



PSG Governor
with Cast Iron Case

Installation and Operation Manual

IMPORTANT



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.

DEFINITIONS

- **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

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.



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.



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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.

NOTICE

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.

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*.

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Chapter 1.

General Information

Introduction

The basic PSG (Pressure Compensated Simple Governor) is a hydraulic speed governor with buffer type compensation. It is normally isochronous, that is, if the engine is not overloaded it maintains the same speed regardless of load, except momentarily at the time load change occurs.

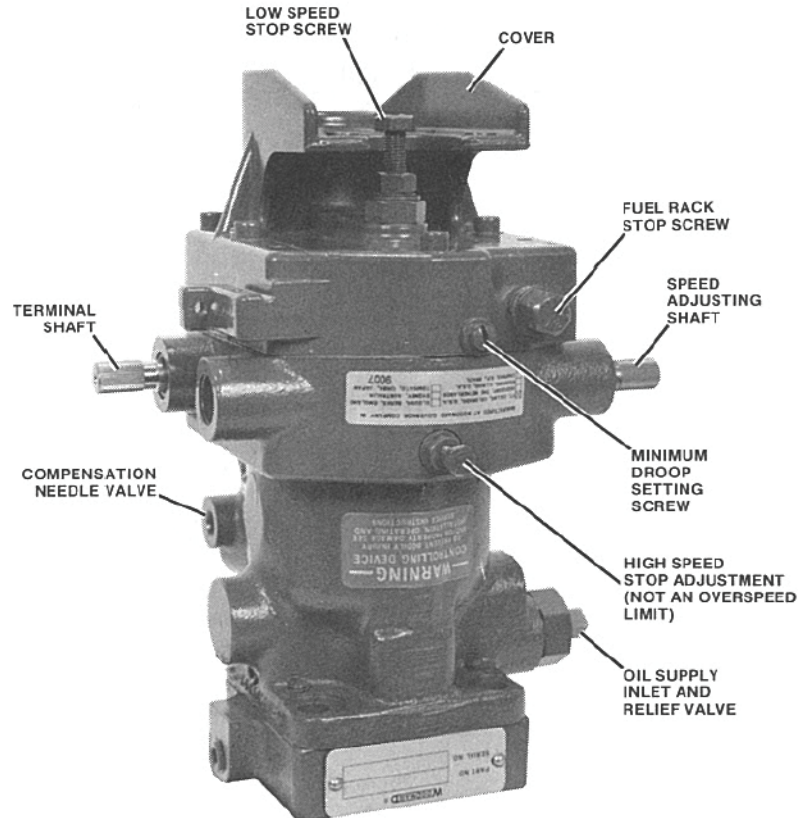


Figure 1-1. Basic PSG Governor

The governor uses engine lubricating oil or an oil supply from a separate sump furnished by the engine manufacturer. If the latter is used, lift should not exceed 300 mm (12 inches) and a foot valve should be furnished.

IMPORTANT

The torque, work capacity, and maximum work values of the PSG governor are based on 172 kPa (25 psi) supply oil pressure to the governor. These values can vary depending on the supply oil pressure.

The standard PSG cover provides for an interior vertical return-spring. The cover includes a bracket for the Pittman PM (Permanent Magnet) speed-setting motor. PSG governors without a motor have a low-speed stop screw installed in the cover. See Figure 1-1 for external features of the PSG.

Special Features

The normal PSG has a cast iron case and base and an aluminum cover. For many years, PSGs were built with aluminum cases. Aluminum case PSGs are still available for special purposes. Aluminum case PSGs are described in manual 37013.

PSGs are built in many special configurations to meet the unique needs of various engine manufacturers. Most of these special features are described in Chapter 6 of this publication. The PSG uses hydraulic pressure to drive the terminal shaft in only one direction. If an internal return spring is not used, a spring must be installed before the engine is started.

References

- 04018 *Speed Adjusting Motor Cover Assembly Manual*
- 25071 *Oils for Hydraulic Controls*
- 25075 *Commercial Preservation Packaging for Storage of Mechanical-Hydraulic Controls*
- 50517 *Recommended Engine Oil Supply System for Small Governors and Actuators*

Chapter 2. Installation

Introduction

This chapter describes receiving, storage, and installation requirements for the PSG governor.

Use care while handling and installing the PSG governor. Be particularly careful to avoid striking the drive shaft, terminal shaft, or a speed setting device. Abuse can damage seals, internal parts, and factory adjustments. Do not set the governor on its drive shaft.

Receiving

After factory testing and calibration, the PSG governor is drained of oil, which leaves a light film of oil on internal parts to prevent rust. The governor is then painted and external parts are coated with a spray lubricant/rust inhibitor.

No internal cleaning or flushing is necessary before installation and operation. The little oil left in the governor is clean, multiviscosity engine oil which will not contaminate an engine oil system.

Storage

The PSG governor may be stored for short periods of time (less than a year) as received from the factory. For long-term storage (more than a year), storage in an environment with large temperature changes, humid or corrosive atmosphere, or if the governor is installed on the engine for storage, fill the governor with oil and follow preservation packaging instructions in Woodward manual 25075, *Commercial Preservation Packaging for Storage of Mechanical-Hydraulic Controls*.

External Return Spring

The PSG uses internal oil pressure to move the output in the more-fuel direction only. A spring is used to move the output in the fuel-off direction. If an internal return spring is not supplied, an external spring must be installed. The return spring must provide a torque of 2.8 to 5.6 N·m (25 to 50 lb-in) on the terminal shaft in the fuel off direction for a governor with 1207 or 1896 kPa (175 or 275 psi) operating pressure respectively.

Oil Supply

Almost all PSG governors use engine oil in the governor. Some governors use oil from a separate sump.

Supply Pressure

A minimum of 172 kPa (25 psi) and a maximum of 517 kPa (75 psi) oil must be supplied from the engine lubricating system. If a separate sump is used the supply must have less than 300 mm (12 inches) of suction lift from the sump. Torque and work capacity will vary according to the amount of supply pressure or suction lift.

IMPORTANT

Consult Woodward if supply pressures must exceed 517 kPa (75 psi).

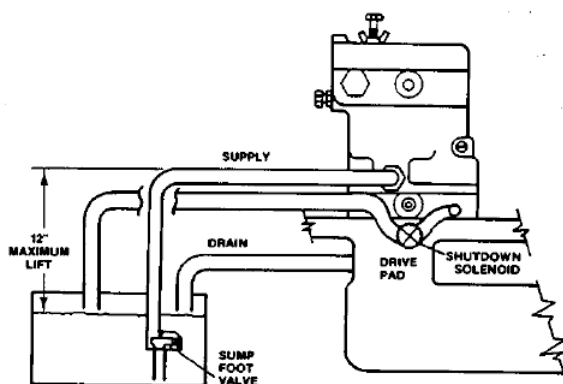


Figure 2-1. Separate Sump Installation

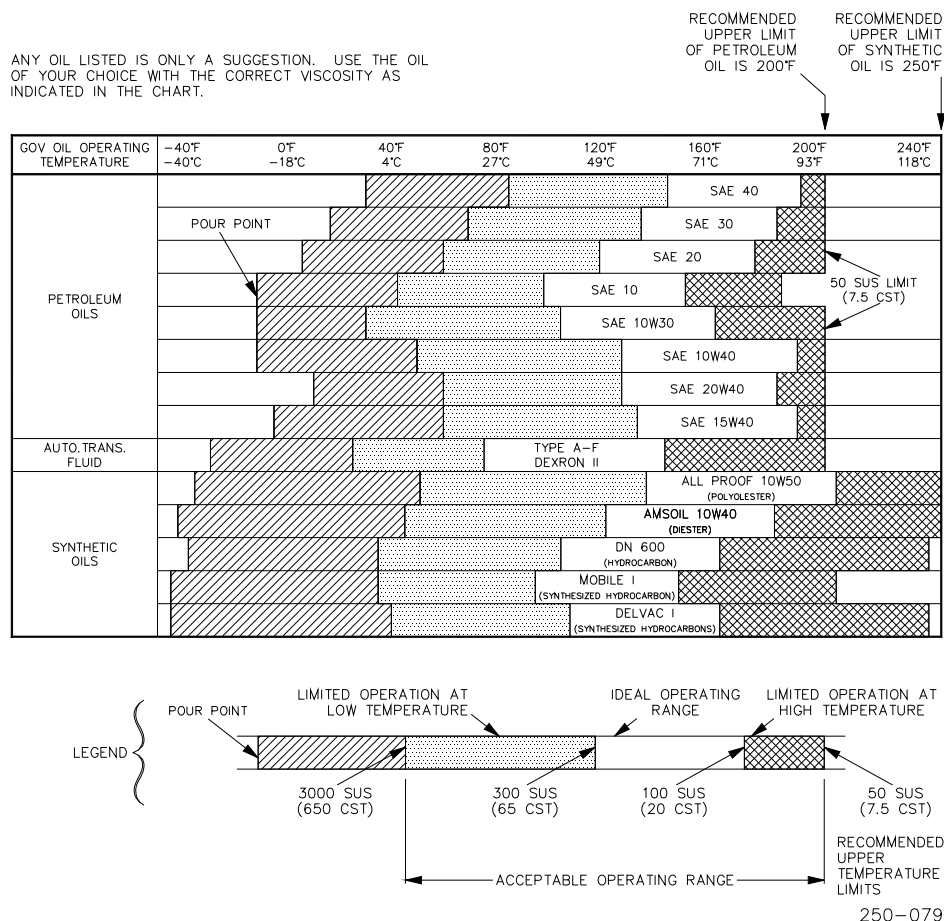


Table 2-1. Oil Chart

Peak demand from the governor will be 7.6 L/min (2 US gal/min) during transients. The Governor will flow 1.3 L/min (0.35 US gal/min) during steady state.

Governor oil is both a lubricating oil and a hydraulic oil. It must have a viscosity index that allows it to perform over the operating temperature range and it must have the proper blending of additives that cause it to remain stable and predictable over this range.

Use the information given in Table 2-1 as a guide in the selection of a suitable lubricating-hydraulic oil. For applications where the governor shares the oil supply with the engine, use the oil recommended by the engine manufacturer for engine lubricating oil. Should this oil not be included in the table, contact Woodward.

Drive Shaft Rotation

Rotation of the governor drive shaft must be the same as that of the engine drive, when looking down on the mounting pad. Correct direction of rotation for the PSG governor is shown by a raised arrow at the bottom of the governor case on the side opposite the oil-supply inlet, when looking at the arrow from the top of the governor. Plugs are inserted in the case and base to determine clockwise or counterclockwise direction. Check valves can be used in the governor case to allow either direction of rotation.

See Chapter 4 for additional information about pump rotation direction.

Governor Installation

Governor to Drive Pad

Place a gasket between the base of the governor and the engine mounting pad. The gasket must not block any holes in the governor base. Install the governor on the engine, taking particular care to mount it squarely on the engine.

Be sure that the drive connection is properly aligned. Do not force the governor onto the drive connection. It must drop into place of its own weight. Improperly aligned governors will not give stable control.

Many governor mounting pads will have studs installed to fasten down the governor. Some installations will require 5/16-inch screws to hold the governor in place. Follow the engine manufacturer's instructions, if available.

Oil Connections

Install a 10 mm (3/8 inch) diameter oil line from the governor to either the engine lubricating oil pump pressure line, or a separate sump, unless the engine mounting pad is drilled for an oil supply. Use a 40 μ m (nominal) filter with a minimum capacity of 7.6 L/min (2 US gal/min). The best installation will include supply features that prevent drain back or siphon back from the pump level of the governor. This will always keep the pump primed with oil in preparation for the next start. See Figures 2-2 and 2-3 for illustration of an installation designed to provide nearly instantaneous governor response, even at cranking speed. See also the "Quick Start" instructions on the next page.

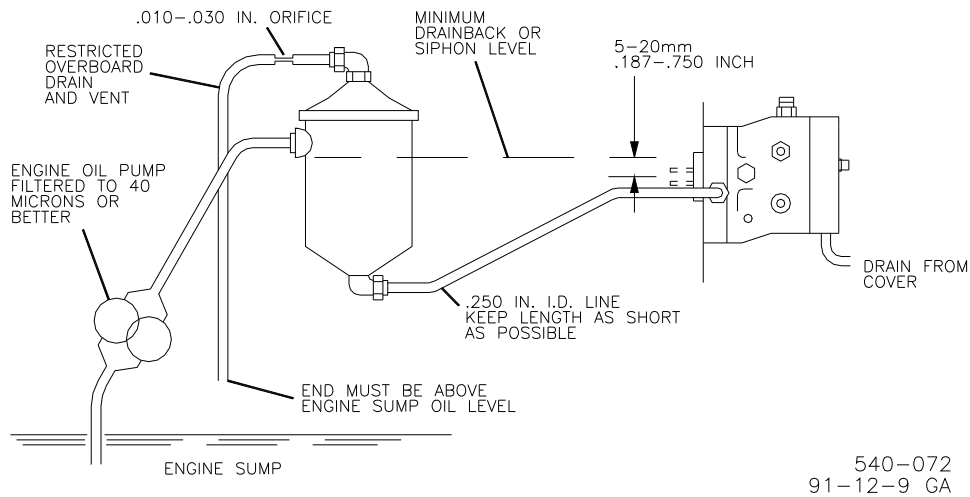
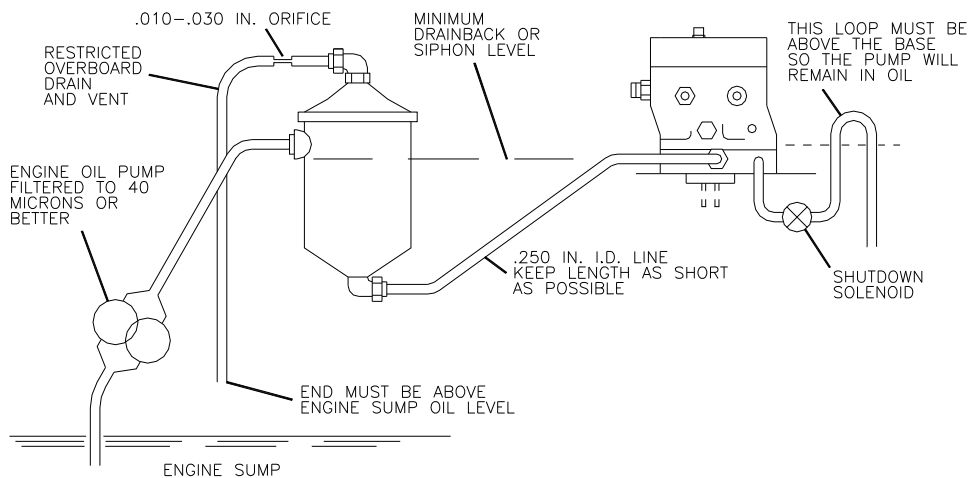


Figure 2-2. Oil System for Horizontal Installation

Figure 2-3. Engine Oil System for Quick Starts
(Vertical Installation)

Vertical Governor Installation

Allow free drainage of oil from the governor pilot valve by providing adequate drain holes from the drive coupling (6 mm [1/4 inch] diameter or equivalent in multiple holes). Be sure the engine mounting pad gasket does not block off the three drain holes in the governor base. See Figures 2-7, 2-8, and 2-9.

Horizontal Governor Installation

If the governor is mounted horizontally, the needle valve adjustment must be on the side and at the lowest level. Horizontal mounting also requires that a drain line be installed from either a 6 mm (1/4 inch) pipe tap or existing 7/16 inch straight thread port in the cover. The drain line must be as large as possible and unimpeded to the sump.

Quick Start

Use a supply system similar to Figure 2-3 for applications requiring quick starts. Note that the end of the overboard drain line must be kept above the engine sump oil level to allow the system to act as a vent before the engine oil pump is adding to the oil supply. Oil level in the oil tank must always be as high as, or higher than, the pump level to prevent the pump from losing its prime and delaying the start of governor operation until the pump regains a flow of oil.

Linkage from Governor to Engine

Connect the fuel-control linkage for 2/3 travel from no-load to maximum fuel. Divide the unused portion of the travel between minimum and maximum. Make sure that the linkage will shut off the fuel at minimum position. The linkage must be free from friction and looseness.

Most PSG governors have internal return springs. The return spring must be able to move the fuel valve or rack to a closed position. The PSG governor does not supply hydraulic pressure control in the minimum fuel direction.

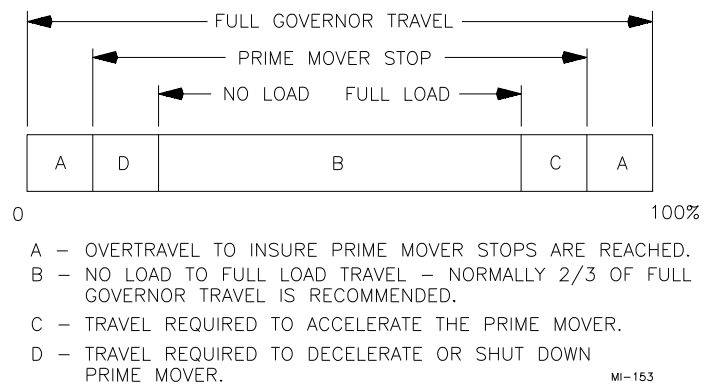
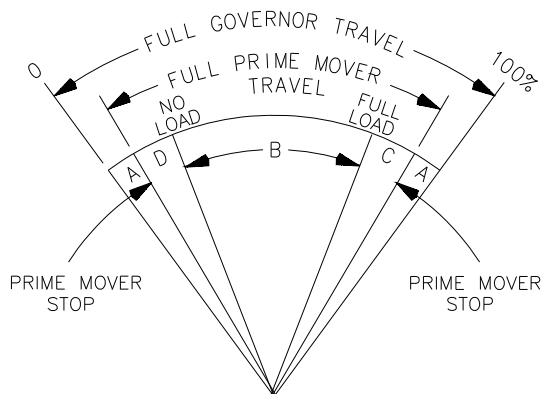
Linear Linkage

Use linear linkage for most diesel engine applications. Adjust the fuel linkage to provide control of engine fuel from Minimum Prime Mover Stop to Maximum Prime Mover Stop within the limits of the governor output-shaft travel. We recommend using two-thirds or more of the 36 degrees of output-shaft travel between prime mover no-load and full-load positions (see Figure 2-4).

Attach the fuel-rack linkage to the governor output shaft. Be sure there is no lost motion or binding in the linkage.

IMPORTANT

Be sure to allow sufficient overtravel at each end of terminal-shaft travel so the governor can shut down the engine and also give maximum fuel when required.



MI-153
98-08-06 skw

Figure 2-4. Recommended Terminal Shaft Travel

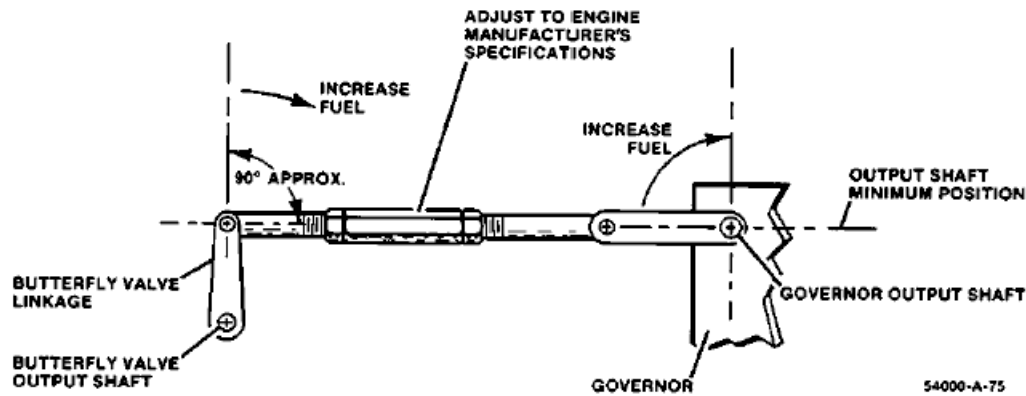


Figure 2-5. Non-linear Linkage

Non-linear Linkage

Applications involving a butterfly valve, such as a gas engine, require a non-linear linkage.

Figure 2-5 illustrates the relationship between governor output shaft and butterfly valve obtained with simple linkage of maximum non-linearity. When installing this linkage, make sure the two following conditions are attained when the linkage is in the no-load position:

1. The lever which is attached to the governor output and the connecting link are in line with the governor output shaft and the point of attachment of the connecting link to the butterfly lever.
2. The butterfly lever is at 90° with the connecting link.

Refer to the engine manufacturer's instructions for the correct linkage selection and installation.

Speed Adjustment

There are several types of speed adjustments available for the PSG.

Lever

Some governors have a lever attached to the external end of the speed-adjusting shaft. This lever is used in conjunction with the high- and low-speed stop screws. Using a linkage arrangement with the lever provides a remote speed adjustment for the governor. The screw in the cover is used to set the minimum-speed stop while the screw in the case controls the maximum-speed stop of the governor. The speed-setting shaft does not usually extend from governors designed for pneumatic or motor speed setting.

Pneumatic Head or Motor

The governor can be equipped with either a pneumatic speed-adjustment head or an electric motor for remote speed adjustment (see Chapter 6 for details about these two types of speed setting). Both of these speed setting systems use a high-speed stop screw.

Constant Speed

Some PSGs are equipped with a speed-setting screw in the cover. This is the same screw used as the minimum-speed stop with speed-setting devices.

Speed Droop

PSG droop is internally or externally adjustable between zero and seven percent. Speed droop, a reduction in speed setting as fuel increases, is expressed as a percentage of the difference between the lower full-load speed and the high speed at no load. Speed droop permits load division between two or more engines driving generators in parallel or connected to a single shaft. If the engine is operated alone or on a dc system with proper generator compounding, the governor may be set for zero droop (isochronous operation).

IMPORTANT

Negative droop (governor speed setting increases as load increases) must not be set into the PSG governor. The governor will not provide acceptable control with negative droop.

IMPORTANT

If the governor output shaft does not use the full 2/3 of available travel from NO LOAD to FULL LOAD, droop will be reduced proportionately.

For ac generating units tied in with other units, set the droop sufficiently high to prevent interchange of load between units. If one unit in the plant or system has enough capacity, set its governor on zero droop and it will regulate the frequency of the entire system. This unit then takes all load changes within the limits of its capacity and control the frequency if its capacity is not exceeded.

All units may be run in droop, but the no load to full load speed change (droop setting) must be equal for all paralleled units. Speed will change as load is increased or decreased. Adjust speed setting to share load: increasing or decreasing speed setting on a particular unit will increase or decrease the load on that unit.

Internally adjusted droop is normally set at the factory on a test stand according to the engine manufacturer's specifications. Do not move the droop position unless you are familiar with PSG governor setup procedures. See Application Note 01302, *Speed Droop & Power Generation*, for more information on setting droop for power generation.

External Shutdown Solenoid

Use an external solenoid for shutdown through the governor.



WARNING

The engine should be equipped with an overspeed shutdown that is completely independent of the PSG governor. Overspeed can and will cause damage to the engine or the engine-driven device with possible personal injury or loss of life. It is likely that the governor, governor drive, or linkage could be the cause of the overspeed and a shutdown connected to the governor would not help control the runaway engine speed.

The shutdown solenoid shown in Figure 2-3 allows draining the control oil from beneath the power cylinder in the governor. This will allow the return spring to move the governor output to minimum fuel.

Figure 2-3 shows the connection options for a solenoid shutdown. Connect the solenoid with tubing runs as short as possible. Mount the solenoid below the governor, oriented so it does not fill with air. Air trapped by the tubing causes governor instability. Figure 2-1 shows a separate sump arrangement and Figure 2-3 shows a typical installation using engine oil.

The solenoid and all connected tubing must pass enough flow to ensure that the governor moves to minimum position and remains there. The solenoid dumps oil directly from the power cylinder, and must handle the full pump output. Different flow capabilities are required, depending on rated governor speed. Figure 2-6 shows PSG pump output versus governor speed and is provided to help size the shutdown solenoid and shutdown connections.

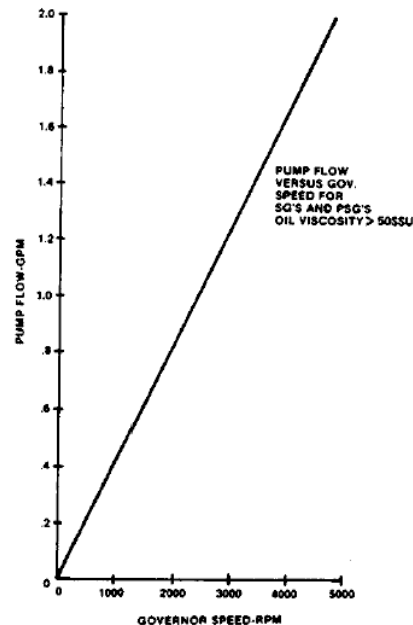


Figure 2-6. Governor Speed vs Pump Flow

All pump output must be discharged with a maximum pressure drop of 138 kPa (20 psi) for 517 kPa (75 psi) governors and 345 kPa (50 psi) for 1207 kPa (175 psi) governors.

