

UG-5.7, 8, and 10 Lever Governor

Installation and Operation Manual



General Precautions

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

Practice all plant and safety instructions and precautions.

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



Revisions

This publication may have been revised or updated since this copy was produced. To verify that you have the latest revision, check manual **26455**, *Customer Publication Cross Reference and Revision Status & Distribution Restrictions*, on the *publications* page of the Woodward website:

www.woodward.com/publications

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




Proper Use

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



Translated Publications

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

The original source of this publication may have been updated since this translation was made. Be sure to check manual **26455**, *Customer Publication Cross Reference and Revision Status & Distribution Restrictions*, 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 Out-of-date translations are marked with .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.

Woodward reserves the right to update any portion of this publication at any time. Information provided by Woodward is believed to be correct and reliable. However, no responsibility is assumed by Woodward unless otherwise expressly undertaken.

Contents

WARNINGS AND NOTICES	III
ELECTROSTATIC DISCHARGE AWARENESS	IV
CHAPTER 1. GENERAL INFORMATION.....	1
Introduction	1
Description.....	1
References	1
CHAPTER 2. INSTALLATION.....	4
Introduction	4
Receiving.....	4
Storage	4
Mounting Requirements	4
Linkage Attachments	6
Oil Supply	7
CHAPTER 3. PRINCIPLES OF OPERATION	10
Introduction	10
Component Description	10
Operation of UG Lever Governor	15
CHAPTER 4. OPERATION AND ADJUSTMENT.....	18
Initial Operation for a New Governor	18
Adjustments	18
Compensation Adjustments.....	18
Initial Operation for a Repaired or Reassembled Governor	20
Test Procedures on the Engine	21
Test Completion	25
CHAPTER 5. TROUBLESHOOTING	26
Introduction	26
Troubleshooting.....	26
Additional Information for Steam Turbines, Gas and Gasoline Engines.....	28
Governor Field Repairs	31
CHAPTER 6. REPLACEMENT PARTS	34
CHAPTER 7. AUXILIARY EQUIPMENT	43
Introduction	43
Shutdown Solenoid.....	43
Low Lube Oil Pressure Shutdown	43
Magnetic Speed Pickup.....	44
Manifold Pressure Fuel Limiter.....	45
Remote Pneumatic Speed Adjustment	46
CHAPTER 8. PRODUCT SUPPORT AND SERVICE OPTIONS.....	47
Product Support Options	47
Product Service Options.....	48
Returning Equipment for Repair.....	48
Replacement Parts	49
Engineering Services.....	49
Contacting Woodward's Support Organization	49
Technical Assistance.....	50
REVISION HISTORY.....	51

Illustrations and Tables

Figure 1-1. Recommended Output Shaft Travel Adjustment	2
Figure 1-2. UG Lever Governor	2
Figure 1-3. Outline Drawing of UG Lever Governor	3
Figure 1-4. Linkage Arrangement for Non-Linear Fuel Systems	3
Figure 3-1. Schematic Diagram, UG Lever Governor	11
Figure 3-2. Speed Droop Assembly	14
Figure 3-3. UG Lever Governor with Shutdown Rod	15
Figure 4-1. Droop Pre-Setting	24
Figure 5-1. Common Bench Tools	32
Figure 5-2. Normal Field Repair Tools	33
Figure 6-1. Illustrated Parts for the UG Lever Governor (sheet 1)	35
Figure 6-2. Illustrated Parts for the UG Lever Governor (sheet 2)	37
Figure 6-3. Illustrated Parts for the UG Lever Governor (sheet 3)	39
Figure 6-4. Illustrated Parts for the UG Lever Governor (sheet 4)	41
Figure 6-5. Illustrated Parts for the UG Lever Governor (sheet 5)	42
Figure 7-1. Low Lube Oil Pressure Shutdown	44
Figure 7-2. Magnetic Speed Pickup	44
Figure 7-3. UG Lever with Manifold Pressure Fuel Limiter	45
Figure 7-4. UG Lever with Remote Speed Adjustment	46
Table 2-1. Viscosity and Operating Temperature of Oils	8
Table 2-2. Equivalent Viscosities for Lubricating Oils	8
Table 4-1. Test Stand Tools	21
Table 4-2. Droop Pre-Setting	25
Table 5-1. Governor Output Shaft Travel vs. Butterfly Valve Travel	28
Table 5-2. Troubleshooting Chart	29
Table 5-3. List of Common Bench Tools	32
Table 5-4. List of Normal Field Repair Tools	33

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

The UG Lever governor is available in three different work outputs, the UG-5.7 (5.2 ft-lb/7.1 J), UG-8 (9.7 ft-lb/13.2 J), and UG-10 (11.7 ft-lb/15.9 J). The UG5.7 and the UG-8 both use 120 psi (827 kPa) oil pressure, and the UG-10 uses 150 psi (1034 kPa).

Basic UG operation, adjustment, troubleshooting, and parts replacement is similar for the UG-5.7, UG-8, and UG-10.

IMPORTANT

The word prime mover used in this manual refers to either engines, turbines, or other types of prime movers.

Description

The UG Lever is a mechanical-hydraulic governor for controlling dual fuel or diesel engines or steam turbines. The UG Lever is mechanically linked to and operates the fuel racks or fuel valves, depending on the system.

The maximum travel of the output shaft (terminal shaft) is 42°. Recommended travel of the output shaft is approximately 2/3 of available travel from no load to full load, which allows sufficient overtravel at each end so that the governor can create a shutdown and also give maximum fuel when required (see Figure 1-1).

Normally, the UG Lever operates isochronously (constant speed) regardless of load on the engine except during transient load conditions. Details of the operation are described in Chapter 3, Principles of Operation.

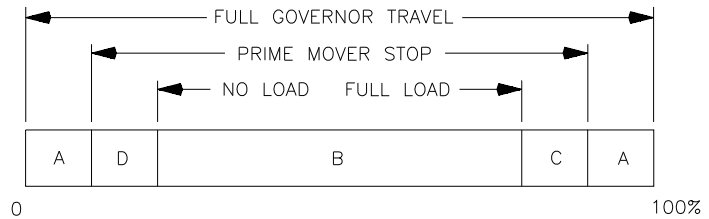
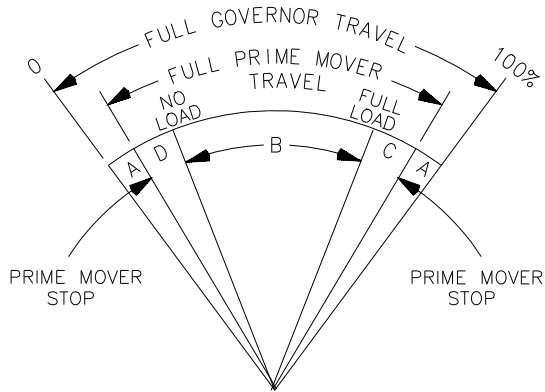
Speed droop is also available as a special auxiliary on the UG Lever governor to divide and balance load between units driving the same shaft.

The UG Lever governor can also be equipped with a shutdown rod which allows the engine to be shut down from the throttle position.

References

Some of the manuals listed below are briefly covered in Chapter 7, Auxiliary Equipment.

Manual 03013	Shutdown Solenoid for UG Governors
Manual 03016	Low Lube Oil Pressure Shutdown for UG Governors
Product Spec. 03029	UG Governor
Manual 03045	UG-8 Speed Adjusting Devices
Manual 03504	Special Tools for UG and UG-40 Governors
Manual 03507	Manifold Pressure Fuel Limiter for UG Lever Governors
Manual 25071	Oils for Hydraulic Controls
Manual 25075	Commercial Preservation Packaging for Storage of Mechanical-Hydraulic Controls
Manual 36052	Magnetic Speed Pickup for PG, UG, and UG-40 Governors
Application Note 50516	Governor Linkage for Butterfly Throttle Valve



- 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.

MI-153a
 98-08-06 skw

Maximum work capacity over full governor travel of 42 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.

- * 5.2 ft-lb (7.1 J) for the UG-5.7
 9.7 ft-lb (13.2 J) for the UG-8
 11.7 ft-lb (15.9 J) for the UG-10

Figure 1-1. Recommended Output Shaft Travel Adjustment

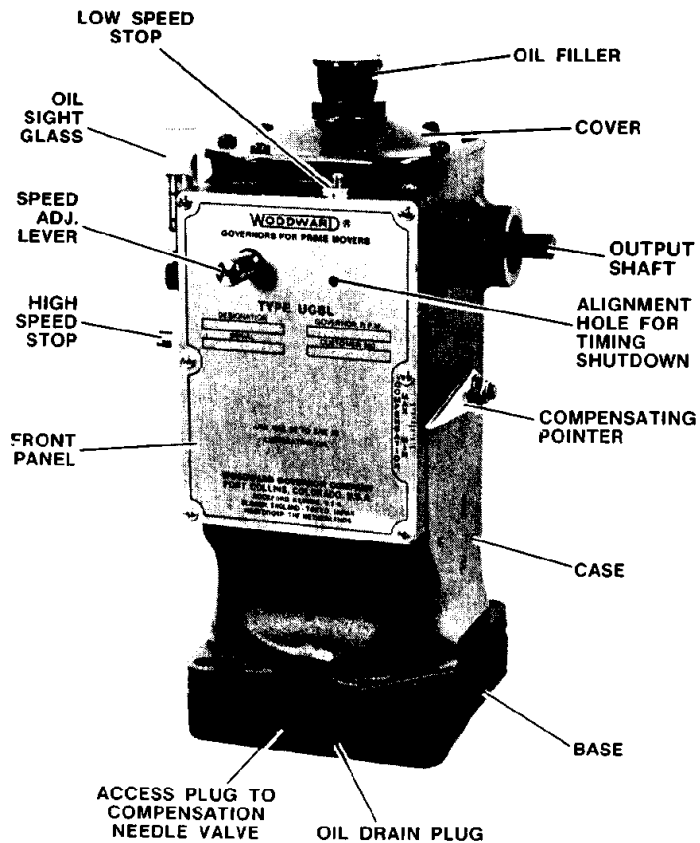


Figure 1-2. UG Lever Governor

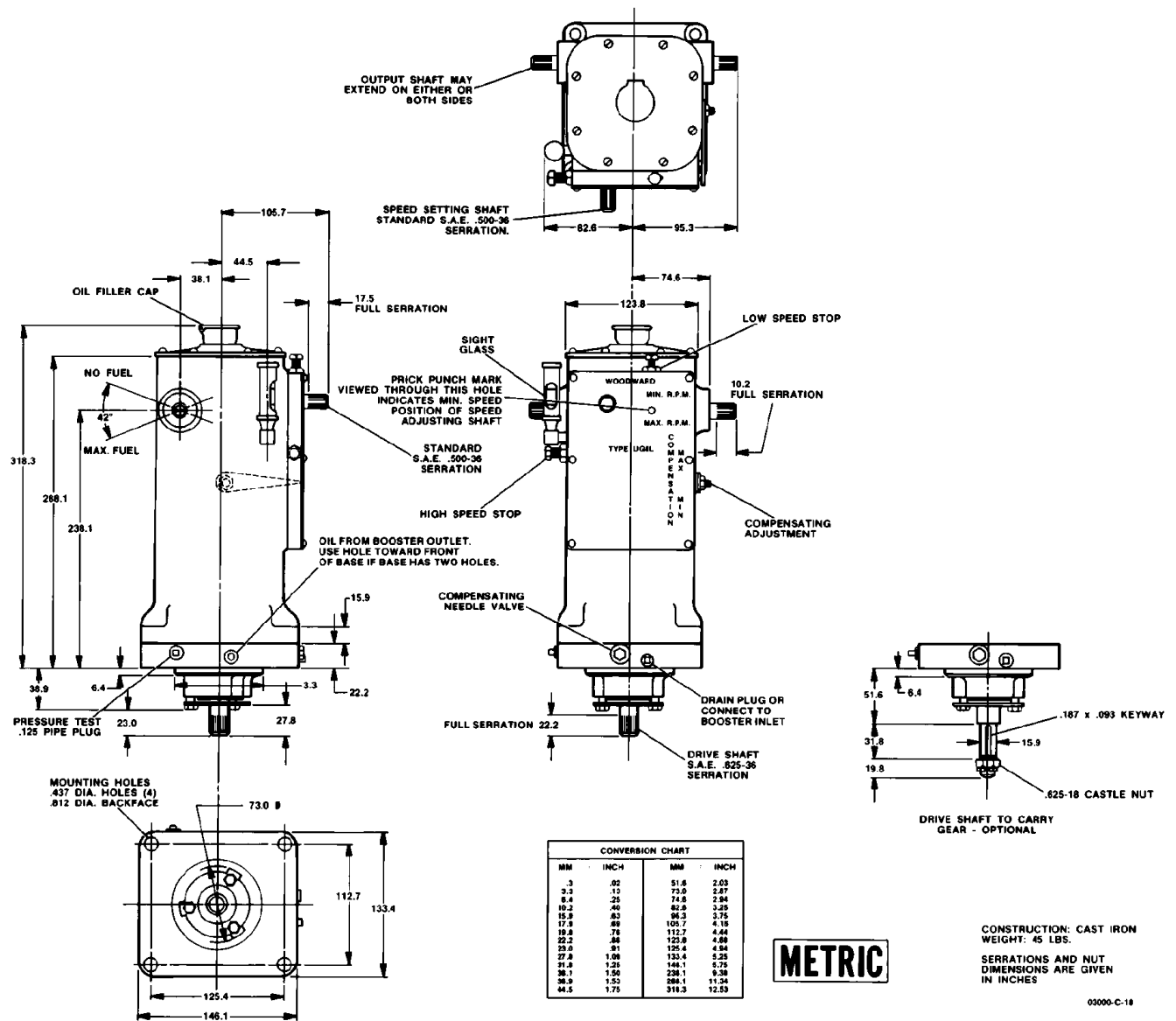


Figure 1-3. Outline Drawing of UG Lever Governor

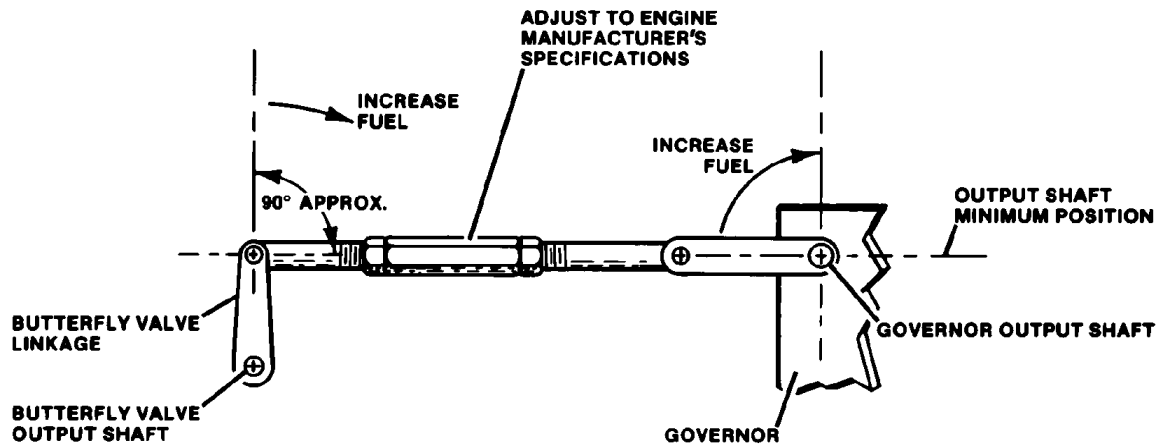


Figure 1-4. Linkage Arrangement for Non-Linear Fuel Systems

Chapter 2. Installation

Introduction

Use care while handling and installing the UG Lever governor. Be particularly careful to avoid striking the governor drive shaft, output shafts, and the speed setting shaft. Abuse can damage seals and internal parts. Do not rest the governor on its drive shaft



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.

