WOODWARD

Product Manual 89013
(Revision A)
Original Instructions

Hydraulic Amplifier (Pressure Input)

Installation and Operation Manual

General Precautions

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.

Revisions

This publication may have been revised or updated since this copy was produced. To verify that you have the latest revision, check manual *26311* , *Revision Status & Distribution Restrictions of Woodward Technical Publications*, on the *publications page* of the Woodward website:

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The latest version of most publications is available on the *publications page*. If your publication is not there, please contact your customer service representative to get the latest copy.

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.

Translated Publications

If the cover of this publication states "Translation of the Original Instructions" please note:

The original source of this publication may have been updated since this translation was made. Be sure to check manual *26311* , *Revision Status & Distribution Restrictions of Woodward Technical Publications*, to verify whether this translation is up to date. Out-of-date translations are marked with ⚠. Always compare with the original for technical specifications and for proper and safe installation and operation procedures.

Contents

Illustrations and Tables

Warnings and Notices

Important Definitions

This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

- **DANGER**—Indicates a hazardous situation which, if not avoided, will result in death or serious injury.
- **WARNING**—Indicates a hazardous situation which, if not avoided, could result in death or serious injury.
- **CAUTION**—Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.
- **NOTICE**—Indicates a hazard that could result in property damage only (including damage to the control).
- **IMPORTANT**—Designates an operating tip or maintenance suggestion.

⚠WARNING

Overspeed / Overtemperature / Overpressure

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

Personal Protective Equipment

The products described in this publication may present risks that could lead to personal injury, loss of life, or property damage. Always wear the appropriate personal protective equipment (PPE) for the job at hand. Equipment that should be considered includes but is not limited to:

- **Eye Protection**
- **Hearing Protection**
- **Hard Hat**
- **Gloves**
- **Safety Boots**
- **Respirator**

Always read the proper Material Safety Data Sheet (MSDS) for any working fluid(s) and comply with recommended safety equipment.

⚠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.

⚠WARNING

Automotive Applications

On- and off-highway Mobile Applications: Unless Woodward's control functions as the supervisory control, customer should install a system totally independent of the prime mover control system that monitors for supervisory control of engine (and takes appropriate action if supervisory control is lost) to protect against loss of engine control with possible personal injury, loss of life, or property damage.

NOTICE

Battery Charging Device

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.

Electrostatic Discharge Awareness

NOTICE

Electrostatic Precautions

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.**

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*.

Follow these precautions when working with or near the control.

1. Avoid the build-up of static electricity on your body by not wearing clothing made of synthetic materials. Wear cotton or cotton-blend materials as much as possible because these do not store static electric charges as much as synthetics.
2. Do not remove the printed circuit board (PCB) from the control cabinet unless absolutely necessary. If you must remove the PCB from the control cabinet, follow these precautions:
   - Do not touch any part of the PCB except the edges.
   - Do not touch the electrical conductors, the connectors, or the components with conductive devices or with your hands.
   - When replacing a PCB, keep the new PCB in the plastic antistatic protective bag it comes in until you are ready to install it. Immediately after removing the old PCB from the control cabinet, place it in the antistatic protective bag.

Chapter 1.
General Information

Description

Hydraulic Amplifier

The Woodward hydraulic amplifier is a linear, pilot-operated, servo actuator used where relatively large forces are required to operate power control mechanisms such as steam turbine control valves or the fuel control linkages of large engines. The pressure controlled hydraulic amplifier is used in conjunction with a modified Woodward PG governor. The output of the modified governor Is a hydraulic pressure signal which Is a function of the load on the prime mover. The hydraulic amplifier amplifies the low level signal from the governor to a usable level for actuating the prime mover power control mechanism. The governor, through a bellows and lever arrangement, controls the movement of a pilot valve plunger in the amplifier. The amplifier pilot valve directs high pressure oil (supplied from the prime mover lubricating system or from an external pump) to the top side of a servo cylinder. The servo cylinder may be of the double acting type (with differential area piston) or of the single acting type. Decrease fuel forces are provided by a return spring in either type cylinder, and additionally, in the double acting cylinder, by oil at supply pressure acting on the bottom side of the servo cylinder piston. The double acting cylinder with differential area piston is normally used in applications where approximately equal forces are required in either direction of movement.

In most applications, the return spring is primarily designed to counteract the unbalanced forces tending to either open or close the steam control valve. This provides a balanced system with a linear response over the full stroke of the amplifier. Secondarily, the return spring ensures closing in the event of loss of oil pressure and, in some instances, also ensures that the fuel control or steam valve remains in the closed position during shutdown. In some applications, the return spring may provide only a low force biasing load. Various return spring preloads within a range of 50 to 2000 pounds (222 to 8896 N) (7-1/4” model) and 50 to 400 pounds (222 to 1779 N) (5-1/4” model) may be used depending on the closing forces of the steam valve itself (or other fuel control) and the steam valve unbalance forces.

Two models of bellows-type pressure-controlled hydraulic amplifiers are covered in this manual. Both models are basically identical except for the diameter of their respective servo cylinders. The work output of either model amplifier is proportional to the oil pressure and length of stroke utilized.

Either model amplifier may be provided with one or more special features to suit the requirements of the particular application in which it is used. In applications which require opening of the steam valve or fuel control preparatory to starting the prime mover and which also have a source of pressurized oil available, a starting oil port is provided in the amplifier case. The port allows starting oil pressure to be used to hydraulically raise the amplifier pilot valve plunger since the governor is inoperative prior to start-up of the prime mover. The starting oil supplied to the normal supply port in the amplifier is then directed by the pilot valve to the top side of the servo cylinder.

The degree to which the steam valve or fuel control opens is dependent on the starting oil supply pressure, whether the servo cylinder is single or double acting, the return spring preload, and linkage loads. In addition to the above, the amplifiers are also provided with an internal oil transfer passage in which either an oil transfer plug. a starting (pressure sensing) valve, or an oil transfer sleeve can be used to adapt the amplifier for use in different applications.

Plug

The oil transfer passage plug is used in all ‘standard’ applications (opening of steam valve or fuel control for starting not required) and also in those applications where opening of the steam valve or fuel control for starting is required and the oil pressure available is at or above the minimum pressures necessary for normal amplifier operation.

Transfer Valve

The transfer valve (starting valve) is substituted for the plug in applications where the oil pressure available for starting (such as from a hand pump) is below the minimum required for normal operation. 45 to 60 psi (310 to 414 kPa) starts the transfer valve moving up against the spring force of the valve.

Sleeve

The oil transfer sleeve is substituted for the plug in applications where a higher opening force Is necessary and an equivalent decrease in closing force can be tolerated. The sleeve blocks the flow of oil to the closing side of the servo cylinder and simultaneously vents the area to drain. Use of the sleeve converts the double acting servo cylinder to a single acting cylinder. This increases the effective piston area on the opening side of the cylinder and thus the opening force available from the amplifier. The closing force is reduced to that of the return spring alone.

PG Governor

The Woodward PG governor used in conjunction with the pressure controlled hydraulic amplifier differs from the conventional PG governor in that a hydraulic pressure signal Is provided as an output rather than the normal mechanical output from the power cylinder. The modified governor also incorporates such conventional features as dial type speed setting, remote speed setting, and speed droop. This manual covers only the non-conventional features of the governor. Refer to the manuals below for complete information concerning the governor.

References

Manual 36014	*PG Governor Speed Adjusting Motor*
Manual 36600	*PG Governor Basic Elements*
Manual 36404	*Analysis and Correction of PG Governing Troubles*
Manual 36614	*PG Governor Dial Type Speed Setting*
Manual 36694	*PG-PL Governor*