Initial Operation and Adjustment

Governor adjustments for speed, droop, and compensation needle valve are set at the factory. Minor adjustments are required after installation due to engine variances.

PSG screw set speed is set at the factory to specified full-load rated speed. Internally adjusted droop setting is factory set as specified for the particular application. Droop should always be set as near isochronous as possible to provide the fastest possible governor response to speed/load changes.

The needle valve is preset to 1/2 turn open. This normally requires adjustment to suit the particular installation.

Make certain the speed is set to minimum (idle). Start the engine under manual control according to the engine manufacturer's recommendations, and allow it to warm up. Transfer the engine to governor control, but be prepared to resume manual control until satisfied that the governing system is fully operative.

Adjust the governor for no-load rated speed. Open the compensation needle valve (1/2 to 2 turns) until the engine begins to hunt or surge. Allow the engine to hunt for about a minute to purge trapped air from the internal passages in the governor. Gradually close the needle valve until hunting just stops. Closing the needle valve further than necessary results in a slow return to speed following a change in load. Do not attempt to operate the governor unless the needle valve is at least 1/8 turn open. The governor cannot provide optimum response with the needle valve too far closed.

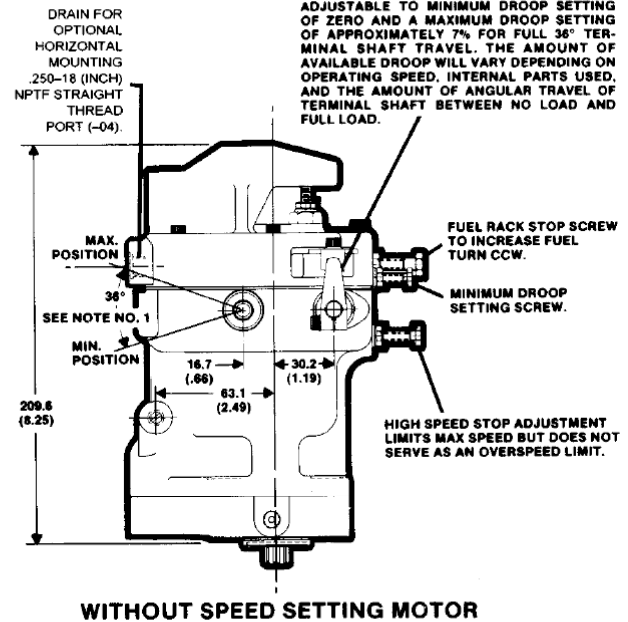
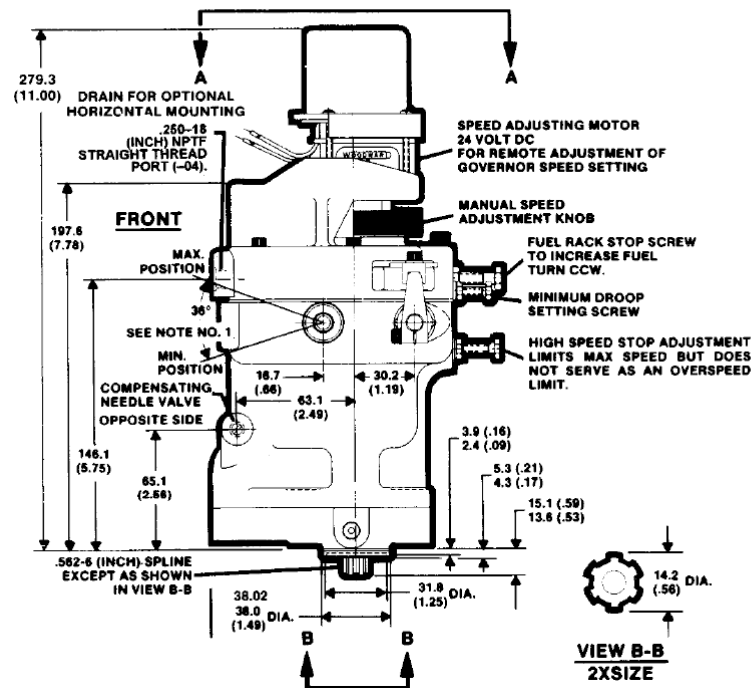
Test the governing action by manually disturbing engine speed. The engine should return promptly to original steady-state speed with only a small overshoot.



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.

PSG GOVERNOR WITH PM MOTOR
AND EXTERNAL RIGHT HAND DROOP

PSG GOVERNOR OPTIONS

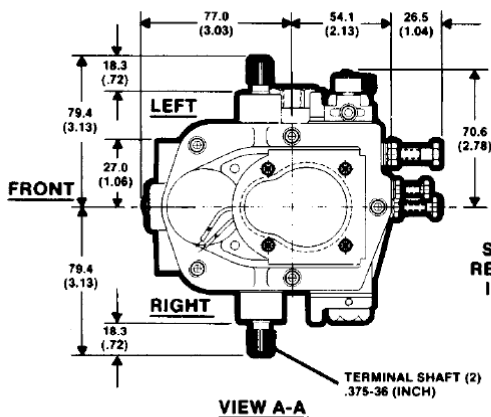


NOTE:
1. 36° MAXIMUM USABLE STROKE AVAILABLE.

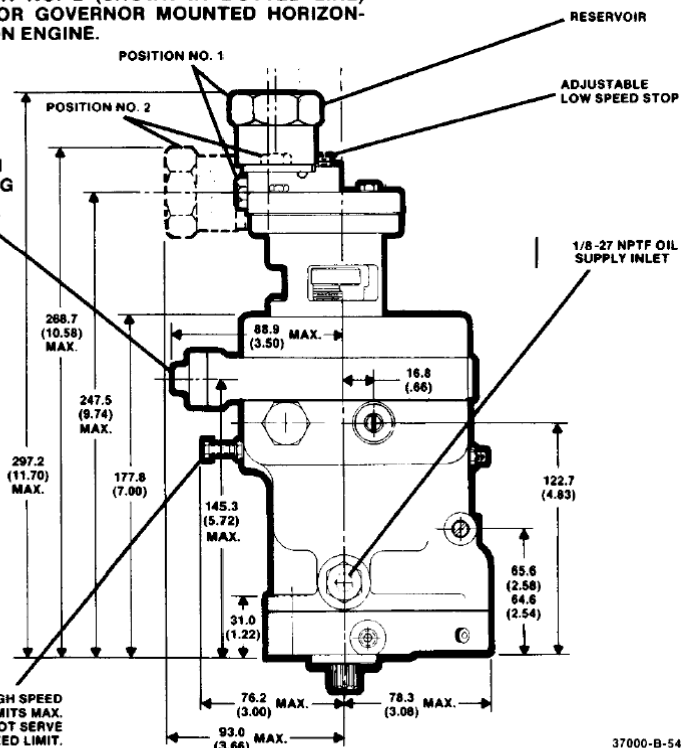
NOTE:
POSITION NO. 1 OF OIL RESERVOIR AND PLUG USED FOR GOVERNOR MOUNTED VERTICALLY ON ENGINE.

RECOMMENDED TRAVEL
BETWEEN NO LOAD AND FULL LOAD IS 24°.

POSITION NO. 2 (SHOWN IN DOTTED LINE) USED FOR GOVERNOR MOUNTED HORIZONTALLY ON ENGINE.



NOTE:
SUBCAP WITH RETURN SPRING IS OPTIONAL.



WITH PNEUMATIC SPEED SETTING ASSEMBLY

METRIC (INCHES SHOWN IN PARENTHESES)

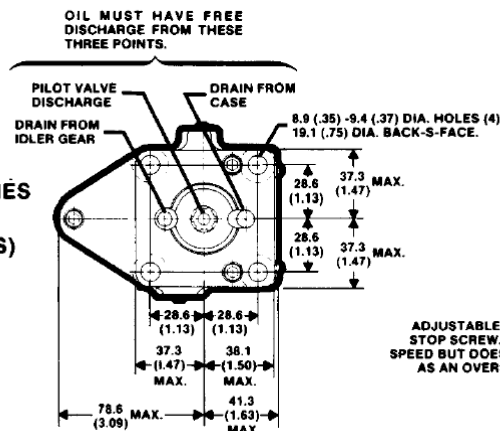


Figure 2-7. PSG Outline Drawing (Do not use for construction)

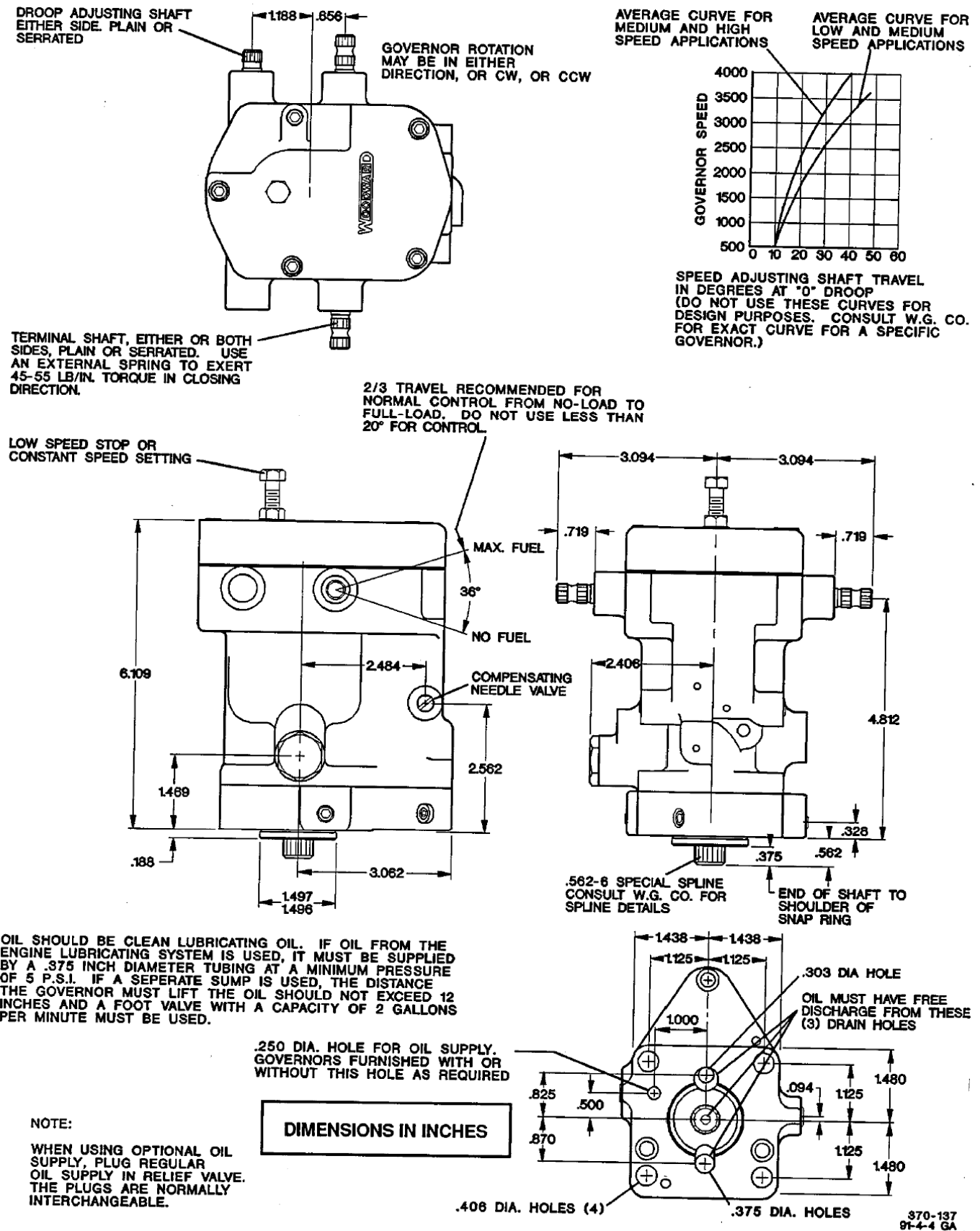


Figure 2-8. PSG Outline Drawing (Do not use for construction)

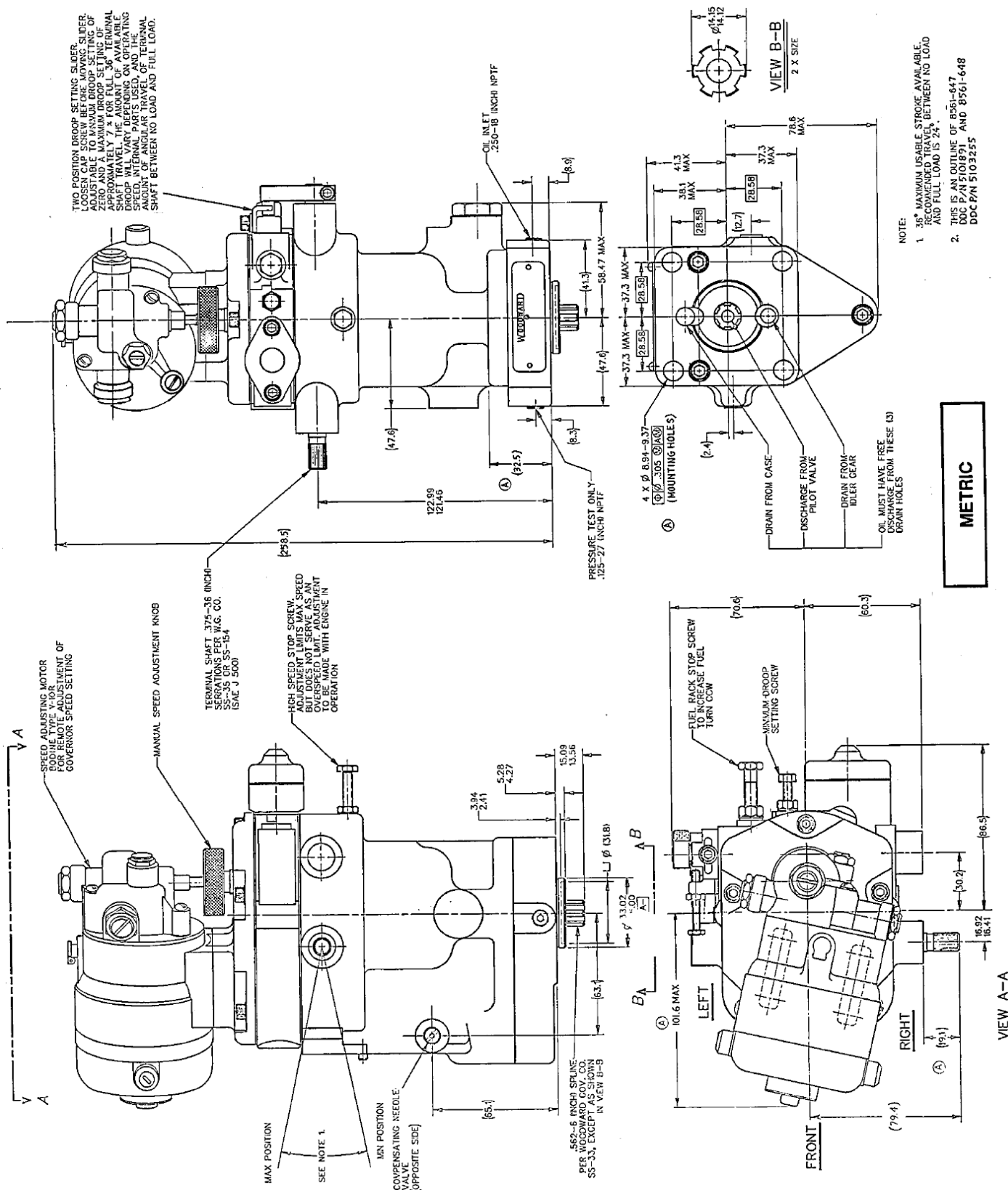


Figure 2-9. PSG Outline Drawing
(PSG with Bodine Type Motor, Horizontal Return Spring, External Droop)
(Do not use for construction)

Chapter 3.

Principles of Operation

Introduction

This chapter describes the operation of the PSG governor, including a description of the hydraulic system and the way it operates.

Figure 3-1 and 3-2 show the relationship of the various parts.

Operation

Mechanical Hydraulic System

Figure 3-1 shows the oil supply coming from the engine lubricating system. It bypasses the relief valve into the governor oil pump where its pressure is increased to either 517, 1207, or 1896 kPa (75, 175, or 275 psi) above inlet pressure. Four check valves permit rotation of the governor in either direction. Some models have two of the passages plugged for rotation in one direction only.

Relief-valve discharge is back to supply, so unused oil is recirculated within the governor.

Pressured oil is supplied through oil passages to the pilot-valve system. The pilot-valve system is a three-way spool valve. It applies pressured oil to the power cylinder when an under-speed signal is received or releases trapped oil from the power cylinder when a over speed signal is received.

Oil flow into the power cylinder forces the power piston upward against the force of the return spring. Pressured oil displaces the buffer piston and forces oil into the upper annulus.

Because all moving parts of the PSG are immersed in oil during normal operation the governor has extremely long wear without changes of speed setting or control ability.

Ballhead System

Flyweights are attached to the pilot valve's rotating bushing by pivot pins. The pilot-valve bushing is driven by an external drive from the engine. A thrust bearing, located under the speeder spring, rides on the toes of the flyweights. This allows the flyweights and pilot-valve bushing to rotate without extreme friction.

The non-rotating pilot-valve plunger inside the rotating bushing is able to respond to minor changes in positioning pressure because of the rotational/non-rotational relationship between the two parts. This reduction of "sticktion" between the parts allows more precise control than would be otherwise possible.

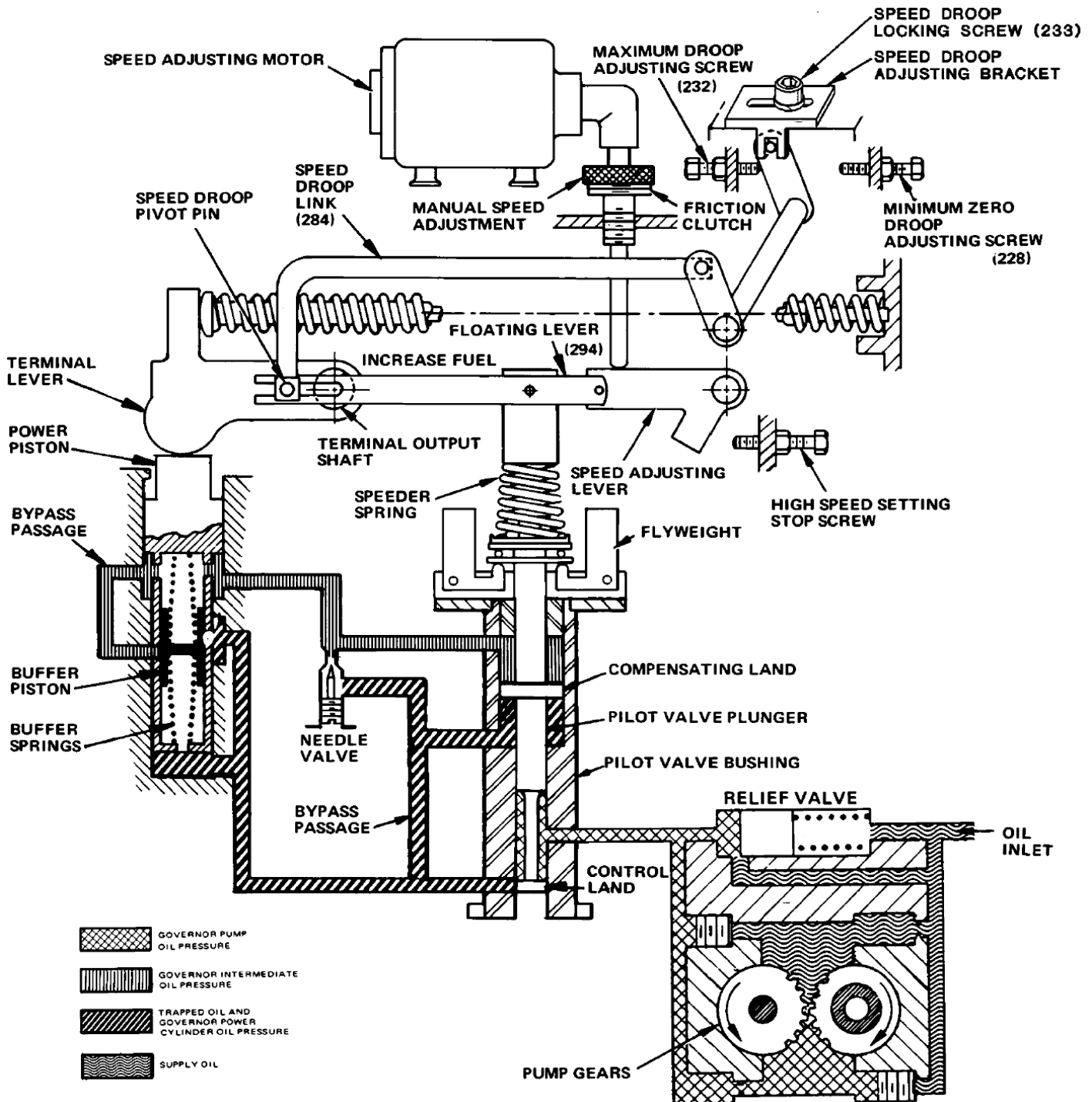


Figure 3-1. Schematic Diagram of PSG with Adjustable Droop

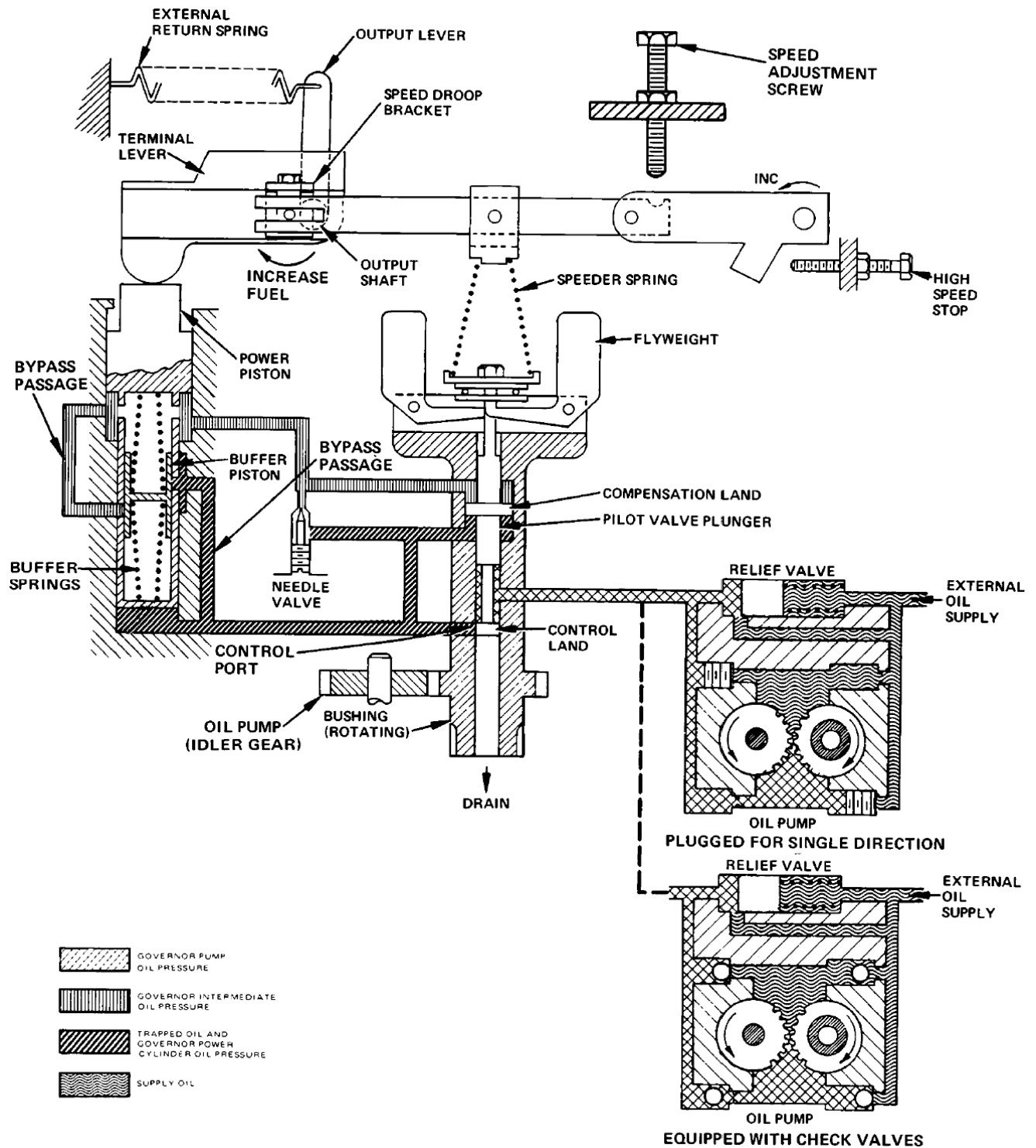


Figure 3-2. Schematic of PSG with External Return Spring

As the pilot-valve bushing rotates, the centrifugal force increases and the flyweights pivot outward. This centrifugal force is opposed by the downward force of the speeder spring. Speeder spring compression, and therefore the speed at which the governor must run, is adjusted by the position of the speed adjusting system (e.g., lever, electric motor, or pneumatic). On-speed occurs when the centrifugal force of the flyweights balances the downward force of the speeder spring, with the flyweights exactly vertical, and the pilot-valve-plunger control land covering the control port of the rotating bushing.