Receiving

When you receive your UG Lever governor, it will be bolted to a wooden platform in the vertical position. After testing the governor at the factory, it is drained of oil. This leaves a light film of oil covering the internal parts, preventing rust. No internal cleaning is required before installation.

Some drive shafts are sprayed with a light film of oil while others (depending on customer requirements) are covered with soft seal. Before installation, remove the soft seal with a rag saturated with mineral spirits.

Storage

The UG Lever governor may be stored for short periods of time as received from our factory. For prolonged storage or storage in a hostile environment, follow instructions given in Woodward manual 25075 (see Chapter 1, References).

Mounting Requirements

The recommended speed range for the UG Lever governor is 375 to 1500 rpm and can be driven clockwise or counterclockwise. The recommended maximum constant speed is 1000 to 1500 rpm, requiring 1/3 hp (249 W) at rated speed and normal operating temperature. Operating temperature range is -40 to $+220$ °F (-40 to $+104$ °C).

Make sure the governor drive shaft rotates freely before installing the governor. Mount and fasten the governor squarely on its mounting pad using the correct length of coupling between the governor and the prime mover drive. Be sure there is no binding, excessive side loading of the drive shaft, or looseness in the coupling. There must be no force pushing the drive shaft into the governor.

Improper alignment or too tight a fit between any of the parts can result in excessive wear or seizure of parts. It can also cause an undesirable high frequency vibration or “jiggle” in the governor output shaft. (See Definitions in Chapter 5 for more information).

The UG Governor is mounted flush with the engine drive pad. If the engine drive pad is at an angle (from 0 to 45° maximum), the UG Governor must be installed with the front panel in the upper position. Use a gasket between governor and engine drive pad to allow for surface imperfections.

Be sure there is adequate space available around the governor to provide easy access for installing the control linkage, filling the governor with oil, and adjusting the speed and compensation system. See Outline Drawing, Figure 1-3, for mounting hole sizes and governor dimensions.

The standard UG Governor serrated drive offers few installation problems. However, the concentricity of the shaft to the drive coupling must be maintained, and the coupling should be as long as possible to permit greater flexibility and a longer life.

**WARNING**

A misalignment of the drive shaft can result in a broken drive shaft, causing an overspeed condition or runaway engine. An overspeeding or runaway engine can result in extensive damage to the equipment, personal injury, and/or loss of life.

If an optional keyed drive is used when installing the governor, take care to avoid the following undesirable conditions:

- Rough gear teeth

Rough gear teeth or shaft out of round, can cause vibrations which can be transmitted to the governor and cause a jiggle in the governor output shaft. The jiggle can be transmitted to the fuel control, resulting in an undesirable condition. Replace gears if necessary.

- Incorrect shimming

Check backlash and re-adjust it necessary to obtain proper mesh without binding or excessive backlash. Refer to the prime mover manufacturer's specifications for the correct amount of backlash.

When installing bevel gears onto a keyed drive shaft, check the gear play between the drive wheel and the driven wheel very carefully.

Re-adjust the shims above and below the driven gear wheel such that there is no loading of the driven gearwheel.

NOTICE

Failure to properly adjust the shims and gear play will result in a frozen governor and major damage.

- a. The correct position for these shims and the correct gear play (also called flank clearance) are provided by the engine manufacturer.
- b. It may be necessary to remove the drive from the engine if the bevel gears cannot otherwise be accessed.
- c. Do not tighten the governor base bolts immediately, but test the gear play several times. Tighten the bolts fully only when there is some gear play.
- d. If the gear play becomes zero before the bolts are tightened, remove one or more shims above the gear wheel.

Linkage Attachments

Terminal Shaft Linkage

Adjustments of fuel linkage must provide for control of fuel from “OFF” to “FULL FUEL” within the limits of the 42° of governor output shaft travel. It must also provide for approximately 30° output shaft travel between “NO LOAD” and “FULL LOAD”.

WARNING

Be sure to allow sufficient overtravel at each end of the terminal movement. Failure to provide sufficient overtravel at the maximum fuel position can prevent the prime mover from getting maximum fuel when required. Failure to provide sufficient overtravel at the minimum fuel position can prevent the governor from shutting down the prime mover and result in possible damage to equipment and personal injury.

Attach the fuel rack linkage to the governor output shaft. There must be no lost motion or binding in this linkage. Adequate locking methods must be employed on the linkage connections.

A linear linkage arrangement is used in applications where the governor output shaft positioning is directly proportional to the torque output of the prime mover. Thus, the governor output shaft travel will be directly proportional to the torque output of the prime mover.

A linear linkage is a linkage arrangement which provides as much movement of the governor output shaft per increment of valve movement at light loads as it does at heavy loads.

In applications where a governor is controlling a butterfly valve, such as on a gas engine, a linear linkage should not be used. This is due to the inherent design of the butterfly valve, which requires only a small amount of valve travel (for example, 10°) to bring an engine from no load to half load. By contrast, this design requires a much greater movement of valve travel (for example, 30°) to bring the engine from half load to full load.

In order to improve governing control at light loads, a compensating linkage is devised (“non-linear” linkage). This linkage provides greater movement of the governor per increment of valve movement at light loads than it does at heavy loads (see Figure 1-4).

See also Table 5-1 for a satisfactory relationship between governor output shaft travel and butterfly valve travel in a non-linear system.

For more Information on non-linear linkage, please refer to Woodward Application Note 50516, *Governor Linkage for Butterfly Throttle Valves*.

Speed Setting Shaft Linkage

Attach the speed setting linkage to the governor speed setting shaft. Approximately 40 to 45° travel (clockwise to increase) is typically used to obtain the full governor speed range.

The governor is shipped from the factory with minimum and maximum speed stops adjusted for the full governor speed range. A center punch mark on an internal stop lever can be viewed through a small panel hole and indicates the minimum speed position of the speed adjusting shaft. The minimum and maximum stop positions are adjustable stop screws with jam nuts.

There must be no binding or lost motion in this linkage. Adequate locking methods must be employed on the linkage connections.

Oil Supply

Use an oil depending on operating temperature for the governor (see Table 2-1).

IMPORTANT

Primary concern is for the oil properties in the governor.

Fill the governor with approximately 1.5 US qt (1.4 L) of oil to the mark on the oil sight glass. After the engine is started and the governor is at operating temperature, add oil if necessary.

Use the information given in Tables 2-1 and 2-2 as a guide in the selection of a suitable lubricating/hydraulic oil. Oil grade selection is based on the operating temperature range of the governor. Also, use this information to aid in recognizing and correcting common problems associated with oil used in Woodward products.

For applications where the governor shares the oil supply with the engine, use the oil recommended by the engine manufacturer.

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

Governor oil must be compatible with seal materials (nitrile, polyacrylic, and fluorocarbon). Many automotive and gas engine oils, industrial lubricating oils, and other oils of mineral or synthetic origin meet these requirements. Woodward governors are designed to give stable operation with most oils with the viscosity, at the operating temperature, between 50 and 3000 SUS (Saybolt Universal Seconds). At the normal operating temperature, the viscosity should be between 100 to 300 SUS. Poor actuator response or instability may be an indication that the oil viscosity is outside this range.

Excessive component wear or seizure in a governor indicates the possibility of:

1. Insufficient lubrication caused by:
 - An oil that flows slowly when it is cold, especially during start-up
 - No oil in the governor
2. Contaminated oil caused by:
 - Dirty oil containers
 - A governor exposed to heating up and cooling down cycles, which creates condensation of water in the oil
3. Oil not suitable for the operating conditions caused by:
 - Changes in ambient temperature
 - An improper oil level which creates foamy, aerated oil

ANY OIL LISTED IS ONLY A SUGGESTION. USE THE OIL OF YOUR CHOICE WITH THE CORRECT VISCOSITY AS INDICATED IN THE CHART.

RECOMMENDED
UPPER LIMIT
OF PETROLEUM
OIL IS 200°F

RECOMMENDED
UPPER LIMIT
OF SYNTHETIC
OIL IS 250°F

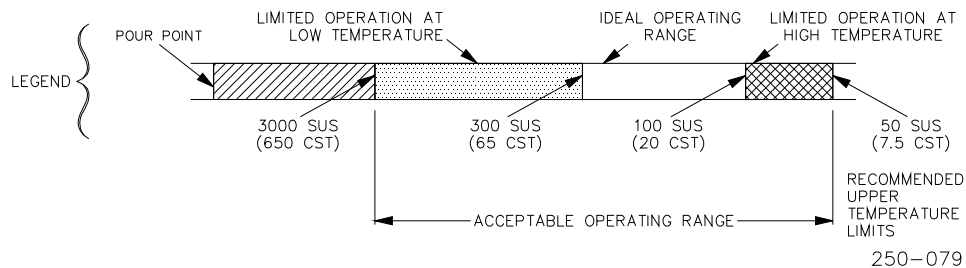
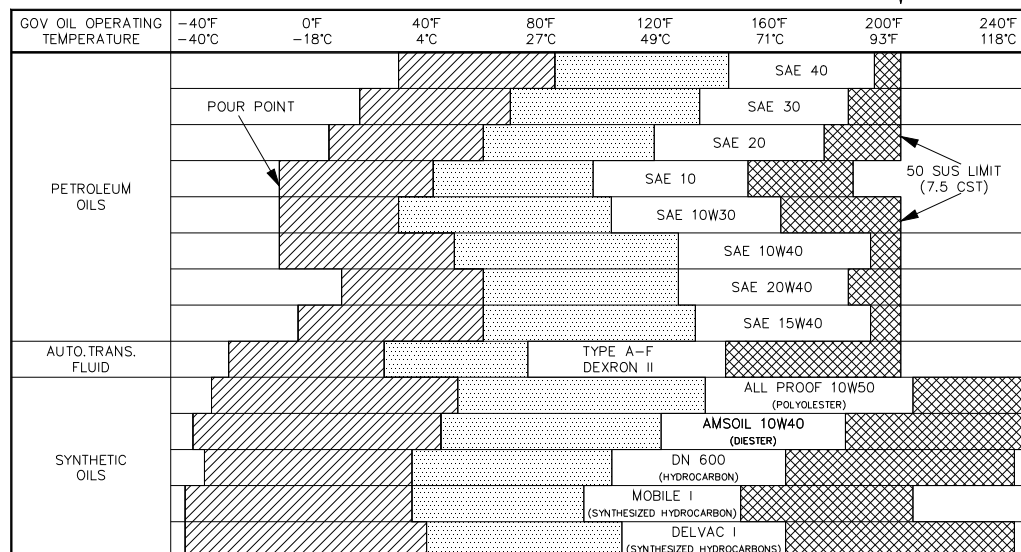


Table 2-1. Viscosity and Operating Temperature of Oils

VISCOSITY COMPARISONS				
CENTISTOKES (CST, CS, OR CTS)	SAYBOLT UNIVERSAL SECONDS (SUS) NOMINAL AT 100 DEGREES F	SAE MOTOR (APPROXIMATE)	SAE GEAR (APPROXIMATE)	ISO
15	80	5W		15
22	106	5W		22
32	151	10W	75	32
46	214	10	75	46
68	310	20	80	68
100	463	30	80	100
150	696	40	85	150
220	1020	50	90	220
320	1483	60	115	320
460	2133	70	140	460

250-087
97-11-04 skw

Table 2-2. Equivalent Viscosities for Lubricating Oils

Operating a governor continuously beyond the high-limit temperature of the oil will result in oil oxidation. This is identified by varnish or sludge deposits on the governor parts. To reduce oil oxidation, lower the actuator operating temperature with a heat exchanger or other means, or change to an oil more oxidation-resistant at the operating temperature.

**WARNING**

A loss of stable governor control and possible prime mover overspeed may result if the viscosity exceeds the 50 to 3000 SUS range. An overspeeding and/or runaway prime mover can result in extensive damage to the equipment, personal injury, and/or loss of life.

Specific oil viscosity recommendations are given in the Oil Chart (Table 2-1). Select a readily available good brand of oil, either mineral or synthetic, and continue using that same brand. Do NOT mix the different classes of oils. Oil that meets the API (American Petroleum Institute) engine service classification in either the "S" group or the "C" group, starting with "SA" or "CA" through "SF" and "CD" is suitable for governor service. Oils meeting performance requirements of the following specifications are also suitable: US MIL-L-2104A, MIL-L-2104B, MIL-L-2104C, MIL-L-46152, MIL-L-46152A, MIL-L-46152B, MIL-L-45199B.

Replace the governor oil if it is contaminated, also change it if it is suspected of contributing to governor instability. Drain the oil while it is still hot and agitated, and flush the governor with a clean solvent having some lubricating quality (such as fuel oil or kerosene) before refilling with new oil. If drain time is insufficient for the solvent to completely drain or evaporate, flush the governor with the same oil it is being refilled with to avoid dilution and possible contamination of the new oil.

To avoid recontamination, the replacement oil should be free of dirt, water, and other foreign material. Use clean containers to store and transfer oil.

Oil that has been carefully selected to match the operating conditions and is compatible with governor components should give long service between oil changes. For governors operating under ideal conditions (minimum exposure to dust and water and within the temperature limits of the oil), oil changes can be extended. If available, a regularly scheduled oil analysis is helpful in determining the frequency of oil changes.

Any persistent or recurring oil problems should be referred to a qualified oil specialist for solution.

The recommended continuous operating temperature of the oil is 140 to 200 °F (60 to 93 °C). The ambient temperature limits are -20 to +200 °F (-29 to +93 °C). Measure the temperature of the governor on the outside lower part of the case. The actual oil temperature will be slightly warmer, by approximately 10 °F (6 °C).

**WARNING**

Follow the manufacturer's instructions or restrictions regarding the use of solvents. If no instructions are available, handle with care. Use the cleaning solvent in a well ventilated area away from fires or sparks.

