

SG Governor

This manual replaces manual 04022.

Installation and Operation Manual



General Precautions

Read this entire manual and all other publications pertaining to the work to be performed before installing, operating, or servicing this equipment.

Practice all plant and safety instructions and precautions.

Failure to follow instructions can cause personal injury and/or property damage.



Revisions

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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.



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Revisions—Changes in this publication since the last revision are indicated by a black line alongside the text.

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Contents

WARNINGS AND NOTICES	3
ELECTROSTATIC DISCHARGE AWARENESS	4
CHAPTER 1. GENERAL INFORMATION.....	5
Introduction	5
Governor Drive	5
Speed Adjustment	6
Speed Droop Adjustment	7
Auxiliary Features (Optional)	7
CHAPTER 2. PRINCIPLES OF OPERATION	8
CHAPTER 3. INSTALLATION AND ADJUSTMENT	10
Installation	10
Linkage	14
Adjustment.....	16
Troubleshooting.....	17
CHAPTER 4. OVERHAUL	18
Introduction	18
Disassembly Instructions.....	18
Repair	22
Assembly Instructions.....	23
CHAPTER 5. PARTS INFORMATION	28
Cover Assembly with Bodine Speed Adjusting Motor	32
Cover Assembly with Pittman PM Speed Adjusting Motor.....	34
Cover Assembly with Vertical Return Spring.....	36
Subcap Assemblies	38
CHAPTER 6. TROUBLESHOOTING	46
General.....	46
Oil Trouble	46
Speed Droop Adjustment	46
Analysis and Correction of Governing Troubles.....	46
CHAPTER 7. PRODUCT SUPPORT AND SERVICE OPTIONS.....	49
Product Support Options	49
Product Service Options.....	49
Returning Equipment for Repair	50
Replacement Parts	50
Engineering Services.....	51
Contacting Woodward's Support Organization	51
Technical Assistance.....	52
REVISION HISTORY.....	53

Illustrations and Tables

Figure 1-1. Typical SG Governor with New Style Cover	6
Figure 1-2. Early Type SG Governor.....	6
Figure 2-1. Schematic Diagram of a Typical SG Governor.....	9
Figure 3-1. Recommended Engine Oil System for Quick Starts	11
Figure 3-2. SG Governor Outline with Direct Pneumatic Speed Setting.....	12
Figure 3-3. SG Governor Outline with Reverse Pneumatic Speed Setting.....	12
Figure 3-4. SG with Fuel Rod and Bodine Electric Motor for Speed Setting.....	13
Figure 3-5. Wiring Diagram for Bodine Motor (Switch not furnished).....	13
Figure 3-6. Wiring Diagram for PM Motor (switch not furnished)	14
Figure 3-7. Recommended Governor Terminal Shaft Travel	14
Figure 3-8. Linear Linkage Arrangement.....	15
Figure 3-9. Non-linear Linkage Arrangement	16
Figure 4 1 Bushing Driver	21
Figure 4-2. Bushing and Gear Stud Replacement	24
Figure 4-3. Centering Pilot Valve Plunger	26
Figure 5-1. Typical SG Governor Parts (later models)	29
Figure 5-2. Typical SG Governor Parts (early models)	31
Figure 5-3. Bodine Speed Adjusting Motor and Installation Parts.....	33
Figure 5-4. Speed Adjusting Motor Parts	33
Figure 5-5. Pittman PM Speed Adjusting Motor and Installation Parts	35
Figure 5-5a. Vertical Return Spring Cover and Installation Parts	37
Figure 5-6. Subcap Assembly Parts (linear output).....	39
Figure 5-7. Subcap Assembly Parts (internal return spring)	40
Figure 5-8. Spring driven, Oil-Damped Ballhead Parts	41
Figure 5-9. Spring-Driven Ballhead Parts.....	42
Figure 5-10. Outline Drawing of SG Governor with Speed Adjusting Motor	43
Figure 5-11. Outline Drawing of SG Governor with Subcap (internal return spring) and Speed Adjusting Motor	44
Figure 5-12. Outline Drawing of SG Governor with and without PM Motor, with Pneumatic Speed Setting Assembly	45

Warnings and Notices

Important Definitions



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

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

WARNING

**Overspeed /
Overtemperature /
Overpressure**

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

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

WARNING

**Personal Protective
Equipment**

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

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

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

WARNING

Start-up

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

WARNING

**Automotive
Applications**

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

NOTICE**Battery Charging
Device**

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

Electrostatic Discharge Awareness

NOTICE**Electrostatic
Precautions**

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

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

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

Follow these precautions when working with or near the control.

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

Chapter 1.

General Information

Introduction

This manual provides description, operation, overhaul and replacement parts information for SG governors (Figure 1-1) and various optional auxiliary features. The SG governor is a hydraulic speed droop type governor used on small diesel, gas, or gasoline engines where isochronous (constant speed) control is not required. The design of the speed droop governor is such that the governor operates at a slower speed as engine load increases. It is through this characteristic that stability of the governed system is achieved, and division of load between paralleled units made possible.

SG governors are available with 10.8 or 21.7 inch-pounds (1.2 or 2.5 J) of work capacity over 36° of terminal shaft (output) travel.

IMPORTANT

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

If not supplied with an internal return spring, the 10.8 inch-pound governor requires an external return spring (not furnished by Woodward) that exerts a 20 pound-inch (2.3 N·m) torque on the terminal shaft in the closing direction. The 21.7 inch-pound governor requires a spring that exerts a 40 pound-inch (4.5 N·m) torque on the terminal shaft in the closing direction.

A new cover for the standard SG governor is a vertical return-spring type cover. This cover is used with or without a return spring, and also, with or without a Pittman PM (Permanent Magnet) speed-setting motor. For SG governors without a motor, the cover is furnished with a guide plug for the low-speed stop screw (see Figures 1-1 and 1-2).

The SG governor is usually arranged to operate at 2400 or 3600 rpm at normal rated engine speed, and will control down to approximately 25% of normal speed. Special configurations are available, however, to meet other speed requirements.

The governor uses engine oil or oil from a separate sump (not furnished by Woodward) as a control medium; it does not have an independent sump.

Governor Drive

The governor drive shaft is splined to fit into the engine drive (see Figures 5-11 and 5-12). The governor may be mounted vertically or horizontally. If mounted horizontally, the terminal shaft must also be horizontal and a 3/8-inch drain line provided to connect to a 1/4-inch pipe-tapped or 0.438-20 (-4) straight-thread port in the tower end of the governor cover. For connection of the drain line on the new-style cover, see Figure 1-2 for vertical installation or Figure 5-12 for horizontally mounted governors.

The governor drive shaft may be rotated in either direction. However, the governor relief valve assembly must, when viewing the governor from the nameplate end, be on the left if the governor is rotated clockwise (when viewed from above). The relief valve assembly must be on the right for counterclockwise rotation of the drive.

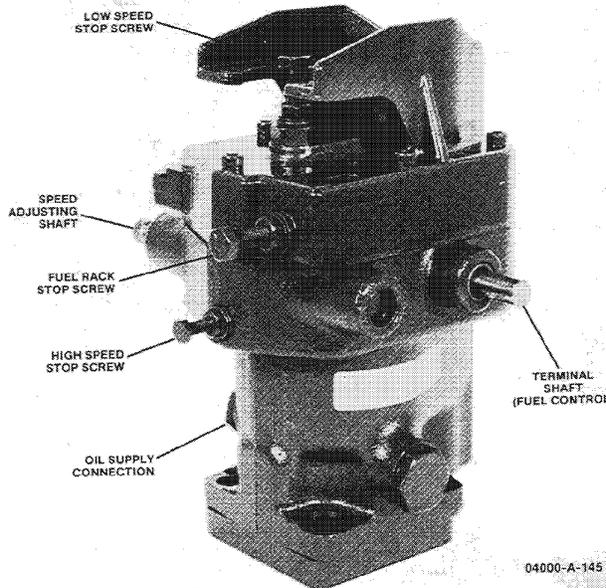


Figure 1-1. Typical SG Governor with New Style Cover

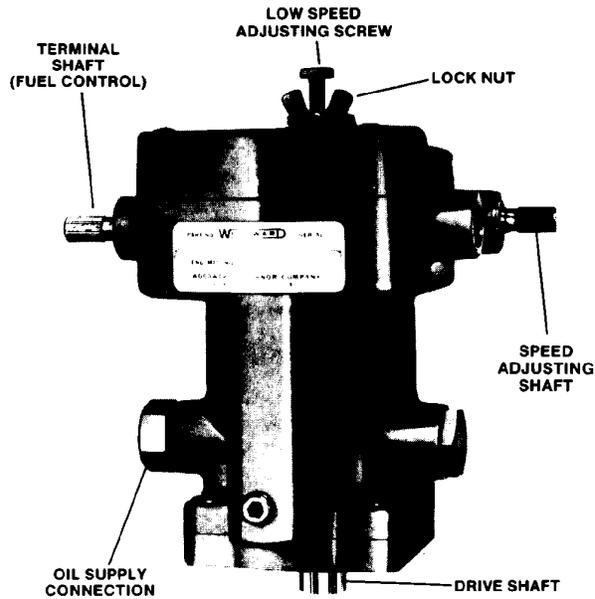


Figure 1-2. Early Type SG Governor

Speed Adjustment

The speed adjusting shaft is used to set the governor for the desired running speed. Low speed and high speed stop screws are provided to limit the speed range of variable speed governors. If the engine is to be operated at one speed setting, the stop screws may be used to lock the position of the speed adjusting shaft.

The terminal shaft may extend on either or both sides of the governor. Shutdown of the engine can be accomplished by turning the speed adjusting shaft below the idle speed setting position.

Speed Droop Adjustment

Speed droop adjustment is provided inside the governor. The droop setting required to gain stability varies with each installation; in most instances it must be set to increase unit speed two or three percent over the terminal shaft rotation used from rated power output at rated speed to zero power output. The range of adjustment is from one-half of one percent to approximately seven percent over the full 36° available travel of the governor terminal shaft.

Auxiliary Features (Optional)

Speed Adjusting Motor

The SG governor can be fitted with a speed adjusting motor to enable the switchboard operator to match the frequency of an alternator with that of other units or a system before synchronizing, and to change load distribution after synchronizing. Two types of motor are available.

The Bodine motor is of the split field, series wound, reversible type (see Figures 3-8 and 3-9). It is available in all standard voltages.

The Pittman motor is of the permanent magnet type 12 or 24 Vdc (see Figures 5-3 and 5-5). When motor supply voltage is other than 12 or 24 Vdc, the following control boxes are available for conversion to 24 Vdc:

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

A manual speed adjusting knob with friction clutch assembly is included on units fitted with a speed adjusting motor.

Vibration Attenuating Ballhead Assemblies

A spring-driven oil-damped ballhead assembly (Figure 5-8) may be used in SG governors in place of the standard solid ballhead assembly where it is necessary to overcome undesirable torsional vibrations transmitted from the engine drive to the governor ballhead.

Subcap Assemblies

Different subcap assemblies are available to match the particular needs of the SG governor installation (see Figures 5-7 and 5-12). Figure 5-7 illustrates the subcap used for an installation with a linear output, Figure 5-12 illustrates a rotary output with an internal return spring. Subcaps usually include a fuel-rack stop screw.

Chapter 2.

Principles of Operation

A schematic arrangement of a typical SG governor is shown in Figure 2-1.

As described earlier, the governor uses engine oil as a control medium and does not have an independent sump. The engine oil enters the governor at the relief valve, drops down into the cavity on the suction side of the governor oil pump, and is carried by the pump gears around to the pressure side of the pump. If the supply of pressure oil is greater than is required for governing purposes, the governor pump will build up pressure until the relief valve plunger is pushed to the right against the force of the relief valve plunger spring. The governor pump will then recirculate the oil within the governor.

If pressure oil is used for governing purposes, the pressure will be reduced and the spring will move the relief valve plunger to the left. The recirculating passage is thus blocked so that operating pressure is maintained.

The pilot valve plunger controls the movement of the power piston by directing oil to and from the area beneath the power piston. The power piston, operating through the power piston pin and terminal lever, positions the terminal shaft to which the engine fuel linkage connects.

When the governor is running on-speed, the control land of the pilot valve plunger covers the control port of the ballhead bushing, and the power piston remains stationary.

If the engine load is increased, the governor speed decreases, and speeder spring force—now greater than the lifting effect of the centrifugal force developed by the rotating ballarms—pushes the pilot valve plunger down. Pressure oil is directed to the area under the power piston and pushes the piston up. The power piston and pin rotate the terminal lever and terminal shaft in the direction to increase fuel.

Note that, as the terminal lever rotates in the “increase fuel” direction, the speed droop pin is raised. The right end of the floating lever pivots about the speed adjusting lever pin as the left end of the lever is raised. Raising the left end of the floating lever raises the spring fork and decreases the speeder spring force. Thus, the governor ballhead is enabled to re-center the pilot valve plunger at lower speeds as fuel is increased, a characteristic described as “speed droop”. Closing the control port stops further movement of the power piston simultaneously with return of the engine to the lower speed, a speed determined by the new speeder spring force.

If the engine load is decreased, the governor speed increases and the ballarms lift the pilot valve plunger against the downward force of the speeder spring. The uncovered control port in the ballhead bushing connects the oil under the power piston to sump. The absence of pressure under the power piston allows the external spring force to rotate the terminal shaft and terminal lever in the “decrease fuel” direction.

When moving in the decrease fuel direction, the terminal lever lowers the speed droop pin. The floating lever lowers the spring fork to increase the speeder spring force. The increase in speeder spring force re-centers the pilot valve plunger, and requires an increase in speed to keep it centered. Closing the control port stops further movement of the power piston simultaneously with return of the engine to the higher speed required by the higher spring force.

