WOODWARD

Installation and Operation Manual

# EG-3P Actuator

**including EG-1P, EG-3P with compensation, EG-3P oil motor, and EG-3P oil pump**

**Manual 82560 (Revision L)**

## WARNING—DANGER OF DEATH OR PERSONAL INJURY

**WARNING—FOLLOW INSTRUCTIONS**

**Read this entire manual and all other publications pertaining to the work to be performed before installing, operating, or servicing this equipment. Practice all plant and safety instructions and precautions. Failure to follow instructions can cause personal injury and/or property damage.**

**WARNING—OUT-OF-DATE PUBLICATION**

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**WARNING—OVERSPEED PROTECTION**

**The engine, turbine, or other type of prime mover should be equipped with an overspeed shutdown device to protect against runaway or damage to the prime mover with possible personal injury, loss of life, or property damage.**

**The overspeed shutdown device must be totally independent of the prime mover control system. An overtemperature or overpressure shutdown device may also be needed for safety, as appropriate.**

**WARNING—PROPER USE**

**Any unauthorized modifications to or use of this equipment outside its specified mechanical, electrical, or other operating limits may cause personal injury and/or property damage, including damage to the equipment. Any such unauthorized modifications: (i) constitute "misuse" and/or "negligence" within the meaning of the product warranty thereby excluding warranty coverage for any resulting damage, and (ii) invalidate product certifications or listings.**

## CAUTION—POSSIBLE DAMAGE TO EQUIPMENT OR PROPERTY

**CAUTION—BATTERY CHARGING**

**To prevent damage to a control system that uses an alternator or battery-charging device, make sure the charging device is turned off before disconnecting the battery from the system.**

**CAUTION—ELECTROSTATIC DISCHARGE**

**Electronic controls contain static-sensitive parts. Observe the following precautions to prevent damage to these parts.**

- **Discharge body static before handling the control (with power to the control turned off, contact a grounded surface and maintain contact while handling the control).**
- **Avoid all plastic, vinyl, and Styrofoam (except antistatic versions) around printed circuit boards.**
- **Do not touch the components or conductors on a printed circuit board with your hands or with conductive devices.**

## IMPORTANT DEFINITIONS

- **A WARNING indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.**
- **A CAUTION indicates a potentially hazardous situation which, if not avoided, could result in damage to equipment or property.**
- **A NOTE provides other helpful information that does not fall under the warning or caution categories.**

**Revisions—Text changes are indicated by a black line alongside the text.**

# Contents



# Illustrations and Tables

# Chapter 1.
# General Information

## 2301 Electric Governor

The 2301 electric governor is one in which its actuator output (terminal) shaft position is directly proportional to the input signal from its electric control unit. It can be used in an isochronous (constant speed) mode for single engine operation or when paralleled with similar units on an isolated bus. It can also be used in the droop mode for paralleling dissimilar units or operating on an infinite bus. The 2301 governor is used in the same type of service as many other governor models. It is particularly well suited, when used with some types of proportional actuators, to engines operated in tandem to drive a common load. In such installations, one electric control is used to furnish the same input signal to the proportional actuator on each engine. Since each actuator receives the same current, their output shafts take the same position and give each engine the same amount of fuel.

The 2301 electric governor consists of an electric control unit, a speed setting potentiometer, and a hydraulic actuator. The electric control receives the input signals to the governor; its output serves as the input signal to the actuator. The actuator output controls the flow of energy medium to the prime mover. The speed setting potentiometer, used to adjust speed setting, provides one of the inputs to the electric control.

The operation of the 2301 type governor is different and distinct from other electric governors. The steady-state output of the electric control is a level of voltage determined by the actuator terminal shaft position required to maintain a particular load on the prime mover. The voltage is always the same polarity. This type of control unit requires an actuator in which the output shaft takes a position proportional to the voltage of the input signal.

In contrast, the electric control unit of the EG series electric governor emits a nominally zero signal during conditions of on-speed, steady-state operation, and larger voltage signal only during off-speed or load-changing periods. In this type of system, the direction of actuator operation depends on signal polarity.

As is the case with any type governor, the prime mover should be equipped with a separate overspeed device to prevent runaway if a failure should render the governor inoperative.

## Proportional Actuators for 2301 Electric Controls

Among the proportional actuators used with the 2301 electric controls are:

### EGB-2P Actuator

This is a proportional actuator that has a mechanical-hydraulic backup governor section as well as an electric-signal-operated governor section. It must be driven directly from the prime mover for speed sense to the flyweights and operation of the governor oil pressure pump. The EGB-2P actuator has a stalled work capacity of 2.5 ft-lb (3.4 J) at a 32° output shaft travel. Useful work capacity is about 2/3 of stalled capacity.

## EG-3P Actuator

This actuator has no mechanical-hydraulic backup governor. Some models require a drive for an internal oil pump, but the rotation need not be proportional to prime mover speed. These models can be mounted external to the prime mover and driven by an electric motor or other device if no drive pad has been furnished on the prime mover. Other models have an oil motor built into the actuator. These units require pressure oil from an external source to operate the oil motor and provide the working pressure needed by the actuator.

The EG-3P has 4.5 ft-lb (6.1 J) of stalled work capacity, a useful work capacity of 3 ft-lb (4 J), and a maximum 42° output shaft travel. Torque rating is 6.0 lb-ft (8.1 N·m).

## 2301 Actuator

The simplest of the proportional actuators, the 2301 actuator does not require a drive of any kind, since there is no flyweight backup governor or pressure pump contained in it. Hydraulic pressure fluid must be supplied from an external source, such as the prime mover's fuel oil or lubricating oil supply. Accepting fluid pressures within a 15–100 psi (103–690 kPa) range, the 2301 actuator will supply 0.166 ft-lb (0.225 J) of stalled work capacity for each 10 psi (69 kPa) hydraulic pressure input (useful work is about 2/3 of stalled capacity), through an angular output shaft travel of 30°. Torque is 0.32 lb-ft (0.43 N·m) per each 10 psi (69 kPa) input.

In applications involving unattended cold starting, an EG-type actuator is recommended unless fuel oil with its low viscosity is available as the pressure source for the 2301 actuator. Most lubricating oils are suitable for controlling the 2301 actuator when oil is at operating temperature. Viscosity of hydraulic fluid above 1000 SSU during cold start will temporarily cause the actuator to operate erratically.

This manual describes the EG-3P actuator, which may be used with any of the 2301 electric controls. Other manuals describe the other actuators and the electric controls available to operate proportional actuators.

# EG-3P Actuator

## Description

The essential element of the EG-3P actuator is an electro-hydraulic transducer which controls oil flow to and from the power piston through the action of a polarized solenoid. The position of the terminal shaft on the EG-3P actuator is proportional to the input current to the solenoid coil controlling the hydraulic pilot valve plunger.

The EG-3P actuator has a stalled work capacity of 4.5 ft-lb (6.1 J) at 400 psi (2758 kPa), a useful work capacity of 3 ft-lb (4 J), and a stalled torque rating of 6.0 lb-ft (8.1 N·m) transmitted through an output shaft rotation of 42°.

Table 1-1 shows a list of typical governor oil pressures versus useful work output. The output is proportional to the pressure input, and applies to the oil motor model only. The oil pump model operates at 400 psi (2758 kPa) for 3 ft-lb (4 J) of useful work output.

| Actuator Operating Oil Pressure | Useful Work Output |
|---|---|
| 400 psi (2758 kPa) | 3.00 ft-lb (4.07 J) |
| 300 psi (2068 kPa) | 2.25 ft-lb (3.05 J) |
| 200 psi (1379 kPa) | 1.50 ft-lb (2.03 J) |
| 100 psi (690 kPa) | 1.00 ft-lb (1.36 J) |

Table 1-1. Typical Governor Oil Pressure vs Useful Work Output

For emergency start-ups, Woodward recommends an oil sump to furnish immediate oil to the actuator.

The EG-3P actuator normally goes to minimum fuel if the electric signal is interrupted. Oil for the EG-3P actuator is taken from the engine lubricating system or from a separate sump (not furnished by Woodward).

An EG-3P actuator can be furnished with or without a drive shaft. The drive shaft of a unit fitted with such a shaft can be driven by the prime mover or some other means to provide relative rotation between the pilot valve plunger and bushing and to rotate the oil pump gears. The drive shaft should rotate between 1200 and 3600 rpm. It can rotate in one direction only. The direction of rotation is determined by the placement of plugs in the oil passages in the actuator base and case. A relief valve is incorporated within the actuator to maintain the operating oil pressure at approximately 350 psi (2413 kPa) above supply pressure.

An EG-3P actuator not fitted with a drive shaft is equipped with an oil motor. Actuators with oil motors do not have oil pumps. Oil under pressure must be supplied to provide working pressure for the actuator and to operate the oil motor which rotates the pilot valve bushing. Oil supply to the Oil Motor is restricted by an orifice. The size of the orifice depends upon the pressure supplying the unit on the following scale:

| Supply Pressure | Orifice Diameter |
|---|---|
| 80 to 99 psi (552 to 687 kPa): | 0.076” (1.93 mm) dia. |
| 100 to 175 psi (688 to 1210 kPa): | 0.062” (1.57 mm) dia. |
| 176 to 300 psi (1211 to 2071 kPa): | 0.055” (1.40 mm) dia. |
| 301 to 500 psi (2072 to 3448 kPa): | 0.047” (1.19 mm) dia. |

The orifice size is supplied inside most of the actuators at the time of purchase and is matched to the specified supply pressure.

Some actuators are designed to have a separate supply line to the oil motor and in these instances the orifice is placed in the connection to the oil motor rather than in an internal oil passage.

Work output of the EG-3P actuator equipped with an oil motor depends upon the pressure of the oil supplied to the actuator. With a 400 psi (2758 kPa) supply pressure, the actuator output would be 4.5 ft-lb (6.1 J).

