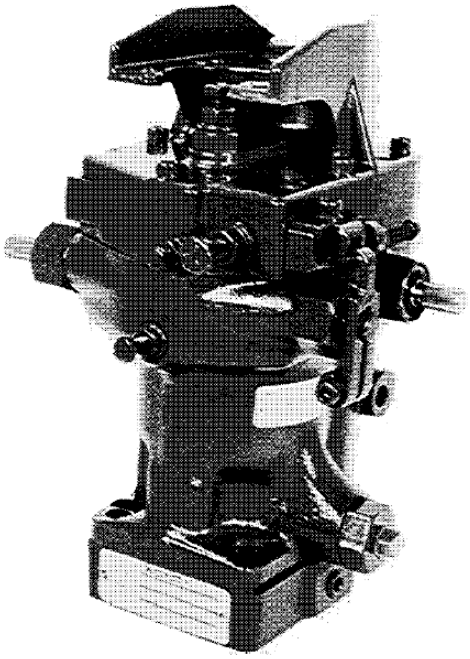
WOODWARD

Product Manual 54055
(Revision NEW, 8/2004)

Original Instructions



PSG Governor

Installation Manual

General Precautions

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

Practice all plant and safety instructions and precautions.

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

Revisions

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

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Proper Use

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

Translated Publications

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

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 Out-of-date translations are marked with ⚠.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

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

Manual 54055

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.

PSG Governor Installation

Introduction

These instructions apply to PSG governors with lever, pneumatic and electric speed settings.

⚠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.

Direction of Rotation

Rotation of 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.

Correct direction of rotation for the PSG governor is shown by a raised arrow at the bottom of the governor case. Some PSG governors have two raised arrows pointing in opposite directions, which indicates that the governor can be rotated in either direction.

NOTICE

Be sure that the 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 squarely 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.

Provide adequate drain holes from the drive coupling, 1/4 inch (6.4 mm) diameter or equivalent in multiple holes, to allow free drainage of oil from the governor pilot valve. See Figure 1.

NOTICE

Be sure the gasket does not block off the three drain holes in the base. Failure to provide free drainage of oil will cause the governor to become inoperative.

Oil Supply

The PSG governor uses oil pressure to move the fuel control linkage in the fuel-on direction and uses a spring to move the fuel control linkage in the fuel-off direction. Some models use an internal spring. Most models require an external spring which exerts a torque of 25 or 50 lb-in (2.8 or 5.6 N·m) on the terminal shaft in the return direction for a PSG with 100 or 200 psi (690 or 1379 kPa) operating pressure, respectively.

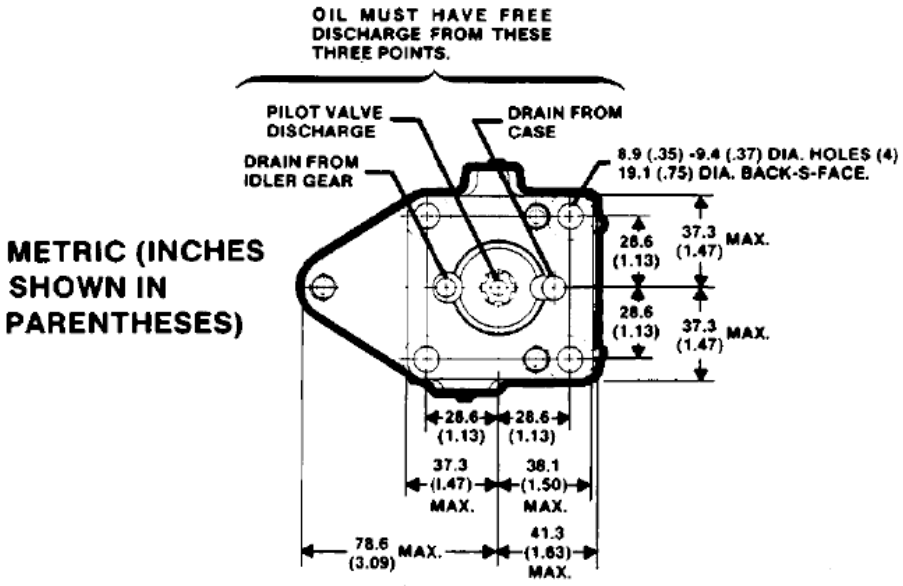

Figure 1. PSG Drain Holes in Base

Oil supply to the governor can be through the oil hole in the base of the governor, or through the oil supply inlet in the relief valve, or through the oil inlet hole in the governor base (optional).