Compensation System

The compensating system consists of a buffer piston between two buffer springs, a needle valve, and a compensating land on the pilot-valve plunger. It provides temporary speed droop and must be properly attuned to the particular engine and load to provide stable operation.

The buffer piston, located between two identical springs in the power piston, and needle valve in the hydraulic circuits between the pilot valve plunger and power cylinder, make up the buffer compensation system. This system stabilizes the governing action by minimizing over or undershoot following a change in governor speed setting or a change in load on the engine. It establishes a temporary negative feedback signal (temporary droop) in the form of a pressure differential which is applied across the compensation land of the pilot valve plunger. The flow of oil into or out of the buffer system displaces the buffer piston in the direction of flow. This movement increases the loading on one spring while decreasing the other and creates a slight difference in the pressures on either side of the piston. These pressures are transmitted to opposite sides of the plunger's compensation land to produce a net force, upward or downward, which assists in centering the plunger whenever a fuel correction is made.

The length of time that the pressure differential is present is determined by the amount of oil allowed between the upper and lower compensation piston areas through the needle valve.

Compensation bypass is provided to circumvent the compensation system during major transients. The bypass passage provides direct flow of pressure oil to both sides of the compensation land any time the buffer piston is moved too far from the centered position. Thus there is no compensation until the buffer piston returns to a more nearly centered position.

The buffer piston and springs are carried in the power piston, but this location has no bearing on the action of the power piston, or on the action of the compensation system.

Fuel Increase Example

The governor increases fuel to the engine with an increase in governor speed setting, or a decrease in engine speed due to an increase in load. Either the increase in the downward force of the speeder spring, or the decrease in centrifugal force of the flyweights, allows the pilot-valve plunger to move downward. Pressured oil is applied through the control port to the buffer system and into the power cylinder area. This causes the power piston to rise against the terminal lever and rotate the output shaft to increased fuel.

At the same time, flow of oil to the compensation area moves the buffer piston from center in the upward direction. The pressure difference on each side of the buffer piston acts on the compensating land, and tends to center the pilot valve. Oil leaks by the needle valve, and dissipates the pressure difference.

With increased fuel, the engine will gain speed, the flyweights will return to the upright position, cutting off movement of the power piston at the new fuel setting required by the change in load or speed.

Droop Feedback

The rotation of the output shaft in the increase direction will also cause movement of the floating lever if the pivot point on the speed-droop bracket is off the center line of the output shaft.

Assuming positive droop is set into the governor, the pivot point will be to the left of the center line and increase fuel will raise the end of the floating lever. This will reduce compression on the speeder spring and in effect lower the speed setting of the governor.

Note that should the pivot point on the speed-droop bracket be to the right of the center line, it will cause the floating lever to increase the compression of the speeder spring on increased fuel, in effect increasing the speed setting. This condition is called negative droop. The governor will not provide satisfactory control with negative droop.

Fuel Decrease Example

The governor decreases fuel to the engine with a decrease in governor speed setting or an increase in engine speed due to a decrease in load on the engine.

Due to the decrease in speed setting or decrease in load, the centrifugal force of the flyweights overcomes the speeder-spring force and lifts the pilot-valve plunger. Upward movement of the pilot-valve plunger opens the control port to drain and the power piston is forced in the reduced fuel direction by the return spring.

At the same time, flow of oil from the compensation area housed in the power piston moves the buffer piston in the downward direction. The pressure difference on each side of the buffer piston acts on the compensating land, and tends to center the pilot-valve plunger. Oil leaks by the needle valve, and dissipates this pressure difference. As the engine returns to steady-state speed, the centrifugal force of the flyweights is again balanced with the downward force of the speeder spring.

Positive speed droop, as described above, will cause an increase in relative speed setting with a decrease in load.

Chapter 4.

Troubleshooting and Maintenance

Introduction

This chapter covers various steps for maintenance of the PSG governor. The portion on troubleshooting provides information if trouble occurs. General troubleshooting advice and instructions for setting the needle valve and droop are provided in advance of the troubleshooting chart.

If the minor adjustments do not help, removal of the governor from the engine for either a complete overhaul or return to an authorized repair facility for repair and testing may be required. Adequate instructions are provided for disassembly, reassembly, and testing of your governor. However, the test specifications for the particular governor must be requested from Woodward.

General Troubleshooting

Governor faults are usually revealed in engine speed variation, but it does not necessarily follow that such speed variations indicate governor faults. Poor governing may be due to faulty operation of the engine or of auxiliary equipment.

Dirty Engine Oil

The PSG governor is normally supplied with engine oil. A failed or dirty filter in the supply line or unusual oil contamination can cause governor problems. If the governor has been contaminated with dirty engine oil, it may be removed from the engine and flushed with a petroleum solvent. The use of non-petroleum-base solvents is not recommended as it may damage oil seals or gaskets. Fuel oil or kerosene are the best solvents for cleaning the inside of a PSG governor.

NOTICE

Always drain the governor of solvents before returning it to the engine to avoid the possible contamination of the engine oil supply.

Oil contamination, oil viscosity, and oil supply are major causes of PSG governor problems.

Any change in the viscosity of the oil supplied to the PSG governor will require a change in the needle valve setting of the governor.

Linkage

The second most common cause of governor related problems is caused by the linkage from the governor to the engine. Always carefully inspect this linkage for wear or other changes when governor problems are suspected. If an external return spring is used, investigate this installation for changes or poor installation.

Governor Drive

Excessive backlash or a tight meshing of the gears driving the governor may cause speed variations or erratic control by the governor.

Check List

Before determining that a governor is the cause of speed variations or aberrations, conduct the following checks of engine/governor operation:

1. Check the load to be sure that the speed changes observed are not the result of load changes beyond the capacity of the engine.
2. Check engine operation to be sure that all cylinders are firing properly and that the injectors are in good operating condition.
3. Check the linkage between the governor and the engine to make certain there is no binding or lost motion.
4. Check for fuel pressure changes.
5. Check the speed-setting mechanism for proper operation. Pneumatic-supply problems can effect the pneumatic head. Erratic motor operation or slippage in the clutch between the motor and the governor can affect motor speed setting.
6. Check the engine drive to the governor.
7. Check the oil supply to the governor.

Glossary of Terms

HUNT—A rhythmic variation of speed which can be eliminated by blocking governor output manually but which will recur when returned to governor control.

SURGE—A rhythmic variation of speed, always of large magnitude, which can be eliminated by blocking governor action manually and which will not recur when returned to governor control unless speed adjustment is changed or the load changes.

JIGGLE—A high frequency vibration of the governor fuel rod end (or terminal shaft) and fuel linkage. Do not confuse this with normal controlling action of the governor.

Jiggle can be extremely damaging to linkage and to the governor, even though it may not adversely effect governor speed control. **DO NOT** run a governor which has visible jiggle.

| Trouble | Probable Cause | Correction |
|--|---|--|
| Engine hunts or surges | Compensation needle valve opened too far. | Adjust needle valve as described in Chapter 2. |
| | Dirty or foaming oil. Loading or power piston sticking. | Remove and drain governor and flush with fuel oil or kerosene. Check oil supply system for air entrapment or proper type of oil. Clean or replace filter. Change oil. Disassemble governor, if necessary, and clean. |
| | Improper relationship between governor output shaft travel and engine power output. | Governor shaft travel to power output should be about linear. Readjust or rework linkage to obtain a linear relationship between engine horsepower and output-shaft position. |
| | Excessive backlash or binding in linkage. | Repair linkage. |
| | Excessive backlash or binding in fuel control. | Repair fuel control. |
| | Insufficient utilization of governor output shaft travel. | Readjust or rework linkage to use more governor output shaft travel. |
| | Negative droop set into governor. | Set correct percentage of positive droop. |
| | Governor case flooded with oil. Case drain line or drain through pilot-valve bushing plugged or restricted. | Clean drain passages and rework the drive to the governor to provide unrestricted drain. No back pressure is tolerated. Also, the drain passages in the case cavity must be free of back pressure. |
| | Buffer spring(s) fatigued or broken. Springs too light. | Replace spring(s). Install heavier springs (contact Woodward). |
| | Governor parts worn (excessive internal leakage or not correctly adjusted). | Repair governor by replacing worn parts. |
| | | Check flyweight pins and bearings for wear. |
| | | Check flyweight toes for wear or flat spots. |
| | | Check flyweight thrust bearing and centering bearing. |
| | Improper relationship between governor output shaft travel and engine power output. | Governor shaft travel to power output should be about linear. Readjust or rework linkage to obtain a linear relationship between engine horsepower and output shaft position. |
| | Power piston sticking in cylinder. | Repair if possible by cleaning and polishing. |
| Jiggle at governor output shaft | Rough engine drive. | Check drive gear alignment. |
| | | Check gear train for eccentricity or excessive backlash. |
| | | Check gear mounting on shafts for looseness. |
| | | Tighten camshaft drive chain, if used. |
| | | Check vibration dampener, if used. |
| | | Check for cyclic load variation. |
| | Failure of spring-driven flyweight head, if used. | Remove flyweight-head assembly and check operation or torsion spring. Disassemble and clean parts. Replace torsion springs if fatigued or broken. Check for accumulated dirt. |
| | Governor not mounted squarely on drive pad. | Loosen governor on pad and realign. Tighten attaching bolts or nuts evenly to proper torque value. |
| Fuel control does not open sufficiently or quickly during starting | Low governor oil pressure. | Check governor oil supply system for restriction or foaming oil. Eliminate restriction. Clean or replace filter. Check for proper oil viscosity. Change oil. |
| | | Check governor oil pressure relief valve for sticking plunger, fatigued or broken spring. Free plunger. Replace worn or damaged parts. |
| | | Inspect pump check valves for operation. Clean or replace leaking check valves. |
| | | Check governor pump gears and gear pockets for excessive wear. Replace worn parts. |

| Trouble | Probable Cause | Correction |
|--|---|---|
| Engine is slow to return to speed following a change in load or is slow in responding to a change in speed setting | Compensation needle valve closed too far. | Adjust needle valve as described in Chapter 2. |
| | Engine is overloaded. | Reduce load. |
| | Compensation buffer piston sticking. | Remove governor and clean it thoroughly. Reinstall governor and clean or replace filter in oil supply system. |
| | Governor case flooded with oil. Case drain line or drain through pilot-valve bushing plugged or restricted | Clean drain line or drain passages in pilot-valve bushing. Rework the drive to the governor to provide unrestricted drain. |
| Engine is slow to return to speed following a change in load or is slow in responding to a change in speed setting | Low governor oil pressure. | Check governor oil supply system for restriction or foaming oil. Eliminate restriction. Clean or replace filter. Check for proper oil viscosity. Change oil. |
| | | Check governor oil pressure relief valve for sticking plunger, fatigued or broken spring. Free plunger. Replace worn or damaged parts. |
| | | Inspect pump check valves for operation. Clean or replace leaking check valves. |
| | | Check governor pump gears and gear pockets for excessive wear. Replace worn parts. |
| | Incorrect buffer springs in governor. | Install correct buffer spring (consult Woodward). |
| Engine is slow to respond to increase in load | Fuel supply restricted, or engine may be overloaded. | Clean fuel filters and fuel supply lines. Reduce the load. |
| Governor goes to and remains at full travel regardless of speed setting or load | Pneumatic speed-setting pressure trapped in air chamber due to clogged orifice or air inlet, or speed setting too high. | Clean orifice. |
| No output from governor | Power piston sticking because of dirty oil. | Remove and drain governor and flush with fuel oil or kerosene. Clean and replace filter in oil supply system. Change oil. Disassemble governor, if necessary, and clean. |
| | No governor oil pressure. | Check oil supply system. |
| | | Check governor oil supply system for restriction or foaming oil. Eliminate restriction. Clean or replace filter. Check for proper oil viscosity. Change oil. |
| | | Check governor oil-pressure relief valve for sticking plunger, fatigued or broken spring. Free plunger, replace worn or damaged parts. |
| | | Inspect pump check valves for operation. Clean or replace leaking check valves. |
| | | Check governor pump gears and gear pockets for excessive wear. Replace worn parts. |
| | | Engine cranking speed too low. |
| | Failure of drive to governor. | Repair drive to the governor. |
| | Damage to internal governor parts. | Disassemble governor, replace damaged parts. |
| No response to changes in control air pressure setting (pneumatic speed setting) | Linkage binding or misadjusted. | Repair or readjust linkage. |
| | Dirty oil. Loading or power piston or linkage sticking. | Remove and drain governor and flush with fuel oil or kerosene. Clean or replace filter in oil supply system. Change oil. Disassemble and clean speed-setting mechanism, if necessary. |
| | Diaphragm ruptured. | Replace diaphragm. |
| | Control air pressure relief valve sticking in open position. Spring fatigued or broken. | Clean relief valve. Repair or replace relief valve. |

| Trouble | Probable Cause | Correction |
|--|--|--|
| Excessive overspeed with inadvertent control air over-pressure (pneumatic speed setting) | Control air pressure relief valve set too high. | Readjust or replace relief valve. |
| | Orifice in control air pressure inlet too large or missing. | Replace orifice. |
| Minimum or maximum control air pressures do not result in the desired idle or rated speeds (pneumatic speed setting) | Governor speed settings not properly adjusted. | Adjust governor speed settings as described in Test section. |
| Engine will not carry full rated load | Fuel control does not fully open. | Check and adjust linkage. Check for binding in fuel control. |
| | Low governor oil pressure. | Check governor oil-supply system for restriction or foaming oil. Eliminate restriction. Clean or replace filter. Check for proper oil viscosity. Change oil. |
| | | Check governor oil-pressure relief valve for sticking plunger, fatigued or broken spring. Free plunger. Replace worn or damaged parts. |
| | | Inspect pump check valves for operation. Clean or replace leaking check valves. |
| | | Check governor pump gears and gear pockets for excessive wear. Replace worn parts. |
| | | Engine cranking speed too low. |
| | Fuel racks do not open far enough. | Check fuel pump stops and adjust as necessary. Check governor fuel-rack relationship. |
| | | Check linkage between governor and fuel pumps and adjust if necessary. |
| | | Oil in governor may be too light, change to next heavier grade. |
| | Gas pressure too low. | Adjust pressure regulator in gas supply line. |
| | Slipping clutch (if used) between engine and driven load. | See clutch instruction manual. |
| | Voltage regulator (if used) not functioning properly. | Readjust or repair voltage regulator. |
| Improper load division between paralleled units (one unit on zero droop—all others on droop) | Incorrect speed droop setting on one or more of the droop units. | Increase droop on affected units until load remains steady on each droop unit. System load variation is absorbed by the lead unit with zero droop. Droop units assist in correcting speed deviations on large load changes but return to their original load after the load change is absorbed by the lead unit. |
| | Different speed settings among the droop units. | Readjust speed setting on improperly set unit. |
| Improper load division between paralleled units (all units on droop) | Incorrect speed droop setting on one or more units. | Adjust droop on each unit until desired division of load is obtained. Increasing droop results in the unit taking a smaller share of load changes; decreasing droop, a larger share. |
| | Different speed settings between units. | Readjust so that all speed settings are the same. |

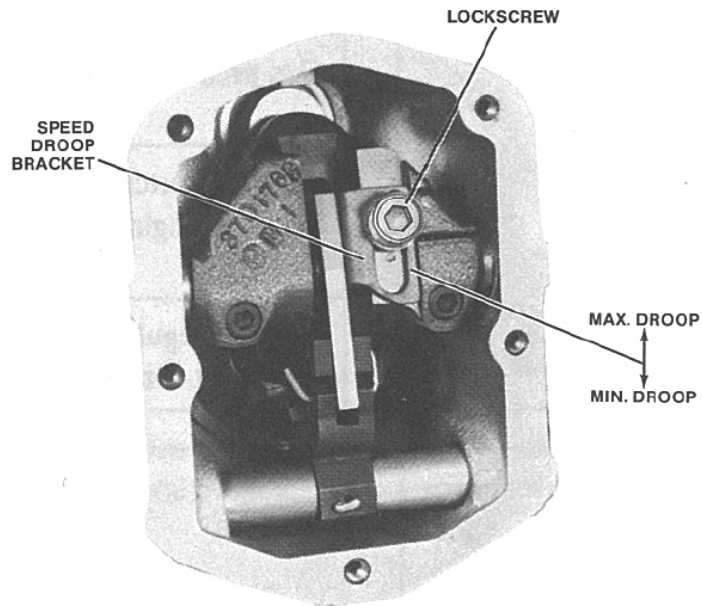


Figure 4-1. Speed Droop Adjustment

Speed Droop Adjustment

Figure 4-1 shows the internal droop governor with the top cover removed to expose the speed-droop mechanism and adjustments. The speed-droop bracket is clamped to the terminal lever by the socket-head screw.

The speed-droop bracket, when loosened, is adjustable radially to the terminal shaft. When the bracket is moved, a pin on the bracket is moved radially from the terminal shaft's centerline to a radius of 1/2 inch. This pin controls the position of the speed-droop lever (floating, position feedback lever). When the pin is set at the centerline of the terminal shaft, the governor is set at zero droop. As the pin is moved away from the shaft's centerline, terminal-shaft rotation moves the pin and, therefore, the end of the speed-droop lever which pivots on the speed-droop pin. The resultant speed setting is a function of terminal-shaft position with speed setting decreasing as fuel flow increases.

Since there is no calibration for the droop adjustment, the zero-droop position may be set only by trial and error on the engine, or by use of a dial indicator over the speed-droop lever during manual rotation of the terminal shaft. Zero droop will show no movement of the speed-droop (feedback) lever when the output shaft is rotated from minimum to maximum position. If speed droop is required, it must be set by operation on the engine, readjusting the slide to obtain the desired speed droop between full load and no load.

IMPORTANT

The governor should not be operated with the cover removed. The low-speed stop is located in the cover, and on most units the cover retains the return spring. The governor will not provide dependable engine-speed control with the cover removed. Governors with internal droop adjustment must have the amount of droop set with the cover removed and the engine stopped.

Setting External Droop

Some PSG governors are equipped with externally adjustable droop. These governors employ a lever inside the governor that moves a feedback pin through a slot in the terminal lever. Droop on these governors can be changed while the engine is running.

Negative Droop

Care must be taken while setting droop, either the internal or external settings, that the moveable droop fulcrum pin not be moved beyond the centerline of the governor terminal shaft. This condition will cause unstable governor operation. When setting zero droop, it is better to error in the direction of slight positive droop. If using a dial indicator while setting droop, the feedback lever must not increase the tension on the speeder spring while the terminal shaft is rotated toward maximum.

Needle Valve Adjustment

The needle valve adjusts the response rate of the governor. Properly set, the response rate will cause the governor to take a new fuel position with a minimum of overshoot and a minimum of settling time after a load change.

Adjust the needle valve when the engine is at operating temperature and the oil in the governor is at its normal operating temperature and likewise at the normal viscosity. Adjust with the needle valve as far open as possible while still providing stable response to load changes. To test the setting, manually disturb the linkage and observe the return to stable operation. Two or three fuel movements immediately after the speed deviation caused by the linkage disturbance is usually the desired response setting.

Having the needle valve too far closed will make the governor sluggish and likewise will make the engine slow to respond to load changes. This can appear as engine power problems. Engine speed will not be stable with the needle valve too far open.



Do not back the needle valve clear out of the threads as hot oil will squirt from the hole, potentially burning the operator.

The governor will not operate correctly with the needle valve closed tightly. In general, the needle valve must be out 1/8 turn or more for correct governor operation.

Having the needle valve closed more than necessary will prevent the most efficient and responsive performance of the engine. Most engines operate with the needle valve open one full turn or more. Governors are shipped from the factory with the needle valve open 1 and 1/4 turns.

When properly set, the governor will be slow in response to load changes while the engine is cold, because the oil in the governor will be thicker, and slower to move through the needle valve opening. Always adjust the needle valve when the engine is at operating temperature.

Once set, the needle valve will not have to be adjusted unless there is a change in engine oil viscosity, linkage from the governor to the engine, or engine performance. Response changes that require a change in the needle-valve setting are probably caused by changes in the engine or in the linkage from the governor to the engine. Always inspect the linkage for wear or looseness before deciding that a needle-valve change is required.

Linearity and Output Shaft Rotation

Unstable engine operation can be caused by faulty linkage arrangement between the governor and the fuel control. The terminal shaft should travel 24 degrees between no load and full load. Travel of less than 18 degrees should be corrected rather than running the governor with the needle valve more fully closed than necessary.

For maximum stability governor output must be nearly linear with engine power gain. (A percent of the total governor travel will produce the same percentage change in the power output of the engine.) Adjusting the linkage to increase the amount of governor travel between no load and full load will normally permit increasing the opening of the needle valve and likewise improving the responsiveness of the governor and engine to load changes.

Jiggle

The PSG is an extremely fast governor and will normally exhibit an active terminal shaft. This terminal shaft activity, or "jiggle", is not connected with the response rates controlled by the needle valve.

Excessive jiggle can damage linkage, engine parts, fuel valves, or the governor.

Jiggle is often the governor's response to drive torsionals transmitted from the governor drive to the governor ballhead. These drive torsionals should be reduced, if possible. Some torsionals are caused by the misalignment of the governor on the governor pad and can be corrected by realigning the installation. In extreme cases it may be necessary to rebuild the governor drive. Oil-damped and spring-driven ballheads are available to filter out some types of drive torsionals. Worn or damaged governor parts can also contribute to a jiggle problem. Nicks on the pilot-valve-plunger control land are occasionally the cause. Minor jiggle, which does not cause undue wear to linkage, fuel valves, or engine parts, will not damage the governor and in most cases can be ignored. Jiggle which will cause damage must be controlled.

Removing a PSG Governor from the Engine

For major repairs, or a complete governor change, remove the governor from the engine as follows:

1. Disconnect the fuel linkage from the governor terminal shaft. Mark the position of the lever on terminal shaft before removing the lever.
2. Disconnect the speed-adjusting linkage from the governor speed-control lever. Mark the position of the lever on the speed-adjusting shaft before removing the lever. For electric or pneumatic speed-setting options, disconnect the electrical connection or the pneumatic tubing from the governor.

3. Disconnect the oil inlet connections.
4. Remove the four stud nuts holding the governor assembly to the governor drive housing and lift the governor off the studs and away from the engine. (Some installations use bolts to attach the governor to the governor drive housing.) Remove the gasket between the governor and governor housing.

IMPORTANT

Use care in handling and setting down the governor. Avoid striking the end of the drive shaft a sharp blow as this could damage the governor oil pump driving gear.

Tools for Disassembly and Assembly

The tools shown in Figure 4-2 and listed in the following table are available from Woodward to facilitate the assembly or disassembly of the governor.