## Operation

Oil from the external source enters the suction side of the oil pump. The pump gears carry the oil to the pressure side of the pump, first filling the oil passages and then increasing the hydraulic pressure. When the pressure becomes great enough to overcome the relief valve spring force and push the relief valve plunger down to uncover the bypass hole, the oil recirculates through the pump.

The movement of two opposing pistons rotates the actuator terminal shaft. The prime mover fuel (or steam) linkage is attached to the terminal shaft.

Pressure oil from the pump is supplied directly to the underside of the loading piston. Pressure in this hydraulic circuit always tends to turn the terminal shaft in the “decrease fuel” direction.

Since the linkage that connects the loading piston to the terminal shaft is shorter than the linkage that connects the power piston to the terminal shaft, the loading piston cannot move up unless the power piston moves down. The power piston moves down only when the oil trapped beneath it escapes to sump.

The flow of oil to and from the power piston is controlled by the pilot valve plunger. With the pilot valve plunger centered, no oil flows to or from the power piston. The pilot valve plunger is centered when its control land exactly covers the control port in the pilot valve bushing.

The greater of two forces moves the pilot valve plunger up or down. When the forces are equal, the plunger does not move.

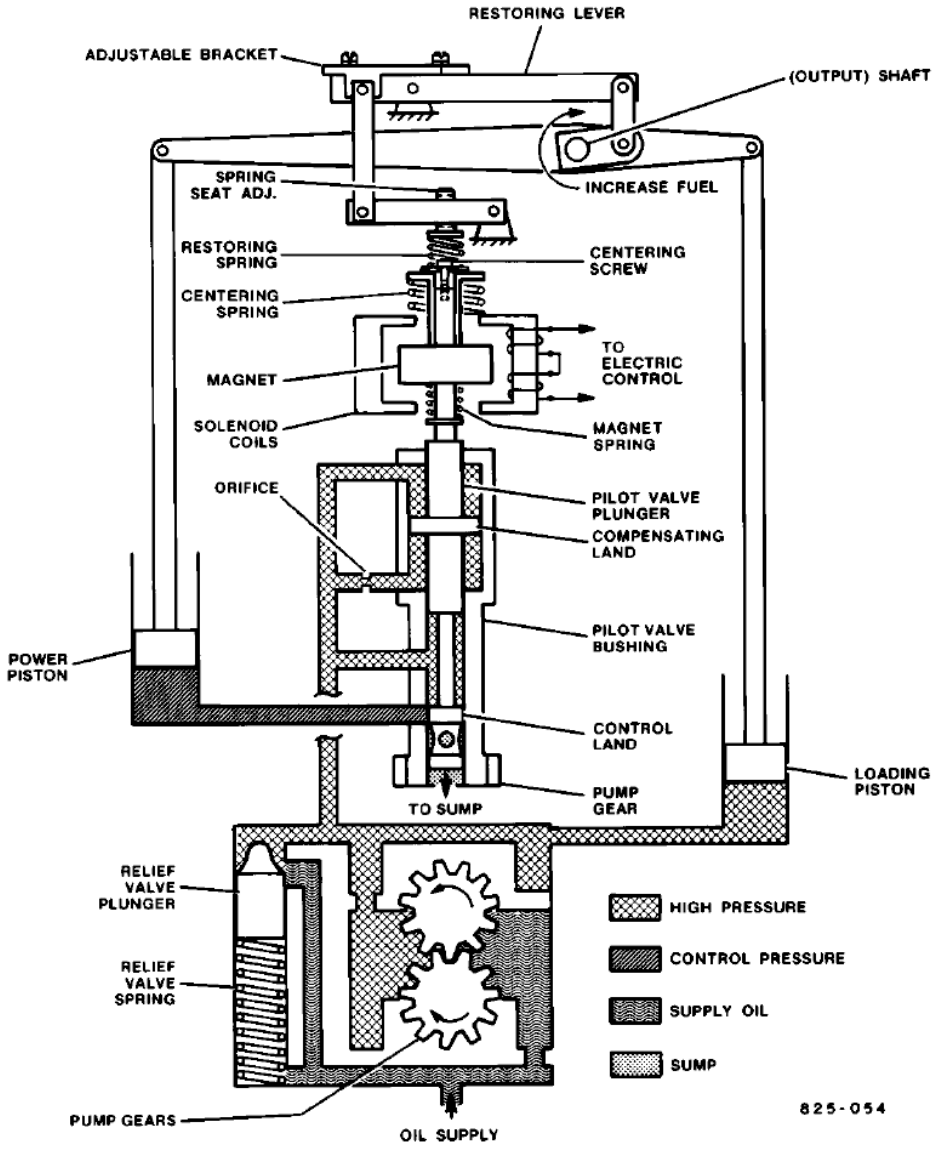



Figure 1-1. EG-3P Schematic

The pilot valve plunger is connected to a permanent magnet that is spring-suspended in the field of a two-coil solenoid. The output signal from the electric control box is applied to the solenoid coils and produces a force, proportional to current in the coils, which tends always to move the magnet—and pilot valve plunger—down.

A spring force tends always to move the pilot valve plunger and magnet up. The centering spring sits atop the case in which the solenoid coils are located. It exerts a constant upward force on the pilot valve plunger. The restoring spring exerts a downward force on the pilot valve plunger. The downward force from the restoring spring depends upon the position of the restoring lever. The restoring lever moves up to decrease the restoring spring force as the terminal shaft rotates in the “increase” fuel (or steam) direction. The resultant force from the combined output of the centering spring and restoring spring is a force that is always urging the pilot valve plunger in the “up” direction; this resultant force increases as the terminal shaft moves in the “increase” fuel (or steam) direction.

With the unit running on-speed under steady-state conditions, the resultant spring force and force from the current in the solenoid coils are equal but opposite.

Assume the unit is running on-speed under steady-state conditions. The pilot valve plunger is centered. A decrease in voltage input to the solenoid coils—due to a decrease in speed setting or a decrease in load—decreases the force tending to lower the pilot valve plunger. Consequently, the unchanged spring force is now greater and lifts the plunger above center. As oil escapes from under the power piston, the terminal shaft rotates in the “decrease” fuel (or steam) direction. When the terminal shaft has rotated far enough to satisfy the new fuel requirement, the increase in restoring spring force will “equal” the decrease in downward force from the current in the solenoid coils, and the pilot valve plunger will be re-centered by the again equal but opposite forces acting upon it.

Were the voltage signal input to the solenoid coils increased—due to an increase in load or an increase in speed setting—similar but opposite reactions would occur. The now greater downward force from the solenoid coils would move the pilot valve plunger down. The power piston and restoring lever would be moved up, decreasing the downward force of the restoring spring. When the terminal shaft would have rotated far enough to satisfy the new fuel requirement, the decrease in restoring spring force would “equal” the increase in downward force from the current in the solenoid coils and the pilot valve plunger would be re-centered by the again equal but opposite forces acting upon it.

# EG-3P Actuator (with Compensation)

## Description

Many EG-3P actuators operate with oil supplied directly from the prime mover. Certain multi-viscosity motor oils require a compensation system within the actuator to provide needed stability.

The EG-3 proportional actuator can be supplied from the factory with a compensation system. The compensation system will supply extra hydraulic pressure to the pilot valve plunger to assist the plunger’s return to a normal, centered position following a fuel change. Figure 1-2 is a schematic of the compensation system.