IMPORTANT **When using the optional oil supply hole in the governor base, plug the regular oil supply inlet in the relief valve. The plugs are normally interchangeable.**

If the engine mounting pad is not drilled for an oil supply, connect a 3/8 inch (9.5 mm) oil supply line from either the oil supply inlet in the relief valve or the optional oil supply hole in the case to either the engine lubricating oil pump pressure line, or a separate sump. Oil from the engine must supply a minimum of 5 psi (34 kPa) to the governor. Also install a 40 µm (nominal) filter with a minimum capacity of 2 US gal/min (7.6 L/min) in the oil line.

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 gal/min (7.6 L/min) must be used. Also install a 40 µm (nominal) filter with a minimum capacity of 2 US gal/min (7.6 L/min). In suction lift applications, the filter must not be in series with the inlet line to the governor. Keep the oil lines as short as possible.

For separate sump installations, the oil recommended by the engine manufacturer for use in the engine will be satisfactory.

Use a supply system similar to Figure 3 for applications requiring quick starts. Note that the ends of the overboard drain lines must be kept above the engine sump oil level. Most standard 1 to 2 quart housings (approximately 1 to 2 liters) with filter omitted, can be adapted for this system.

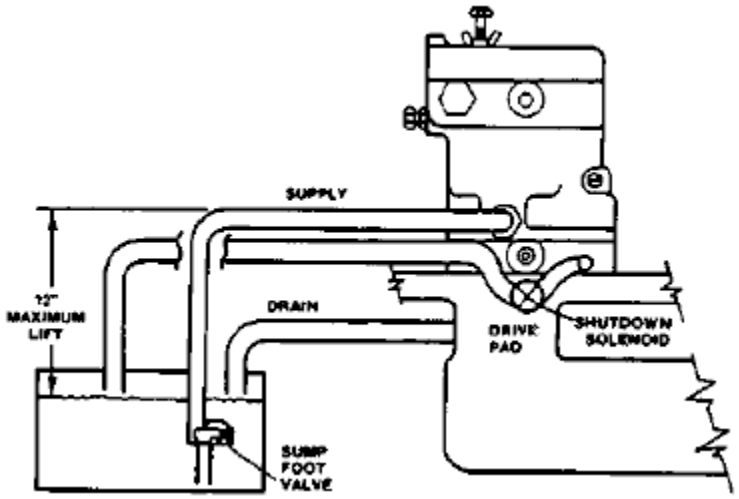

Figure 2. PSG Separate Sump Installation

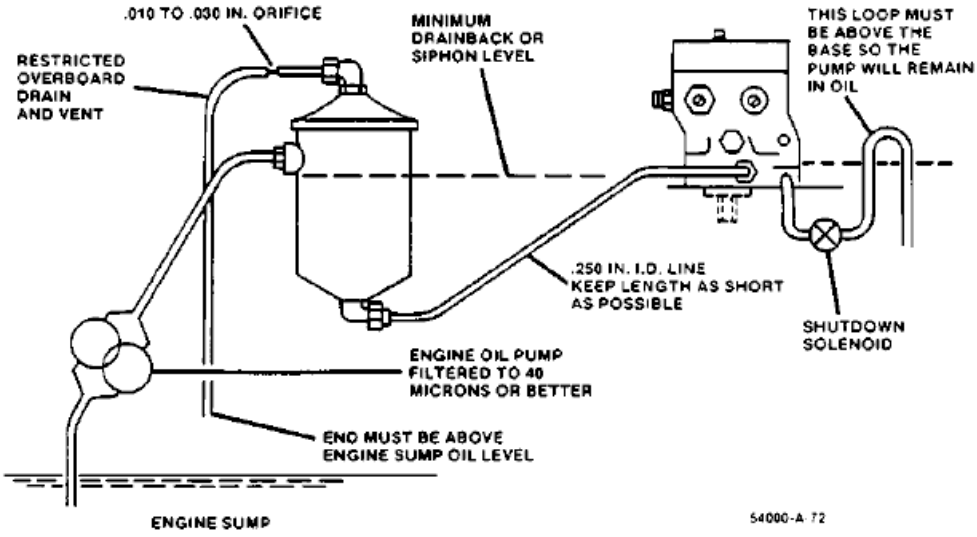

Figure 3. Recommended Engine Oil Systems for Quick Starts

NOTICE

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

IMPORTANT

A permissible oil supply pressure range is a maximum of 12 inches (30 cm) suction lift from a separate sump (Figure 2) to a maximum of 75 psi (517 kPa) from the engine lube oil system. Torque and work values vary accordingly. Consult Woodward when supply pressures must exceed 75 psi (517 kPa).