The amount of speed change for a given terminal shaft rotation depends upon the setting of the speed droop pin. Moving the pin towards the ballhead decreases the speed change; moving it away from the ballhead increases the speed change.

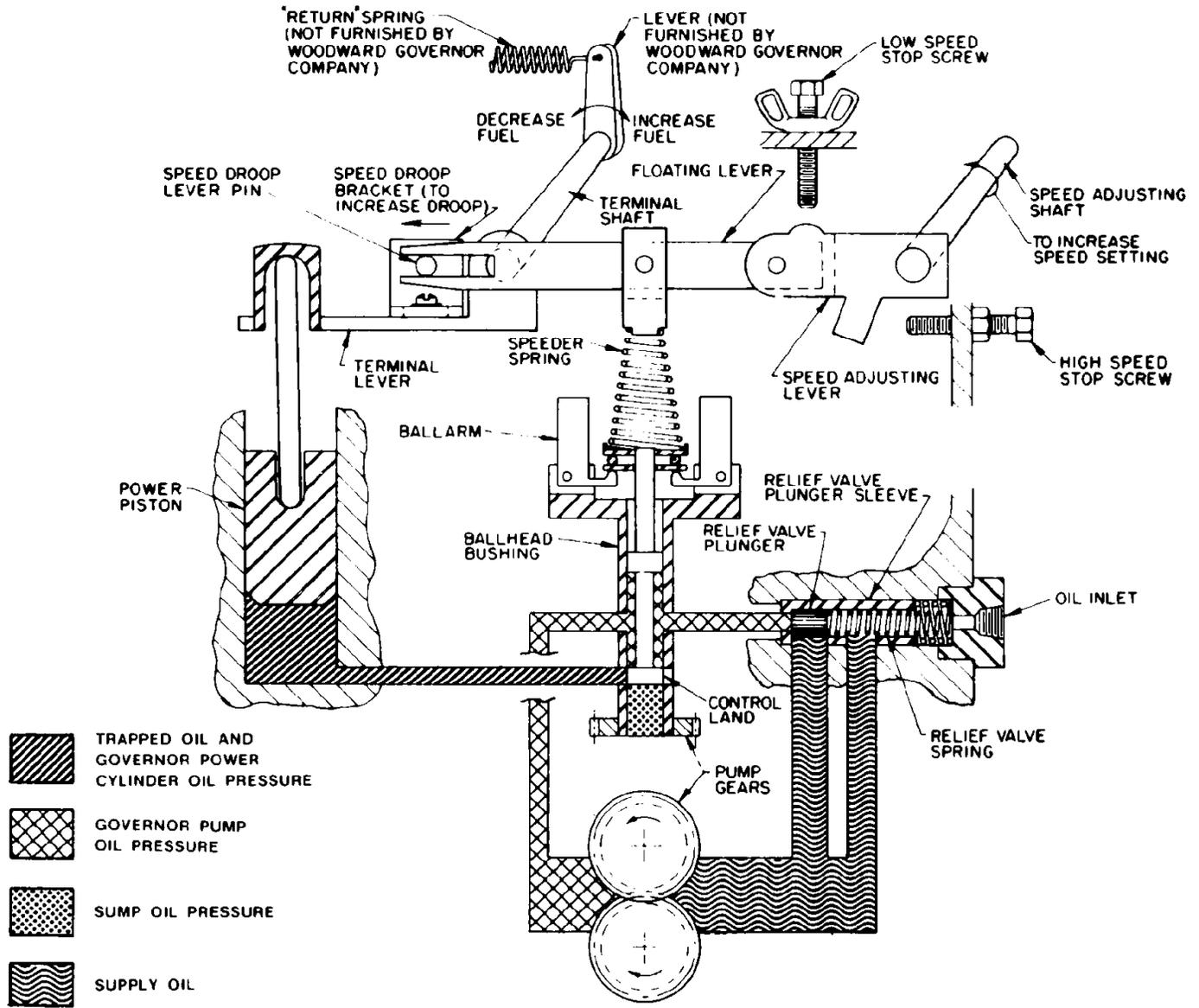


Figure 2-1. Schematic Diagram of a Typical SG Governor

Chapter 3. Installation and Adjustment

Installation

Introduction

These instructions apply to three types of SG governors differentiated by their speed settings:

- Lever
- Pneumatic
- Electric

Additional considerations for governors with pneumatic or electric speed setting are listed under respective headings.

Direction of Rotation

Rotation of the governor drive shaft as viewed from the top of the governor must be the same as that of the engine drive when looking down on the mounting pad.

When the governor is to be rotated clockwise (when viewed from above), the governor relief valve assembly must, when viewing the governor from the nameplate end, be on the left.

When the governor is to be rotated counterclockwise (when viewed from above), the governor relief valve assembly must, when viewing the governor from the nameplate end, be on the right.

NOTICE

Be sure engine mounting-pad drive and governor drive rotation are the same. Incorrect drive rotation will cause the governor to become inoperative and may cause governor damage.

Place a gasket between the base of the governor and the engine mounting pad. Mount the governor square with the engine drive and in line with the linkage. The splined drive shaft must fit the engine drive freely with no tightness. Do not force the governor onto the mounting pad.

NOTICE

Be sure the gasket does not block off the three drain holes in the base. See Figures 5-10, 5-11, and 5-12.

Oil Supply

Connect a 0.250 inch ID oil supply line to the 0.125 inch pipe-tapped hole in the relief valve. Oil from the engine must supply a minimum of 5 psi (34 kPa) to the governor. If a separate sump is used, the distance the governor must lift the oil should not exceed 12 inches (30 cm), and a foot valve with a capacity of 2 US gallons per minute (7.6 L/min) must be used. Use a 2 USgal/min (7.6 L/min), 40 µm filter in the oil supply line. In suction lift applications, the filter must not be in series with the inlet line to the governor. Keep oil lines as short as possible.

If mounted horizontally, the terminal shaft must also be horizontal and a 3/8 inch external drain line provided to connect to either a 1/4-inch pipe tapped hole or 0.438-20 (-4) straight-thread port in the lower end of the governor cover or subcap. See Figure 5-12 to connect the drain to the new style cover when the governor is mounted horizontally.

Use a supply system similar to Figure 3-1 for applications requiring quick starts.

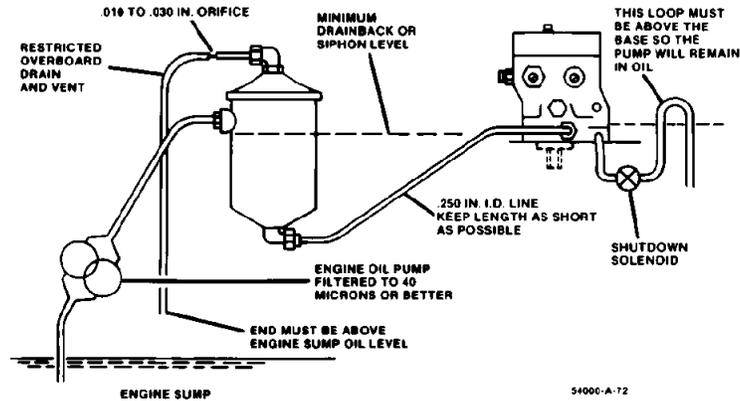


Figure 3-1. Recommended Engine Oil System for Quick Starts

Minimum drainage or siphon level is that oil level in the governor below which the governor pump gears are no longer submerged in oil. Oil level in the oil tank must always be as high as, or higher than, this line. If not, governor pump gears are no longer submerged in oil and will cavitate when the prime mover is started, causing possible loss of governor control.

NOTICE

Most problems of mechanical hydraulic governors occur because of dirty oil. Be sure to use clean oil.

Keep the end of the overboard drain line above the engine sump oil level.

Most standard 1 to 2 quart housings (approximately 1 to 2 L), with filter omitted, can be adapted for this system.

Pneumatic Speed Setting

There are two types. The reverse acting increases speed with a decrease in air pressure, while the direct acting increases speed with an increase in air pressure.

The pneumatic speed-setting cover has two tapped holes for the oil reservoir. Use one of the two holes for the reservoir and plug the other. Always mount the oil reservoir with the hole for the air connection up. Be sure the other hole is plugged (see outline drawing, Figure 3-2 or 3-3). Install the governor on the engine. Using a funnel, fill the oil reservoir to approximately 3/8 inch (10 mm) from the top via the hole for the air connection in top of the reservoir.

Attach the air signal pressure line to the hole in top of the oil reservoir.

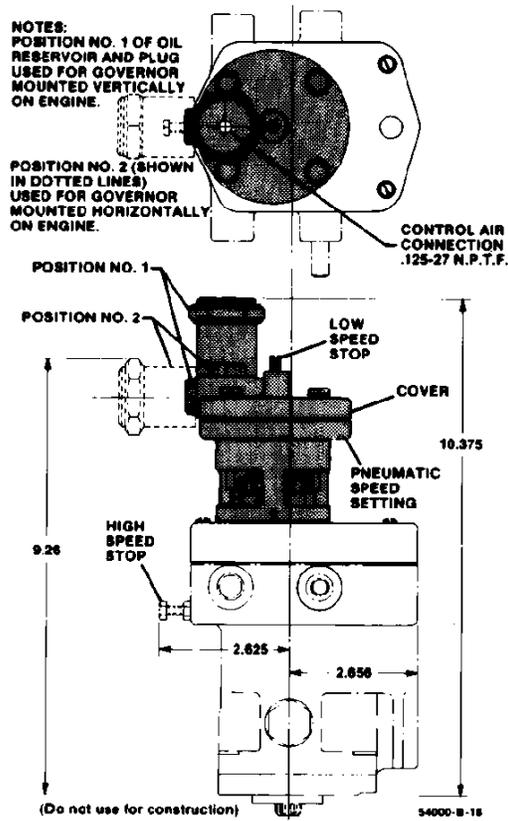


Figure 3-2. SG Governor Outline with Direct Pneumatic Speed Setting

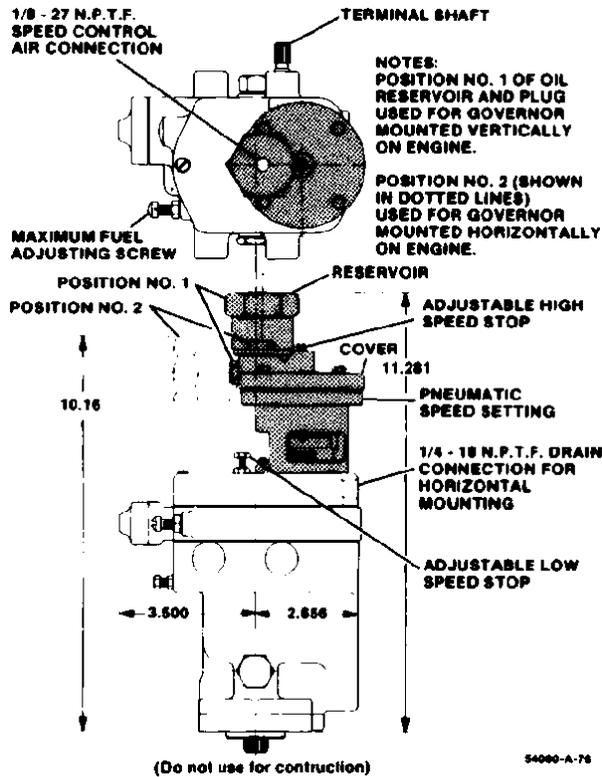


Figure 3-3. SG Governor Outline with Reverse Pneumatic Speed Setting

Electric Speed Setting

The Bodine motor and the PM motor are 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, thereby protecting the speed-adjusting motor.

Connect the electric speed setting as shown in Figure 3-5 or 3-6. Figure 3-5 is for the Bodine motor, and Figure 3-6 is for the PM motor. Voltage for the Bodine motor is shown on the motor.

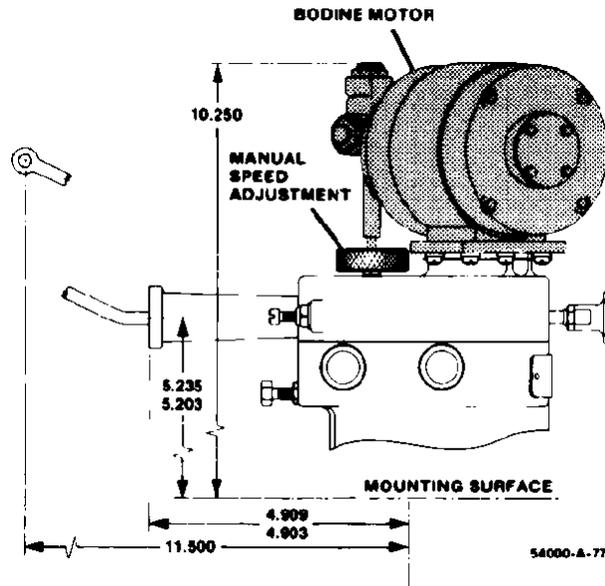


Figure 3-4. SG with Fuel Rod and Bodine Electric Motor for Speed Setting

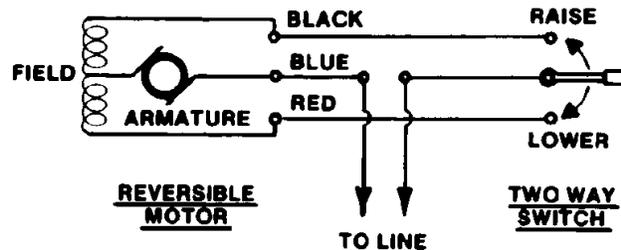


Figure 3-5. Wiring Diagram for Bodine Motor (Switch not furnished)

NOTICE

The permanent magnet motor operates on dc power. If a 115 or 230 Vac or Vdc power source is used, convert the power source to 24 to 32 Vdc. A converter can be ordered from Woodward. See Chapter 1, Speed Adjusting Motor.

Connect to correct voltage.