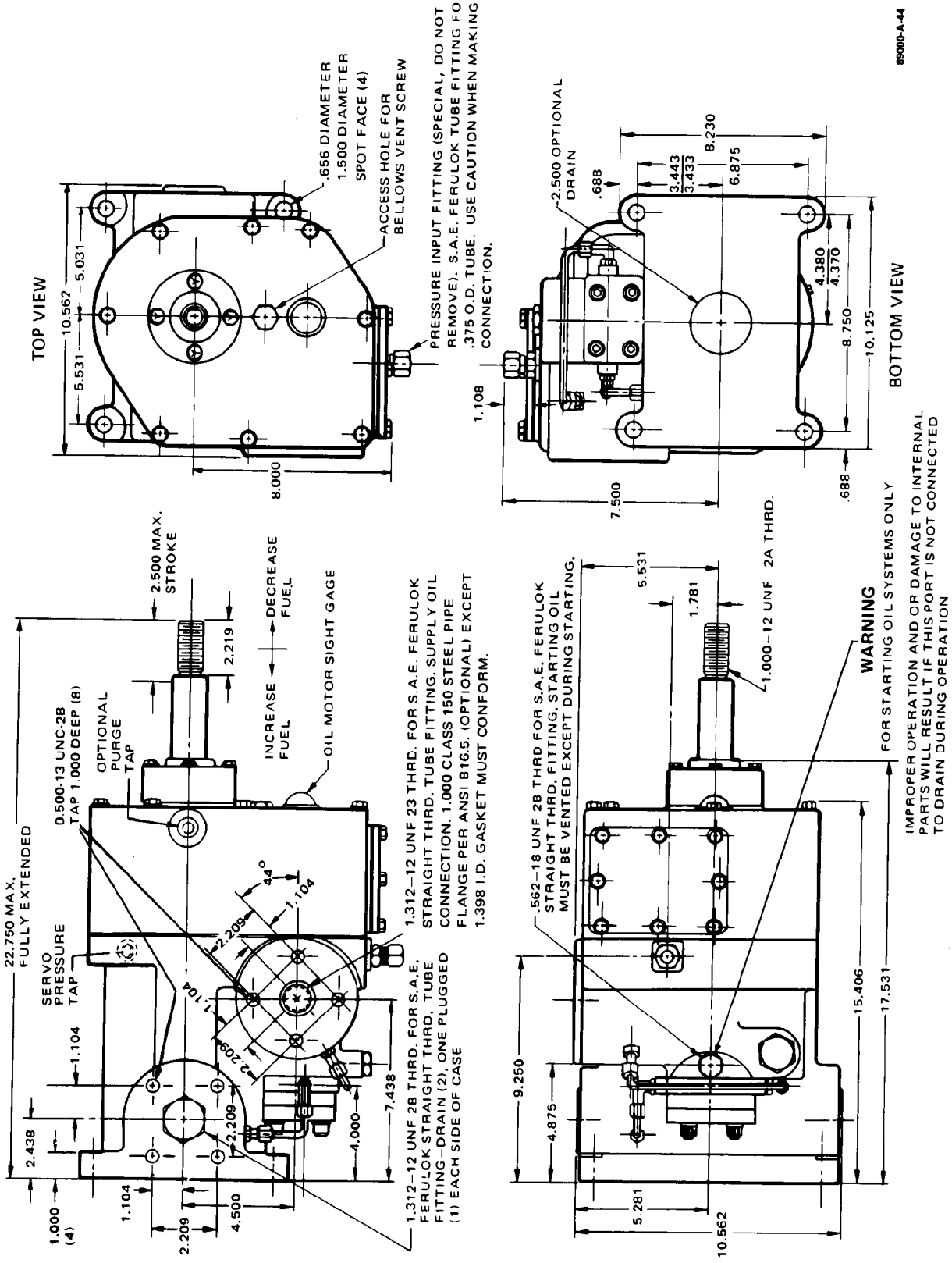

Figure 1-1. Outline Drawing of 5-1/4” Pressure Input Hydraulic Amplifier

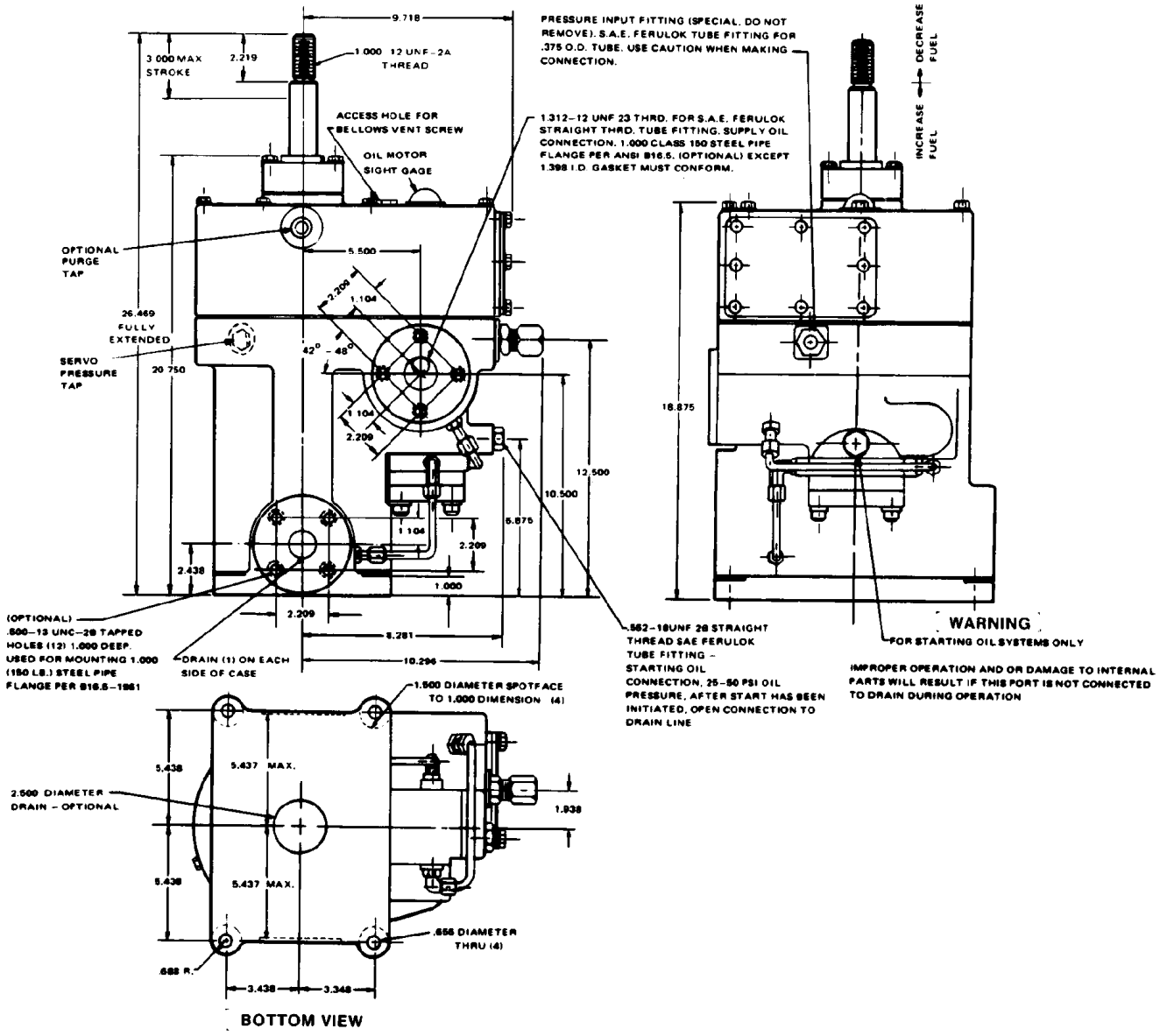

Figure 1-2. Outline Drawing of 7-1/4” Pressure Input Hydraulic Amplifier

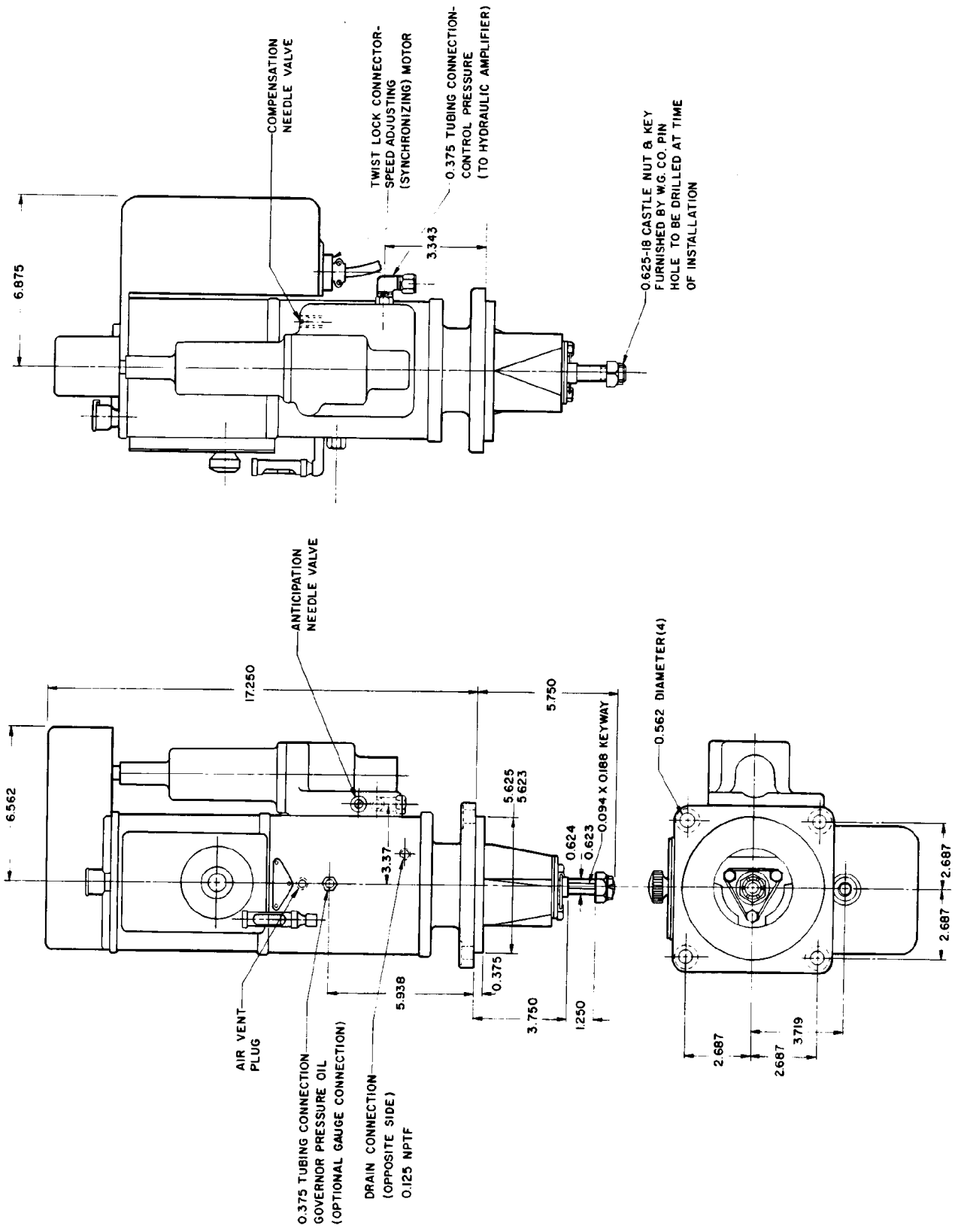

Figure 1-3. Typical Outline Drawing of PGD Governor

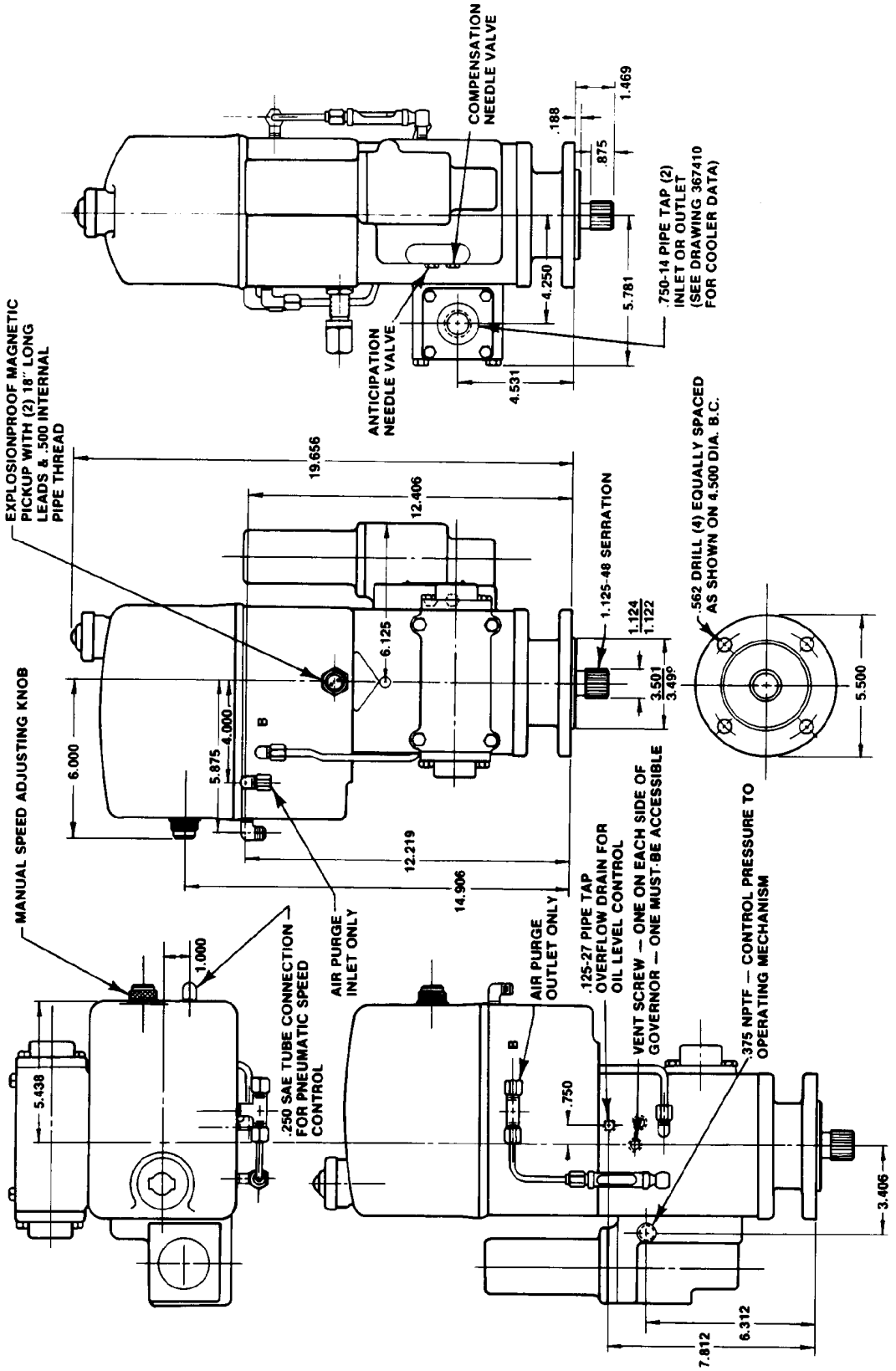

Figure 1-4. Outline Drawing of PG-PL Governor

Chapter 2.
Installation

Introduction

This chapter provides information for connecting oil lines to the amplifier along with basic adjustments for start-up.

Installation

Refer to Figures 1-1, 1-2, 1-3, and 1-4 for overall dimensioning and connecting data for the hydraulic amplifier and the governor. More complete installation data for the governor is found in the applicable governor manual.

The same grade and type of lubricating oil used for the prime mover generally is satisfactory for use in the hydraulic amplifier. The oil supply to the amplifier may be provided directly from the prime mover lubricating oil system or from an auxiliary pump independent of the prime mover. If a good transient response (piston movement in the order of 30 inches/second [76 cm/s]) is required, it is essential to provide the amplifier with an adequate supply of oil. For the 5-1/4 inch (133 mm) amplifier, this rate of movement requires a flow of 330 in^3/s (85 USgal/min or 320 L/min). The 7-1/4 inch (184 mm) amplifier requires a flow of 780 in^3/s (200 USgal/min or 760 L/min). Use accumulators to provide the necessary flow rate if it is impractical to do so directly from a pump.