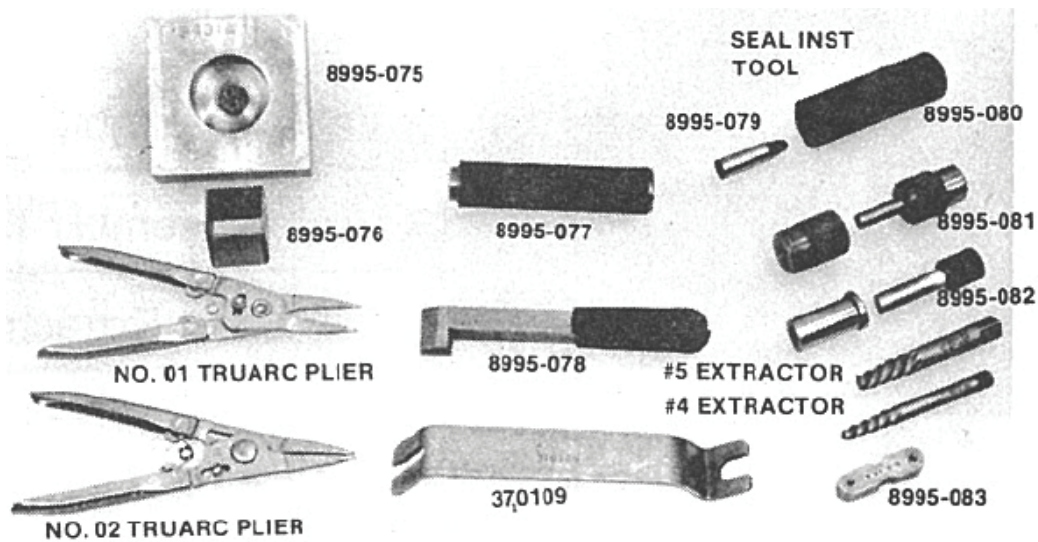


Figure 4-2. Assembly Tools

| Tool Description | No. | Application |
|------------------------------|----------|--|
| No. 1 Waldes Truearc Pliers | | remove and install snap ring |
| No. 2 Waldes Truearc Pliers | | remove and install snap ring |
| Welch Plug Assembly Tool | 8995-077 | install seal cup |
| Bending Tool | 8995-078 | for spring pin on floating lever |
| Pilot Valve Plunger Wrench | 370109 | center pilot valve plunger |
| Seal Installation Tool | 8995-079 | place seal on terminal shaft |
| Seal Installation Tool | 8995-080 | seat seal in housing |
| Idler Stud Installer | 8995-081 | seat idler stud |
| Check Valve Assembly Tool | 8995-082 | install check valves in case |
| Check Valve Assembly Tool | 8995-082 | install check valves in base |
| 17/64 Drill, No. 5 Extractor | None | remove base check valves |
| 1/4 Drill, No. 4 Extractor | None | remove case check valves |
| Hard Arkansas Stone | | polish nicks and burrs |
| Seating Tool | 8995-084 | seat retaining ring |
| Droop Alignment Tool | 8995-085 | set zero droop (isochronous operation) |

Governor Disassembly

Refer to Figure 5-1 (exploded view) and the following steps for governor disassembly and assembly. Some PSGs have slightly different arrangements. These instructions apply to most PSGs. The exploded view is helpful when assembling or disassembling a governor. Before removing speed-adjusting screws, needle valve, and droop bracket, record their positions for future use in assembly.

IMPORTANT

Do not disassemble the governor any more than necessary for the particular repairs or service required.

1. Clamp governor lightly in vice, using soft jaws below case-to-base joint.
2. Remove the cover and sub cap (if used). Many PSG governors use an internal return-spring system. In these cases the return spring can add complication to the removal of the cover or sub cap.

If an internal vertical return spring is used, remove the two middle screws and insert No. 15 (0.180) drill blanks in the holes. Then hold the cover in place while removing the other three cover screws. Release the spring slowly.

Use a similar system during assembly.

WARNING

Springs can cause personal injury and even death if incorrectly released. Use extreme caution and follow the instructions when removing a cover from a PSG governor with a vertical return spring.

3. Mark the position of the speed droop bracket if it is to be removed or loosened from the terminal lever, to permit assembly with the bracket in about the same position.

On units with externally adjustable droop remove the droop-link assembly.

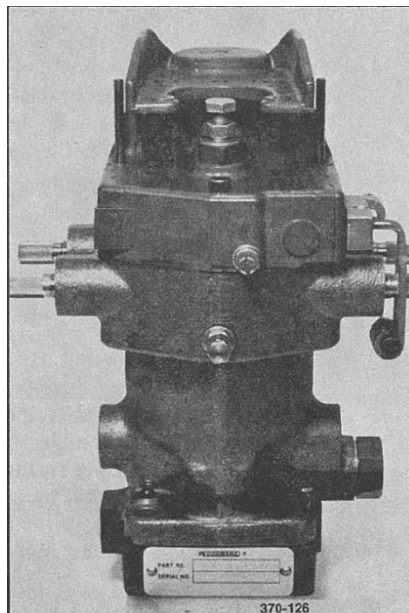


Figure 4-3. Align Cover with Drill Blanks

4. Unbend and remove the spring-wire pin that holds the fork of the speeder-spring assembly to the floating lever. Remove the floating lever. (Discard the used spring pin, do not attempt to re-bend it when the governor is assembled.)
5. Remove the two socket-head screws that hold the terminal shafts to the terminal lever. Remove the terminal shafts from the terminal lever and remove the terminal lever from the assembly.
6. If necessary remove the terminal-shaft bearings and oil seals from the body of the case. (The bearings are pressed into the case.) (It is best to replace the seals any time the terminal shafts are removed.)
7. (Removal of the speed-adjusting shaft and speed adjusting lever and droop adjusting shaft and lever is not normally required.) If necessary, drive out the roll pin that attaches the speed-adjusting lever to the speed adjusting shaft. Remove the speed adjusting shaft from the case. An o-ring is used to seal the shaft against oil leakage. Be prepared to replace the o-ring if the shaft is removed. Units with externally adjustable droop will have split speed-adjusting shafts. A roll pin attaches the droop adjusting lever to the droop shaft in externally-adjustable droop governors. Remove this pin before removing the droop adjusting shaft.
8. Remove the power-piston-stop screw (Figure 4-16, #3).
9. Lift out the power-piston assembly (see Figures 4-15 & 4-16).
10. Using snap-ring pliers, remove the snap ring from the power-piston assembly and remove the spring seat, the lower spring, buffer piston, and the upper spring. The upper and lower springs are interchangeable within the governor but are not necessarily interchangeable between governors.
11. Wedge the pilot-valve wrench (Woodward part number 370109) between the coils of the speeder-spring assembly and spring seat. Hold the spring fork and bend spring towards the open end of the bottom coil. At the same time, turn the spring to disengage the coil from the seat lip (see Figure 4-5). Remove the spring fork and spring from the case.
12. Hold the spring seat with the short end of tool 370109 and use a 5/16" socket wrench to remove the pilot-valve-plunger lock nut.
13. Place a small screwdriver in the slot in the top of the pilot-valve plunger and screw the plunger down and out of the spring seat.
14. Lift out the spring-seat and thrust-bearing assembly. The thrust bearing consists of an upper and lower race and a bearing assembly. The races are interchangeable and reversible. There is not an "up" or "down" to the bearing assembly.
15. Remove the snap ring with snap-ring pliers and lift out the ballhead parts.

IMPORTANT

Be careful when separating the base from the case as loose parts can be dropped and damaged. Be prepared to replace the oil seal between the base and case before separating the two units.

16. Remove the three screws from the base and carefully tap and pry the base until the dowel pins holding the base to the case are free. Separate the base and case.

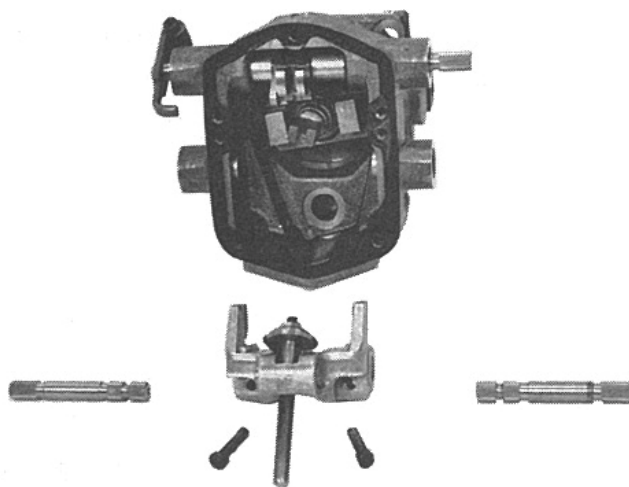


Figure 4-4. Removal of Terminal Levers

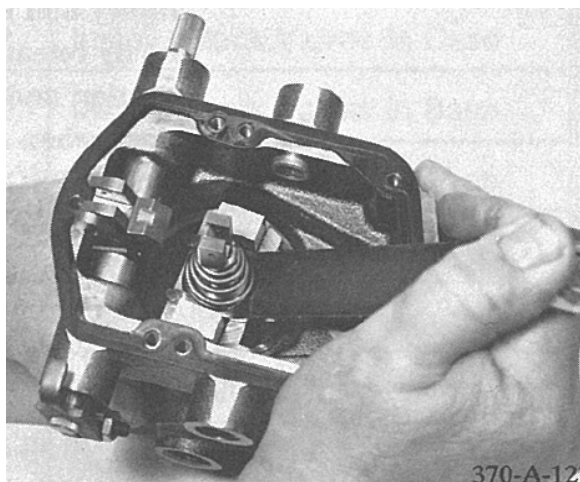


Figure 4-5. Removal of Speeder Spring

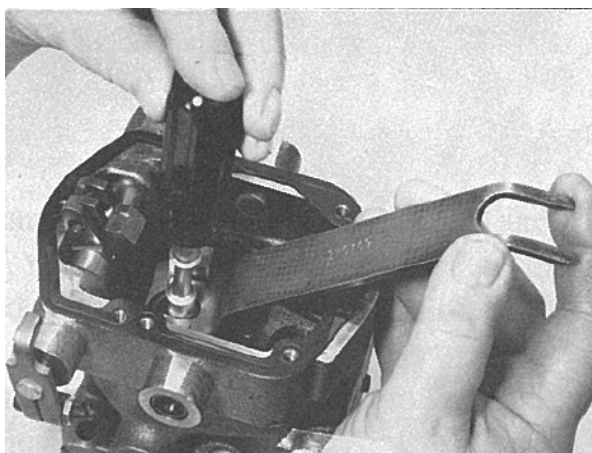


Figure 4-6. Pilot Valve Disassembly

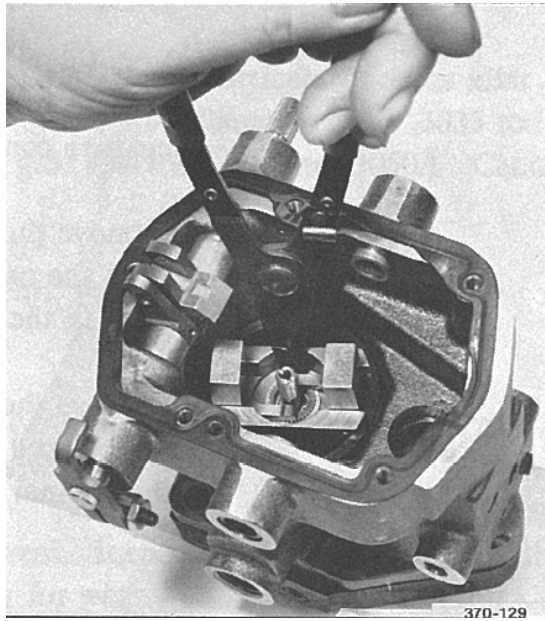


Figure 4-7. Removal of Ballhead

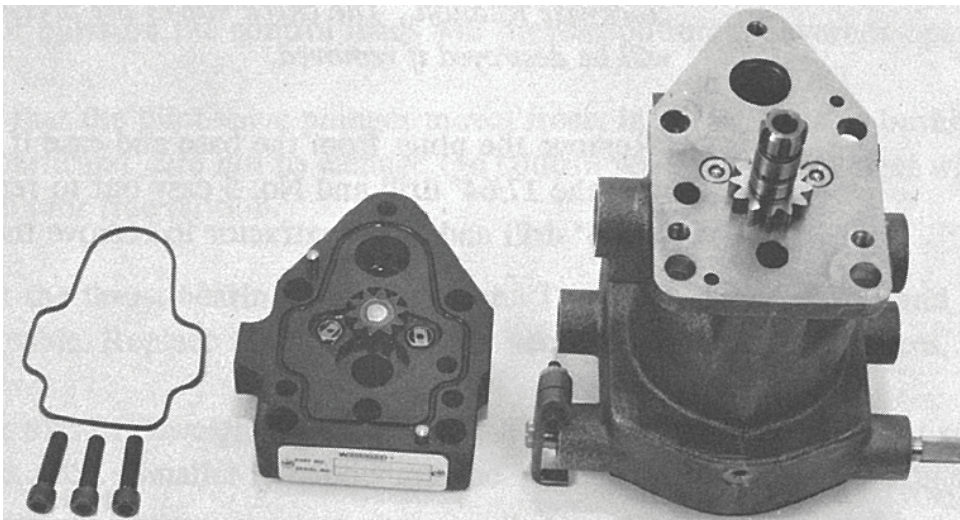


Figure 4-8. Base Separated from the Case

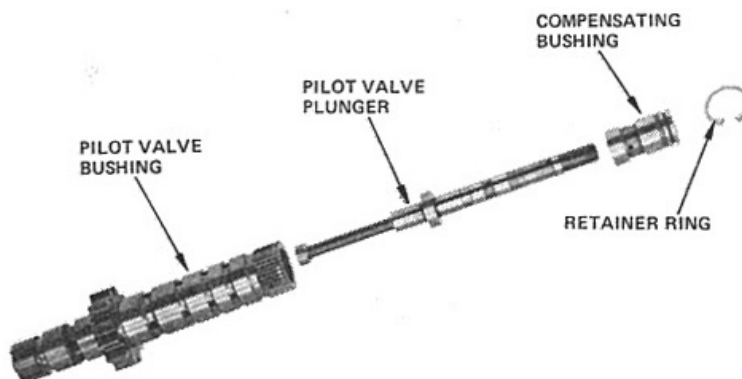


Figure 4-9. Pilot Valve Assembly

17. Remove the pilot-valve bushing from the case and the idler gear from the base.
18. Remove the internal snap ring from the upper end of the pilot-valve bushing.
19. Separate the compensating bushing and pilot-valve plunger from the pilot-valve bushing.

NOTICE

Do not damage any edges on the pilot-valve plunger. Store the plunger carefully to avoid any contact with other parts which could nick the sensitive control lands.

20. Remove the relief-valve assembly from the supply port on the governor case. Note the order of removal of the relief-valve parts as assembly must place the parts in the relief-valve bore in the correct order (see Figure 4-25).
21. Remove the needle valve and the needle-valve plug. The needle valve should be replaced to provide the most convenient access when the governor is on the engine.

IMPORTANT

If plugs are used in the base and case record the locations before removal to be sure they are replaced in the same positions (see Figure 4-10). The location of the plugs determines the direction of rotation of the governor. If check valves are used, the governor can operate in both clockwise and counterclockwise rotation. The check valves are pressed into the base and case and will be destroyed if removed.

22. Remove the plugs from the base and case if used.

Parts Check and Cleaning

Cleaning

All metal parts of the governor may be cleaned in normal cleaning lines. Take particular care that the pilot-valve plunger, the pilot-valve bushing, and the thrust bearing and bearing plates are not damaged during the cleaning operation.

Dry the washed parts with a soft, lint-free cloth or blow dry with shop air. Take particular care that all oil passages in the governor case are clear.

Parts Check

1. Check all parts for wear, corrosion, cracks, nicks, and burrs.
2. Check threads for stripping or cross-threading.
3. Check for mismatching of serrations or other tooth damage.
4. Check idler gear and stud for wear in mating parts. Particularly check idler stud for wear. (New specifications call for the stud diameter to be 0.3035 to 0.3038. The inside diameter of the idler gear specifies 0.3045 to 0.3050). Check pump gear teeth for wear.

5. Check the gear pockets for excessive wear. Factory tolerance calls for the gear pockets to be 0.263" to 0.2635" deep.
6. Check power-cylinder bore and pilot-valve-bushing bores for roundness and wear. Replace the case if wear is excessive.
7. Carefully inspect the power piston for wear. Inspect the buffer piston and the buffer-piston bore in the power cylinder for wear. The buffer piston must slide freely in the power cylinder. Check that the grooves around the buffer piston are clean. Grit and dirt in the system may freeze the buffer piston.
8. Check that the pilot-valve plunger has square edges on the control lands. Any nicks or burrs on the control lands will prevent optimum governor operation.
9. Check that the pilot-valve plunger moves freely in the pilot-valve bushing. Take particular care not to damage the control lands on the plunger while checking for free motion.
10. Check the thrust-bearing races for wear. The races are reversible and interchangeable. Replace the bearing if it is necessary to replace the races.
11. Check toes of flyweights for flat spots. Replace flyweights if the flat spots exceed 0.89 mm (0.035"). Smaller flat spots may be stoned out with a hard Arkansas stone.
12. Check all pivot-pin holes and pivot pins for wear.

Parts Repair and Replacement

1. Chase any damaged threads.
2. Polish corroded areas with a hard Arkansas stone.
3. Remove flat spots from the flyweight toes with the hard stone. If possible, replace the flyweights with new ones.
4. Replace all o-rings.
5. Replace the seals on the terminal shaft and speed-setting shaft(s).
6. Replace any Welsh plugs removed during disassembly (not used on all governors).
7. If check valves were removed, they must be replaced.
8. The spring-wire pin that connects the floating lever to the speed adjusting lever must be replaced.

Assembly

Perform assembly in a dust-free environment. Refer to the exploded view in Chapter 5 which most closely represents your governor before starting assembly.

Lubricate all o-rings with petroleum jelly before installation. Protect the new o-rings from damage with installation tools whenever possible. O-rings are easily damaged when installed over serrations or threads.

Basic Assembly

1. Replace all plugs removed from the governor case and base. Use new o-rings around all plugs. Use Loctite 242 sealant or equivalent to seal the plugs. Put sealant on plug threads, not in the hole.

IMPORTANT

Leave out the 1/8" pipe plug in line with the pilot-valve bushing on the governor base until after the pilot valve plunger is assembled and adjusted.

2. Seat new check valves in base and case. Use tool 8995-083 for seating valves in base and tool 8995-082 for seating valves in case. The tools seat the valves to the correct depth.

NOTICE

The check valves can be easily damaged if the correct tool is not used for installation.

If plugs were used, install new o-rings on the plugs and install exactly as removed. Governor rotation is not reversible when plugs are used. Rotational direction is determined by viewing the drive pad on the engine and observing the direction of rotation of the drive coupling. Figure 4-10 shows plugs with o-rings installed for clockwise rotation.

3. Place idler stud (if previously removed) in position and press into base with tool 5995-081.
4. Assemble the pilot-valve plunger parts as shown in Figures 4-11 and 4-12. Use Waldes Truarc pliers to fit retaining ring into top of pilot-valve plunger. Seat the retaining ring into the inside groove with tool 8995-048. See Figure 4-13.
5. Assemble base to case with parts as shown in Figure 4-14. Insert pilot valve bushing in the case and idler gear in the base. Place oil seal ring, flat side down, in groove provided in the base. Secure base to case with three screws.

Check that the pilot-valve bushing rotates freely. It may be necessary to loosen the base, free the gears and then tighten the base again.

IMPORTANT

Damaged alignment pins must be replaced.

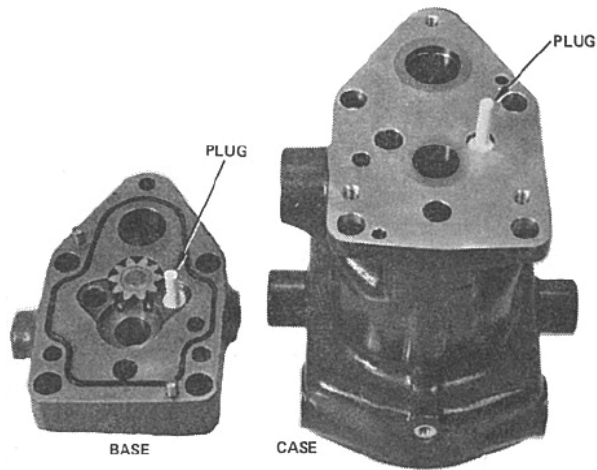


Figure 4-10. Plugs Installed for Counterclockwise Rotation
(install plugs in left-hand holes for clockwise rotation)