Governor output can be with either terminal shaft or with fuel rod; connect linkage accordingly. Some sub caps 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.

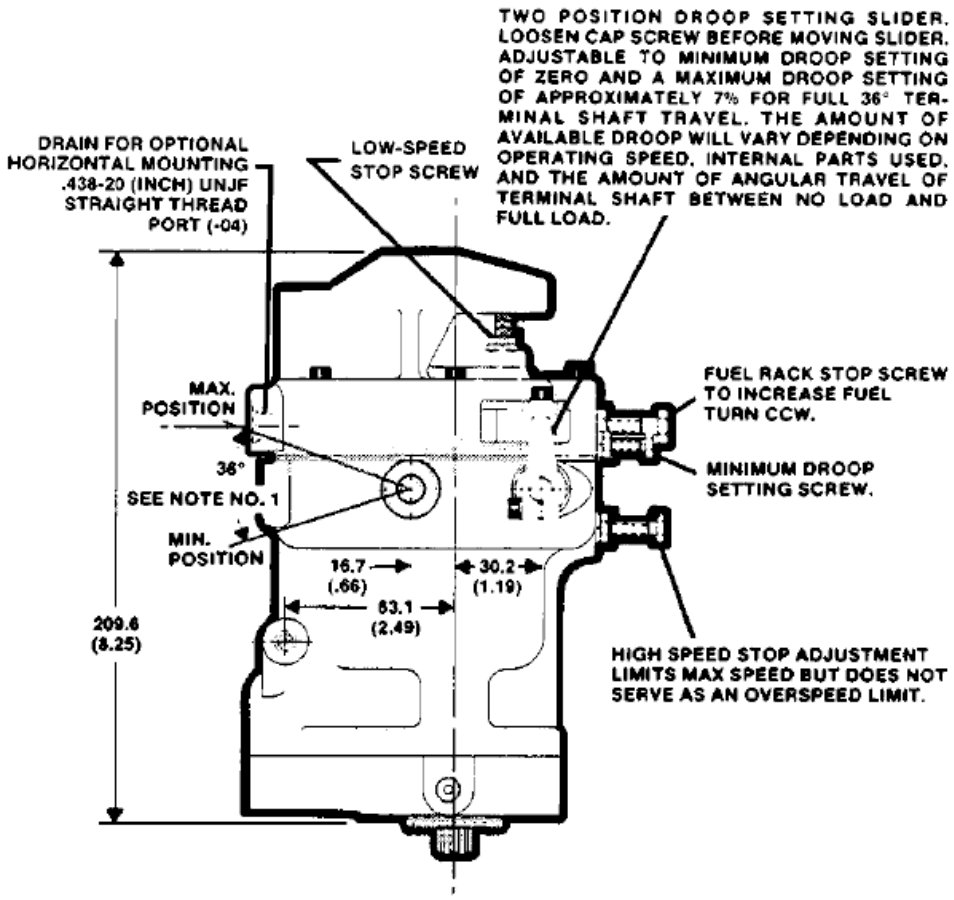

Figure 4. Standard PSG with New Style Cover

Speed Setting

There are several types of speed settings for the PSG. Some have a lever attached to the external end of the speed adjusting shaft. This lever is used with the high-and the low-speed stop screws. Using a linkage arrangement with the lever will provide a remote speed setting 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.

The governor can also be equipped with either a pneumatic speed setting head or an electric motor (Bodine or Permanent Magnet) for remote speed adjustment.

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. See outline drawing, Figure 5. Install the governor on the engine. Fill the oil reservoir approximately 3/8 inch (9.5 mm) from the top using a funnel and 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.