Normally mount the hydraulic amplifier upright. Make the supply lines as large, short, and straight as possible and avoid elbows. Give equal consideration to the drain lines. If the prime mover mounting pad has integral provisions for drain to sump or reservoir, remove the sealing cup in the bottom of the amplifier case to provide direct draining through the mounting pad. Be sure the pipe line to the control port does not trap air in any portion.

When the amplifier has porting provisions for starting oil, and regardless of whether starting oil is used or not, connect the starting oil port to drain for normal operation. We recommend the use of a 3-way valve in the starting oil line to the pilot valve plunger in applications using starting oil. If the starting oil port Is plugged or otherwise closed during operation, normal leakage will hydraulically lock the pilot valve plunger and render the amplifier inoperative. The area under the pilot valve plunger is internally drained in amplifiers which do not require starting oil.

On the older-style amplifiers, adjust the flow limiting device used in the supply line to the amplifier oil motor for an approximate flow rate of 1 qt/min (1 L/min). Normal rotation of the pilot valve plunger is within the range of 100 to 500 rpm. A clear plastic window is provided in the amplifier cover for observation of the rotation indicator strip attached to the top of the pilot valve plunger.

⚠WARNING

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.

Adjustments

For a new amplifier, adjustments are preset at the factory and normally do not need any corrections. The following information for adjustments is provided for your convenience in cases of repair or trouble.

Hydraulic Amplifier

Adjust the minimum stroke position of the fuel or steam control as follows:

1. Provide a supply of oil at normal operating pressure for the amplifier in that particular application and connect to the amplifier supply port.

   For older models, make a separate connection from the supply to the flow limiting device in the line to the oil motor.

2. Connect a source of oil pressure (0 to 65 psi/0 to 448 kPa) to the governor control pressure port in the amplifier case using an adjustable pressure regulating valve.

NOTICE

When connecting or disconnecting this connection, do not turn the fitting into or out of the case as either the O-ring is damaged or the fitting is lost.

3. Remove the amplifier cover.

NOTICE

Considerable oil spray occurs over a large area when the amplifier Is cycled while under pressure with the cover removed. Drape a clear plastic sheet over the amplifier and tuck the edges under as well as possible so that most or all of the oil spray is contained. Arrange the sheet so the spring seat (70) Is accessible if adjustment is necessary.

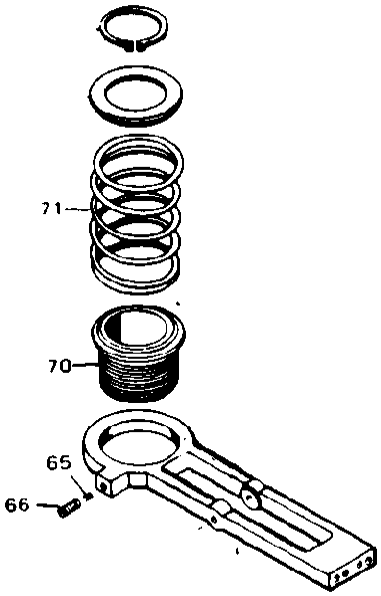

Figure 2-1. Restoring Spring Seat Adjustment

4. Turn on the oil supply to the amplifier and the oil motor to make certain the pilot valve plunger is rotating. Observe the indicator strip. Set the 3-way valve (if used) to the drain position.

5. Adjust the governor control pressure input as specified for that particular application (see specifications sheet furnished with the amplifier) to obtain the required minimum stroke of the amplifier piston rod. If necessary, adjust the preload on the restoring spring (71) to obtain the required minimum stroke at the specified governor control pressure Input. Loosen set screw (66) and turn the spring seat (70) clockwise (cw) to decrease the preload and lengthen the stroke counterclockwise (ccw) to increase the preload and shorten the stroke. Tighten screw (66).

6. Turn off the oil supply to the amplifier and oil motor and then reduce the governor control pressure input to 0 psi/0 kPa.

7. Make certain the linkage connecting the amplifier to the fuel or steam control operates freely and has minimum backlash. Depress the amplifier piston rod sufficiently to compensate for expansion (usually 1/8 to 1/4 inch [3.2 to 6.4 mm]) and ensure closing of the fuel or steam control at shutdown when the prime mover is hot. In some cases, differential expansion may require that these dimensions be increased, Adjust the connecting linkage until the fuel or steam control is in the fully closed position with the rod depressed.

8. Disconnect all special lines and make permanent connections as required.

After completing installation of the governor and amplifier and making all necessary connections, fill the governor with oil. Bleed trapped air from the governor, control pressure line, and the bellows in the amplifier as follows. In instances where the signal line from the governor to the amplifier is unusually long or has bends or elbows, a bleed valve installed in the signal line immediately adjacent to the amplifier facilitates the bleeding operation. Run a length of clear plastic tubing from the valve back to the governor to avoid excessive loss of oil.

1. Close the anticipation needle valve in the governor and then open it 1/2 turn.

2. Set the governor for idle speed and start the prime mover.

3. Open the compensation needle valve in the governor not more than two turns. This should cause the prime mover to hunt.

4. Loosen the air vent plug in the governor (see instruction plate on governor case) enough to establish a leak. Allow oil leakage to continue until air bubbles are no longer apparent. Tighten the vent plug and, if necessary, add oil to the governor to the proper level in the sight glass. Clean up spilled oil.

5. Open the bleed valve (if used) In the signal pressure line and allow oil to flow until air bubbles are not longer visible in the plastic tube.

6. Remove the access or vent plug in the top of the amplifier cover. Insert a screwdriver through the access port and loosen the vent screw in the top of the bellows enough to establish a leak. It may be necessary to add oil to the governor several times during the bleeding operation depending on the diameter and length of the connecting line between the governor and the amplifier. Tighten the vent screw when air bubbles are no longer apparent In the oil.

7. Repeat steps 4 through 6 above several times to make certain all air has been bled from the system.

8. Gradually close the compensation needle valve until the prime mover hunting is minimized or eliminated.

9. Close the anticipation needle valve until prime mover hunting occurs and then open the valve just far enough to eliminate the hunting.

10. After determining the best setting for the anticipation needle valve, open the compensation needle valve as far as possible without causing hunting but not more than two turns.

11. Alternately repeat steps 9 and 10 until the compensation needle valve is opened as far as possible and the anticipation needle valve is closed as far as possible. The objectives are to obtain minimum overshoot by the governor following a speed (power) correction and to minimize the time lag between initiation of a correction by the governor and the response by the amplifier. Do not fully close the anticipation needle valve as this renders the speed droop feature of the governor inoperative and also causes very unstable operation of the prime mover.

PG Governor

Refer to the references for the appropriate governor manual.

PGD Governor

Adjust the governor speed droop by loosening clamp screw (206, Figure 2-2) and changing the position of the cam on the speed droop lever (211) with respect to the speed droop lever shaft (207). Move the cam away from the shaft to increase the droop, and toward the shaft to decrease the droop. If the center of the cam coincides with the center of the shaft, zero droop results and the governor will provide isochronous (constant speed) operation.

NOTICE

Do not move the cam beyond the zero droop point as this results in negative droop (speed increases with load increase) with consequent unstable operation.

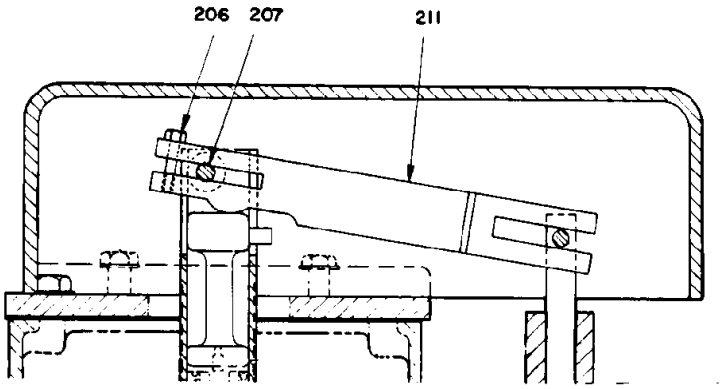

Figure 2-2. Speed Droop Adjustment

Chapter 3.
Description of Operation

PGD Governor

Refer to Figure 3-1 or Figure 3-2 for a schematic diagram of a modified PG governor connected to a single acting and a double acting hydraulic amplifier with a solid pilot valve plunger. Figure 3-3 shows the hydraulic amplifier equipped with a yield plunger in the pilot valve plunger. Operation of the basic elements of the PG governors is given in Manual 36600; other features are described in Manuals 36014 and 36614. The governor shown In Figures 3-1 and 3-2 differs in operation from the conventional PG governor in that no mechanical motion is imparted by the governor to the steam or fuel control by direct linkage. As with the conventional PG governor, at any given speed setting, the pressure in the buffer system is a function of the load on the prime mover. In the conventional governor, the buffer system pressure acting on the power piston causes a movement of the piston proportional to the load on the prime mover which, in turn, is transmitted through linkage to the fuel control. With the modified PG governor, the buffer system pressure serves as the input signal to the bellows in the hydraulic amplifier.

The power piston In the modified governor is used as a means of simulating (proportionally) the movement of the servo piston in the hydraulic amplifier and/or as an accumulator to provide sufficient volume in the buffer system for proper displacement of the buffer piston. Movement of the power piston is fed back through a tail rod, lever, and plunger arrangement to bias the speeder spring force, at any given speed setting, such that as steam or fuel is increased, the speeder spring force is decreased (speed droop). For any given speed setting, the speeder plug remains stationary while the position of the plunger, which is free to move in the plug, is determined by the relative angle of the speed droop lever with the centerline of the plunger. Note that the lever pivot shaft is offset from the centerline of the plunger such that any relative movement of the lever with respect to a given speeder plug setting causes an upward or downward movement of the plunger. An upward movement of the plunger, as the governor moves to increase fuel for an increase in load, decreases the speeder spring force, and the governor and prime mover run at a lower speed than called for at that specified speeder plug position. Conversely, a downward movement of the plunger, with a decrease in load, causes an increase in speeder spring force and the governor and prime mover run at a higher speed.

IMPORTANT

In isochronous applications where speed droop is not required, the tail rod, speed droop lever, and speeder plug plunger are not used. In this case, the power cylinder functions as an accumulator, and also provides a pressure source as a function of load. In applications without speed droop a PG-PL governor may replace the PGD governor. The PG-PL has no speed droop.

The anticipation needle valve and oscillator piston are features not found in conventional PG governors. The anticipation needle valve restricts the flow of oil into or out of the power cylinder so that the immediate effect of any displacement of the buffer piston in either direction is sensed by the bellows in the hydraulic amplifier as a relatively sharp impulse or kick. This impulse causes a nearly instantaneous response by the amplifier to a correction signal from the governor, minimizing lag time and contributing to a stable governing system. The oscillator piston, actuated by a cam on the drive gear shaft, creates low magnitude pulsations in the power cylinder hydraulic circuit which, in turn, causes the power piston to continuously oscillate, minimizing friction. The pressure of the oil in the power cylinder holds the piston against the cam.

Hydraulic Amplifier (Single Acting)

The amplifier in Figure 3-1 is an older type with a spring return servo piston (single-acting). Basic operation of the single acting amplifier is similar to the double acting (differential) amplifier in Figure 3-2.

The output of the PG governor is connected to the governor control pressure port in the hydraulic amplifier case. Any Increase or decrease in governor control pressure is converted into mechanical motion by the expansion or contraction of the bellows in the hydraulic amplifier. The movement of the bellows is transmitted through a restoring lever and flexible support spring to a pilot valve plunger which controls the flow of oil to and from the amplifier servo cylinder. The movement of the amplifier servo piston is led back to the bellows by a restoring spring and floating lever arrangement which recenters the pilot valve plunger when the steam valve or fuel control reaches its new position as called for by the governor.

