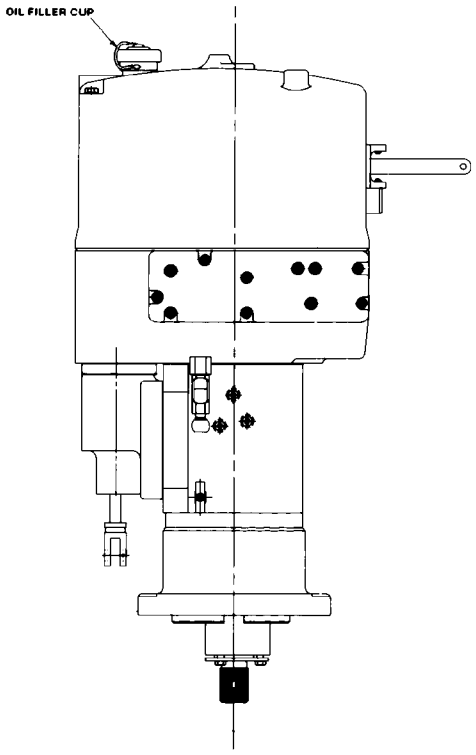
WOODWARD

Product Manual 36629
(Revision NEW)
Original Instructions



PGA-TL Governor

8558-657

Installation and Operation Manual

General Precautions

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

Practice all plant and safety instructions and precautions.

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

Revisions

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

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Proper Use

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

Translated Publications

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

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 Out-of-date translations are marked with ⚠.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

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

Contents

Illustrations and Tables

Warnings and Notices

Important Definitions

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

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

⚠WARNING

Overspeed / Overtemperature / Overpressure

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

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

⚠WARNING

Personal Protective Equipment

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

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

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

⚠WARNING

Start-up

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

⚠WARNING

Automotive Applications

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

NOTICE

Battery Charging Device

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

Electrostatic Discharge Awareness

NOTICE

Electrostatic Precautions

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

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

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

Follow these precautions when working with or near the control.

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

Chapter 1.
General Information

Introduction

This manual describes the PGA-TL governor model 8558-657.

The governor is pressure compensated with pneumatic, lever, and manual speed setting, and pre-established torque limitation. A 12 ft-lb (16 J) power cylinder with 1.0 inch (25.4 mm) of linear movement provides the control output from the governor. The governor has been specifically developed and manufactured for use with the ALCO marine-power system.

Torque Limitation

The governor will limit torque in the governed engine on a preset schedule. This limitation of torque is scheduled in relation to the speed of the controlled engine, not in relationship to load. The governor includes provisions for droop speed setting (decreasing speed setting with increasing load) and likewise will run when connected with other engines. The amount of droop is adjustable, but should not need adjustment during operation.

Speed-Setting Features

Speed of the governor Is determined by any of three different speed-setting devices:

Pneumatic Speed Setting Is the normal method used to set the speed of the governor. This system accepts a 10 to 60 psi (69 to 414 kPa) air signal and sets the speed of the engine proportionately: 10 psi (69 kPa) will provide a low speed of 430 rpm, and 60 psi (414 kPa) will provide a high speed of 1100 rpm. Pneumatic speed setting permits the setting of two or more governors with a single air signal.

Lever Speed Setting is provided from the front of the governor, permitting the substitution of a cable should the control air pressure be lost. The lever setting will override the pneumatic setting.

A **Speed-Setting Knob** is available for the operation of the governor and will override both the pneumatic and the manual setting. The knob speed setting is advanced by manually turning the knob clockwise. The knob should normally be set as far counterclockwise as possible.

IMPORTANT

The speed-setting knob provides a minimum-speed setting. If the knob speed setting is changed, it will change the reference point of both the pneumatic and lever speed setting. Unless the knob is being used to set the speed of the engine, it should be at the maximum counterclockwise setting.

⚠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.

Rotation

Check valves in the governor power case permit the governor drive to rotate either clockwise or counterclockwise. Reversible drive allows a reversing engine to be controlled with equal accuracy. Internal hydraulic pressure will be 100 psi (690 kPa) at all times the governor is controlling the engine speed.

Accessories

The PGA-TL is equipped with a 24-volt, dc-shutdown solenoid which energizes to operate. When energized, the shutdown feature will cause the governor to go to minimum fuel immediately. De-energized, the engine may be restarted with an undisturbed speed setting.

References

Manual 36652, *PG Automatic Safety Shutdowns and Alarms*
Manual 25071, *Oils for Hydraulic Controls*
Manual 25075, *Commercial Preservation Packaging for Storage of Mechanical-Hydraulic Controls*

Chapter 2. Installation

Receiving

A new or rebuilt PGA-TL will arrive bolted to a wooden skid in a cardboard box. The governor has been thoroughly tested and calibrated at the factory and no adjustments should be necessary. It has been drained of oil, and a film of oil remains which will protect the governor from rust for the period of time of shipping and storage prior to prompt installation. If longer storage is planned, the governor should be filled with oil and anti-rust precautions taken in the column and cover areas. For additional information, see Woodward manual 25075, *Commercial Preservation Packaging for Storage of Mechanical-Hydraulic Controls*.

Mounting

For installation dimensions, see the outline drawing (Figure 2-1). The governor must fit evenly on the mounting pad. Use a thin gasket between the mounting pad and the base of the governor, if desired. Care must be taken that the mounting surface and the base are smooth prior to mounting. The use of fluid-gasket materials or cements is not recommended. The gasket, if used, provides some thermal isolation for the governor and accommodates possible imperfections in the mounting surfaces. It is not used to prevent the movement of oil. The four mounting bolts must be evenly torqued, and there must be no movement or rocking of the actuator on its mounting surfaces.

The drive shaft must fit into the drive coupling with a free-slip fit. Do not apply external force. Be sure the drive does not bind or have too much side load or end play.

Control Linkage

The rod end will move 1.0 inch (25.4 mm), retracting toward maximum fuel. Linkage should use 2/3 of the total travel between no load and full load, The additional overtravel should be split and used at both ends to provide overfuel for transients and to assure shutdown at minimum fuel position. The linkage must be free of binding, without backlash. If there is a collapsible member in the linkage, it must not yield when the actuator moves the linkage rapidly. The linkage may be spring loaded to remove looseness, but caution should be exercised to be sure the spring load is toward minimum fuel.

A linear linkage should be used, with each movement of the output creating a proportional movement of the fuel rack.

Filling the Governor

The PGA-TL governor will require about 1.5 quarts (1.4 L) of oil if it is totally empty. Fill with the proper weight and grade of oil to the proper level on the oil sight gauge. Do not overfill as this will cause the oil to aerate and the governor to lack stability.

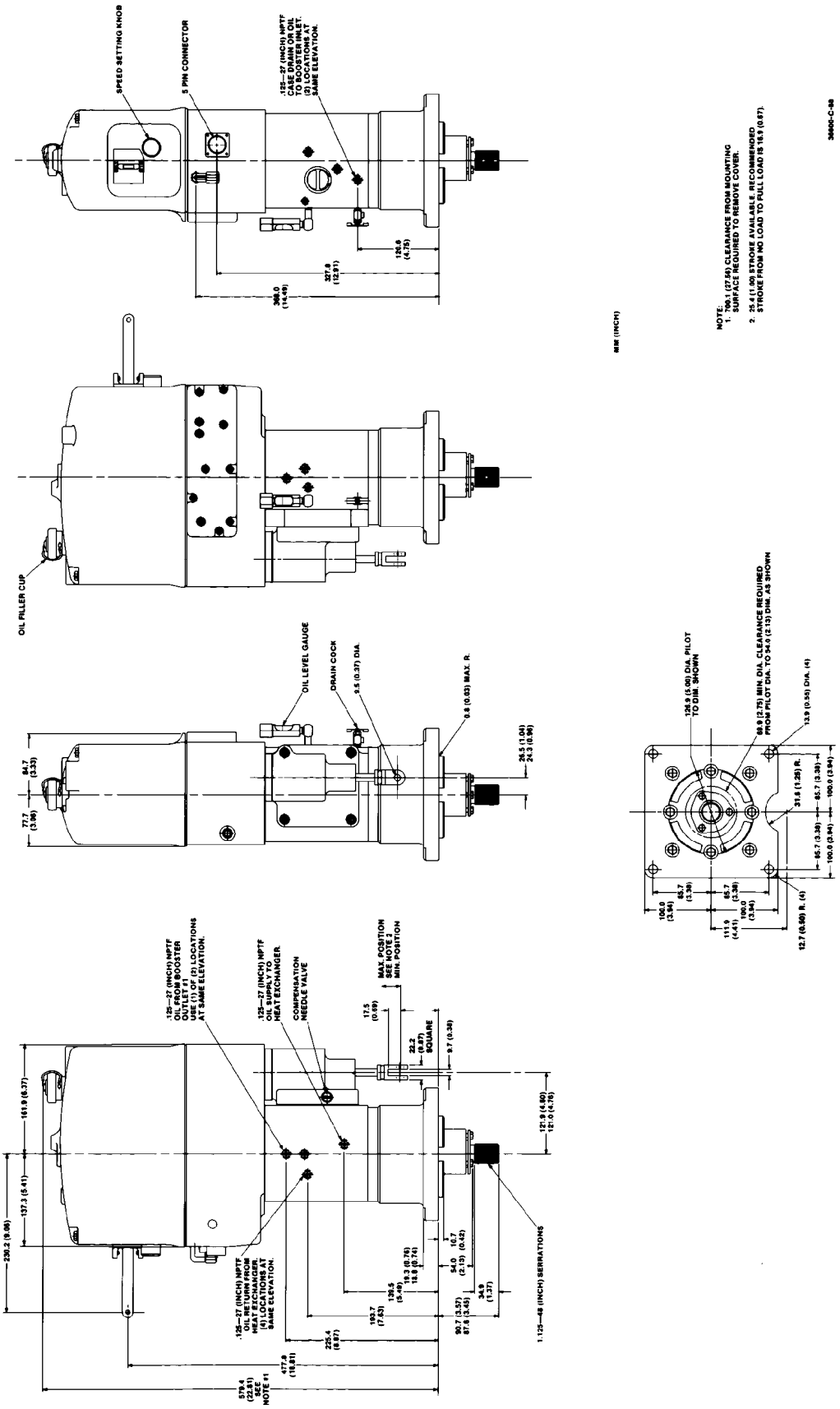

Figure 2-1. PGA-TL Governor Outline Drawing

The governor must run for several minutes after filling before all air is exhausted from the system. After the governor has been run for several minutes, recheck the oil level to make sure it remains in the sight gauge. Add oil as necessary. Recheck the oil level again when the governor is at operating temperature.

Speed-Setting Devices

Normal speed-setting control of the PGA-TL governor is through the pneumatic control. Using a 10 to 60 psi (69 to 414 kPa) control signal, the speed setting of the governor is changed. The speed-setting mechanism is a bellows type, permitting load division of paralleled units as well as a definite, accurate relationship between speed and speed signal.

The PGA-TL governor also offers a lever speed setting, allowing cable control of the speed setting should control air not be available. The lever speed setting will override the pneumatic speed setting.

Also available is a speed-setting knob which will firmly set the speed of the governor should both the lever and pneumatic speed-setting devices fail. The knob also allows speed setting at the governor rather than from the normal remote locations used for the pneumatic and lever control systems.

IMPORTANT **Always turn the speed-setting knob to the counterclockwise stop when not in use. If the knob is left with any speed set, this will be added to the speed set of the pneumatic system.**

Droop

The governor described in this manual is factory set for 6 percent droop operation. This provides for a no-load speed of 1166 rpm and a full-load speed of 1100 rpm. Droop allows the governed engine to assume a share of load with a parallel engine and adds stability to governors which are operating alone.