Failure to follow the above safety instructions can result in dangerous fires, extensive damage to equipment, personal injury, and/or loss of life.

Chapter 3.

Principles of Operation

Introduction

Basic UG Lever Governor operation is similar for all types. The only difference is in the method of setting the speed. Auxiliary devices provide different functions but do not alter the basic operation of the governor. Along with the text, a schematic diagram, Figure 3-1. is provided for visual means of understanding the operation of the UG Lever governor.

Component Description

Before getting into the operation of the UG Lever governor, a brief description of the components will facilitate understanding the operation.

Oil Pump

The purpose of the oil pump (12) is to provide oil pressure for the governor.

The pump gets its oil from the self-contained sump (13). The oil pump is a positive displacement gear pump with four check valves (11) for either direction of rotation. One pump gear is part of the rotating bushing (15), and the other is part of the laminated drive (19). The rotating bushing (15) is driven by the governor drive shaft (17) which is driven by the prime mover. As the bushing (15) rotates, it rotates the laminated drive (19). The oil pump gears (12) can be driven either clockwise or counterclockwise.

Oil flow is directed through the check valve system (11) into the accumulator system (8).

Accumulator

The purpose of the accumulator (8) is to store oil under pressure for the operation of the UG Lever governor.

The accumulator (two cylinders) also acts as a pressure relief valve if oil pressure is increased above 120 psi/827 kPa (150 psi/1034 kPa for UG-10).

The accumulator (8) consists of two spring-loaded pistons (9). Oil is pumped into the cylinders and pressure is increased as the accumulator springs (9) are compressed. When the oil pressure exceeds 120 psi/827 kPa (150 psi/1034 kPa for UG-10), oil is released back to sump through a relief port (10) in each cylinder.

Oil flows from the accumulator (8) through passages to the top of the power piston (7) and to the pilot valve system (14 and 15).

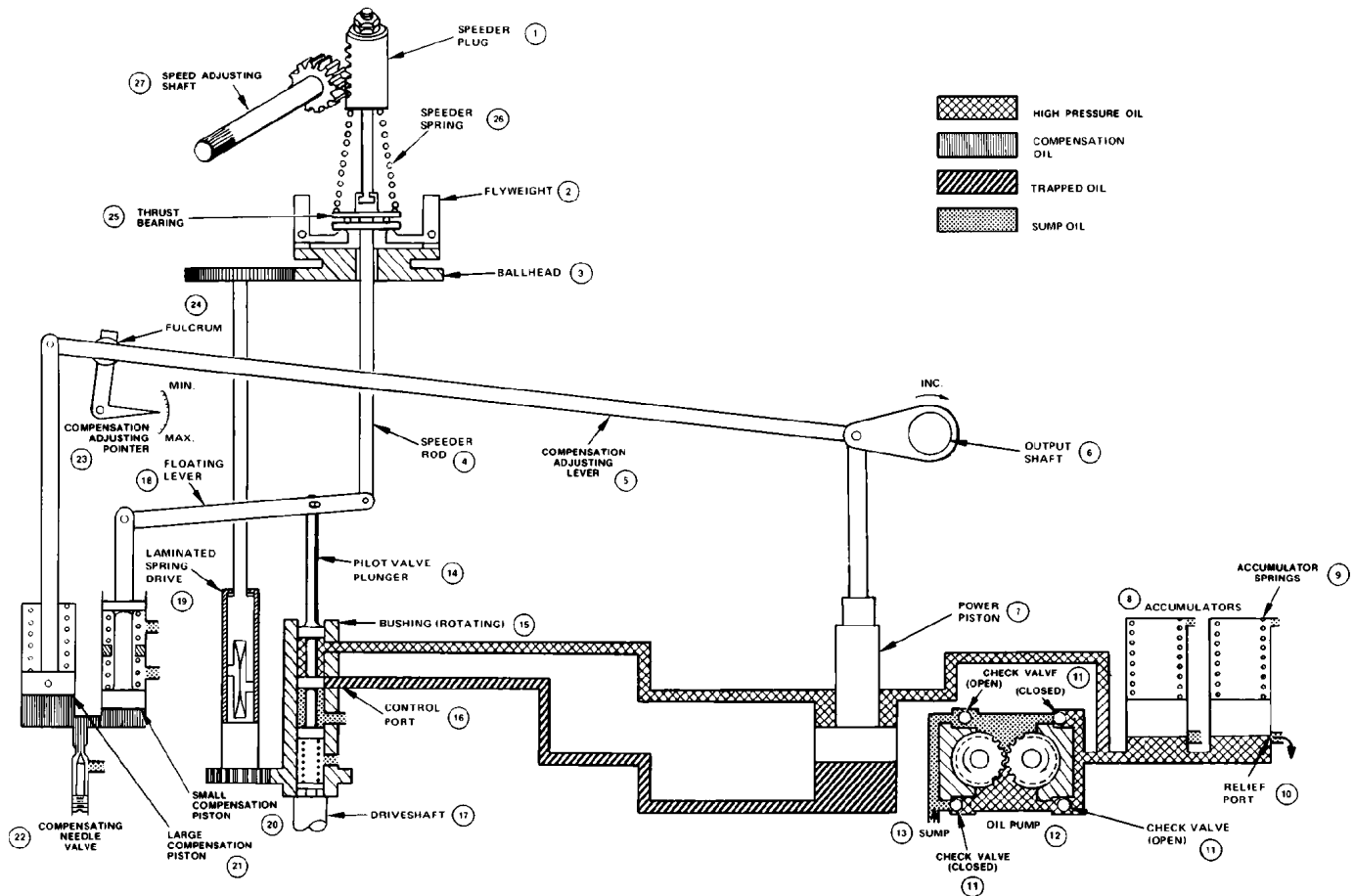


Figure 3-1. Schematic Diagram, UG Lever Governor

Power Piston

The purpose of the power piston (7) is to rotate the governor output shaft to the increase or decrease fuel position.

The power piston (servo) is a differential type with oil pressure on both sides of the piston. The upper end of the piston is connected to the governor output shaft (6) through a power lever and link assembly.

The bottom of the power piston (7) has a larger area than the top of the piston. Therefore, less oil pressure is required on the bottom than on the top to maintain the piston stationary. If the oil pressure is the same on both the top and bottom of the piston, the piston is moved upward to rotate the terminal shaft in the increase fuel direction. The piston moves downward only when oil under the piston is released to sump.

Oil to or from the bottom of the power piston is regulated by the pilot valve system.

Pilot Valve System

The purpose of the pilot valve system (14 and 15) is to control the flow of oil to or from the bottom of the power piston (7).

The bushing (15) is rotated by the drive shaft (17), and through this rotation, friction between the pilot valve plunger and bushing is reduced. The pilot valve plunger (14) has a control land that regulates oil flow through ports in the bushing (15).

When the pvp (14) is lowered, high pressure oil flows under the power piston (7), raising it. When the pvp is raised, oil is released to sump from under the power piston, lowering it. The higher pressure on the top of the piston (7) forces the piston downward. When the pvp (14) is in its centered position, the control land covers the control port as shown in the schematic (Figure 3-1), and there is no movement of the power piston. The pvp movement is controlled by the ballhead system (3) and the small and large compensation pistons (20 and 21).

Ballhead System

The purpose of the ballhead system (3) is to sense speed changes of the prime mover as compared to the speed setting reference given by the speeder spring (26) and to position the pilot valve plunger (14).

The ballhead system consists of a ballhead (3), flyweights (2), speeder spring (26), thrust bearing (25), speeder plug (1), and speeder rod (4). The ballhead (3) is geared and is driven by the laminated drive (19). The flyweights (2) are attached to the ballhead (3) with pivot pins. A thrust bearing (25) rides on the toes of the flyweights (2). The speeder spring (26) is held against the thrust bearing (25) by the speeder plug (1). As the ballhead (3) rotates, the flyweights (2) pivot outward due to the centrifugal force. At the same time, the speeder spring (26) is forcing the thrust bearing (25) downward on the flyweight toes (2). This downward force opposes the centrifugal force of the flyweights (2). Increasing the drive speed increases the centrifugal force. Compressing the speeder spring (26) with the speeder plug (1) increases the downward force and in turn increases the governor speed setting. The prime mover must run faster to produce a higher centrifugal force to overcome the speeder spring force and rebalance the system.

Speeder spring force or speed setting is controlled manually through the speed adjusting shaft (1).

Compensation System

The purpose of the compensation system is to give stability to the governor and to obtain steady state speed control.

Also, when correctly adjusted, the compensation system effectively regulates the amount of fuel necessary to bring the engine to the required output to adjust to a decrease or an increase in load.

A large compensation piston (21), small compensation piston (20), a floating lever (18), a compensation adjusting lever (5) with adjustable fulcrum (24), along with a compensating needle valve (22) make up the compensation system (see Figure 3-1).

Compensation is simply another word for temporary speed droop characteristic. The compensation system introduces a temporary readjustment of speed setting with output shaft movement to produce a stabilizing speed droop characteristic, followed by a relatively slow return of speed setting to its original value.

The large compensation piston (21) is linked to the output shaft (6) by a compensation adjusting lever (5). A pivotable fulcrum (24) rides on the adjusting lever. Changing the fulcrum's position allows the adjusting lever (5) to control the amount of stroke available for the actuating compensating piston.

The small compensation piston (20) is connected through a floating lever to the pilot valve plunger and the speeder rod.

Moving the large compensation piston (21) downward forces oil under the small compensation piston (20). As the small compensation piston (20) is forced upward, it lifts the pvp to close off the control port which stops the flow of oil to the bottom of the power piston (7).

The needle valve (22) controls the flow of oil between the oil sump and the large compensation piston (21) and the small compensation piston (20).

IMPORTANT

Compensation must be properly adjusted to the particular engine and load to provide stable operation (see Chapter 4, Compensation Adjustments).

Speed Droop

The UG Lever governor may be equipped at the factory with a speed droop assembly.

Speed droop, or simply droop, is one method of creating stability in a governor.

Droop is also used to divide and balance load between two or more prime movers operating in parallel or connected to a single shaft.

Droop is the decrease in speed taking place when the governor output shaft moves from the minimum to the maximum fuel position in response to a load increase, expressed as a percentage of rated speed.

If, instead of a decrease in speed, an increase takes place, the governor is showing a negative droop. Negative droop will cause instability in a governor.

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 a load.

Using an example where the governor speed is 1500 rpm at no load and 1450 rpm at full load, droop can be calculated with the formula:

$$\begin{aligned}\% \text{ Droop} &= \frac{\text{No load speed} - \text{Full load speed}}{\text{Full load speed}} \times 100 \\ \% \text{ Droop} &= \frac{1500 \text{ rpm} - 1450 \text{ rpm}}{1450 \text{ rpm}} \times 100 = 3.5\%\end{aligned}$$

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.

If the decrease in speed is greater than 50 rpm, droop greater than 3.5% is shown by the governor.

If the decrease in speed is less than 50 rpm, droop less than 3.5% is shown by the governor.

As the governor output shaft (5) moves to increase fuel, the speed setting spring compression is reduced, which reduces the governor speed setting. The unit starts reducing its speed as load is applied. When the governor output shaft (5) moves to decrease fuel, the speed setting spring compression is increased, which increases the governor speed setting. The unit starts increasing its speed as load is decreased. This change of governor speed setting when load is increased or decreased helps the governor resist a load change when the unit is connected mechanically with other units.

The speed droop assembly (Figure 3-2) consists of a speed droop lever assembly, a speed droop cam, and a speed droop link assembly which, when set, changes the compression of the speed setting spring as the governor output shaft rotates. For illustrated parts and part reference numbers of the optional speed droop assembly, see Figure 6-1.

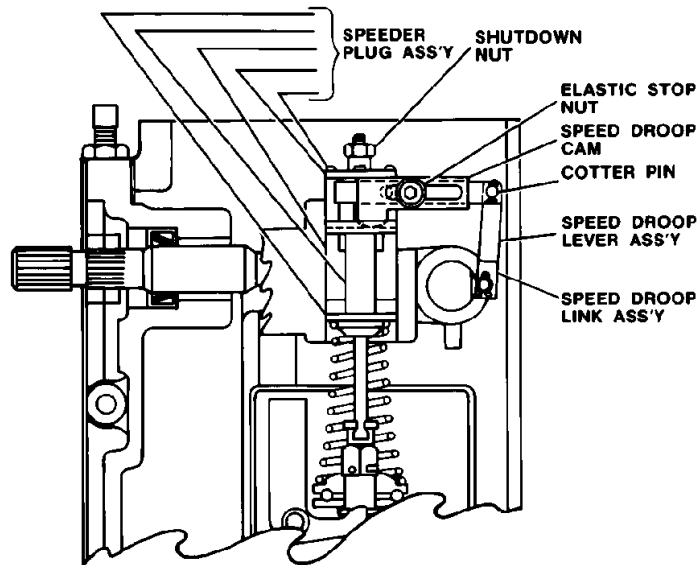


Figure 3-2. Speed Droop Assembly

If it is desired that the engine be shut down from the throttle position, the UG Lever governor can be equipped with a shutdown rod (Figure 3-3) operating as follows:

When the throttle is moved toward the shutdown position, the speeder plug rises, contacting the nut on the shutdown rod. Further movement lifts the shutdown rod, lifting speeder rod and inner end of floating lever, thus raising the pilot valve plunger and uncovering the control port in the pilot valve bushing. This permits oil under the power piston to flow to sump. Oil pressure on top of the power cylinder forces the power piston down to the zero fuel position. If the linkage to engine is correctly adjusted, the engine will shut down.