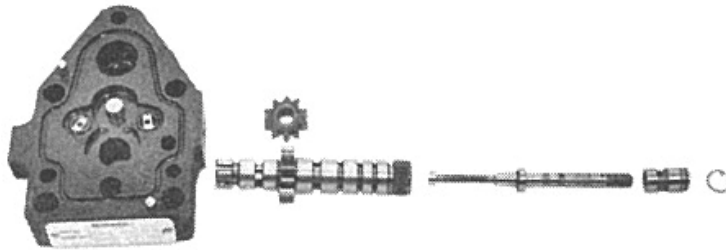


Figure 4-11. Pilot Valve Bushing Assembly

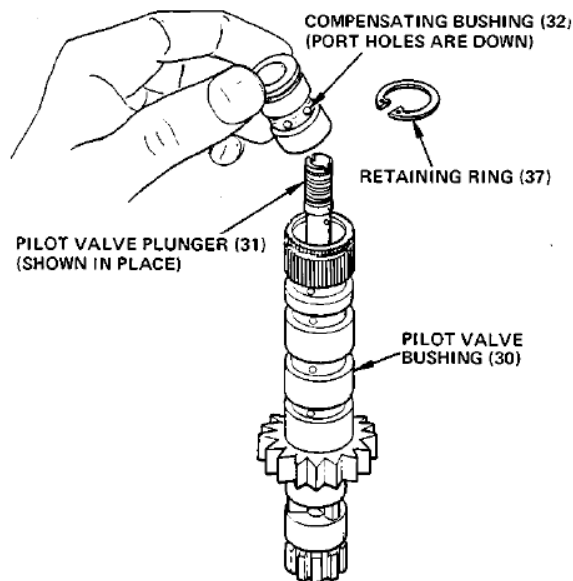


Figure 4-12. Assembly of Compensating Bushing

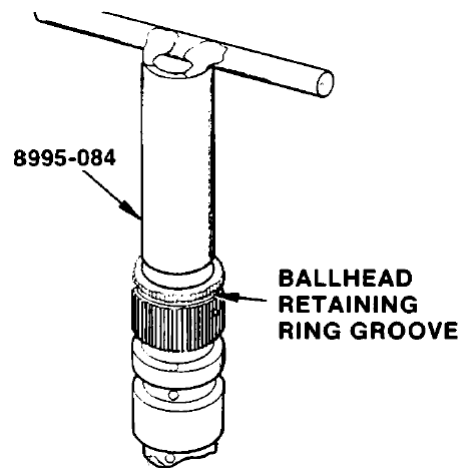


Figure 4-13. Seating the Retaining Ring

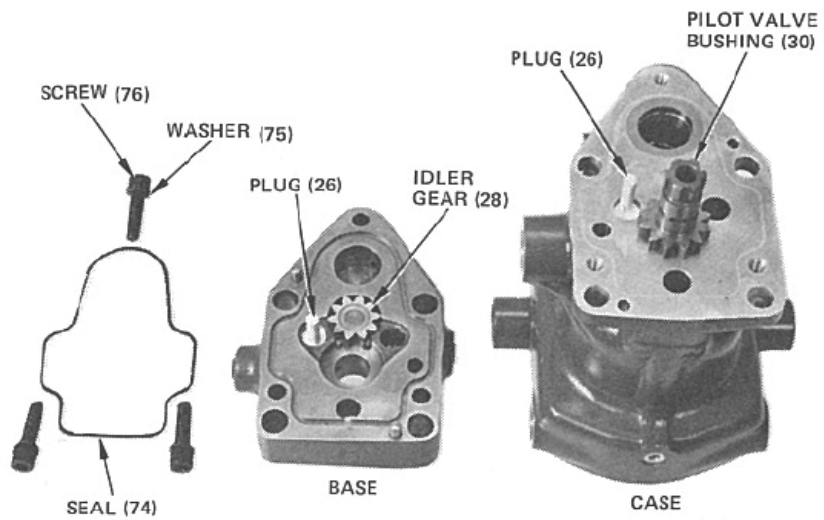


Figure 4-14. Base to Case Assembly

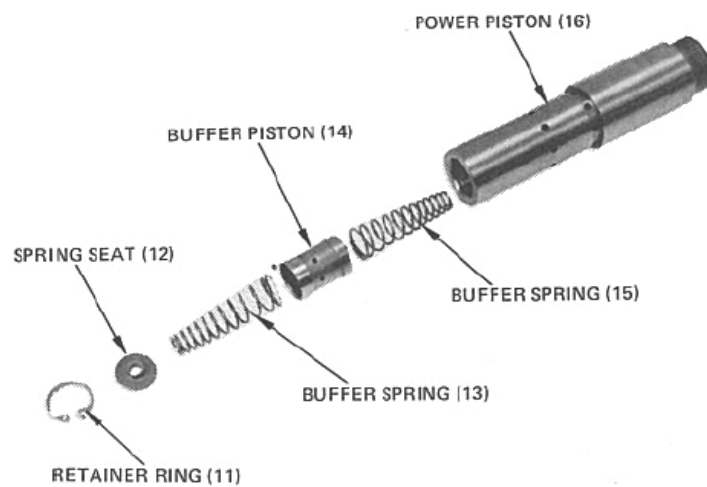


Figure 4-15. Assembly of Buffer System

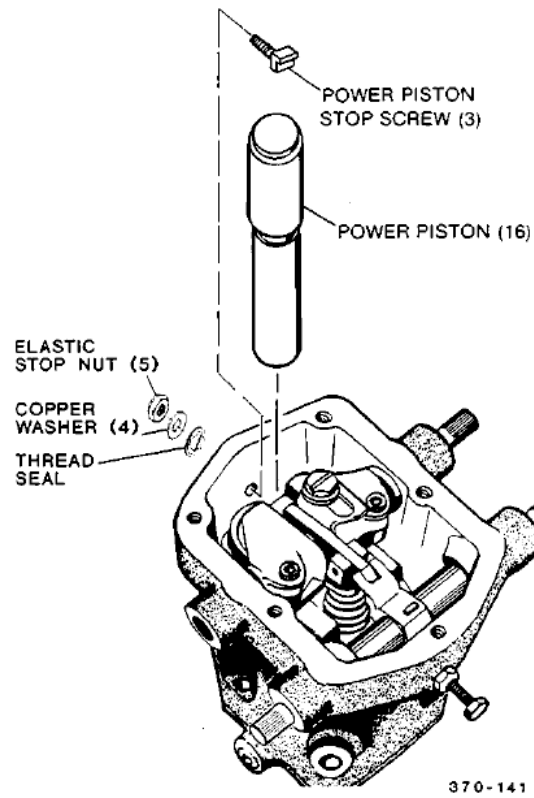


Figure 4-16. Installation of Power Piston and Piston Stop Screw



Figure 4-17. Installation of Ballhead

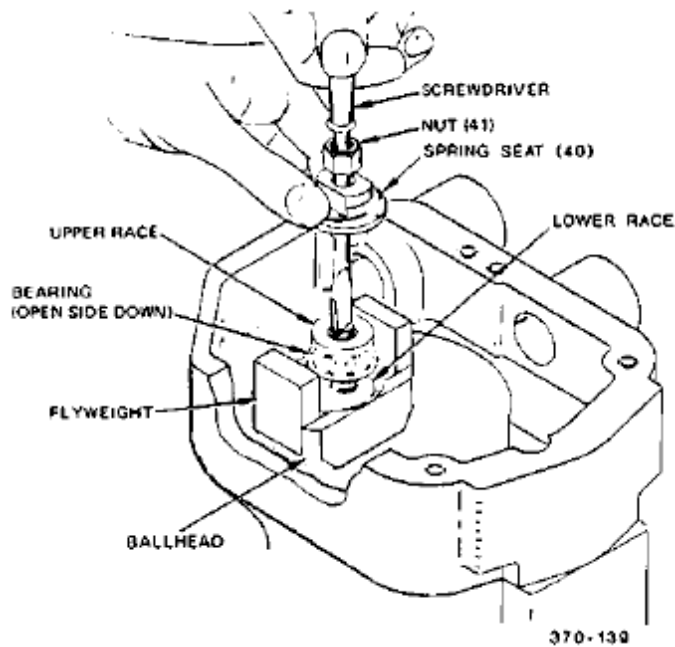


Figure 4-18. Thrust Bearing and Speeder Spring Parts

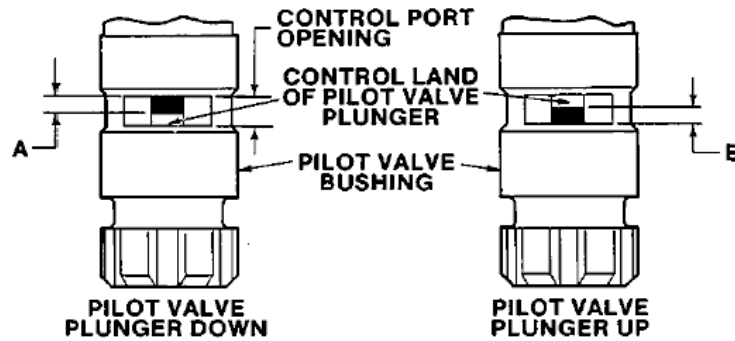


Figure 4-19. Centering the Pilot Valve Plunger

6. Assemble buffer system parts into the power piston. Note the position of the holes in the buffer piston. They must be in this position for proper operation. The buffer springs are interchangeable top to bottom, but not necessarily interchangeable between governors. Different governor applications require buffer springs with different scales. Use Truarc pliers to install the retaining ring.
7. Place the piston into the case. Install the piston stop screw, if used. (Piston stop screws are not necessary in governors with vertical return springs in the cover.) If a piston stop screw is used, secure it to the case with a thread seal and elastic stop nut.
8. Assemble flyweights to the ballhead with pins and secure by fitting the ring around the ballhead assembly. The retaining ring has a reduced inner diameter to prevent shifting during governor operation. Use care not to overstress the ring during installation.

9. Assemble lower race, thrust bearing, upper race, spring seat, nut and speeder spring. The upper and lower races are interchangeable and reversible. Both sides of the lower race must be "good". Only the side toward the bearing must be "good" on the upper race.
10. Use a screwdriver and guide the spring seat and nut onto the pilot-valve plunger. Hold the spring seat and nut, and turn the plunger counterclockwise, threading seat and nut on until the nut is just below the top of the plunger.
11. Release the nut and continue threading the spring seat down until it bottoms.

Centering the Pilot Valve

1. Turn the pilot valve bushing until the port is visible through the base.
2. Push on the flyweight toes to lower the pilot-valve plunger as far as possible. Check distance A (Figure 4-19). Pivot flyweights out as far as possible and check distance B. Distance A must equal distance B when flyweights have been moved from the extreme inward to the extreme outward position.
3. If the control land is too high, use pilot-valve wrench 370109 to hold the spring seat stationary and turn the plunger clockwise to lower it. Should the control land be too low, turn the plunger counterclockwise while holding the spring seat stationary.
4. When the pilot-valve plunger is centered (the same amount of opening in the port when the flyweights are full out as there is when the flyweights are clear in), tighten the nut by torquing it to 7.9 N·m (70 lb-in) while holding the spring seat stationary.
5. Check the setting again and, if correct, seal the inspection port by installing the plug with Loctite 228.
6. Install the speeder spring onto the spring seat. Place tool 370109 under the spring seat and force the spring seat upwards and at the same time place the speeder spring on top of the spring seat. Hold the spring seat in place and push the spring down and turn clockwise to secure to the spring seat. When properly assembled, the pilot valve can be lifted by the speeder spring.

Droop Assembly

1. Internal Droop:
 - a. Assemble the droop bracket to the terminal lever. Do not tighten the screw.
 - b. Align the droop bracket to zero droop, using tool 8995-085 as shown, aligning the pin in the droop bracket with the end of the tool. Tighten the screw. If droop is required for governor operation, it must be set after the governor is completely assembled, preferably on a test stand.
 - c. The droop bracket pin may be installed to the right of the centerline if droop is desired in the governor (the farther right of centerline the more droop the governor will provide). The droop pin must not be set to the left of centerline.

2. External Droop:
 - a. Assemble the speed-adjustment and droop-adjustment shafts into the governor. (The droop-adjustment shaft has a smaller roll-pin hole than the speed-adjustment shaft.)
 - b. Add the torsion spring (if used) to the speed-adjustment shaft, and the speed-adjustment lever. Notice that the 45-degree notch on the speed-adjustment lever must be up. Use the appropriate roll pin to attach the lever to the shaft. Connect the torsion spring to the speed-adjustment lever, if necessary.

IMPORTANT

The speed-adjustment shaft and the droop-adjustment shaft can be assembled from either side. Check to make sure the assembly is correct for the final governor installation.

- c. Insert the droop-adjusting shaft through the bushing and attach the droop-adjusting lever, relieved side toward the case, with the appropriate roll pin.
- d. Attach the droop-link assembly to the droop-adjusting lever. Normal assembly is for the lever to attach directly to the link with the spacer going on the side of the link away from the lever. The speed-adjusting lever must be able to operate between the shafts of the droop link assembly.

Final Assembly

1. Assemble the terminal lever and terminal shafts into the case.
2. Assemble the floating lever to the speed adjusting lever and the speeder spring fork with the wire clip. The slot in the floating lever engages the droop pin on internally adjusted droop governors.

Externally adjusted droop governors engage the slot of the floating lever with a pin through the droop link assembly. Sliders go on both sides of the pin, and upper slides then bolt to the terminal lever to engage the movable droop pin.

3. Bend wire pin forward with tool 8995-078.
4. Place tool 8995-079 on either a speed-setting or droop-adjustment shaft and slide the seal onto the tool with the cup facing the governor. Insert the seal with tool 8995-080. Seals must be installed over all shafts which extend from the governor. Shafts are the same size and seals are interchangeable.

Some governors are built without some shafts extending from the governor. Welsh plugs must be installed over all these short shafts. Install the Welsh plugs to the proper depth with tool 8995-077.

5. Assemble the four-piece relief valve, add the copper washer, and screw into the case.
6. Install the needle valve/o-ring and the needle-valve plug/o-ring assemblies. Turn the needle valve clear in, then back out 1 and 1/2 turns for an initial test position.
7. Assemble the low-speed stop screw and lock nut in the cover.

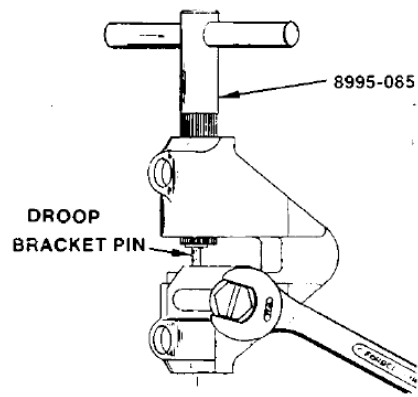


Figure 4-20. Using Tool to Set Zero Droop

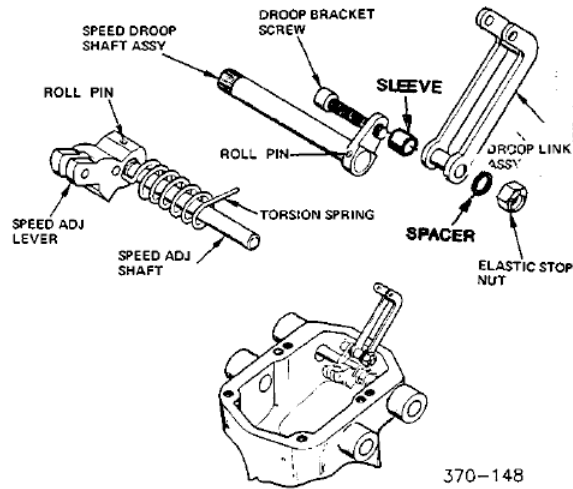


Figure 4-21. Assemble External Droop

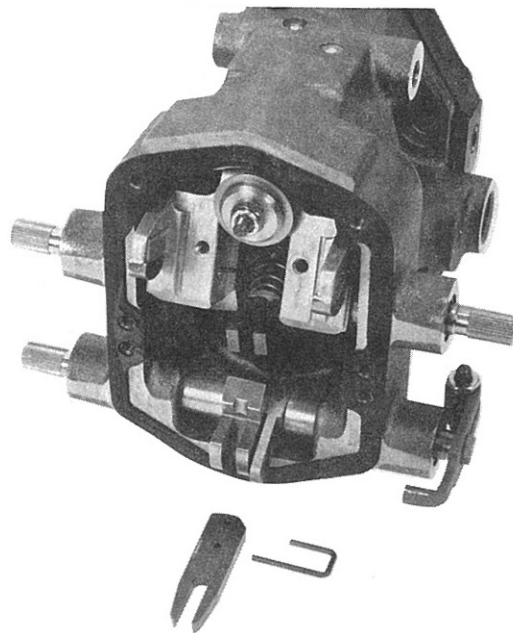


Figure 4-22. Speed and Droop Adjusting Shafts and Terminal Lever Assembled

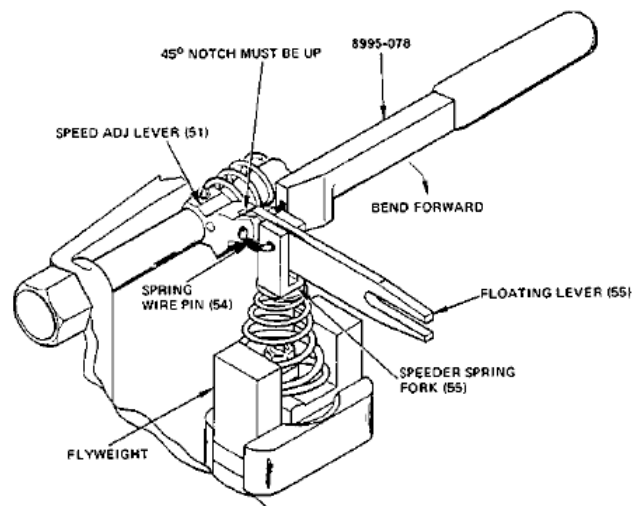


Figure 4-23. Bending the Wire Clip

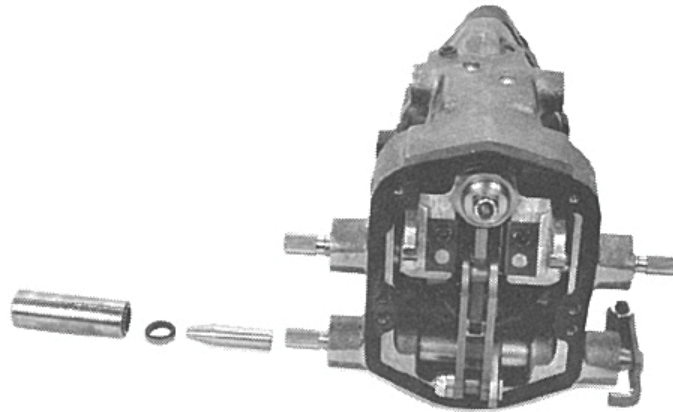


Figure 4-24. Install Seals on All Shafts

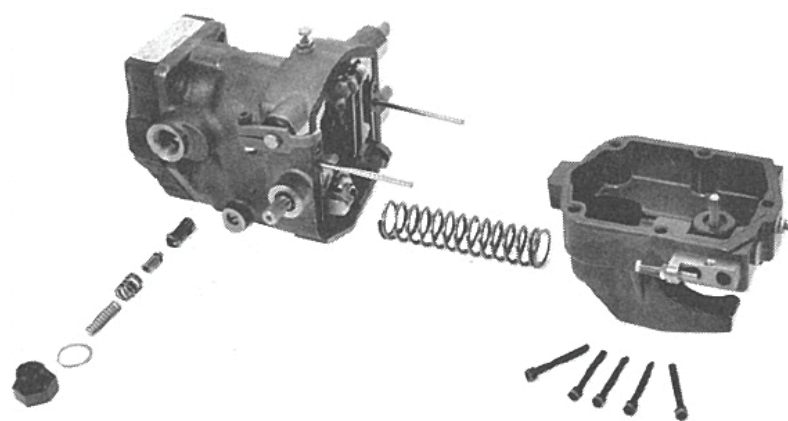


Figure 4-25. Relief Valve and Cover Installation

Position the gasket on top of the case and secure the cover to the case with five screws. Use two drill blanks to aid in the assembly of an internal vertical return spring.

Testing

It is important to test the governor, either on a test stand or on the engine it operates on.

Woodward makes a test stand (8909-053) which makes the testing of PSG and many other governors safe and efficient. Various adapters are also available to permit test stand operation of a test PSG governor.

Special test equipment, while recommended, is not necessary for the testing of a governor. If accurate tests are to be run on governors, contact Woodward and obtain a copy of the test specification for each particular governor.

If adequate test facilities are not available, make minor tests before and after installation on the engine.

Before installation, check that there is no negative droop by attaching a dial indicator to the governor case so the indicator rod rides on top of the floating lever directly above the pilot valve plunger (center of the spring fork on the speeder spring).

Rotate the terminal lever from minimum to maximum fuel position and observe the dial to see whether or not there is movement of the floating lever. No movement of the indicator is zero droop. Upward movement of the lever is positive droop.

Check the final droop setting with the governor operating on the engine. Only zero droop (isochronous operation) or positive droop is allowed. If the bracket is set on a previously scribed line, droop should be very close to the correct amount.

Reset low-speed and high-speed stop screws to pre-measured settings after installation on the engine. Make sure all linkages are correctly installed. Then start the engine.



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.

Assuming that everything is operating properly, turn the needle valve in as far as it will go, then back it out until the engine hunts (about 1 and 1/2 turns). Let the governor hunt for about a minute. This allows air to bleed out of the oil passages. Close the needle valve to just enough to stop the hunt and provide optimum performance.

Check that the correct amount of droop is set and, if necessary, readjust the droop bracket.

Test Equipment

Woodward electric drive test stand (part number 8909-051) should be used to test a reassembled PSG governor and to set the high-speed stop, the low-speed stop, and droop before installation on an engine. (Many other test stands will adequately test and calibrate the PSG governor.) The needle valve will still have to be set for the individual response characteristics of the engine.

Adapter kit 6995-637 and multiplication drive assembly 5337-509 are required for testing a PSG governor on a test stand.

Chapter 5. Replacement Parts

When ordering replacement parts, include the following information:

- Governor serial number and part number shown on the nameplate
- Manual number (this is manual 37017)
- Part reference number and part name from parts list



WARNING

Injury may result if compressed springs are released suddenly. Use the proper equipment to remove springs and spring covers. Review the disassembly information in the preceding chapter before disassembly to prevent damage to certain critical surfaces and to provide necessary position marks for assembly.

Parts List for Figures 5-1 and 5-2

| Ref. | Part Description | Quantity | Ref. | Part Description | Quantity |
|-----------|--|----------|----------|---------------------------------------|----------|
| 37017-1 | Case | 1 | 37017-37 | Retaining Snap Ring | 1 |
| 37017-2 | Not used | | 37017-38 | Spirolox Ring | 1 |
| 37017-3 | Droop Setting Bushing | 1 | 37017-39 | Thrust Bearing Assembly | 1 |
| 37017-4 | Speed Setting Bushing | 1 | 37017-40 | Spring Seat | 1 |
| 37017-5 | .067-27 Hex Socket Plug | 3 | 37017-41 | Nut, Pilot Valve Plunger | 1 |
| 37017-6 | Screw, 10-32 x 1.062 Speed Setting Stop 2 | | 37017-42 | Speeder Spring Assembly | 1 |
| 37017-6A | Nut, 10-32 Hex | 3 | 37017-43 | Drive Screw, #2 x .125 Inch | 2 |
| 37017-6B | Washer, No. 10 | 3 | 37017-44 | Nameplate | 1 |
| 37017-6C | Thread Seal | 3 | 37017-45 | Not used | |
| 37017-6D | Power Piston Stop Screw | 1 | 37017-46 | Spring, L.H. | 1 |
| 37017-7 | Screw, Needle Valve | 1 | 37017-47 | Terminal Shaft Bushing | 2 |
| 37017-8 | O-Ring, .176 ID | 2 | 37017-48 | Oil Seal | 2 |
| 37017-9 | Plug, .250-28 | 1 | 37017-49 | Not used | |
| 37017-10 | Not used | | 37017-50 | Speed Adjust Shaft | 1 |
| 37017-11 | Snap Ring, Internal, .584 Free Dia. | 1 | 37017-51 | Speed Adjusting Lever | 1 |
| 37017-12 | Seat, Buffer Spring | 1 | 37017-52 | Roll Pin | 1 |
| 37017-13 | Spring, Buffer | 2 | 37017-53 | Welch Plug | 2 |
| 37017-14 | Piston, PG Buffer | 1 | 37017-54 | Spring Wire Pin | 1 |
| 37017-15 | Power Piston | 1 | 37017-55 | Floating Lever Assembly | 1 |
| 37017-16 | Plug, Relief Valve | 1 | 37017-56 | Not used | |
| 37017-17 | Washer, .703 x .875 | 1 | 37017-57 | Terminal Shaft | 2 |
| 37017-18 | Spring, Relief Valve | 1 | 37017-58 | Terminal Lever | 1 |
| 37017-19 | Spring, Sleeve | 1 | 37017-59 | 1/4" Flat Washer | 1 |
| 37017-20 | Relief Valve Plunger | 1 | 37017-60 | Screw, 10-32 x .625 Inch Soc Hd | 2 |
| 37017-21 | Relief Valve Sleeve Assembly | 1 | 37017-61 | Droop Adjustment Bracket | 1 |
| 37017-22 | Not used | | 37017-62 | Screw, 10-32 | 1 |
| 37017-23 | Base, PSG | 1 | 37017-63 | Not used | |
| 37017-24 | Soc. Hd. Pipe Plug, .125 Inch | 2 | 37017-64 | Cover Gasket | 1 |
| 37017-25 | Taper Pin | 2 | 37017-65 | Cover | 1 |
| 37017-26 | Rotational Plug | 2 | 37017-66 | Not used | |
| 37017-27 | O-Ring, .239 ID x .070 Inch | 2 | 37017-67 | Not used | |
| 37017-26A | Check Valve, optional | 4 | 37017-68 | Cover Screw | 5 |
| 37017-28 | Idler Gear | 1 | 37017-69 | Not used | |
| 37017-29 | Idler Gear Stud | 1 | 37017-70 | Not used | |
| 37017-30 | Pilot Valve Bushing | 1 | 37017-71 | Not used | |
| 37017-31 | Pilot Valve Plunger | 1 | 37017-72 | Not used | |
| 37017-32 | Bushing, Compensating | 1 | 37017-73 | Not used | |
| 37017-33 | Internal Retaining Ring | 1 | 37017-74 | Preformed Packing Ring | 1 |
| 37017-34 | Ballhead | 1 | 37017-75 | Not used | |
| 37017-35 | Flyweight | 2 | 37017-76 | Screw | 1 |
| 37017-36 | Pin | 2 | | | |