When the governor senses an underspeed condition and signals for an increase in speed (power), the bellows expands from the increased governor control pressure. This raises one end of the restoring lever which lifts the pilot valve plunger, admitting oil at supply pressure (less the pressure drop occurring across the pilot valve) to the lop side of the servo piston. As the piston moves, the restoring spring on the piston rod is compressed which forces the free end of the floating lever downward. Since the floating lever is pivoted on the restoring lever, the restoring lever also moves down against the force exerted by the bellows. The downward movement continues until the increase in restoring spring force counterbalances the force change which occurred on the bellows. The bellows is compressed until the pilot valve plunger Is recentered, stopping further movement of the servo piston.

During an on-speed condition, the governor maintains a given control pressure and the pilot valve plunger land is held in the centered position over the control port. With flow to the servo piston blocked, except to compensate for leakage, the servo piston maintains its position in relation to the speed (load) setting of the governor.

When the governor senses an overspeed condition and signals for a decrease in speed (power), the bellows contracts with the decrease in governor control pressure. This lowers one end of the restoring lever and pushes the pilot valve plunger downward which allows oil to drain from the open side of the servo piston. The return spring force causes the servo piston to move upward, decreasing power. Movement of the piston continues until the decrease in restoring spring force counterbalances the force change which occurred on the bellows, allowing the bellows to expand until the pilot valve plunger is again recentered.

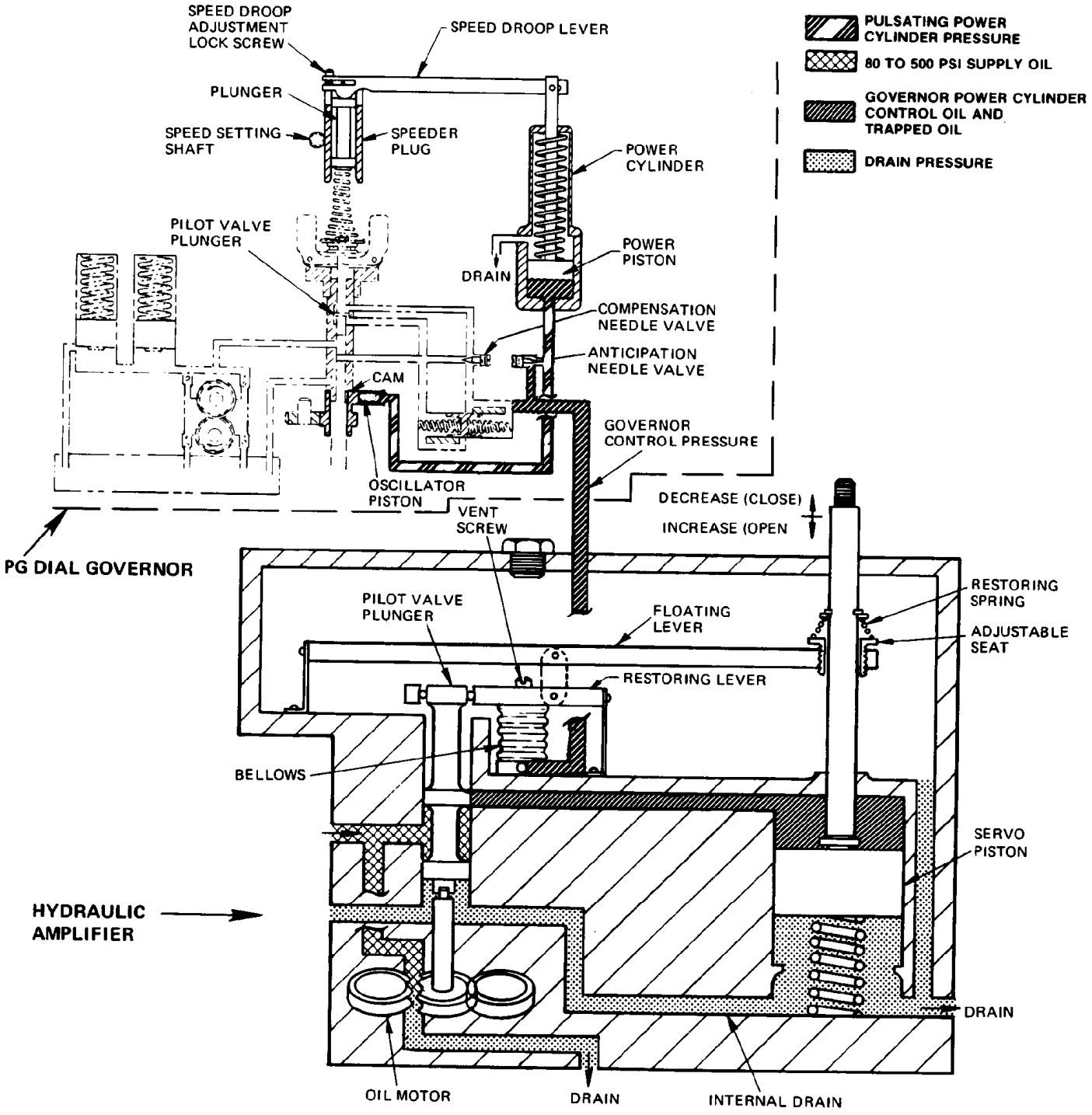

Figure 3-1. Old Type Hydraulic Amplifier (Single Acting) Schematic Diagram

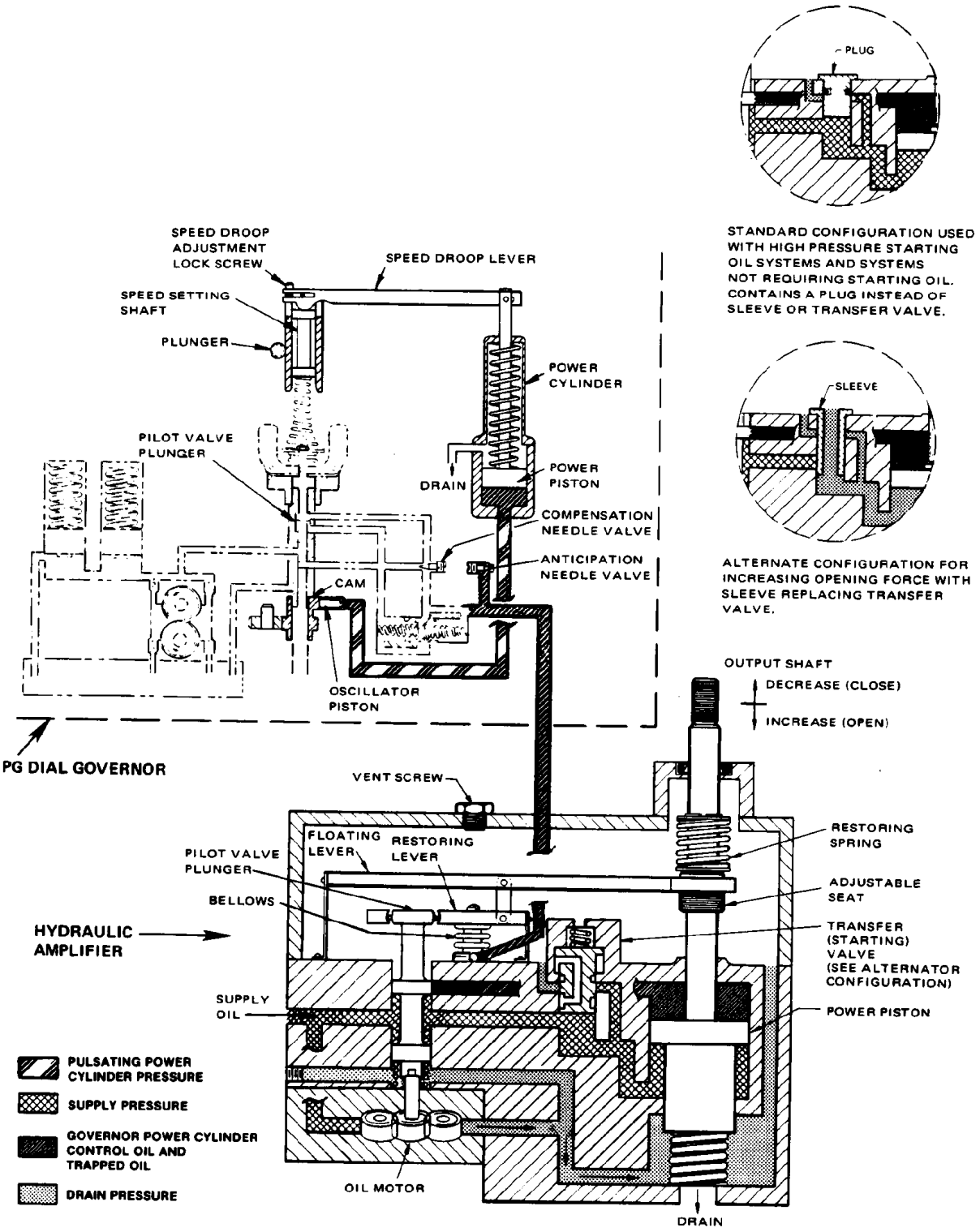

Figure 3-2. Hydraulic Amplifier (Double acting) Schematic Diagram

Hydraulic Amplifier (Double Acting)

Figure 3-2 is a schematic of the double acting amplifier.

The output of the PG governor is connected to the governor control pressure port in the hydraulic amplifier case. Any increase or decrease in governor control pressure is converted into mechanical motion by the expansion or contraction of the bellows in the hydraulic amplifier. The movement of the bellows is transmitted through a restoring lever and flexible support spring to a pilot valve plunger which controls the flow of oil to and from the amplifier servo cylinder. The movement of the amplifier servo piston is fed back to the bellows by a restoring spring and floating lever arrangement which recenters the pilot valve plunger when the steam valve or fuel control reaches its new position as called for by the governor.

Pressurized oil from the external supply source is directed from the amplifier inlet to the pilot valve plunger and to the bottom side of the servo piston. When double acting amplifiers are used in applications which use low pressure starting oil, a transfer (pressure sensing) valve is used in the oil transfer passage to the closing side of the servo piston. The transfer valve has no function during normal operation, being held in the open position by normal oil supply pressures.

When the governor senses an underspeed condition and signals for an increase in speed (power), the bellows expands from the increased governor control pressure. This raises one end of the restoring lever which lifts the pilot valve plunger, admitting oil at supply pressure (less the pressure drop occurring across the pilot valve) to the top side of the servo piston. The oil pressure acting on the top side of the piston is lower than that on the bottom (decrease) side. However, it acts over a much larger surface area and causes the servo piston to move downward, increasing power. As the piston moves, the restoring spring on the piston rod is compressed which forces the free end of the floating lever downward. Since the floating lever is pivoted on the restoring lever, the restoring lever also moves down against the force exerted by the bellows. The downward movement continues until the increase In restoring spring force counterbalances the force change which occurred on the bellows.

The bellows is compressed until the pilot valve plunger is recentered, stopping further movement of the servo piston.

During an on-speed condition, the governor maintains a given control pressure and the pilot valve plunger land is held in the centered position over the control port. With flow to the top side of the servo piston blocked, except to compensate for leakage, the servo piston will maintain its position in relation to the speed (load) setting of the governor.

When the governor senses an overspeed condition and signals for a decrease in speed (power), the bellows contracts with the decrease in governor control pressure. This lowers one end of the restoring lever and pushes the pilot valve plunger downward which allows oil to drain from the topside of the servo piston. The return spring force and, in the supply oil pressure acting on the bottom side of the servo piston causes the servo piston to move upward, decreasing power. Movement of the piston continues until the decrease in restoring spring force counterbalances the force change which occurred on the bellows, allowing the bellows to expand until the pilot valve plunger is again recentered.

In applications that require the steam valve or fuel control to be opened as a prerequisite to starting the prime mover, one of two methods Is used depending on the available source of pressurized oil for operating the amplifier. When starting oil pressure at or above the minimum requirement for normal operation of the amplifier are available (high pressure starting oil systems), the oil transfer plug or sleeve is used in the amplifier. If the available pressure is less than the minimum requirement (low pressure starting oil systems), the transfer valve is used. The oil transfer sleeve can be used with either high or low pressure starting oil systems. In all applications where starting provisions are required, an additional connection must be made to the starting oil port in the amplifier case. Make the connection using a 3-way valve with one port connected to drain. This allows oil pressure (25 to 50 psi [172 to 345 kPa] maximum) to be used to raise the pilot valve plunger for starting since the governor is inoperative prior to start-up.