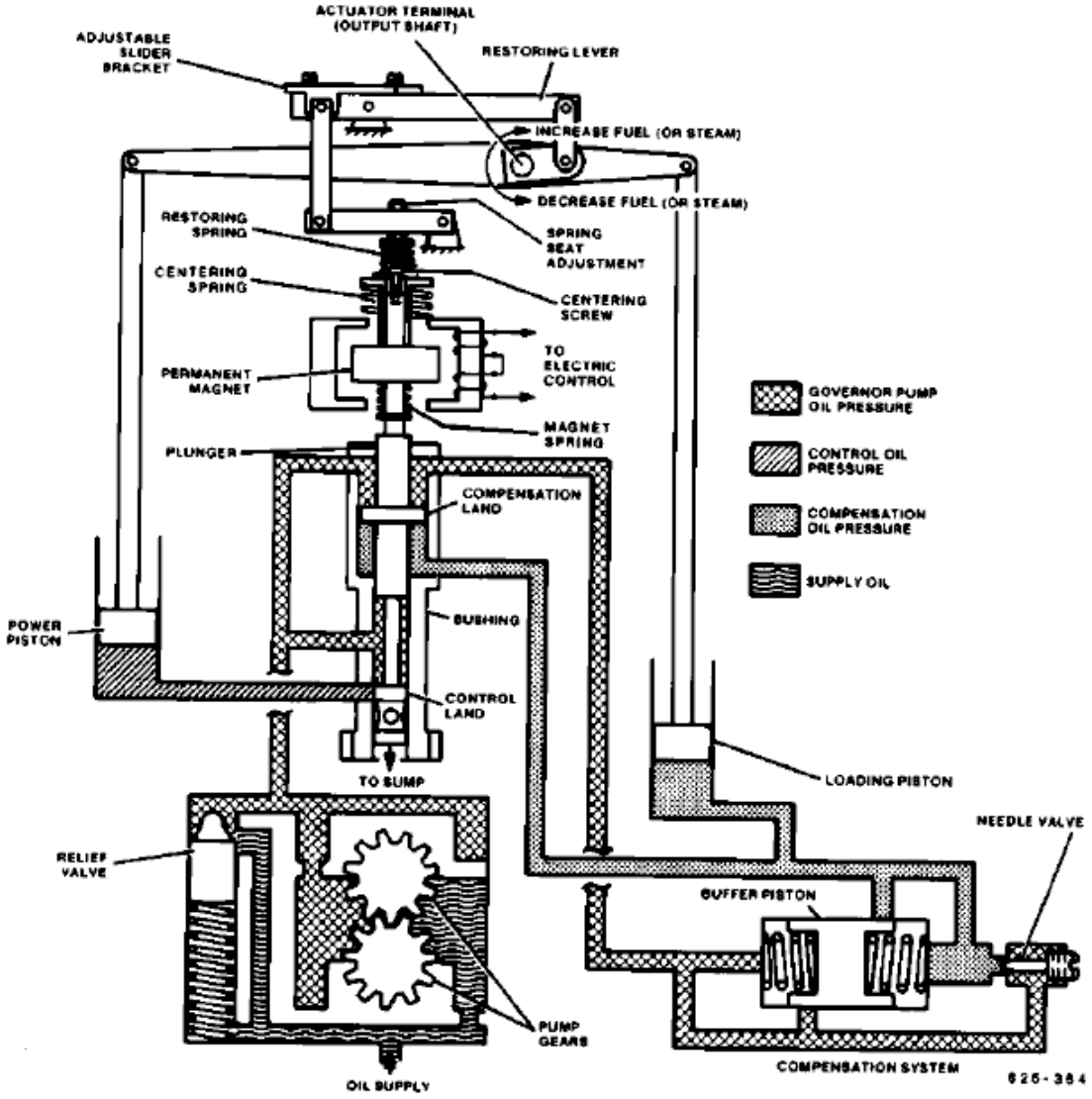



Figure 1-2. EG-3PC Schematic

## Buffer System

With a fuel change, the new position taken by the loading piston changes the pressure of the compensation oil, temporarily. The new pressure causes a pressure difference across the compensation land and this assists in re-centering the plunger. The buffer piston is also displaced by the pressure difference and this energy is stored in the buffer springs. As the engine returns to speed, the pressure difference stored by the buffer system is dissipated through the needle valve.

## EG-1P and EG-1PC

The EG-1 P and EG-1 PC (with compensation) actuators offer reduced work output and faster response time than the EG-3 units. The quick response variation is built in both the oil pump and oil motor model.

All adjustment, maintenance and other information contained in this manual is equally applicable to the EG-1 model. Many parts are interchangeable. Since part designations in this manual are reference numbers, not actual part numbers, parts for the EG-1 may be ordered from this manual as well as parts for the EG-3P and EG-3PC actuators.

## Needle Valve Adjustment

The needle valve is factory set at two turns out from closed. If instability is experienced during operation with cold multi-viscosity oils the needle valve can be turned in until stability is obtained. The actuator should not be run at a needle valve opening of less than one turn out from closed as response would not be acceptable. A wider needle valve opening provides quicker actuator response but less stability. This adjustment must be made at startup, before engine oil warms up. See Figure 1-3 for the needle valve location.

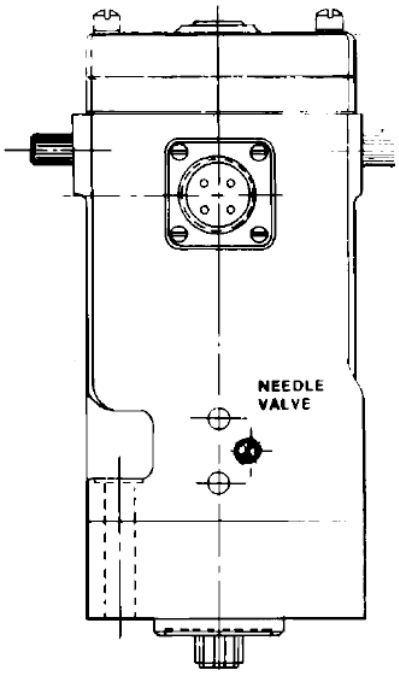



Figure 1-3. Needle Valve Location

## Parts

Six additional parts are added to the base for the EG-proportional-compensated actuator. The configuration of the base is also slightly changed. The additional parts are shown in Figure 1-4. A needle valve with O-ring is added to the case.

| Ref. No. | Part Name ..... Quantity |
|---|---|
| 82560-107 | Snap Ring ..... 1 |
| 82560-108 | Buffer Plug ..... 1 |
| 82560-109 | O-ring ..... 1 |
| 82560-110 | Buffer Spring ..... 2 |
| 82560-111 | Buffer Piston ..... 1 |
| 82560-112 | O-ring ..... 1 |
| 82560-113 | Needle Valve ..... 1 |

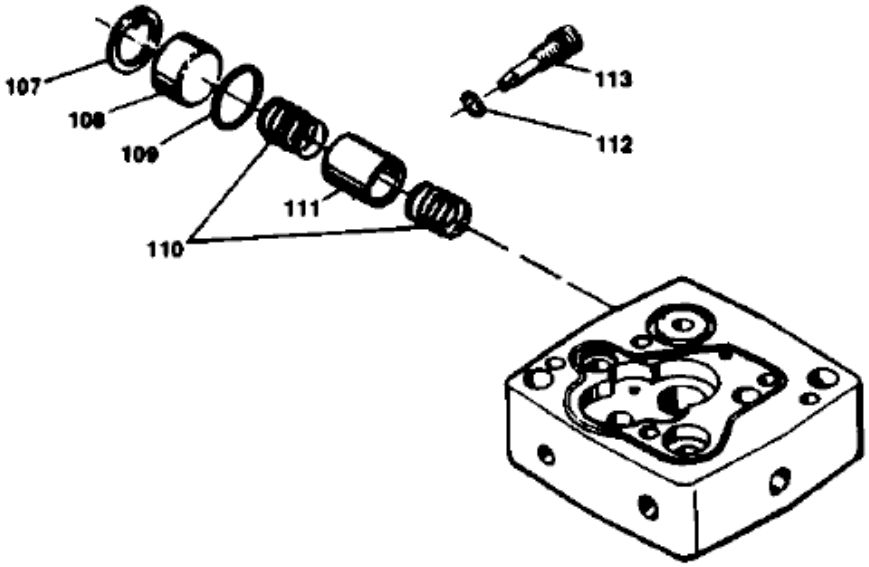



Figure 1-4. Parts for Compensation

**NOTE**

**If the unit will not be activated within three months of delivery, place an adequate desiccant in the packing to help keep the actuator free of rust formation.**

# Chapter 2.
# Installation

## Introduction

Take care to mount the actuator “square” with the engine (or turbine) linkage.

If the actuator is one driven by the engine or some other source, a gasket should be placed between the base and the base mounting pad. The gasket must not block the two drain holes adjacent to the centering pilot of the base (see Figure 4-3).

**NOTE**
**Seal the oil supply hole in the base with a gasket when it is not being used. See Figure 4-5, Note 2.**

Oil draining through the drive shaft bore must flow freely to sump. The splined drive shaft must fit into the drive with a free, slip fit; no tightness is permitted. The actuator must drop onto the mounting pad of its own weight without applying force.

Horizontal mounting configurations are provided with a drain in the cover (Figure 4-1 parts 83 and 84). Drain through the base is plugged.

Jumper wire connections C and D of the mating connector to the actuator (see Figures 4-3 and 4-4).

### Linkage Attachments

Adjustment of the fuel linkage must provide for control of fuel from “OFF” to “FULL FUEL” within the limits of the 42° of actuator output shaft travel. It must also provide for approximately 28° output shaft travel between “NO LOAD” and “FULL LOAD,” (See Figure 2-1).

The engine linkage must be free of binding and without backlash. If there is a collapsible member in the linkage, be sure it does not yield each time the actuator moves the linkage rapidly.

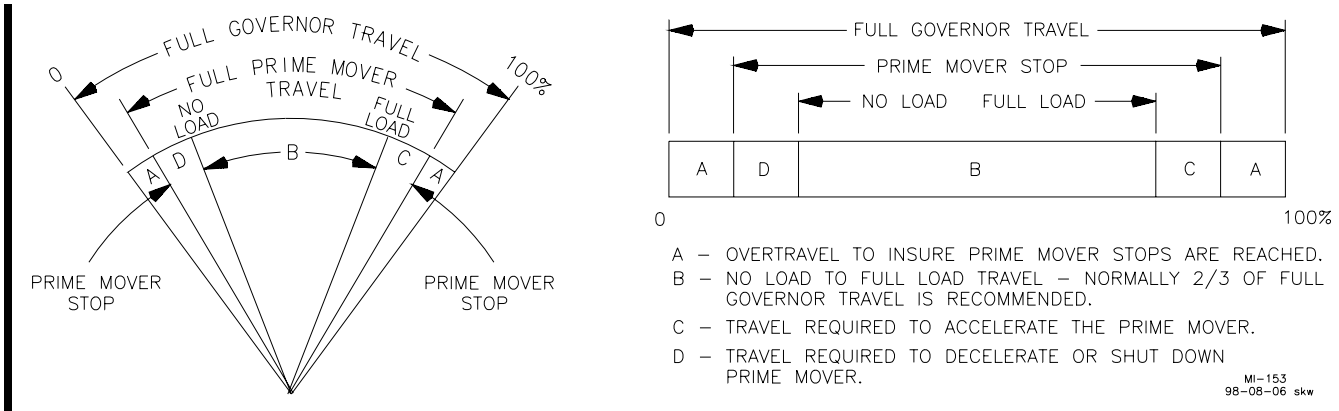



Figure 2-1. Recommended Actuator Output Shaft Travel Adjustment

**NOTE**
**Maximum work capacity over full governor travel of 42° is *. See Figure 2-1 for recommended governor output travel. In special applications, min and max prime mover stops may be outside the governor stops.**

***—See Table 1-1 for values.**

**WARNING—MINIMUM/MAXIMUM FUEL POSITIONS**
**Be sure to allow sufficient overtravel at each end of the output shaft so that the actuator can shut down the prime mover and also give maximum fuel when required.**

### Shaft Driven Oil Supply

A 3/8” (~9.5 mm) OD tubing oil line must be connected from the oil supply to either of two 1/8” (~3.2 mm) pipe tapped inlet holes in the actuator case. A minimum of 5 psi (34 kPa) oil pressure is required at the actuator end of the line. If a separate sump is used (rather than engine lubricating oil), the lift head must not exceed 12” (30 cm) and a foot valve should be used.