If a new cover and PM motor is ordered for use on an existing governor, all that is required to install the new cover is to remove the old cover and set the new assembly in place. If some adjustment is necessary, loosen the screws holding the PM motor in place and align the motor shaft with the clutch. Apply Loctite 242 or equivalent to the screws and tighten to 10 lb-in (1.1 N·m).

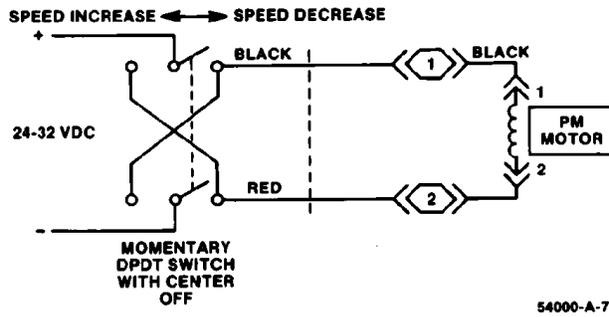


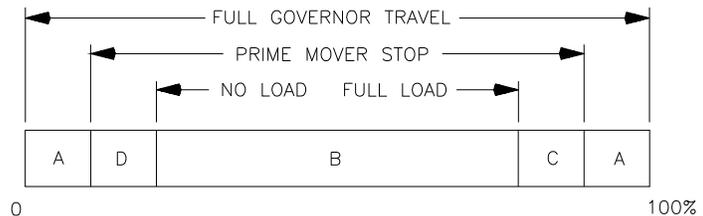
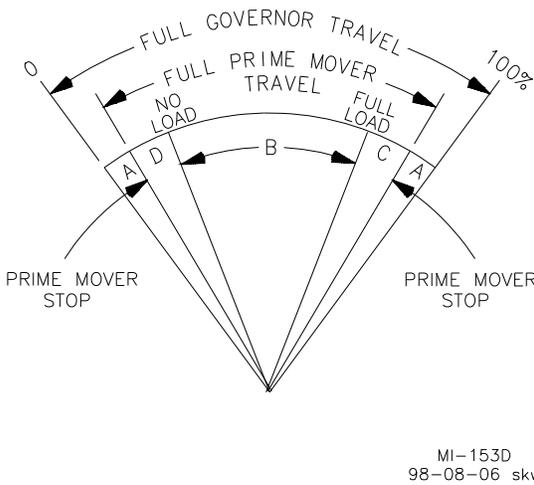
Figure 3-6. Wiring Diagram for PM Motor (switch not furnished)

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.

Linkage

Linear

Use a linear linkage for diesel-engine applications. Adjust the fuel linkage to provide control of engine fuel from the minimum to the maximum engine fuel stops. Use two-thirds of the output shaft travel between the fuel rack's no load and full load positions. See Figure 3-7 for recommended governor terminal shaft travel. Adjust the maximum-fuel-rack stop screw to obtain the maximum output rotation. Maximum rotation for vertical-return-spring governors is 40°. Maximum rotation for other units is 36°.



- A - OVERTRAVEL TO INSURE PRIME MOVER STOPS ARE REACHED.
- B - NO LOAD TO FULL LOAD TRAVEL - NORMALLY 2/3 OF FULL GOVERNOR TRAVEL IS RECOMMENDED.
- C - TRAVEL REQUIRED TO ACCELERATE THE PRIME MOVER.
- D - TRAVEL REQUIRED TO DECELERATE OR SHUT DOWN PRIME MOVER.

Maximum work capacity over full governor travel of 36 degrees is * ft-lbs. See above for recommended governor output travel. In special applications min and max prime mover stops may be outside the governor stops.

*-10.8 OR 21.7 IN-LB AT OPERATING PRESSURE OF 100 OR 200 PSI, RESPECTIVELY.

Figure 3-7. Recommended Governor Terminal Shaft Travel

Attach the fuel rack linkage to the governor output shaft. Be sure there is no lost motion or binding in the linkage. See Figure 3-8 for linear linkage arrangement.



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



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

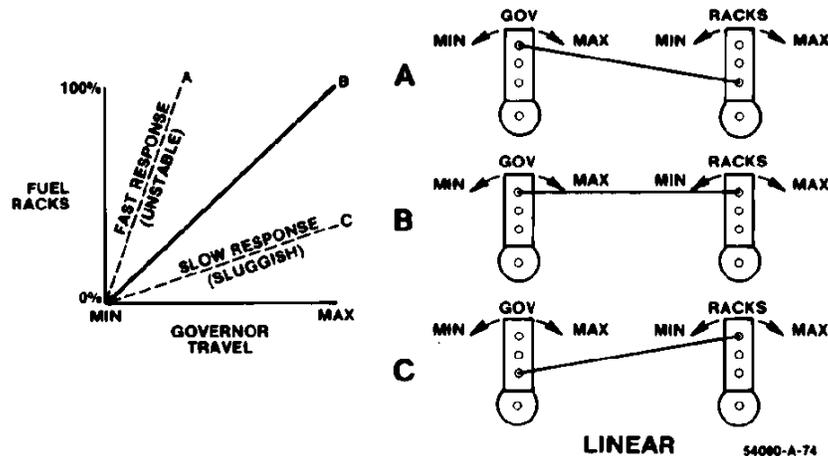


Figure 3-8. Linear Linkage Arrangement

Governor output can be with either terminal shaft or with fuel rod: connect linkage accordingly. Some subcaps with a fuel rod have a knob which can be pushed in to open the fuel racks when starting an engine, or pulled out to close the fuel racks and stop the engine.

Non-Linear

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

Figure 3-9 illustrates the relationship between governor output shaft and butterfly 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 and the connecting link is in line with the governor output shaft and the point of attachment of the connecting link to the butterfly lever.
2. The butterfly lever must be at 90 degrees with the connecting link.

Refer to the prime-mover manufacturer's manual for the correct linkage selection and installation.

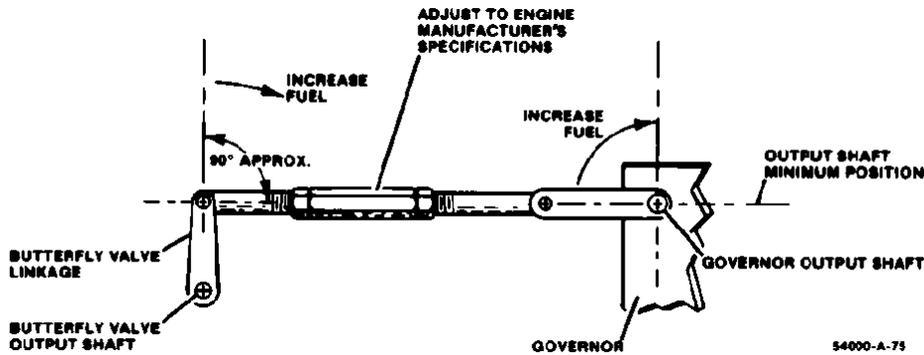


Figure 3-9. Non-linear Linkage Arrangement

Adjustment

Starting the Engine for the First Time

Start the engine as instructed by the engine manufacturer. For a safe start-up, adjust the governor for a reduced speed and allow the engine to warm up.

WARNING

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.

IMPORTANT

Make the following adjustments to the governor only if the engine does not stabilize. The governor was adjusted at the factory and should not require any adjustment.

Speed Droop Adjustment

(The cover must be removed to access the speed droop adjustment. Use caution if internal return springs are used. See Figure 5-1, part 15, or Figure 5-2, part 111.)

SINGLE ENGINE OPERATION—If engine speed does not stabilize, shut down the engine. Increase droop slightly (about 0.0625 inch [1.588 mm] movement of bracket away from the governor ballhead), and restart the engine. Manually move the engine fuel linkage to cause a temporary engine speed change. Continue to increase the droop until operation is satisfactory.

Not enough droop can cause instability in the form of hunting, surging, or difficulty in response to a load change. Too much droop can result in slow governor response in picking up or dropping off load.

OPERATING IN PARALLEL WITH OTHER ALTERNATORS—Droop is used to divide and balance load between units driving the same shaft or paralleled in the electrical system. If total load does not divide properly, increase droop on units taking too much of the load.

On interconnected units, set the least amount of droop possible to provide satisfactory load division.

IMPORTANT

The no load to full load speed change must be equal for all paralleled units.

Adjust the speed setting of SG governors or other governors with speed droop to get distribution of load between synchronized units. Increasing the speed setting of a particular unit will increase the load on that unit.

IMPORTANT

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

Normally, the amount of droop set into the SG governor to make it stable in a system will be enough to allow the units to parallel.

Troubleshooting

If engine hunts or surges:

- Adjust and align linkage, check for lost motion, binding, excessive friction, and linearity of load to governor travel.
- Increase speed droop.
- Make sure that the ballhead cavity is not full of oil. This could be a drain problem.

If engine speed increases as load increases:

- Increase droop slightly.

Load does not divide properly on interconnected engines:

This applies when load is increased or decreased. and speed setting is constant.

- Repeat speed droop adjustment.
- Check voltage regulator droop.
- Adjust droop to divide load properly.
- Increase droop to resist picking up (or dropping off) load.
- Reduce droop to increase picking up (or dropping off) load.
- Adjust droop and tighten screw securely.

Engine will not pick up rated full load:

- Adjust and align fuel linkage, check for lost motion, binding, excessive friction, and linearity of load to governor travel.
- Adjust maximum speed stop.
- Check speed-adjusting linkage, if present, for interference.
- Check for insufficient fuel flow.
- If engine is at maximum fuel stop and still cannot pick up rated full load, the problem is elsewhere in the system and not in the governor.

Governor oil overflows:

Make sure that oil flow through the two drain holes is not restricted by the gasket between the governor base and engine. See Figure 5-10 for drain holes.

Chapter 4. Overhaul

Introduction

The components of the SG governor have undergone substantial modification since first introduced. For this reason it is imperative that requests for information or parts for SG governors include:

- Governor model and serial number as shown on governor nameplate.
- Manual number (this is manual 04048).
- Part reference number and name or description of part.

Exploded views of the most recent and early versions of the SG governor are shown in Figures 5-1 and 5-2.

Disassembly Instructions

Governor

It is suggested that the best mechanic available—preferably one with small parts assembly experience—be assigned to all governor maintenance and repair work. Cleanliness of tools and work area is essential to a satisfactory overhaul of any governor. Aside from the usual hand tools, one would require only a pair of Waldes No. 2 external snap ring pliers. A work bench with vise, an arbor press, and containers for cleaning solvents should be provided.

If the governor is to be taken apart completely, proceed in this manner:

1. Clamp the governor lightly in a vise; vise jaws must grasp the base below the base-case joint on the sides under the terminal shaft.
2. Remove cover screws. Lift off cover. Use caution if a return spring is present.

At this point, inspection of the terminal lever (13, Figure 5-1, or 113, Figure 5-2) will reveal whether the governor is of the type shown in Figure 5-1 or Figure 5-2. The first number following in parenthesis identifies parts shown in Figure 5-1; the second number, parts shown in Figure 5-2.

3. Remove speed droop screw (10/109), washer(s) (11 and 12/110), and bracket (15/111).
4. Remove cotter pins (14/112) from terminal lever (13/113).
5. Remove long terminal shaft (37/136) and synthetic rubber seals (36/135).
6. Insert a 5/16-inch diameter rod in the opening left by the long terminal shaft and drive short terminal shaft (39/138) out; plug (32/139) will be forced out at this time.
7. Remove terminal lever (13/113) from the governor.

8. Make a note of the distance the high speed stop screw (29/128) protrudes from the governor case so that it can be set approximately the same when reassembling. Remove stop screw (29/1 28), locknut (30/129), and washer (31/—).
9. Remove speed adjusting shaft (35/134) as follows:

Figure 5-1—

- A. Using a 1/8-inch diameter punch or rod, drive roll pin (26) out of speed adjusting lever (27) and into the governor case.
- B. Pull speed adjusting shaft (35) out of the case.
- C. Lift out the assembly consisting of speed adjusting lever (27), pilot valve plunger (20), thrust bearing (21), and connecting parts. Remove torsion spring (34).

IMPORTANT

If the governor is equipped with a spring-driven ballhead, see Figure 5-8 or 5-9. Parts are not available for the ballhead shown in Figure 5-9.

On those governors in which the speed adjusting shaft does not stick out through governor case, remove shaft as follows:

- D. Drive roll pin (26) out of speed adjusting lever (27) as in step A above.
- E. Remove spring wire pin (28) and lift out floating lever (25), pilot valve (20), thrust bearing (21), and connecting parts.
- F. Using a soft (brass) rod against the speed adjusting lever—hold the rod against either side of lever as close to the shaft as possible—drive lever (27) and bushing (33) out until welch plug (32) pops out of case.
- G. Insert a 5/16-inch diameter rod in the hole left by the welch plug and drive the speed adjusting shaft back in the other direction, knocking the other welch plug out.
- H. Pull the shaft out, removing speed adjusting lever (27) and torsion spring (34) as the shaft is withdrawn.

Figure 5-2—

- A. Unscrew speed adjusting sleeve (133) and spacer cap (130)—each with a copper gasket (131).
 - B. Lift out the assembly consisting of speed adjusting shaft (134), pilot valve (118), thrust bearing (119), and connecting parts.
 - C. Remove cotter pin (124) and speed adjusting shaft (134) from assembly just removed.
10. Disassemble speed adjusting lever (27/126), floating lever (25/125), and spring fork (18/116) by twisting off the bent end of spring wire pin (28/123).
 11. Remove plug (41/141) opposite the relief valve assembly and copper gasket (42/131).

12. Remove relief valve assembly as follows:

Figure 5-1—

- A. Remove oil inlet plug (47) and copper gasket (42).
- B. Remove springs (46 and 45).
- C. Remove relief valve plunger (60) and sleeve assembly (43).