Needle Valve

The PGA-TL governor is equipped with a needle valve which must be adjusted for the type of oil being used, the engine being controlled, and the normal heat at which the governor operates.

To Initially Adjust The Needle Valve—With the prime mover running at idle, open the needle valve three turns to cause the engine to hunt. The droop in the governor may prevent hunting, even with the needle valve open several turns. If necessary, manually disturb the output shaft to induce hunting. If the governor still does not hunt, disturb the governor several times to assure that all of the trapped air in the governor is expelled.

When all of the air is expelled, close the needle valve gradually until hunting is just eliminated. Keep the needle valve open as far as possible to prevent sluggishness in the governor response. The needle valve setting varies from 1/8 to 2 turns open. Never close it tight—the governor cannot operate satisfactorily when this condition exists.

Check governor stability by manually disturbing the governor speed setting. The compensation adjustment Is satisfactory when the governor returns to speed with only a slight overshoot or undershoot. Once the needle-valve adjustment is correct, it is not necessary to change the setting except for large, permanent changes in temperature or other changes which affect the governor oil viscosity.

WARNING

When backing out the needle valve, as described above, use care that the needle valve is not backed out too far. Beyond six full turns, there is danger that the needle valve will be disengaged from the threads and 100 psi (690 kPa) oil will be expelled from the running governor.

IMPORTANT

It may be impossible to cause the governor to hunt as described above. In that case, set the needle valve at 2 turns open. Be prepared to reduce this setting if instability is discovered at full load. Do not fully close the needle valve.

Prior to Operation of the Engine

After any installation of a new or repaired governor, make a final check of the following items before leaving the job.

1. Re-inspect the four bolts which fasten the governor to the pad. They must be evenly torqued and the governor must not rock or move.
2. Re-inspect the linkage attachment between the governor and the engine. It must not come free during operation and it must not bind.
3. Check the speed-setting attachments to be sure they are secure and dependable. Be sure the manual speed-setting knob is at the maximum counterclockwise setting.
4. Affirm that the overspeed protection is in place and is operative. Check the operation of the overspeed protection device, if possible.
5. Be sure the oil level is correct and the oil condition is good. Do not leave the governor with oil that indicates it has air in it or is otherwise in less than perfect condition.

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.

Clean Oil Supply

In general, the oil used in the engine will be satisfactory for use in the governor.

The governor oil supply is self contained. Sump capacity is 1.5 quarts (1.4 L). Whenever the governor is filled, always check the oil level after starting, especially when a starting booster is used. If the oil sight glass shows a high level, oil should be drained. If the glass shows a low level after the unit is in operation, add new, clean oil to bring the level up.

Proper oil selection is necessary to realize best governor performance and maximum service life. The oil should have a minimum tendency to foam or retain air, form sludge, or deposit varnish, it should protect governor parts from corrosion and not be detrimental to oil seals or paint. Refer to Woodward manual 25071, *Oils for Hydraulic Controls*, for more information on selection of oils for use in hydraulic governors.

The oil selected should have a high-viscosity index, within the range of 100 to 300 SUS at normal operating temperatures. Only oils of the grade specified for a particular temperature range should be used (see Figure 2-2).

Many oil problems are caused by the use of the wrong oil for the temperatures being experienced within the governor. Careful selection of the oil is extremely important.

NOTICE

Oil contamination is the major cause of actuator troubles. Use only new oil or filtered oil. Containers used for filling the actuator must be clean and should be rinsed with a light grade of the same oil before using. Oil is responsible for more than half of the control problems associated with PGA-TL governors.

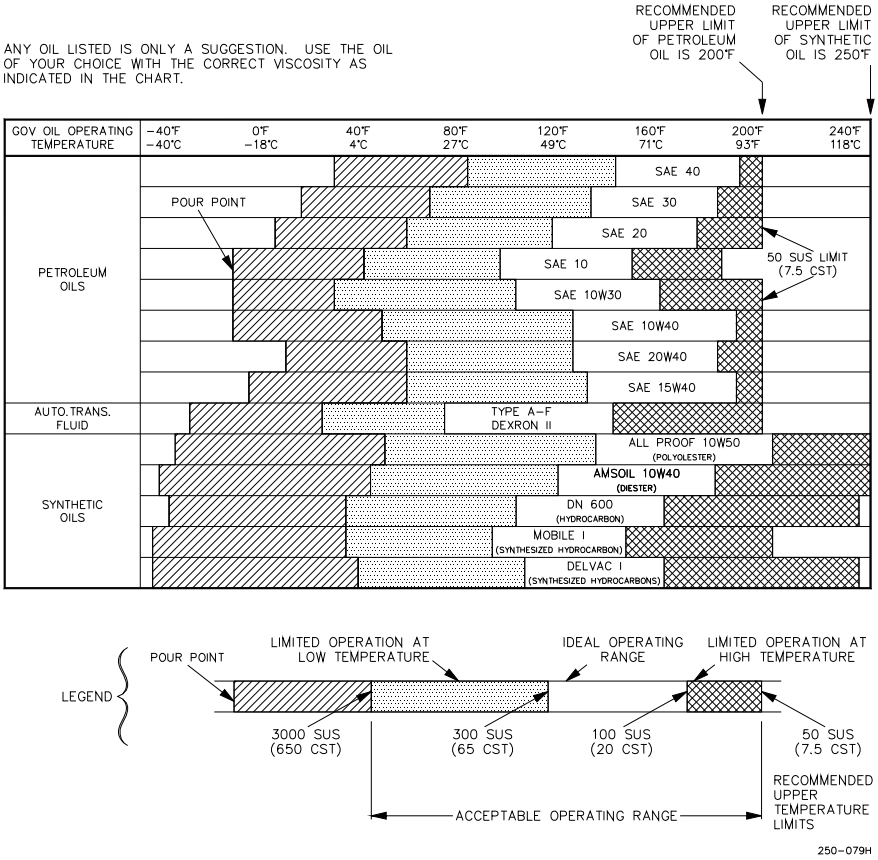

Figure 2-2. Oil Temperature-Viscosity Chart

Chapter 3. Adjustments

Introduction

These adjustments may be made on the engine for optimum performance or after repairs. Always note the starting point before making any adjustment.

Normally, the only requirements for putting a new or overhauled governor into service are filling the governor with oil and adjusting the compensation needle valve to obtain maximum stability. All other operating adjustments are made during factory testing according to engine manufacturer's specifications and should not require further adjustment. Do not attempt internal adjustment of the governor unless thoroughly familiar with the proper procedures.

⚠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.

Compensation Needle Valve Adjustment

The compensation needle valve is an adjustable part of the compensation system. Its setting, which directly affects governor stability, depends on the individual characteristics of the engine and of the oil used in the governor.

See Figure 2-1 for the location of the needle valve.

To Adjust The Needle Valve:

1. With the engine operating at IDLE, open the needle valve several turns to cause the engine to hunt. In some cases opening of the needle valve may not cause the engine to hunt but manually disturbing the governor speed setting or the output-shaft position will induce the governor to move through its full output stroke. If the governor has just been filled with oil, allow several minutes of hunting to remove trapped air in the hydraulic circuits. If It was necessary to force the governor to move through its output stroke, this should be done several times to be sure the hydraulic circuits are clear of air.

2. Close the needle valve gradually until hunting is just eliminated. Keep the needle valve open as far as possible to prevent sluggishness in governor response. Needle valve settings will vary from 1/8 to 2 turns open. Never close the valve tight, as the governor cannot operate satisfactorily with this condition. In the case of governors which will not hunt as described above, set the needle valve 2 turns open and be prepared to close the needle valve should Instability be observed when load is applied.

3. Check governor stability by manually disturbing the speed setting. The compensation adjustment is satisfactory when the governor returns to speed with only a slight overshoot or undershoot. Ideally, the response to a load change (speed change) should include an over-response followed by a lesser deviation from set speed in the opposite direction before the exact fuel setting Is found. If the needle valve is open too far, it may cause numerous deviations before the new fuel setting is found. If the needle valve is closed too far, it may provide the new fuel setting with almost no deviations from set speed, but it may take too long to reach the new fuel setting, causing an unacceptable lag in response to load changes.

IMPORTANT

If the engine does not return to stable condition after a disturbance and the needle valve is almost closed, it may be necessary to change the scale of the buffer springs. This solution to control problems should be used only after all other possibilities have been exhausted.

Speed Setting Adjustments

Pneumatic

The pneumatic speed-setting mechanism is a direct type which increases the governor speed setting as the control air-pressure signal increases. The speed settings are set at the factory and must not be changed except by a qualified technician with adequate test stand facilities. All speed settings are interrelated between the manual, pneumatic, and torque limiting features of the governor. Particular care should be taken not to change any of the adjustment screws which are shown in Figures 6-2 and 6-4 in this manual.

The recommended speed range is from 430 to 1100 rpm. Control air pressure of 10 psi (69 kPa) should provide a 0.875 inch (22.22 mm) gap between the servo housing and the rod end at 430 rpm. Control air pressure of 60 psi (414 kPa) should reduce this gap to 0.220 inch (5.59 mm) under full load condition (1100 rpm). With no control air pressure (0 psi/0 kPa), the governor should bring the engine to idle (400 to 420 rpm).

Cable-Speed Setting

The minimum and maximum stops on the cable-speed setting may be changed, should it be necessary. The lower screw (269, Figure 6-3) should provide a maximum of 420 rpm. To check the location, remove all control air pressure from the governor. The upper screw (269, Figure 6-3) should provide a maximum speed location (1100 rpm under full load.)

The cable-speed setting minimum-speed location must be lower than the 10 psi (69 kPa) position under pneumatic control or it will provide the minimum-speed stop for the governor at all times. The maximum-speed setting will not effect pneumatic control but should be set low enough to prevent overspeed should the cable-speed system be used. The cable-speed-setting mechanism will only set speeds in excess of the pneumatic control. The pneumatic control will always take precedence in setting the minimum speed.

Speed-Setting Knob

Speeds set by the speed-setting knob will be added to those called for by the pneumatic control. The speed-setting knob must be set at the maximum counterclockwise position anytime pneumatic control is being used. In the absence of a pneumatic signal, the speed-setting knob may be used to set the governor speed. The cable-speed-setting device will provide speed control from the speed set by the knob to the maximum speed setting of the cable device.

NOTICE

Do not attempt to adjust the pneumatic or knob speed setting devices as they are related to the torque-limiting speed settings. These adjustments should only be attempted by qualified repair technicians with repair or test stand facilities.

Shutdown Solenoid

Normal shutdown of the engine is accomplished by energizing the shutdown solenoid. When energized, the solenoid bleeds oil pressure from the speed-setting servo, lowering the speed setting below that of the minimum knob-speed setting, and causing the servo to move the output fitting to a shutdown position.

⚠WARNING

Do not use the solenoid shutdown for any safety device. All safety shutdown devices must be totally independent of the governor.

To Adjust the Shutdown Solenoid

IMPORTANT

This adjustment was made when the governor was calibrated and should not be necessary under any normal operating conditions.

Remove the locknut and the plunger stop plug, then energize the solenoid. Turn the adjusting screw down (clockwise) until oil starts to seep from the slot in the shutdown-valve body. Turn the adjusting screw down 1 and 1/4 turns further. De-energize the solenoid, insert the plunger stop plug, and screw the plug down until it touches the solenoid plunger. Back off the plunger stop plug 2 turns, and lock it in place with the lock nut.