### Oil Motor Oil Supply

A 3/8” (~9.5 mm) OD tubing oil line must be connected to the inlet hole in the case. See Figure 4-4. Some actuators require an additional 3/8” (~9.5 mm) supply through an appropriate orifice directly to the oil motor.

### Oil Supply Filtration

Shaft-driven oil-pump models require a 20 to 25 µm (nominal) filter in the oil-supply line. This fitter is omitted in units supplied directly from the motor through the base.

Oil motor models require a 10 to 15 µm (nominal) filter in the oil supply line.

To avoid possible damage to the actuator the units must not be run with the filter off or bypassed.

## Factory Adjustments

**NOTE**
**Make the following adjustments on a bench with the proper equipment. All adjustments are preset at the factory to the proper specification for your part number.**

## Pilot Valve Centering

Refer to Figure 4-1b (oil motor model), for the item numbers used in the following information. Initial adjustment consists of physically centering the magnet (74) between the coils of the transducer (100) when the control land on the pilot valve plunger (81) is centered over the control port in the pilot valve bushing (26). This minimizes the effect of temperature drift when changes occur in the operating temperature of the actuator.

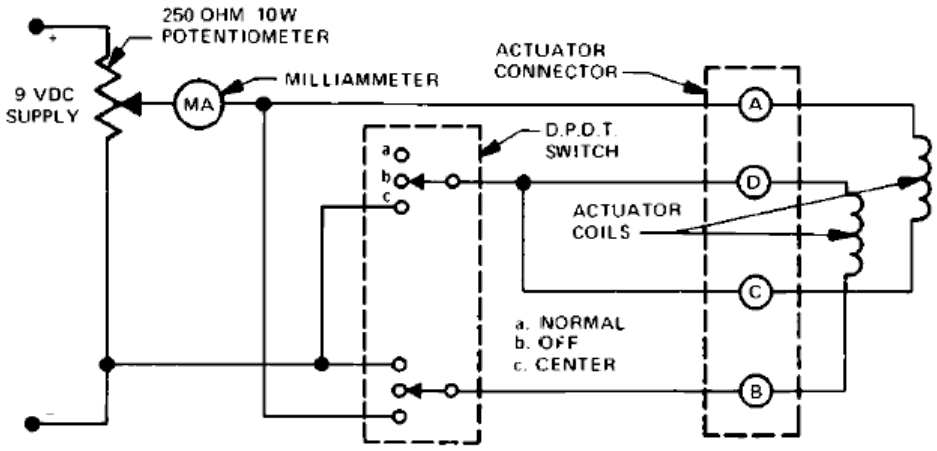



Figure 2-2. Actuator Test Circuit

**CAUTION—CENTERING SPRINGS**
**Bottom the centering screw (71) very gently to prevent damage to the centering springs in the coil cover.**

Center the pilot valve plunger as follows:

1. Connect the test circuit to the terminal block on the actuator as shown in Figure 6. Set the test switch to OFF.

2. Install and secure the protractor over the terminal shaft. Install the actuator terminal lever for use as an indicator. Rotate the terminal shaft over its full range of travel. Note or mark the minimum and maximum shaft positions on the protractor. The total terminal shaft travel should be 42 to 45 degrees.

**NOTE**
**The magnet is centered at the factory and seldom needs to be readjusted. Do not change this adjustment unless thoroughly familiar with the adjustment procedure.**

3. Insert a 7/64 inch Allen wrench through the clearance hole in the center of the cover, through the hollow center of the adjustable spring seat (70), and engage the centering screw (71). Turn the centering screw CW until it bottoms GENTLY, then CCW 1 3/4 to 2 turns to establish an initial starting position.

**NOTE**
**For an oil pump unit, drive the unit on the test stand at any speed between 1200 to 3600 rpm.**

**For an oil motor unit, mount it on the test stand, turn on the oil supply and allow a few minutes for the actuator to warm up to operating temperature. Make certain the oil motor is operating by observing if the splined end of the pilot valve bushing is rotating.**

4. Set the test switch to CENTER and adjust the potentiometer for 400 mA on the milliammeter. Set the test switch to OFF.

5. Insert a 1/8 inch Allen wrench through the clearance hole in the center of the cover, and engage the adjustable spring seat. Center the terminal shaft at the approximate mid point of its travel. Turn the spring seat CW to move the terminal shaft in the increase fuel direction or CCW to move the terminal shaft in the decrease fuel direction. Note the exact position of the terminal shaft for future reference.

6. Set the test to CENTER and observe the terminal shaft for rotation. If necessary, readjust the potentiometer for 400 mA.

   If the terminal shaft remains stationary, when shifting from 0 to 400 mA, the pilot valve plunger is centered and no further centering adjustments are required.

   If the terminal shaft moves to another position when switching from OFF to CENTER, note the direction of movement and then set the test switch to OFF.

7. If the terminal shaft moves in the increase fuel direction, turn the pilot valve centering screw CW a small amount using the 7/64 inch Allen wrench. If the terminal shaft movement was in the decrease fuel direction, turn the centering screw CCW.

   Note the new position of the terminal shaft for reference if further adjustment is required.

8. Repeat steps 6 and 7 until no movement of the terminal shaft occurs when the test switch is moved from OFF to CENTER.

9. Set the test switch to OFF and turn the potentiometer fully CCW (decrease).

## Terminal Shaft Travel

1. Remove cover (6 on Figure 4-1b) for access to feedback bracket (47).

**NOTE**
**Fasten sub cap (8) to case (22) with shorter screws.**

2. Set the test switch to normal.

3. Adjust the potentiometer to 20 mA.

**CAUTION—USE 1/8 INCH WRENCH ONLY**
**Check carefully that the Allen wrench being used to set the adjustable spring seat is 1/8 inch. Should an undersized Allen wrench be used, the centering adjustment could be changed, putting the actuator completely out of adjustment. DO NOT USE AN UNDERSIZE WRENCH.**

4. Using a 1/8 inch Allen wrench, turn the ad just-able spring seat CCW until the actuator terminal lever is at its minimum fuel position, then turn the seat CW until the shaft moves 2° to 3° from its minimum fuel position towards maximum fuel position.

5. Adjust the potentiometer for 160 mA. The terminal shaft should move an additional 36 (±1/2) degrees in the increase fuel direction.

**NOTE**
**To increase terminal shaft travel, move the feedback bracket pivot pin (47) towards the terminal shaft.**

6. Repeat the adjustments at minimum and maximum current alternately, until no further adjustment is required at either point and 36 (±1/2) degrees rotation is obtained.

7. Replace the cover.

8. Recheck the range and if adjustment is required, adjust spring seat (70) through the vent hole in the cover. Use a 1/8 inch Allen wrench to make this adjustment.

9. Disconnect the test circuit and the oil supply line if used. Remove the protractor.

## Control Box

Set the gain and reset controls on the control box at their mid-positions and the speed setting potentiometer at minimum speed. Start the engine using the speed setting potentiometer to bring the speed to the speed-no-load level.

**WARNING—EMERGENCY STOP**
**Be ready to manually overcome the actuator output shaft in case the speed setting potentiometer is connected to call for maximum rather than minimum speed.**

Stability is achieved through adjustment of the reset-droop and the gain controls. After achieving stability turn the gain control clockwise until unstable. Now readjust the reset-droop control until stability is achieved again. The objective is to have the gain control as far clockwise as possible while still maintaining stable operation.

In units designated EGB-3PC, a needle valve is present in the case (see Figure 4-3). The needle valve normally operates at two turns out from closed. If stability cannot be obtained at this setting close the valve slightly. The needle valve must be set at least one turn out from closed to provide satisfactory operation. Now readjust the reset-droop control until stability is achieved again. The objective is to have the gain control as far clockwise as possible while still maintaining stable operation.

The shaft-driven EG-3P actuator (most often used) requires about 3/4 volt to move the terminal shaft from the minimum stop. Six or seven volts are required to move the terminal shaft to maximum stop. Some EG-3P actuators require less voltage for full travel.

# Chapter 3. Troubleshooting

This chapter gives instructions for checking actuator and prime mover operation. See appropriate manual for troubleshooting your 2301 governor system.

1. Check the load to be sure that speed changes are not the result of unusual load variations.

2. On a diesel or gas engine, check engine operation to be sure all cylinders are firing properly and that injectors or spark plugs are in good operating condition.

3. Check operating linkage between actuator and prime mover for misalignment, for binding, or for excessive backlash or “play” in linkage motion.

4. Check the voltage regulator for proper action.

5. Make sure the hydraulic pressure supply to the actuator is adequate, clean, and free of foaming. See that lines are not clogged; that the filter is seated properly in its housing.

**NOTE**

**Actuator oil pressure may be checked with a pressure gauge installed in the base. Another method to check actuator oil pressure is to check the torque on the output shaft with a torque wrench. If torque is approximately at the rated figure, it can be assumed that the oil supply pressure is correct or the oil pump is operating correctly.**

**WARNING—EMERGENCY STOP**

**The following tests remove the engine or turbine from governor control. Do NOT attempt the tests unless you have another means to control the speed of the engine or turbine. Otherwise overspeed and prime mover runaway are possible, which can cause property damage or personal injury.**

A 6 Vdc battery connected between posts A and B on the actuator with posts C and D jumpered should cause the terminal shaft to go to almost maximum fuel. A 1.5 V battery across posts A and B, with posts C and D jumpered, should cause the terminal shaft to barely leave the minimum-fuel position. If this does not occur, further testing is required.