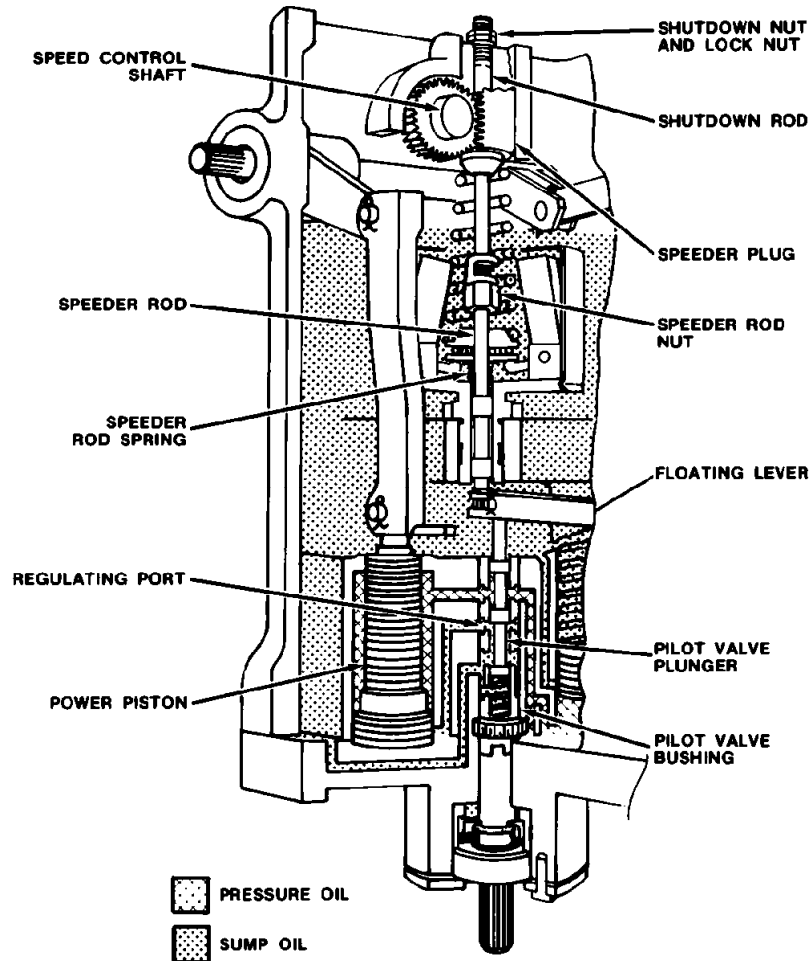


Figure 3-3. UG Lever Governor with Shutdown Rod

Operation of UG Lever Governor

Refer to Figure 3-1 with the text to better understand the operation of the UG Lever governor. This schematic diagram is of a basic design and does not include any auxiliary equipment.

This description is based on speed changes resulting from load changes. However, the same sequence of governor movements would occur if the governor speed setting were changed by repositioning the speed control linkage.

Decrease in Load

Assume the prime mover is running on-speed. The flyweights are in a vertical position for normal steady-state operation. The control land of the pilot valve plunger (14) is centered over the control port of the rotating bushing (15). This stops the flow of pressure oil through the bushing (15) control port. As a result, there is no movement of the power piston (7) and no movement of the governor output shaft (6).

When a decrease in load occurs and the same fuel setting is maintained, a decrease in load creates an increase in speed. This generates the following sequence of movements:

1. As speed increases, the centrifugal force of the flyweights (2) increases, overcoming the opposing speeder spring force.
2. The flyweights (2) tip outward, raising the speeder rod (4) and the right end of the floating lever (18).
3. This raises the pilot valve plunger (pvp) (14), opening the control port in the rotating bushing (15). Oil is released from the bottom of the power piston (7) to sump.
4. The pressure oil acting on the top side of the power piston (7) forces it down and rotates the output shaft (6) in the decrease fuel direction.
5. Linkage from the output shaft (6) lowers the compensation adjusting lever (5) which pivots at the fulcrum (24), lifting up the large compensation piston (21).
6. Suction is thus applied to the chamber of the small compensation piston (20), lowering the left end of the floating lever (18).
7. The pvp (14) is lowered in turn, closing off the control port (16).
8. As sump oil flows through the needle valve (22) from the sump into the compensation piston assembly (20 and 21), the small dashpot compensation piston (21) is returned to its normal centered position by the compensation spring at the same rate as the speeder rod (4). This keeps the pilot valve plunger (14) in its centered position.
9. This keeps the control port in the pilot valve bushing (15) covered by the land on the pvp (14).
10. The output shaft (6) and power piston (7) movement is stopped in the new decrease fuel position required to run the prime mover at the selected speed setting with the decrease in load.

Increase in Load

Again, assume the prime mover is running on-speed. The flyweights are in a vertical position and the pilot valve plunger is centered.

When an increase in load occurs and the same fuel setting is maintained, an increase in load creates a decrease in speed. This generates the following sequence of governor movements:

1. As speed decreases, the centrifugal force of the flyweights (2) decreases and the opposing speeder spring (26) force is now greater than the centrifugal force of the flyweights (2).
2. The flyweights (2) tip inward, lowering the speeder rod (4) and the right end of the floating lever (18).
3. This lowers the pilot valve plunger (14) opening the control port in the rotating bushing (15). Pressure oil is released through the control port to the bottom side of the power piston (7).

4. The pressure oil acting on the bottom side of the power piston forces it up and rotates the output shaft in the increase fuel direction.
5. Linkage from the output shaft (6) raises the compensation adjusting lever (5) which pivots at the fulcrum (24), lowering the large compensation piston (21).
6. Pressure oil is applied to the chamber of the small compensation piston (20), raising the left end of the floating lever (18).
7. The pvp is raised in turn, closing off the control port (18).
8. As sump oil flows through the needle valve (22) from the dashpot compensation piston assembly (20 and 21), the small compensation piston (20) is returned to its normal centered position by the compensation spring at the same rate as the speeder rod (4). This keeps the pilot valve plunger (14) in its centered position.
9. This keeps the control port in the pilot valve bushing (15) covered by the land on the pvp (14).
10. The output shaft (6) and power piston (7) movement is stopped in the new increase fuel position required to run the prime mover at the selected speed setting with the increase in load.

In either case, a decrease or an increase in load, the compensation system operates in the same manner: the compensation or amount of movement of the large compensation piston is controlled by the compensation adjustment (the fulcrum position).

The rate at which the small compensation piston (20) is returned to normal is controlled by the needle valve (22) adjustment—the rate of flow of oil through the needle valve (22).

When correctly adjusted, the compensation system effectively regulates the amount of fuel necessary to bring the engine to the required output to adjust to a decrease or an increase in load or to a speed setting change.

Chapter 4. Operation and Adjustment

Initial Operation for a New Governor

Before initial operation of the UG Lever governor, check that all previous installation steps are successfully accomplished and all linkages are secure and properly arranged and attached (see Chapter 2). Also read all of this chapter.

Fill the governor with oil to the top mark on the oil sight glass. Close the needle valve carefully (clockwise), then open it 1/2 to 3/4 turn. Loosen the nut holding the compensation adjusting pointer enough to move the pointer and set the pointer in the middle of the scale. Tighten the nut.

If replacing a governor, the initial compensation setting can be that of the governor just removed.



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.



Follow the prime mover manufacturer's instructions to start the prime mover.

Adjustments

Normally, the only adjustments for putting a new governor into service are bleeding trapped air and adjusting compensation to obtain satisfactory stability and response. All other operating adjustments were made during factory testing in accordance with the prime mover manufacturer's specifications and should not require further adjustment. Speed droop, high and low speed stops, and shutdown nut(s) adjustments are given in the "Test Procedures on the Engine" section of this manual.



Do not attempt internal adjustment of the governor unless you are thoroughly familiar with the proper procedure.

Compensation Adjustments

The needle valve and adjusting pointer are adjustable parts of the compensation system. Their settings directly affect governor stability.

Compensation must be properly adjusted to the particular engine and load to provide stable operation.

When the engine or turbine is started for the first time after the governor has been filled with oil, the governor may be stable at constant speed, yet the governor may need adjustment. High overspeeds and underspeeds after load changes and slow return to normal speed indicate the need for compensation adjustment.

IMPORTANT

Maximum compensation settings generally provide stable steady state operation but result in greater off-speeds on load changes.

After the oil in the governor has reached its normal operating temperature, make the following compensation adjustments without load on the prime mover to be certain that the governor gives optimum control. See Figure 1-1 for location of the adjustment parts.

1. To bleed trapped air from the governor oil passages, first loosen the nut holding the compensation adjusting pointer enough to set the pointer at its extreme upward position for maximum compensation.

Next, remove the needle valve access plug and open the needle valve two turns counterclockwise. Use a Phillips screwdriver to avoid damage to the threads inside the bore and to the needle valve.

Damage to the threads or to the needle valve will cause the governor to change fuel rhythmically. This is called governor hunt. See Chapter 5 for more information on hunting.

There are two screwdriver slots in the needle valve, a shallow slot and a deep slot, located at right angles to each other. The deeper slot is used to expand the head of the needle valve and increase friction to prevent vibrations from changing the needle valve setting.

IMPORTANT

If a plain screwdriver must be used, be sure to use the shallow slot of the needle valve.

Allow the prime mover to hunt for approximately 30 seconds to bleed trapped air from the governor oil passages.

2. Loosen the nut holding the compensation pointer just enough to lower the pointer as far as it will go for minimum compensation. Tighten the nut again.

IMPORTANT

The objective of the compensation adjustment procedure is to find the particular settings for the compensation needle valve and compensation adjustment pointer at which the engine, turbine, or other type of prime mover will return quickly to speed (needle valve adjustment) after a speed disturbance with only a slight over or undershoot (compensation pointer adjustment).

3. Gradually close the needle valve until hunting just stops. If hunting does not stop, open the needle valve one turn and move the compensation pointer up by one mark on the front panel indicator scale. Again gradually close the needle valve until hunting stops.

If hunting does not stop, set the needle valve 1/4 turn open and repeat setting the compensation pointer up by one mark. Retest the governor until hunting stops.

4. From this setting, open the needle valve one turn and manually disturb the governor fuel setting. Gradually close the needle valve until the governor returns to speed with only a small overshoot or undershoot and:
 - a. The needle valve is between 1/8 to 1/4 turn open on a governor with an oil sight glass located in the center of the dial panel.
 - b. The needle valve is between 3/8 to 3/4 turn open on a governor with an oil sight glass located on the side of the governor.

Compensation adjustment determines off-speed, and needle valve adjustment determines recovery time.

IMPORTANT

For most responsive governor control, use as little compensation as possible. Too much compensation causes excessive speed overshoots and undershoots on load changes.

IMPORTANT

Closing the needle valve more than indicated in a. or b. above makes the governor slow to return to normal speed after a load change.

Opening the needle valve more than indicated above decreases governor stability and can cause hunting.

Once the needle valve adjustment is correct, it is not necessary to change the setting except for large, permanent changes in temperature which affect governor oil viscosity.

When the adjustment is correct, tighten the compensation pointer nut and reinstall the needle valve access plug with a copper washer. The plug and the washer will seal oil seepage around the needle valve.

Initial Operation for a Repaired or Reassembled Governor

After disassembly or repair, it is very important to test the governor on a test stand. If a test stand is not available, testing of the governor can be done on the engine.

! WARNING

If testing of the governor is done on the engine, be careful to manually control the engine speed until you have proven that the governor will control engine speed.

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

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

Before operating a repaired governor for the first time, check that all installation steps have been correctly completed (see Chapter 2). Also read all of this chapter.

Attach a serration wrench to the speed setting shaft in addition to the normal linkage attachment to manually control engine speed with the serration wrench. Then fill the governor with oil (see Chapter 2, Oil Supply). The oil level must be to the mark on the oil sight glass. Close the needle valve and reopen it 1/2 to 3/4 turns (see Chapter 4, Compensation Adjustments) and set the compensation adjusting pointer at mid-point.

If accurate tests and adjustments are to be made, it is best to use a test stand since it is difficult to make them when the governor is mounted on an engine. Contact Woodward for a copy of the test specification for each governor designation.

The tools listed in Table 4-1 are optional and not absolutely necessary unless a large number of governors is being repaired. The pressure gauge, however, is always needed to check operating oil pressure.



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

Follow prime mover manufacturer's instructions to start the prime mover.

Table 4-1. Test Stand Tools

Tool Description	Application
Test stand, Woodward P/N 205975	Drives governor, supplies oil under pressure and contains gauges for monitoring governor operation.
Electronic Counter & Frequency Pickup	To indicate governor drive speed. Must have an output of at least 60 Hz per revolution on a one-second time base. Must indicate drive speed to within ± 1 rpm. Readouts of display time must not exceed 5 seconds.
Pressure Gauge (0 to 200 psi/0 to 1400 kPa)	Check governor oil pressure.

Test Procedures on the Engine

These adjustments and test procedures are divided by whether the governor has droop parts or does not. Follow whichever instructions are applicable.

UG Lever Test without Droop Parts

(Reference Figure 6-1)

1. Remove pipe plug (9) in the base of the governor on the opposite side of the needle valve plug (146) and attach a 0–200 psi (0–1400 kPa) pressure gauge.
2. Install the governor on a test stand or on the engine pad. See Chapter 2.
3. Fill the governor with oil. See Chapter 2, Oil Supply. The oil level must be to the mark on the oil sight glass.
4. Set the compensation adjusting pointer at mid-point on the pointer scale.

5. If the governor is tested on the engine, start the prime mover according to the instructions from the manufacturer. Run the governor until it is at operating temperature.
6. Check that the governor has 110–120 psi/758–827 kPa (135–150 psi/931–1034 kPa for UG-10) oil pressure at normal operating speed.
7. Close the needle valve (148) and open it just enough to cause a small hunt. Use a Phillips screwdriver. If a plain screwdriver must be used, make sure to use only the shallow slot of the needle valve to avoid damage to the threads inside the bore and to the needle valve.

Damage to the threads or to the needle valve will cause the governor to hunt.

Let the prime mover hunt for approximately 30 seconds to bleed trapped air from the governor oil passages.

8. Close the needle valve and open it again one-half turn. If the governor continues to hunt, repeat step 6.
9. Adjust the compensation system. See Compensation Adjustments in this chapter.

IMPORTANT

Maximum speed for constant operation for the UG Lever governor is 1500 rpm.

10. Move the speed setting shaft to obtain the specified high speed. The stop levers have been installed on the shaft at governor assembly. Now slide the high speed stop on the shaft serration as close to the boss and the left hand side stop screw (high speed stop screw) as possible.
11. Use the high speed stop screw to make fine adjustments to the high speed setting (counterclockwise to increase) and lock with nut (23).
12. Move the speed setting shaft to the specified low speed setting. Slide the low speed stop lever into position as close to the boss of upper stop screw (low speed stop screw) as possible.
13. Use the low speed stop screw to make fine adjustments to the low speed setting (counterclockwise to decrease speed) and lock with nut (23).
14. If shutdown is not required, lock shutdown nuts (30) together at the top of the shutdown rod. If a self-locking nut is used, thread it onto the shutdown rod until 1/4" (6 mm) of threads is above the nut.

To set the nut(s) for shutdown operation, adjust the low speed stop screw to allow 10° rotation of the speed adjusting shaft below minimum speed setting. Thread the nut down on top of the speeder plug to obtain shutdown at 5° below minimum speed setting. Lock the nut in place.

IMPORTANT

If the governor was factory set for shutdown, there is a center punch indentation in the stop lever. Set the low speed and adjust the stop lever until the indentation is visible through the hole in the front cover plate. Thread the nuts down onto the speeder plug to obtain shutdown.

15. Shut down the engine. Remove the pressure gauge and install a 1/8" socket pipe plug. Apply a pipe sealer to the threads and torque pipe plug down to 90 lb-in (10 N·m).