IMPORTANT

If the plunger and sleeve cannot be removed easily with a small pair of long-nosed pliers (or tweezers) and a hook scribe, leave them in place until step 17.

Figure 5-2—

- D. Remove relief valve sleeve (146) and copper gasket (131). The sleeve contains the other elements of the relief valve assembly.
13. Remove the governor from the vise and invert it, catching, in—
- Figure 5-1—**power piston pin (16), power piston (17), and roll pin (26) (driven out of speed adjusting lever earlier);
- Figure 5-2—**power piston (114).
14. If the governor has a spring-driven ballhead assembly (Figure 5-8 or 5-9), remove snap ring (306/324) under the ballarms (310/329) and lift out the ballhead (311/328).
15. Remove snap ring (S7/157) or collar (—/159) from drive shaft. Lift out ballhead assembly (22, 23, 24, Figure 5-1; 120, 121, 122, Figure 5-2; 306 through 314, Figure 5-8). Remove press-fit collar (—/159) by driving the shaft into the base using a plastic or other soft hammer.
16. Remove three screws (58/155), and remove governor base (55/154). If the base does not separate easily from the case, clamp the base, governor nameplate side of case up, lightly in a vise. Using a plastic or soft hammer, tap the underside of the case to loosen it from base.

NOTICE

Hold a hand under the base-case joint to catch the pump gears which may drop out as the base and case are separated.

Remove pump gears (52, 53/151, 152) and seal ring (54/153).

17. If the relief valve sleeve and plunger (Figure 5-1) could not be removed in step 12C, insert a 3/16-inch diameter rod in the tapped hole opposite the relief valve opening, push plunger (60) out, and pull out the sleeve assembly (43).

Case

If necessary to replace the idler gear stud, terminal sleeves, oil seals, or bushings, proceed as follows:

Figure 5-1—

1. Clamp idler gear stud (51) in a vise. Twist and pull the case to remove the stud.

NOTICE

Be careful not to score the bottom surface of the case.

2. Drive out plugs (32) and bushings (33 and 38) using a 3/8-inch diameter rod and a piloted driving block similar to that shown in Figure 4-1. In each instance, drive the bushings outward (rather than towards the center of the case).

Figure 5-2—

3. Remove idler stud (150) as outlined in step 1 above.
4. Drive terminal sleeves (137) out of case. Use the piloted driving block shown in Figure 4-1, or insert a 5/16-inch diameter threaded rod through one side of the case, install a nut, and drive out the sleeve.
5. Remove synthetic rubber seals (135) if not already taken out.
6. Press bushings (132) out of sleeves (137) if worn.

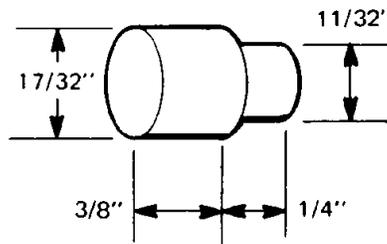


Figure 4 1 Bushing Driver

Spring Fork, Speeder Spring, and Pilot Valve Plunger

Figure 5-1 or 5-2—

1. Twist speeder spring (19/117) to detach from pilot valve plunger (20/118).
2. Clamp spring fork (18/116) in a vise with the pin hole up. Using a thin screwdriver or small punch, drive the speeder spring off the fork.
3. On some early modal governors (Figure 5-2), pilot valve plunger (161) may be pressed out of spring seat (160). The pilot valve plunger and spring seat are one piece in Figure 5-1.

Figure 5-8—

4. Twist speeder spring assembly (301) to detach from spring seat (304). The speeder spring and spring fork are a bonded assembly and must not be disassembled. Replace the assembly if the bond has separated.
5. Do not disturb the position of, or remove spring seat (304) from, pilot valve plunger (305) unless replacement of parts is necessary. Should the relationship of these parts be disturbed for any reason, the pilot valve plunger must be re-centered in the bushing at time of reassembly. If disassembly is necessary, hold the pilot valve plunger with a screwdriver while loosening the nut.

Relief Valve

Previous steps have removed the relief valve elements of governors shown in Figure 5-1.

1. The relief valve assembly in Figure 5-2 will have either plunger (162) or bushing (142) and plunger (143).
2. To remove plunger (162), insert long-nosed pliers in the end of the sleeve, push the plunger down, and grip pin (145). Slide the pin out and remove the plunger and spring (144).
3. To remove bushing (142) and plunger (143), insert a small sharp chisel in the end of the bushing. With a sharp blow, cut pin (145). Remove the broken pin. Insert a small rod in the threaded end of the relief valve and push out the bushing, plunger, and spring (144).

Ballhead Assemblies

SOLID BALLHEAD ASSEMBLY—Grind off one end of ballarm pins (23/121 or 164) to remove ballarms.

SPRING-DRIVEN OIL-DAMPED BALLHEAD ASSEMBLY (FIGURE 5-8)

1. Remove snap ring (306) under ballarms (310) and then pull pilot valve bushing (307) out of the ballhead.
2. Support drive cup (314) on a 1 or 1-1/8-inch (25 or 29 mm) diameter pipe or wooden dowel and press off ballhead cover (308). Use a 3-inch (76 mm) long pipe or tube machined to 2.150 (+0.005–0.000) [54.61 (+0.13–0.00) mm] inside diameter and a depth of 0.750 inch (19.05 mm) as a pusher.
3. Lift off ballhead (311) and remove pins (309) and ballarms (310).
4. Remove torsion spring (312) and ball bearing (313) from drive cup (314).

SPRING-DRIVEN BALLHEAD ASSEMBLY (FIGURE 5-9)

This ballhead has been replaced by the oil damped version shown in Figure 5-8. Spare parts are no longer available.

1. Remove spiral retaining ring (323).
2. Remove ballarm pins (326) and ballarms (329).
3. Lift the centering spring coupling assembly (325) out of ballhead (328).

Repair

Most repair work consists of cleaning and polishing of parts. Use 320 to 500 grit emery cloth for polishing. All pistons should move freely without binding or catching. Excessive clearance between mating parts, however, will result in excessive leakage of pressure oil within the governor.

Pilot Valve Plunger

Be extremely careful when polishing the pilot valve plunger control land. Leave the corners sharp. Broken or rounded corners on this land will ruin the pilot valve plunger.

Case

If the ground bottom surface of the case is grooved or worn from rotation of the pump gears, or scratched from mishandling, it may be surface ground to clean-up. Up to 1/32 inch (0.79 mm) material may be removed. Lap the surface smooth on a flat plate if a surface grinder is not available.

Base

If the ground flat surface of the base is warped, nicked, or deeply scratched, it may be lapped smooth on a flat plate. Do not remove more material than necessary to clean-up. If the depth of the gear pockets is reduced, the gears will bind. In this event, the faces of the gears must be lapped to provide clearance.

Pump Gears

The pump gears should be laid in the gear pockets and tested for free rotation. If the gears turn roughly, inspect for nicks or wear of gear teeth and for interference at the internal corners of the gear pockets in the base.

Assembly Instructions

Handle parts with care during assembly. In general, the assembly procedure is the reverse of the disassembly operation. Assembly suggestions follow.

Case

Figure 5-1—

If necessary to install new bushings (33 and 38), press the bushings in with an arbor press to the dimensions shown in Figure 4-2. Press in the idler gear stud to the depth shown in Figure 4-2.

After installing the bushings, line size or line ream with standard 3/8-inch diameter line reamer.

Figure 5-2—

Press bushings (132) in flush with small end of terminal sleeves (137). Press the terminal sleeves into the case; sleeve shoulder to be tight against case. (Insert a support plate of exactly the correct width between the inside walls of the case.) Press in the gear stud. The stud should project 3/8 inch (9.5 mm) out of the case.

Press bushings (132) in flush with each end of speed adjusting sleeve (133).

After installing the bushings, line size or line ream with standard 3/8-inch diameter line reamer.

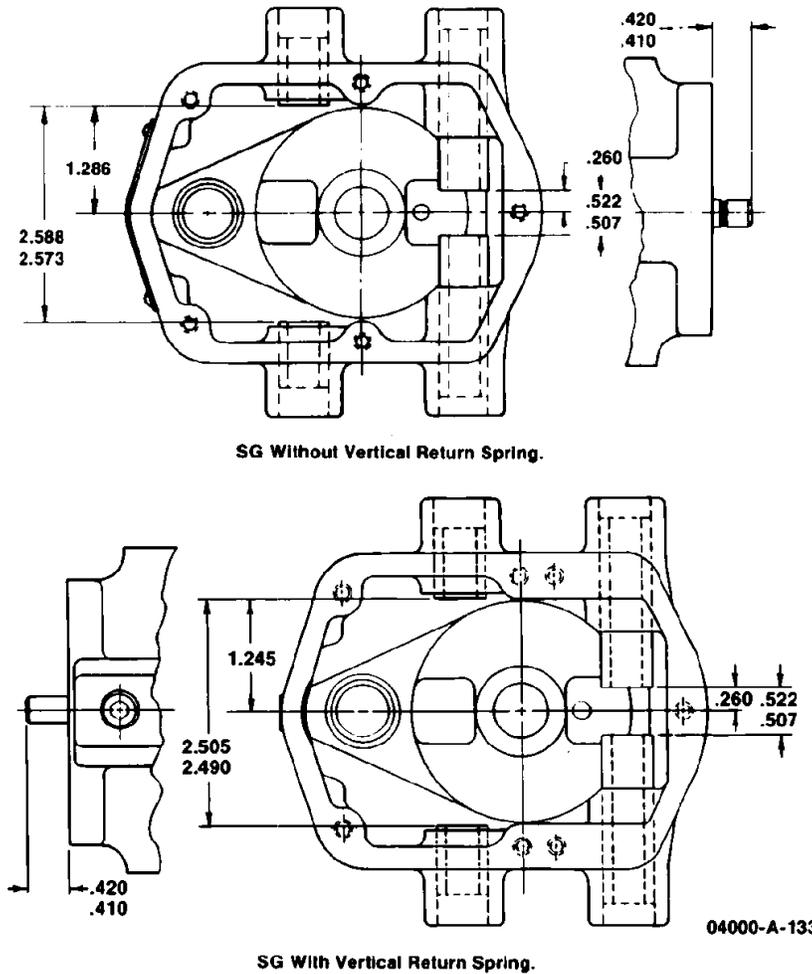


Figure 4-2. Bushing and Gear Stud Replacement

Ballhead Assemblies

SOLID BALLHEAD ASSEMBLY (FIGURE 5-1 or 5-2)—Use new ballarm pins (23/121) and lightly upset each end to retain in position.

SPRING-DRIVEN OIL-DAMPED BALLHEAD ASSEMBLY (FIGURE 5-8)—Reassemble ballhead components (309 through 314) and then press on ballhead cover (308). A minimum force of 90 pounds (400 N) should be required to reinstall a used cover, or a minimum of 100 pounds (445) for a new cover. The top edge of the cover must be flush with the top surface of the ballhead. If the cover is pressed too far, it will bind on the drive cup and result in erratic or no vibration dampening. Take care not to bend or otherwise distort the base or walls of the cup.

Case and Base

Figures 5-1 or 5-2

1. Drive dowel pins (56/156) out of the base.
2. Place the pump gears in the gear pockets of the base.

3. Coat the surface of the base with oil. Do not use shellac.
4. Place base seal ring (54/153) in the base groove. If gasket (158, Figure 5-2) is reused, it must not be torn or compressed to less than 0.003 inch (0.08 mm). If so, use a new 0.005-inch (0.13 mm) thick gasket. Do not tap out a new gasket with a hammer since this may round the sharp edges of gear pockets.
5. Place the case on the base, invert, and insert the ballhead-drive shaft assembly through the bottom of the base to permit rotation of the pump gears (the ballhead and ballarms now stick outside of the governor). On governors in which the drive shaft is integral with the pump drive gear, the shaft projects through the base to provide a means of rotating the pump gears.
6. Insert the base screws and tighten while turning the ballhead (or drive shaft) to ensure free rotation of gears.
7. Insert the dowel pins and drive them down approximately 1/16 inch (1.6 mm) below the base surface. Remove the ballhead drive shaft.
8. On governors using snap ring (57/157), place the ballhead and drive shaft assembly into position in the governor case. Use snap ring pliers to install the snap ring.

On governors using a drive shaft collar (159, Figure 5-2), clamp a 1 to 1-3/16 inch (25 to 30 mm) diameter sleeve or pipe having a 5/8 inch (15.9 mm) diameter bore upright in a vise. Place the ballhead-drive shaft assembly into position in the governor and slip the drive shaft collar over the drive shaft. Hold the governor on the sleeve with the drive shaft slipping into the 5/8 inch diameter hole with the collar resting against the sleeve. Place a 7/18 inch (9.9 mm) diameter brass rod on the ballhead between the ballarms, and drive the collar onto the drive shaft. Take the governor off the drive sleeve and lap the end of the drive shaft lightly with a plastic or soft hammer until the drive shaft turns freely with a minimum of end play.

9. Turn the drive shaft with your fingers. If it binds, loosen the screws slightly and free-up by striking at the corners of the base. Tighten screws and recheck.

Spring Fork, Speeder Spring and Pilot Valve Plunger

Figure 5-1 or 5-2

1. Reassemble spring seat and pilot valve plunger (160 and 161, Figure 5-2), if necessary.
2. Attach spring fork (18/116) to conical shaped speeder springs (19/117) by "winding" the fork into the spring.
3. Wind the spring and fork assembly firmly into the spring seat on the pilot valve plunger (20/118).
4. Each end of speeder spring must be securely attached to its mating part.