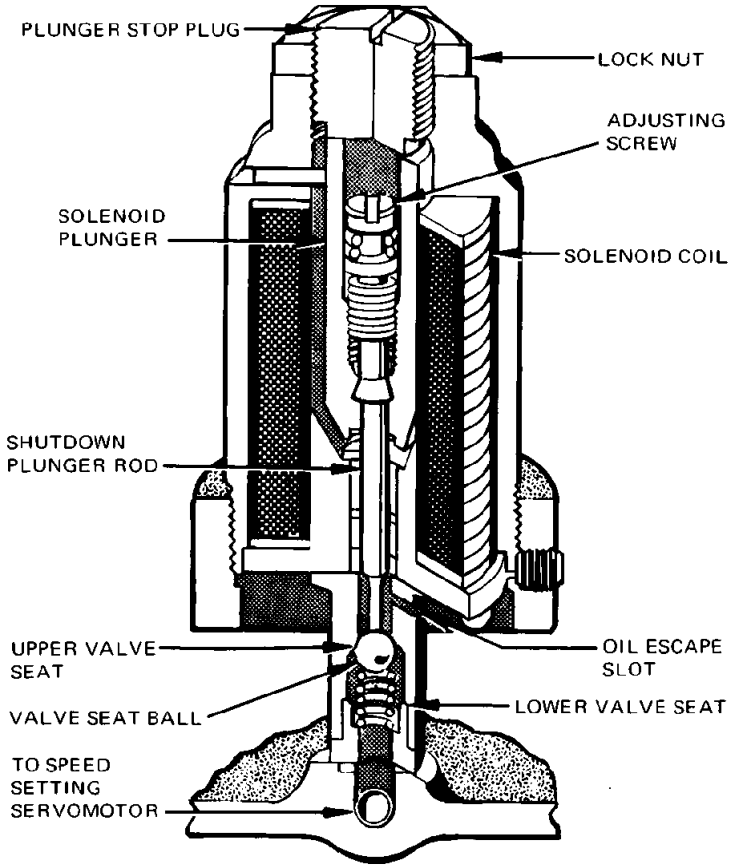

Figure 3-1. Shutdown Solenoid

Chapter 4.
Principles of Operation

Introduction

Governor response to either speed change or load change is almost instantaneous within the limitations imposed by the torque-limiting feature and by the capacity of the engine to respond to fuel setting changes.

Since load change is always seen as a speed change of the engine, there is no difference in governor response between a governor speed change and an engine load change. The terms “load change” and “speed change” are used interchangeably in the following description of how the governor operates.

Two Functions

For purposes of description, the PGA-TL governor consists of two parts: the basic-governor portion and the speed-setting portion.

The basic governor can be divided into three sections: the hydraulic-pressure section, the speed-sensing section, and the power-servo section. The speed-setting portion of the governor divides into the speed-setting section, the fuel-limiting section, and the droop section.

All of the sections operate dependently within the governor and are separated in this discussion only for the advantage of description.

Basic Governor

In the hydraulic-pressure section, the governor drive shaft passes through the governor base and engages the oil-pump drive gear. The rotating bushing and ballhead come through the top of the power case and engage the oil-pump drive gear.

The pump supplies pressure oil for operation of the entire governor. The pressure oil from the two-gear pump is directed through check valves to two accumulator pistons. The pistons are pushed up against springs until they uncover a bypass valve which returns excess pressure oil to sump. The oil in the accumulator cylinders provides a reservoir of 100 psi (690 kPa) oil available to operate the governor servo and the speed-setting devices.

The check valve arrangement allows either clockwise or counterclockwise rotation of the governor drive.

Ballhead and Pilot Valve

The main speed-sensing ballhead and pilot valve control the flow of pressure oil to the power cylinder. The drive gear of the pump is a part of the rotating bushing which, in turn, is the drive link to the ballhead. The ballhead is rotated at a speed proportionate to the speed of the engine, and the ballarms (flyweights) attached to the ballhead are tipped out according to the balance of the force of the speeder spring and the centrifugal force created by the engine speed.

The toes of the ballarms position the pilot-valve plunger, which regulates the flow of pressure oil to and from the power cylinder in the servo.

The pilot-valve plunger does not rotate with the ballhead and the pilot-valve bushing. The stationary plunger and the rotating bushing combine to provide a reduced-friction condition to provide more exact control of engine speed. The ballhead also provides the drive gears for the speed-setting bushing and the torque-limiting ballhead.

Governor Servo

The governor servo produces 12 ft-lb (16 J) of torque as the piston is raised against a return spring in the increased fuel direction. When the 100 psi (690 kPa) pressure oil is directed through the pilot valve to the bottom of the piston, the piston rises. When oil below the piston is held motionless by the pilot valve, the piston remains stable. When the pilot valve vents control oil from the bottom of the piston, the return spring forces the piston down, the control oil flows to sump, and the rod end moves toward reduced fuel,

Compensation System

Governor control of the engine would be erratic if compensation were not present to prevent large overshoots and undershoots during load or speed changes. The compensation system provides temporary speed-setting changes within the governor while the engine moves to a new load or speed position. The compensation system must be adjusted to match the time lag between a change in fuel-rack position at the engine and the engine reaching the new speed or power setting caused by the change in fuel supply.

The compensation system is needed to match the extremely quick reaction of the governor to the slower reaction level of the engine. The compensation system does not slow the rate of movement of the governor output shaft, but rather limits this movement to the location needed for the completion of a specific load or speed change.

The flow of pressure oil to or from the power piston activates the compensation system in the PGA-TL governor. As the oil in the control circuit flows, it moves the compensation piston from its normal, centered position, to a position off center. This position provides a spring-loaded pressure differential within the control circuit. The pressure differential is sensed by the compensation land of the pilot valve, causing the pilot valve to be influenced by a pressure urging it toward the null position.

The compensation pressure is always in the direction opposing the load or speed change, temporarily balancing out some of the speed change being ordered by the flyweights.

The pressure differential in the control circuit is allowed to dissipate at a controlled rate through the needle valve. If the needle valve is correctly set, the pressure differential will be equalized at the same moment that the engine is settled at the new speed or load position.

Compensation Bypass

The compensation system is bypassed during a portion of major fuel position changes. If the flow of pressure oil is of sufficient volume, it will drive the compensation piston beyond a bypass port in the compensation cylinder. The bypass port limits the amount of pressure differential in the compensation-hydraulic circuits and allows major changes in the fuel setting which would not otherwise be possible.

Speed-Setting Changes and Controls

Governor speed reference is determined by the compression of the speeder spring which rides on the toes of the flyweights. The greater the compression of the spring, the more fuel the governor servo will direct to the engine. Lessening the compression of the speeder spring will cause the governor to reduce the amount of fuel directed to the engine.

Pneumatic Control

Speed reference in the PGA-TL is normally set by a change in the pneumatic signal to the governor. The pneumatic control will cause the governor to go from 430 rpm with a 10 psi (69 kPa) signal to 1100 rpm with a 60 psi (414 kPa) signal. (Note that all control features respond to a desired change in engine speed. Changes in load, which are referenced by the governor as changes in engine speed, are automatically corrected within the governor.)

A change in the pneumatic signal strength causes a change in the length of the bellows which moves the link and the attached speed-setting plunger. This plunger, located in a rotating, speed-setting bushing, directs oil to or from the speed-setting servo, which, in turn, changes the compression of the speeder spring. The link is balanced between the bellows pressure pushing it down toward increase fuel and the restoring spring which attempts to move it and the attached plunger toward minimum fuel.

A loss of air pressure causes the governor to go toward minimum fuel to an idle speed of 400 rpm. The idle speed is set by the low-speed adjusting screw located on the link hitting a stop pin in the restoring lever. This speed-setting location is the lowest that can be achieved by any of the three methods of changing the speed setting.

The absolute maximum-speed-setting position for the pneumatic control is controlled by the maximum-speed limiting valve located in the top of the speed-setting servo. As the servo piston moves down to increase the speed setting of the speeder spring, it also lowers the limiting-valve adjustment screw attached to the piston rod. When this screw dislodges the ball in the limiting valve, it releases oil from on top of the speed-setting piston to sump in exact proportion to the oil being directed to the speed-setting servo from the speed-setting valve.

Speed-Setting Lever

A speed-setting lever provides remote speed setting for the PGA-TL governor should the pneumatic speed-setting signal be interrupted or lost. The lever is attached, through a spring connection, to the link. It can provide a minimum-speed stop which is faster (more rpm) than the pneumatic-speed stop, should the limit screws located on the front of the governor be incorrectly set. The maximum stop on the front of the governor will not affect the other speed-setting devices, but can limit the lever speed setting to a speed which is lower than that set by the limiting-valve adjustment on the speed-setting servo. The maximum setting will not provide a speed setting in excess of that of the limiting valve.

Manual Speed-Setting Knob

The manual speed-setting knob permits adjustment of the governor-speed setting at the governor by turning the knob clockwise. The knob setting will override either the pneumatic or the lever speed setting in the maximum-fuel direction. The knob will not override the maximum-speed limiting valve. Any of the three speed-setting mechanisms will provide the minimum setting with the highest speed setting of the three controlling the governor speed. The knob setting will provide a minimum reading which will be added to the pneumatic setting if the knob is not at its minimum location (fully counterclockwise).

When the knob is turned, it raises or lowers the pivot bracket located on the speed-setting assembly, raising or lowering the restoring lever and the attached “C” link. The “C” link then repositions the speed-setting plunger with governor oil pressure moving the speed-setting piston and changing the tension of the speeder spring. The piston also moves one end of the restoring lever, causing the speed setting plunger to be re-centered and to stop the movement of the speed setting cylinder.

The pivot bracket location on the speed-setting assembly is adjustable, but should never need to be moved. The adjustment is set by the manufacturer to match the governor to the specified pneumatic speed-setting range. (The PGA-TL range is from 430 to 1100 rpm.)

Shutdown Rod

A rod is attached directly to the top of the speed setting pilot-valve plunger. The rod extends through the speeder spring and through the power-piston rod inside the speed-setting piston. The rod then extends above the speed-setting servo. This rod allows for the mechanical drain of pressure oil from the governor servo anytime the rod is lifted. The governor shutdown solenoid drains oil from the speed setting servo to the extent the speed-setting piston rod lifts the shutdown rod, shutting down the engine. The rod is also used to prevent increased fuel setting when it is held by the torque-limit linkage.

Droop Setting

The PGA-TL governor is preset with 6 percent droop. Droop provides a decreasing speed setting as the power cylinder and output rod move toward the maximum-fuel position. Because the decrease is proportional to power cylinder position, the final speed setting of the governor at any point is located on a slope which predicts that engine speed will be highest when the engine is requiring the least fuel (no-load condition). The speed will decrease from a high of 1166 at no load to a high of 1100 at full load. The presence of droop allows the engine to work in tandem with another engine without trading loads and becoming unstable.

The droop system employed by the PGA-TL governor involves a lever from the power-cylinder tailrod which changes the tension on a spring, which in turn affects the pressure exerted on the droop rod. The droop rod runs through the speed-setting piston and directly influences the pressure of the speeder spring. This pressure is decreased as the power cylinder tailrod position is increased toward maximum fuel, in effect lowering the speeder-spring setting for a given position. Droop percentage is adjustable but should not be changed except by experienced repair technicians who have access to a test stand and other test equipment.

Torque Limit

The PGA-TL governor is equipped with a secondary fuel-limiting system which protects the engine from excessive torque end prevents undesirable fuel increases in response to heavy loads.

The torque-limiting system senses speed with a separate ballhead, speeder spring, pilot-valve system. This speed-sensing system uses governor oil pressure to position the torque-limit piston and speed feedback cam as well as the special torque-limit cam.