UG Lever Test with Droop Parts

(Reference Figure 6-1)

Adjustment of the speed stop levers and final check of droop lever and cam adjustment must be made only while the prime mover being controlled is operating in a single unit configuration. This test requires loading of the prime mover. Adjust the governor to use as little droop as possible yet obtain satisfactory control.

IMPORTANT

On applications such as paralleled generator sets where maximum loading is difficult, observation of governor behavior may be the best way of checking droop operation. Presetting of dimension "C" on the droop lever and cam during assembly gives a reasonably accurate droop setting for prime mover operation during the observation period.

If, over an observation period, the unit takes greater load than the other units, its droop setting is lower than the other units and should be increased slightly for better load sharing.

1. Remove pipe plug (9) in the base of the governor on the opposite side of the needle valve plug (146) and attach a 0–200 psi (0–1400 kPa) pressure gauge.
2. Install the governor on a test stand or on the engine pad. See Chapter 2.
3. Fill the governor with oil. See Chapter 2, Oil Supply. The oil level must be to the mark on the oil sight glass.
4. Set the compensation adjusting pointer at mid-point on the pointer scale.
5. If the governor is tested on the engine, start the prime mover according to the instructions from the manufacturer. Run the governor until it is at operating temperature.
6. Check that the governor has 110–120 psi/758–827 kPa (135–150 psi/931–1034 kPa for UG-10) oil pressure at normal operating speed.
7. Close the needle valve (148) and open it just enough to cause a small hunt. Use a Phillips screwdriver. If a plain screwdriver must be used, make sure to use only the shallow slot of the needle valve to avoid damage to the threads inside the bore and to the needle valve.

Damage to the threads or to the needle valve will cause the governor to hunt.

Let the prime mover hunt for approximately 30 seconds to bleed trapped air from the governor oil passages.

8. Close the needle valve and open it again one-half turn. If the governor continues to hunt, repeat step 7.

9. Adjust the compensation system. See Compensation Adjustments in this chapter.

Adjustment of the droop lever and cam (37 and 38) affect the speed settings. For this reason, droop must be checked and adjusted before the high and low speed stop settings are made.

Using an example where the speed is 1450 rpm and droop setting is 3%, move the speed setting shaft to obtain approximately 1450 rpm off minimum fuel.

IMPORTANT

Maximum recommended constant operation speed for the UG Lever governor is 1500 rpm.

10. Increase load to maximum and observe a decrease in speed to 1405 rpm, which is a 3% decrease.

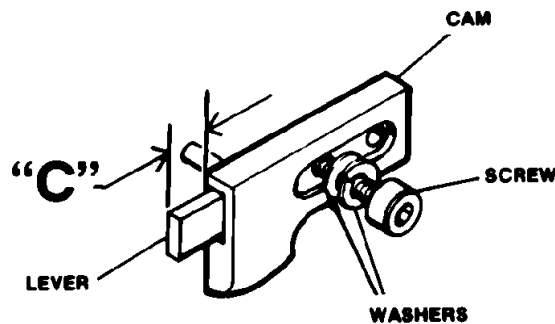


Figure 4-1. Droop Pre-Setting

If speed decreases below 1405 rpm, droop greater than 3% is indicated. Dimension "C" of the droop lever and cam assembly should be increased slightly.

If speed decreases to more than 1405 rpm, droop less than 3% is indicated. Dimension "C" of the droop lever and cam assembly should be decreased slightly.

Once the droop adjustment is correct, set the high and low speed stops.

11. Move the speed setting shaft to the maximum specified speed and apply maximum load. Push the high speed stop lever on the shaft serrations as close to the boss at the left hand stop screw (high speed stop screw) as possible.
12. Use the high speed stop screw to make fine adjustments to the high speed setting (counterclockwise to increase) and lock with nut (23).
13. Move the speed setting shaft to the specified low speed setting with minimum load. Slide the low speed stop lever into position as close to the boss of the upper stop screw (low speed stop screw) as possible.
14. Use the low speed stop screw to make fine adjustments to the low speed setting (counterclockwise to decrease) and lock with nut (23).

15. Shut down the engine. Remove the pressure gauge and install a 1/8" socket pipe plug. Apply a pipe sealer to the threads and torque pipe plug down to 90 lb-in (10 N·m).

Table 4-2. Droop Pre-Setting

Distance "C"	Droop %
0.328 inch (8.33 mm)	3
0.266 inch (6.76 mm)	5
0.141 inch (3.58 mm)	10

Test Completion

When adjustments are complete, replace the front panel and governor cover. Shutdown auxiliary devices require installation, adjusting, and testing described in the applicable manuals before governor installation is complete.

Chapter 5. Troubleshooting

Introduction

It is impossible to anticipate every kind of trouble that is encountered in the field. This manual covers the most common troubles experienced. Poor governing may be due to faulty governor performance, or it may be due to the governor attempting to correct for faulty operation of the prime mover or the equipment driven. The effect of any auxiliary equipment on the overall control required of the governor must also be considered.



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.

Troubleshooting

Oil

Keep the governor oil level to the mark on the oil sight glass with the unit operating. The correct oil level is 0.75 to 1.25 inch (19 to 32 mm) below the top of the governor case.

Dirty oil causes most of all governor troubles. Use clean new or filtered oil. Oil containers used must be perfectly clean. Oil contaminated with water breaks down rapidly, causing foaming and corrodes internal governor parts.

Compensating Adjustment and Needle Valve

The compensating adjustment and needle valve must be correctly adjusted with the governor controlling the engine or turbine, even though the compensation may have been previously adjusted at the factory or on governor test equipment.

Although the governor may appear to be operating satisfactorily because the unit runs at constant speed without load, the governor still may not be correctly adjusted to the load and to the engine it is to control.

High overspeeds and low underspeeds, or slow return to speed after a load change or speed setting change are some of the results of an incorrect setting of the compensating adjustment and needle valve.

Definitions

Use the troubleshooting chart (Table 5-2) on the following pages to determine the probable causes of faulty operation and to correct these troubles.

Terms used in the chart are defined as follows:

Hunt

A rhythmic variation of speed which can originate in the governor or in the prime mover. (See Table 5-2, Paragraph 1A, for troubleshooting information.) A hunt usually has a frequency of less than 50 Hz/min.

Surge

A sudden variation of speed occurring at periodic intervals which can also originate in the governor or in the prime mover. (See Table 5-2, Paragraph 1A, for troubleshooting information.)

Jiggle

A high frequency vibration of the governor output shaft and fuel linkage. Do not confuse this with the normal, controlling action of the governor. A jiggle has a frequency of more than 50 Hz/min.

Preliminary Inspection

Governor troubles are usually revealed in speed variations of the prime mover, but it does not necessarily follow that such variations are caused by the governor. When improper speed variations appear, the following procedure should be performed:

1. Check the load to be sure the speed changes are not the result of load changes beyond the capacity of the prime mover.
2. Check engine operation to be sure all cylinders are firing properly and that the fuel injectors are in good operating condition and properly calibrated.
3. Check the linkage between the governor and fuel racks or valve. There must be no binding or lost motion.
4. Check the setting of the needle valve and compensation adjustment (see Chapter 4, Compensation Adjustments).
5. Check that the oil is clean and oil level is correct at operating temperature.

The source of most troubles in any hydraulic governor stems from dirty oil. Grit and other impurities can be introduced into the governor with the oil, or form when the oil begins to break down (oxidize) or becomes sludgy.

The internal moving parts are continually lubricated by the oil within the unit. Valves, pistons, and plungers will stick and even "freeze" in their bores due to grit and impurities in the oil.

If this is the case, erratic operation and poor response can be corrected (if wear is not excessive) by flushing the unit with fuel oil or kerosene.

The use of commercial solvents is not recommended as they may damage seals or gaskets.

Change the oil and flush the governor twice a year if possible.

To change oil, remove the drain plug and drain out the old oil, Flush the governor by filling it with fuel oil and, with the prime mover running at low speed, cycle the governor by opening the needle valve two or three turns.

Let the governor hunt for a minute or two, then stop the engine and drain the governor. Flush the governor once again. Refill the governor with oil (see Chapter 2, Oil Supply).

Restart the engine and reset the compensation adjustment and needle valve.

6. Check that the drive to the governor is correctly aligned and free of roughness, side loading, and excessive backlash.



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.

Additional Information for Steam Turbines, Gas and Gasoline Engines

The engine torque versus throttle position for a steam turbine gives a wide variety of non-linear relations. Each type must be compensated for with the correct compensating linkage to bring the governor output shaft movement back into a near linear relation with the prime mover torque output.

Please refer to the prime mover manufacturer's handbook for the correct linkage selection and installation.

The torque vs. throttle position curve for a gas or gasoline engine which is controlled through a butterfly valve is always very non-linear. When adapting a governor to this type of engine, if the linkage is made linear, operation at idle and light loads is never very stable.

The proper procedure for adapting a governor to this engine with the butterfly valve is to make the linkage so that it requires greater movement of the governor per increment of butterfly movement at light loads than it does at high loads.

This linkage tends to linearize the relation between engine developed torque and governor output shaft position (see Figure 1-4).

The chart below shows a satisfactory angular position of the governor output shaft for different openings of the butterfly valve in order to have a more stable operation at idle and at light loads.

Table 5-1. Governor Output Shaft Travel vs. Butterfly Valve Travel

Governor Output Shaft Travel	Butterfly Valve Shaft Travel
0°	0°
6°	3°
12°	9°
15°	20°
18°	30°
24°	82°

Table 5-2. Troubleshooting Chart

Trouble	Cause	Correction
1. The engine, turbine, or other type of prime mover hunts or surges.	A. The trouble may be originating in the governor or the prime mover.	Block the throttle, fuel racks, or steam valve in the direction of increase fuel. (NEVER block the governor output shaft in the direction that would prevent a complete shutdown.) If hunting and/or surging continues while the governor output shaft is blocked, the problem is in the prime mover. If after removing the block, hunting and/or surging starts again, the problem can be in the governor or in the prime mover. Go through the compensation adjustment procedure for the governor (see Chapter 4, Compensation Adjustments). If the problem is still there, replace the governor with a replacement governor. Go through the compensation adjustment procedure for the replacement governor. If the hunting and/or surging continues, the problem is in the prime mover.
	B. Compensation adjustments incorrect.	Adjust the needle valve and compensation adjusting pointer.
	C. Dirty oil in governor—sludge.	Drain oil, clean governor, and refill.
	D. Low oil level which permits air to enter and cause foaming. This is evident in the governor as spongy operation.	Add oil to the correct level on the oil sight glass. If oil level decreases and no external oil leaks can be seen on the governor, check the drive shaft for oil leaks. If foaming continues, drain oil and refill, using a different type oil.
	E. Oil varnish which causes sticking of parts.	Repair governor.
	F. Lost motion in engine linkage or fuel pumps.	Repair linkage or pumps.
	G. Binding in engine linkage or fuel pumps.	Repair and realign linkage or pumps.
	H. Governor output shaft travel too short to provide full fuel.	Adjust lever until proper travel is attained.
	I. Spring on yield linkage to fuel racks too weak.	Install heavier spring.
	J. Low oil pressure. Normal operating pressure 110 to 120 psi for the UG-5.7 and UG-8; 135 to 150 psi for the UG-10. (See Outline Drawing Figure 1-2 for pressure test point location.) Pump check valves are not seating or accumulator springs weak.	Return governor to factory to replace check valves and/or accumulator springs.
	K. Power piston is sticking.	Check for side play or binding of output shaft.
	L. Voltage regulator not operating properly.	Check voltage regulator. Operate in voltage droop or manual. Don't disconnect voltage regulator. Adjust, repair, or replace voltage regulator.
	M. Incorrect non-linear relationship between governor travel and horsepower output of the prime mover. Engine may hunt with light loads and be stable with heavy loads.	Adjust linkage from governor to valve to obtain linear relationship between governor travel and engine output. See Figure 1-3. Also see Application Note 50516.
	N. Governor worn.	Return governor to factory for repair.
	O. Gas or steam pressure too high.	Adjust gas or steam pressure.
	P. Engine misfiring. (Bad fuel injector, low pilot fuel on dual fuel engine.)	Check pyrometer readings of each cylinder and make necessary repairs or adjustments.

Trouble	Cause	Correction
2. Fuel racks do not open quickly when cranking engine, turbine, or other type of prime mover.	A. Cranking speed too low.	May be necessary to use a booster servomotor. See Booster Servomotor manual 36684.
	B. Booster servomotor (if used) not functioning properly.	Check action of automatic air starting valve. See Booster Servomotor manual 36684.
	C. Low oil pressure in governor.	Return governor to factory to repair. See item 1J above.
3. Jiggle at governor output shaft.	A. Rough engine drive or governor drive.	<p>Inspect drive mechanism.</p> <ol style="list-style-type: none"> Check alignment of gears. Inspect for rough gear teeth, eccentric gears, or excessive backlash in gear train. Check gear keys and nuts or set screws holding drive gears to shafts. Check for bent drive shaft. Check serrated or spline coupling for wear and alignment. Tighten chain between crankshaft and camshaft (if used). Check engine vibration damper (if used). <div style="background-color: #006400; color: white; padding: 2px; text-align: center; font-weight: bold; margin: 10px 0;">IMPORTANT</div> <p>If a keyed drive is used, the backlash must be checked and the gear shimmed so that there is no binding and the backlash is not too great. This should be done each time a new or replacement governor is installed.</p> <p>If a serrated drive is used, concentricity of shaft to pilot valve should be maintained. Coupling should be as long as possible to permit greater flexibility.</p>
	B. Governor is not aligned properly.	Loosen governor mounting screws and move the governor slightly on its mounting pad to align the drive shaft with its coupling.
	C. Failure of flexible drive in flyweight head.	Return governor to factory to repair.
	D. Other possible causes are: <ul style="list-style-type: none"> dirty or worn ballhead bearing rough or worn gear teeth bent speeder spring damaged drive shaft seal retainer 	<p>Return governor to factory to repair.</p> <p>Replace seal retainer.</p>
	E. Air in governor system can cause a jiggle during start-ups or transients.	Bleed air (see Chapter 4, paragraph 7).
4. Load does not divide properly on Inter-connected engines, turbines, or other type of prime movers.	A. Speed settings of the governor are not the same.	Adjust speed setting so both prime movers run at the same speed.
	B. Internal speed droop adjustment incorrect.	<p>Readjust droop lever assembly to divide load properly.</p> <p>Increase droop to resist picking up (or dropping off) load.</p> <p>Reduce droop to Increase picking up (or dropping off) load.</p>

Trouble	Cause	Correction
5. The engine, turbine, or other type of prime mover is slow to respond to a speed change or a load change.	A. Needle valve adjustment incorrect.	Readjust compensating needle valve. Open further if possible to do so without causing instability when running without load. Compensation pointer may be too far toward maximum.
	B. Governor is not sensitive in measuring speed change (deadband).	Friction or wear on flyweight toes—sludge in governor. Return governor to factory.
	C. Low oil pressure in governor.	Return governor to factory to inspect pump and check valves if oil pressure is low.
	D. Engine may be overloaded.	Reduce load.
	E. Restricted fuel supply.	Clean fuel supply filters.
6. The engine, turbine, or other type of prime mover will not pick up rated full load.	A. Fuel racks will not open far enough for governor at end of its stroke.	Adjust engine-to-governor fuel linkage. Adjust fuel pump stops.
	B. Restricted fuel supply.	Clean fuel supply filters. Gas pressure low. Gas with different calorific value.
	C. Engine misfiring.	Check pyrometer readings of each cylinder and make necessary repairs or adjustments.