Figure 5-8—

5. Remove pipe plug (50, Figure 5-1; 149, Figure 5-2) 50 that the control land on the pilot valve plunger may be observed.
6. Assemble spring seat (304) and nut (303) on pilot valve plunger (305). Do not tighten the nut.
7. Install thrust bearing (302) and plunger in the case.
8. Push the plunger downward as far as possible, moving the ballarms to their innermost position.
9. Using a flashlight, observe the position of the upper edge of the control land on the plunger with respect to the metering port in the pilot valve bushing and note the amount of port opening (see Figure 4-3, A).
10. Hold the plunger in contact with the toes of the ballarms while pushing the ballarms to their outermost position. Observe the position of the lower edge of the plunger control land with respect to the metering port and again note the amount of port opening (see Figure 4-3, B).
11. Openings A and B should be equal within 0.010inch (0.25 mm) or as nearly as can be determined by visual observation.

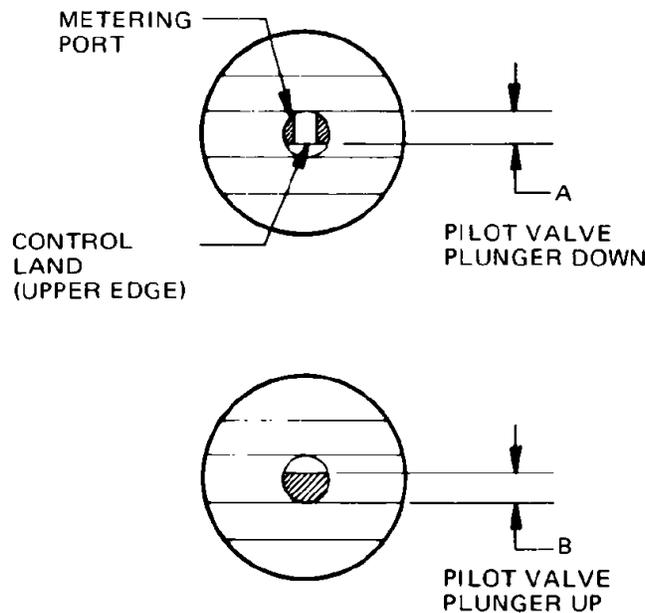


Figure 4-3. Centering Pilot Valve Plunger

12. If openings A and B are not approximately equal, hold the spring seat stationary and turn the plunger in or out as required. Tighten the plunger nut and recheck the centering adjustment. Readjust, if necessary.
13. Remove the plunger from the case and “wind” the speeder spring assembly (301) firmly into the spring seal on the plunger. Reinstall the plunger in the case.
14. Reinstall the pipe plug using a thread-sealing compound.

Relief Valve

Figure 5-1—

Be sure relief valve plunger (60) moves freely in relief valve sleeve (43) (plunger installed with small diameter towards inside of governor). The sleeve must fit freely into the case bore.

Figure 5-2—

Plunger (143 or 162) must move freely in sleeve (146). If of the type using bushing (142), rotate the bushing 90° from the previous alignment, press in flush with the end of the sleeve, and drill a 1/16 inch (1.6 mm) diameter hole for new pin (145). Use pin holes in relief valve sleeve (146) as pilot holes when drilling the bushing.

Chapter 5. Parts Information

When ordering replacement parts it is essential that the following information be given.

- Governor model, serial number, and part number (shown on nameplate); needed since a manual reference number does not identify the exact part required for any one governor.
- Manual number (this is manual 04048).
- Part reference number as given in the parts list, figure number showing part, and name or description of part.

Figures 5-1 and 5-2 illustrate the most common versions of the SG governor. Figures 5-3 through 5-9 illustrate the various optional features which may be used with these governors.

Parts List, Figure 5-1

Ref. No.	Part Name	Quantity	Ref. No.	Part Name	Quantity
04048-1	Cover	1	04048-31	Copper washer.....	1
04048-2	Low speed stop screw	1	04048-32	Welch plug	AR
04048-3	Hex. nut. 1/4-28	1	04048-33	Bushing	2
04048-4	Vent screw	1	04048-34	Torsion spring	1
04048-5	Lockwasher.....	1	04048-35	Speed adjusting shaft	1
04048-6	Pipe plug, 1/4.....	1	04048-36	Oil seal.....	AR
04048-7	Sems fastener, 10-32 x 1.....	3 or 5	04048-37	Terminal shaft (Long).....	1
04048-8	Not used		04048-38	Bushing	2
04048-9	Cover gasket.....	1	04048-39	Terminal shaft (Short)	1
04048-10	Fil. hd. screw, 10-32 x 1/2.....	1	04048-40	Case.....	1
04048-11	Shakeproof washer, #10.....	1	04048-41	Plug.....	1
04048-12	Washer	1	04048-42	Copper gasket.....	2
04048-13	Terminal lever.....	1	04048-43	Relief valve sleeve assembly.....	1
04048-14	Cotter pin, 3/32 x 1	2	04048-44	Deleted	
04048-15	Speed droop adjusting bracket.....	1	04048-45	Relief valve plunger spring.....	1
04048-16	Pin.....	1	04048-46	Relief valve sleeve spring	1
04048-17	Power piston	1	04048-47	Oil inlet plug	1
04048-18	Spring fork	1	04048-48	Nameplate.....	1
04048-19	Speeder spring	1	04048-49	Drive screw, #2	2
04048-20	Pilot valve plunger	1	04048-50	Pipe plug, 1/8	1
04048-21	Thrust bearing.....	1	04048-51	Idler gear stud.....	1
04048-22	Ballarm.....	2	04048-52	Idler gear.....	1
04048-23	Ballarm pin.....	2	04048-53	Drive gear	1
04048-24	Ballhead—Pilot valve bushing	1	04048-54	Base seal ring	1
04048-25	Floating lever	1	04048-55	Base	1
04048-26	Roll pin.....	1	04048-56	Dowel pin	2
04048-27	Speed adjusting lever	1	04048-57	Snap ring.....	1
04048-28	Spring wire pin.....	1	04048-58	Fil hd. screw, 10-24 a 1/2.....	3
04048-29	High speed stop screw, 10-32 x 1-1/4	1	04048-59	Deleted	
04048-30	Nut, 10-32	1	04048-60	Relief valve plunger	1

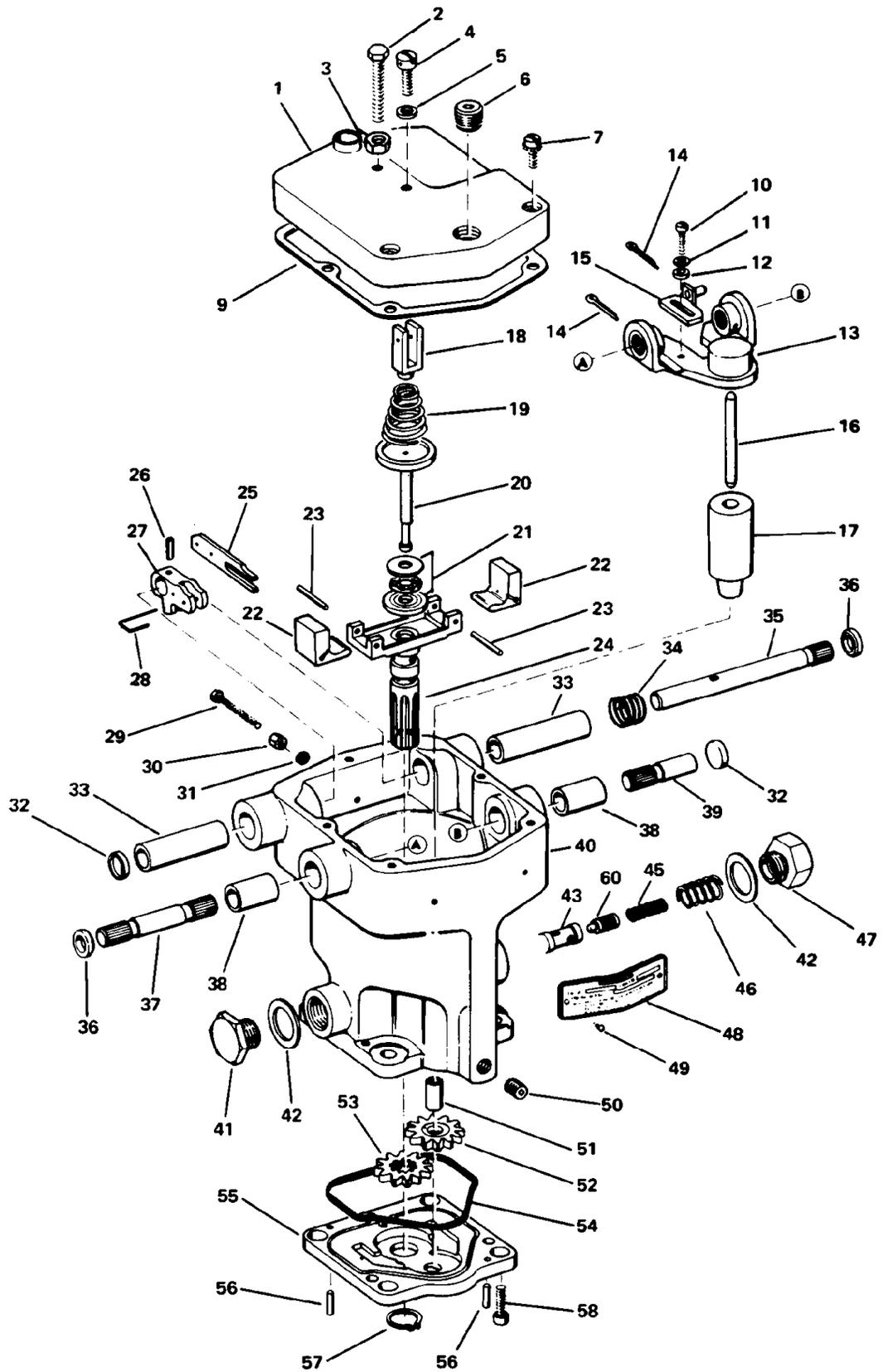


Figure 5-1. Typical SG Governor Parts (later models)

Parts List, Figure 5-2

Ref. No.	Part Name	Quantity	Ref. No.	Part Name	Quantity
04048-101	Cover	1	04048-133	Speed adjusting sleeve	1
04048-102	Low speed stop screw	1	04048-134	Speed adjusting shaft	1
04048-103	Hex, nut, 1/4-28	1	04048-135	Synthetic rubber seal	4
04048-104	Vent screw	1	04048-136	Terminal shaft (Long)	1
04048-105	Lock washer	1	04048-137	Terminal sleeve	2
04048-106	Fil. hd. screw, 10-32 x 1	3	04048-138	Terminal shaft (Short)	1
04048-107	Shakeproof washer, #10	3	04048-139	Welch plug	1
04048-108	Cover gasket	1	04048-140	Case	1
04048-109	Hex. hd. screw	1	04048-141	Plug	1
04048-110	Washer	1	04048-142	Bushing	1
04048-111	Speed droop adjusting bracket	1	04048-143	Relief valve plunger	1
04048-112	Cotter pin	2	04048-144	Relief valve spring	1
04048-113	Terminal lever	1	04048-145	Pin	1
04048-114	Power piston	1	04048-146	Relief valve sleeve	1
04048-115	Pin	1	04048-147	Nameplate	1
04048-116	Spring fork	1	04048-148	Drive screw, #2	2
04048-117	Speeder spring	1	04048-149	Pipe plug, 1/8	1
04048-118	Pilot valve plunger	1	04048-150	Idler gear stud	1
04048-119	Thrust bearing	1	04048-151	Idler gear	1
04048-120	Ballarm	2	04048-152	Drive gear	1
04048-121	Ballarm pin	2	04048-153	Base seat ring	1
04048-122	Ballhead—Pilot valve bushing	1	04048-154	Base	1
04048-123	Spring wire pin	1	04048-155	Screw	3
04048-124	Cotter pin	1	04048-156	Dowel pin	2
04048-125	Floating lever	1	04048-157	Snap ring	1
04048-126	Speed adjusting lever	1	04048-158	Base gasket	1
04048-127	Pin	1	04048-159	Drive collar	1
04048-128	High speed stop screw	1	04048-160	Spring seat	1
04048-129	Nut	1	04048-161	Pilot valve plunger	1
04048-130	Spacer cap	1	04048-162	Relief valve plunger	1
04048-131	Copper gasket	4	04048-163	Ballarm pin washer	4
04048-132	Bushing	4	04048-164	Ballarm pin	2