The ballhead and bushing for the torque-limiting system are driven directly by gear teeth on the speed-sensing ballhead.

The torque-limit ballhead reacts to speed In the same manner as the main ballhead. Likewise, anytime the power servo moves to a new setting, the torque-limit linkage also moves. The amount of movement in proportion to the speed-setting location is regulated by the cam surface located on the bottom of the piston. As the piston moves, it increases the scale of the speeder spring.

Movement of the torque-limit cam attached to the end of the piston operates linkage on a predetermined scale, which can prevent continued movement of the output shaft of the governor by lifting the shutdown rod.

The cam scale is built to prevent overfueling of the engine during heavy-load transients.

As engine speed gradually increases, the torque-limit cam moves, and the resistance on the shutdown rod is relaxed. Unique design of the torque-limit cam provides specific control limits for different speeds. At low speed, the cam surface will prevent major fuel changes, while at high speeds, the system presents almost no control.

In operation, the torque-limiting feature will provide an absolute maximum-fuel setting for every engine speed. This maximum-fuel schedule in relation to engine speed provides a positive horsepower limit for each engine speed according to the manufacturer’s design. The torque limiter within the governing system prevents sudden power surges in response to load changes.

Chapter 5. Troubleshooting

Introduction

It is impossible to anticipate every kind of trouble encountered with the operation of the PGA-TL governor. This section 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 engine or auxiliary equipment. The effect of any auxiliary equipment on the overall control required of the governor must 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.**

Oil

Governor oil level must be kept between the lines on the oil-level gauge glass with the unit operating. The correct level is at the joint line of the power case and column—the upper line on the gauge glass—and no higher. Instructions given on decals near the oil gauge should be strictly obeyed. Dirty oil causes about half of all governor troubles. Use clean, new, or filtered oil. Containers used to fill governors from bulk containers should be perfectly clean. Oil contaminated with water breaks down rapidly, causes foaming, and corrodes internal governor parts.

Compensating Needle Valve

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

The compensation needle valve must be adjusted with the governor controlling the engine. 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 for best control under load.

Definitions

Use the chart 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 be eliminated by blocking governor operation manually, but which will recur when returned to governor control.
- **Surge**—A rhythmic variation of speed, always of large magnitude, which can be eliminated by blocking governor action manually and which will not recur when returned to governor control unless speed or load changes.

- **Jiggle**—A high-frequency vibration of the governor-fuel rod end and fuel linkage. The vibration is seldom seen in the engine's performance, but can damage linkage and the governor if not corrected.

Preliminary Inspection

Governor troubles are usually revealed in speed variations of the engine, 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 engine.

2. Check engine operation to be sure all cylinders are firing properly and the fuel injectors are in good condition and properly calibrated.

3. Check linkage between the governor and the fuel control to be sure there is no binding or excessive backlash.

4. Check the setting of the governor's compensation needle valve.

5. Check operation of the control-air-pressure transmitter.

6. Check governor oil pressure. A test port is provided in the governor power case for this purpose.

7. 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 become sludgy. The internal moving parts are continually lubricated by the oil within the unit. Valves, pistons, and plungers can stick and even "freeze" in their bores due to excessive wear caused by grit and impurities in the oil. In many cases erratic operation and poor response can be corrected by flushing the unit with fuel oil or kerosene. The use of commercial solvents is not recommended.

   Change the oil and flush the governor twice a year if possible. Open the drain cock and drain the old oil. Flush the governor by filling it with fuel oil and, with the engine running at low speed, cycle the governor. Cycle the governor by opening the needle valve two turns. Let the governor hunt for a minute or two and then stop the engine and drain the governor. Fill the governor with oil, start the engine, and reset the compensation needle valve. Run 15 to 30 minutes until hot then drain the governor again. Refill the governor with new, clean oil.

8. Check the drive to the governor for any evidence of misalignment, roughness, or excessive backlash.

Table 5-1. Troubleshooting

Trouble	Cause	Correction
1. Engine hunts or surges.	A. Needle Valve adjustment incorrect.	Adjust needle valve as described in this manual.
	B. Lost motion in engine linkage or fuel pumps.	Repair linkage or fuel pumps. If possible correct cause of engine linkage wear.
	C. Binding in engine linkage or fuel pumps.	Repair and realign linkage or fuel pumps.
	D. Governor stroke too short. Stroke must be at least 50% of governor travel between idle and full load.	Redesign or rework the fuel linkage to require more governor stroke. 2/3 of the total stroke is recommended.
	E. Low oil level.	Add oil slowly to bring it to the correct level.
	F. Dirty or foaming oil in the governor.	Drain governor oil, flush governor to clean, and refill with proper clean oil. Bleed air and adjust the needle valve as described in governor manual.
2. Fuel pump racks do not open quickly when cranking engine.	A. Low oil pressure in governor.	a. Check governor-pump gear pockets for excessive wear. No correction except to replace worn parts. b. Flush governor and refill with clean oil to remove dirt in pump check valves. c. Examine pump check valves. If not seating tight, install new ones.
	B. Cranking speed too low.	Install a booster servomotor or check existing booster for oil supply and air pressure.
	C. Speed setting too low.	increase maximum starting fuel.
3. Jiggle at governor rod end.	A. Rough engine drive.	Inspect drive mechanism. Inspect for wear of drive shaft and serrated coupling.
	B. Governor not bolted down evenly on engine mounting pad.	Loosen screws, disconnect fuel linkage, and turn governor 45 degrees clockwise and counterclockwise on the mounting pad a few times. Tighten screws. A thin gasket may be installed between the governor and the mounting pad to absorb some irregularities. Make sure the two surfaces are clean and free of distortions. Gasket cements are not recommended.
4. Load does not divide properly between connected units for ship propulsion or similar type installation.	A. Droop setting too low on one or more units.	a. Check if governor travel is at least 50% of total travel. If necessary increase governor travel by shortening the terminal-shaft lever. b. Adjust droop on each unit until desired division of load is obtained. c. Increasing droop results in the unit taking a smaller share of load changes. d. Decreasing droop results in the unit taking a larger share of load changes.
	B. Speed settings of the governors are not the same.	a. Check control air pressure at both governors with accurate pressure gauges. b. Check both manual speed-setting knobs to be sure they are at minimum.

Trouble	Cause	Correction
5. Engine is slow to recover from a speed deviation resulting from a change in load or speed setting.	A. Governor oil pressure is low.	See item 2-A in this table.
	B. Fuel supply restricted.	Clean fuel filters and fuel supply lines.
	C. Engine may be overloaded.	Reduce the load.
6. Engine does not pick up rated full load.	A. Fuel racks do not open far enough.	a. Check fuel pump stops and adjust as necessary. b. Check linkage between governor and fuel pumps and adjust if necessary. c. Oil pressure may be too low, see item 2-A of this table.
	B. Fuel supply restricted.	See item 7-C of this table.
	C. Supercharger does not supply sufficient air.	Overhaul supercharger.
7. Engine does not reach full speed and full load.	A. Low control air pressure.	Check pneumatic transmitter and air lines.
	B. Minimum and maximum speed too low.	Send governor to maintenance facility for recalibration of speed settings.
	C. Governor at end of travel.	a. Check fuel linkage adjustment. b. Check fuel supply and filters.
	D. Linkage out of adjustment and torque limiter limits speed.	a. Reset linkage to cure problem.
8. Engine overspeeds on starting.	A. Governor is too slow.	Adjust needle valve for highest opening.
	B. Speed setting too high.	Decrease starting speed setting.
	C. Governor sets too much fuel for starting.	a. Limit travel of booster servomotor. b. Readjust speed setting.
	D. Compensation bypass retarded.	Have maintenance facility install short buffer piston.
9. Engine stalls on deceleration to minimum speed.	A. Governor is too slow.	Adjust needle valve for maximum opening. Have maintenance facility install lighter buffer springs. Try shorter buffer piston.
	B. Minimum speed. too low.	Raise minimum speed.

Chapter 6.
Replacement Parts

This section provides replacement parts information for the PGA-TL governor, part number 8558-857.

When ordering replacement parts, include the following information:

- Governor serial number and part number shown on nameplate
- Manual number (this is manual 36829)
- Parts reference number in parts list, Woodward part number from parts list, and description of part or part name

⚠CAUTION

Injury may result if compressed springs are released suddenly. Use the proper equipment to remove all springs and spring covers. Particular care must be taken when releasing compression on the accumulator springs in the power case and the return springs in the power cylinder.

Parts for Figure 6-1

Ref. No.	Part Name	Quantity
36629-1	Basic PG Power Case	1
36629-2	Dowel Pin, 0.250 x 0.562	2
36629-3	Inner Accumulator Spring	2
36629-4	Outer Accumulator Spring	2
36629-5	Spring Seat	2
36629-6	Internal Retainer Ring, 1.942 free diameter	4
36629-7	Case-Column Gasket	1
36629-8	Plug, 0.125-27 Hex Socket	13
36629-9	Oil Seal Ring	1
36629-10	Buffer-Spring Seat	1
36629-11	Buffer Spring	2
36629-12	Buffer Piston	1
36629-13	Buffer-Bore Plug	1
36629-14	0-ring, 1.296 ID x 0.139	1
36629-15	Internal Retainer Ring, 1.804 free diameter	1
36629-16	Plug, Hex Socket, 0.062-27	1
36629-17	Speed Setting Plug Assembly	1
36629-18	Speeder Spring	1
36629-19	Speeder Spring Seat	1
36629-20	Thrust Bearing Assembly	1
36629-21	Adjusting Spring Washer, 0.328 x 0.582 x 0.032	1
36629-22	Spring. PG Pilot Valve Adj. Comp.	1
36629-23	Ballarm	1
36629-24	Bearings	1
36629-25	Screw, Round Head, Spilt, 8-32 x 0.500	1
36629-26	Washer, Shakeproof, No.8	1
36629-27	Coupling Assembly Spring	2
36629-28	Sems Fastener	4
36629-29	Ballhead Assembly	1
36629-30	Straight Pin	1
36629-31	Cotter Pin, 0.062 x 0.375	1
36629-32	Shutdown Rod Assembly	8
36629-33	SG Compression Spring	1
36629-34	Pilot Valve Plunger Nut	4
36629-35	Cotter Pin, 0.082 x 0.625	8
36629-36	Sub Shutdown Rod	1
36629-37	Internal Retaining Ring, 0.831 Diameter	1
36629-38	Compensation Bushing	1
36629-39	Pilot Valve Plunger	1
36629-40	Ball Bearing	1
36629-41	Preformed Packing, 3.489 x 0.070	1
36629-42	Ballhead Gear Bushing Assembly	1
36629-43	Idler Stud	1
36629-44	Idler Gear	1
36629-45	Drive Gear	1
36629-46	Accumulator Piston Assembly	2
36629-47	Short Check Valve Assembly	2
36629-48	Long Check Valve Assembly	2
36629-49	Drain Cock	1
36629-50	Elbow	1
36629-51	Gauge	1
36629-52	Hex Nut, 10-32	2

