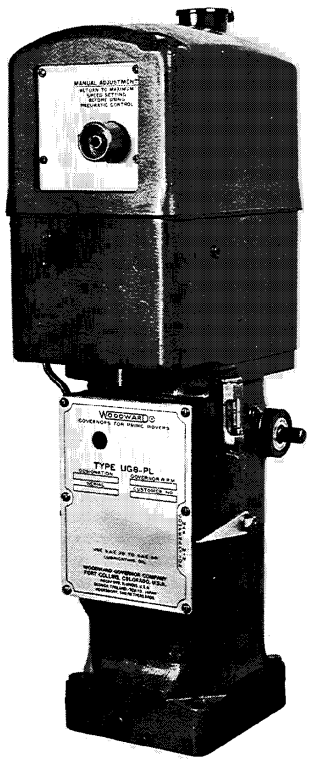
WOODWARD

**Product Manual 03025**
**(Revision B)**
**Original Instructions**




# UG-8PL Governor with Direct or Reverse Pneumatic Speed Setting

## 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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**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 *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 Out-of-date translations are marked with ⚠.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.**

# Contents

# Illustrations and Tables

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## 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-8PL is a compensated, isochronous governor for use with diesel, gas, and dual-fuel engines or steam and industrial gas turbines driving pumps, compressors, alternators, generators, etc. The UG-8PL governor has an integral oil reservoir (sump) and oil pump and does not require an external oil supply for its operation. The governor also has both a spring-driven ballhead assembly and laminated-spring ballhead drive for attenuation of undesirable torsional vibrations which may be transmitted to the governor (see Figure 1-1).

Speed setting of the UG-8PL governor is accomplished either manually (knob) at the governor or remotely by a pneumatic signal from a standard air pressure controller used for automatic industrial process control or from a manually operated air pressure regulator on a remote control panel. Either of two types of pneumatic speed setting mechanisms are commonly used with the UG-8PL governor, a direct type where speed setting increases with increasing pneumatic (control air) pressure, or a reverse type where speed setting increases with decreasing control air pressure.

## Auxiliary Features (Optional)

A brief description of the various optional auxiliary features which may be used with the UG-8PL governor is given in the following paragraphs.

### Booster Servomotor

The booster servomotor is an external, pneumatically-operated hydraulic accumulator for use in applications where quick starting is desirable to conserve the starting air supply and/or in some marine applications using direct reversing engines to improve maneuverability of the vessel. The booster servomotor eliminates the normal time lag required for the governor oil pump to create sufficient pressure to open the fuel control at start-up by supplying a small volume of pressurized oil to the governor as the instant starting air is turned on. This allows the governor to open the fuel control quickly and thus minimize cranking time. Refer to manual 36684 for more detailed information covering the booster servomotor.

### Load Limit Control

The load limit control is a manually adjustable linkage mechanism which may be incorporated in the governor for use in applications where it is desirable to limit the prime mover horsepower output (load) to a predetermined maximum value at a given speed. The load limit control accomplishes this by restricting the angular rotation of the governor output shaft and consequently, the flow of fuel or steam to the prime mover.

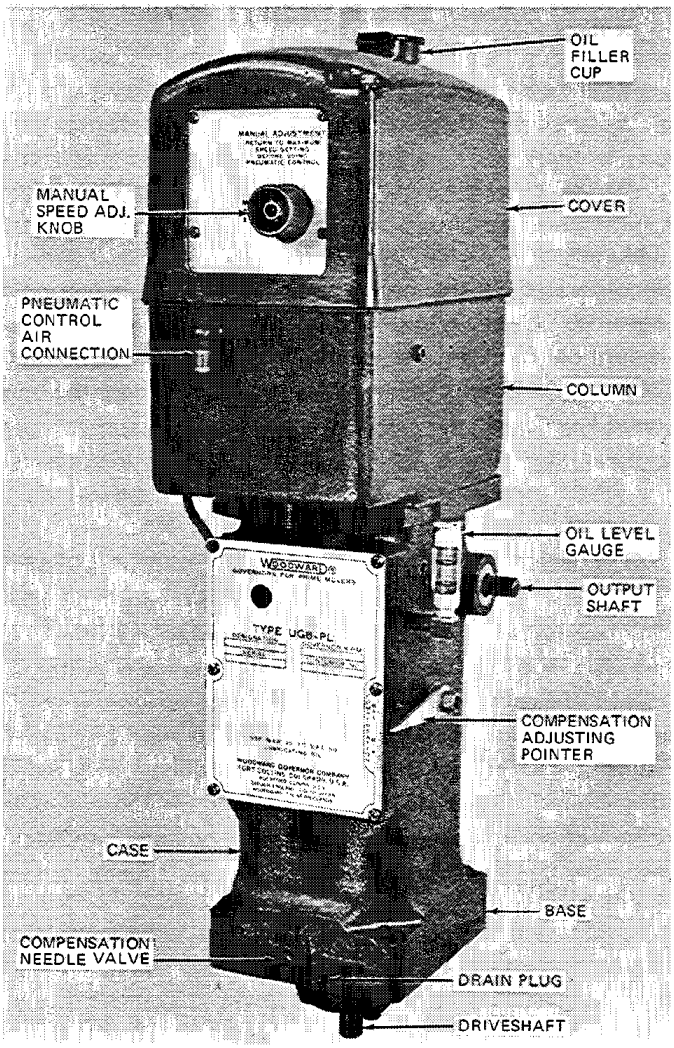


Figure 1-1. UG-8PL Governor

## Magnetic Speed Pickup

The magnetic speed pickup is a device which may be incorporated in the governor no obtain an indication of governor speed without having no provide an additional mounting pad on the prime mover. Refer to manual 36052 for more detailed information covering the magnetic speed pickup.

## Solenoid Operated Shutdown Assembly

The solenoid operated shutdown assembly may be incorporated in the governor to provide a means of automatically effecting prime mover shutdown in the event of equipment malfunction. The shutdown assembly can be adjusted to effect shutdown either when energized or de-energized. Refer to manual 36650 for more detailed information covering the solenoid operated shutdown assembly.

## Pressure Actuated Shutdown Assembly

The pressure actuated (air, oil, water) shutdown assembly provides the same protective function as the solenoid operated shutdown assembly. The pressure actuated shutdown assembly can be adjusted to effect shutdown with either high or low signal pressure. Refer to manual 36651 for more detailed information covering the pressure actuated shutdown assembly.

## Reduced Compensation

In some applications, particularly on small prime movers, it may be necessary to reduce the compensation below the minimum value normally attainable with a standard governor so that the governor can be adjusted to more closely match the characteristics of the prime mover. To accomplish this, a large compensation piston of slightly smaller diameter is used which proportionally reduces the corresponding movement of the small compensation piston for a given movement of the large compensation piston. The large compensation piston bore in the controlet is sleeved to accept the smaller diameter piston.