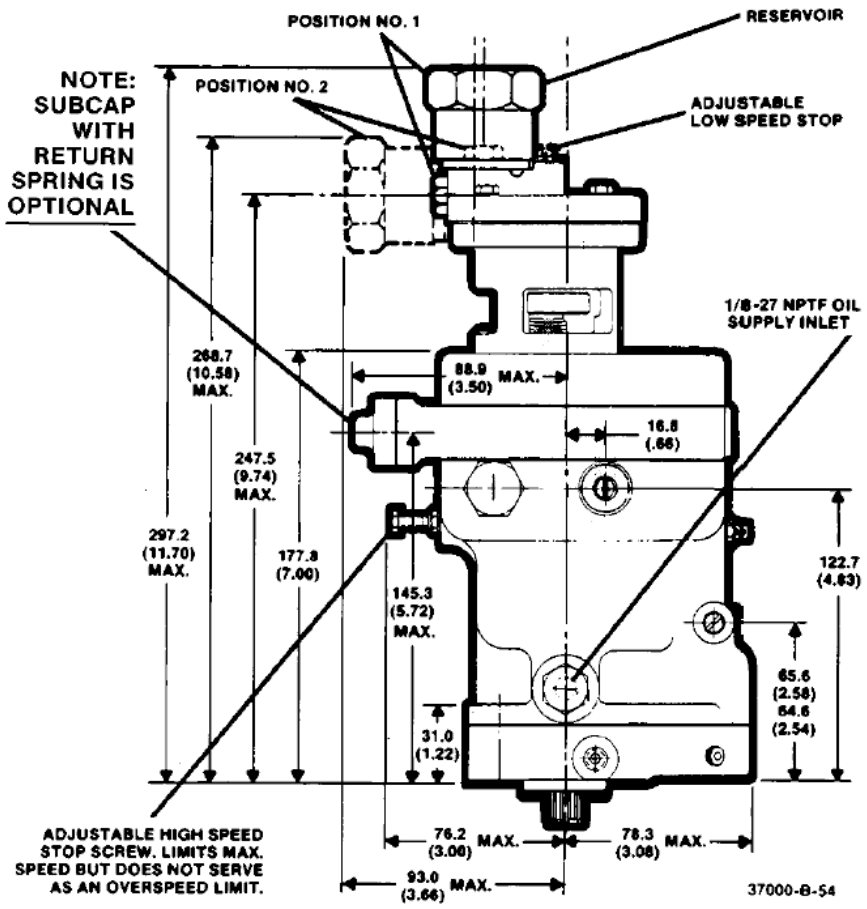

Figure 5. PSG Governor Outline with Pneumatic Speed Setting

Electric Speed Setting

The Bodine motor and the Permanent Magnet (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 motor as shown in Figure 7 or 9. Figure 7 is for the Bodine motor, and Figure 9 is for the PM motor. Voltage for the Bodine motor is shown on the motor.

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

NOTICE

Be sure to connect the permanent magnet motor to the correct current source. Failure to do so can damage the electric motor.

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. Retighten the screws.

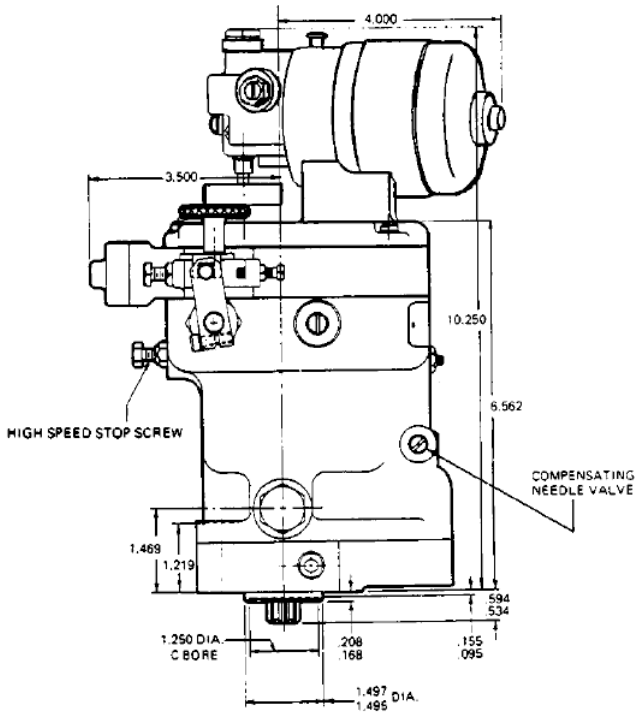

Figure 6. PSG Governor Outline with Bodine Electric Motor

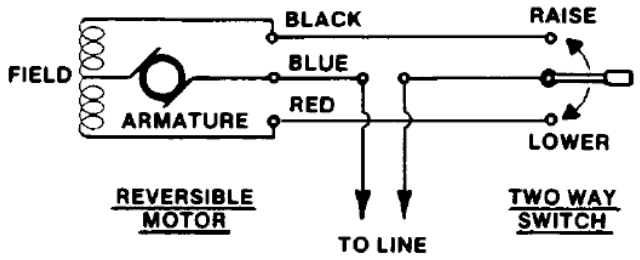

Figure 7. Wiring Diagram for Bodine Motor (switch not furnished)

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

Governor output can be with either terminal shaft or with fuel rod: connect linkage accordingly. Some sub caps 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.