The restoring spring permits one end of the floating and restoring levers to move upward when oil pressure is applied to the bottom of the plunger. Turn the 3-way valve to drain after starting, otherwise oil is trapped under the pilot valve plunger and will render the amplifier inoperative.

In high pressure starting oil systems, starting oil need only be supplied to the amplifier supply port after raising the pilot valve plunger. Starting oil, when directed to the top side of the servo piston, opens the steam valve or fuel control. In low pressure starting oil systems, the transfer valve minimizes the force acting on the bottom side of the servo piston. Starting (auxiliary) oil pressures within the range of 25 to 50 psi (172 to 345 kPa) (typical) cannot generate sufficient force on the top side of the servo piston to overcome the combined forces of starting oil pressure and spring tension on the bottom side of the piston. In shutdown position, the transfer valve blocks the flow of starting oil to the bottom aide of the servo piston and simultaneously opens the area to drain. When the prime mover starts and the normal supply pressure becomes greater than the starting oil pressure, the increasing pressure is sensed through the axial passage in the transfer valve plunger. Oil flow Into the area under the large diameter of the plunger begins to lift the plunger against the opposing spring force. When the pressure of the supply oil reaches 45 to 60 psi (310 to 414 kPa), the plunger snaps to the open position, closing the drain passage and opening the control port which admits supply oil to the bottom side of the servo piston. The transfer valve remains in the open position during normal operation. At shutdown, spring force returns the plunger to the closed position.

The amplifier pilot valve plunger is continuously rotated by an oil motor to minimize friction between the plunger and the pilot valve sleeve.

When starting oil is used, there is usually insufficient high pressure oil available. Starting oil forces the pilot valve plunger upward. Lack of high pressure oil allows the yield plunger to remain stationary. This yield linkage allows the pilot valve plunger, which is spring loaded upward (increased fuel direction), to move upward, opening the control port to the top of the power piston. Once the supply oil builds up to high pressure, the yield plunger is locked in place. The rest of the operation was explained earlier.

The amplifier has its pilot valve plunger spring loaded upward. If supply pressure should decrease to where the spring pressure forces the pilot valve plunger upward, supply pressure could move the servo piston in the Increase fuel position.

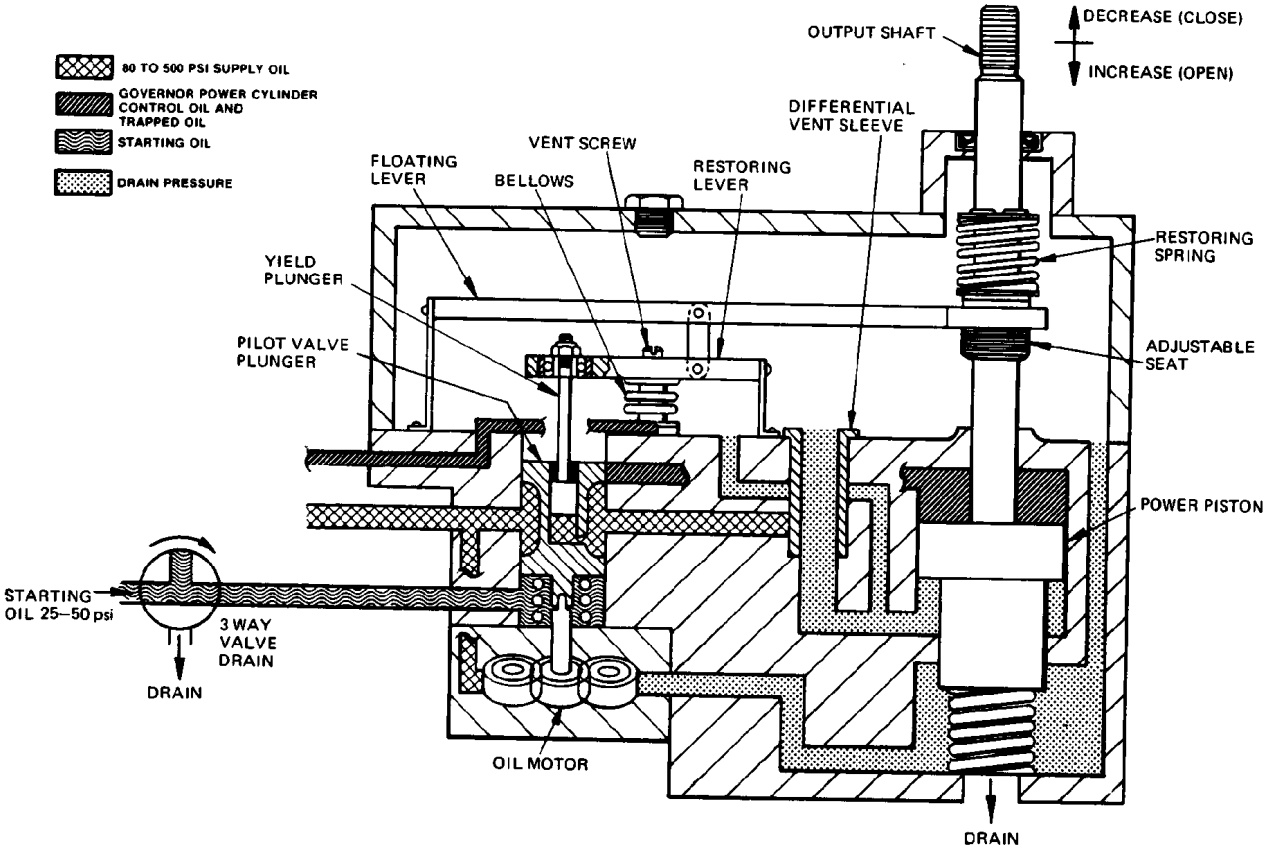

Figure 3-3. Schematic Diagram of the Hydraulic Amplifier with Yield Plunger

Chapter 4.
Maintenance

Troubleshooting

The troubleshooting chart is for use in determining probable causes and corrective actions for troubles that may be encountered in the field. Every possible trouble which may be experienced cannot be anticipated and may, in some instances, be due to faulty operation of other equipment used in conjunction with the amplifier. Consider the effect of the PG governor, oil supply system, and prime mover power control mechanism when troubleshooting apparent malfunctions of the hydraulic amplifier. Refer to manual 36404 for analysis and correction of troubles with the PG governor.

Amplifier troubles such as erratic operation and poor repeatability are usually caused by dirty oil. In many instances, this type of trouble can be corrected by flushing the unit with fuel oil or kerosene. The use of commercial solvents is not recommended as they may damage oil seals or gaskets.

Do not disassemble the hydraulic amplifier any further than necessary to repair or replace the particular damaged part or parts if applicable.

⚠WARNING

Cylinder cover (47, Figure 4-1) is spring loaded in the range of 50 to 2000 pounds (222 to 8896 N) force. Jack screws may be necessary to remove this cover. Refer to the warning tag on the cylinder cover (47). Refer to disassembly for jack screw method of removal.

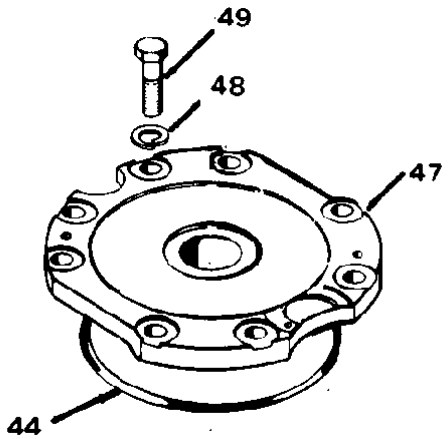

Figure 4-1. Cylinder Cover

Table 4-1. Troubleshooting Chart

Trouble	Probably Cause	Correction
Fuel control or steam valve will not open.	Low oil supply pressure.	Check prime mover lubricating oil or other oil supply system for proper operation.
	Fuel control or steam valve sticking	Disconnect linkage and check operation of fuel control or steam valve. Check steam valve unbalance forces.
	Amplifier bellows ruptured.	Replace bellows assembly.
Erratic or lagging servo response.	Air in governor control pressure line or in amplifier bellows.	Bleed air from line and bellows as Instructed in Installation section.
	Fuel control or steam valve sticking.	Disconnect linkage and check operation of fuel control or steam valve. Check steam valve unbalance forces.
	Pilot valve plunger not rotating and sticking—drive coupling spring broken or missing allowing coupling to disengage. Coupling pin sheared. Oil motor excessively worn.	Replace coupling spring or pin. Disassemble oil motor, clean, replace worn parts as required.
	Fluctuating oil supply pressure—pump cavitation.	Check prime mover lubricating oil or other oil supply system for proper operation.
Fuel control or steam valve will not close or closes too slowly	Fuel control or steam valve sticking.	Disconnect linkage and check operation of fuel control or steam valve.
	Starting oil port not connected to drain or internal drain passages clogged.	Make proper connections to drain, Disassemble amplifier and clean drain passages.
	Starting valve plunger sticking in close position—decrease side of servo piston open to drain.	Disassemble and clean amplifier. Check oil supply for contamination.
	Fatigued or broken servo piston return spring—excessive leakage past servo piston.	Disassembly of amplifier to the extent necessary to replace the return spring or servo piston is not recommended in the field unless absolutely necessary.
Fuel control or steam valve will not open for starting (low starting oil pressure systems).	Fuel control or steam valve sticking.	Disconnect linkage and check operation and force requirements of fuel control or steam valve.
	Starting valve plunger sticking in open position—plunger spring broken or missing.	Disassemble and clean amplifier. Check oil supply for contamination. Replace plunger spring.
	Starting oil pressure too low.	Increase starting oil pressure to a minimum of 25 psi (172 kPa). Do not exceed 50 psi (345 kPa).
Servo piston will not hold position, erratic over or undershoot, full stroke either direction with minor speed or power correction.	Restoring spring broken or missing.	Replace restoring spring.
Fuel control or steam valve will not fully close at shutdown.	Fuel control or steam valve sticking.	Disconnect linkage and check operation of fuel control or steam valve.
	Incorrect minimum stroke adjustment.	Adjust minimum stroke of amplifier and/or connecting linkage to fuel control or steam valve. Refer to Installation section.
Fuel control or steam valve will not open to maximum power position.	Fuel control or steam valve sticking.	Disconnect linkage and check operation of fuel control or steam valve.
	Incorrect maximum stroke adjustment.	Check scale of restoring spring.

Disassembly

Hydraulic Amplifier

Refer to Figure 5-1 for disassembly of the hydraulic amplifier. Important points and special precautions to be observed are noted below. Do not disassemble the amplifier any further than necessary for replacement of worn or damaged parts.

1. When replacing wiper seal (79), pry out the old seal using a screwdriver or similar tool. Use care not to nick the edges of the bore or seating surfaces in seal plate (76).

2. Do not disturb the position of the adjustable spring seat (70) in the floating lever unless necessary.

3. If it is necessary to remove the cylinder cover, use an arbor or hydraulic press with a minimum stroke of 7 inches (180 mm) to slightly compress the spring(s) while unbolting the cover and to permit a controlled rate of expansion for removal. Make adequate provisions to anchor the amplifier securely and also to prevent the piston rod from slipping off the face of the ram. This operation requires two people, one to operate the press and the second to disassemble the parts. An alternate method of cover removal is to remove two diametrically opposite hold-down screws and install two 12” all-thread rods for use as jackscrews. Use a 1/2-13 thread for the 5-1/4” amplifier, and a 5/8-11 thread for the 7-1/4” amplifier. Then, using nuts, back off the cover after removing the remaining hold-down screws.

4. Do not disassemble the servo piston and piston rod. The piston is ground concentric with the rod after assembly and, if disassembled, cannot be properly reassembled to maintain the required concentricity.