**⚠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.**

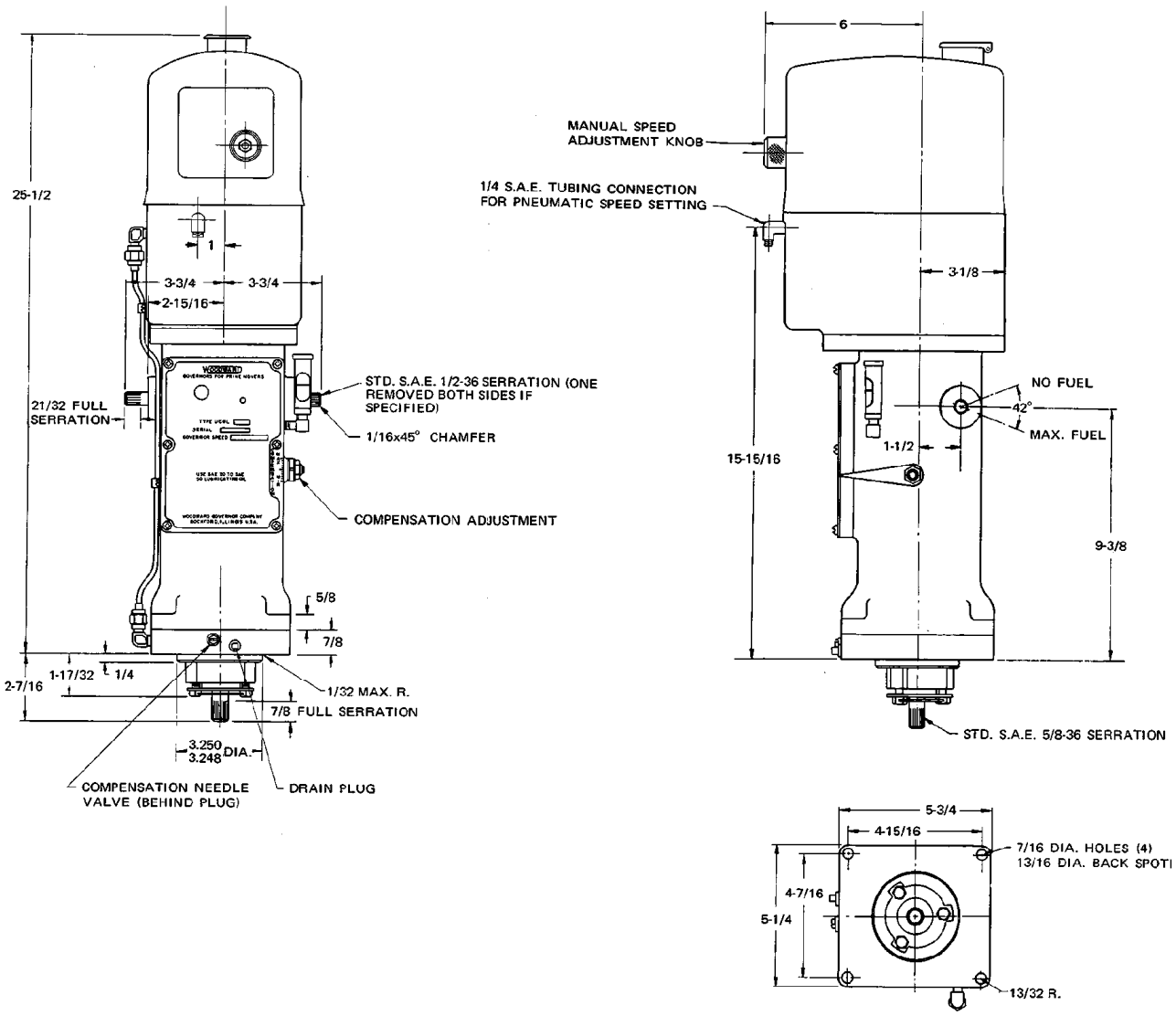


Figure 1-2. Outline Drawing of UG-8PL Governor

# Chapter 2.
# Installation and Adjustment

## Introduction

The UG-8PL governor may be mounted vertically or at any angle up to a maximum of 45° from vertical. If mounted at an angle, the governor dial plate on the case must face upward. See Figure 1-2 for installation data and envelope dimensions. Adequate clearance must be provided to allow installation and removal and permit access to the oil filler cup, drain plug, controls, indicators, and adjustments.

During installation of the governor, take particular care to ensure that the governor is mounted squarely and that the drive train is properly aligned. A gasket should be used between the governor base and prime mover mounting pad. If the governor has a serrated driveshaft, it must slip into the mating coupling or accessory driveshaft freely enough to drop into place of its own weight.

**NOTICE** **Do not drop or rest the governor on its driveshaft, or drive a coupling on or off the shaft.**

If the governor has a keyed driveshaft for installation of a gear, check the gearing for backlash and runout. Misalignment of the governor on the mounting pad, improper gear backlash, excessive shaft runout, too tight a fit between mating serrations, etc., can cause premature wear or seizure. This can also cause or transmit torsional vibrations to the governor ballhead which may result in undesirable “jiggle” at the governor terminal (output) shaft.

The interconnecting linkage between the governor and prime mover fuel or steam control should be designed to use 20° to 30° of the governor output shaft travel from the rated speed no-load position to the rated speed full-load (or overload) position. The linkage must be properly aligned and must operate freely without excessive backlash (lost motion) or binding. If a spring is used to compensate for backlash due to wear, the spring rate should be low so that the useful work capacity of the governor is not exceeded. A spring connected between linkage pins will minimize lost motion without putting additional load on the governor. The relationship between prime mover torque output and governor output shaft travel (throttle position) should be approximately linear. With gas or gasoline engines controlled through a butterfly valve, the torque output versus throttle position is very non-linear. In these applications, the linkage should be designed to require a greater movement of the governor output shaft per increment of butterfly movement at low loads (in the order of approximately 2:1) than is required at high loads (0.3:1).

After mounting the governor, complete the installation as follows.

1. Rotate the governor output shaft to the minimum position (fully counterclockwise as viewed from the left side of the governor) using a lever or Woodward serration wrench (P/N 030943). Then rotate output shaft 2° to 3° clockwise (toward maximum) and hold in this position. Install the linkage, adjusting as required so that the prime mover fuel or steam control is in the closed position with the governor output shaft at 2° to 3° travel.

2. Rotate the governor output shaft clockwise. The fuel or steam control should open to the rated speed full-load (or overload) position at 39° to 40° (or less) governor output shaft travel.

3. Connect the control air pressure line to the 1/4-inch tube fitting in the front of the governor column.

4. Fill the governor with oil to the full level as indicated by the external sight gauge. Oil must be clean and of a grade suitable for the particular operating conditions.

As is the case with a governor of any type, the prime mover should be equipped with a separate overspend device to prevent runaway in the event of any failure which might render the governing system inoperative.

## Initial Operation and Adjustment

Normally, the only adjustments required when first putting a new or factory overhauled governor into service are the compensation adjustments. The control air pressure versus prime mover speed relationship will have been factory calibrated to the parameters applicable to the particular installation and should not ordinarily require further adjustment.

Prior to staring the prime mover for the first time after installation of a new or overhauled governor, make certain the speed is set to minimum (idle). Start the prime mover under manual control and allow to warm up. Transfer the prime mover to governor control but be prepared to assume manual control until satisfied that the governing system is fully operative. Bleed the governor of trapped air and adjust governor compensation with the prime mover operating an rated speed (no load). Check the speed settings and adjust as necessary.

## Compensation Adjustments

(Figure 1-1)

1. Loosen the nut securing compensation adjustment pointer and set the pointer to MAX (extreme upward position). Tighten the nut.

2. Remove the hexagon head plug covering the compensation needle valve in front of the governor base. Open the needle valve three or more turns using a screwdriver.

**NOTICE**

**Insert the screwdriver blade in the shallow slot in the head of the needle valve, as the deep slot has been expanded to provide a means of locking the needle valve in position.**

3. Allow the prime mover to hunt or surge for approximately 30 seconds to bleed trapped air from governor oil passages. In the event that opening the needle valve does not cause the prime mover to hunt, manually disturb prime mover speed sufficiently to cause the governor output shaft to rotate full travel several times to force all air out of the oil passages.

4. Reset the compensation adjustment pointer to MIN (extreme downward position) and tighten nut.

**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 prime mover will return promptly to speed after a speed disturbance with only a slight over- or undershoot. It is desirable to have as little compensation as possible for best governing action. Closing the compensation needle valve further than necessary will cause the prime mover to return to speed slowly following a speed disturbance. Setting the compensation adjustment pointer too far toward maximum will cause excessive over- or undershoot upon return to speed following a speed disturbance. The compensation needle valve should never be fully closed as this will prevent proper operation of the governor.**

5. Gradually close the compensation needle valve until prime mover hunting just stops (do not go beyond this position). Check the amount of needle valve opening by fully closing the valve and noting the number of turns required to close the valve. Reopen the valve to the point at which hunting stopped.

6. Check the governing action by manually disturbing prime mover speed. If governing action is satisfactory (prompt return to speed with only a slight over- or undershoot) and the needle valve is open 1/8-turn or more, proceed to steps 10 and 11 as no further adjustments are required. If the needle valve is less than 1/8-turn open, perform steps 7 through 11.

7. Raise the compensation adjustment pointer two divisions on the scale.

8. Open the needle valve until the prime mover begins to hunt.

9. Repeat steps 5 through 8 until governing action is satisfactory.

10. After making final adjustment, replace the compensation needle valve plug.

11. Check the governor oil level and add oil as necessary.

## Speed Adjustments (Direct Speed Setting)

(Figure 2-1)

**IMPORTANT**

**The governor speed setting adjustments, particularly those which establish the governor speed range versus the control air pressure range, are mutually interactive such that a change cannot be made to one end of the range without also affecting the other end. For this reason, the entire adjustment procedure should be performed in sequence whenever any change in the low or high speed setting is necessary. It is preferable that speed adjustments be made on a test stand; however, they may be made on the prime mover if care is taken to avoid any possibility of overspeeding the prime mover.**

1. Remove the governor cover.

2. Set the load limit knob to maximum load (10 on the dial plate) if the governor is equipped with optional load limit control.