6. Disconnect leads from actuator terminals. Hook up circuit to actuator, as shown in Figure 2-2, with hydraulic pressure applied as usual to the actuator input. Terminal (output) shaft should move through its range as the potentiometer is rotated and should take the same position each time for a given potentiometer setting. If the output shaft positions or operates erratically, the problem may be in the hydraulic supply.

**CAUTION—RECHECK TERMINAL SHAFT TRAVEL**

**Any time the cover is removed, recheck the terminal shaft travel after replacing the cover. The feedback linkage is attached to the subcap, and tightening the cover and subcap changes the pivot point of the feedback unless the same amount of pressure Is applied to the screws.**

**WARNING—START-UP**

**Be prepared to make an emergency shutdown when starting the engine, turbine, or other type of prime mover, to protect against runaway or overspeed with possible personal injury, loss of life, or property damage.**

# Chapter 4.
# Replacement Parts

When requesting additional information concerning governor operation or when ordering parts, the following information must accompany the request:

- Governor serial number (shown on nameplate)
- Manual number (this is manual 82560)
- Part reference number, name of part, or description of part

**Parts for Figures 4-1a and 4-1b**

| Ref. No. | Part Name | Quantity |
|---|---|---|
| 82560-1 | Screw, # 1/4 - 28 vent | 1 |
| 82560-2 | Washer, -.265 ID copper | 1 |
| 82560-3–5 | Not used | |
| 82560-6 | Cover | 1 |
| 82560-7 | Gasket (cover-spacer-case) | 2 |
| 82560-8 | Adapter spacer assembly | 1 |
| 82560-9 | Drive screw | 2 |
| 82560-10 | Nameplate | 1 |
| 82560-11 | Needle bearing | 2 |
| 82560-12 | Oil seal | 2 |
| 82560-13 | Dowel pin | 2 |
| 82560-14 | Connector gasket | 1 |
| 82560-15 | Connector receptacle-4 pin | 1 |
| 82560-16 | Washer, #4 splitlock | 4 |
| 82560-17 | Screw, #4-40 X 5/16 rd. hd. | 4 |
| 82560-18–20 | Not used | |
| 82560-21 | Pipe plug, 1/16 NPTF, soc. hd. | 4 |
| 82560-22 | Not used | |
| 82560-23 | Case plug (short plug) | 1 |
| 82560-24 | O-ring | 2 |
| 82560-25 | O-ring | 1 |
| 82560-26 | Pilot valve bushing | 1 |
| 82560-27 | Not used | |
| 82560-28 | Idler gear stud | 1 |
| 82560-29 | Idler gear assembly | 1 |
| 82560-30 | Piston | 2 |
| 82560-31 | Pipe plug, 1/8-27, Hex Soc. | 3 |
| 82560-32 | Sleeve, relief valve | 1 |
| 82560-33 | Plunger | 1 |
| 82560-34 | Spring, relief valve | 1 |
| 82560-35 | Spacer, relief valve | 1 |
| 82560-36 | Actuator base, oil motor | 1 |
| 82560-37 | Stop, servo piston | 1 |
| 82560-38 | O-ring, 0.754 OD | 1 |
| 82560-39–41 | Not used | |
| 82560-42 | Base plug (long plug) | 1 |
| 82560-43 | Washer, #10 splitlock | 2 |
| 82560-44 | Screw, #10-24 X 1 soc. hd. | 2 |
| 82560-45 | Actuator base, gear pump | 1 |
| 82560-46 | Cotter pin, 1/16 X 1/2 | 4 |
| 82560-47 | Feedback adjusting bracket assembly | 1 |
| 82560-48 | Roll pin | 2 |
| 82560-49 | Screw, #8-32 X 7/16 fill. hd. | 2 |
| 82560-50 | Lockwasher #8 | 2 |
| 82560-51 | Washer, .174 ID steel | 2 |
| 82560-52 | Feedback lever assembly | 1 |
| 82560-53 | Not used | |
| 82560-54 | Roll pin | 2 |
| 82560-55 | Lever (short) | 1 |
| 82560-56 | Rod assembly | 2 |
| 82560-57 | Drilled straight pin | 1 |
| 82560-58 | Lever (long) | 1 |
| 82560-59 | Terminal shaft | 1 |
| 82560-60 | Feedback link pin | 1 |
| 82560-61 | Feedback link | 1 |
| 82560-62 | Restoring link | 1 |
| 82560-63 | Washer, 0.296 OD | 2 |
| 82560-64 | Screw, #10-32 X 2 soc. hd cap torque screw 64 to 17 lb-in | 2 |
| 82560-65 | Washer, #10 splitiock | 2 |
| 82560-66 | Drilled headed pin | 1 |
| 82560-67 | Restoring spring lever assy | 1 |
| 82560-68 | Drilled straight pin | 1 |
| 82560-69 | Transducer clamp bracket | 1 |
| 82560-70 | Adjustable spring seat | 1 |
| 82560-71 | Screw, socket hd. Nyloc | 1 |
| 82560-72 | Washer, 0.375 OD. | 1 |
| 82560-73 | Not used | |
| 82560-74 | Magnet assembly | 1 |
| 82560-76 | Washer, 0.223 OD | 1 |
| 82560-76–77 | Not used | |
| 82560-78 | Spring | 1 |
| 82560-79 | Retaining ring | 1 |
| 82560-80 | Compensating bushing | 1 |
| 82560-81 | Pilot valve plunger | 1 |
| 82560-82 | Screw, 1/4-28 X 3/8 hex | 1 |
| 82560-83 | Plug, 1/4-18 NPTF | 3 |
| 82560-84 | Cover, horizontal mounting | 1 |
| 82560-85 | Actuator case, horizontal mtg. | 1 |
| 82560-86 | Seal ring (base to case) | 1 |
| 82560-87 | Idler gear stud | 2 |
| 82560-88 | Idler gear assembly | 2 |
| 82560-89 | Gasket (base to drain adapter) | 1 |
| 82560-90 | Drain adapter | 1 |
| 82560-91 | Screw, 5/16-24 X 3 1/2 hex hd. | 1 |
| 82560-92 | Washer | 1 |
| 82560-93 | Washer, 5/16 splitlock | 1 |
| 82560-94 | Hex nut, 5/16-24 | 1 |
| 82560-95 | Actuator case, oil motor horizontal | 1 |
| 82560-96–98 | Not used | |
| 82560-99 | Plug | 2 |
| 82560-100 | Transducer assembly | 1 |
| 82560-101 | Top coil retainer | 1 |
| 82560-102 | Centering spring assembly | 1 |
| 82560-103 | External retaining ring, 0.461 free dia. | 2 |
| 82560-104 | Screw | 4 |
| 82560-105 | Base (oil motor) | 1 |
| 82560-106 | Base (horizontal mounting) | 1 |

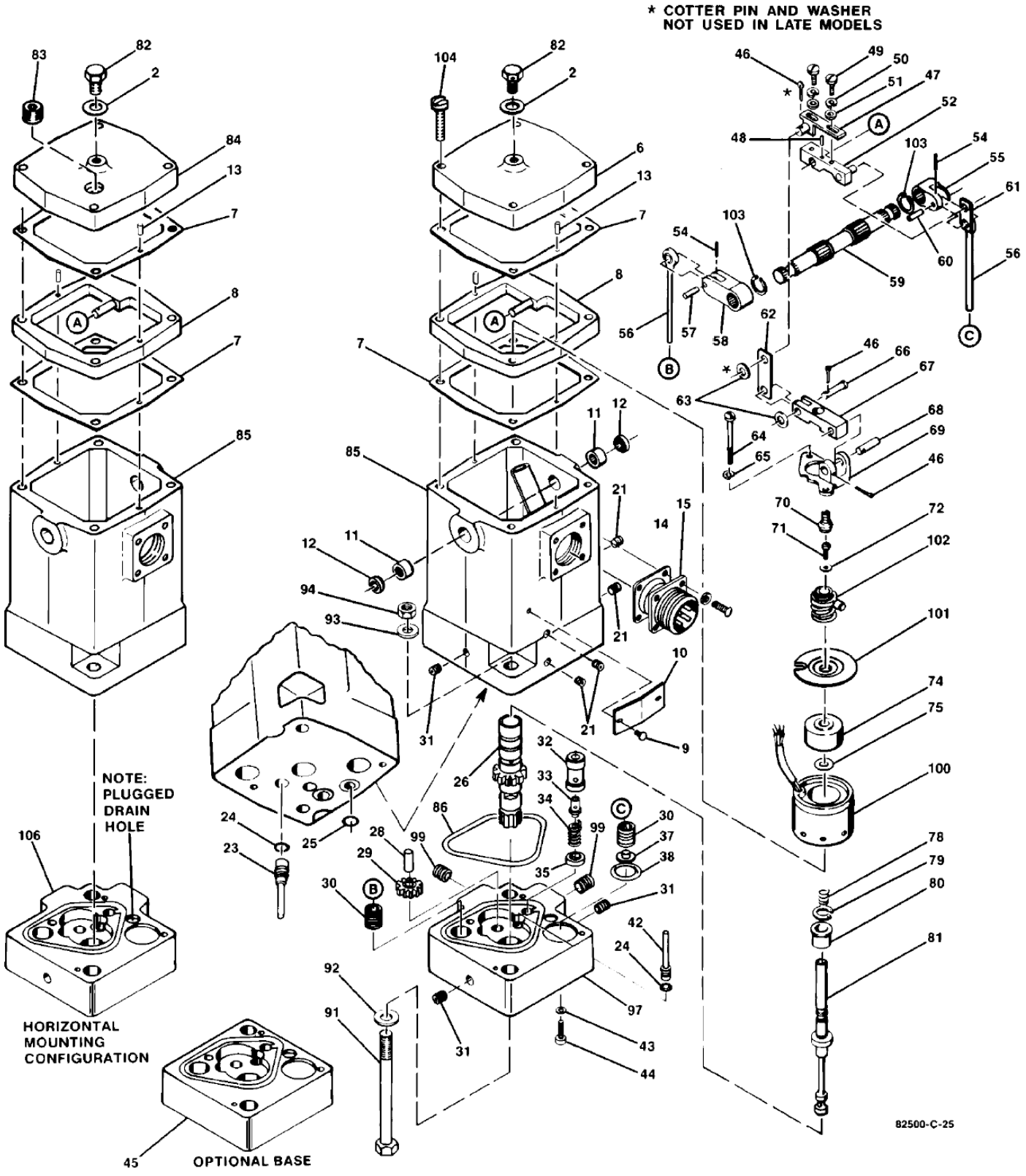



Figure 4-1a. Exploded View (EG-3P with Gear Pump)