IMPORTANT

Replacement of the oil motor housing (104) or cover (98) in the field is not recommended since these parts are match drilled and dowel pinned at time of assembly. Return the oil motor to Woodward for repair should either of these parts require replacement.

PG Governor

Refer to the applicable governor manuals for removal and/or disassembly of the speed adjusting motor (if used), dial type speed setting feature, and the basic governor assembly. Refer to Figure 5-2 for disassembly of the speed droop feature on the PG dial governor.

Cleaning

Clean parts in fuel oil or kerosene. Do not use commercial solvents as they may damage gaskets or oil seals. Do not handle parts roughly or allow highly polished sealing or mating surfaces to contact the other objects.

Repair

Repair should generally be limited to light burnishing of parts to remove superficial corrosion and other minor scores and scratches in finely finished surfaces. Do not remove sharp edges from lands of plungers or piston or from oil ports in sleeves or bushings. Use a fine grit crocus cloth or paper and light oil to remove corrosion or other damage. The linkages should move freely without excessive play.

Reassembly

Observe the following general instructions during reassembly.

1. Never reuse a cotter or roll pin, replace with new parts.

2. Lubricate O-rings (preformed packing) with white petroleum jelly prior to assembly.

3. When installing O-rings over threaded surfaces, tape the threaded area to prevent damage to the O-ring.

4. Observe strict rules of cleanliness to prevent the introduction of lint or other foreign material into interior cavities.

5. Lubricate all moving parts and surfaces liberally with oil at assembly.

Hydraulic Amplifier

Refer to Figure 5-1 for disassembly of the hydraulic amplifier. Important points and special precautions to be observed are noted below.

1. When reassembling parts of the servo cylinder, refer to the WARNING note following step 3 in the disassembly instructions. A hydraulic press is not recommended for reassembly since the operator cannot feel whether or not the piston is entering the cylinder without binding or cocking. Use an arbor press or the jackscrew method for reassembly. Do not force the piston if it begins to bind in the bore. Make certain the pilot valve sleeve Is installed in its bore if the sleeve is normally retained by the overlapping edge of the cylinder cover.

2. When replacing wiper seal (79), make certain to install the new seal with the wiping edge facing outward. Install vee seal (74) with vee facing inward.

3. Make certain that the thickness of laminated shim (96) is sufficient to maintain 0.000 to 0.002 inch (0.00 to 0.05 mm) compression on spacer (95) and pilot valve sleeve (94) with mounting plate (98) and stop plate (28) installed.

4. Adjust screw (21) to limit the pilot valve plunger movement in the upward direction to 3/16 to 1/4 inch (4.8 to 6.4 mm) from its centered position. Do not exceed 1/4 inch (6.4 mm) travel as damage may occur to the bellows or other linkage components. Use a dial indicator to check this movement.

5. If bellows (51) needs to be replaced, preload it correctly to prevent failure. Adjust the preload by varying the thickness of the laminated shim stock (125) so the bellows is slightly preloaded 0.002 inch (0.05 mm) to the restoring lever (61).

6. If the spring strap supports (60 and 67) need to be replaced:

   a. Check the spacing between the top edge of stop block (27) and the bottom surfaces of lever (62).

   b. Check the spacing between the top edge of stop clamp (39) and the bottom surface of lever (61).

      This clearance must be 0.015 inch (0.38 mm). After achieving this clearance, drill and pin clamps (24) in place to hold strap supports (60 and 67) in place.

7. After completing reassembly of the amplifier, adjust the minimum stroke as instructed in the Installation section.

8. Check bearing (87) at top of pilot valve for correct alignment.

9. Check oil motor alignment and rotation carefully.

10. Install the scraper seal, on amplifiers equipped with the etched output shaft, by extending the servo shah to its outmost position and then pressing the metal edge of the scraper seal (79) until it is aligned with the “0” on the output (servo) shaft.

PG Governor

Reassemble the PG governor in accordance with the applicable manuals and figure. Adjust the compensation needle valve, anticipation needle valve, and speed droop (if used) after installing the governor on the prime mover. See the Installation and Adjustments sections.

Chapter 5.
Replaceable Parts

Replacement Parts Information

This chapter provides replacement parts information for the hydraulic amplifier and PGD governor. Figure 5-1 illustrates all the replaceable parts for the pressure input hydraulic amplifier. Figure 5-2 illustrates the parts for the PGD governor droop assembly.

When ordering replacement parts, include the following information.

- Amplifier and governor serial number and part number shown in nameplate.
- Manual number (this is manual 89013).
- Parts reference number in parts list and description of the part or part name.

Hydraulic Amplifier Parts List

Ref. No.	Part Name	Quantity
89013-1	Hydraulic amplifier cover	1
89013-2	Hex hd. screw	8
89013-3	Washer, .265 x .500 x .031	8
89013-4	Hex hd. plug	1
89013-5	Washer, .641 x .875 x .025-029	1
89013-6	Case to cover gasket	1
89013-7	Side plate gasket	1
89013-8	Side plate	1
89013-9	Screw	8
89013-10	Splitlock washer, #10	8
89013-11	Washer, .375 O.D.x.l95 l.D.x.031	8
89013-12	Cover warning decal	1
89013-13	Hydraulic amplifier case	1
89013-14	Soc. cap screw, .250-28 x .750	1
89013-15	High collar lock washer, .250 1.0.	1
89013-16	Sensing valve clamp	1
89013-17	Plug	1
89013-18	Vent sleeve (optional)	1
89013-19	Lock washer, .250	2
89013-20	Cap screw, .250-28 x .750	2
89013-21	Hex hd. dog pt., 3/8-24	1
89013-22	Fil. screw, 8-32 x .625	4
89013-23	Splitlock washer, .178	4
89013-24	Spring clamp	2
89013-25	Lockwasher, #6	4
89013-26	Fil hd. screw, 6-32 x .375	4
89013-27	Slop block	1
89013-28	P.V. stop plate assembly	1
89013-29	Soc. hd. pipe plug	1
89013-30	O-ring, .924 1.0. x .103	1
89013-31	Plug, 1.002-12	1
89013-32	O-ring, .463 1.0. x .078	2
89013-33	Pressure input fitting	1
89013-34	Plug	1
89013-35	Sealing cup	1
89013-36	O-ring 1.171 ID. x .116	2
89013-37	Bleeder plug, AN814-16D	2
89013-38	Roll pin, .062 0 x .250	5
89013-39	Stop clamp	1
89013-40	Lockwasher, 116	2
89013-41	Fil. hd. screw	2
89013-42	Dowel pin	2
89013-43	Spring block	1
89013-44	O-ring, 4.984 1.0.	1
89013-45	Warning plate	1
89013-46	Drive screw	4
89013-47	Cylinder cover	1
89013-48	Lockwasher, .500 1.0.	8
89013-49	Hex hd. screw, 500-13 x 1.25	8
89013-50	O-ring, .176 ID. x .070	1
89013-51	Bellows	1
89013-52	Bellows clamping plate	1
89013-53	Lock washer	2
89013-54	Soc. hd. screw, 8-32 x .500	2
89013-55	Washer	2
89013-56	Cotter pin, .060 x .375	2
89013-57	Straight pin .188 x 2.125	1
89013-58	Thread seal	1
89013-59	Clamp block	1
89013-60	Spring strap support	1
89013-61	Restoring lever	1
89013-62	Floating lever	1
89013-63	Vent screw	1
89013-64	Screw	2
89013-65	Plug	1
89013-66	Nyloc set screw, 8-32 x .500	1
89013-67	Spring strap support	1
89013-68	Straight pin	1
89013-69	Phillips fil. hd. screw 6-32 x .375	2
89013-70	Restoring spring seat	1

Ref. No.	Part Name	Quantity
89013-71	Restoring spring	1
89013-72	Restoring spring seat	1
89013-73	Retaining ring. 1.272 1.0.	1
89013-74	Block vee seal	1
89013-75	Ring gasket	1
89013-76	Seal plate	1
89013-77	Lock washer, 1/4	4
89013-78	Hex hd. cap screw,.250-20x2.000	4
89013-79	Wiper scraper seal	1
89013-80	Stop ring	1
89013-81	Servo return spring seat	1
89013-82	Servo return spring	1
89013-83	Servo piston	1
89013-84	Elastic hex thin nut, .312-24	1
89013-85	Rotation indicator strip	1
89013-86	Washer	3
89013-87	Self aligning bearing	1
89013-88	O-ring,.426 1.0. x .070	1
89013-89	Retaining ring, 1.249 OD	1
89013-90	Yield plunger retainer	1
89013-91	Yield plunger	1
89013-92	Pilot valve plunger	1
89013-93	Spring drive coupling	1
89013-94	Pilot valve sleeve	1
89013-95	Pilot valve sleeve spacer	1
89013-96	Laminated shim	1
89013-97	O-ring 2.555 1.0. x .103	1
89013-98	Mounting plate	1
89013-99	O-ring, .351 1.0. x .072	4
89013-100	Straight thread elbow	2
89013-101	Oil motor tube	1
89013-102	Straight thread fitting	2
89013-103	Soc. hd. pipe plug	4
89013-104	Oil motor body	1
89013-105	Oil motor orifice	1
89013-106	Preformed packing,2.1 121.D.x.103	1
89013-107	Oil motor tube	1
89013-108	Idler gear stud	2
89013-109	Idler gear assembly	4
89013-110	Drive gear	1
89013-111	Cover	1
89013-112	Lock washer, .375	4
89013-113	Soc. hd. cap screw..375-16x1.500	2
89013-114	Screw	2
89013-115	Nameplate	1
89013-116	Soc. hd. plug, 1/16 NPTF	1
89013-117	Gauge	1
89013-118	Roll pin, .094 x .625	1
89013-119	Washer	2
89013-120	Preformed packing,2.3641.D.x.070	1
89013-121	Loctite TL242 adhesive (use with part 35)	AR
89013-122	Plug (optional)	1
89013-123	O-ring (optional)	1
89013-124	Transfer valve (starting oil) (optional)	1
89013-125	Laminated shim	1
89013-126	Solid pilot valve plunger	
89013-127	Breather cap	1
89013-128	Adapter	1