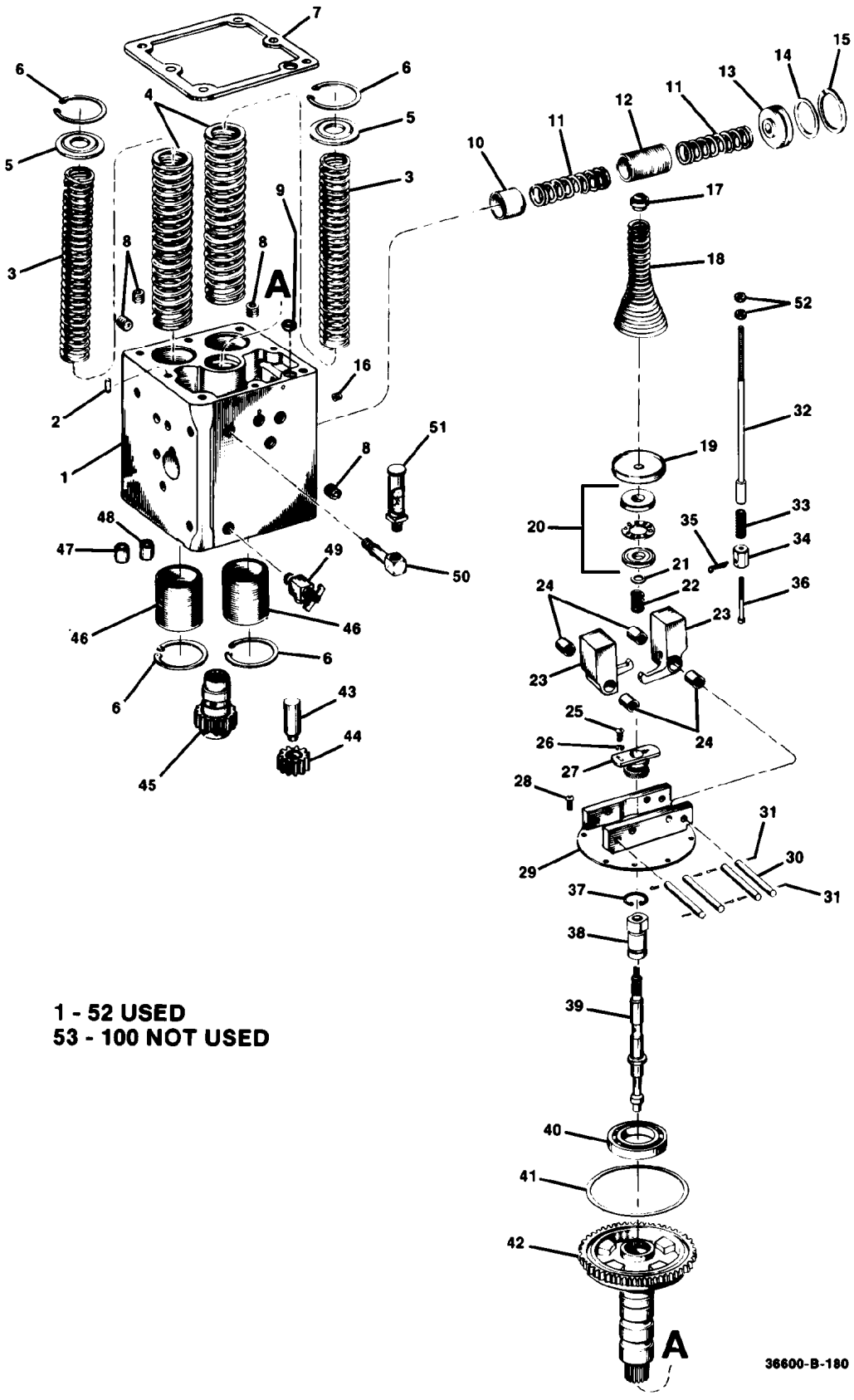

Figure 6-1. Power Case and Ballhead Assembly

Parts for Figure 6-2

Ref. No.	Part Name	Quantity
36629-101	Lever	1
36629-102	Screw, 8-32 x 0.750	1
36629-103	Taper Pin	1
36629-104	Screw, 10-32 x 0.625	1
36629-105	Roller Bearing	1
36629-106	Nut, 10-32, Elastic Hex	1
36629-107	Rack	1
36629-108	Pin	1
36629-109	Drive Screw, 0 x 0.125	2
36629-110	Droop Nameplate	1
36629-111	Gear	1
36629-112	Spring	1
36629-113	Nut, 8-32 Elastic Hex	1
36629-114	Tension Washer	1
36629-115	Screw, 0.250-28	2
36629-116	Washer, Spring Lock	2
36629-117	Drive Location Pin	2
36629-118	Screw, 8-32 x 0.500	2
36629-119	Washer, No. 8 Internal Shakeproof	2
36629-120	Wedge	1
36629-121	Cam	1
36629-122	Piston	1
36629-123	Retaining Snap Ring	1
36629-124	Spring Seat	1
36629-125	Spring	1
36629-126	Torque Limit Cylinder	1
36629-127	Spring	1
36629-128	Stop Rod Piston	1
36629-129	Bushing	1
36629-130	Spring Seat	1
36629-131	Snap Ring	1
36629-132	Gasket	1
36629-133	Cylinder Head	1
36629-134	Washer	1
36629-135	Washer	1
36629-136	Cotter Pin	1
36629-137	Screw, 10-32 x 0.500	4
36629-138	Washer, Internal Shakeproof	4
36629-139	Shoulder Screw	1
36629-140	Lever	1
36629-141	Needle Bearing	1
36629-142	Retaining Ring	1
36629-143	Seat	1
36629-144	Spring	1
36629-145	Seat	1
36629-146	Washer	1
36629-147	Cotter Pin, 0.031 x 0.375	2
36629-148	Lever Assembly	1
36629-149	Ball Bearing	1
36629-150	Pin	1

Ref. No.	Part Name	Quantity
36629-151	Lever	1
36629-152	Washer	1
36629-153	Needle Bearing	1
36629-154	Nut	1
36629-155	Washer	1
36629-156	Screw	2
36629-157	Spring	1
36629-158	Pin	1
36629-159	Screw	1
36629-160	Lever	1
36629-161	Plate	1
36629-162	Screw. 6-32 x 0.500	2
36629-163	Washer	1
36629-164	Cotter Pin. 0.031 x 0.375	1
36629-165	Spring	1
36629-166	Screw	2
36629-167	Block	1
36629-168	Drilled Screw, 6-32	4
36629-169	Strap	2
36629-170	Spring Plate	1
36629-171	Elastic Hex Nut, 6-32	1
36629-172	Block Assembly	1
36629-173	Pin, 6-32 Holes	1
36629-174	Nut	1
36629-175	Cotter Pin, 0.062 x 0.375	1
36629-176	Elastic Hex Hut. 10-32	1
36629-177	Cantilever Spring	1
36629-178	Not Used	
36629-179	Stop Screw, NOT SHOWN. install in spring guard	1
36629-180	Jam Nut, NOT SHOWN, install in spring guard	1
36629-181	Ball Bearings	1
36629-182	Adjustment Stop	1
36629-183	Bearing Pin	1
36629-184	Cam Roller Retainer	1
36629-185	Adjusting Screw	1
36629-186	Adjusting Nut	1
36629-187	Speeder Spring, SG	1
36629-188	Pilot Valve Plunger	1
36629-189	Thrust Bearing Assembly	1
36629-190	Ball Arm	2
36629-191	Ballhead Assembly	1
36629-192	Straight Pin	2
36629-193	Idler Gear	1
36629-194	Stud	1
36629-195	Torque Limit Column	1
36629-196	Governor Gasket	1
36629-197	Bushing	1
36629-198	Piston Gap Scale	1
36629-199	Washer, 0.203 x 0.438 x 0.032	1
36629-200	Screw, 10-32 x 0.375	1

Ref. No.	Part Name	Quantity
36629-201	Screw, 0.250-28 x 0.750	10
36629-202	Washer, 0.250 spring lock	10
36629-203	Side Plate	1
36629-204	Side Plate Gasket	1
36629-205	O-ring, 0.339 ID x 0.070	1
36629-206	Tube	1
36629-207	Not Used	
36629-208	O-ring, 0.364 ID	2
36629-209	Plug	1
36629-210	Screw, 0.250-20 x 0.375	1
36629-211	Washer	1
36629-212	Elbow, Pneumatic Supply	1
36629-213	Screw, 4-40 x 0.438	4
36629-214	Receptacle, 5 contact points	1
36629-215	Receptacle Gasket	1
36629-216	Spring Guard Seal	1
36629-217	Ring	1
36629-218	Spring	1
36629-219	Spring Guard Assembly	1
36629-220	Screw, 0.250-28 x 0.500	1
36629-221	Shockproof Washer, 0.250	4
36629-222	Tailrod Yield Plunger	4
36629-223	Tailrod Yield Spring	1
36629-224	Spring	1
36629-225	Cotter Pin	1
36629-226	Pin	2
36629-227	12 ft-lb Tailrod	1
36629-228	Spring	1
36629-229	Special Elastic Stop Nut, 0.375-24	1
36629-230	Tall Rod Lift Nut	1
36629-231	Washer, 0.375 Shakeproof	1
36629-232	PG Power Piston Assembly	1
36629-233	0.312 x 2.938 Steel Rod, fits behind pneumatic elbow (part reference number 212) NOT SHOWN	1