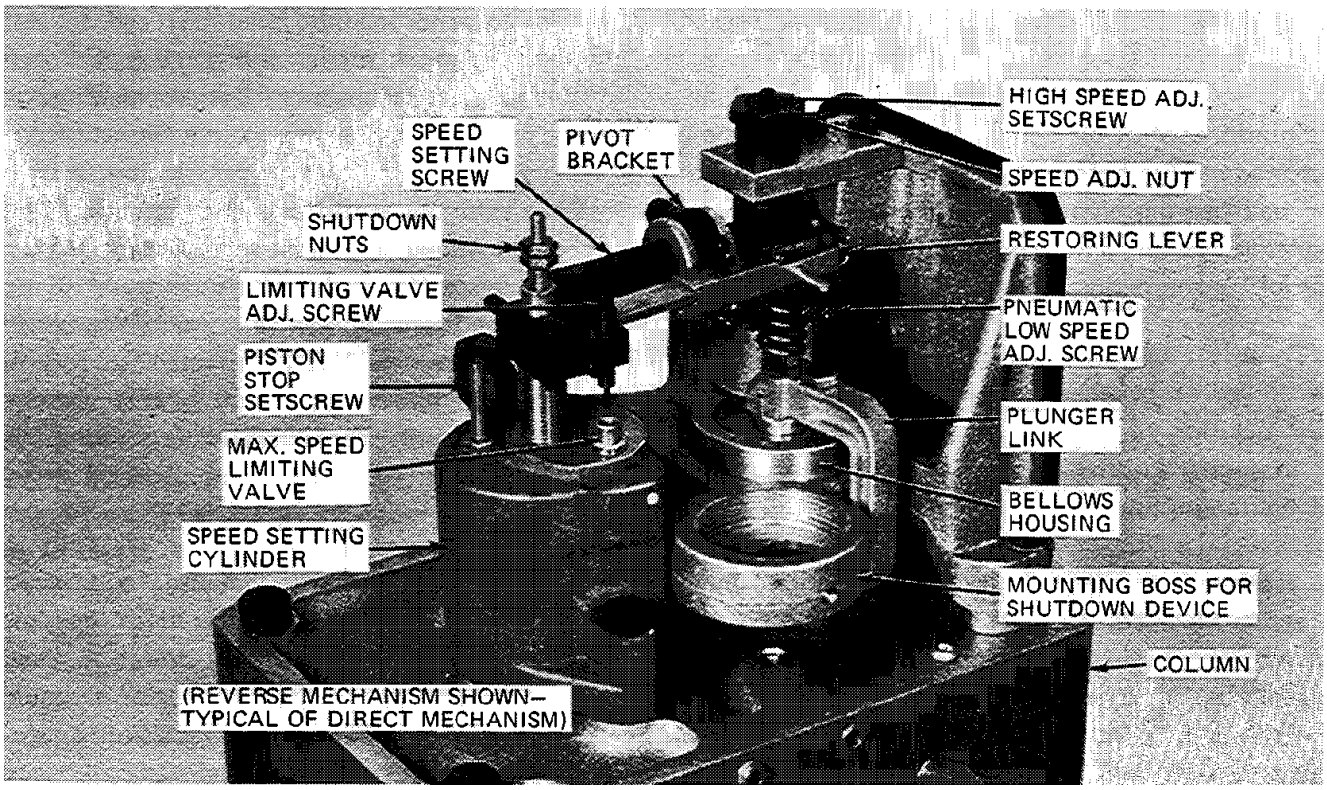


Figure 2-1. Speed Setting Adjustments

3. If the governor is equipped with an optional solenoid or pressure actuated shutdown device—
   a. Solenoid type—must be energized if adjusted to shut down when de-energized.
   b. Pressure type—must be pressurized above shutdown point if adjusted to shut down on low pressure.

**IMPORTANT**

**If desired, either shutdown device may be temporarily rendered ineffective when making speed adjustments by installing a taper screw (116, Figure 6-1) to block the oil passage to the shutdown device. Make certain to remove the screw after completing the adjustment procedure.**

4, Turn the manual speed adjusting knob fully counterclockwise (until clutch slips) to the minimum speed position. The knob must remain in the minimum speed position during subsequent adjustments until noted otherwise.

5. Initially position the high speed adjusting set screw so that upper end is flush with top of the speed setting screw.

6. Initially position the speed setting piston stop set screw so that it projects 1/2-inch (13 mm) above top of speed setting cylinder.

7. Adjust the governor low speed setting as follows:
   a. Turn on control air to the governor and adjust to the required minimum pressure corresponding to the required low (idle) speed.

b. Turn the speed adjusting nut on the speed setting screw as required (counterclockwise to increase) until the required speed is reached at minimum control air pressure.

**IMPORTANT**

**Make certain the pneumatic low speed adjusting screw is not contacting the stop pin in the restoring lever and that the piston stop set screw is not interfering with upward movement of the speed setting piston.**

8. Calibrate the governor speed range to the control pressure range as follows:
   a. Slowly increase control air pressure toward the required maximum value. Exercise care not to overspeed the prime mover.

**IMPORTANT**

**Make certain the maximum speed limiting valve adjusting screw on the speed setting piston rod is not contacting and prematurely unseating the limiting valve check ball in the top of the speed setting cylinder.**

   b. Should the required high speed be reached before control air pressure is adjusted to the required maximum value, the ball bearing pivot (fulcrum) must be moved toward the speed setting cylinder to decrease the governor speed range in relation to the control air pressure range.
   c. Should control air pressure be adjusted to the desired maximum value before the required high speed is reached, the ball bearing pivot must be moved away from the speed setting cylinder to increase the governor speed range in relation to the control air pressure range.
   d. To adjust the ball bearing pivot, loosen the uppermost screw in the pivot bracket on the arm of the speed setting screw. Adjust position of the bracket (and ball bearing pivot) arm by loosening the knurled nut on the appropriate side of the bracket and tightening the opposite nut.

After every adjustment of the pivot bracket, the speed setting must be readjusted. Repeat steps 7 and 8 until the required low speed exactly corresponds with the required minimum control air pressure, and both high speed and maximum control air pressure are reached simultaneously. Speed must begin to increase instantly with any increase in control air pressure above the minimum value.

Adjust control air pressure to the maximum value. Allow the speed to stabilize at the required maximum value and then turn the limiting valve adjusting screw clockwise until it just contacts the check ball in the maximum speed limiting valve. Increase control air pressure slightly above the required maximum value. The prime mover speed should not rise more than 5 rpm above the high speed setting. Readjust if necessary.

Reduce control air pressure to the minimum value and allow the prime mover to decelerate to low speed.

Turn the piston stop set screw clockwise until it just contacts the top of the speed setting piston and then back out three full turns (3/32”/2.4 mm) and lock in position.

**IMPORTANT**

**The piston stop set screw is normally used to limit upward movement of the speed setting piston during shutdown periods to 3/32" (2.4 mm) above the low speed position of the piston. This allows the governor to open the fuel or steam control more quickly on start-up and thus minimize the cranking time.**

**Some governor applications may require a low or minimum speed stop, in which case the piston stop set screw is used to limit upward movement of the piston at the low or minimum speed point. Where this is done, the governor cannot then be used to shut down the prime mover, and some means external to the governor must be provided for this purpose.**

13. Lift the shutdown rod upward far enough to remove any end play (lost motion) but not so far as to also lift the speeder rod and cause speed to drop below the low speed setting. While holding the shutdown rod up, position the lower shutdown nut on the rod so that it is 0.050" (1.27 mm) above the upper end of the speed setting piston rod and lock in place with the upper nut.

**IMPORTANT**

**The shutdown nuts are usually omitted where the governor application does not require a shutdown capability. If the nuts have been included but shutdown is not a requirement, make certain that the nuts are positioned at the top of the shutdown rod at maximum distance from the speed setting piston rod.**

14. If the governor is to shut down the prime mover when control air is turned off or inadvertently interrupted, adjust the pneumatic low speed stop screw so that it is 0.040 to 0.050" (1.02 to 1.27 mm) below the stop pin in the restoring lever at low speed. Turn off control air to the governor and allow the prime mover to shut down. Readjust the stop screw for 0.002 to 0.005" (0.05 to 0.13 mm) clearance between the head of the screw and the stop pin in the restoring lever.