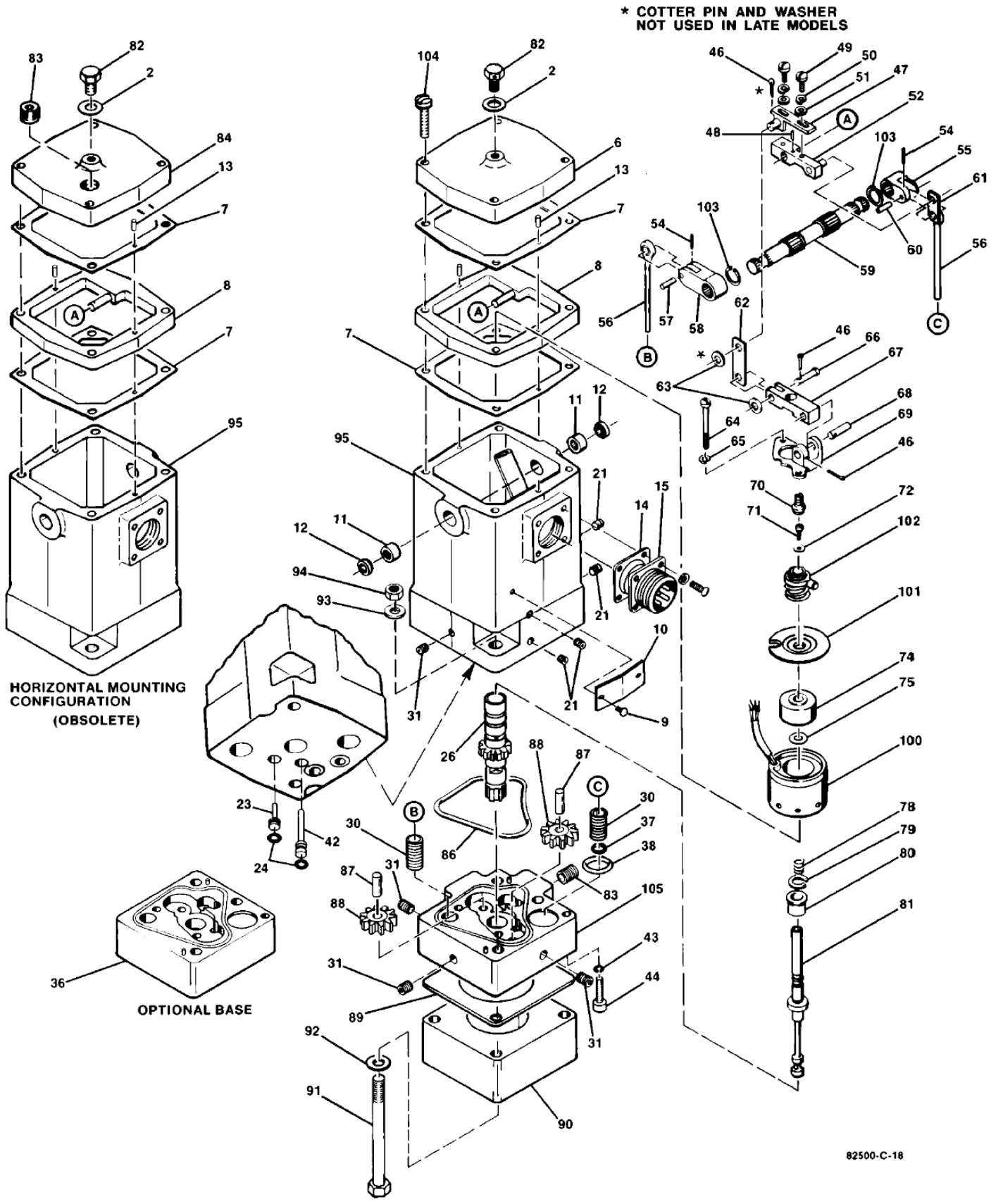



Figure 4-1b. Exploded View (EG-3P with Oil Motor)

**NOTE:**

**FOR COUNTER CLOCKWISE ROTATION PLUG HOLE "A" IN BASE AND HOLE "A" IN CASE AS SHOWN IN LAYOUT.**

**USE PART 42 TO PLUG "A" OR "B" IN BASE ONLY.**

**USE PART 23 TO PLUG "A" OR "B" IN CASE ONLY.**

**FOR CLOCKWISE ROTATION PLUG HOLE "B" IN BASE AND HOLE "B" IN CASE.**

One rotation plug is shorter than the other. The short plug goes into the case and the long plug goes into the base.

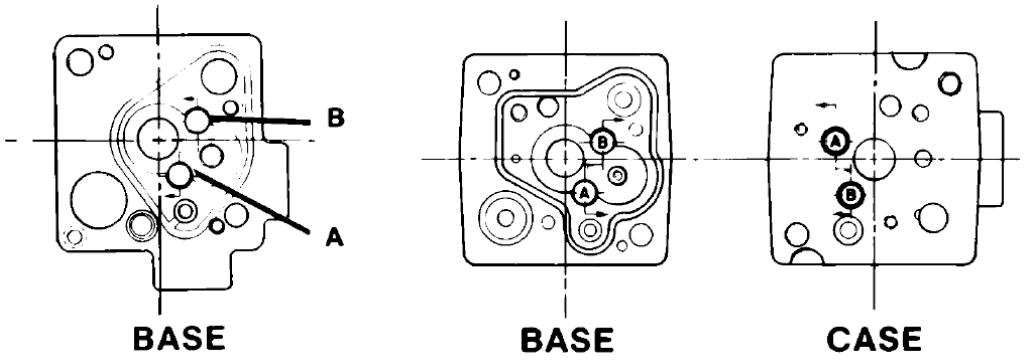



Figure 4-2. Plug Location for Oil Pump

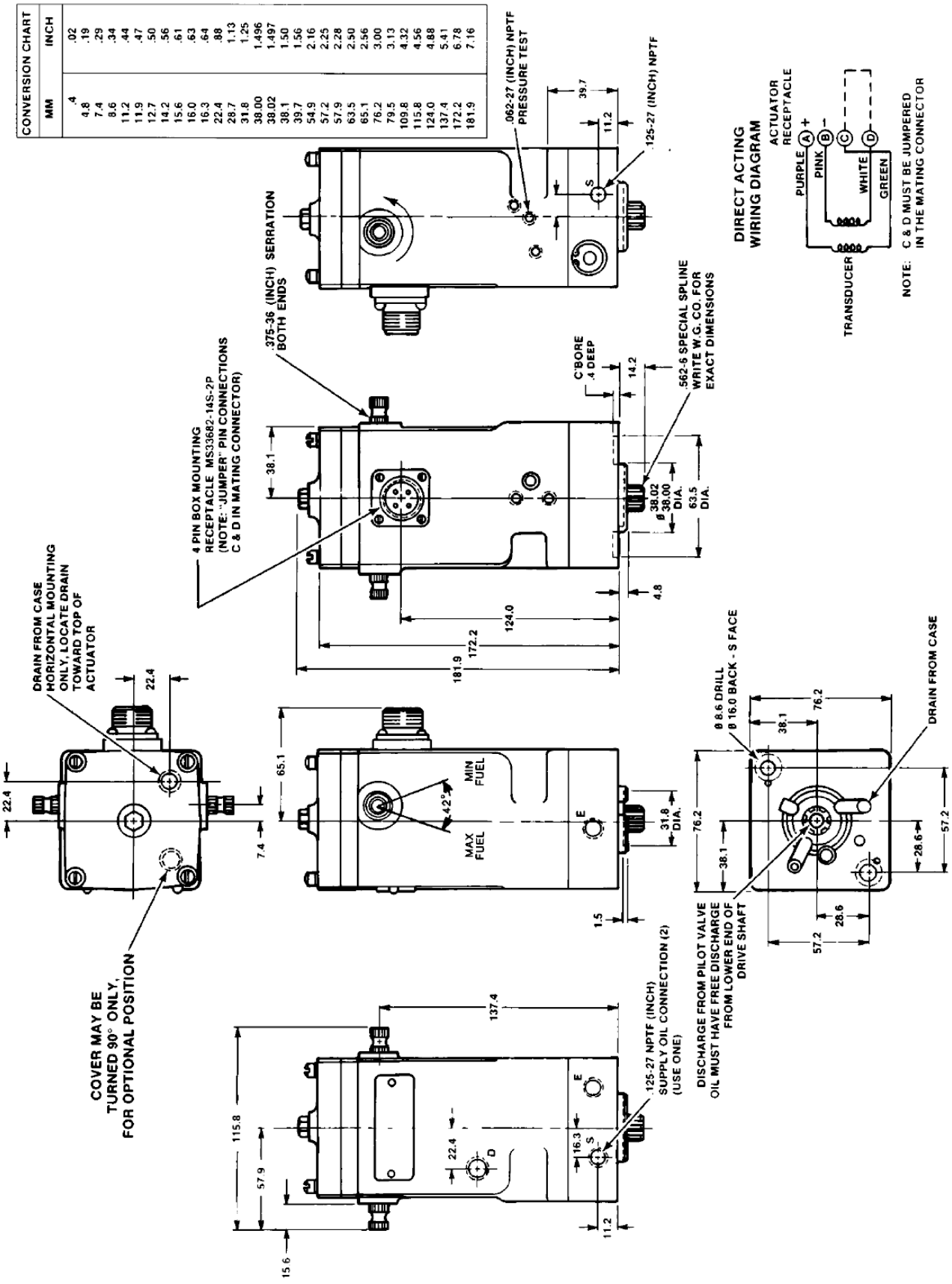



Figure 4-3. Outline Drawing (EG-3P with Gear Pump)