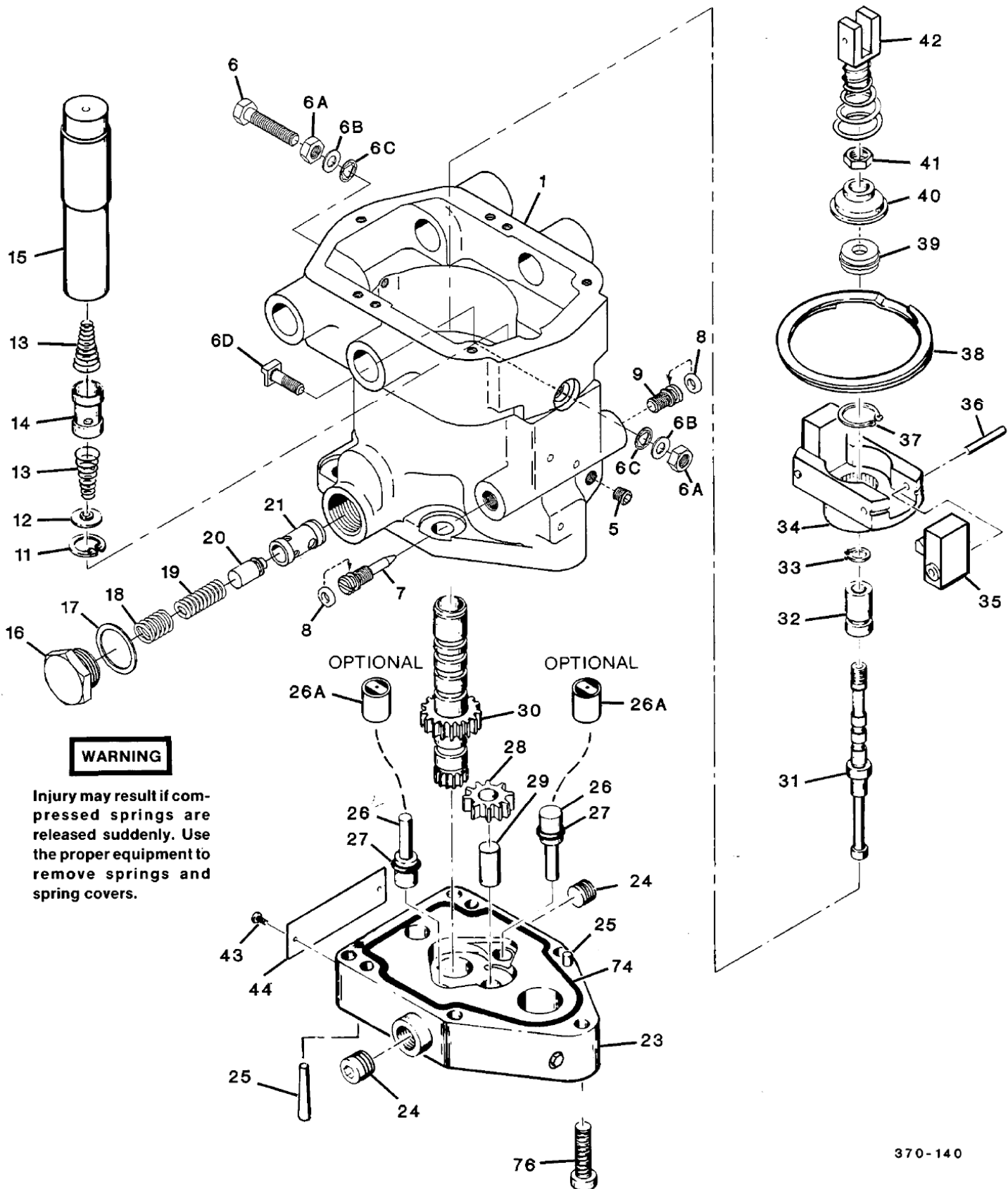


Figure 5-1. Exploded View of Basic PSG Governor

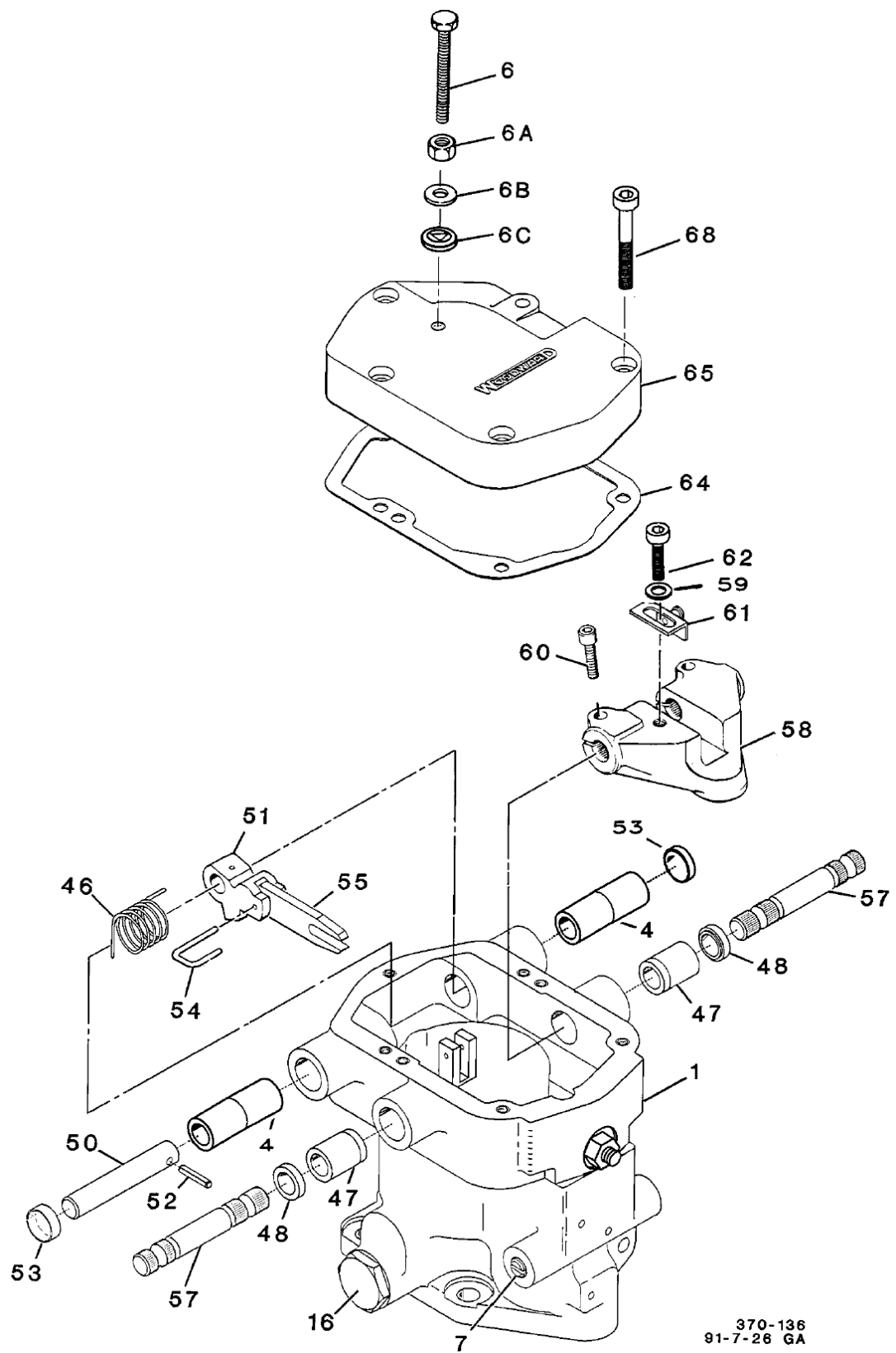


Figure 5-2. Basic PSG with Internal Droop and External Return Spring

Chapter 6.

Auxiliary Equipment

Introduction

This chapter includes information about auxiliary equipment that your governor may have. Using this section in conjunction with the other chapters in this manual provides instruction and parts for most PSG governors.

Auxiliary equipment supported by information in this chapter includes:

- Spring-driven, oil-damped ballhead
- Torsion spring
- Pneumatic speed setting
- Electric motor speed setting
- Externally adjustable droop
- Temperature compensated needle valve
- Fuel rod
- Internal return spring (vertical or horizontal)

Spring-driven, Oil-damped Ballhead

A spring-driven, oil-damped ballhead serves as a filter for torsional vibrations that originate in the drive to the governor. It consists of a ballhead drive cup (driving element) driven from the rotating bushing. The ballhead rests on a thrust bearing carried by the driver. A torsion spring connects the ballhead to the rotating bushing.

Torsional vibrations cause relative motion between the drive cup and the ballhead. This movement is inhibited by the action of a volume of oil being forced through a relatively narrow leak path, which provides the damping action.

The ballhead fills with oil through a combination of pressure feed and centrifugal action. The fill time varies with dimensional tolerances, governor pressure, and oil viscosity. The ballhead drains down partially on shutdown.

Since the oil-feed circuit functions whenever the governor is operating, there is a continuous flow of oil through the ballhead assembly. If the supply of oil is not clean, contaminants will accumulate in the ballhead and the ballhead will eventually assume the characteristics of a solid ballhead. If the governor is subject to excessive dirt accumulation, consider using a separate sump system.

Ballhead Check

Check for dirt accumulation by holding the governor drive shaft and turning the ballhead against its internal stop. Repeat in the opposite direction. Travel should be smooth and about 22 degrees in each direction. Replace the ballhead if it does not return promptly to mid position when released.

Replace the cover if it is damaged or dished. Damage is normally attributed to rough handling.

Check that the flyweights have no flat spots on the toes and that the flyweight bearings are not worn. Also check pivot pins for wear or damage.

Parts List for Figure 6-1

| Ref. | Part Description | Quantity |
|----------|--------------------------|----------|
| 37017-90 | Ballhead Cover | 1 |
| 37017-91 | Ballhead Drive Cup | 1 |
| 37017-92 | Ball Bearing | 1 |
| 37017-93 | Torsion Spring | 1 |
| 37017-94 | Flyweight Pin | 2 |
| 37017-95 | Ballhead | 1 |
| 37017-96 | Flyweight | 2 |
| 37017-97 | Needle Bearing | 4 |

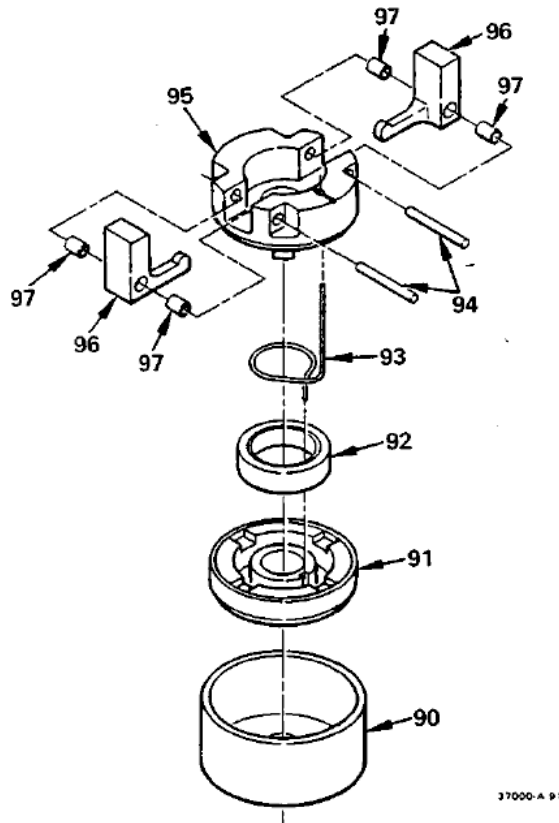


Figure 6-1. Exploded View of Oil-damped Ballhead

Torsion Spring

A torsion spring is provided on PSGs that are equipped with an electric motor for speed setting. The spring is also provided on governors that are not equipped with a speed adjusting shaft, and on governors that are operated below 800 rpm.

The spring forces the speed-adjusting lever to maintain contact with either the speed-adjusting screw or the adjusting shaft on the motor.

When used with external droop, the spring must mount on the speed-adjusting sleeve, on the side opposite the droop-adjusting shaft.

Pneumatic Speed Setting

Remote speed adjustment is provided through a pneumatic speed-setting assembly consisting of a diaphragm, housing, oil reservoir, adjusting screws, and pushrod, extending down through the cover to the floating lever. Air signal pressure to the speed-setting assembly is applied to an oil reservoir to damp out oscillations of air compression. Oil pressure, acting on the diaphragm, is transmitted by the pushrod to the governor floating lever, increasing or decreasing the speeder-spring force to produce a change in speed setting.

Pneumatic speed setting is factory preset to specified minimum (idle) speed at a minimum control air pressure of typically 21 kPa (3 psi), and to specified rated speed at a maximum control air pressure of typically 103 kPa (15 psi). Field adjustment is not normally recommended.

The schematic diagram of a PSG with horizontal return spring and pneumatic speed setting illustrates the relationship of the speed setting head to the governor speed setting system.

In an overhaul or repair situation, the main parts that may need replacement are the bellofram seals, rolling diaphragm, springs, and all o-rings. Figures 6-2 and 6-3 show the pneumatic speed setting equipment.

When assembling a governor with pneumatic head, position the floating lever with the edge with the 45-degree angle down and the hole on top. The positioning of the floating lever is the opposite from other types of PSG governors.

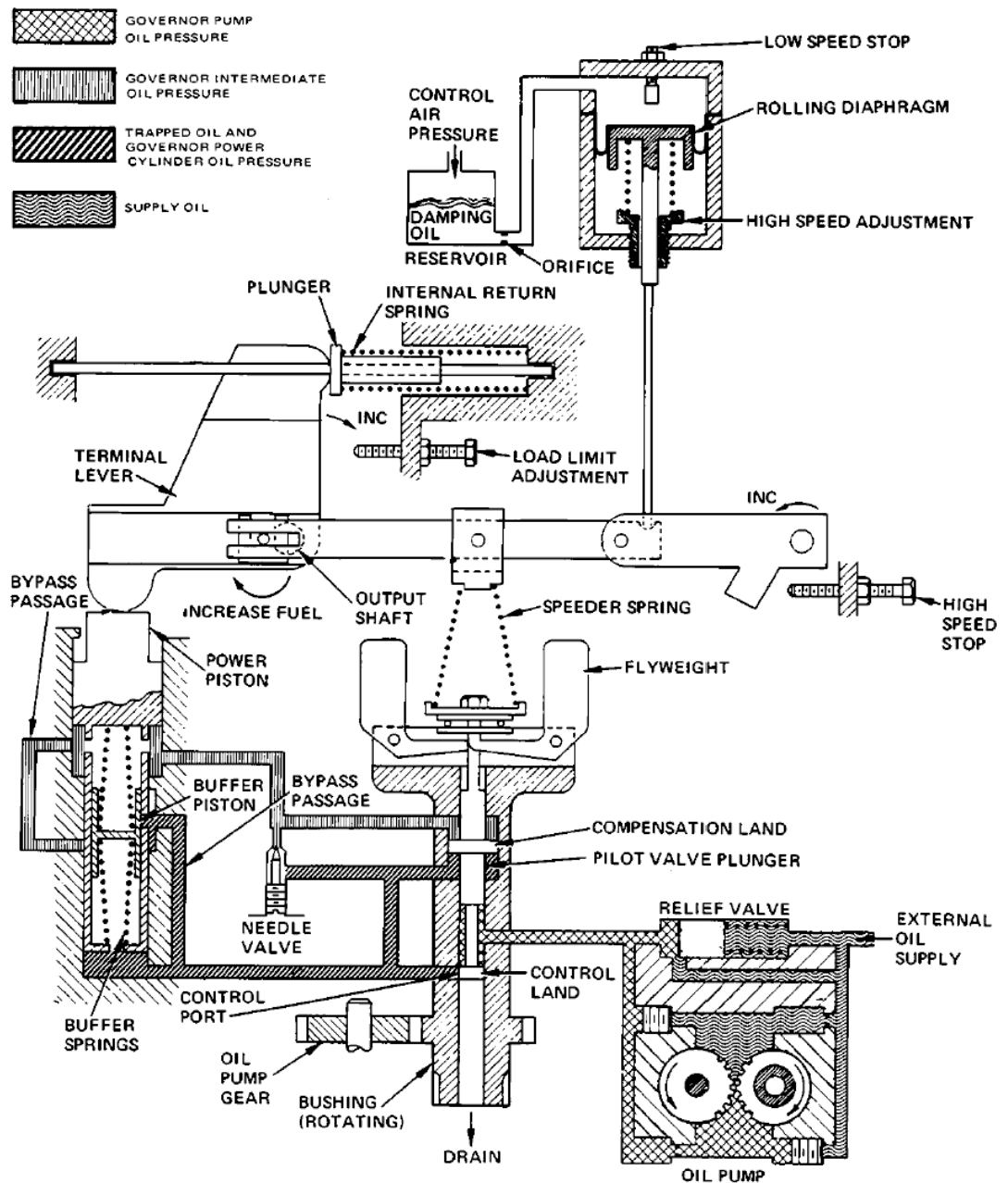


Figure 6-2. Schematic of Pneumatic Speed Setting and PSG Governor

Parts List for Figure 6-3

| Ref. | Part Description..... | Quantity |
|-----------|--------------------------------------|----------|
| 37017-101 | Accumulator assembly | 1 |
| 37017-102 | #4 DL plug..... | 1 |
| 37017-103 | O-ring 0.500 O.D. | 2 |
| 37017-104 | Adjustment screw | 1 |
| 37017-105 | Bellofram Cover Assm..... | 1 |
| 37017-106 | Screw, 10-32 x 0.750 | 4 |
| 37017-107 | Not used | |
| 37017-108 | O-ring, 0.203 I.D., 0.343 O.D..... | 1 |
| 37017-109 | Nut, 10-32 | 1 |
| 37017-110 | Not used | |
| 37017-111 | Plate retainer | 1 |
| 37017-112 | Bellofram seal..... | 1 |
| 37017-113 | Bellofram cup assembly. | 1 |
| 37017-114 | Needle thrust bearing | 1 |
| 37017-115 | Washer, 1.250 O.D..... | 1 |
| 37017-116 | Pneumatic speed setting spring | 1 |
| 37017-117 | Shutdown plunger spring..... | 1 |
| 37017-118 | Washer, 0.625 O.D..... | 1 |
| 37017-119 | Spring seat | 1 |
| 37017-120 | Speed Adjustment Body..... | 1 |
| 37017-121 | Not used | |
| 37017-122 | Nylon plug | 1 |
| 37017-123 | Nyloc 8-32 x 0.500 set screw | 1 |
| 37017-124 | Seal retainer | 1 |
| 37017-125 | Socket head 10-32 screw | 5 |
| 37017-126 | Not used | |
| 37017-127 | Not used | |
| 37017-128 | Cover..... | 1 |
| 37017-129 | Cover gasket | 1 |
| 37017-130 | Steel washer, 0.203 I.D. | 2 |
| 37017-131 | Socket head cap screw, 10-32 | 2 |
| 37017-132 | Seal bushing..... | 1 |
| 37017-133 | O-ring | 1 |
| 37017-134 | Rolling diaphragm | 1 |
| 37017-135 | Diaphragm clamp washer..... | 1 |
| 37017-136 | Diaphragm clamp washer..... | 1 |
| 37017-137 | Bower retaining ring | 1 |
| 37017-138 | Output rod end assembly | 1 |

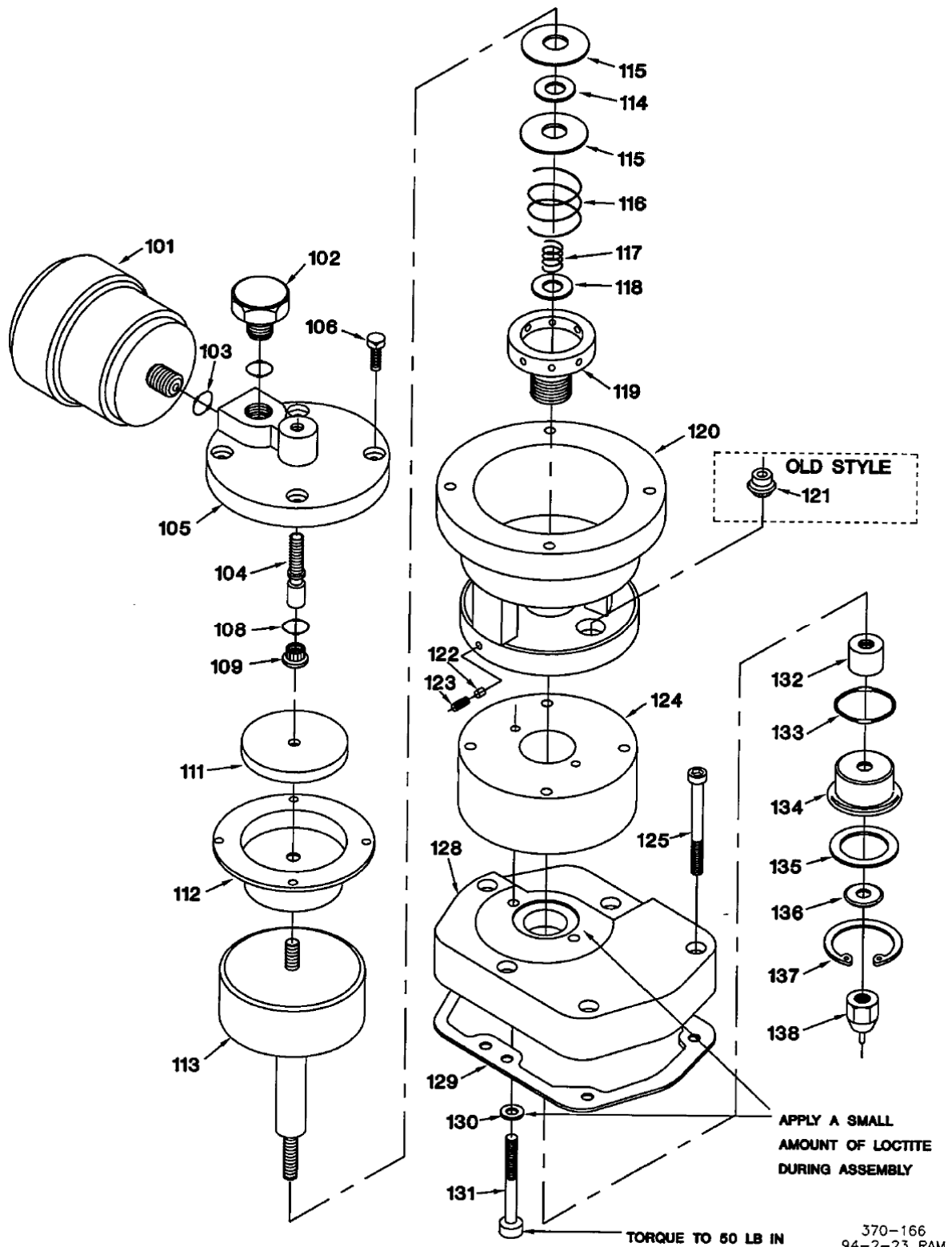


Figure 6-3. Exploded View of PSG Sealed Pneumatic Speed Setting

Parts List for Figure 6-4

| Ref. | Part Description..... | Quantity |
|-------------|------------------------------------|-----------------|
| 37017-151 | Accumulator assembly | 1 |
| 37017-152 | #4 DL plug..... | 1 |
| 37017-153 | O-ring 0.364 I.D. X .070 | 2 |
| 37017-154 | Adjustment screw | 1 |
| 37017-155 | Bellofram Cover Assembly | 1 |
| 37017-156 | Screw, 10-32 x 0.750 | 4 |
| 37017-157 | Not used | |
| 37017-158 | O-ring, 0.208 I.D., 0.070 O.D..... | 1 |
| 37017-159 | Nut, 10-32 | 1 |
| 37017-160 | Not used | |
| 37017-161 | Plate retainer | 1 |
| 37017-162 | Bellofram seal..... | 1 |
| 37017-163 | Plug. | 1 |
| 37017-164 | Nyloc set screw, 8-32 x .500 | 1 |
| 37017-165 | Soc. Hd. cap screw, 10-32 | 2 |
| 37017-166 | Steel washer, .203 I.D. | 2 |
| 37017-167 | Not used | |
| 37017-168 | Body | 1 |
| 37017-169 | Pneumatic head cup assembly..... | 1 |
| 37017-170 | Bearing..... | 1 |
| 37017-171 | Washer, 1.250 O.D..... | 1 |
| 37017-172 | Spring..... | 1 |
| 37017-173 | Spring..... | 1 |
| 37017-174 | Washer, 0.625 O.D..... | 1 |
| 37017-175 | Spring seat | 1 |
| 37017-176 | Not used | |
| 37017-177 | Drain pipe plug, .250 NPT | 1 |
| 37017-178 | Socket head screw, 10-32..... | 5 |
| 37017-179 | Not used | |
| 37017-180 | Cover..... | 1 |
| 37017-181 | Gasket..... | 1 |

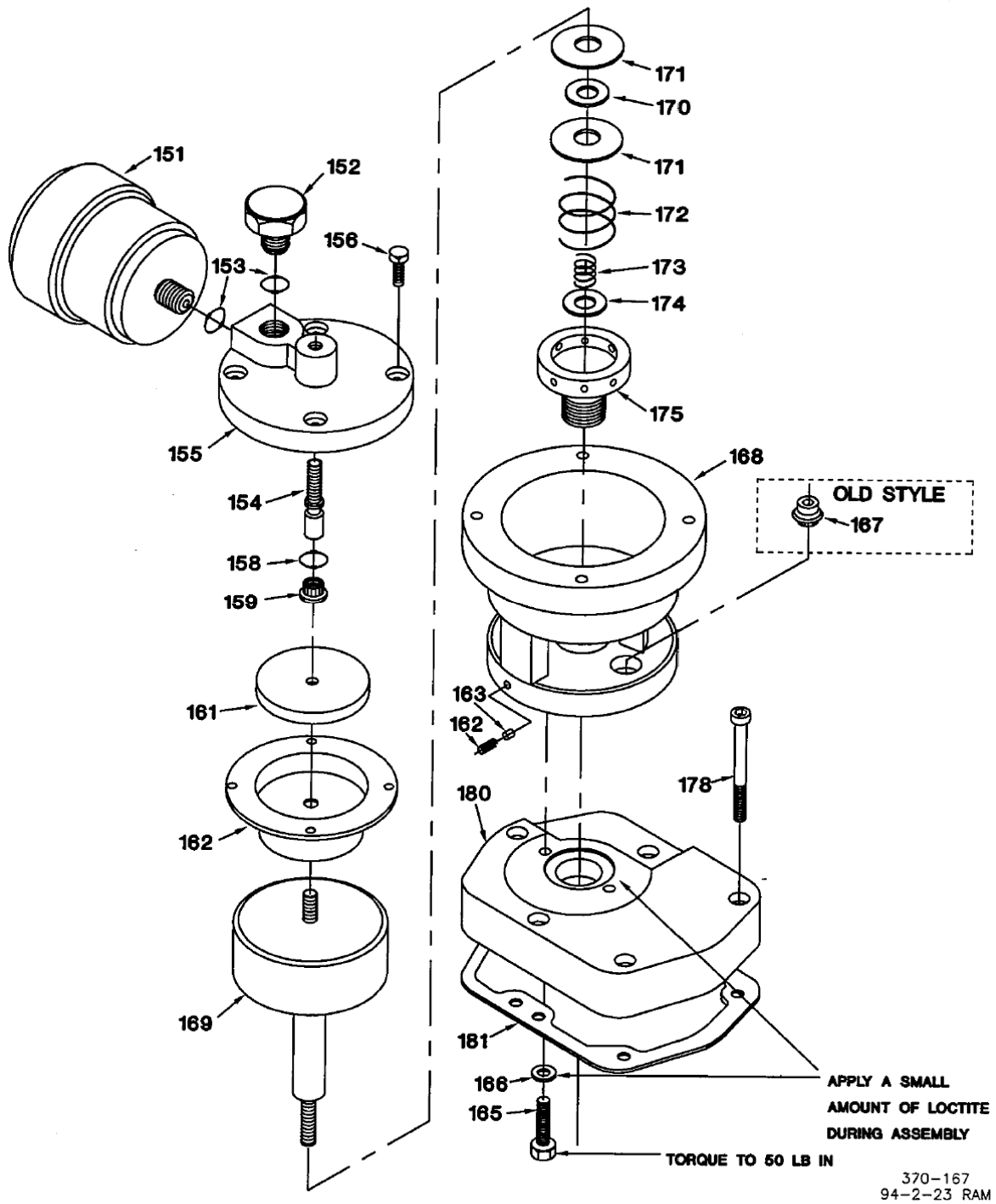


Figure 6-4. Unsealed Pneumatic Speed Setting

Speed Adjusting Motors

An electric speed adjusting motor, mounted on the PSG cover, is used for remote adjustment of the governor speed setting. There are two types of motors available.