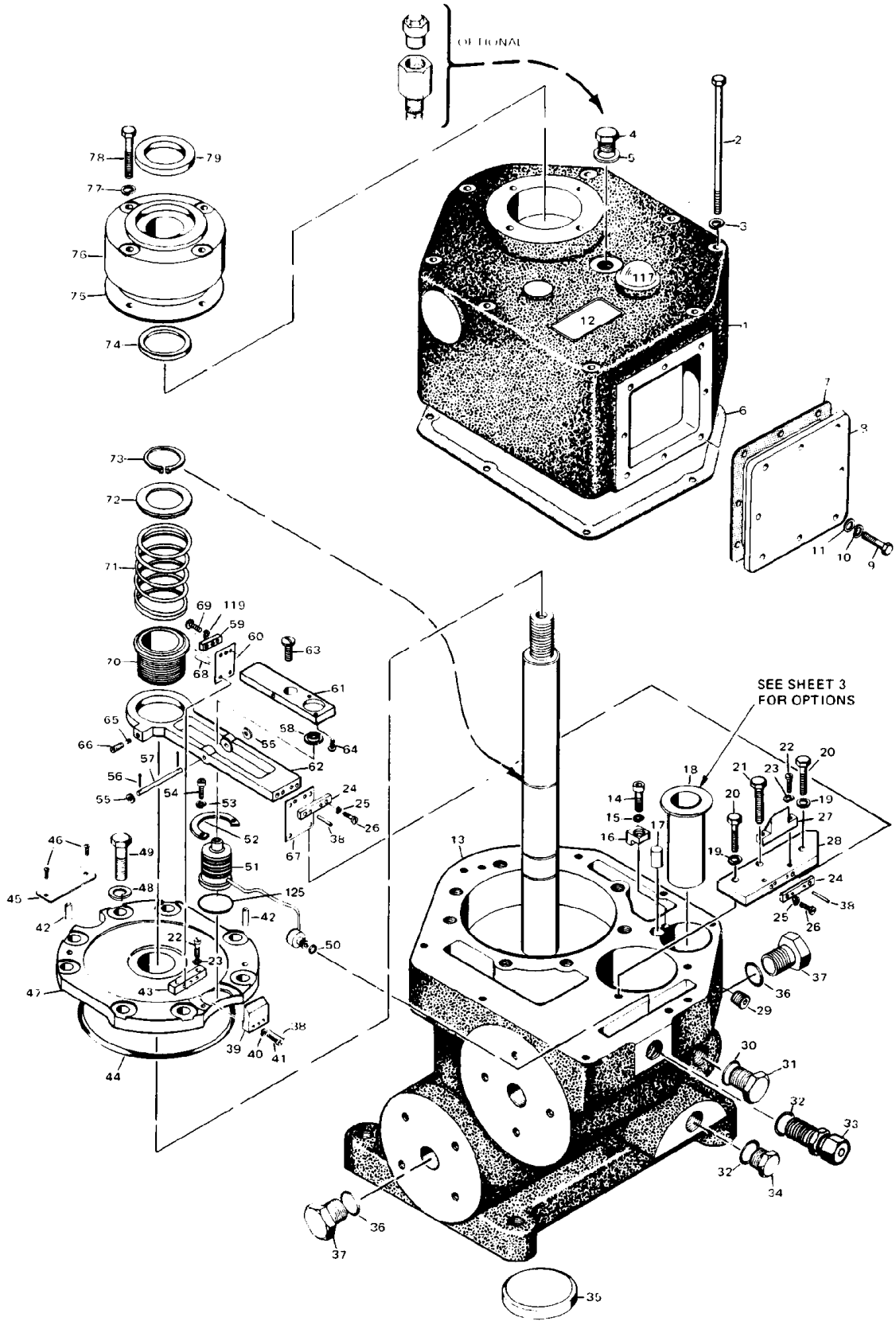

Figure 5-1a. Exploded View of the Hydraulic Amplifier

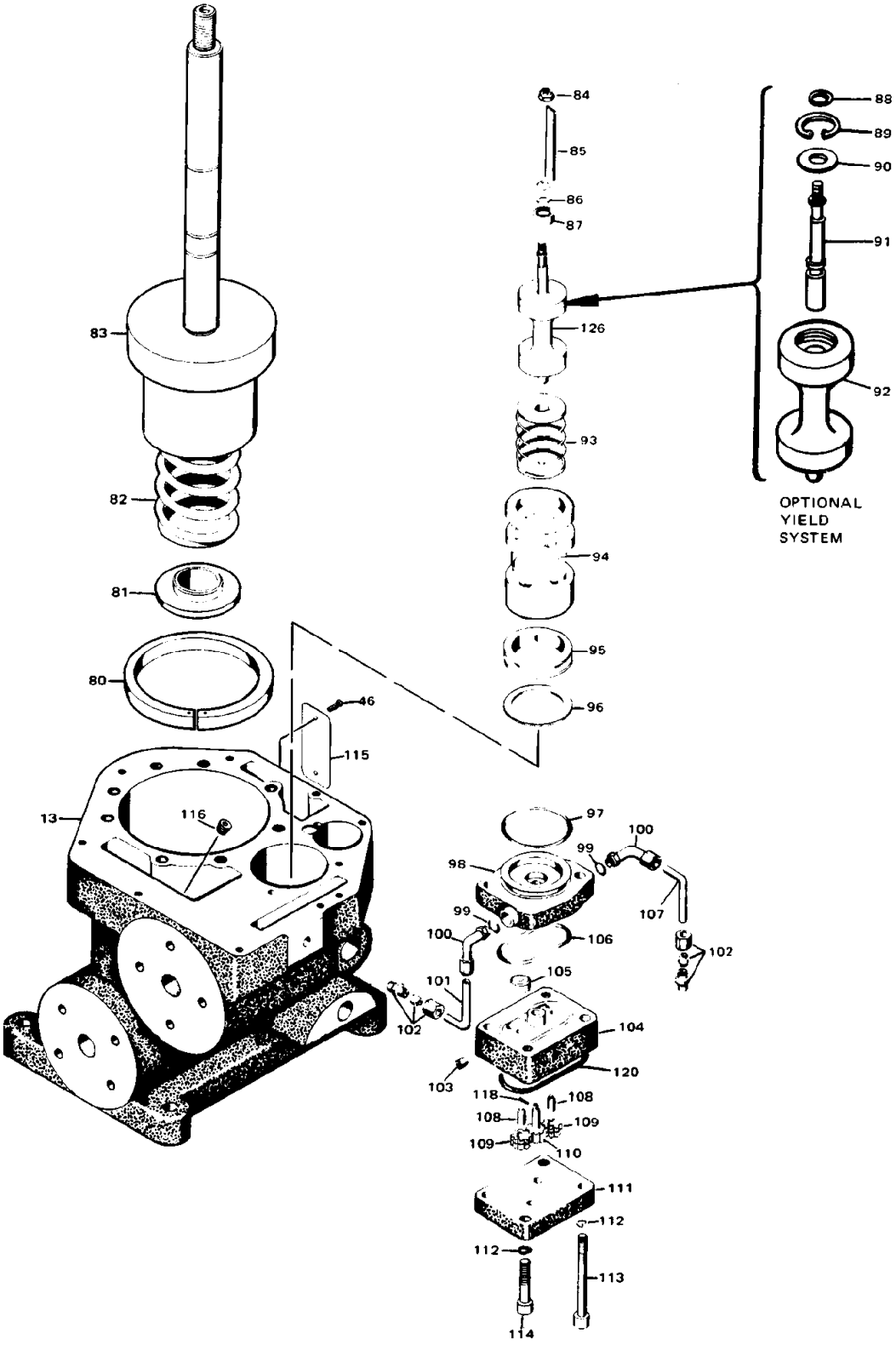

Figure 5-1b. Exploded View of the Hydraulic Amplifier

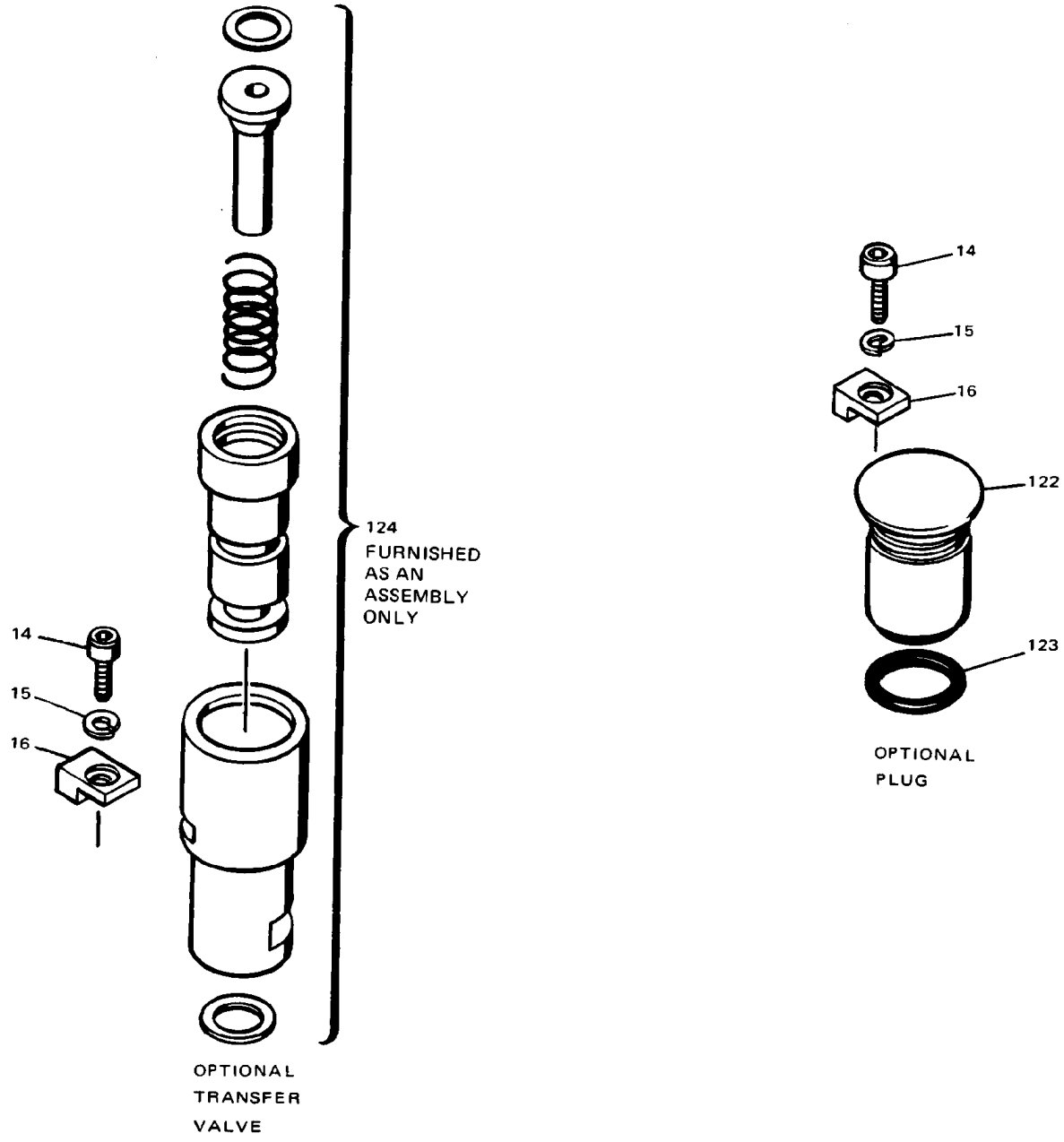

Figure 5-1c. Exploded View of Optional Plug and Transfer Valve Assembly

PG Dial Governor Parts List

Refer to Figure 5-2 for part reference numbers. This list covers only the speed droop feature, refer to the applicable governor manuals for remaining parts.

Ref. No.	Part Name	Quantity
89013-201	Drive gear (with oscillator cam)	1
89013-202	Speeder plug	1
89013-203	Speeder plug plunger	1
89013-204	Screw, 1/4-20x5/8", hex.hd.	4
89013-205	Lockwasher, split, 1/4" ID	4
89013-206	Screw, 8-32x5/8" hex. hd.	1
89013-207	Speed droop lever shft	1
89013-208	Needle bearing	2
89013-209	Pin, 0.263" driv-lok	1
89013-210	Speed droop cover	1
89013-211	Speed droop lever	1
89013-212	Straight pin	1
89013-213	Drive pin, 1/8 O.D.xO.207" lg	1
89013-214	Power piston tall rod	1
89013-215	Preformed packing, 11/16" OD	1
89013-216	Piston spring	1
89013-217	Spring guard	1
89013-218	Locknut, 3/8-24, fibre	1
89013-219	Screw, 1/4-28 x 3/4", soc. hd.	4
89013-220	Lockwasher, internal tooth, 1/4 ID	4
89013-221	Spring guard gasket	1
89013-222	Piston rod lift nut	1
89013-223	Lock washer, internal tooth, 3/8" ID	1
89013-224	Spacer, 0.100" thk.	2
89013-225	Spacer, 0.200' lhk.	1
89013-226	Power cylinder	1
89013-227	Power piston	1
89013-228	Oscillator piston	1
89013-229	Retaining ring, square wire, 0.236" ID	1
89013-230	Oscillator strut	1
89013-231	Power cylinder gasket	1
89013-232	Connector, straight, 9/16-18 to 3/8' OD turbe plug, 9/16-18 (alternate if gauge connection not used)	1
89013-233	Preformed packing, 5/8" OD	2
89013-234	Elbow. 9/16-18 to 3/8" OD lube	1
89013-235	Lock washer, split. 3/8" ID	4
89013-236	Screw, 3/8-16x1", soc. hd.	4
89013-237	Preformed packing. 7/16" OD	1
89013-238	Needle valve, compensation	1
89013-239	Preformed packing, 5/16" OD	1
89013-240	Needle valve, anticipation	1
89013-241	to –250	Not used