Refer to the prime-mover manufacturer's manual for the correct linkage selection and installation. When attaching the fuel rack linkage to the governor output shaft, make sure there is no lost motion or binding in the linkage.

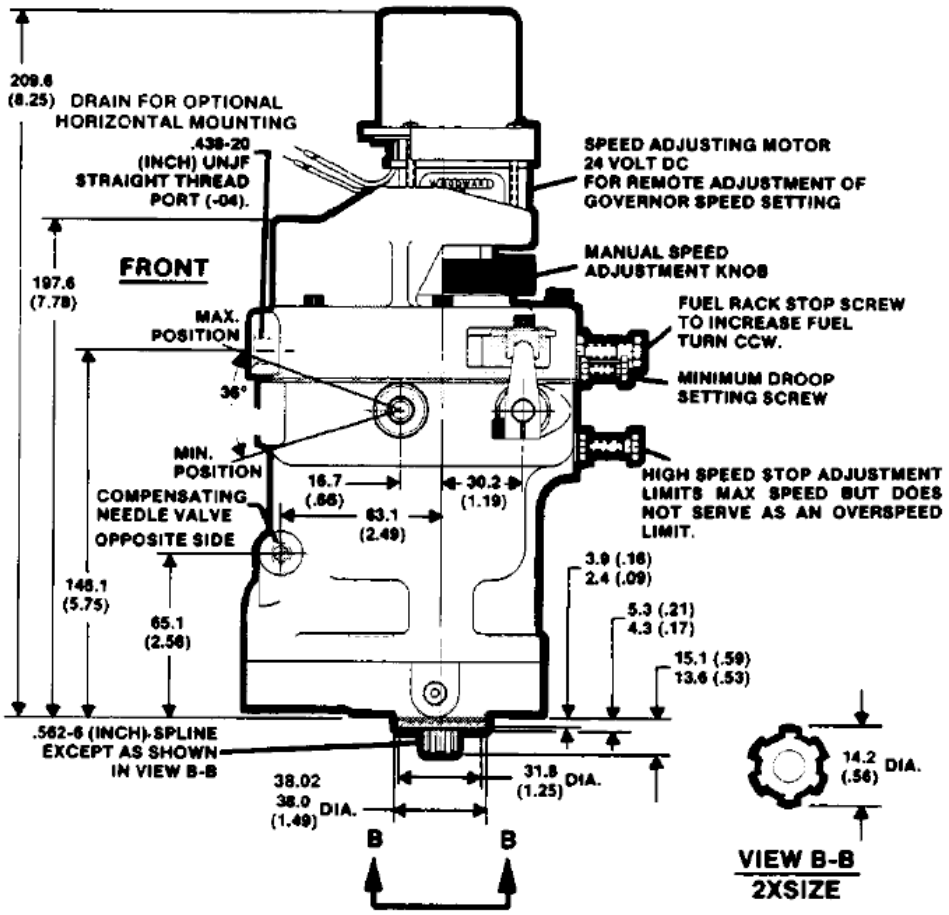

Figure 8. PSG Governor Outline for PM Electric Motor and External Right Hand Droop

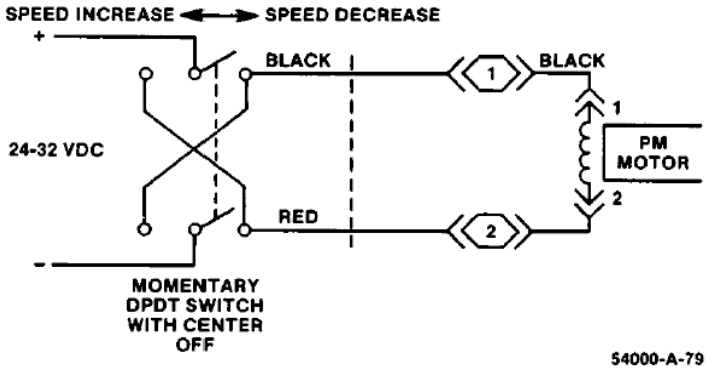

Figure 9. Diagram for PM Motor (switch not furnished)

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 output shaft travel between PRIME MOVER NO LOAD POSITION and FULL LOAD POSITION (see Figure 10).