The Pittman motor is of the permanent magnet type, 12 or 24 Vdc. When supply voltage is other than 12/24 Vdc, the following Woodward control boxes will convert the supply voltage to 12 or 24 Vdc for use by the motor speed setting:

24 Vdc P/N 8272-515
 110 Vdc P/N 8272-518
 110 Vac P/N 8272-516
 220 Vac P/N 8272-517

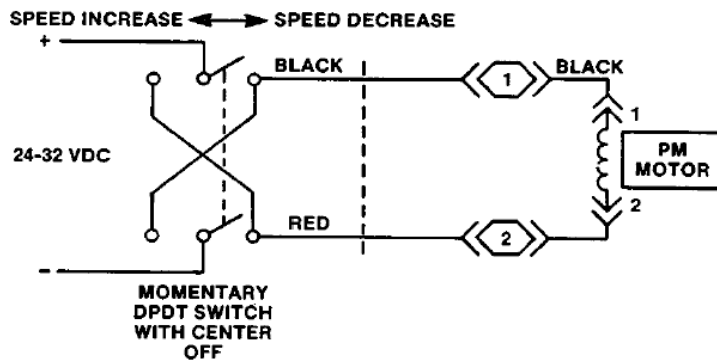


Figure 6-5. PM Motor Wiring Diagram
 (switch not furnished)

The Bodine motor has a split field. The motor is a series-wound reversible type. It is available in all standard voltages.

A manual speed adjusting knob is included on all units fitted with the speed adjusting motor.

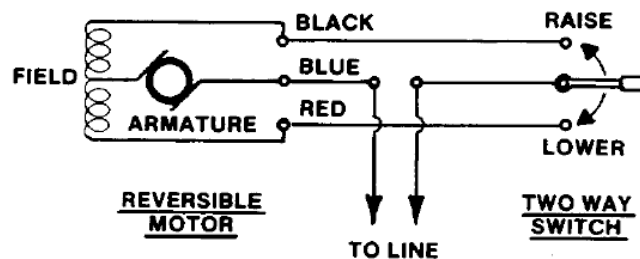


Figure 6-6. Wiring Diagram for Bodine Motor
 (switch not furnished)

The PM or Bodine motor is coupled to the governor speed-setting mechanism through a friction clutch. If the operator runs the speed adjustment to its limit, the clutch is set to slip, protecting the speed-adjusting motor.

Connect the electric speed setting as shown in the accompanying diagrams. Voltage for the Bodine motor is shown on the motor. The Pittman motor operates on dc power.

If the cover and PM motor are ordered separately for use on an existing governor, all that is required for the installation of the new cover is to remove the old cover before setting the new assembly in place on the governor. Some adjustment for mounting may be necessary. Loosen the screws holding the PM motor in place and align the motor shaft with the clutch. Tighten the screws.

When the cover is used without the PM motor, a screw is placed in the hole where the motor drive shaft normally fits. This screw is then used as a low-speed stop. The cover also houses a vertical return spring, when one is used.

Speed Adjustment

Rotating the speed-adjusting lever and shaft, using a speed-adjusting motor, changes the governor speed setting. See the schematic diagram for reference.

One end of the floating lever attaches to the speed-adjustment lever. The other end of the lever pivots about the speed-droop pivot pin. The spring-fork/speed-spring assembly connects to the floating lever. Rotating the speed-adjusting lever changes the compression of the speeder spring. This changes the speed that the governor must run to develop the flyweight force necessary to balance the spring force.

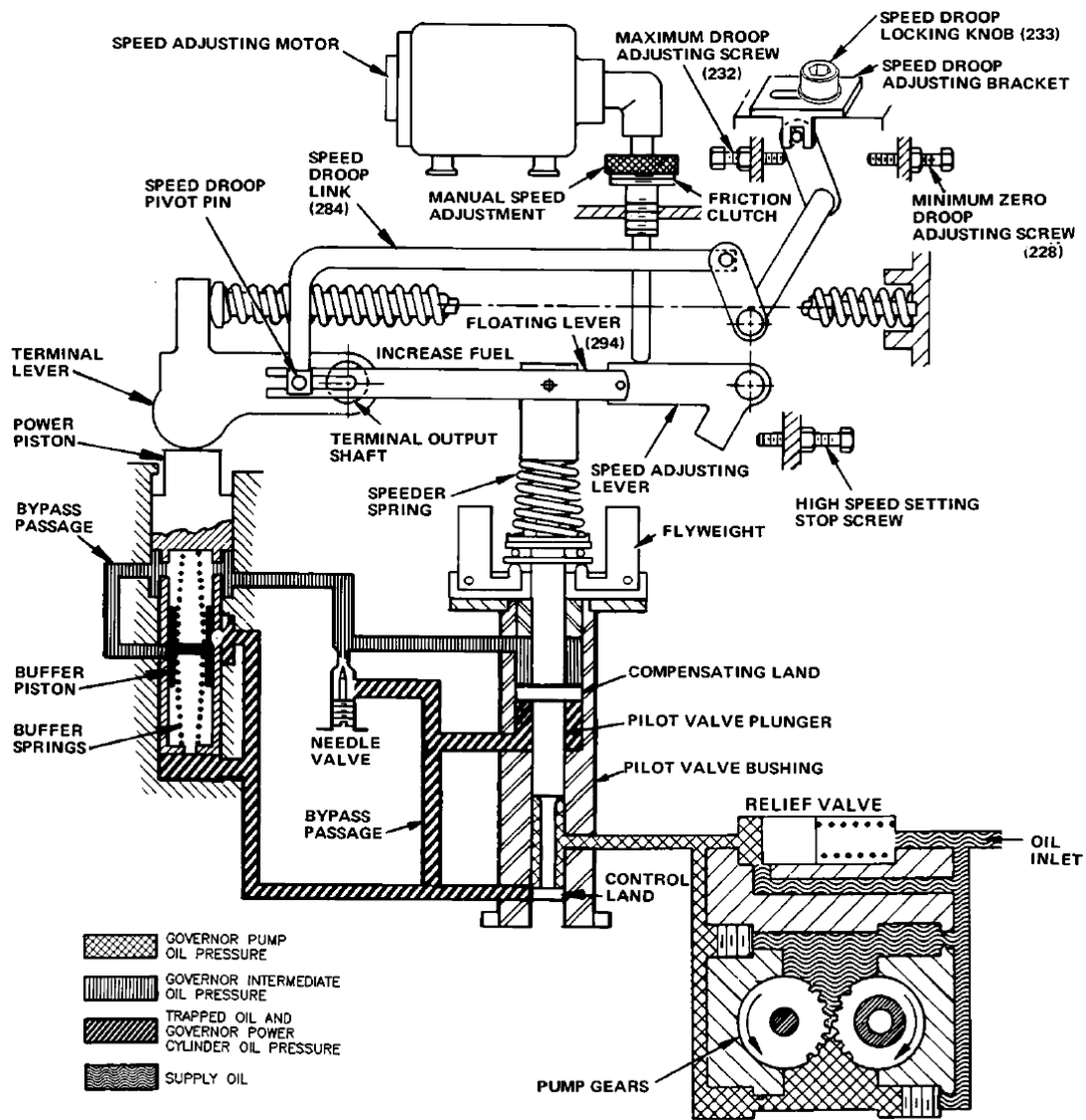
Turning the speed-adjusting screw, either manually by turning the knurled friction clutch or electrically by means of the speed adjusting motor, repositions the speed-adjusting lever. Maximum speed setting is established by setting the high-speed stop screw to limit travel of the speed-adjusting lever.

Externally Adjusted Speed Droop

Many PSG governors are built with externally adjusted droop. Speed droop is adjustable externally between zero and seven percent, depending on speed setting, speeder spring, flyweights, and terminal shaft travel. Speed droop is used to permit load division between two or more engines driving generators in parallel or connected to a single shaft. If the engine is operated alone, or on a dc system with proper generator compounding, the governor may be set for zero droop (isochronous operation).

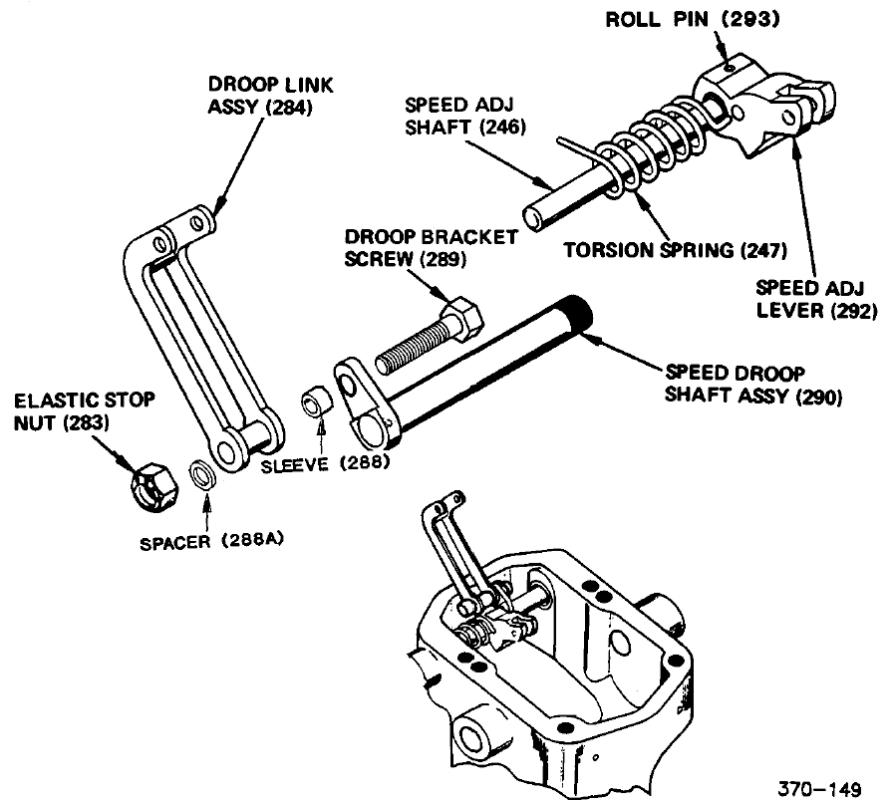
For ac generating units tied in with other units, set the droop sufficiently high to prevent interchange of load between units. If one unit in the system has enough capacity, set its governor to zero droop and it will regulate the frequency of the entire system. This unit can then take all load changes within the limits of its capacity and will control frequency if its capacity is not exceeded.

The speed-droop bracket is positioned by means of the speed-droop bracket screw, lever, and two screws on the outside of the governor case. Two values of droop can be established and a rapid change made between them. A stop screw in the end of the cover is factory set to establish the zero droop setting and requires no adjustment. If the percent of droop has not been specified at the time of manufacture, the maximum droop position should be set with the screw at the back of the adjustment. Use the bracket screw to lock the droop setting at either of the two positions, or to select a third position.



3700-A-96

Figure 6-7. Schematic Diagram of PSG
(horizontal internal return spring, externally adjustable droop, and electric speed setting)



370-149

Figure 6-8. Adjustable Speed Droop Parts

The speed-droop lever is mounted on the droop shaft, supported by the governor case. The inner end of the shaft is joined to one end of the droop linkage with a roll pin. The other end of the linkage carries a pivot pin that is supported by the terminal lever. This pin can be adjusted from a position on the terminal shaft centerline to a location with a radius of about 15 mm (about 1/2 inch). When the pin is at the shaft center, rotation produces no vertical movement of the pin and likewise no movement of the speed-droop lever. As the pin is moved away from the shaft center, rotation produces movement of the end of the speed-droop lever, which is pivoted on the speed-droop pin. When the speed-droop lever moves, it produces a speed setting which is a function of terminal shaft position with speed setting decreasing as fuel flow increases. This is speed droop.

Speed droop is increased by moving the external lever forward, and is reduced to zero when the lever is moved back, bringing the pivot pin to the shaft center. Since there is no calibration for the droop adjustment, the zero droop position may be set only by trial and error on the engine, or by the use of a dial indicator on the speed-droop lever during manual rotation of the terminal shaft. If speed droop is not previously set, it must be set by operation on the engine, readjusting the screw on the side of the governor to obtain the desired speed change between full load and no load.

Disassembly

It is not necessary to disassemble the external parts of the speed droop. If it is disassembled, mark the position of the droop bracket on the case before disassembly. Before removing the sub cap, refer to the section about the internal return spring. When the sub cap is removed, remove the speed-droop link. Pivot the terminal lever upward until slider blocks can move the droop pin from the slot in the floating lever. Notice that there are washers on both sides of the floating lever which could drop into the governor.

Perform the rest of the disassembly similar to the basic governor.

Assembly

A spacer is used on the screw which attaches the droop link assembly to the speed droop shaft. When the adjustable speed droop is assembled to the left-hand side of the governor, this spacer is located on the nut side of the droop link assembly, to strike the zero-droop-setting screw in the sub cap. When adjustable speed droop is assembled on the right side of the governor, the lever on the speed droop setting shaft strikes the zero-droop-setting screw, and the location of the spacer becomes unimportant.

Internal Return Springs

There are two types of internal return springs. One is mounted horizontally in the sub cap, and one is mounted in a vertical position (in line with the power piston and going into the cover).



WARNING When removing the cover from a governor equipped with a vertical return spring, be careful of the spring compression. Serious personal injury is possible if the spring compression is not controlled when the screws holding the cover are removed.

When disassembling a sub cap with a horizontal return spring, use a small screwdriver to pry the wing on the terminal lever away from the sub cap housing. Place a 25 mm (1 inch) square of 3 mm (1/8 inch) thick metal on top of the guide rod, between the spring seat and the sub cap housing. This releases the spring force on the terminal lever.

When assembling a governor with a vertical return spring, insert two Number 23 drill blanks in the governor case to guide the cover into place while the spring is being compressed (see Figure 4-3).

Temperature Compensated Needle Valve

The optional temperature compensated needle valve uses bi-metal washers and a spring-loaded needle valve to automatically adjust the needle valve setting as a function of temperature, which is related to oil viscosity (parts 260 to 267). Adjust the valve the same as a standard valve.

NOTICE

Do not close the needle valve to more than a maximum of 0.68 N·m (6 lb-in) of torque as this damages the valve seat. The valve must be open during operation for the compensation system and the governor to function properly.

Parts List for Figure 6-9

| Ref. | Part Description | Quantity | Ref. | Part Description | Quantity |
|------------|---|----------|------------|--|------------------|
| 37017-201 | Motor Assembly | 1 | 37017-259 | Relief Valve spring | 1 |
| 37017-202 | Friction cover | 1 | 37017-260 | Needle valve adjusting screw | 1 |
| 37017-203 | Friction disc | 1 | 37017-261 | O-ring | 1 |
| 37017-204 | Fiber washer | 1 | 37017-262 | Washer-spacer | 0-6 as required |
| 37017-205 | Spring washer | 1 | 37017-263 | Bi-metal washer | 4-10 as required |
| 37017-206 | Speed adjusting screw | 1 | 37017-264 | Needle valve | 1 |
| 37017-207 | Set screw (6-32) | 1 | 37017-265 | Loading spring | 1 |
| 37017-208 | Screw, 1-32 x 1.375 | 5 | 37017-266 | Needle valve housing | 1 |
| 37017-209 | Not used | | 37017-267 | O-ring | 1 |
| 37017-210 | Cover | 1 | 37017-268 | Plug (optional) | 2 |
| 37017-211 | Gasket | 2 | 37017-268A | Check valve (optional) | 2 |
| 37017-212 | Copper washer | 4 | 37017-269 | Pipe plugs, 1/8 inch | 2 |
| 37017-213 | Screw, 10-32 x .875 | 4 | 37017-270 | Not used | |
| 37017-214 | Lock wire | 1 | 37017-271 | O-ring | 1 |
| 37017-215 | Socket cap screw, 10-32 x 1.000" | 2 | 37017-272 | Plug, .250-28 | 1 |
| 37017-216 | Not used | | 37017-273 | Case assembly | 1 |
| 37017-217 | Screw, 10-32 | 2 | 37017-274 | Case to base oil-seal ring | 1 |
| 37017-218 | Spring pad cover | 1 | 37017-275 | Idler gear stud | 1 |
| 37017-219 | Gasket | 1 | 37017-276 | Base | 1 |
| 37017-220 | Horizontal return spring | 1 | 37017-277 | Pipe plug, 1/16 inch | 3 |
| 37017-221 | Guide rod spring seat | 1 | 37017-278 | Not used | |
| 37017-222 | Sub cap | 1 | 37017-279 | Socket hd screw, .250-20 x 1.000 inch .. | 3 |
| 37017-223 | Spring guide rod | 1 | 37017-280 | Nameplate | 1 |
| 37017-224 | Plug | 1 | 37017-281 | Drive screw | 2 |
| 37017-225 | Load Limit Screw | 1 | 37017-282 | Dowel pin | 2 |
| 37017-226 | Hex nut, .250 - 28 | 1 | 37017-283 | Elastic stop nut, 10-32 thin | 1 |
| 37017-227 | Washer | 1 | 37017-284 | Speed droop link assembly | 1 |
| 37017-227A | Thread seal | 1 | 37017-285 | Speed droop slider block | 2 |
| 37017-228 | Screw | 1 | 37017-286 | Washer | 2 |
| 37017-229 | Hex nut | 1 | 37017-287 | Pin | 1 |
| 37017-230 | Washer | 1 | 37017-288 | Sleeve | 1 |
| 37017-230A | Thread seal | 1 | 37017-288A | Spacer | 1 |
| 37017-231 | Hex nut, 8-32 | 1 | 37017-289 | Socket head screw, 10-32 x 1.000 inch .. | 1 |
| 37017-232 | Droop adjusting screw | 1 | 37017-290 | Speed droop lever | 1 |
| 37017-233 | Speed droop bracket screw | 1 | 37017-291 | Spring wire pin | 1 |
| 37017-234 | Not used | | 37017-292 | Speed adjusting lever | 1 |
| 37017-235 | Washer | 1 | 37017-293 | Roll pin - speed adjust lever | 1 |
| 37017-236 | Bracket | 1 | 37017-294 | Floating lever | 1 |
| 37017-237 | Lever attachment screw | 1 | 37017-295 | Speeder spring assembly | 1 |
| 37017-238 | Speed droop adjustment lever | 1 | 37017-296 | Pilot valve plunger nut | 1 |
| 37017-239 | High speed stop screw, 10-32 x 1.500 .. | 1 | 37017-297 | Speeder spring seat | 1 |
| 37017-240 | Stop nut, 10-32 | 3 | 37017-298 | Thrust bearing | 1 |
| 37017-241 | Washer, 203 ID | 2 | 37017-299 | Flyweight | 2 |
| 37017-242 | Thread seal | 2 | 37017-300 | Needle bearing | 4 |
| 37017-243 | Droop adjusting bushing | 1 | 37017-301 | Flyweight pin | 2 |
| 37017-244 | Speed adjusting shaft | 1 | 37017-302 | Ballhead | 1 |
| 37017-245 | Roll pin - droop lever | 1 | 37017-303 | Retaining ring | 1 |
| 37017-246 | Droop adjusting shaft | 1 | 37017-304 | Retaining ring | 1 |
| 37017-247 | Torsion spring | 1 | 37017-305 | Retaining ring | 1 |
| 37017-248 | Oil seal | 3 | 37017-306 | Compensating bushing | 1 |
| 37017-249 | Speed adjusting bushing | 1 | 37017-307 | Pilot valve plunger | 1 |
| 37017-250 | Welch plug | 1 | 37017-308 | Cotter pin | 2 |
| 37017-251 | Terminal shaft bushing | 2 | 37017-309 | Terminal lever | 1 |
| 37017-252 | Terminal shaft (left) | 1 | 37017-310 | Power piston | 1 |
| 37017-253 | Power piston stop screw | 1 | 37017-311 | Buffer spring | 2 |
| 37017-254 | Terminal shaft (right) | 1 | 37017-312 | Buffer piston | 1 |
| 37017-255 | Relief valve sleeve | 1 | 37017-313 | Buffer spring seat | 1 |
| 37017-256 | Plug | 1 | 37017-314 | Retainer ring | 1 |
| 37017-256A | Washer, .703 x .875 | 1 | 37017-315 | Pilot valve bushing | 1 |
| 37017-257 | Sleeve spring | 1 | 37017-316 | Idler gear assembly | 1 |
| 37017-258 | Relief valve plunger | 1 | 37017-317 | Preformed packing | 2 |

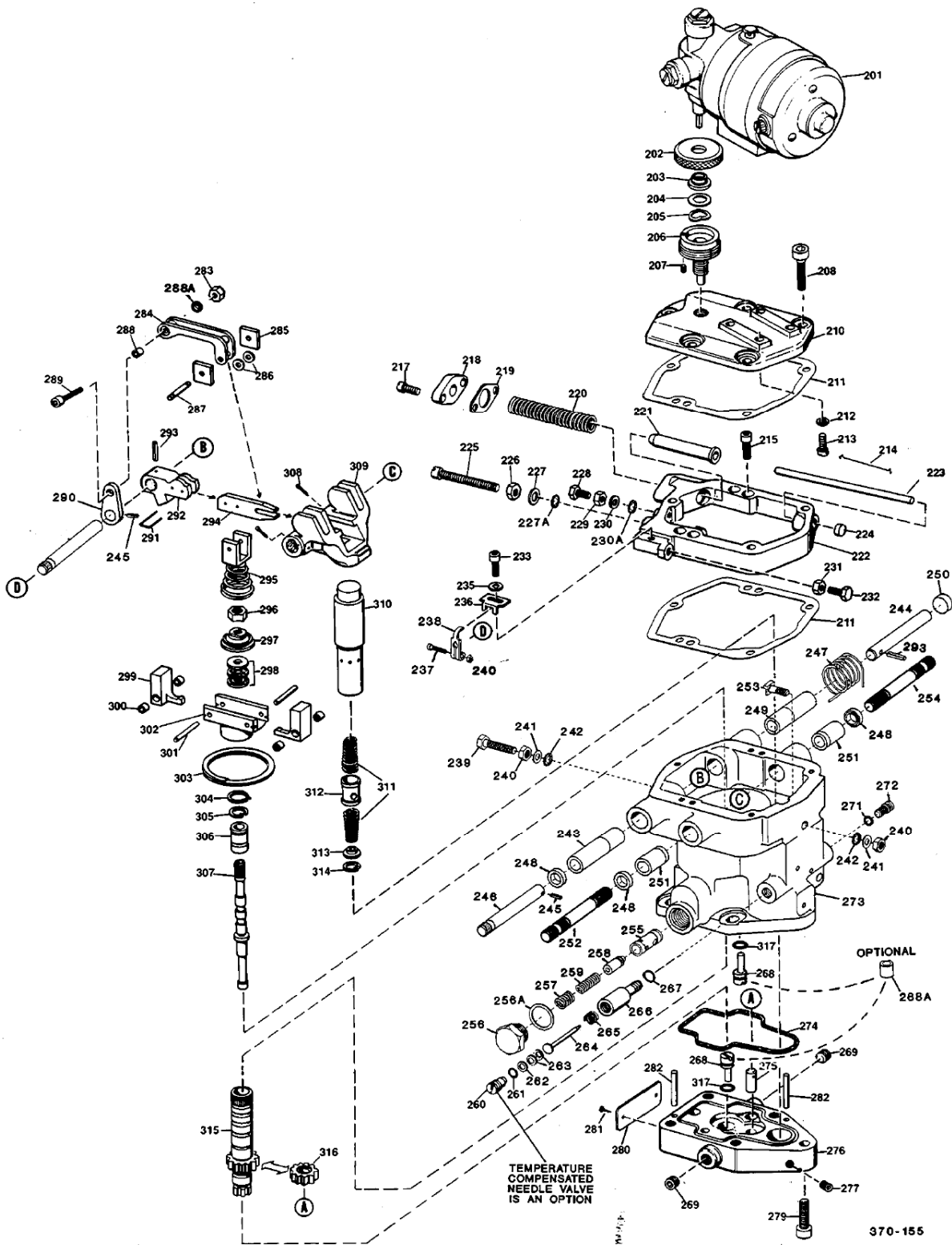


Figure 6-9. PSG
(horizontal return spring, externally adjusted droop, torsion speed setting spring,
and Bodine motor)