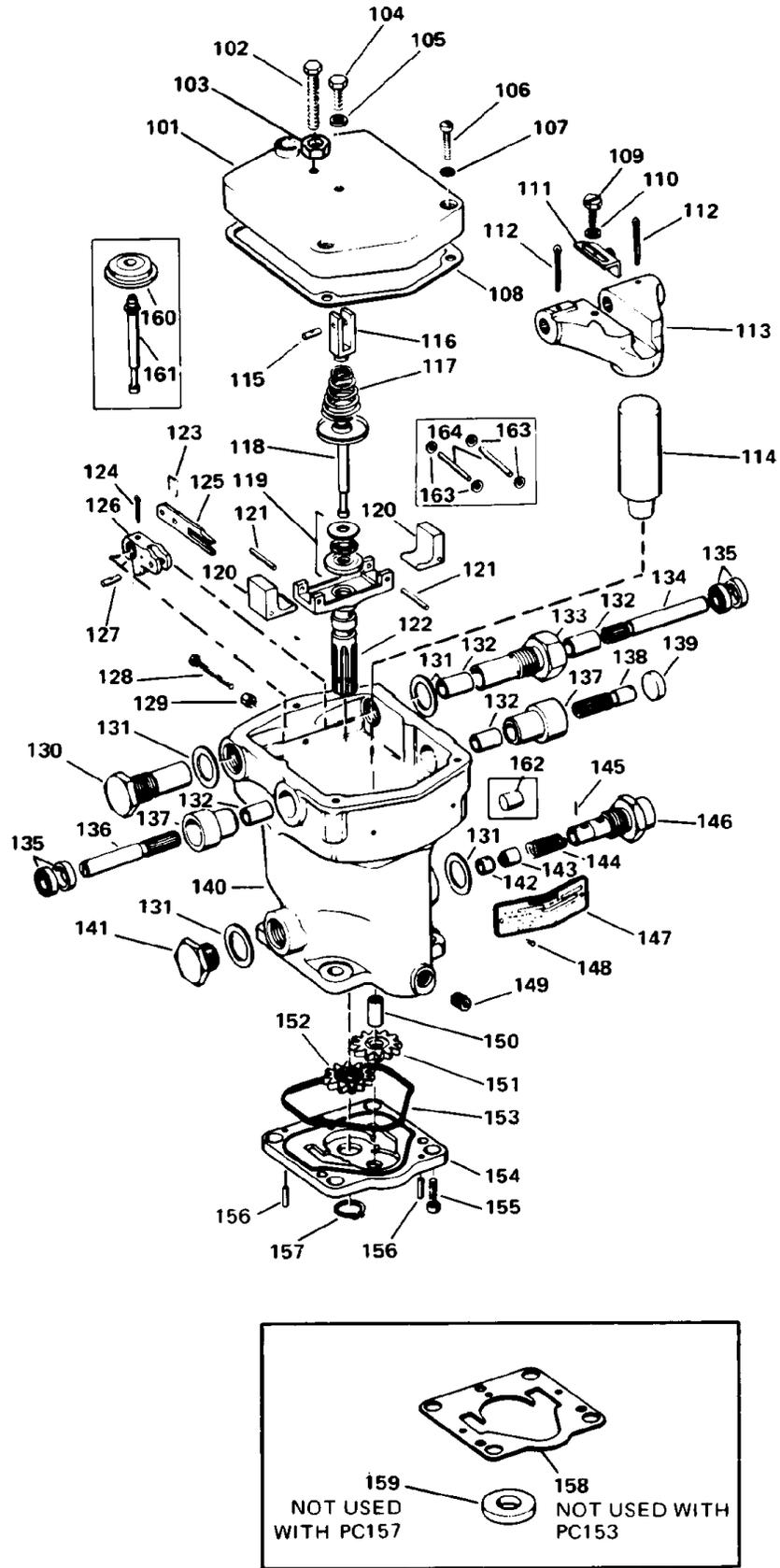


Figure 5-2. Typical SG Governor Parts (early models)

Cover Assembly with Bodine Speed Adjusting Motor

Adjustments

A friction coupling is incorporated in these cover assemblies to permit overtravel of the motor with no resulting damage. This coupling should be adjusted to slip at 4.5 to 5.5 lb-in (0.5 to 0.6 N·m) of torque. The motor must be mounted in such a manner as to center the shaft in the coupling. Full travel of the shaft in each direction should produce no binding.

Bearing Lubrication

Use Regal A oil or a good 10 weight oil for bearing lubrication. Under normal, intermittent operation, apply 5 drops of oil to the oil hole and oil cup every year. If the motor is run for long periods of time, apply 5 drops of oil to the oil hole and oil cup every six months.

Gear Lubrication

The speed reduction gear housing of a new motor is filled with sufficient lubricant to last for two years under normal, intermittent operation. Under extensive use, when the motor is run for long periods of time, the lubricant will last about one year.

To replace grease, clean out the old grease and refill the gear housing 3/4 full of one of the following greases:

- Bodine
- Supermil Grease No. A72832, by Standard Oil Company
- Dow Corning Grease No, 44, when specified (temperature range is –40 to +400 °F/–40 to +204 °C).

Make sure the ball thrust bearing is reinstalled with the gearbox.

Parts List, Figure 5-3

Ref. No.	Part Name	Quantity
04048-201	Motor.....	1
04048-202	Friction cover	1
04048-203	Friction disc.....	1
04048-204	Friction spring	1
04048-205	Set screw, 6-32.....	2
04048-206	Speed adjusting screw.....	1
04048-207	Cover	1
04048-208	Copper washer, 0.203 x 3/8 x 1/32.....	1
04048-209	Fit hd. screw, 10-32 x 3/4	1
04048-210	Lockwire.....	1
04048-249	Micarta washer	1

Parts List, Figure 5-4

Ref. No.	Part Name	Quantity
04048-211	Motor brush.....	2
04048-212	Brush spring.....	2
04048-213	Worm shaft.....	1
04048-214	Bakelite gear	1
04046-215	Brushholder cap screw	2
04048-216	Brushholder.....	2
04048-217	Bronze gear	1
04048-218	End shield (Front)	1
04048-219	Gear housing	1
04048-220	Field frame assembly (Complete)	1
04048-221	Armature (Complete)	1
04046-222	Output shaft	1

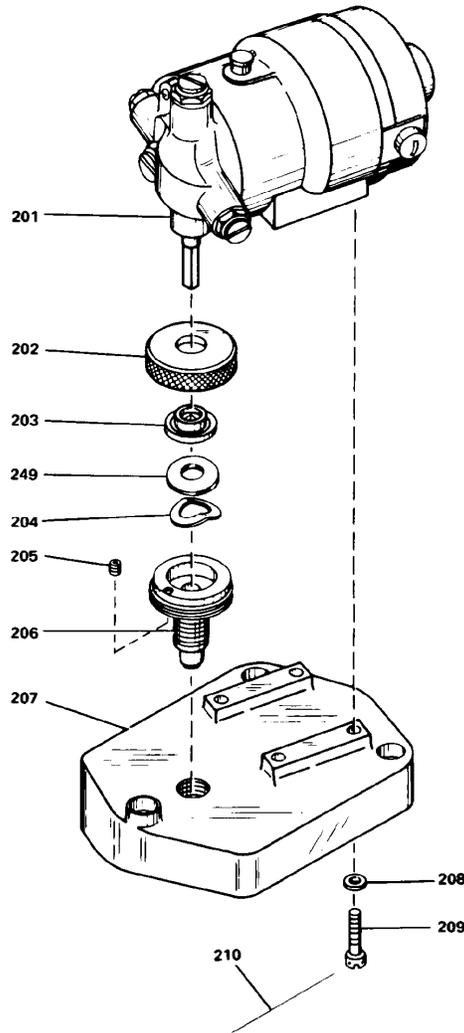


Figure 5-3. Bodine Speed Adjusting Motor and Installation Parts

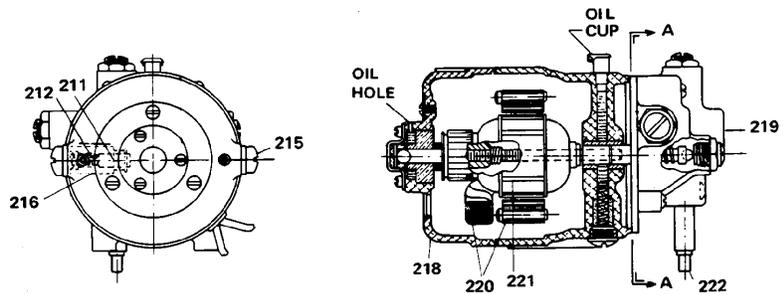
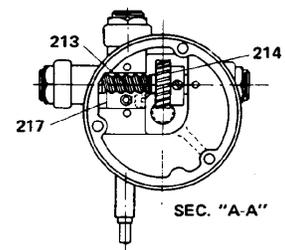
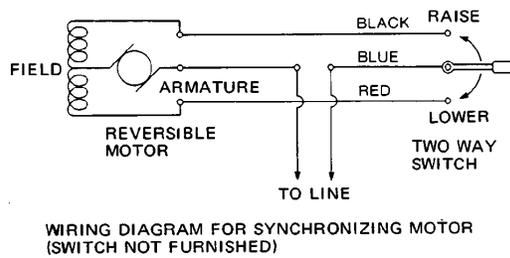


Figure 5-4. Speed Adjusting Motor Parts

Cover Assembly with Pittman PM Speed Adjusting Motor

Adjustments

A friction coupling is incorporated in these cover assemblies to permit overtravel of the motor with no resulting damage. This coupling should be adjusted to slip at 4.5 to 5.5 lb-in (0.5 to 0.6 N·m) of torque and be locked in place with set screw (205). The motor must be mounted in such a manner as to center the shaft in the coupling. Full travel of the shaft in each direction should produce no binding.

High-slip torque clutches use two springs (349) and are adjusted to 8 to 10 lb-in (0.9 to 1.1 N·m) slip torque.

Parts List, Figure 5-5

Ref. No.	Part Name	Quantity
04048-341	Screw	4
04048-342	Bracket.....	1
04048-343	Motor Cover	1
04048-344	Foam Buffer	1
04048-345	PM Motor	1

NOTE—Items 343, 344, and 345 are epoxied together as an assembly and are furnished that way only.

04048-346	Friction Clutch	1
04048-347	Friction Disc	1
04048-348	Washer	1
04048-349	Friction Washer Spring	1
04048-350	Speed Adjusting Screw.....	1
04048-351	Cover	1
04048-352	Seal.....	1
04048-353	Flat Washer.....	1
04048-354	Nut	1
04048-355	Stop Screw.....	1
04048-356	Set Screw.....	1

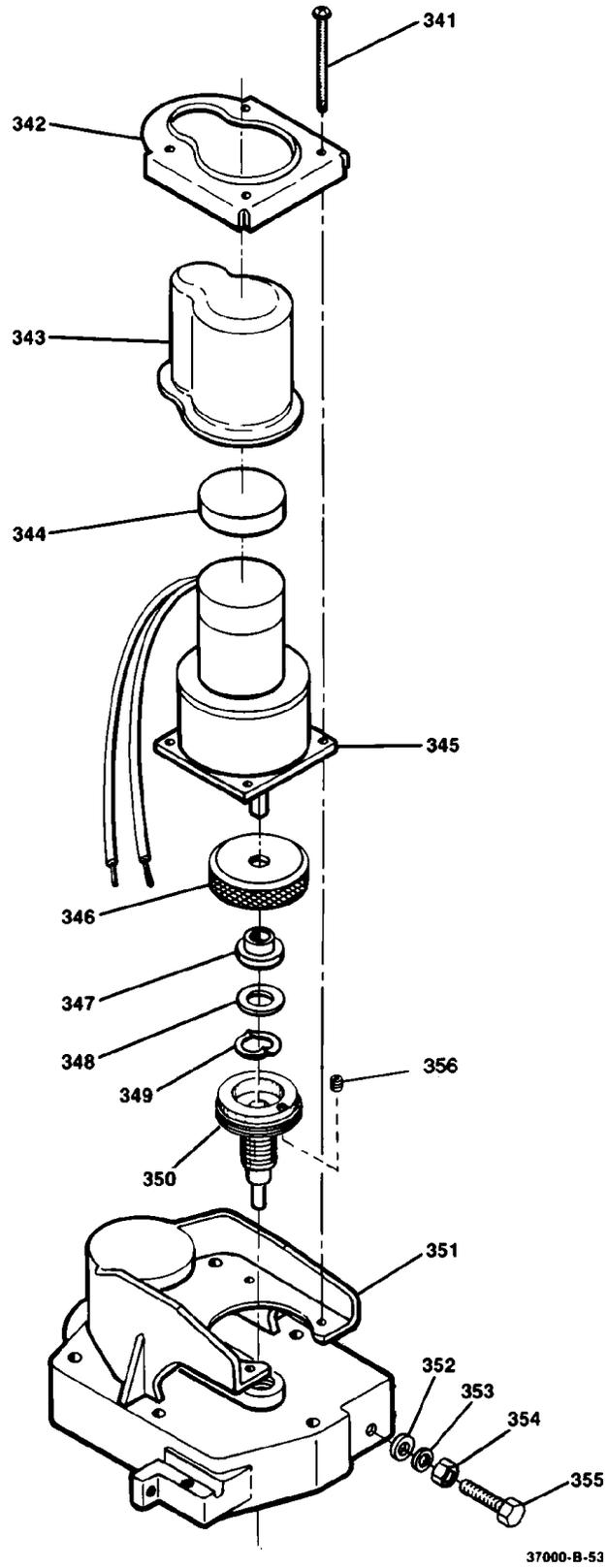
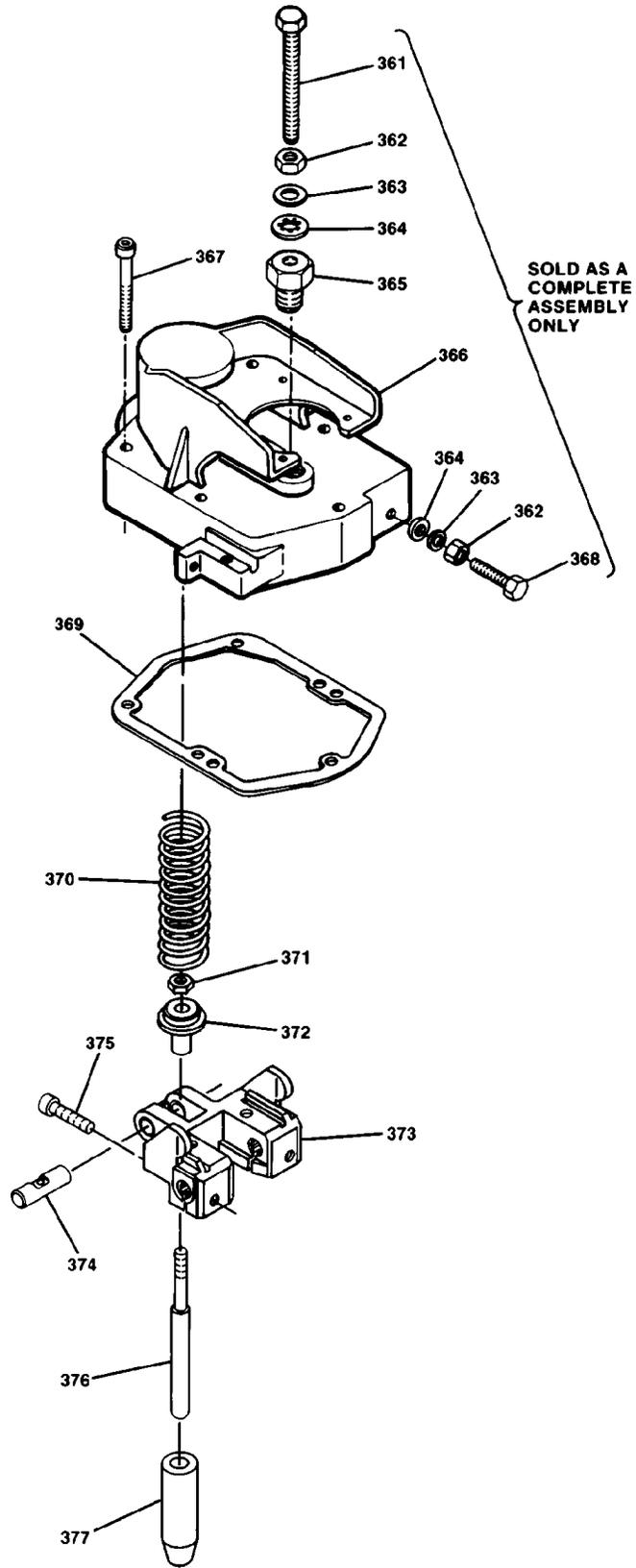