Governor Field Repairs

Replacement of output shaft and drive shaft seals and bearings can be done in the field.

Refer to Figures 5-1 and 5-2 and to Tables 5-3 and 5-4 for a listing of common bench tools and normal field repair tools.

These tools are not considered to be essential. They do, however, make replacement of seals and bearings more convenient.

Tools can be ordered from Woodward. See Chapter 8 for contact information. Include the following information:

- The tool description.
- The tool number or part number of the tool required.
- The manual number (this is manual 03036).

Removal of Governor from Engine

To replace a governor on the engine, or to replace seals or bearings on the governor, remove the governor from the engine as follows:

NOTICE

Use care in handling and resting the governor on the work area. Do not strike or rest the governor on the end of the drive shaft as damage may result to the drive shaft, oil seal, bearing, or other internal parts or surfaces. Set the governor on wooden block(s) to protect the drive shaft when performing any maintenance operation.

1. Drain oil from the governor and install the drain plug again. Some governors are equipped with a drain cock for draining.
2. Clean exterior surfaces using a cloth moistened with cleaning solvent.
3. Disconnect auxiliary device wiring and pneumatic or hydraulic tubing connections if applicable.

4. Before detaching output shaft and speed setting linkages, mark both shaft and lever so they may be easily reinstalled in their original positions.
5. Remove the four stud nuts holding the governor to the mounting pad and lift the governor off. Remove the gasket between the governor and governor mounting pad.
6. Set the governor on wooden blocks to protect the drive shaft. Be very careful to avoid striking the end of the drive shaft a sharp blow. Damage to internal parts may result.

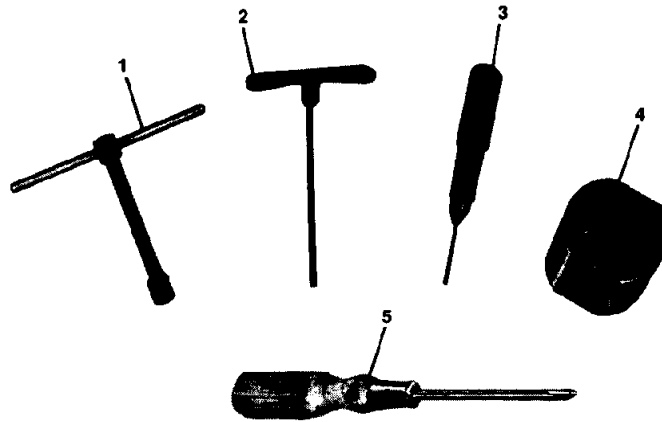


Figure 5-1. Common Bench Tools

Table 5-3. List of Common Bench Tools

Tool Description	Ref. No.	Tool No.	Application
T-Handle Hex Wrench 7/16"	1	189440	Various bolts on UG Lever Governor
"T" Handle, Allen Wrench 3/16"	2	8995-047	To install 1/8" pipe plugs
Standard Allen Wrench 5/64"	3	8995-048	For No. 8:32 headless set screws
Bench Block	4	011971	To press out small bearings and bushings
No. 2 Phillips Head Screwdriver	5	8995-049	Various screws on UG Lever Governor
Hooked Scribe (not shown)		189792	Removing and installing Cotter pins

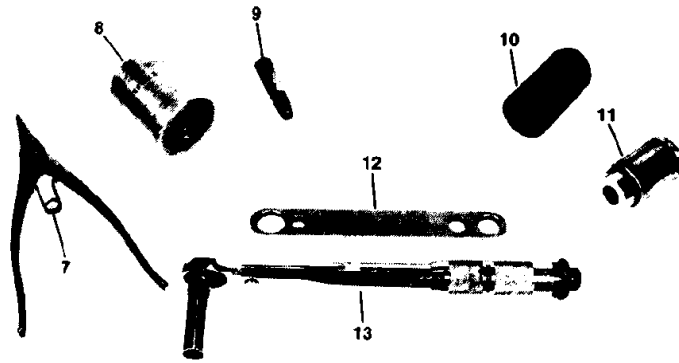


Figure 5-2. Normal Field Repair Tools

Table 5-4. List of Normal Field Repair Tools

Tool Description	Ref. No.	Tool No.	Application
William Pliers	7	8995-023	Replace retaining ring on drive shaft
Bearing Seater	8	8995-024	Replace drive shaft bearing
Seal Protector (used with 030952)	9	030951	Fit on output shaft to protect seal
Seal Installing Tool (Micarta type)	10	030952	Install output shaft seals
Bushing Driver	11	8995-028	Adjust output shaft bushings
Serration Wrench	12	030943	Turning output shaft or drive shaft
Torque Wrench w/ 7/16" Socket	13	8995-038	Torque drive shaft retainer bolts to 25 lb-in

Chapter 6.

Replacement Parts

When ordering replacement parts, include the following information:

- Governor serial number and part number shown on the nameplate
- Manual number (this is manual 03036)
- Part reference number in parts list and description of part or part name



Do not disassemble or reassemble the governor unless fully familiar with correct and safe procedures. Injury may result if accumulator springs are released suddenly. Use an arbor press to release or to install the compressed accumulator springs.

Parts List for Figure 6-1

Ref. No.	Part Name	Quantity	Ref. No.	Part Name.....	Quantity
03036-1	Phillips rd. hd. screw, 10-32 x 1/2"	8	03036-23	Nut 5/16-18	2
03036-2	Lockwasher #10	8	03036-24	Soc. set screw, 5/16-18	2
03036-3	Oil filler cup	1	03036-25	Oilite bushing	1
03036-4	Cover	1	03036-26	UG-8L front panel	1
03036-5	Cover gasket	1	03036-27	Oilite bushing	1
03036-6	Washer, 3/8" OD	1	03036-28	Gear.....	1
03036-7	Cotter pin, .030" x 3/8"	1	03036-29	Roll pin, 1/8" x 3/4".....	1
03036-8	Case.....	1	03036-30	Nut	2
03036-9	Soc. pipe plug, 1/8"	8	03036-31	Speeder plug, non-droop	1
03036-10	Front panel gasket	1	03036-32	Elbow, 1/8".....	1
03036-11	Speeder spring.....	1	03036-33	Oil sight glass	1
03036-12	Shutdown rod	1	03036-34	Shutdown nut.....	1
03036-13	Shutdown strap	1	03036-35	Droop link assembly	1
03036-14	Pin	2	03036-36	Cotter pin	1
03036-15	Soc. hd. screw, 10-32	8	03036-37	Droop lever assembly	1
03036-16	Lockwasher, #10	8	03036-36	Droop cam	1
03036-17	Oil seal	1	03036-39	Washer, .175" x 3/8" OD.....	1
03036-18	High-speed stop lever	1	03036-40	Lockwasher #8.....	1
03036-19	Low-speed stop lever	1	03036-41	Soc. hd. cap screw, 8-32	1
03036-20	UG-8L front plate.....	1	03036-42	Speeder plug assy, optional droop	1
03036-21	Phillips rd. hd screw, 8-32 x 3/8"	6	03036-43	Optional 1-position stop lever	1
03036-22	Speed adjusting shaft.....	1	03036-44	Soc. hd. cap screw, 10-32 x 0.500.....	1

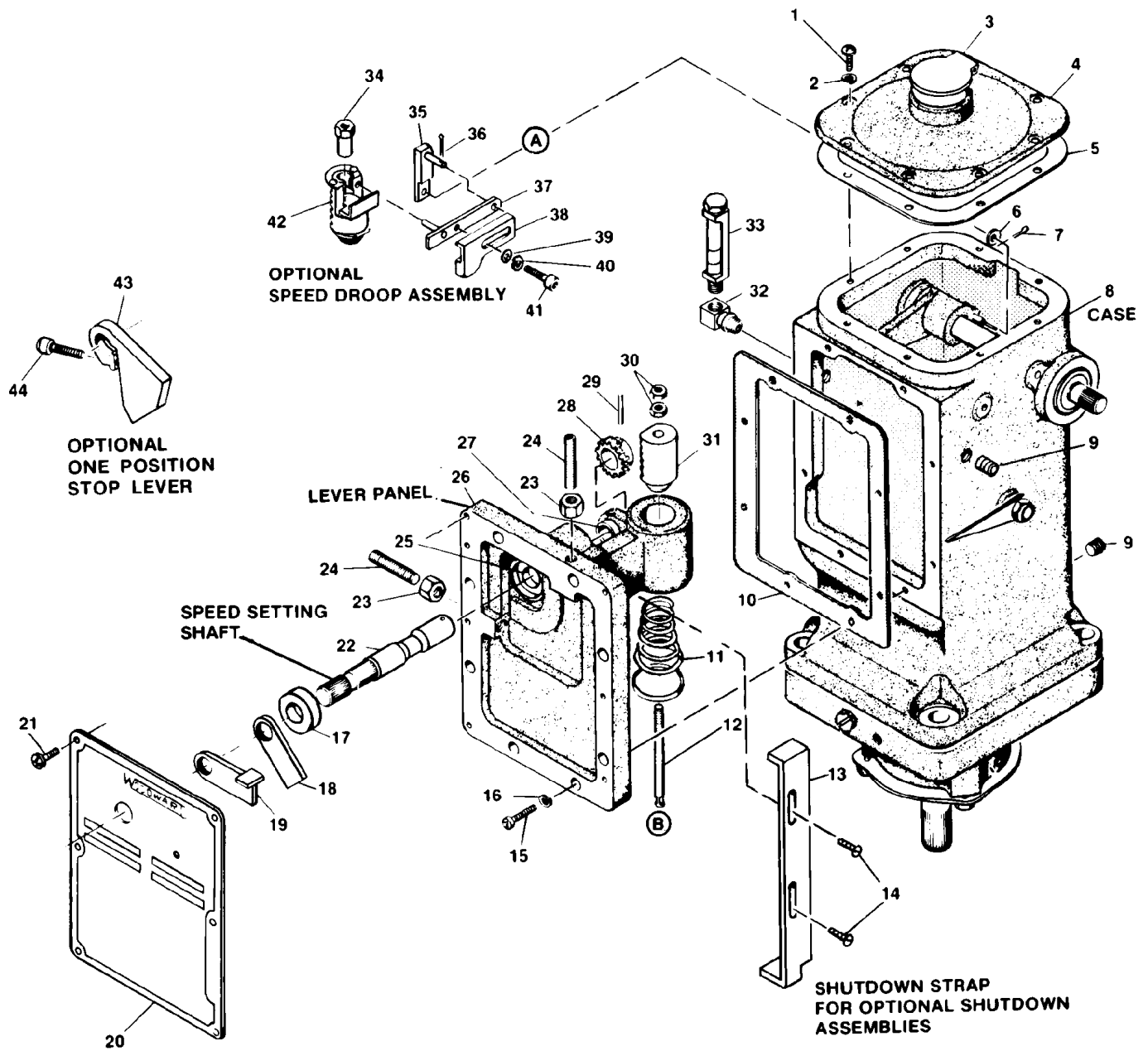


Figure 6-1. Illustrated Parts for the UG Lever Governor (sheet 1)

Parts List for Figure 6-2

Ref. No.	Part Name	Quantity
Reference numbers 45-54 are not used		
03036-55	Oil seal, 1.120" OD	2
03036-56	Terminal shaft bushing	1
03036-57	Output (terminal) shaft	1
03036-58	Soc. set screw, 1/4-28 x 5/16"	2
03036-58A	Compensation adjustment lever pin stop	2
03036-59	Washer, 7/16" x 5/8" x 1/32" thick	1
03036-60	Compensation adjusting pointer	1
03036-61	Washer, .328" x 0.562" x 0.064" thick	1
03036-62	Elastic stop nut, 5/16-24	1
03036-63	Gasket, case to controlet	1
03036-64	Preformed packing ring, 0.301" x 10 x 0.070" ...	1
03036-65	Compensation lever adjustment assembly	1
03036-66	Compensation lever adjustment fulcrum	1
03036-67	Compensation adjustment link	1
03036-68	Straight pin, drilled	1
03036-69	Cotter pin	1
03036-70	Straight pin, drilled	1
03036-71	Power lever	1
03036-72	Taper pin, #3 x 1 1/4"	2
03036-73	Droop pin	1
03036-74	Cotter pin, 0.060" x 3/4"	1
03036-75	Compensating lever	1
03036-76	Straight pin, drilled	1
03036-77	Cotter pin	1
03036-78	Power piston link	1
03036-79	Not Used	
03036-80	Washer, aluminum seal	9
03036-81	Hex hd. screw, 1/4-28 x 1.00"	4