15. If the governor is to go to low speed when control air is turned off or interrupted, adjust the pneumatic low speed stop screw so that it just contacts the stop pin in the restoring lever at low speed.

16, Turn off control air to the governor. (If the governor is adjusted to shut down on interruption of control air, turn the manual speed adjusting knob clockwise until prime mover speed increases slightly before turning off control air.) Continue turning the knob clockwise until the prime mover is running at high speed. Turn the high speed adjusting set screw in the speed adjusting screw clockwise until it just contacts the high speed stop pin. If the set screw is turned too far, prime mover speed will decrease.

17. Make certain to turn the manual speed adjusting knob fully counterclockwise to the minimum speed position before resuming normal operation under pneumatic control.

18. Replace the governor cover.

## Speed Adjustments (Reverse Speed Setting)

(Figure 2-1)

**IMPORTANT**

**The governor speed setting adjustments, particularly those which establish the governor speed range versus the control air pressure range, are mutually interactive such that a change cannot be made to one end of the range without also affecting the other end. For this reason, the entire adjustment procedure should be performed in sequence whenever any change in the low or high speed setting is necessary. It is preferable that speed adjustments be made on a test stand; however, they may be made on the prime mover if care is taken to avoid any possibility of overspeeding the prime mover.**

1. Remove the governor cover.

2. Set the load limit knob to maximum load (10 on the dial plate) if the governor is equipped with the optional load limit control.

3. If the governor is equipped with an optional solenoid or pressure activated shutdown device—
   a. Solenoid type—must be energized if adjusted to shut down when de-energized.
   b. Pressure type—must be pressurized above shutdown point if adjusted to shut down on low pressure.

**IMPORTANT**

**If desired, either shutdown device may be temporarily rendered ineffective when making speed adjustments by installing a taper screw (116, Figure 6-1) to block the oil passage to the shutdown device. Make certain to remove the screw after completing the adjustment procedures.**

4. Turn the manual speed adjusting knob fully counterclockwise (until the clutch slips) to the minimum speed position.

5. Initially position the high speed adjusting setscrew so that the upper end is flush with the top of speed setting screw.

6. Initially position the speed adjusting nut so that the speed setting screw projects 1/4” (6 mm) above the nut.

7. Initially position the speed setting piston stop set screw so that it just touches the speed setting piston, and then back it off 1/8th turn.

8. Adjust the governor high speed setting as follows:
   a. Turn on control air to the governor and adjust to the required minimum pressure corresponding to the required high (rated) speed.
   b. Turn the manual speed adjusting knob clockwise until the required high speed is reached at minimum control air pressure. Exercise care not no overspeed the prime mover. If high speed is not reached by the time the knob is turned fully clockwise, turn the knob counterclockwise two full turns (toward minimum) and then turn the speed adjusting nut on the speed setting screw counterclockwise until the required high speed is reached.

**IMPORTANT**

**Make certain the limiting valve adjusting screw on the speed setting piston rod is not contacting and prematurely unseating the limiting valve check ball in the top of the speed setting cylinder.**

c. Turn the high speed adjusting set screw in the speed setting screw clockwise until it just contacts the high speed stop pin. If the set screw is turned too far, speed will decrease.
d. Again turn the speed adjusting knob fully clockwise. Speed must not increase above the high speed setting. Readjust the setscrew, if necessary.

**IMPORTANT**

**The manual speed adjusting knob must remain in the maximum speed position during subsequent adjustments until noted otherwise.**

9. Calibrate the governor speed range to the control air pressure range as follows:
   a. Gradually increase control air pressure until speed decreases to the required low speed.

**IMPORTANT**

**Make certain the pneumatic low speed adjusting screw is not contacting the stop pin in the restoring lever and that the piston stop set screw is not interfering with upward movement of the speed setting piston.**

   b. Should low speed be reached before control air pressure is adjusted to the required maximum value, the ball bearing pivot (fulcrum) must be moved toward the speed setting cylinder to decrease the governor speed range in relation to the control air pressure range.
   c. Should control air pressure be adjusted to the required maximum value before low speed is reached, the ball bearing pivot must be moved away from the speed setting cylinder to increase the governor speed range in relation to the control air pressure range.
   d. To adjust the ball bearing pivot, loosen the uppermost screw in the pivot bracket on the arm of the speed setting screw. Adjust the position of the bracket (and ball bearing pivot) on the arm by loosening the knurled nut on the appropriate side of the bracket and tightening the opposite nut.

10. After every adjustment of the pivot bracket, the high speed setting must be readjusted. Repeat steps 8 and 9 until the required high speed setting exactly corresponds with the required minimum control air pressure, and both low speed and maximum control air pressure are reached simultaneously. Speed must begin to increase instantly with any decrease in control air pressure below the maximum value.

11. Calibrate the manual speed adjusting knob for low speed as follows:
    a. Adjust control air pressure to the minimum value and allow speed to increase to the maximum setting.
    b. Turn the manual speed adjusting knob counterclockwise toward the minimum position until the required low speed is reached.
    c. Should the knob be turned fully counterclockwise (until clutch slips) before low speed is reached, turn off control air to the governor (speed will increase slightly). Turn the speed setting nut clockwise, decreasing speed, until the required low speed is reached.

d. Should the required low speed be reached before the knob is turned fully counterclockwise, alternately turn the speed setting nut 1/2-turn counterclockwise (increasing speed) and the knob counterclockwise (decreasing speed) until the knob can be turned fully counterclockwise slightly before (or at the same instant) low speed is reached. Make final low speed adjustment, if necessary, as instructed in step c above.

12. With control air off and the governor at the low speed setting, turn the piston stop set screw clockwise until it just contacts the top of the speed setting piston and then back out three full turns (3/32”/2.4 mm) and lock in position.

**IMPORTANT**

**The piston stop set screw is normally used to limit upward movement of the speed setting piston during shutdown periods to 3/32” (2.4 mm) above the low speed position of the piston. This allows the governor to open the fuel or steam control more quickly on start-up and thus minimize the cranking time.**

**Some governor applications may require a low or minimum speed stop, in which case the piston stop set screw is used to limit upward movement of the piston at the low or minimum speed point. Where this is done, the governor cannot then be used to shut down the prime mover, and some means external to the governor must be provided for this purpose.**

13. Lift the shutdown rod upward far enough to remove any end play (lost motion) but not so far as to also lift the speeder rod and cause speed to drop below the low speed setting. While holding the shutdown rod up, position the lower shutdown nut on the rod so that it is 0.050” (1.27 mm) above the upper end of the speed setting piston rod and lock in place with the upper nut.

**IMPORTANT**

**The shutdown nuts are usually omitted where the governor application does not require a shutdown capability. If the nuts have been included but shutdown is not a requirement, make certain that the nuts are positioned at the top of the shutdown rod at maximum distance from the speed setting piston rod.**

14. With control air off, turn the manual speed adjusting knob clockwise to the maximum speed position. Allow speed to stabilize at the required high speed setting and then turn the limiting valve adjusting screw clockwise until it just contacts the check ball in the maximum speed limiting valve. This will prevent or limit inadvertent overspeeding of the prime mover should the speed setting piston be moved past the high speed position for any reason.

15. Adjust control air to the required maximum value. Allow speed to stabilize at the required low speed setting and then turn the pneumatic low speed adjusting screw clockwise until it just contacts the stop pin in the restoring lever.

16, Make certain to turn the manual speed adjusting knob fully clockwise to the maximum speed position before resuming normal operation under pneumatic control.

17. Replace the governor cover.

# Chapter 3.
# Principles of Operation

## Introduction

Figure 3-1 schematically illustrates the UG-8PL governor. Both direct and reverse type pneumatic speed setting mechanisms are shown. For purposes of description, the governor is considered as four distinct but interconnected functional sections: a pressure section, a speed setting section, a speed sensing and output section, and a compensation section.

## Pressure Section

The pressure section consists of a gear type oil pump. four check valves, and two accumulators. The oil pump gears are integral with the pilot valve bushing and ball-head laminated spring drive. The check valves are arranged in opposing pairs to permit use of the governor without change on either clockwise or counterclockwise accessory drives. The accumulators function as a reservoir of pressurized oil and provide the additional oil volume required when large changes in speed or load would temporarily exceed the capacity of the pump.