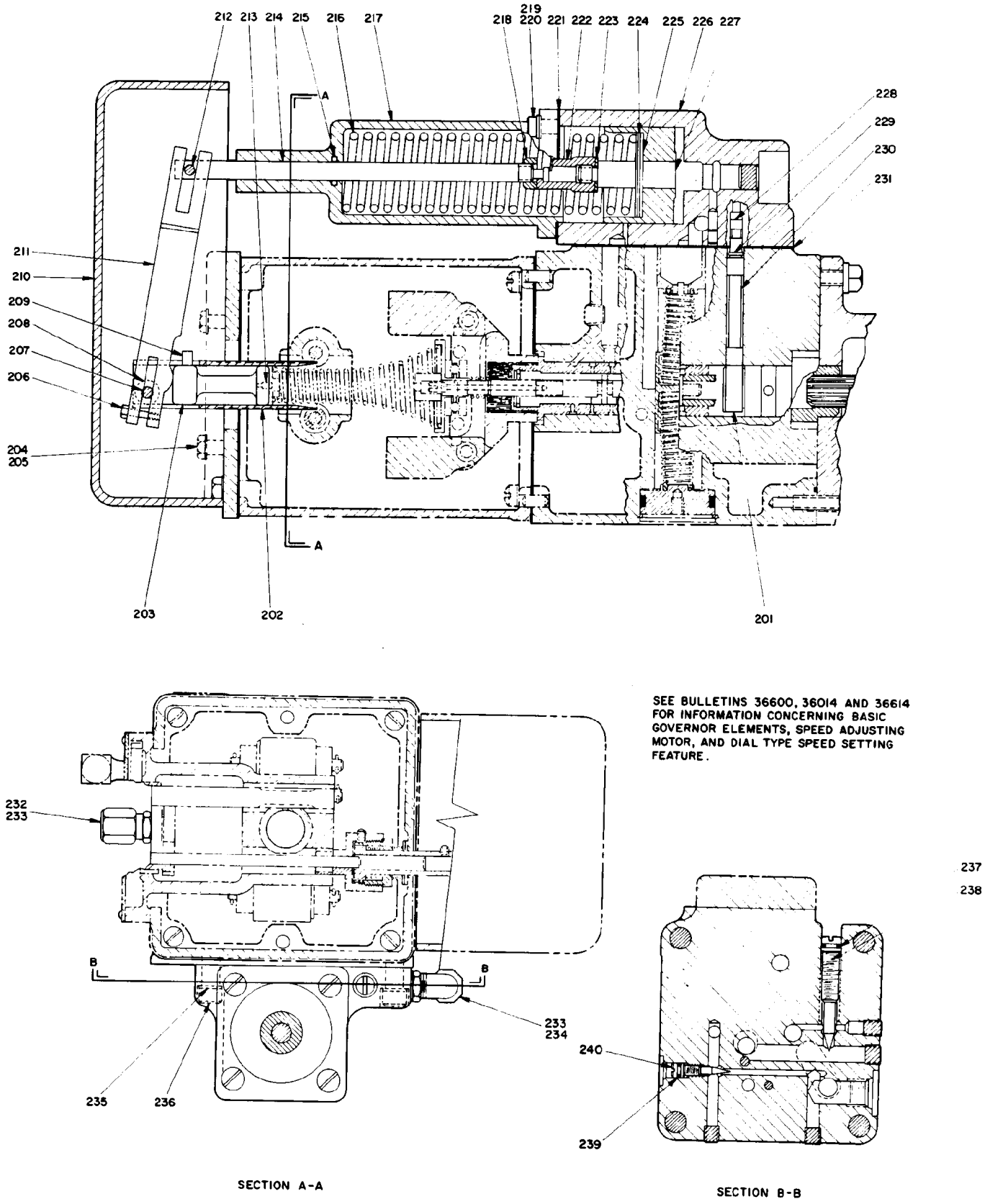

Figure 5-2. PG Dial Governor Assembly with Speed Droop

Ref. No.	Part Name	Quantity
89013-251	Power cylinder	1
89013-252	High collar lockwasher; 0.3751.0.	4
89013-253	Soc. hd. screw 0.375-16x1.000	4
89013-254	Needle valve	2
89013-255	Servo spring	1
89013-256	Spring guard gasket	1
89013-257	Spring guard	1
89013-258	Slat-o-seal	1
89013-259	Hex hd. screw, .438-20x1 .000	1
89013-260	Internal shakeproof washer, 0.250	4
89013-261	Soc. cap screw, 0.250-28x0.750	4
89013-262	Power piston	1
89013-263	Power piston spacer	1
89013-264	Power piston spacer	2
89013-265	Servo identification plate	1
89013-266	Drive screw	2

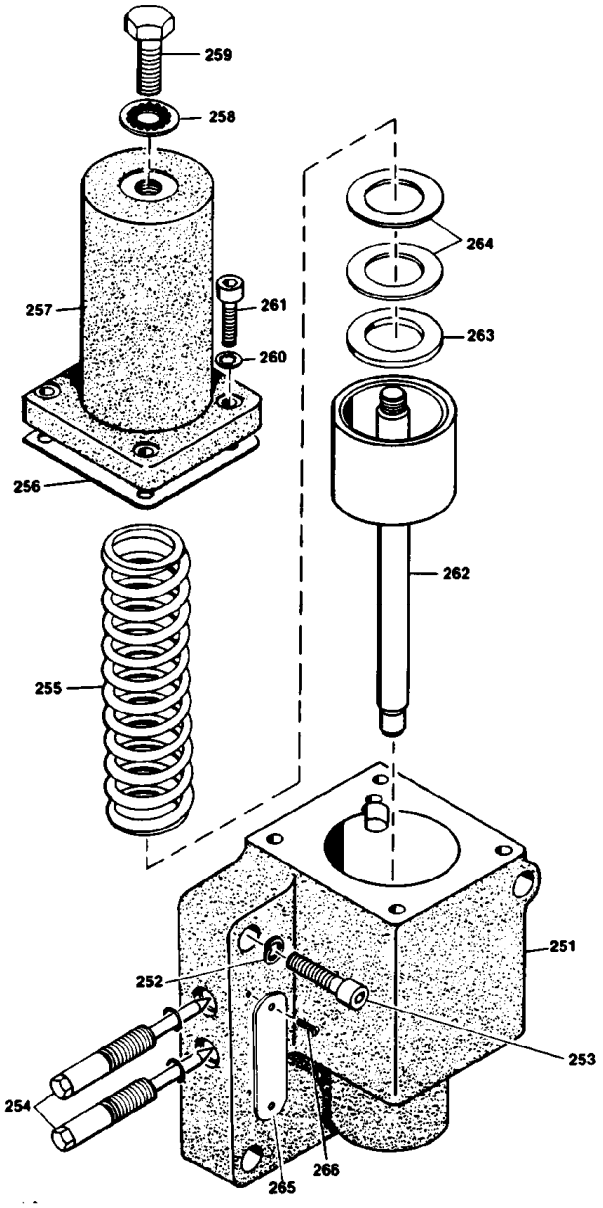

Figure 5-3. Exploded View of the Power Cylinder for a PG-PL Governor
(See manual 36694 for complete governor)

Chapter 6.
Service Options

Product Service Options

If you are experiencing problems with the installation, or unsatisfactory performance of a Woodward product, the following options are available:

- Consult the troubleshooting guide in the manual.
- Contact the manufacturer or packager of your system.
- Contact the Woodward Full Service Distributor serving your area.
- Contact Woodward technical assistance (see "How to Contact Woodward" later in this chapter) and discuss your problem. In many cases, your problem can be resolved over the phone. If not, you can select which course of action to pursue based on the available services listed in this chapter.

OEM and Packager Support: Many Woodward controls and control devices are installed into the equipment system and programmed by an Original Equipment Manufacturer (OEM) or Equipment Packager at their factory. In some cases, the programming is password-protected by the OEM or packager, and they are the best source for product service and support. Warranty service for Woodward products shipped with an equipment system should also be handled through the OEM or Packager. Please review your equipment system documentation for details.

Woodward Business Partner Support: Woodward works with and supports a global network of independent business partners whose mission is to serve the users of Woodward controls, as described here:

- A **Full Service Distributor** has the primary responsibility for sales, service, system integration solutions, technical desk support, and aftermarket marketing of standard Woodward products within a specific geographic area and market segment.
- An **Authorized Independent Service Facility (AISF)** provides authorized service that includes repairs, repair parts, and warranty service on Woodward's behalf. Service (not new unit sales) is an AISF's primary mission.
- A **Recognized Engine Retrofitter (RER)** is an independent company that does retrofits and upgrades on reciprocating gas engines and dual-fuel conversions, and can provide the full line of Woodward systems and components for the retrofits and overhauls, emission compliance upgrades, long term service contracts, emergency repairs, etc.
- A **Recognized Turbine Retrofitter (RTR)** is an independent company that does both steam and gas turbine control retrofits and upgrades globally, and can provide the full line of Woodward systems and components for the retrofits and overhauls, long term service contracts, emergency repairs, etc.

You can locate your nearest Woodward distributor, AISF, RER, or RTR on our website at:

www.woodward.com/directory

Woodward Factory Servicing Options

The following factory options for servicing Woodward products are available through your local Full-Service Distributor or the OEM or Packager of the equipment system, based on the standard Woodward Product and Service Warranty (5-01-1205) that is in effect at the time the product is originally shipped from Woodward or a service is performed:

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

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 a flat-rate program and includes the full standard Woodward product warranty (Woodward Product and Service Warranty 5-01-1205).

This option allows you to call your Full-Service Distributor 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 Full-Service Distributor.

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 within 60 days, a credit for the core charge will be issued.

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 for repair, please contact your Full-Service Distributor in advance to obtain Return Authorization and shipping instructions.

When shipping the item(s), attach a tag with the following information:

- return authorization number;
- 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.

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.

NOTICE

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*.

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.

Engineering Services

Woodward offers various Engineering Services for our products. For these services, you can contact us by telephone, by email, or through the Woodward website.
- Technical Support
- Product Training
- Field Service

Technical Support is available from your equipment system supplier, your local Full-Service Distributor, or from many of Woodward's worldwide locations, depending upon the product and application. This service can assist you with technical questions or problem solving during the normal business hours of the Woodward location you contact. Emergency assistance is also available during non-business hours by phoning Woodward and stating the urgency of your problem.

Product Training is available as standard classes at many of our worldwide locations. 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.

Field Service engineering on-site support is available, depending on the product and location, from many of our worldwide locations or from one of our Full-Service 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 information on these services, please contact us via telephone, email us, or use our website: **www.woodward.com**.

How to Contact Woodward

For assistance, call one of the following 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.

Electrical Power Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
Germany	+49 (0) 21 52 14 51
India	+91 (129) 4097100
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
Poland	+48 12 295 13 00
United States	+1 (970) 482-5811

Engine Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
Germany	+49 (711) 78954-510
India	+91 (129) 4097100
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
The Netherlands	+31 (23) 5661111
United States	+1 (970) 482-5811

Turbine Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
India	+91 (129) 4097100
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
The Netherlands	+31 (23) 5661111
Poland	+48 12 295 13 00
United States	+1 (970) 482-5811

You can also locate your nearest Woodward distributor or service facility on our website at:

www.woodward.com/directory

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:

Your Name	
Site Location	
Phone Number	
Fax Number	
Engine/Turbine Model Number	
Manufacturer	
Number of Cylinders (if applicable)	
Type of Fuel (gas, gaseous, steam, etc)	
Rating	
Application	
Control/Governor #1	
Woodward Part Number & Rev. Letter	
Control Description or Governor Type	
Serial Number	
Control/Governor #2	
Woodward Part Number & Rev. Letter	
Control Description or Governor Type	
Serial Number	
Control/Governor #3	
Woodward Part Number & Rev. 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.

We appreciate your comments about the content of our publications.

Send comments to: icinfo@woodward.com

Please reference publication 89013A.

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Email and Website—www.woodward.com

**Woodward has company-owned plants, subsidiaries, and branches,
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.

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