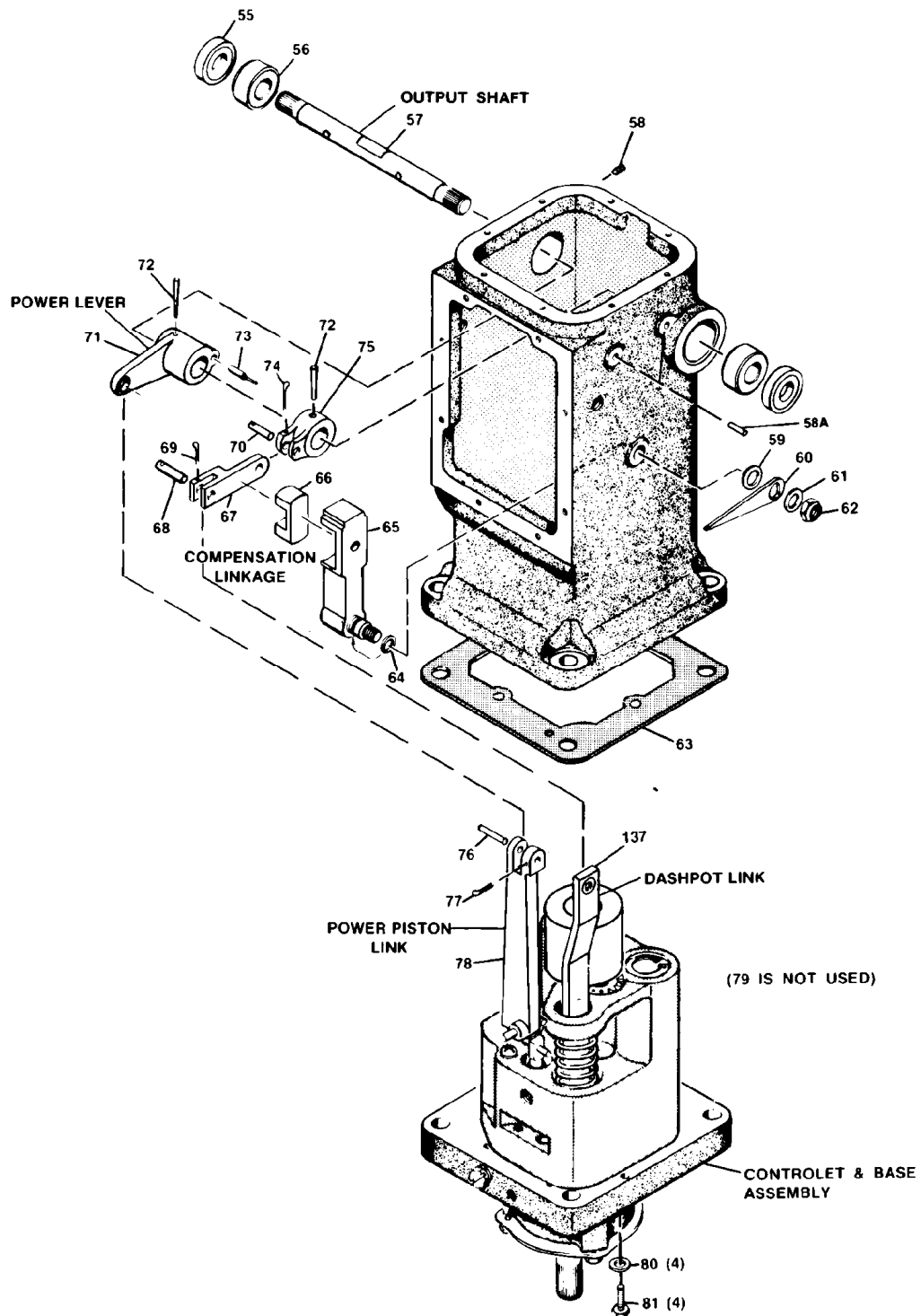


Figure 6-2. Illustrated Parts for the UG Lever Governor (sheet 2)

Parts List for Figure 6-3

Ref. No.	Part Name	Quantity
Reference numbers 82-84 are not used		
03036-85	Drive shaft, optional keyed	1
03036-86	Key, 0.188" x 0.190" x 1.062"	1
03036-87	Spacer	1
03036-88	Castle nut, 5/8-18	1
03036-89	Cotter pin, 1/8" 5 1 1/2"	1
03036-90	Pilot valve plunger	1
03036-91	Spring seat.....	1
03036-92	Pilot valve spring.....	1
03036-93	Drive shaft, standard 5/8-36 serration.....	1
03036-94	Sealed bearing.....	1
03036-95	Snap ring	1
03036-96	Bearing retainer	1
03036-97	Hex hd. screw, 1/4-28 x 5/8"	3
03036-98	Oil seal, 1.379" OD	1
03036-99	Oil seal retainer.....	1
03036-100	Seal retainer gasket.....	1
03036-101	Floating lever	1
03036-102	Straight pin, drilled	1
03036-103	Cotter pin, 0.030" x 3/8"	2
03036-104	Ballhead drive gear	1
03036-105	Cotter pin, 0.060" x 1/2"	1
03036-106	Cotter pin	1
03036-107	Washer	1
03036-108	Speeder rod	1
03036-109	Ballhead assembly.....	1
03036-110	Speeder rod spring	1
03036-111	Thrust bearing.....	1
03036-112	Cotter pin	1
03036-113	Speeder rod nut	1

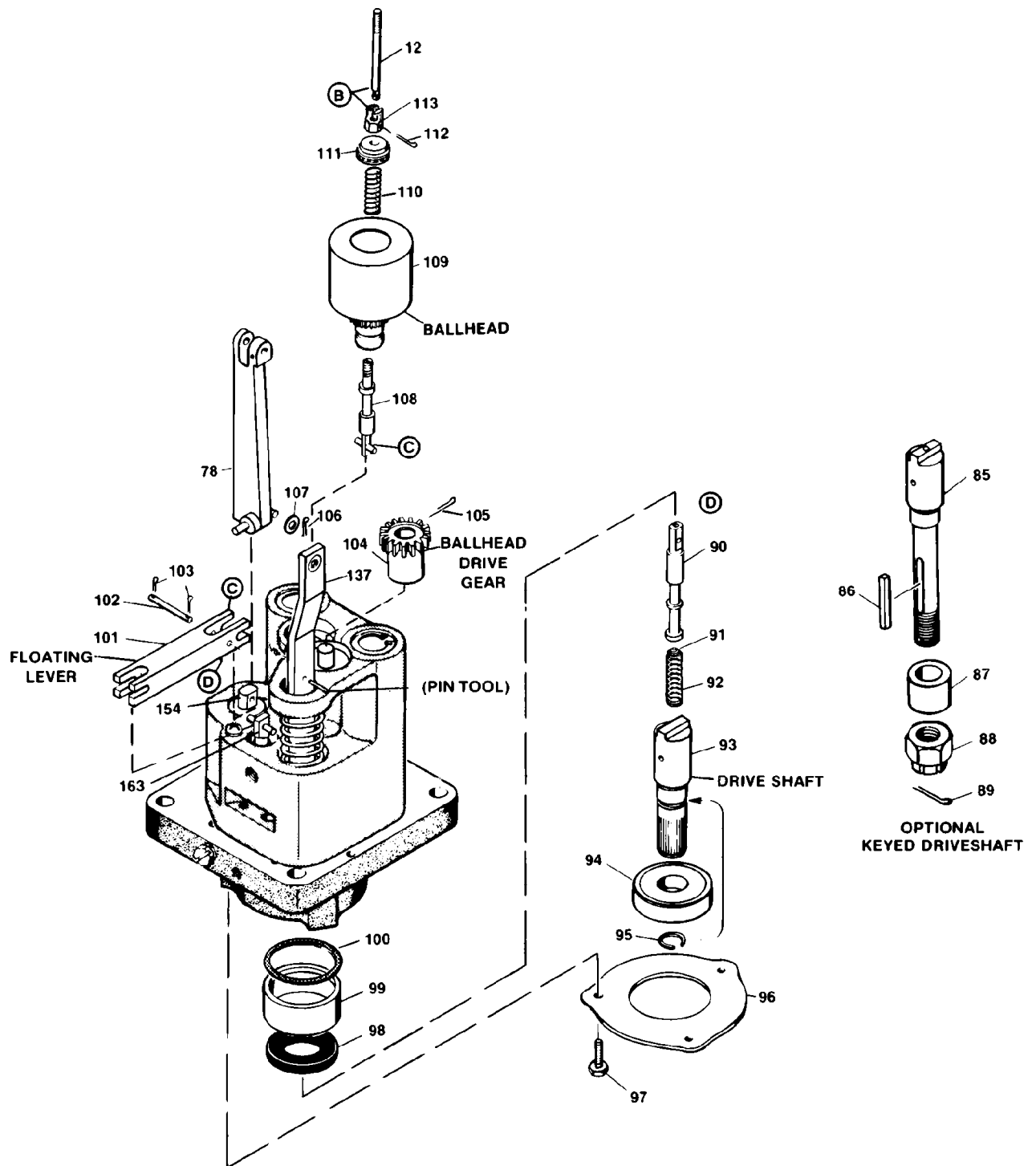


Figure 6-3. Illustrated Parts for the UG Lever Governor (sheet 3)

Parts List for Figure 6-4

Ref. No.	Part Name	Quantity
Reference numbers 114-119 are not used		
03036-120	Retainer ring, 1.283"	2
03036-121	Washer, 1.185" OD	2
03036-122	Accumulator spring	2
03036-122A	Accumulator spring (used only on the UG-10) ..	2
03036-123	Accumulator piston	2
03036-124	Not Used	
03036-125	Not Used	
03036-126	Controlet	1
03036-127	Not Used	
03036-128	Laminated shaft assembly	1
03036-129	Retaining sleeve	1
03036-130	Roll pin	1
03036-131	Retaining ring, 0.671" ID	1
03036-132	Washer	1
03036-133	Driver assembly	1
03036-134	Spring drive lamination	12
03036-135	Pump gear assembly	1
03036-136	Oilite bushing	2
03036-137	Large dashpot link	1
03036-138	Large dashpot spring	1
03036-139	Large dashpot compensation piston	1
03036-140	Straight pin	1
03036-141	UG-8 base	1
03036-142	Not Used	
03036-143	Not Used	
03036-144	Dowel pin	2
03036-145	Not Used	
03036-146	Needle valve plug	1
03036-147	Washer	1
03036-148	Compensating needle valve	1
03036-149	Dowel pin	2
03036-150	Not Used	
03036-151	Check valve	4
03036-152	Retaining ring, 1.283" OD	2
03036-153	Pilot valve bushing	1
03036-154	Power piston	1
03036-155	Dashpot piston assembly	1
03036-156	Rd. hd. screw (must be included if originally factory equipped)	2
03036-157	Washer	2
03036-158	Compensating spring	2
03036-159	Dashpot spring seat	1
03036-160	Not Used	
03036-161	Compensating piston guide	1
03036-162	Hex. nut, 1/4-48	1
03036-163	Dashpot nut	1
03036-164	Headed pin	1
03036-165	Shutdown lever	1
03036-166	Spring	1
03036-167	Cotter pin	1
03036-168	Flatwasher	1
03036-169	Dashpot cover	1

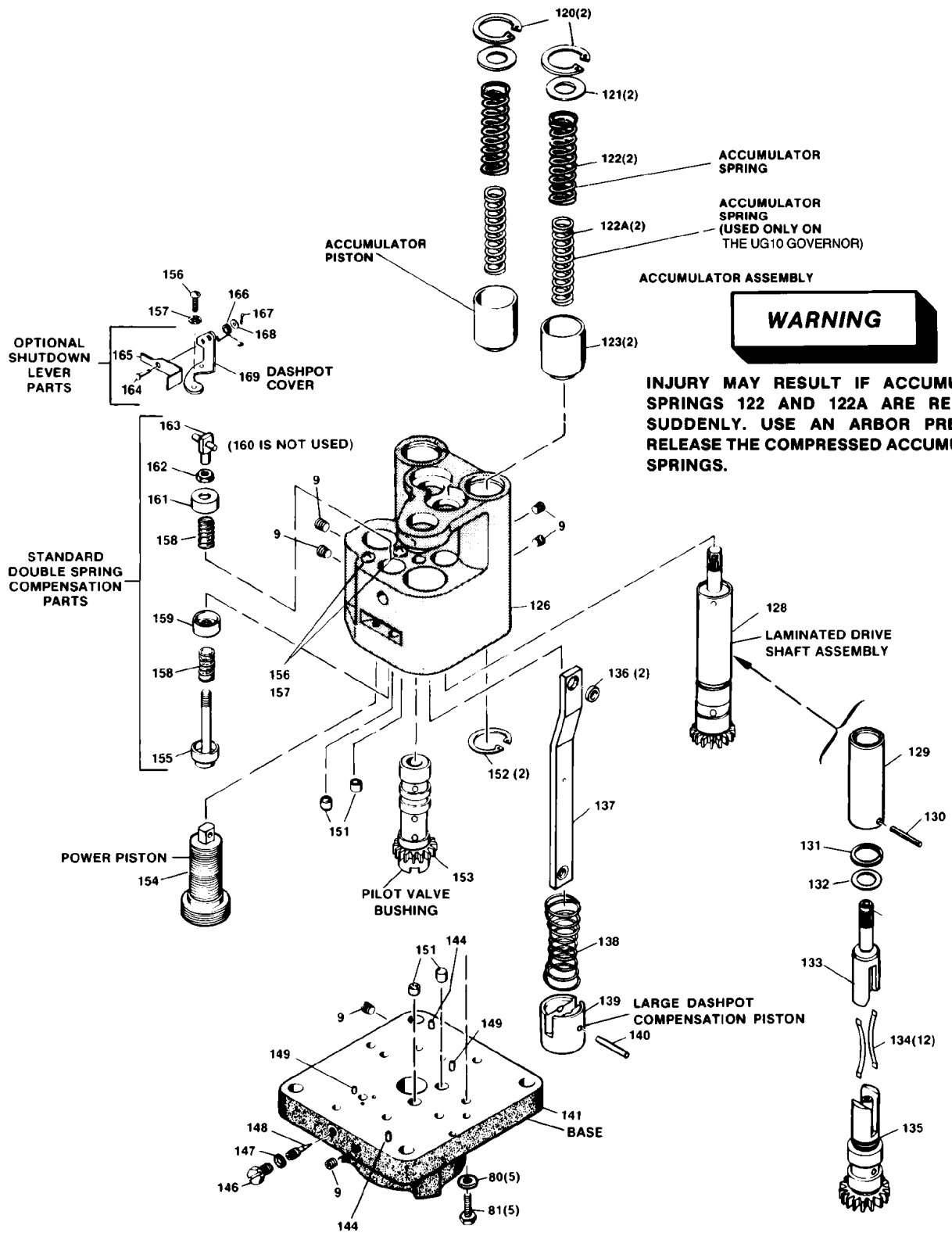


Figure 6-4. Illustrated Parts for the UG Lever Governor (sheet 4)

Parts List for Figure 6-5

Ref. No.	Part Name	Quantity
Reference numbers 170-199 are not used		
03036-200	Ballhead cover	1
03036-201	Flyweight	2
03036-202	Needle bearing	4
03036-203	Flyweight pin	2
03036-204	Torsion spring	1
03036-205	Ball bearing	1
03036-206	Ballhead gear assembly	1
03036-207	Early torsion spring	1
03036-208	Spirol pin	4
03036-209	Spring damped ballhead	1

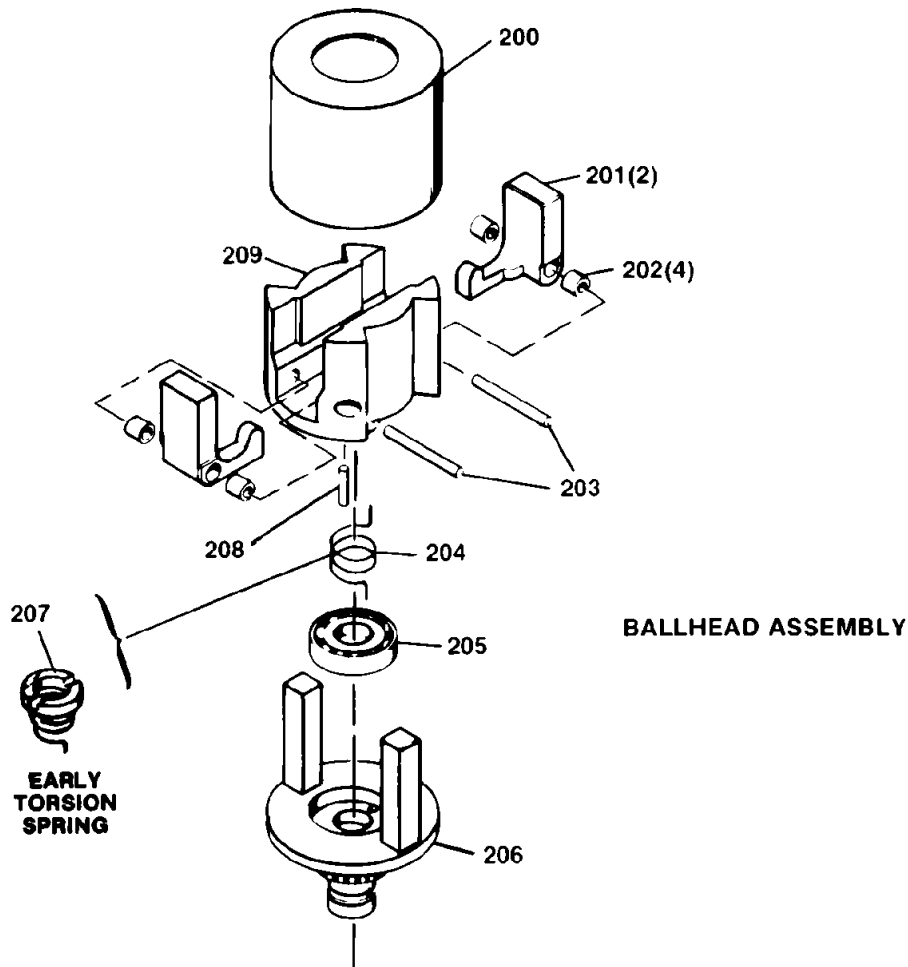


Figure 6-5. Illustrated Parts for the UG Lever Governor (sheet 5)

Chapter 7.