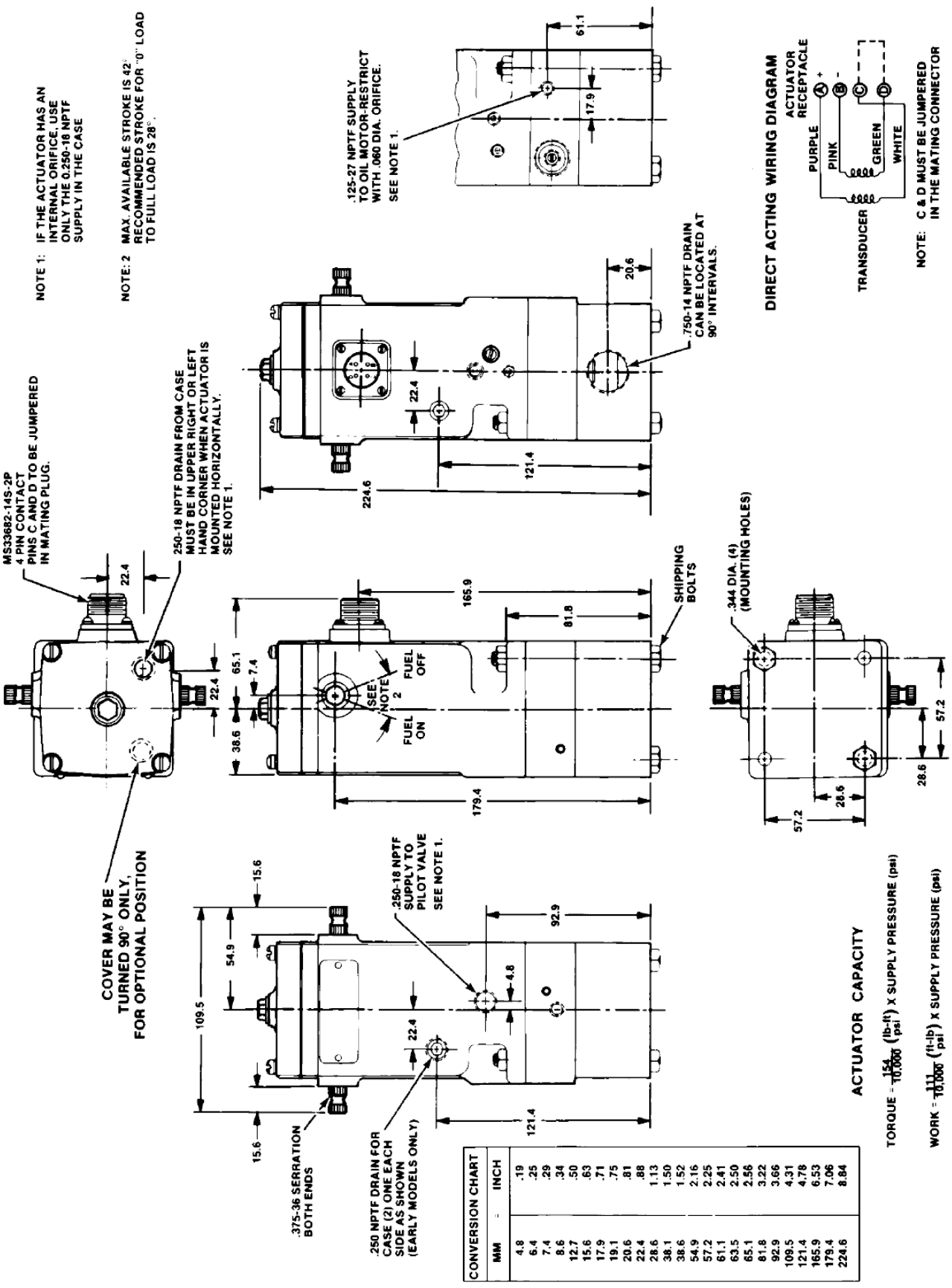
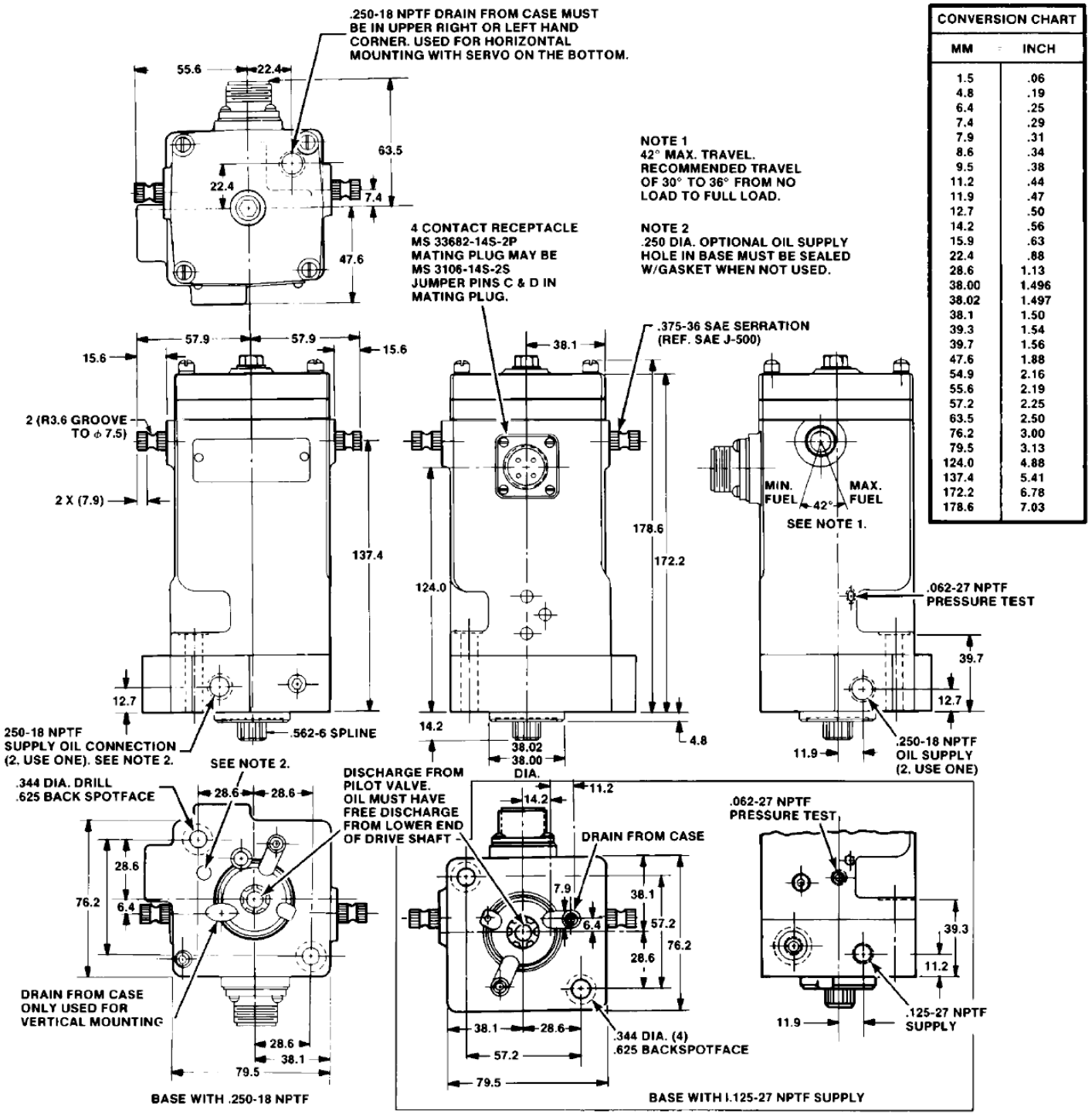



Figure 4-4. Outline Drawing (EG-3P with Oil Motor)




| CONVERSION CHART | |
|---|---|
| MM | INCH |
| 1.5 | .06 |
| 4.8 | .19 |
| 6.4 | .25 |
| 7.4 | .29 |
| 7.9 | .31 |
| 8.6 | .34 |
| 9.5 | .38 |
| 11.2 | .44 |
| 11.9 | .47 |
| 12.7 | .50 |
| 14.2 | .56 |
| 15.9 | .63 |
| 22.4 | .88 |
| 28.6 | 1.13 |
| 38.00 | 1.496 |
| 38.02 | 1.497 |
| 38.1 | 1.50 |
| 39.3 | 1.54 |
| 39.7 | 1.56 |
| 47.6 | 1.88 |
| 54.9 | 2.16 |
| 55.6 | 2.19 |
| 57.2 | 2.25 |
| 63.5 | 2.50 |
| 76.2 | 3.00 |
| 79.5 | 3.13 |
| 124.0 | 4.88 |
| 137.4 | 5.41 |
| 172.2 | 6.78 |
| 178.6 | 7.03 |

Figure 4-5. Outline Drawing (EG-3P with Oil Pump)

# Chapter 5.
# Service Options

## Product Service Options

The following factory options are available for servicing Woodward equipment, based on the standard Woodward Product and Service Warranty (5-01-1205) that is in effect at the time the product is purchased from Woodward or the service is performed:

- Replacement/Exchange (24-hour service)
- Flat Rate Repair
- Flat Rate Remanufacture

If you are experiencing problems with installation or unsatisfactory performance of an installed system, the following options are available:

- Consult the troubleshooting guide in the manual.
- Contact Woodward technical assistance (see “How to Contact Woodward” later in this chapter) and discuss your problem. In most cases, your problem can be resolved over the phone. If not, you can select which course of action you wish to pursue based on the available services listed in this section.