In the pressure section, oil from the governor sump enters the suction side of the pump through one of two check valves (depending on direction of governor rotation). The oil is discharged from the pump, again through one of two check valves, at a greatly increased pressure. The pump discharge oil is then directed to the accumulators, the speed setting valve, to one side of the power piston, and to the speeder (pilot) valve. The oil pressure is regulated by the accumulators which bypass excess oil back to the sump when the accumulator pistons have been displaced far enough to uncover the relief ports.

## Speed Setting Section

The speed setting section (direct or reverse) consists of a bellows housed within a pressure chamber, a hydraulic speed setting valve (pilot valve plunger and rotating bushing), a single-acting spring-return speed setting hydraulic cylinder, a restoring linkage for re-centering the speed setting valve plunger, and a manual speed setting mechanism. With the direct mechanism, the governor speed setting is directly proportional to control air pressure (speed setting increases as air pressure increases); with the reverse mechanism, the speed setting is inversely proportional to control air pressure (speed increases as pressure decreases). The direct and reverse speed setting mechanisms are essentially identical, differing only in the manner in which air pressure is used to effect changes in the governor speed setting. As will be noted in Figure 3-1, the position of the bellows in the reverse mechanism is opposite that of the bellows in the direct mechanism.

With the direct mechanism, an increase in control air pressure causes the bellows to contract and thus move the speed setting valve plunger downward (increase speed). With the reverse mechanism, the bellows is initially pressurized to the high end of the control air pressure range so that expansion of the bellows, as pressure is decreased, will also cause a downward movement of the speed setting valve plunger.

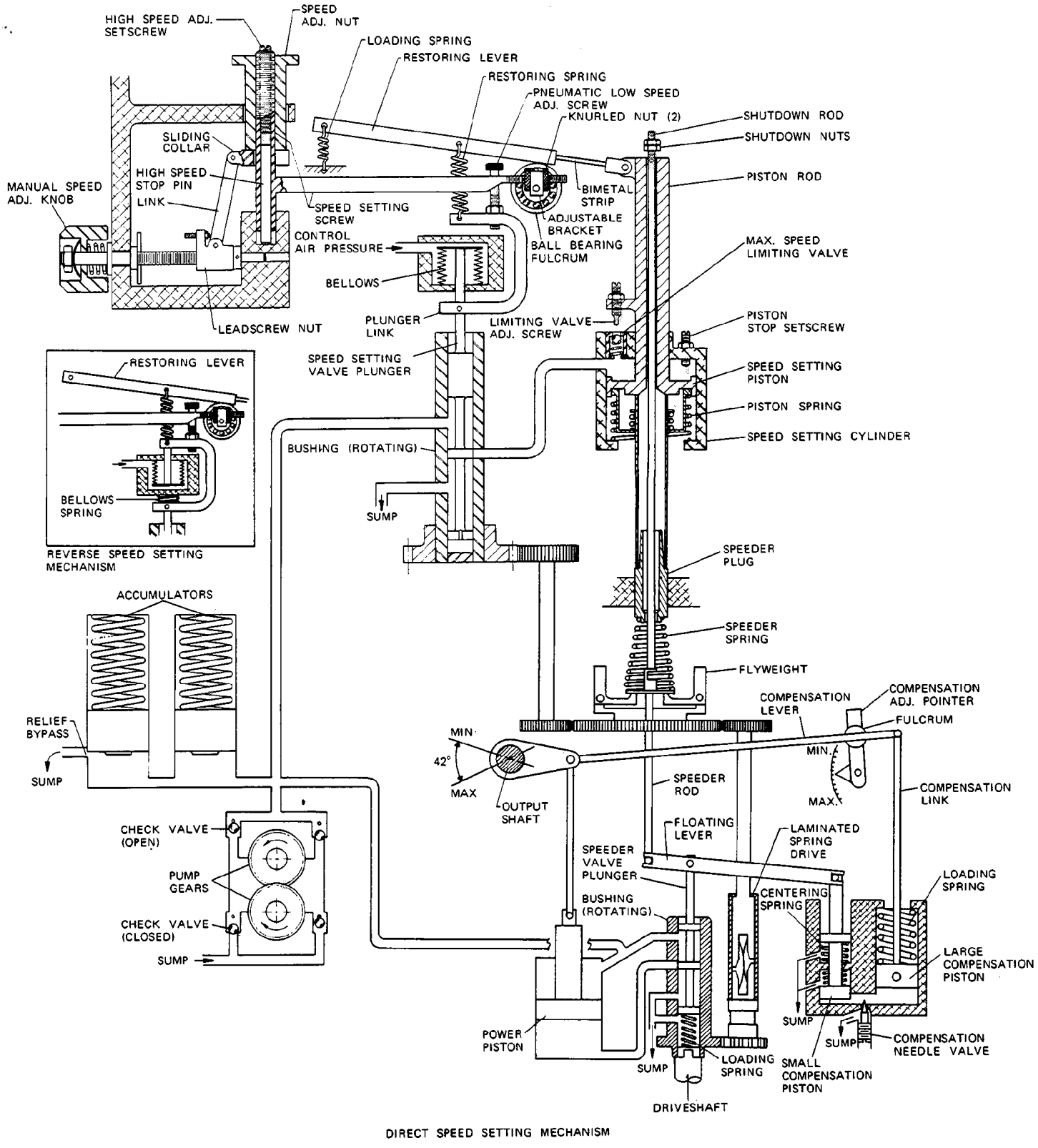


Figure 3-1. Schematic Diagram

The speed at which the governor will control is determined by the force exerted on the toes of the flyweights by the speeder spring in the speed sensing and output section of the governor. Speeder spring force is determined by the position of the piston in the speed setting cylinder. The position of the piston, in turn, is determined by the volume of oil trapped in the area above the piston. The direction and rate of oil flow into or out of this area is controlled by the speed setting valve plunger which is mechanically linked to the bellows. If the plunger is moved downward, uncovering the upper edge of a metering port in the bushing, pressurized oil is allowed to flow into the speed setting cylinder. This displaces the piston downward, further increasing speeder spring tension and thus increasing the speed setting. If the plunger is moved upward, uncovering the lower edge of the metering port, oil is permitted to drain from the cylinder. This allows the piston spring to raise the piston, decreasing speeder spring force and thus lowering the speed setting.

## Direct Pneumatic Operation

**IMPORTANT**

**The manual speed setting knob must be turned fully counterclockwise to raise the manual speed setting screw to its uppermost (minimum or low spend) position during pneumatic operation. If the speed setting screw (knob) is in any position other than minimum speed, it will, in effect, raise the pneumatic low speed setting of the governor and prevent normal pneumatic operation at speeds below this setting.**

The bellows and restoring spring comprise a force-balance system which is mechanically connected to the speed setting valve plunger through a C-shaped link. Control air pressure acting externally on the bellows exerts a downward force on the lower leg of the C-shaped link. The restoring spring connected to the upper leg of the link exerts an opposing upward force. Except during a speed setting change, the downward force of the air pressure acting on the bellows exactly counterbalances the upward force of the restoring spring. With these forces in “balance”, the control land on the speed setting valve plunger covers the metering port in the valve bushing and no oil, other than leakage make-up, can flow into or out of the speed setting cylinder. A change in control air pressure disturbs this balance and results in a speed setting change.

With an increase in control air pressure (increase speed setting), the force acting on the bellows becomes greater than restoring spring force and the bellows contracts in a downward direction. This pushes the C-shaped link downward and lowers the speed setting valve plunger. High pressure oil then flows into the speed setting cylinder, forcing the piston downward to further compress the speeder spring and thereby increase the governor speed setting. As the piston moves downward, a restoring lever attached at the right end to the upper end of the piston rod pivots clockwise about an adjustable ball bearing fulcrum on the extended arm of the manual speed setting screw. The left end of the lever is connected to the restoring spring and a loading spring. The clockwise movement of the lever causes a proportional increase in restoring spring force which, acting through the link, gradually expands the bellows to its original length while simultaneously lifting the plunger. When the net increase in restoring spring upward force equals the increase in downward force resulting from the increase in control air pressure, the bellows and plunger will again be re-centered (restored) with the control land on the plunger covering the metering port in the bushing. This stops the flow of oil into the speed setting cylinder, halting downward movement of the piston an the instant speeder spring force reaches its new higher value corresponding to that higher control air pressure. The loading spring “loads” the restoring lever to maintain positive contact between the lever and ball bearing fulcrum at all times and serves no other function.