Auxiliary Equipment

Introduction

A number of optional auxiliary features and devices are available for use with the UG Lever governor.

These devices permit the governor to perform other secondary functions such as fuel limiting, low lube oil pressure shutdown, or effect a shutdown through an electrical solenoid.

Auxiliary equipment should be supplied as original equipment on the governor. It is recommended that the customer contact Woodward if field installations are desired.

The following paragraphs provide a brief description of the auxiliary equipment available and list the manuals where detailed information may be obtained.

Shutdown Solenoid

Two models of the shutdown solenoid are available. One provides shutdown when energized, the other when de-energized.

A different front panel containing a shutdown strap is provided on the governor. The governor also contains a dashpot cover with shutdown lever. See Figure 6-1 for the shutdown strap and 6-4 for the dashpot cover parts.

Latches are also available that require resetting in order to start the engine after shutdown.

Refer to manual 03013 for set-up procedures and parts breakdown.



To protect against possible personal injury, loss of life, and/or property damage, do not use the shutdown solenoid for overspeed protection. Any failure that would cause the governor to be inoperative would also cause the shutdown solenoid to be inoperative. Overspeed protection must come from a unit completely separate from the UG governor.

Low Lube Oil Pressure Shutdown

Figure 7-1 shows a low lube oil pressure shutdown. This device stops the prime mover when engine oil pressure fails below a safe level. There is no additional external linkage required. A different front panel, shutdown strap, dashpot lever, and shutdown lever are required.

Refer to Manual 03016 for operation information and a parts breakdown of the low lube oil pressure shutdown.

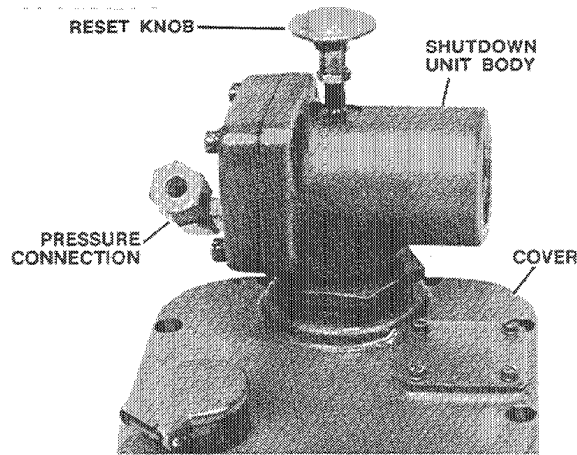


Figure 7-1. Low Lube Oil Pressure Shutdown

Magnetic Speed Pickup

The magnetic speed pickup monitors governor without speed having to provide an additional drive pad on the engine. Figure 7-2 shows the assembly on a UG Lever governor.

Refer to manual 36052 for installation information and a parts breakdown of the magnetic speed pickup.

! WARNING

To protect against possible personal injury, loss of life, and/or property damage, do not use the magnetic speed pickup for overspeed protection. Any failure that would cause the governor to be inoperative would also cause the magnetic pickup to be inoperative. Overspeed protection must come from a unit completely separate from the UG governor.

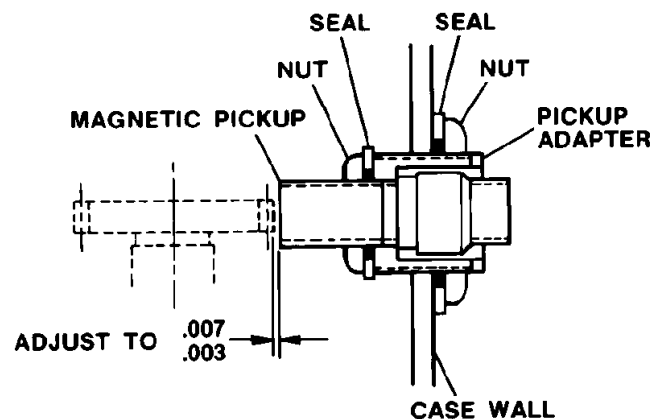


Figure 7-2. Magnetic Speed Pickup

Manifold Pressure Fuel Limiter

The manifold pressure fuel limiter, Figure 7-3, is designed for use on governors used on turbo-supercharged engines.

During acceleration, it restricts the movement of the governors power piston in the increase fuel direction and limits fuel to the engine as a function of manifold air pressure.

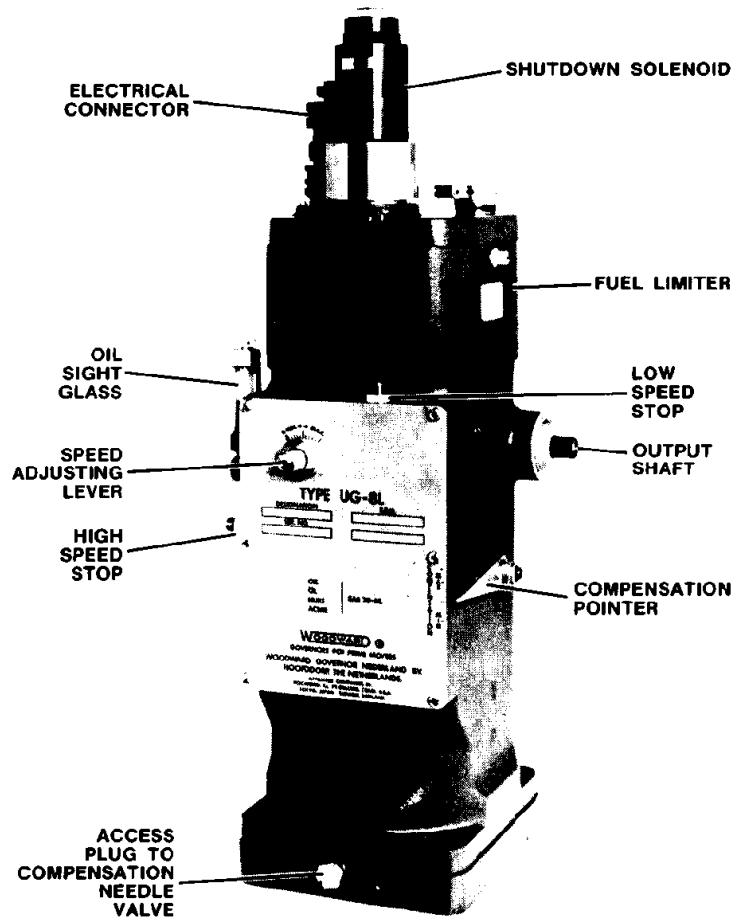


Figure 7-3. UG Lever with Manifold Pressure Fuel Limiter

Fuel is limited so the amount of air available provides complete combustion which improves engine acceleration and reduces smoke. A starting fuel limit can also be Incorporated.

Refer to manual 03507 for operating and adjustment information.

Remote Pneumatic Speed Adjustment

Remote speed adjustment, Figure 7-4, is possible by using a pneumatic speed adjustment unit. It is mounted on top of the UG Lever governor in a separate cast aluminum housing. The unit operates on direct air pressure of 3 to 15 psi (21 to 103 kPa) or 10 to 50 psi (69 to 345 kPa).

The housing can be factory machined to accept any of our standard shutdown devices, such as solenoid, pneumatic, or low lube oil pressure shutdown devices.

The manual speed adjustment is retained on the UG Lever as an auxiliary.

Refer to manual 03045 for operating and adjustment Information.

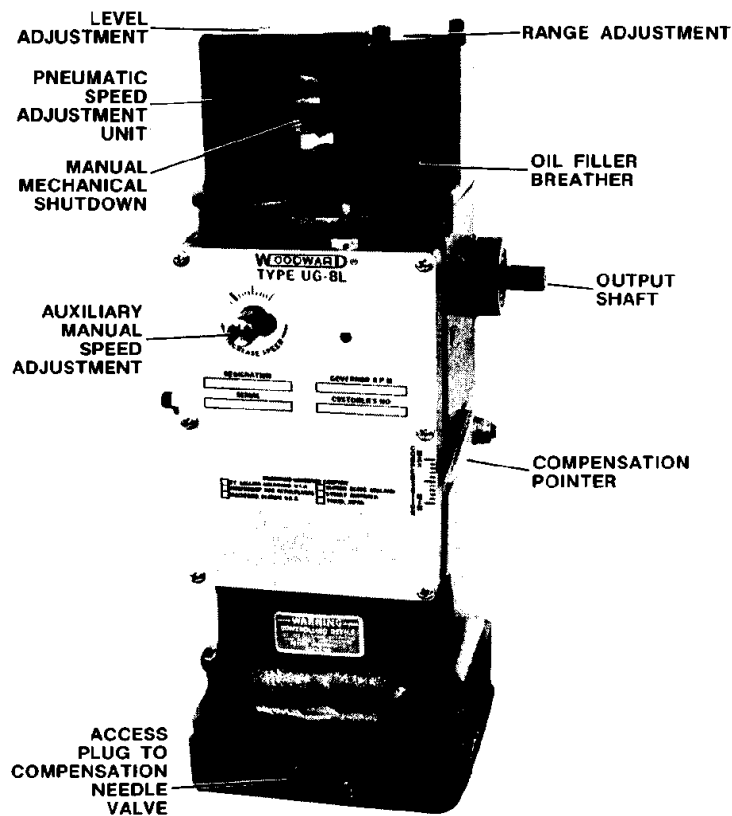


Figure 7-4. UG Lever with Remote Speed Adjustment

Chapter 8.

Product Support and Service Options

Product Support Options

IMPORTANT

UG governors have the same overhaul interval as the prime mover.

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

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

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

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

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

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

Product Service Options

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

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

Replacement/Exchange: Replacement/Exchange is a premium program designed for the user who is in need of immediate service. It allows you to request and receive a like-new replacement unit in minimum time (usually within 24 hours of the request), providing a suitable unit is available at the time of the request, thereby minimizing costly downtime.

This option allows you to call your Full-Service Distributor in the event of an unexpected outage, or in advance of a scheduled outage, to request a replacement control unit. If the unit is available at the time of the call, it can usually be shipped out within 24 hours. You replace your field control unit with the like-new replacement and return the field unit to the Full-Service Distributor.

Flat Rate Repair: Flat Rate Repair is available for many of the standard mechanical products and some of the electronic products in the field. This program offers you repair service for your products with the advantage of knowing in advance what the cost will be.

Flat Rate Remanufacture: Flat Rate Remanufacture is very similar to the Flat Rate Repair option, with the exception that the unit will be returned to you in “like-new” condition. This option is applicable to mechanical products only.

Returning Equipment for Repair

If a control (or any part of an electronic control) is to be returned for repair, please contact your Full-Service Distributor in advance to obtain Return Authorization and shipping instructions.

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

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

Packing a Control

Use the following materials when returning a complete control:

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

NOTICE

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

Replacement Parts

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

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

Engineering Services

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

- Technical Support
- Product Training
- Field Service

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

Product Training is available as standard classes at many Distributor locations. Customized classes are also available, which can be tailored to your needs and held at one of our Distributor locations or at your site. This training, conducted by experienced personnel, will assure that you will be able to maintain system reliability and availability.

Field Service engineering on-site support is available, depending on the product and location, from one of our Full-Service Distributors. The field engineers are experienced both on Woodward products as well as on much of the non-Woodward equipment with which our products interface.

For information on these services, please contact one of the Full-Service Distributors listed at www.woodward.com/directory.

Contacting Woodward's Support Organization

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

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

Products Used In Electrical Power Systems

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

Products Used In Engine Systems

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

Products Used In Industrial Turbomachinery Systems

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

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

Technical Assistance

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

General

Your Name _____

Site Location _____

Phone Number _____

Fax Number _____

Prime Mover Information

Manufacturer _____

Engine Model Number _____

Number of Cylinders _____

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

Power Output Rating _____

Application (power generation, marine,
etc.) _____

Control/Governor Information

Control/Governor #1

Woodward Part Number & Rev. Letter _____

Control Description or Governor Type _____

Serial Number _____

Control/Governor #2

Woodward Part Number & Rev. Letter _____

Control Description or Governor Type _____

Serial Number _____

Control/Governor #3

Woodward Part Number & Rev. Letter _____

Control Description or Governor Type _____

Serial Number _____

Symptoms

Description _____

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

Revision History

Changes in Revision L—

- Added bevel gear installation step to Chapter 2, Mounting Requirements

Changes in Revision K—

- Added overhaul interval information to Chapter 8

We appreciate your comments about the content of our publications.

Send comments to: icinfo@woodward.com

Please reference publication **03036L**.



B03036:L



PO Box 1519, Fort Collins CO 80522-1519, USA
1000 East Drake Road, Fort Collins CO 80525, USA
Phone +1 (970) 482-5811 • Fax +1 (970) 498-3058

Email and Website—www.woodward.com

Woodward has company-owned plants, subsidiaries, and branches,
as well as authorized distributors and other authorized service and sales facilities throughout the world.

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