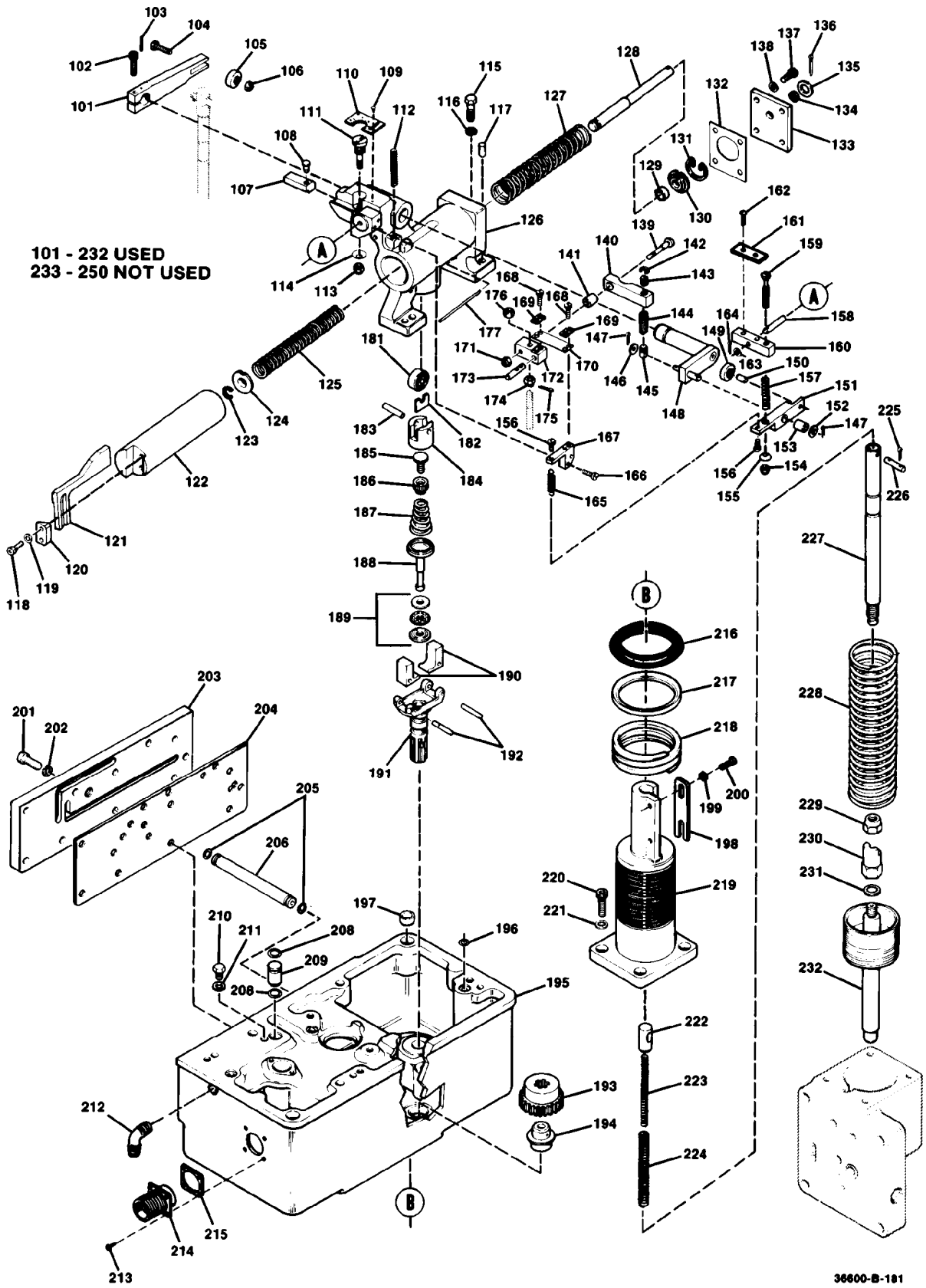

Figure 6-2. PGA-TL Column, Torque Limiter, Return Spring and Power Piston

Parts for Figure 6-3

Ref. No.	Part Name	Quantity
36629-251	Receiver Bracket	1
36629-252	Screw, 6-32 x 0.250	1
36629-253	Diode, Suppressor	1
36629-254	2-Pin Terminal Strip	1
36629-255	Screw, 6-32 x 0.500	2
36629-256	Shakeproof Washer	2
36629-257	Plate Assembly	1
36629-258	Extruded Fiber Washer	4
36629-259	Screw, 8-32 x 0.375	4
36629-260	Manual Speed Adjustment Shaft	1
36629-261	Pin	1
36629-262	Torsion Clutch Spring	1
36629-263	O-ring, 0.989 ID x 0.070	1
36629-264	Knob	1
36629-265	Friction Drive Spring	2
36629-266	O-ring, 0.739 ID x 0.070	1
36629-267	Plug Assembly	1
36629-268	Lever	1
36629-269	Set Screw	2
36629-270	Lock Washer, No. 10	4
36629-271	Screw, 10-32 x 0.500	4
36629-272	Pin, 0.248 x 1.000	1
36629-273	Bracket Assembly	1
36629-274	Gasket	1
36629-275	Loading Spring	1
36629-276	Plunger Assembly	1
36629-277	Screw, 0.250-28 x 1.5	1
36629-278	Spring Seat	1
36629-279	Speed Bias Spring	1
36629-280	Screw, 6-32 x 0.250	1
36629-281	Washer, 0.149 x 0.375	1
36629-282	Spring Seat	1
36629-283	Special Screw, 10-32	1
36629-284	Block Assembly	1
36629-285	Screw, 10-32 x 0.375	1

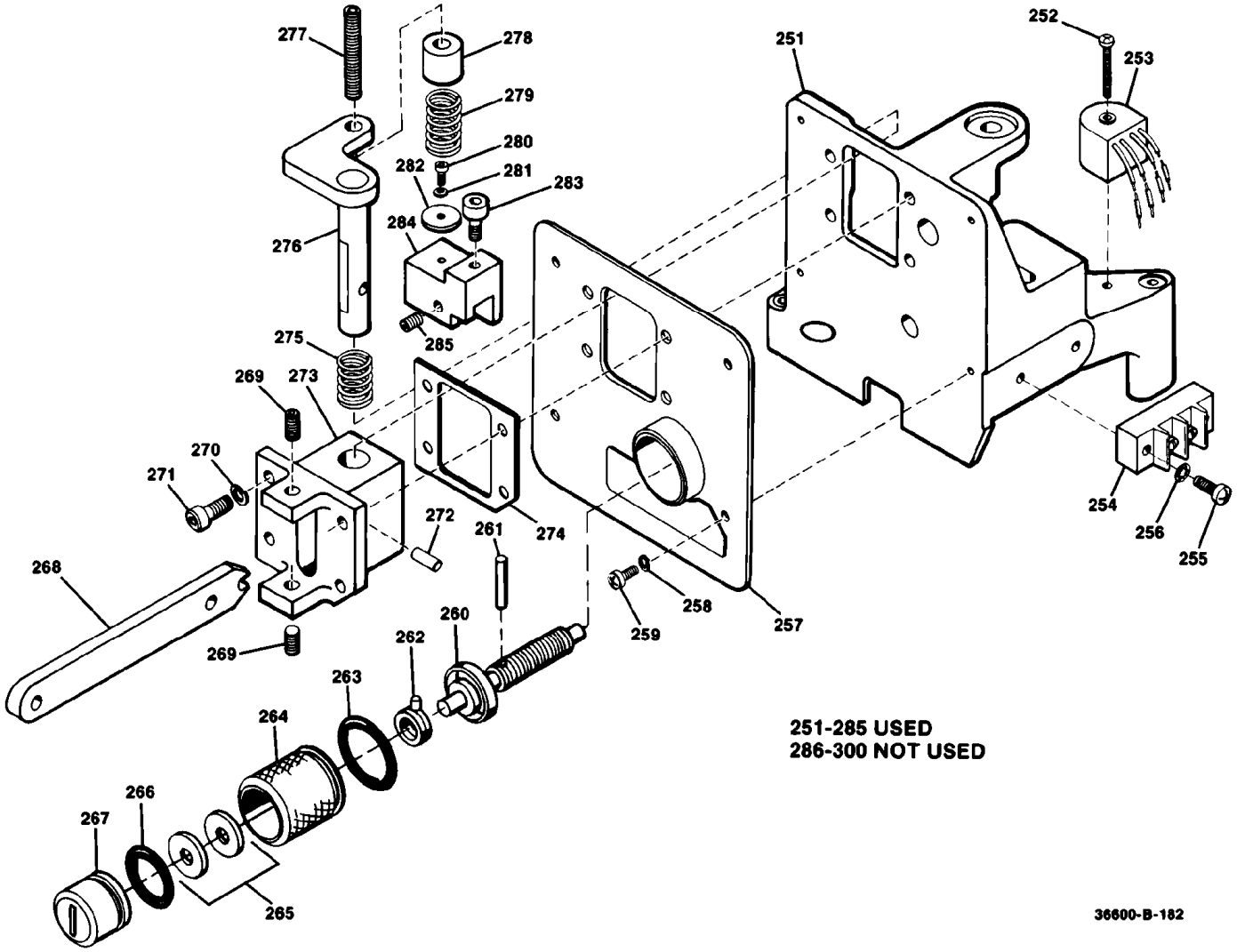

Figure 6-3. PG Receiver, Lever and Manual Speed Setting

Parts for Figure 6-4

Ref. No.	Part Name	Quantity
36629-301	Passage Screw	1
36629-302	Washer, 0.400 OD	1
36629-303	Screw, 5-40 x 0.500	1
36629-304	Spring Lock Washer, No. 5	1
36629-305	Pilot Valve Link	1
36629-306	Not Used	
36629-307	Not Used	
36629-308	Tension Spring	1
36629-309	Speed Setting Spring Assembly	1
36629-310	Spring Anchor Pin	1
36629-311	Speed Set Lever Assembly	1
36629-312	Speed Setting Pin	1
36629-313	Cotter Pin, 0.082 x 0.375	1
36629-314	Receiver Cup Gasket	1
36629-315	Socket Head Set Screw, 5-40 x 0.250	1
36629-316	Pneumatic Receiver Cup	1
36629-317	O-ring, 1.364 ID x 0.070	1
36629-318	0.12 Sq. In, Bellows Assembly	1
36629-319	Internal Retaining Ring, 1.680 Free Dia	1
36629-320	Bellows Coupling	1
36629-321	Screw, 8-32 x 0.312	1
36629-322	Screw, 10-32 x 1.000	1
36629-323	Speed Setting Nut Assembly	1
36629-324	Speed Setting Screw Assembly	1
36629-325	Button Head Screw	1
36629-326	Ball Bearing	1
36629-327	Spacer	1
36629-328	High Collar Lock Washer, No. 10	2
36629-329	Screw, 10-32 x 1.125	1
36629-330	Lock Nut	2
36629-331	Pivot Bracket	1
36629-332	Pin, 0.187x1.875	1
36629-333	Link Assembly Sleeve	1
36629-334	Pin	4
36629-335	Link	1
36629-336	Stop	1
36629-337	Spring Washer	1
36629-338	Lead Screw Nut	1
36629-339	Set Screw, 8-32 x 0.375	1
36629-340	Washer	1