Figure 5-5. Pittman PM Speed Adjusting Motor and Installation Parts

Cover Assembly with Vertical Return Spring

Parts List, Figure 5-5a

Ref. No.	Part Name	Quantity
04048-361	Hex. screw, 250-28 x 2.250	1
04048-362	Hex. nut, .250-28, SS.....	2
04048-363	Washer, 265 x .500 x .032 thick, SS	2
04048-364	Seal, 1/4 Nitrite thread	2
04048-365	Plug, low speed guide.....	1
04048-366	Cover	1
04048-367	Soc. hd. cap screw, 10-32 x 1.500.....	5
04048-368	Hex. hd. stop screw, .250-28 x 3.000.....	1
04048-369	Gasket	1
04048-370	Spring, vertical return.....	1
04048-371	Elastic hex. nut (thin), 10-32	1
04048-372	Spring seat.....	1
04048-373	Lever assembly.....	1
04048-374	Strut pivot pin	1
04048-375	Soc. hd. cap screw 10-32 x .875.....	2
04048-376	Servo-piston strut.....	1
04048-377	Servo-piston.....	1



04000-B-29

Figure 5-5a. Vertical Return Spring Cover and Installation Parts

Subcap Assemblies

The parts comprising typical subcap assemblies are shown in Figures 5-6 and 5-7. Except for the subcap assembly, the operation and construction of a governor equipped with a subcap are similar to the conventional governors described in preceding pages.

Governors with subcaps do not require an external spring acting in the shutdown direction since the subcap springs perform the same function.

The output of a governor with the subcap assembly shown in Figure 5-6 is at fuel rod (235) rather than at a terminal shaft. As in other model SG governors, the terminal lever (245) is rotated by the power piston movement as fuel changes are called for by the governor ballhead and pilot valve. The terminal lever pin (247), pushing against fuel rod collar (240), effects the movement of the fuel rod.

Maximum fuel to the engine is limited by the setting of stop screw (232) which limits the angular travel of the terminal lever.

The fuel rod spacer (243) is positioned by the setting of hex nut (242), and must be adjusted to match the engine linkage. The engine manufacturer's manual provides instructions for this adjustment. After the hex nut is properly set, use knob (241) to lock it in position.

Knob (241) provided on the front of the subcap assembly may be manually pushed in to open the fuel racks when starting, or pulled out to close the fuel racks and stop the engine.

Some governors are equipped with the subcap assembly shown in Figure 5-7. The purpose of this type of subcap assembly is to provide a spring force within the governor to urge the terminal lever in the "fuel off" direction.

Parts List, Figure 5-6

Ref. No.	Part Name	Quantity
04048-225	Some Fastener, fil hd., 10-32 x 1-3/8.....	5
04048-226	Cover	1
04048-227	Speed adjusting lever stop.....	1
04048-228	Gasket	1
04048-229	Subcap.....	1
04048-230	Screw, fil. hd., 10-32 x 1	2
04048-231	Lock washer, #10.....	2
04048-232	Stop screw	1
04048-233	Lock nut, 1/4-28	1
04048-234	Washer	1
04048-235	Fuel rod.....	1
04048-236	Plug.....	1
04048-237	Spring	1
04048-238	Fuel rod disc	1
04048-239	Spring	1
04048-240	Fuel rod collar	1
04048-241	Knob	1
04048-242	Lock nut, 10-32	1
04048-243	Fuel rod spacer.....	1
04048-244	Oil seal.....	1
04048-245	Terminal lever	1
04048-246	Cotter pin	2
04048-247	Terminal lever pin	1
04048-248	Gasket	1

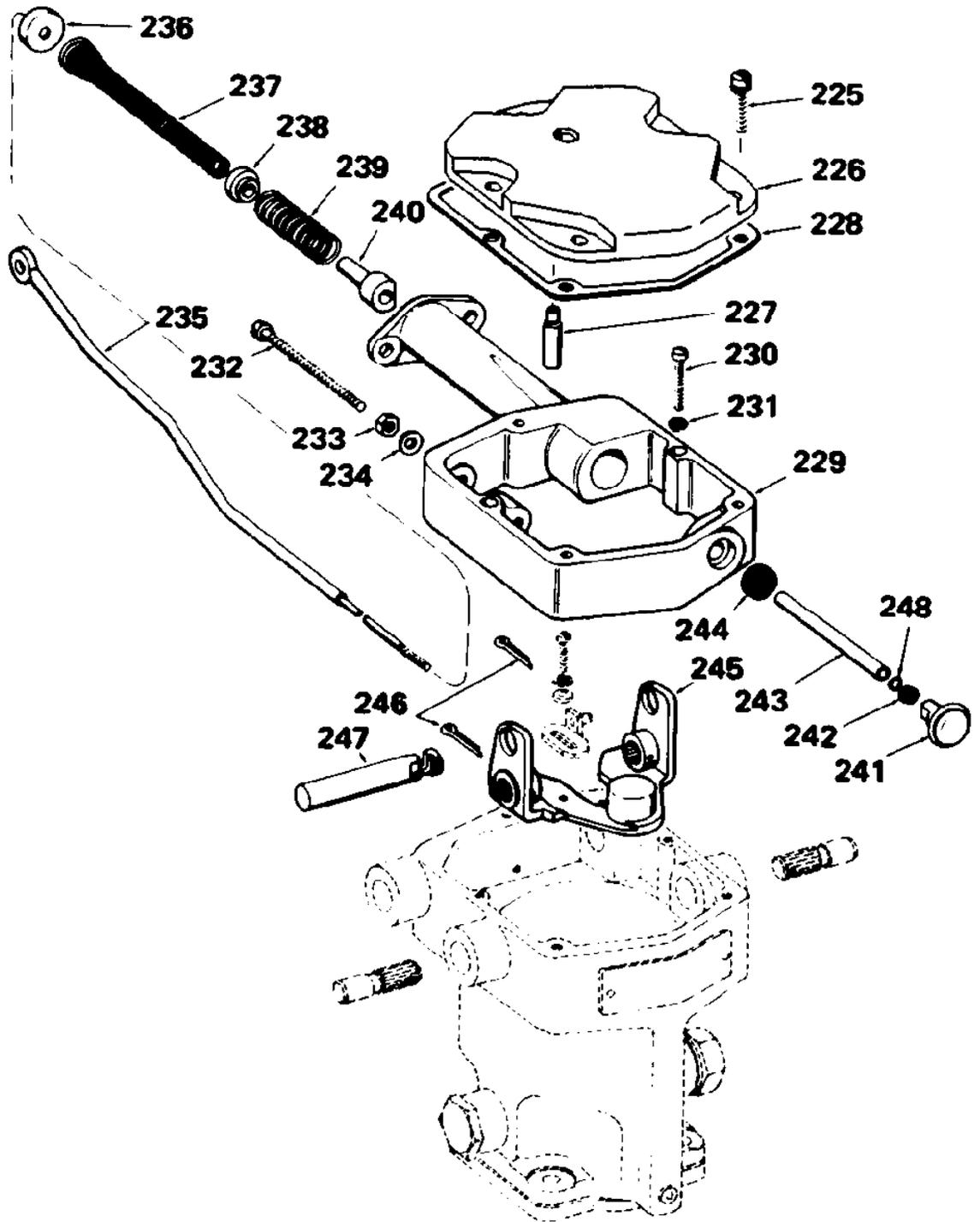


Figure 5-6. Subcap Assembly Parts (linear output)

Parts List, Figure 5-7

Ref. No.	Part Name	Quantity
04048-275	Vent screw	1
04048-276	Shakeproof washer, 1/4	1
04048-277	Sems fastener, fil. hd., 10-32 x 1-3/8	3
04048-278	Gasket	2
04048-279	Low speed stop screw	1
04048-280	Hex nut, 1/4-28	1
04048-281	Cover	1
04048-282	Screw, fil. hd., 10-32 x 1/2	2
04048-283	Lock washer, #10	2
04048-284	Spring pad cover	1
04048-285	Spring pad gasket	1
04048-286	Spring	1
04048-287	Guide rod spring seat	1
04048-288	Load limit screw	1
04048-289	Hex nut, 1/4-20	1
04048-290	Copper washer	1
04048-291	Screw Ill. hd., 10-32 x 1	2
04048-292	Lock washer, #10	2
04048-293	Subcap	1
04048-294	Spring guide rod	1
04048-295	Plug	1
04048-296	Terminal lever	1
04048-297	Cotter pin	2
04048-298	Terminal lever pin	1

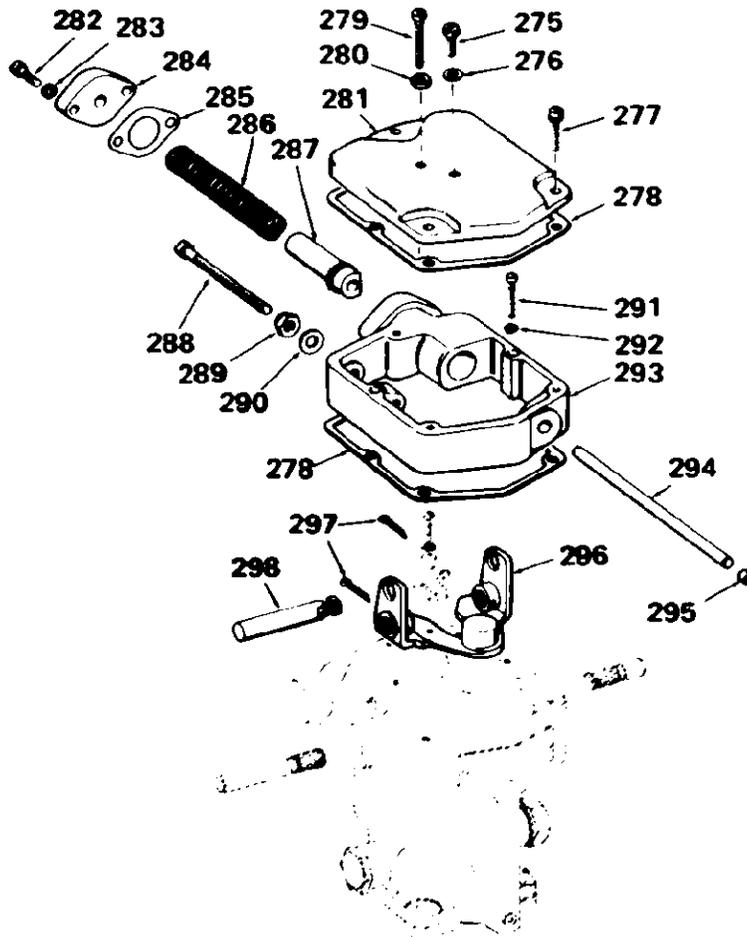


Figure 5-7. Subcap Assembly Parts (internal return spring)

Parts List, Figure 5-8

Ref. No.	Part Name.....	Quantity
04048-301	Speeder spring assembly	1
04048-302	Thrust bearing	1
04048-303	Plunger nut	1
04048-304	Spring seat	1
04048-305	Pilot valve plunger	1
04048-306	Snap ring	1
04048-307	Pilot valve bushing	1
04048-308	Ballhead cover.....	1
04048-309	Ballarm pin	2
04048-310	Ballarm assembly	2
04048-311	Ballhead	1
04048-312	Torsion spring.....	1
04048-313	Ball bearing	1
04048-314	Drive cup	1

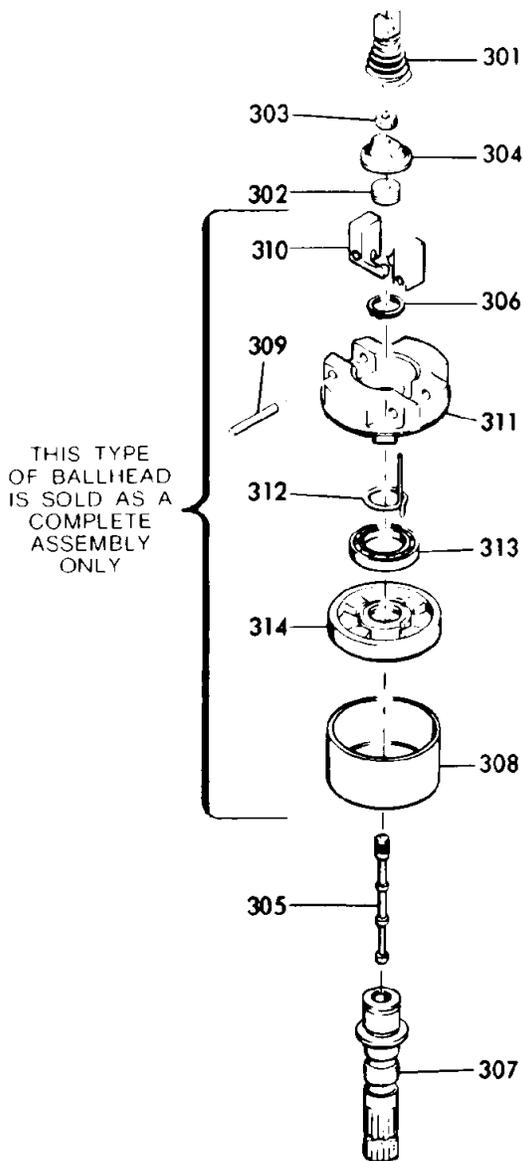


Figure 5-8. Spring driven, Oil-Damped Ballhead Parts

Parts List, Figure 5-9

Ref. No.	Part Name	Quantity
04048-320	Speeder spring	1
04048-321	Pilot valve plunger	1
04048-322	Thrust bearing	1
04048-323	Retaining ring	1
04048-324	Snap ring	1
04048-325	Spring coupling assembly	1
04048-326	Ballarm pin	2
04048-327	Ballarm bearing	4
04048-328	Ballhead	1
04048-329	Ballarm	2
04048-330	Pilot valve bushing—drive gear	1

Spring-driven ballheads have been replaced by oil-damped ballheads shown in Figure 5-8. Spare parts are not available.