With a decrease in control air pressure (decrease speed setting), the force acting on the bellows becomes less than restoring spring force and the bellows expands in an upward direction. This allows the restoring spring no lift the C-shaped link and speed setting valve plunger. Oil then drains from the speed setting cylinder which allows the piston to rise, decreasing speeder spring force, and thus lowering the governor speed setting. As the piston rises, the restoring lever pivots in a counterclockwise direction to proportionally reduce restoring spring force, which allows the bellows to gradually contract to its original length and simultaneously lower the plunger. When the net decrease in restoring spring upward force equals the decrease in downward force resulting from the decrease in control air pressure, the bellows and plunger will again be re-centered with the control land on the plunger covering the metering port in the bushing. This stops oil drainage from the speed setting cylinder, halting upward movement of the piston at the instant speeder spring force reaches its new lower value corresponding to that lower control air pressure.

The ratio of change in restoring spring force for a given movement of the speed setting piston is determined by the distance between the ball bearing fulcrum and the point at which the restoring lever is attached to the piston rod. Shortening this distance will decrease the governor speed range for a given control air pressure range; lengthening this distance will increase the speed range for a given air pressure range.

Some applications may require that the governor be adjusted to go to low speed upon intentional or inadvertent interruption of control air pressure or when control air pressure drops below the required minimum value. In these instances, the pneumatic low speed adjusting screw is set to contact a stop pin projecting from the restoring lever when control air pressure and prime mover speed are at their normal minimum values. Thus, should control air pressure be lost or reduced below the minimum value, the restoring spring will raise the speed setting valve plunger until the low speed adjusting screw contacts the stop pin in the restoring lever. As the speed setting piston moves upward, the stop pin in the restoring lever simultaneously pushes downward on the adjusting screw to re-center the speed setting valve plunger at the moment the piston reaches its low speed position. Governors set to go to low speed upon loss of control air pressure are usually equipped with an auxiliary shutdown device.

If the governor is adjusted to go to shutdown on loss of control air pressure, the pneumatic low speed adjusting screw is set so that a definite clearance exists between it and the stop pin in the restoring lever with control air pressure reduced no zero and the governor shut down. In this case, should control air pressure be interrupted or reduced below the minimum value, the movement of the restoring lever as the speed setting piston moves upward does not tend to re-center the speed setting valve plunger. Thus, the piston continues to move upward past the low speed position to the shutdown position.

## Reverse Pneumatic Operation

**IMPORTANT**

**The manual speed setting knob must be turned fully clockwise to lower the manual speed setting screw to its lowest (maximum or high speed) position during pneumatic operation. If the speed setting screw (knob) is in any position other than maximum speed, it will, in effect, lower the pneumatic high speed setting of the governor and prevent normal pneumatic operation at speeds above this setting.**

The bellows, restoring spring, and bellows spring comprise a force-balance system which is mechanically connected to the speed setting valve plunger through a C-shaped link (see inset, Figure 3-1). Control air pressure acting externally on the bellows exerts an upward force on the upper leg of the link. The restoring spring connected to the upper leg of the link also exerts an upward force. The bellows spring between the bellows housing and the lower leg of the link exerts an opposing downward force. Except during a speed setting change, the combined upward forces of air pressure acting on the bellows and the restoring spring exactly counterbalance the downward force of the bellows spring. With these forces in “balance”, the control land on the speed setting valve plunger covers the metering port in the valve bushing and no oil, other than leakage make-up, can flow into or out of the speed setting cylinder. A change in control air pressure disturbs this balance and results in a speed setting change.

With a decrease in control air pressure (increase speed setting), the force acting on the bellows becomes less and the bellows expands in a downward direction. This allows the bellows spring, now the greater force, to push the C-shaped link downward and lower the speed setting valve plunger. High pressure oil then flows into the speed setting cylinder, forcing the piston downward to further compress the speeder spring and thereby increase the governor speed setting. As the piston moves downward, a restoring lever attached at the right end to the upper end of the piston rod pivots in a clockwise direction about an adjustable ball bearing fulcrum on the extended arm of the manual speed setting screw. The left end of the lever is connected to the restoring spring. The clockwise movement of the lever causes a proportional increase in restoring spring force which, acting through the link, gradually contracts the bellows to its original length, compresses the bellows spring, and simultaneously lifts the plunger. When the net increase in restoring spring upward force equals the decrease in the downward bellows force resulting from the decrease in control air pressure, the bellows and plunger will again be re-centered (restored) with the control land on the plunger covering the metering port in the bushing. This stops the flow of oil into the speed setting cylinder, halting downward movement of the piston at the instant speeder spring force reaches its new higher value corresponding to that lower control air pressure.

With an increase in control air pressure (decrease speed setting), the force acting on the bellows becomes greater. Since the sum of the upward forces (bellows force plus restoring spring force) is now greater than the downward force (bellows spring), the bellows contracts in an upward direction and lifts the C-shaped link and speed setting valve plunger. Oil then drains from the speed setting cylinder which allows the piston to rise, decreasing speeder spring force, and thus lowering the governor speed setting. As the piston rises, the restoring lever pivots in a counterclockwise direction to proportionally reduce restoring spring force which allows the bellows to gradually expand to its original length and permits the bellows spring to simultaneously lower the plunger. When the net decrease in restoring spring upward force equals the increase in the upward bellows force resulting from the increase in control air pressure, the bellows and plunger will again be re-centered with the control land on the plunger covering the metering port in the bushing. This stops oil drainage from the speed setting cylinder, halting upward movement of the piston at the instant speeder spring force reaches its new lower value corresponding to that higher control air pressure.

The ratio of change in restoring spring force for a given movement of the speed setting piston is determined by the distance between the ball bearing fulcrum and the point at which the restoring lever is attached to the piston rod. Shortening this distance will decrease the governor speed range for a given control air pressure range; lengthening this distance will increase the speed range for a given air pressure range.

Intentional or inadvertent interruption of control air pressure will allow the bellows spring to move the speed setting valve plunger downward, and the governor will go to the maximum speed setting as determined by the maximum speed limiting valve.

## Manual Speed Setting Mechanism

The manual speed setting mechanism consists of a knob and friction clutch, a lead screw and nut linked to a sliding collar, a speed adjusting nut, high speed adjusting set screw and stop pin, and the manual speed setting screw with ball bearing fulcrum. The knob can be used to adjust the speed setting to any point within the normal speed range when control air pressure is not available or its use is not desired.

**Manual Operation (Direct Mechanism)**—With no control air pressure, the pneumatic low speed adjusting screw is held against the stop pin in the restoring lever by the restoring spring. The restoring lever is thus directly connected, through the C-shaped link, to the speed setting valve plunger. Turning the knob clockwise (increase speed setting) causes the lead screw nut to move outward and lower the sliding collar under the speed adjusting nut on the shaft of the speed setting screw. This allows the loading spring to move the speed setting screw (and ball bearing fulcrum) downward with the collar until the high speed adjusting set screw contacts the high speed stop pin. At this point, further clockwise movement of the knob will cause the friction clutch to slip.

As the speed setting screw moves downward to a new position, the left end of the restoring lever, pulled downward by the loading spring, pushes downward on the pneumatic low speed adjusting screw and link to un-center the speed setting valve plunger. Pressurized oil can then flow into the speed setting cylinder and force the piston downward to increase the speed setting. The movement of the piston causes a clockwise rotation of the restoring lever. Since the pneumatic low speed adjusting screw is held against the stop pin in the restoring lever by the restoring spring, the speed setting valve plunger is lifted upward as the (ever rotates until the plunger is again re-centered at the instant the new higher speed position is attained by the piston.

Turning the knob counterclockwise (decrease speed setting) causes the lead screw nut to move inward and raise the sliding collar under the speed adjusting nut. This lifts the speed setting screw (and ball bearing fulcrum) upward, raising the left end of the restoring lever and thereby lifting the speed setting valve plunger above its centered position. As oil drains from the speed setting cylinder, the piston will move upward to decrease the speed setting. The counterclockwise movement of the restoring lever re-centers the plunger at the instant the new lower speed position is attained by the piston.