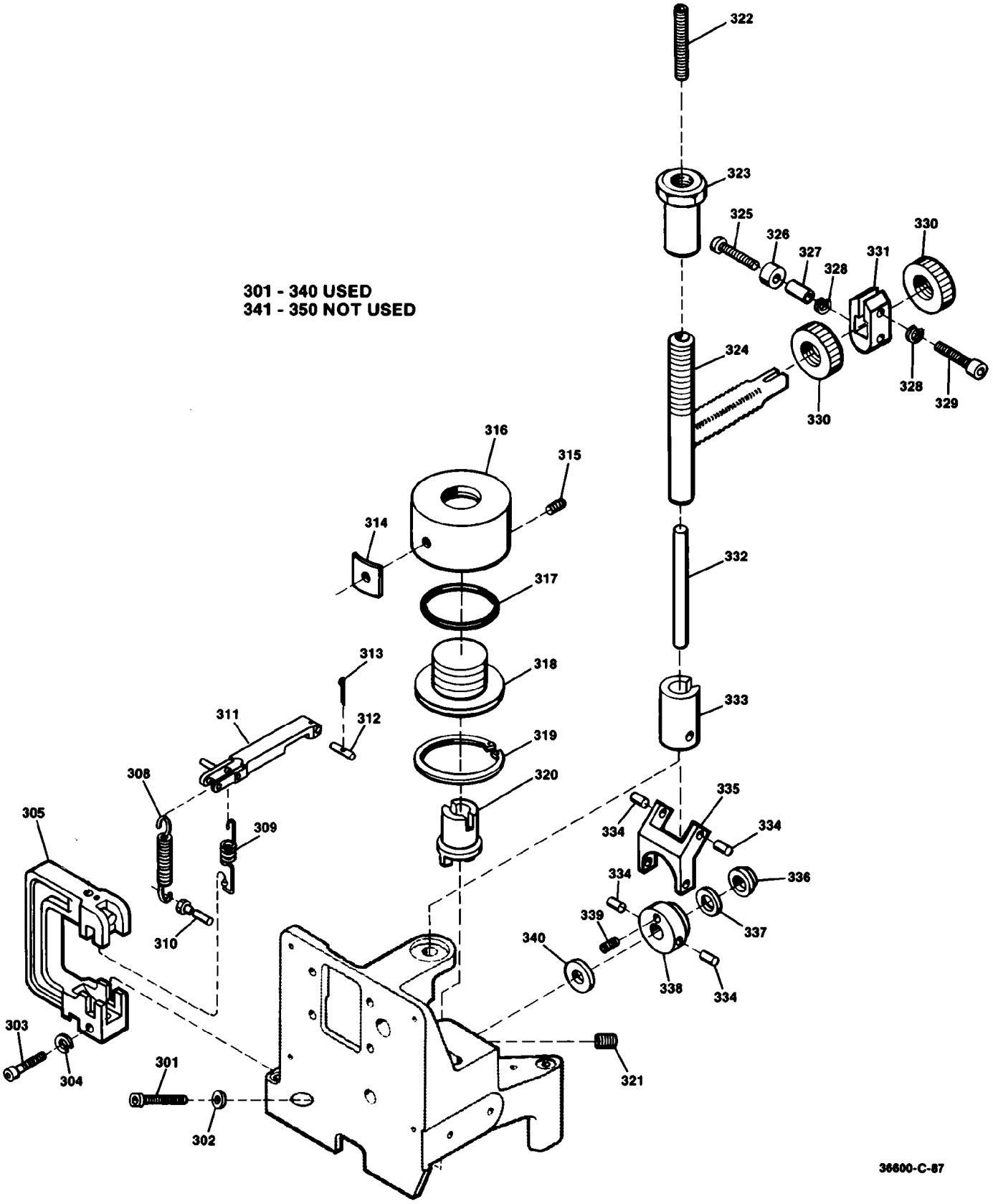

Figure 6-4. Speed Setting Linkage

Parts for Figure 6-5

Ref. No.	Part Name	Quantity
36629-351	Screw, 0.250-28 x 1.250	1
36629-352	Screw, 0.250-28 x 2.000	1
36629-353	Split Lock Washer, 0.250	2
36629-354	Flat Washer, 0.265 ID	2
36629-355	Screw, 10-32 x 0.500	2
36629-356	Spring Lock Washer, No. 10	2
36629-357	Bearing Retainer	1
36629-358	Washer, 0.375 x 0.750 x 0.109	1
36629-359	Thrust Bearing Assembly	1
36629-360	Speed Adjustment Pilot Valve Plunger	1
36629-361	Speed Adjustment Pilot Valve Bushing	1
36629-362	Speed Setting Bushing Plug	1
36629-363	Pilot Valve Bushing Spring	1
36629-364	Power Piston Fulcrum	1
36629-365	Screw, 10-32 x 0.375	1
36629-366	Nut, 10-32	1
36629-367	Bracket Assembly	1
36629-368	Special Set Screw, 10-32 x 1.250	1
36629-369	Check Valve Assembly	1
36629-370	Speeder Spring Power Cylinder	1
36629-371	Guide Pin	1
36629-372	Set Screw, 10-32 x 1.260	1
36629-373	Nut, 10-32	2
36629-374	Screw, 0.250-28 x 1.375	2
36629-375	Split Lock Washer	2
36629-376	Power Cylinder Plug	1
36629-377	Power Piston	1
36629-378	Roll Pin, 0.094 x 0.375	1
36629-379	Rod	1
36629-380	Spring	1
36629-381	Screw, 0.312-24 x 5.000	3
36629-382	Screw, 0.312-24 x 3.500	1
36629-383	Washer, 0.328 x 0.582 x 0.032	4
36629-384	Nameplate	1
36629-385	Drive Screw, No. 1 x 0.188	2
36629-386	Cover	1
36629-387	Cover Dwelling Bushing	2
36629-388	Cover Gasket	1
36629-389	Oil Cup	1
36629-390	Screw, 0.312-24 x 7.250	2
36629-391	Washer, 0.328 x 0.562 x 0.032	2
36629-392	Drive Screw	4
36629-393	PGA-TL Nameplate	1
36629-394	Bracket to Cover Gasket	1

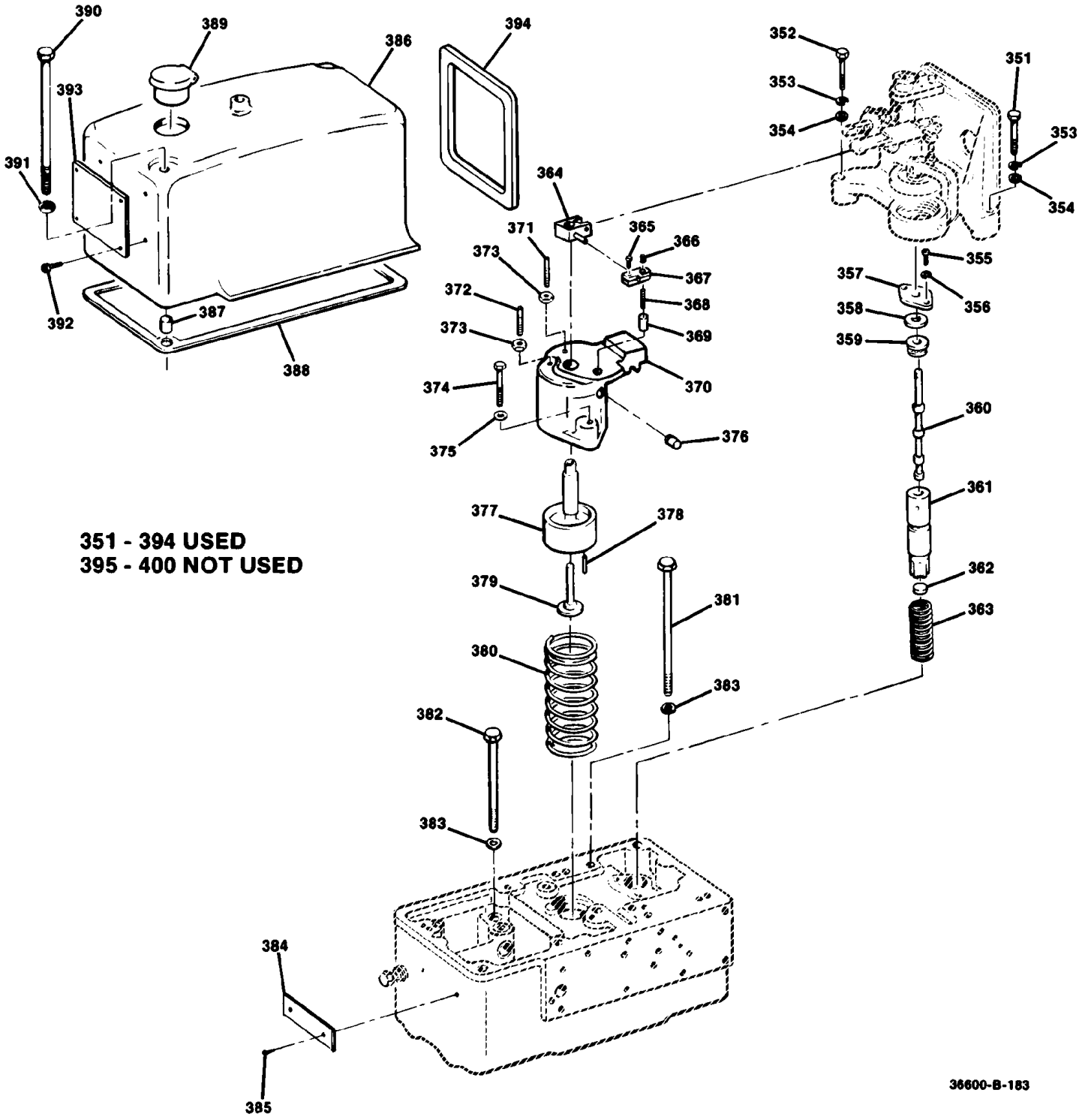

Figure 6-5. Speed Setting Servo Parts List

Parts for Figure 6-6

Ref. No.	Part Name	Quantity
36629-401	Solenoid Locknut, 0.750-32	1
36629-402	Plunger Stop Plug	1
36629-403	Solenoid Plunger Lock Pin	1
36629-404	Solenoid Case	1
36629-405	Wave Spring Washer	1
36629-406	Paper Insulator	1
36629-407	24 Vdc Solenoid Coil	2
36629-408	Solenoid Washer	2
36629-409	O-ring, 0.178 ID x 0.070	1
36629-410	Adjusting Screw	1
36629-411	Solenoid Plunger	1
36629-412	Washer, 0.500	1
36629-413	Solenoid Plunger Rod	1
36629-414	Bushing. 0.1875 x 0.2508 x 0.250	2
36629-415	Shutdown Valve Body	1
36629-416	Teflon Tube, 0.337 ID	2
36629-417	Plunger Guide Pin	1
36629-418	Steel Ball, 0.250 Dia	1
36629-419	Solenoid Valve Spring	1
36629-420	Seat Valve	1
36629-421	O-ring, 0.239 x 0.070	1

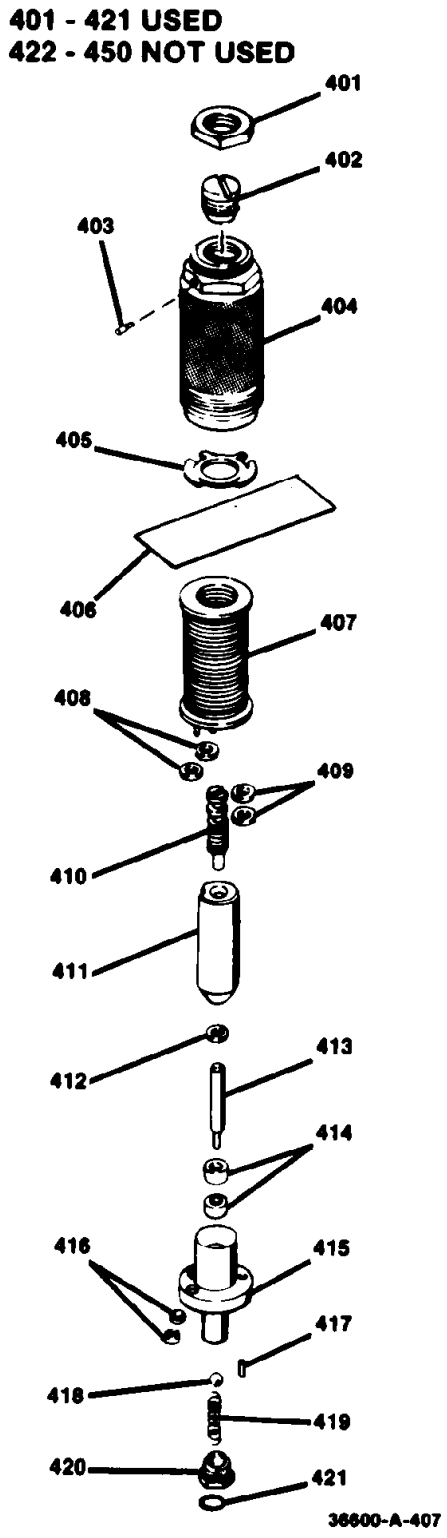

Figure 6-6. Solenoid Shutdown Parts

Parts for Figure 6-7

Ref. No.	Part Name	Quantity
36629-451	Compensation Needle Valve	1
36629-452	O-ring, 0.302 ID x 0.070	1
36629-453	Screw, 0.375-16 x 1	4
36629-454	High Collar Lock Washer, 0.375 ID	4
36629-455	Power Cylinder	1
36629-456	Power Case to Servo Gasket	1
36629-457	Oil Seal, 1.128 OD	1
36629-458	Oil Seal	1
36629-459	Rod End	1
36629-460	Taper Pin	1
36629-461	Cotter Pin, 0.062 x 0.375	1
36629-462	Spring Guard Gasket	1

