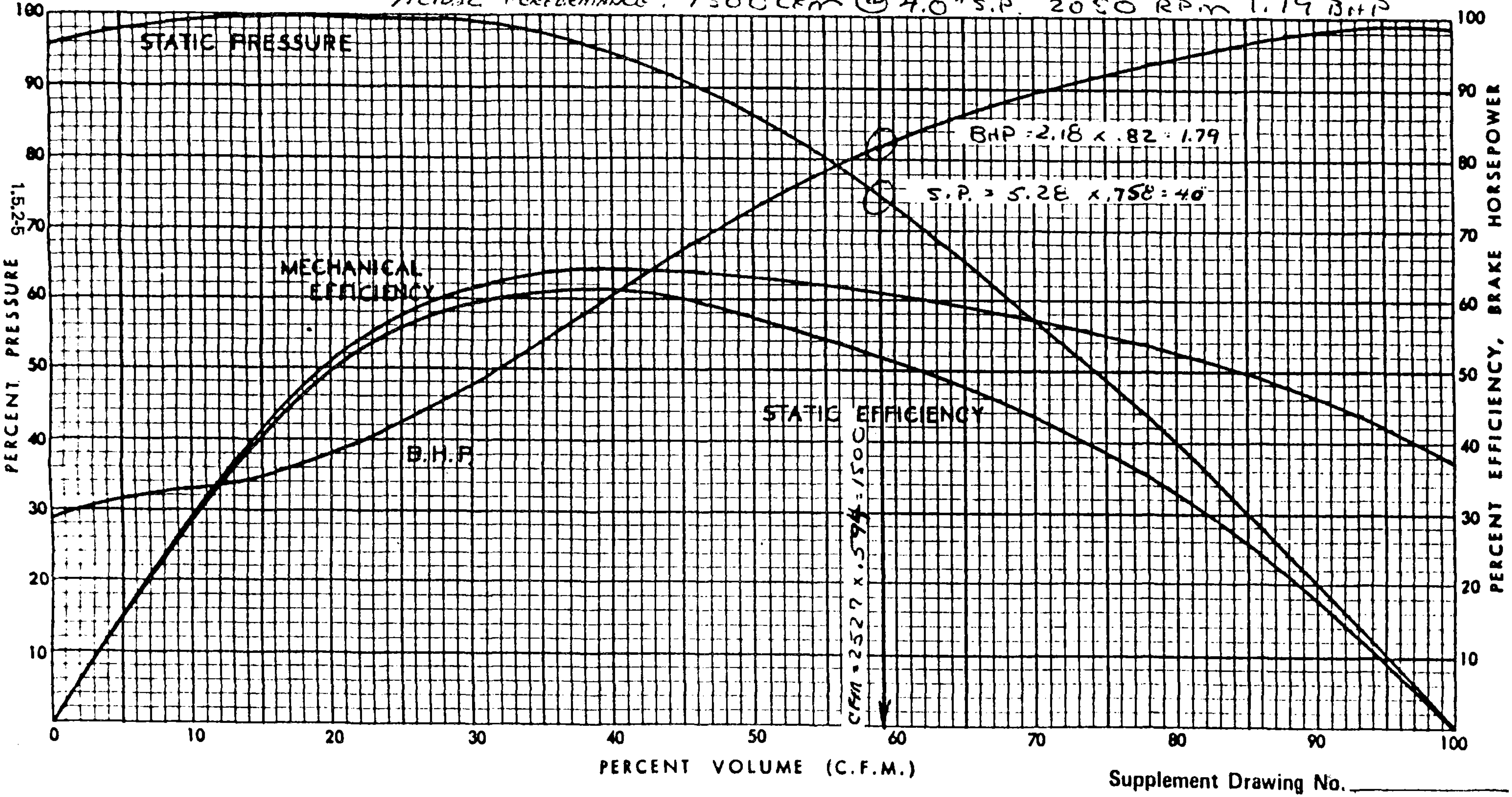
FAN SIZE	100% VALUES AT ACTUAL CONDITIONS			
	RPM	CFM	SP	BHP
15	2050	2527	5.28	2.18

Actual Performance: 1500 CFM @ 4.0" S.P. 2050 RPM 1.79 BHP



BHP = 2.18 x .82 = 1.79

S.P. = 5.28 x .758 = 4.0

CFM = 2527 x .594 = 1500

Supplement Drawing No. ____

Equipment Number	Description	Maintenance Section	P&ID Dwg. Number
PR-901	Turbine lube oil centrifuge	1.6.1	G. E. lube oil

Aladdin
AIR HANDLING EQUIPMENT

CHARACTERISTIC CURVES

FAN TYPE "MR" INDUSTRIAL
SERIES 2000
WIDTH SISW
SIZES 9 THRU 22

FAN SIZE	BASIC VALUES			
	RPM	CFM	SP	BHP
9	5000	1 082	9.88	1.74
12	4000	2 304	12.1	4.55
15	3000	3 698	11.3	6.82
19	2000	4 521	7.55	5.55
22	2000	7 482	10.8	12.9