**Manual Operation (Reverse Mechanism)**—

**IMPORTANT**

**The manual speed adjusting knob must be returned to the minimum or low speed position (fully counterclockwise) prior to operation under manual control.**

With no control air pressure and the manual speed adjusting knob turned fully counterclockwise (low speed), the speed setting piston will assume a position at which the upward force of the restoring spring is balanced by the downward force of the bellows spring. Turning the knob clockwise (increase speed setting) causes the lead screw nut to move outward and lower the sliding collar under the speed adjusting nut on the shaft of the speed setting screw. This allows the speed setting screw (and ball bearing fulcrum) to move downward with the collar until the high speed adjusting set screw contacts the high speed stop pin. At this point, further clockwise movement of the knob will cause the friction clutch to slip.

As the speed setting screw moves downward to a new position, the upward force of the restoring spring is decreased. This allows the bellows spring to push the link downward and un-center the speed setting valve plunger. Pressurized oil can then flow into the speed setting cylinder and force the piston downward to increase the speed setting. The movement of the piston causes a clockwise rotation of the restoring lever which increases restoring spring force and lifts the plunger back to its centered position at the instant the new higher speed position is attained by the piston.

Turning the knob counterclockwise (decrease speed setting) causes the lead screw nut to move inward and raise the sliding collar under the speed adjusting nut. This lifts the speed setting screw (and ball bearing fulcrum) upward, raising the left end of the restoring lever and increasing restoring spring force. The increase in restoring spring force lifts the speed setting valve plunger above its centered position. As oil drains from the speed setting cylinder, the piston will move upward to decrease the speed setting. The movement of the piston causes a counterclockwise rotation of the restoring lever which decreases restoring spring force. This allows the bellows spring to re-center the plunger at the instant the new lower speed position is attained by the piston.

## Maximum Speed Limiting Valve

The maximum speed limiting valve is a ball check valve located in the top of the speed setting cylinder. A limiting valve adjusting screw in a lug on the rod of the speed setting piston unseats the ball whenever the piston reaches the maximum speed position (approximately 5 rpm above the normal high speed rpm). With the ball unseated, excess oil tending to increase the speed setting beyond the maximum speed set point is by-passed to sump. The valve is effective whether the speed setting is changed pneumatically or manually.

## Piston Stop Set Screw

The piston stop set screw is normally used to limit upward travel of the speed setting piston at shutdown to 3/32” (2.4 mm) above the low speed position of the piston. This minimizes the cranking required when the prime mover is restarted since a lesser volume of oil is required to move the piston downward to the low speed position and thus effect a more rapid opening of the fuel or steam control.

### Temperature Compensation

In early model governors, a bimetal strip incorporated in the restoring lever compensates for differential expansion and changes in spring rates due to temperature variations. In late model governors, a temperature compensated (reverse modulus) speeder spring is used in place of the bimetal strip. The governor speed settings are thus stabilized and drifting, due to changes in ambient, and for operating temperatures, minimized.

## Speed Sensing and Output Section

The speed sensing and output section consists of a speeder spring, two centrifugal flyweights attached no a rotating ballhead, a speeder rod, a floating lever, a hydraulic speeder valve (pilot valve plunger and rotating bushing), plunger loading spring, a double-acting hydraulic power piston connected to a rotary terminal (output) shaft, a shutdown device, and a laminated-spring ballhead drive.

The power piston is of the differential area type with a constant pressure (pump discharge) applied to that side of the piston having the least area with the resultant force (pressure x area) acting in a direction (downward) to decrease fuel or steam. Metered oil from the speeder valve at a somewhat lower pressure is applied to that side of the piston having the greatest area with the resultant force acting in a direction (upward) to increase fuel or steam. When these decrease vs. increase forces are equal, the piston is stationary. An increase in metered oil pressure results in a greater upward force and thus causes the piston to move upward; a decrease in metered oil pressure results in a greater downward force and thus causes the piston to move downward.

The flyweight toes act upon a thrust bearing attached to the speeder rod which is connected indirectly to the speeder valve plunger through the floating lever. The loading spring under the plunger serves primarily to eliminate lost motion in the various linkage elements and performs no other function. For purposes of the following description, consider the right end of the floating lever as being pivoted from a fixed point. Flyweight centrifugal force (in-out movement) is translated by the thrust bearing into an axial force (up-down movement). This axial (centrifugal) force is opposed by speeder spring force to comprise a force-balance system. When these forces are equal or in balance (on-speed), the control land on the speeder valve plunger covers a metering port in the speeder valve bushing. No oil, other than leakage make-up, can flow into or out of the area under the power piston.

Where speeder spring force is greater than flyweight centrifugal force (an underspeed condition which can be brought about by an increase in speed setting or an increase in load at a given speed setting), the flyweights are forced inward by the speeder spring which lowers the speeder rod and left end of the floating lever. This displaces the speeder valve plunger downward and uncovers the upper edge of the metering port in the speeder valve bushing. Metered oil at increased pressure is thus allowed to flow into the area under the power piston, forcing the piston upward and rotating the output shaft in the direction to increase fuel or steam. As speed (and centrifugal force) increases, the flyweights begin moving outward against the force of the speeder spring which lifts the speeder rod, floating lever, and plunger. When flyweight centrifugal force is again equal to speeder spring force, the control land on the plunger will be re-centered, closing off the in-flow of oil and stopping further piston movement at the instant the new higher speed setting is attained or the prime mover is again on-speed after a load increase.

Where flyweight centrifugal force is greater than speeder spring force (an overspeed condition which can be brought about by a decrease in speed setting or a decrease in load at a given speed setting), the flyweights move outward and raise the speeder rod and left end of the floating lever. This lifts the speeder valve plunger, uncovering the lower edge of the metering port in the bushing, and allows trapped oil to drain from the area under the power piston. High pressure oil in the area above the piston forces the piston downward which rotates the output shaft in the direction to decrease fuel or steam. As speed (and centrifugal force) decreases, the speeder spring begins to force the flyweights inward, which lowers the speeder rod, floating lever, and plunger. When flyweight centrifugal force is again equal to speeder spring force, the control land on the plunger will again be re-centered, closing off the out-flow of oil and stopping further piston movement at the instant the new lower speed setting is attained or the prime mover is again on-speed after a load decrease.

The shutdown device consists of a shutdown rod attached to the top of the speeder rod and which projects upward through the hollow center of the speed setting piston rod. Two nuts on the upper end of the rod complete the device. When control air pressure is turned off (direct speed setting mechanism), the speed setting piston will move upward past its normal low speed position. After a movement of 1/32” (0.8 mm), the end of the piston rod will contact the lower (shutdown) nut and further movement of the piston will thus lift the shutdown rod, speeder rod, left end of the floating lever, and the speeder valve plunger. This allows the trapped oil under the power piston to drain, and the piston will then move downward and rotate the output shaft to the zero fuel or steam position. Some applications may require that the speed setting piston stop set screw be used to provide a positive low speed stop. In such cases, the shutdown nuts are usually omitted as the governor cannot then be used to shut down the prime mover.

## Compensation Section

The compensation section consists of a large and a small compensation piston, a compensation needle valve, and a feedback linkage connecting the large piston to the governor output shaft. The small piston is connected to the right end of the floating lever in the speed sensing and output section. The large and small pistons, as a unit, are commonly referred to as a dashpot. The compensation section stabilizes the governed system by minimizing over-or undershoot following a change in governor speed setting or a change in load on the prime mover. It accomplishes this by establishing a temporary negative feedback signal (temporary droop) which is used to mechanically modulate or bias the position of the floating lever in the speed sensing and output section. This signal opposes the speed correction called for by the speed sensing elements of the governor. In effect, the signal assists the flyweights (during an underspeed condition) or the speeder spring (during an overspeed condition) in re-centering the speeder valve plunger and stopping movement of the power piston slightly before the prime mover attains, or returns to, the set speed. As the prime mover accelerates (or decelerates), the bias is removed at a rate proportional to the rate of increase (or decrease) in flyweight centrifugal force. Where these rates are equivalent, the bias will be reduced to zero at the instant flyweight centrifugal force is again in balance with speeder spring force (on-speed).