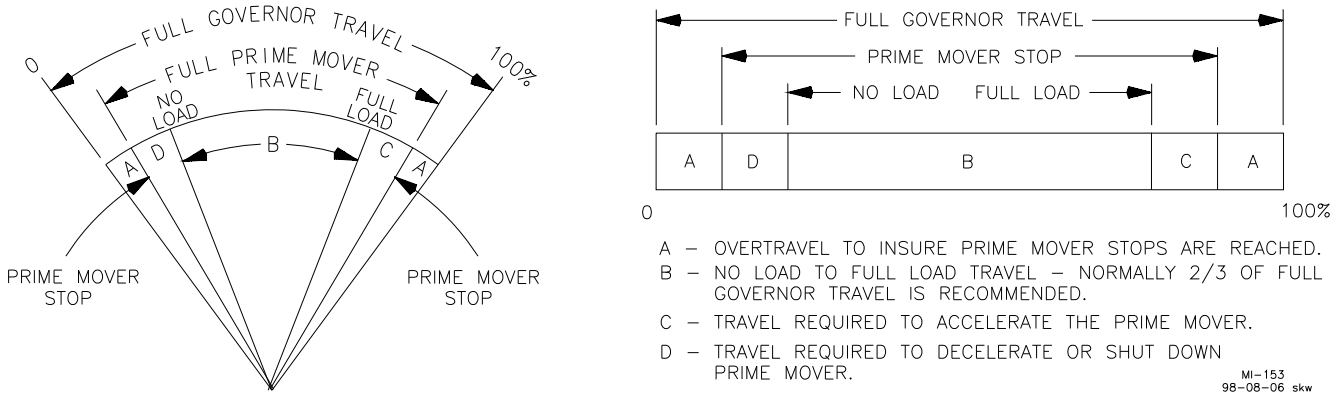

Figure 10. Recommended Governor Output Shaft Travel Adjustment

WARNING

Be sure to allow sufficient overtravel at each end of output shaft travel. Insufficient overtravel adjustment at minimum or maximum fuel can prevent the governor from shutting down the engine or giving maximum fuel, respectively, when required.

Use a linear linkage for diesel engine applications. For applications involving a butterfly valve, such as on a gas engine, use a non-linear linkage.

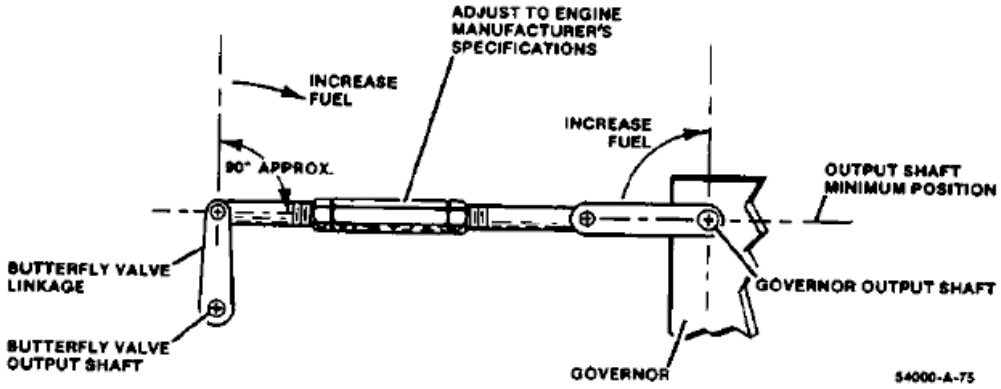

Figure 11. Non0linear Linkage Arrangement

Figure 11 illustrates the relationship between governor terminal shaft and butterfly obtained with simple linkage of maximum non-linearity. When installing this linkage, make sure the following conditions are attained when the linkage is in the no-load position:

1. The lever attached to the governor and the connecting link must be in line with the governor output shaft lever 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.

Initial Operation and Adjustments

Before initial operation of the PSG-equipped turbine or prime mover, be sure that all installation steps have been successfully accomplished.

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.