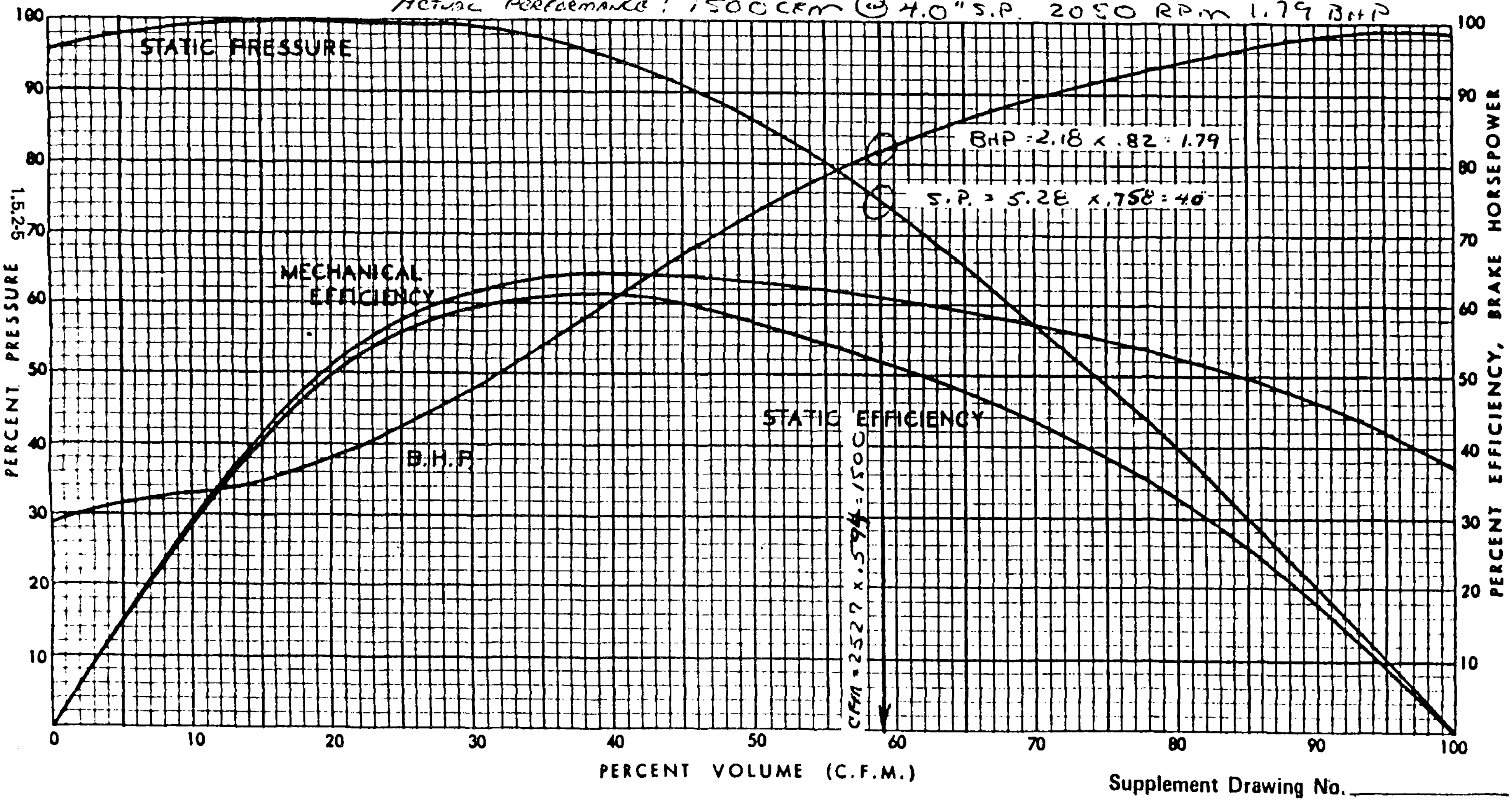
The characteristic curves are for all fan sizes shown and the basic values apply for 100% of the chart scale at RPM listed. At actual RPM, determine 100% scale values of chart as follows:

$$\frac{\text{ACTUAL RPM}}{\text{BASIC RPM}} = R \qquad \begin{aligned} \text{CFM} &= \text{BASIC CFM} \times R \\ \text{SP} &= \text{BASIC SP} \times (R)^2 \\ \text{BHP} &= \text{BASIC BHP} \times (R)^3 \end{aligned}$$

462- 21/23

FAN SIZE	100% VALUES AT ACTUAL CONDITIONS			
	RPM	CFM	SP	BHP
15	2050	2527	5.28	2.18

ACTUAL PERFORMANCE : 1500 CFM @ 4.0" S.P. 2050 RPM 1.79 BHP



BHP = 2.18 x .82 = 1.79

S.P. = 5.28 x .758 = 4.0"

CFM = 2527 x .594 = 1500

Supplement Drawing No.

Equipment Number	Description	Maintenance Section	P&ID Dwg. Number
PR-901	Turbine lube oil centrifuge	1.6.1	G. E. lube oil

1.6 CENTRIFUGES