### Replacement/Exchange

Replacement/Exchange is a premium program designed for the user who is in need of immediate service. It allows you to request and receive a like-new replacement unit in minimum time (usually within 24 hours of the request), providing a suitable unit is available at the time of the request, thereby minimizing costly downtime. This is also a flat rate structured program and includes the full standard Woodward product warranty (Woodward Product and Service Warranty 5-01-1205).

This option allows you to call in the event of an unexpected outage, or in advance of a scheduled outage, to request a replacement control unit. If the unit is available at the time of the call, it can usually be shipped out within 24 hours. You replace your field control unit with the like-new replacement and return the field unit to the Woodward facility as explained below (see “Returning Equipment for Repair” later in this chapter).

Charges for the Replacement/Exchange service are based on a flat rate plus shipping expenses. You are invoiced the flat rate replacement/exchange charge plus a core charge at the time the replacement unit is shipped. If the core (field unit) is returned to Woodward within 60 days, Woodward will issue a credit for the core charge. [The core charge is the average difference between the flat rate replacement/exchange charge and the current list price of a new unit.]

**Return Shipment Authorization Label.** To ensure prompt receipt of the core, and avoid additional charges, the package must be properly marked. A return authorization label is included with every Replacement/Exchange unit that leaves Woodward. The core should be repackaged and the return authorization label affixed to the outside of the package. Without the authorization label, receipt of the returned core could be delayed and cause additional charges to be applied.

### Flat Rate Repair

Flat Rate Repair is available for the majority of standard products in the field. This program offers you repair service for your products with the advantage of knowing in advance what the cost will be. All repair work carries the standard Woodward service warranty (Woodward Product and Service Warranty 5-01-1205) on replaced parts and labor.

### Flat Rate Remanufacture

Flat Rate Remanufacture is very similar to the Flat Rate Repair option with the exception that the unit will be returned to you in "like-new" condition and carry with it the full standard Woodward product warranty (Woodward Product and Service Warranty 5-01-1205). This option is applicable to mechanical products only.

## Returning Equipment for Repair

If a control (or any part of an electronic control) is to be returned to Woodward for repair, please contact Woodward in advance to obtain a Return Authorization Number. When shipping the item(s), attach a tag with the following information:

- name and location where the control is installed;
- name and phone number of contact person;
- complete Woodward part number(s) and serial number(s);
- description of the problem;
- instructions describing the desired type of repair.

**CAUTION—ELECTROSTATIC DISCHARGE**

**To prevent damage to electronic components caused by improper handling, read and observe the precautions in Woodward manual 82715, *Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules*.**

### Packing a Control

Use the following materials when returning a complete control:

- protective caps on any connectors;
- antistatic protective bags on all electronic modules;
- packing materials that will not damage the surface of the unit;
- at least 100 mm (4 inches) of tightly packed, industry-approved packing material;
- a packing carton with double walls;
- a strong tape around the outside of the carton for increased strength.

### Return Authorization Number

When returning equipment to Woodward, please telephone and ask for the Customer Service Department [1 (800) 523-2831 in North America or +1 (970) 482-5811]. They will help expedite the processing of your order through our distributors or local service facility. To expedite the repair process, contact Woodward in advance to obtain a Return Authorization Number, and arrange for issue of a purchase order for the item(s) to be repaired. No work can be started until a purchase order is received.

**NOTE**

**We highly recommend that you make arrangement in advance for return shipments. Contact a Woodward customer service representative at 1 (800) 523-2831 in North America or +1 (970) 482-5811 for instructions and for a Return Authorization Number.**

## Replacement Parts

When ordering replacement parts for controls, include the following information:

- the part number(s) (XXXX-XXXX) that is on the enclosure nameplate;
- the unit serial number, which is also on the nameplate.

## How to Contact Woodward

In North America use the following address when shipping or corresponding:

Woodward Governor Company
PO Box 1519
1000 East Drake Rd
Fort Collins CO 80522-1519, USA

Telephone—+1 (970) 482-5811 (24 hours a day)
Toll-free Phone (in North America)—1 (800) 523-2831
Fax—+1 (970) 498-3058

For assistance outside North America, call one of the following international Woodward facilities to obtain the address and phone number of the facility nearest your location where you will be able to get information and service.

| Facility | Phone Number |
|---|---|
| Brazil | +55 (19) 3708 4800 |
| India | +91 (129) 230 7111 |
| Japan | +81 (476) 93-4661 |
| The Netherlands | +31 (23) 5661111 |

You can also contact the Woodward Customer Service Department or consult our worldwide directory on Woodward's website (**www.woodward.com**) for the name of your nearest Woodward distributor or service facility.

# Engineering Services

Woodward Industrial Controls Engineering Services offers the following after-sales support for Woodward products. For these services, you can contact us by telephone, by email, or through the Woodward website.

- Technical Support
- Product Training
- Field Service

Contact information:

Telephone—+1 (970) 482-5811
Toll-free Phone (in North America)—1 (800) 523-2831
Email—icinfo@woodward.com
Website—**www.woodward.com**

**Technical Support** is available through our many worldwide locations or our authorized distributors, depending upon the product. This service can assist you with technical questions or problem solving during normal business hours. Emergency assistance is also available during non-business hours by phoning our toll-free number and stating the urgency of your problem. For technical support, please contact us via telephone, email us, or use our website and reference ***Customer Services*** and then ***Technical Support***.

**Product Training** is available at many of our worldwide locations (standard classes). We also offer customized classes, which can be tailored to your needs and can be held at one of our locations or at your site. This training, conducted by experienced personnel, will assure that you will be able to maintain system reliability and availability. For information concerning training, please contact us via telephone, email us, or use our website and reference ***Customer Services*** and then ***Product Training***.

**Field Service** engineering on-site support is available, depending on the product and location, from one of our many worldwide locations or from one of our authorized distributors. The field engineers are experienced both on Woodward products as well as on much of the non-Woodward equipment with which our products interface. For field service engineering assistance, please contact us via telephone, email us, or use our website and reference ***Customer Services*** and then ***Technical Support***.

# Technical Assistance

If you need to telephone for technical assistance, you will need to provide the following information. Please write it down here before phoning:

## General

Your Name _____
Site Location _____
Phone Number _____
Fax Number _____

## Prime Mover Information

Engine/Turbine Model Number _____
Manufacturer _____
Number of Cylinders (if applicable) _____
Type of Fuel (gas, gaseous, steam, etc) _____
Rating _____
Application _____

## Control/Governor Information

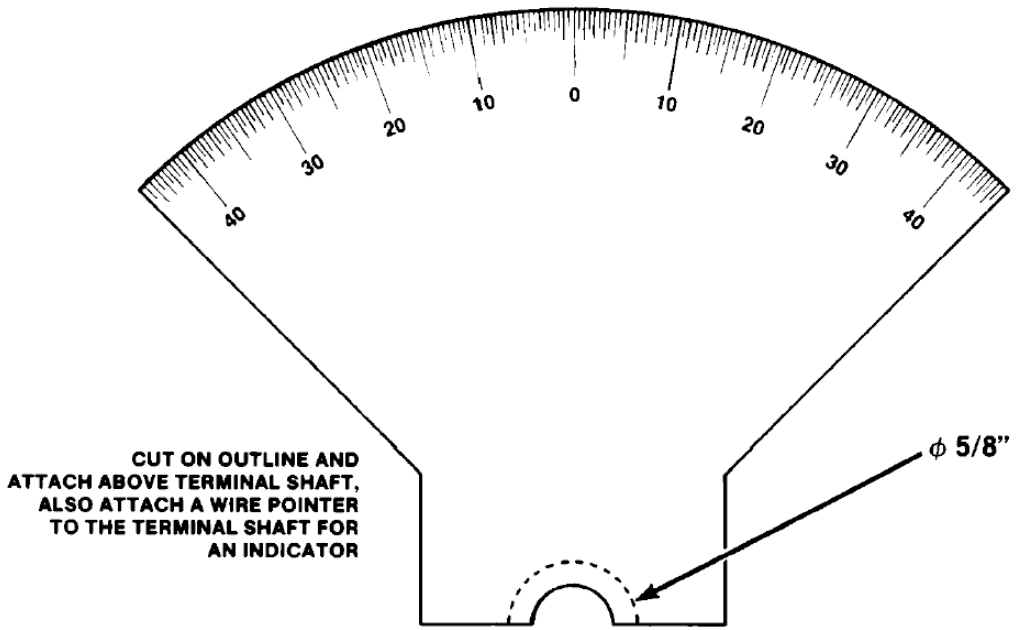
Please list all Woodward governors, actuators, and electronic controls in your system:

Woodward Part Number and Revision Letter _____
Control Description or Governor Type _____
Serial Number _____

Woodward Part Number and Revision Letter _____
Control Description or Governor Type _____
Serial Number _____

Woodward Part Number and Revision Letter _____
Control Description or Governor Type _____
Serial Number _____

*If you have an electronic or programmable control, please have the adjustment setting positions or the menu settings written down and with you at the time of the call.*




**PROTRACTOR**

82500-A-316

**We appreciate your comments about the content of our publications.**

**Send comments to: icinfo@woodward.com**

**Please include the manual number from the front cover of this publication.**

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as well as authorized distributors and other authorized service and sales facilities throughout the world.**

**Complete address / phone / fax / email information for all locations is available on our website.**

06/6/F