Attach a serration wrench to the output shaft in addition to the normal linkage to manually control engine speed with the serration wrench.

Start the engine or turbine under manual control according to the manufacturer's instructions, and allow the governor to reach its normal operating temperature

When satisfied that the governing system is fully operative, remove the serration wrench.

Compensation Needle Valve Adjustment

Make the following adjustments to the governor only if the engine does not stabilize. With the prime mover operating at lowest speed setting to provide stable governor operation, make the following adjustments:

1. Open the compensation needle valve 2 to 3 turns until the engine or turbine begins to hunt or surge.

   If opening the needle valve alone does not cause the engine or turbine to hunt, manually disturb the governor speed setting to induce the governor to hunt.

   Allow the governor to hunt for approximately 1/2 minute to purge trapped air from the internal passages in the governor.

2. Gradually close the needle valve until hunting just stops. However, keep the needle valve open as far as possible to prevent sluggishness in the governor response. Never close the needle until it is tight.

3. Test the governor action by manually disturbing the engine or turbine speed. The engine should return quickly to original steady-state speed with only a small overshoot.

Speed Droop

Speed droop is provided and can be internally or externally adjustable (depending on the governor model) between 0% and 7%.

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.

Speed droop allows 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 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 controls the frequency if its capacity is not exceeded.

Adjust the system frequency by changing the speed setting of the governor having zero droop. Load distribution between units is accomplished by changing the speed setting of the governor having speed droop.

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

Speed Droop Adjustment

For governors with internally adjustable speed droop, the droop slider is moved away from the output shaft center line to increase droop. Since there is no calibration for the droop adjustment, the desired droop position may be set only by trial and error on the engine. Be sure to shut down the engine before removing the governor top cover and be sure to reinstall the governor top cover before restarting the engine or turbine.

⚠WARNING **Do not operate the governor with the cover removed to protect against runaway or overspeed condition.**

Figure 12 shows the governor with the top cover removed to expose the speed droop mechanism.

For governors with externally adjustable speed droop, the droop slider is moved toward the terminal shaft center line to increase droop (see Figure 4). Readjust the droop slider to obtain the desired speed droop between no load and full load. Since there is no calibration for the droop adjustment, the desired droop position may be set only by trial and error on the engine.

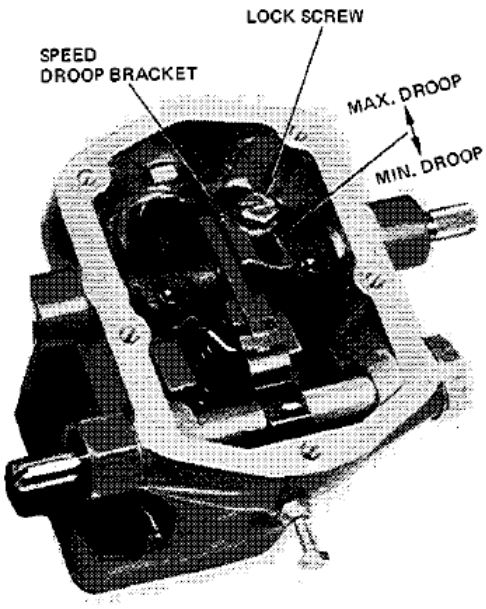

Figure 12. PSG with Internally Adjustable Droop

Troubleshooting Checklist

Drive gear:

- Check drive gear for proper alignment.
- Inspect gear teeth for roughness.
- Check gear train for eccentricity or backlash.
- Check gear mounting on shafts for looseness.

Linkage:

- Make sure the correct linkage selection is made.
- Check linkage for backlash or binding.
- Check fuel or Steam control for backlash or binding.
- Check terminal shaft travel for sufficient overtravel at minimum and maximum positions.
- Make sure the correct linkage relationship exists between governor and fuel pump.

Oil:

- Check oil for proper viscosity.
- Check oil supply system for clean oil and filter.
- Make sure that gasket between governor base and engine mounting pad allows free oil discharge from governor.

Needle Valve:

- Make sure needle valve adjustment is correct.

Engine Load:

- Make sure the engine or turbine is not overloaded.

Governor Speed Setting:

- Make sure control air pressure is not set too high if a pneumatic speed setting device is used.

If problems are encountered with the installation or operation of the PSG Governor, contact Woodward.

We appreciate your comments about the content of our publications.

Send comments to: icinfo@woodward.com

Please reference publication 54055.

B54055:NEW

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