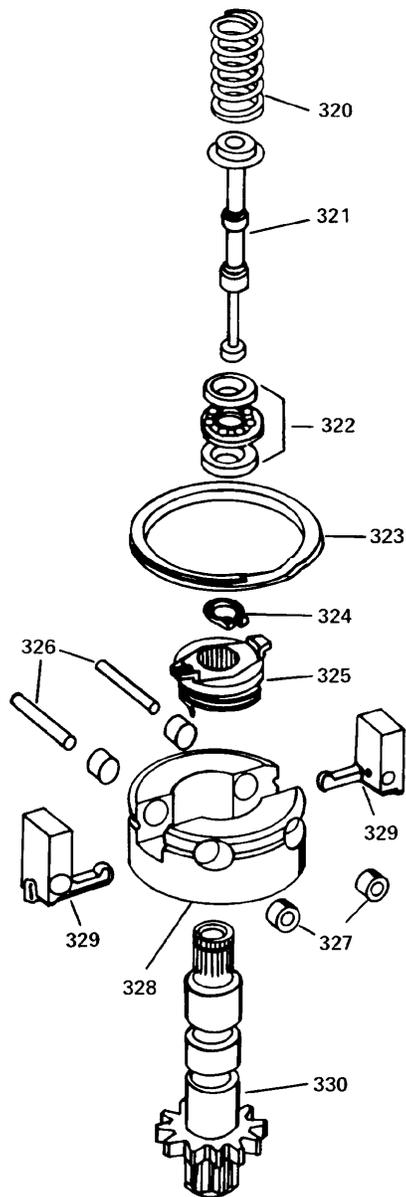


Figure 5-9. Spring-Driven Ballhead Parts

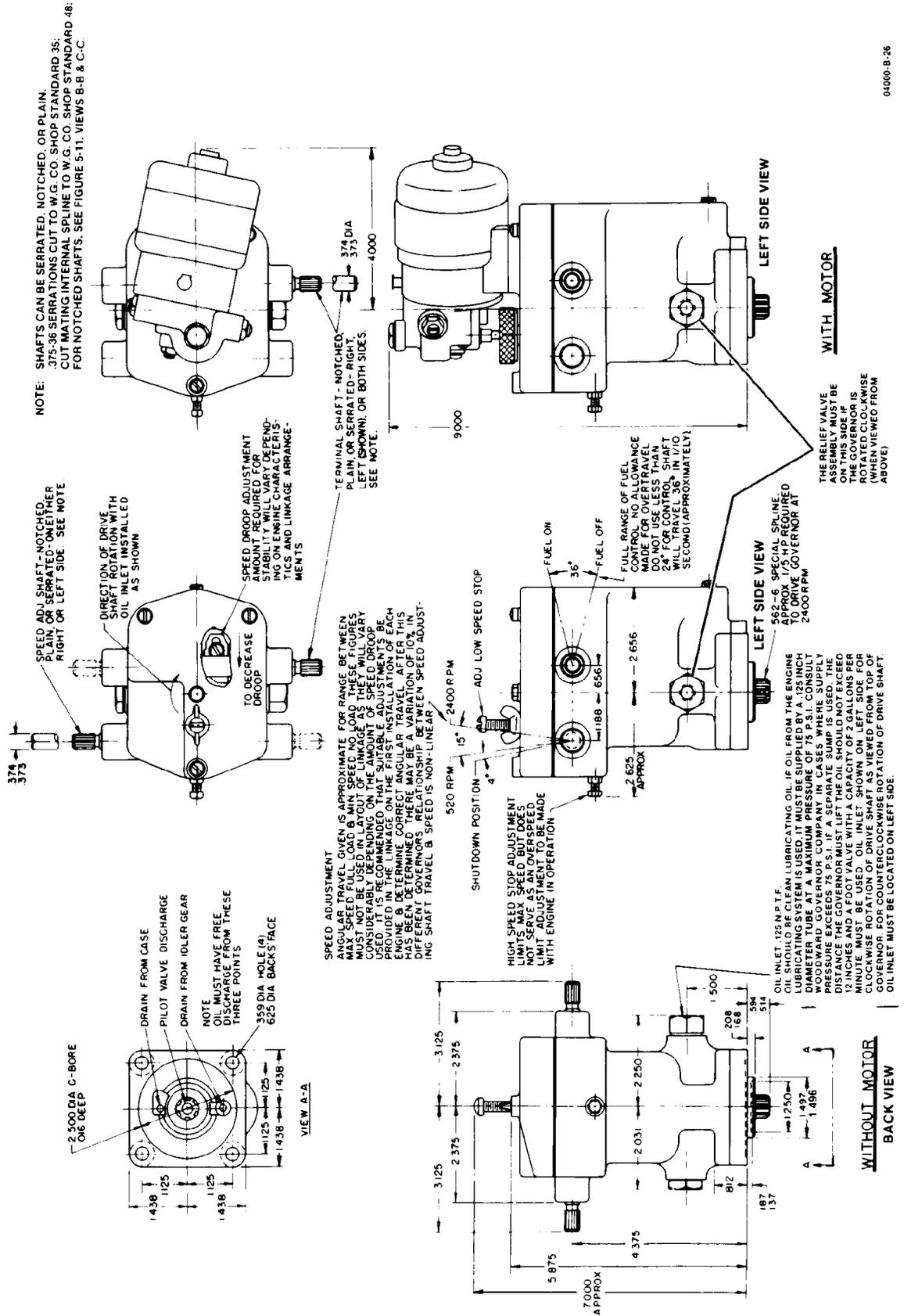


Figure 5-10. Outline Drawing of SG Governor with Speed Adjusting Motor

Chapter 6. Troubleshooting

General

It is impossible to anticipate every kind of trouble that is encountered in the field. This manual covers most common troubles experienced. Governor performance or operation of auxiliary equipment may cause poor regulation. Consider the effect of the auxiliary equipment used on the overall control required of the governor.

You can correct approximately 95% of all trouble by following these instructions, the other 55% may require the service of a governor engineering specialist.

Oil Trouble

Diesel engine lubricating oils are satisfactory, but if they contain additives (inhibitors) which are used to free up rings, remove carbon, etc., a non-foaming additive must also be present.

The oil must not foam or sludge excessively when agitated, or form gummy deposits when heated to operating temperature and subjected to operating pressure changes. Oil contaminated with water will cause foaming.

Dirty oil causes approximately 75% of all SG governor troubles. Change the engine lubricating oil more often than essential for engine maintenance purposes if proper filters are not used in the supply line to the governor.

Speed Droop Adjustment

Although the governor appears to operate satisfactorily because the engine runs at constant speed (without load), the governor may require adjustments.

Analysis and Correction of Governing Troubles

Use the following chart to determine the probable causes of faulty governor operation and to correct these troubles.

Definitions of a few common terms used in the chart follow:

HUNT—A rhythmic variation of speed which can be eliminated by blocking the fuel supply manually but which reappears when returned to governor control.

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

JIGGLE—A high frequency vibration of the governor terminal shaft or engine linkage. Do not confuse with normal regulating action of the governor.



WARNING

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.

Trouble	Cause	Correction
1. Engine hunts or surges.	A. Speed droop adjustment incorrect.	Increase speed droop.
	B. Dirty oil in governor.	Clean governor, change engine oil if necessary.
	C. Foamy oil supplied to governor.	Drain engine oil. Refill.
	D. Insufficient oil supply.	1. Clean oil supply line. 2. Clean or replace oil supply filters if used.
	E. Lost motion in engine linkage or fuel pumps.	Repair linkage and pumps.
	F. Binding in engine linkage or fuel pumps.	Repair and realign linkage and pumps.
	G. Governor worn or not correctly adjusted.	Repair and adjust governor, See governor instruction bulletin. a. Check ballarms for sticking. b. Inspect wear on ballarm toes. c. Check pilot valve bearing. d. Pilot valve may be sticking. e. Inspect for excessive end play of drive shaft.
	H. Low oil pressure.	1. Pump gear clearance incorrect. 2. Relief valve plunger may be sticking. 3. Excessive end play of drive shaft.
	J. Engine misfiring.	Check pyrometer readings of each cylinder and make necessary repairs or adjustments.
	K. Voltage regulator (if used) not operating properly.	Adjust or repair voltage regulator.
2. Fuel pump racks do not open quickly when cranking engine.	A. Low oil pressure.	See 1-H.
3. Terminal shaft or rod and engine linkage jiggles.	A. Rough engine drive.	1. Check alignment of gears.
		2. Inspect for rough gear teeth.
		3. Inspect for eccentric gears.
4. Check backlash of gears.		
5. Tighten chain between crankshaft and camshaft (if used).		
B. Speed droop at critical setting.	Reduce droop to eliminate critical setting if possible. Load division will be affected if this is done. Readjust droop on units affected.	
C. Governor base not bolted down evenly.	Loosen bolts, realign, and secure.	

Trouble	Cause	Correction
4. Load does not divide properly on inter-connected engines.	A. Speed droop adjustment incorrect.	1. Readjust droop to divide load properly. 2. Increase droop to resist picking up (or dropping off) load. 3. Reduce droop to increase picking up (or dropping off) load.
	B. Speed droop adjustment vibrating out of position. NOTE —Speed droop is not essential in a dc electrical system. The equivalent of speed droop in a dc system is obtained by changing the compounding of the generators at the bus between generators. An under-compounded generator is equivalent to a speed droop governor. Governors with speed droop adjustment are commonly used for dc service since the droop adjustment may be used to correct for errors or inequalities of generator compounding.	Readjust droop and tighten screw securely.
	C. Slippage in hydraulic or electric couplings if used.	Adjust couplings.
	5. Engine is slow to respond so a speed change or a load change.	A. Governor is not sensitive in measuring speed change. B. Governor may be intentionally designed to protect engine from overloading during a load change. C. Low oil pressure in governor. D. Engine may be overloaded. E. Restricted fuel supply.
6. Engine will not pick up rated full load.	A. Fuel racks will not open far enough.	1. Adjust engine to governor fuel linkage. 2. Adjust load limiting device or fuel pump stops.
	B. Restricted fuel supply.	See 5-E.
	C. Voltage regulator (if used) not functioning.	Readjust or repair.
	D. Engine misfiring.	Check pyrometer readings of each cylinder and make necessary repairs or adjustments.
	E. Slipping clutch (if used) between engine and driven load.	1. Foaming oil or low oil level in hydraulic clutch. 2. See engine instruction manual.
	F. Speed adjustment of the governor is restricted.	1. Check maximum speed limit adjustment. 2. Inspect speed adjusting linkage for interference.
7. Governor oil overflows.	A. Drain holes plugged.	1. Clean governor. 2. The governor to engine gasket may be restricting the two drain holes at the governor pilot.
	B. Insufficient drain capacity below governor.	1. Engine to governor drive shaft (coupling, shaft, gear, etc.) not assembled properly. 2. Drain holes in engine plugged up.

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	Products Used In Engine Systems	Products Used In Industrial Turbomachinery Systems
<u>Facility</u> ----- <u>Phone Number</u>	<u>Facility</u> ----- <u>Phone Number</u>	<u>Facility</u> ----- <u>Phone Number</u>
Brazil -----+55 (19) 3708 4800	Brazil -----+55 (19) 3708 4800	Brazil -----+55 (19) 3708 4800
China -----+86 (512) 6762 6727	China -----+86 (512) 6762 6727	China -----+86 (512) 6762 6727
Germany:	Germany-----+49 (711) 78954-510	India -----+91 (129) 4097100
Kempen----+49 (0) 21 52 14 51	India -----+91 (129) 4097100	Japan-----+81 (43) 213-2191
Stuttgart--+49 (711) 78954-510	Japan-----+81 (43) 213-2191	Korea-----+82 (51) 636-7080
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Japan-----+81 (43) 213-2191	The Netherlands- +31 (23) 5661111	Poland-----+48 12 295 13 00
Korea-----+82 (51) 636-7080	United States----+1 (970) 482-5811	United States----+1 (970) 482-5811
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.

Revision History

Changes in Revision D—

- Revision advanced to coordinate with new installation sheet, and to update manual to latest formats and safety warnings.

We appreciate your comments about the content of our publications.

Send comments to: icinfo@woodward.com

Please reference publication **04048D**.



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