Parts List for Figure 6-10

| Ref. | Part Description | Quantity |
|-----------|-------------------------------|----------|
| 37017-341 | Cover gasket..... | 2 |
| 37017-342 | Sub Cap..... | 2 |
| 37017-343 | Washer, .296 OD | 2 |
| 37017-344 | Soc. head cap screw | 2 |
| 37017-345 | Power piston strut..... | 1 |
| 37017-346 | Pivot pin | 1 |
| 37017-347 | Terminal lever | 1 |
| 37017-348 | Soc. head cap screw | 2 |
| 37017-349 | Lock washer..... | 2 |
| 37017-350 | Spring seat..... | 1 |
| 37017-351 | Elastic stop nut, 10-32 | 1 |
| 37017-352 | Vertical return spring..... | 1 |
| 37017-353 | Cover | 1 |
| 37017-354 | Thread seal..... | 2 |
| 37017-355 | Screw..... | 3 |
| 37017-356 | Washer | 1 |
| 37017-357 | Screw..... | 1 |
| 37017-358 | Washer | 1 |
| 37017-359 | Elastic hex nut | 2 |
| 37017-360 | Screw..... | 1 |
| 37017-361 | Power piston | 1 |

Parts List for Figure 6-11

| Ref. | Part Description | Quantity |
|------------|--------------------------------|----------|
| 37017-431 | Power piston | 1 |
| 37017-432 | Power piston strut | 1 |
| 37017-433 | Terminal lever | 1 |
| 37017-434 | Pivot pin | 1 |
| 37017-435 | Screw, 10-32 x .750 | 2 |
| 37017-436 | Not used | 2 |
| 37017-437 | Spring seat | 1 |
| 37017-438 | Elastic Stop Nut, 10-32 | 1 |
| 37017-439 | Vertical return spring | 1 |
| 37017-440 | Cover Gasket | 1 |
| 37017-441 | Cover | 1 |
| 37017-442 | Speed Adjusting screw | 1 |
| 37017-443 | Friction spring washer | 1 |
| 37017-444 | Washer, .750 OD | 1 |
| 37017-445 | Friction disc | 1 |
| 37017-446 | Friction clutch | 1 |
| 37017-447 | Socket head set screw | 1 |
| 37017-448 | Electric motor | 1 |
| 37017-449 | Not used | 4 |
| 37017-450 | Screw, 10-32 x .625 | 4 |
| 37017-451 | Not used | |
| 37017-452 | Screw | 4 |
| 37017-453 | Not used | |
| 37017-454 | Screw, 10-32 | 1 |
| 37017-455 | Not used | |
| 37017-456 | Not used | |
| 37017-457 | Washer | 1 |
| 37017-457A | Thread seal | 1 |
| 37017-458 | Nut, 10-32 | 1 |
| 37017-459 | Cap screw, 10-32 x 1.500 | 1 |

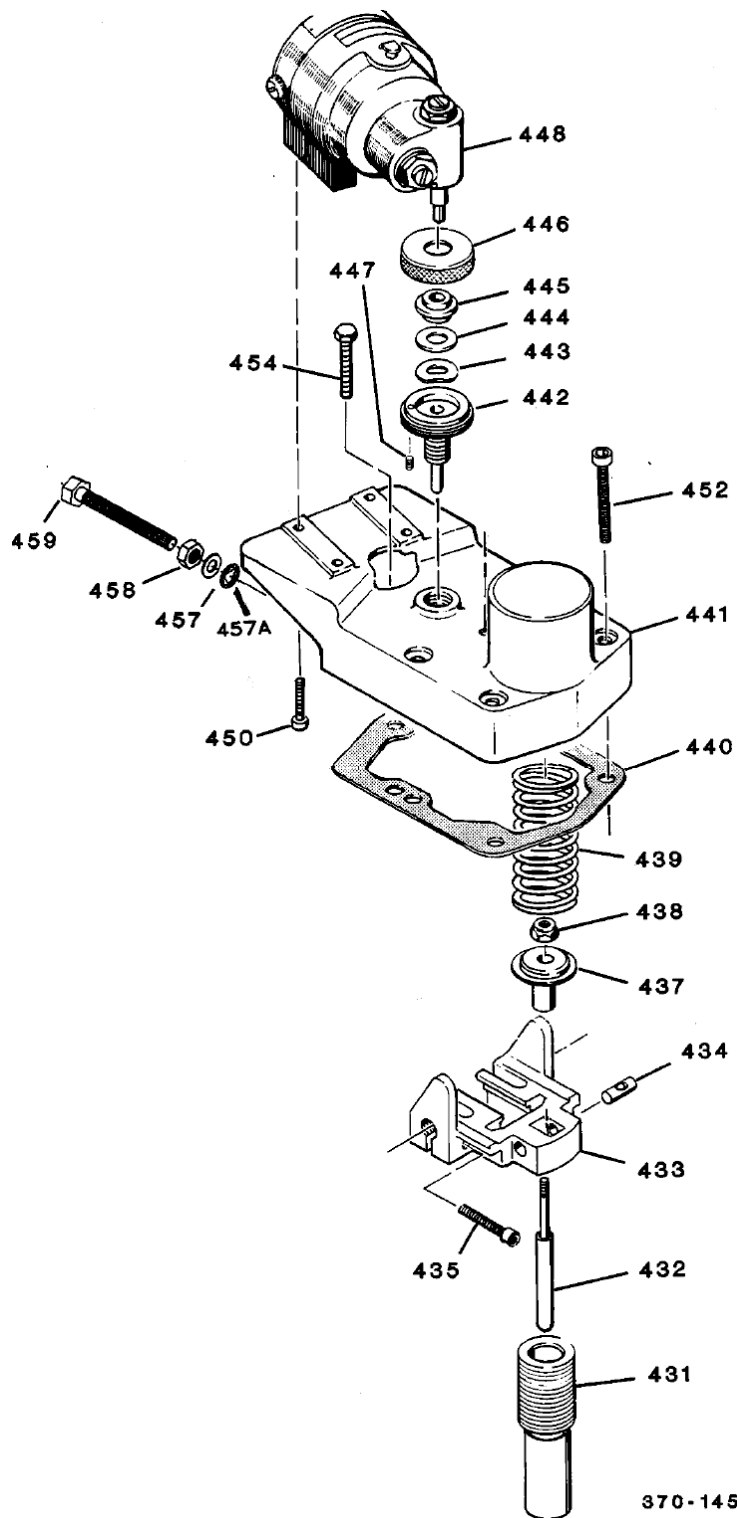


Figure 6-11. PSG with Vertical Return Spring and Electric Motor



WARNING Injury may result if compressed spring 352 is released suddenly. Use the proper equipment to remove springs and spring covers.

Parts List for Figure 6-12

| Ref. | Part Description | Quantity | Ref. | Part Description | Quantity |
|-----------|-----------------------------|----------|-----------|------------------------|----------|
| 37017-371 | Cover gasket | 1 | 37017-383 | Oil seal | 1 |
| 37017-372 | Sub cap | 1 | 37017-384 | Fuel rod spacer | 1 |
| 37017-373 | Not used | | 37017-385 | Fuel rod gasket | 1 |
| 37017-374 | Cap screw, 10-32 x 1" | 2 | 37017-386 | Hex jam nut | 1 |
| 37017-375 | Fuel rod | 1 | 37017-387 | Knob | 1 |
| 37017-376 | Breather cap assy. | 1 | 37017-388 | Not used | |
| 37017-377 | Compression spring | 1 | 37017-389 | Cap screw | 2 |
| 37017-378 | Shutdown spring seat | 1 | 37017-390 | Thread seal | 1 |
| 37017-379 | Shutdown spring | 1 | 37017-391 | Flat washer | 1 |
| 37017-380 | Fuel rod spring seat | 1 | 37017-392 | Stop nut | 1 |
| 37017-381 | Fuel rod gasket | 1 | 37017-393 | Stop screw | 1 |
| 37017-382 | Oillite bushing | 1 | | | |

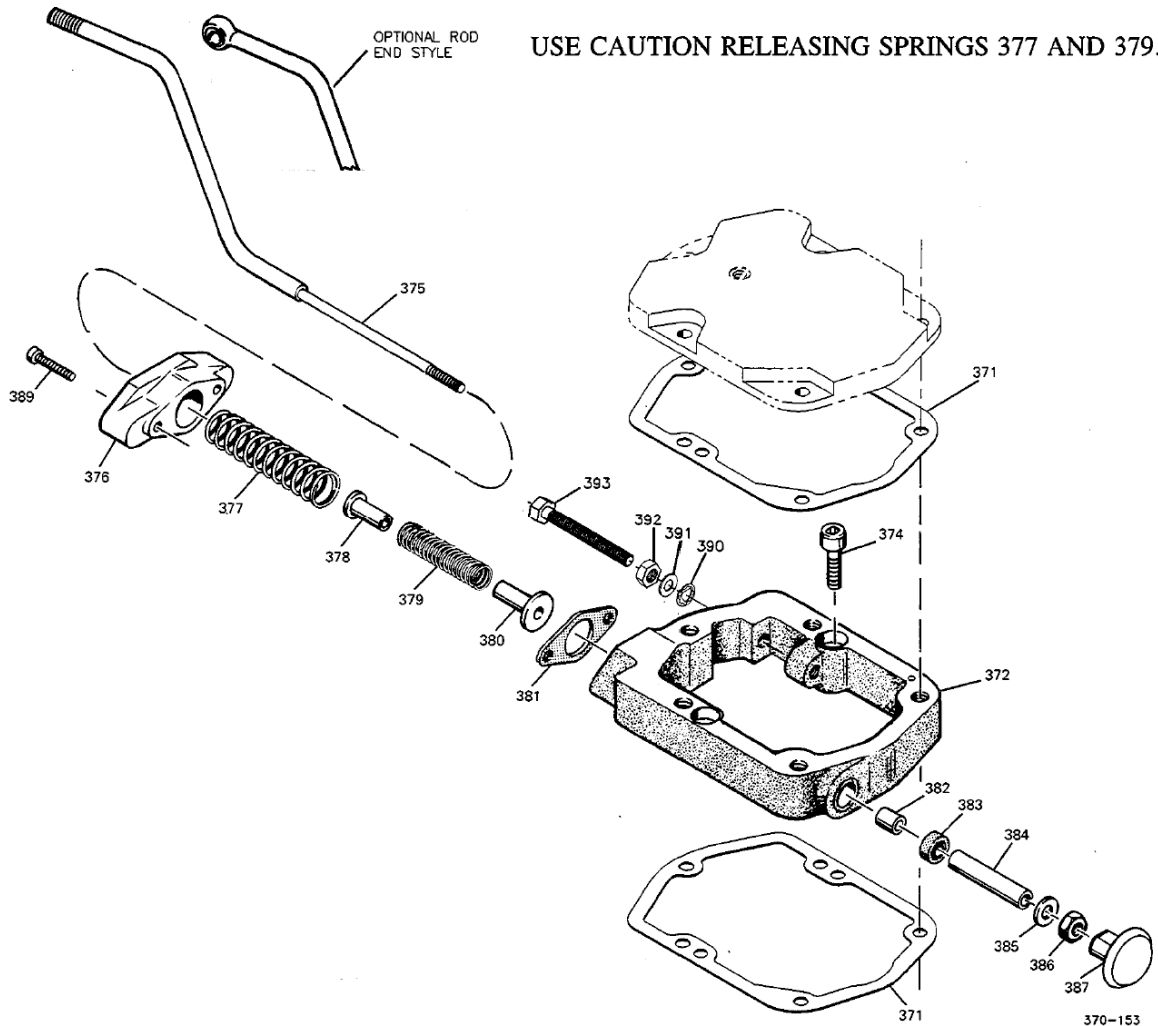


Figure 6-12. PSG with Fuel Rod

Some PSGs are equipped with a spring-loaded fuel rod instead of a terminal shaft. The fuel rod takes the position of the guide rod on the horizontal return spring. Short terminal shafts are used in these governors with Welsh plugs installed on both sides of the governor case.

Parts List for Figure 6-13

| Ref. | Part Description..... | Quantity |
|-----------|------------------------------|----------|
| 37017-471 | Hex. Screw | 1 |
| 37017-472 | Hex nut, .250-28 | 2 |
| 37017-473 | Washer | 2 |
| 37017-474 | Thread seal | 2 |
| 37017-475 | Plug, guide | 1 |
| 37017-476 | Cover | 1 |
| 37017-477 | Cap Screw, 10-32 | 5 |
| 37017-478 | Stop screw | 1 |
| 37017-479 | Gasket | 1 |
| 37017-480 | Vertical return spring | 1 |
| 37017-481 | Thin elastic hex nut | 1 |
| 37017-482 | spring seat | 1 |
| 37017-483 | Lever assembly | 1 |
| 37017-484 | Strut pivot pin | 1 |
| 37017-485 | Cap Screw, 10-32 | 2 |
| 37017-486 | Servo piston strut | 1 |
| 37017-487 | Servo piston | 1 |

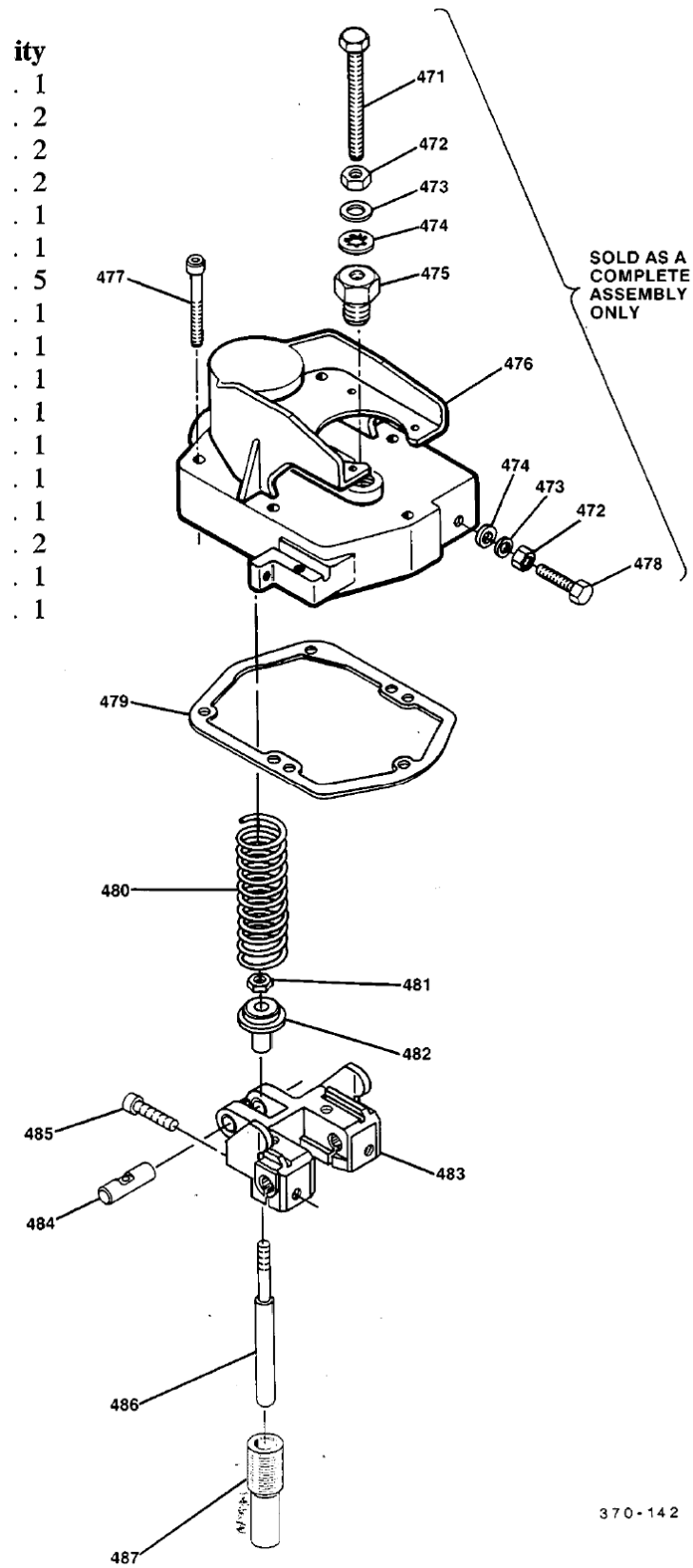


Figure 6-13. Vertical Return Spring Cover and Associated Parts

Parts List for Figure 6-14

| Ref. | Part Description..... | Quantity |
|--|-------------------------------|----------|
| 37017-501 | Screw, 6-32 x 1.875 | 4 |
| 37017-502 | Bracket..... | 1 |
| 37017-503 | Motor Cover..... | 1 |
| 37017-504 | Foam Buffer..... | 1 |
| 37017-505 | PM Motor..... | 1 |
| [Items 503, 504, 505 are epoxied together as an assembly and are furnished this way only.] | | |
| 37017-506 | Friction Clutch | 1 |
| 37017-507 | Friction Disc..... | 1 |
| 37017-508 | Washer, .062 thick..... | 1 |
| 37017-509 | Spring Washer,..... | 1 |
| 37017-510 | Speed Adjusting Screw | 1 |
| 37017-511 | Cap Screw, 10-32 x 1.5 | 5 |
| 37017-512 | Cover..... | 1 |
| 37017-513 | Nitrile Thread Seal..... | 1 |
| 37017-514 | Washer, .032 thick..... | 1 |
| 37017-515 | Hex Nut, .250-28 | 1 |
| 37017-516 | Stop Screw, .250-28 x 3 | 1 |

A friction coupling is incorporated in these cover assemblies to permit overtravel of the motor without damage to either the motor or the governor. This coupling should be adjusted to slip at 0.5 to 0.6 N·m (4.5 to 5.5 lb-in) of torque. The motor shaft must center in the coupling. When properly centered, the shaft will not bind when rotated from the highest to the lowest speed.

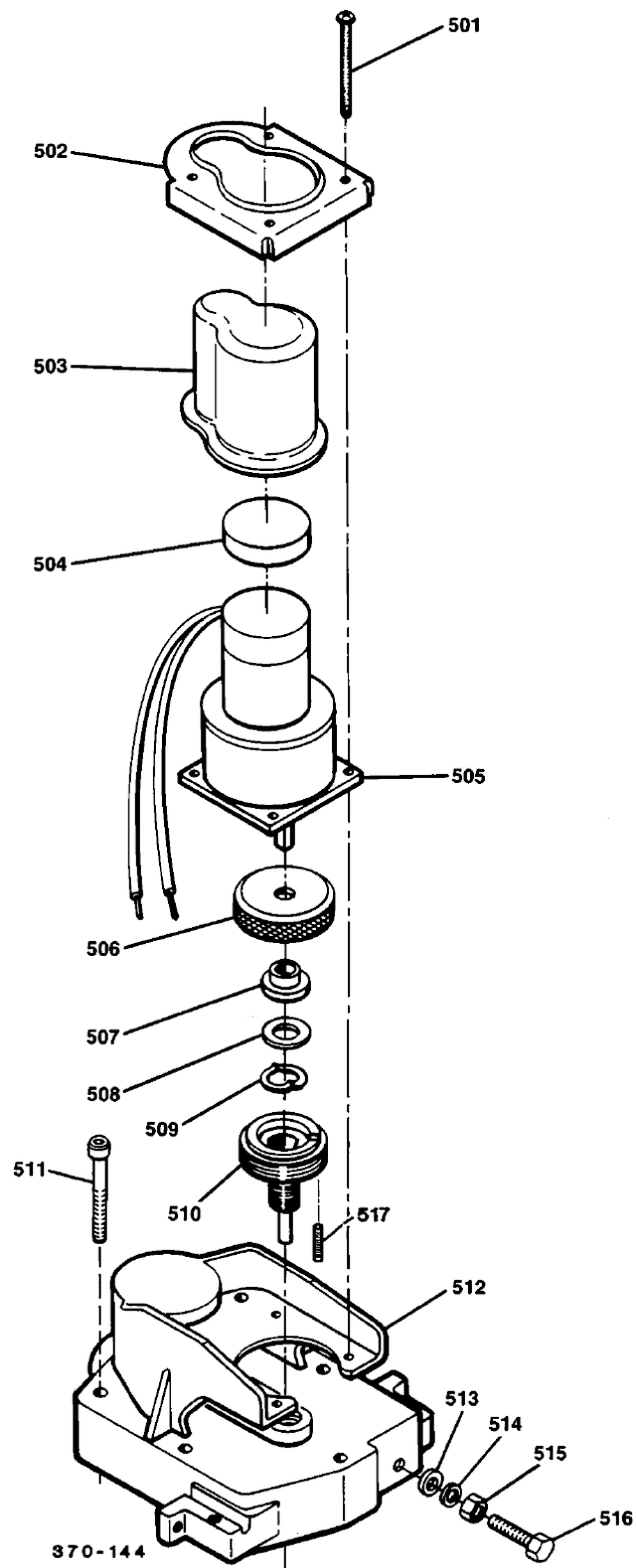


Figure 6-14. Pittman PM Speed Adjusting Motor

Chapter 7.

Product Support and Service Options

Product Support Options

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

1. Consult the troubleshooting guide in the manual.
2. Contact the **OE Manufacturer or Packager** of your system.
3. Contact the **Woodward Business Partner** serving your area.
4. Contact Woodward technical assistance via email (EngineHelpDesk@Woodward.com) with detailed information on the product, application, and symptoms. Your email will be forwarded to an appropriate expert on the product and application to respond by telephone or return email.
5. If the issue cannot be resolved, you can select a further course of action to pursue based on the available services listed in this chapter.

OEM or 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 current list of Woodward Business Partners is available at www.woodward.com/directory.

Product Service Options

Depending on the type of product, the following options for servicing Woodward products may be available through your local Full-Service Distributor or the OEM or Packager of the equipment system.

- 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 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.

Flat Rate Repair: Flat Rate Repair is available for many of the standard mechanical products and some of the electronic 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.

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. 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 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's Full-Service Distributors offer various Engineering Services for our products. For these services, you can contact the Distributor by telephone or by email.

- 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.

Product Training is available as standard classes at many Distributor locations. Customized classes are also available, which can be tailored to your needs and held at one of our Distributor 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 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 one of the Full-Service Distributors listed at www.woodward.com/directory.

Contacting Woodward's Support Organization

For the name of your nearest Woodward Full-Service Distributor or service facility, please consult our worldwide directory published at www.woodward.com/directory.

You can also contact the Woodward Customer Service Department at one of the following Woodward facilities to obtain the address and phone number of the nearest facility at which you can obtain information and service.

Products Used In Electrical Power Systems

| <u>Facility</u> ----- | <u>Phone Number</u> |
|-----------------------|---------------------|
| Brazil ----- | +55 (19) 3708 4800 |
| China ----- | +86 (512) 6762 6727 |
| Germany: | |
| Kempen---- | +49 (0) 21 52 14 51 |
| Stuttgart-- | +49 (711) 78954-510 |
| 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 |

Products Used In Engine Systems

| <u>Facility</u> ----- | <u>Phone Number</u> |
|-----------------------|---------------------|
| 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 |

Products Used In Industrial Turbomachinery Systems

| <u>Facility</u> ----- | <u>Phone Number</u> |
|-----------------------|---------------------|
| 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 |

For the most current product support and contact information, please visit our website directory at www.woodward.com/directory.

Technical Assistance

If you need to contact technical assistance, you will need to provide the following information. Please write it down here before contacting the Engine OEM, the Packager, a Woodward Business Partner, or the Woodward factory:

General

Your Name _____

Site Location _____

Phone Number _____

Fax Number _____

Prime Mover Information

Manufacturer _____

Engine Model Number _____

Number of Cylinders _____

Type of Fuel (gas, gaseous, diesel,
dual-fuel, etc.) _____

Power Output Rating _____

Application (power generation, marine,
etc.) _____

Control/Governor Information

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 _____

Symptoms

Description _____

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 **37017A**.



B37017:A



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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.