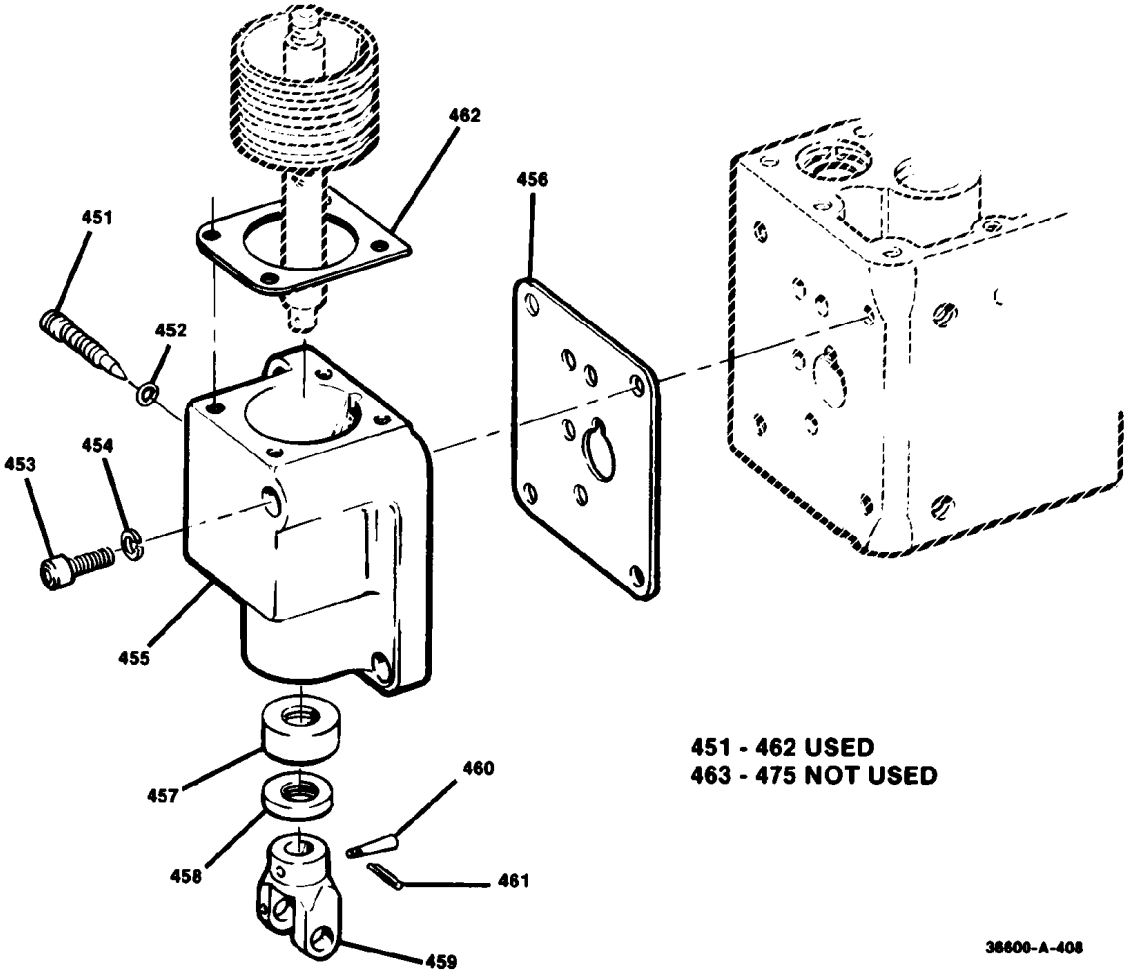

Figure 6-7. Power Servo Parts

Parts for Figure 6-8

Ref. No.	Part Name	Quantity
36629-476	Taper Pin, No. 5	2
36629-477	Base	1
36629-478	Screw, 0.312-28 x 4.250	8
36629-479	Spring Lock Washer, 0.312	8
36629-480	Retainer Gasket	1
36629-481	Oil Seal	1
36629-482	Oil Seal Retainer	1
36629-483	External Retaining Ring, 0.621 Free Dia	1
36629-484	Ball Bearing	1
36629-485	Drive Shaft	1
36629-486	Retainer	1
36629-487	Screw, .250-28 x 0.625	3
36629-488	Lock Wire, 0.026 Dia	1
36629-489	Governor Gasket	1

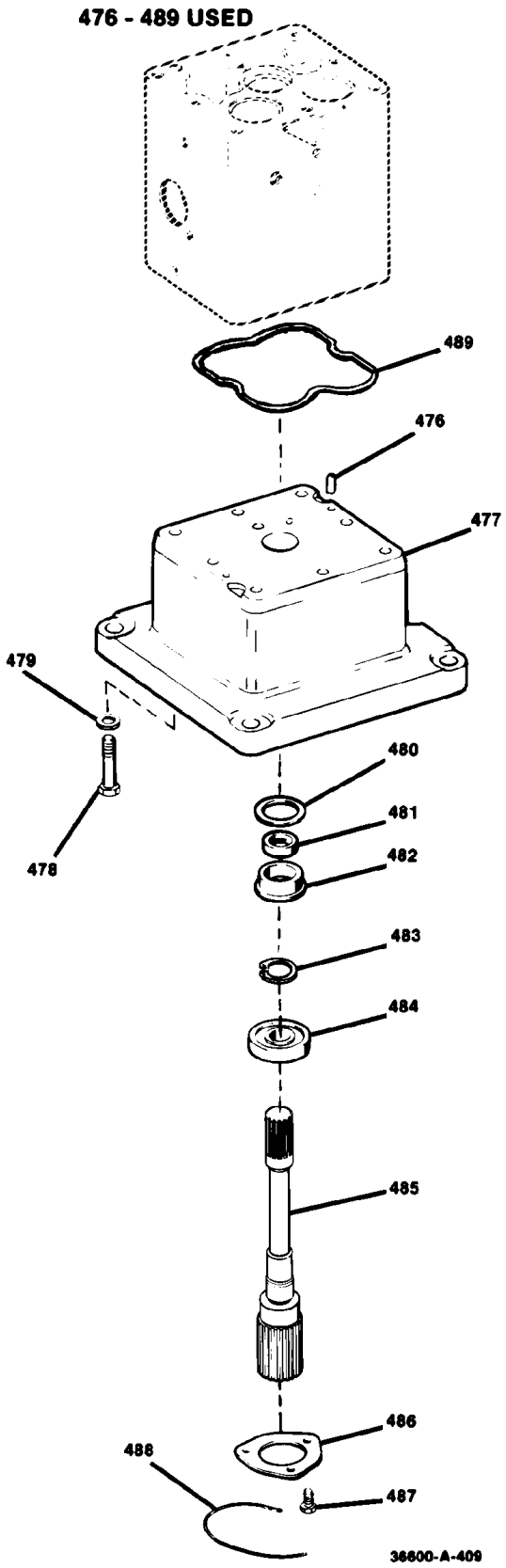

Figure 6-8. PGA-TL UG-40 Base Parts

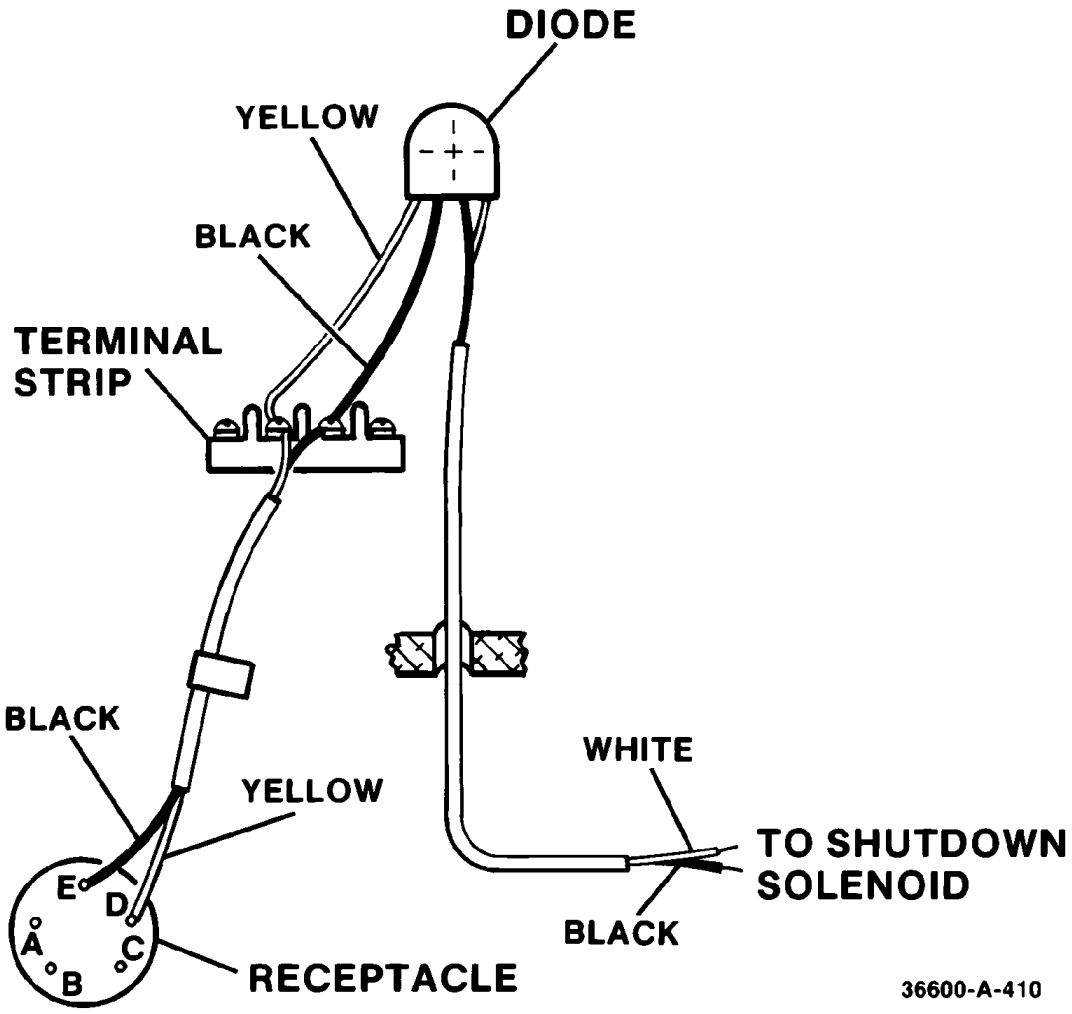

Figure 6-9. Wiring Diagram

Chapter 7.
Product Support and Service Options

Product Support Options

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

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

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

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

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

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

Product Service Options

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

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

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

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

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

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

Returning Equipment for Repair

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

When shipping the item(s), attach a tag with the following information:
- return number;
- name and location where the control is installed;
- name and phone number of contact person;
- complete Woodward part number(s) and serial number(s);
- description of the problem;
- instructions describing the desired type of repair.

Packing a Control

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

NOTICE

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

Replacement Parts

When ordering replacement parts for controls, include the following information:
- the part number(s) (XXXX-XXXX) that is on the enclosure nameplate;
- the unit serial number, which is also on the nameplate.

Engineering Services

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

- Technical Support
- Product Training
- Field Service

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

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

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

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

Contacting Woodward's Support Organization

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

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

Products Used In Electrical Power Systems

Facility	Phone Number
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

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

Products Used In Industrial Turbomachinery Systems

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

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

Technical Assistance

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

General

Your Name _____

Site Location _____

Phone Number _____

Fax Number

Prime Mover Information

Manufacturer _____

Engine Model Number _____

Number of Cylinders _____

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

Power Output Rating _____

Application (power generation, marine, etc.)

Control/Governor Information

Control/Governor #1

Woodward Part Number & Rev. Letter _____

Control Description or Governor Type _____

Serial Number

Control/Governor #2

Woodward Part Number & Rev. Letter _____

Control Description or Governor Type _____

Serial Number

Control/Governor #3

Woodward Part Number & Rev. Letter _____

Control Description or Governor Type _____

Serial Number

Symptoms

Description _____

_____

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

We appreciate your comments about the content of our publications.

Send comments to: icinfo@woodward.com

Please reference publication 36629.

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as well as authorized distributors and other authorized service and sales facilities throughout the world.**

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

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