Assuming an underspeed condition, the left end of the floating lever will move downward and un-center the speeder valve plunger, Metered oil, flowing into the area under the power piston, will force the piston upward and rotate the output shaft counterclockwise to increase fuel or steam. The movement of the output shaft is transmitted through the compensation linkage to the large compensation piston, causing the piston to move downward, which displaces a quantity of the oil trapped in the dashpot area under both the large and small compensation pistons. This causes an equivalent upward displacement of the small piston, compressing the lower centering spring and raising the right end of the floating lever which, in turn, lifts the speeder valve plunger. The above actions will continue until the plunger is re-centered, stopping movement of the output shaft at a new position corresponding to the additional fuel or steam required to operate the prime mover at a higher speed or increased load. Thus, the governor will have stopped the corrective action before the prime mover has fully accelerated to the set speed.

With continued acceleration of the prime mover, the flyweights will return to their normal position and raise the left end of the floating lever. Simultaneously, the lower centering spring will return the small compensation piston to its normal position, lowering the right end of the floating lever at the same rate as the flyweights raise the right end of the lever. The action of the centering spring in returning the small piston to its normal position causes an equivalent quantity of the oil trapped in the dashpot area to flow to sump through the compensation needle valve. The setting of the needle valve determines the rate at which the small piston returns to its normal (centered) position. The governor actions during an overspeed condition are identical to the above except in a reverse direction.

The adjustable fulcrum in the compensation linkage determines the ratio between a given output shaft movement and the corresponding large compensation piston movement. This, in turn, determines the distance the small compensation piston will move and thus the point at which the speeder valve plunger will be re-centered for a given change in speed or load.

# Chapter 4. Troubleshooting

## Introduction

A troubleshooting chart is provided in this chapter for use in determining the probable causes and corrective actions for troubles which may be encountered in the field. Every possible trouble which may be experienced cannot be anticipated and may, in some instances, be due to faulty operation of other equipment used in conjunction with the governor. The effect of the fuel or steam control mechanism, excessive backlash or binding in linkages, air pressure controller, improper operation of engine or turbine, excessive load, etc., must be considered when troubleshooting apparent malfunctions of the governor.

Governor troubles such as erratic operation and poor repeatability are almost always caused by contaminated oil. In many instances, this type of trouble can be corrected by flushing the governor with fuel oil or kerosene. The use of non-petroleum base solvents is not recommended as they may damage oil seals or gaskets.

Definitions of a few of the terms used in the chart are as follows:

**Hunt**—A rhythmic variation of speed (less than 50 Hz/min) which can be eliminated by manually blocking the throttle, fuel racks, or steam valve or with load limit but which will reappear when control is returned to the governor.

**Surge**—A rhythmic variation of speed of large magnitude which can be eliminated by manually blocking the throttle, fuel racks, or steam valve or with load limit and will not reappear when control is returned to the governor unless the governor speed setting or prime mover load is changed.

**Jiggle**—A high frequency vibration (more than 50 Hz/min) of the governor output shaft or linkage.

| Trouble | Probable Cause | Correction |
|---|---|---|
| 1. Prime mover hunts or surges. | Compensation needle valve opened too far, pointer incorrectly set, or both. | Readjust needle valve and pointer as described in Chapter 2. |
| | Contaminated or foamy oil. Sludge formation. Speeder valve plunger or small compensation piston sticking. | Drain oil, flush with fuel oil or kerosene. Refill with clean oil, operate for a short time, drain and refill with new oil. Disassemble governor, if necessary, and clean. |
| | Low oil level (air entrainment). | Add oil to correct level as indicated on sight gauge glass. Check for leakage, particularly at driveshaft oil seal. |
| | Excessive backlash (lost motion) or binding in governor-prime mover linkage. | Repair linkage. Spring load linkage, if necessary, to eliminate all lost motion. Check yield links, shutdown arrangements, etc., and make certain prime mover power (torque) output changes with very small increments of governor output shaft travel. |
| | Non-linear relationship between governor output shaft travel and prime mover power output. | Readjust or rework linkage to obtain a linear relationship. If governor is equipped with optional load limiter, set no-load at 2 on load indicator and full-load at 8. See installation instructions, Chapter 2. |
| | Engine gas valve not properly shaped to provide linear relationship between governor output shaft travel and engine torque output. Engine may hunt at low loads and stabilize at high loads. Gas pressure too high. Manifold volume too large. The above also applies to steam valves. | Readjust or rework linkage to linearize relationship between governor output shaft travel and engine or turbine torque output. See installation instructions, Chapter 2. |
| | Insufficient utilization of governor output shaft travel. | Readjust or rework linkage to use more governor output shaft travel from cutoff to no-load rated speed. |
| | Lost motion or binding in engine linkage or fuel pumps. | Repair linkage or pumps. Realign linkage and pumps. |
| | Improper reassembly and internal adjustment of governor. | • Check flyweights for sticking, and/or flat-spotting of toes.<br>• Check condition of speeder rod thrust bearing.<br>• Check controlet linkages (speeder rod, floating lever, speeder valve plunger, small compensation piston) for excessive backlash, binding or sticking. See assembly instructions in Chapter 5. Polish moving parts to remove burrs or rough spots.<br><br>***NOTICE***<br>**Sharp edges on lands or grooves in plunger, pistons, or bushings must be maintained.**<br>• Check speeder valve plunger centering adjustment.<br>• Check small compensation piston centering spring preload adjustment.<br>• Check alignment of power piston, link, and power lever.<br>• Check side play of output shaft. |
| | Engine misfiring. | Check pyrometer readings of each cylinder and make necessary adjustments or repairs. Check fuel injectors. Low pilot fuel on dual-fuel engine. |
| | Voltage regulator, if used, malfunctioning. | Readjust or repair regulator. |
| | Governor parts worn—excessive internal leakage. | Replace worn parts. |

| Trouble | Probable Cause | Correction |
|---|---|---|
| 2. Jiggle at governor output shaft. | Rough prime mover accessory drive. | • Check gear alignment.<br>• Check gear teeth for wear, damage or other roughness.<br>• Check gear train for eccentricity or excessive backlash.<br>• Check gears for proper attachment to shafts. Tighten camshaft drive chain, if used.<br>• Check vibration dampener, if used.<br>• Check for cyclic load variations. |
| | Governor not mounted squarely on drive pad. Failure of flexible ballhead drive. Improper degree of flexibility. | Loosen governor on pad. Realign and tighten bolts or nuts evenly to proper torque value.<br><br>Replace spring laminations. Alter flexibility of drive (consult Woodward). |
| 3. Fuel or steam control does not open sufficiently or quickly during starting. | Low governor oil pressure. | • Check oil for proper viscosity. Change oil, if necessary.<br>• Check pump gears and gear pockets for excessive wear. Replace worn parts.<br>• Examine pump check valves for proper seating. Clean or replace check valve(s) if leakage is suspected.<br>• Check accumulator springs. Replace springs, if necessary. |
| | Cranking speed too low. | If necessary, install optional booster servomotor. |
| | Booster servomotor, if used, malfunctioning. | Check operation of automatic air starting valve. |
| 4. Slow response to a change in governor speed setting or a change in prime mover load. | Compensation needle valve closed too far. Compensation pointer set too far toward MAX. | Readjust needle valve and pointer as described in Chapter 2. Open needle valve further, if possible to do so without causing instability when running at no-load. |
| | Prime mover overloaded. | Reduce load. |
| | Poor governor sensitivity—sludge formation, excessive friction or wear on toes of flyweights. | Drain oil, flush with fuel oil or kerosene. Refill with clean oil, operate for a short time, drain and refill with new oil. Disassemble governor and inspect flyweights and thrust bearing. Replace flyweights if toes are flat-spotted. Replace thrust bearing if lower race is worn or there is detectable roughness when bearing is rotated. |
| | Speeder valve plunger not properly centered. | Disassemble governor as necessary and re-center plunger. Also check controlet linkages (speeder rod, floating lever, speeder valve plunger, small compensation piston) for excessive backlash, binding, or sticking. See assembly instructions in Chapter 5. |
| | Low governor oil pressure. | See item 3 above. |
| | Fuel supply restricted. | Clean fuel filter. |
| | Load limit control, if used, set too low. | Increase setting. |

| Trouble | Probable Cause | Correction |
|---|---|---|
| 5. Prime mover will non carry full rated load. | Fuel or steam control does non open sufficiently. | • Check and adjust linkage. Check for binding in fuel or steam control.<br>• Check and adjust load limiter control or fuel pump stops.<br>• Check tension of load limiter control friction spring. Low tension may allow cam to gradually work toward reduced load position. |
| | Fuel supply restricted. | Clean fuel filters. Low gas pressure or gas has a lower calorific value. |
| | Voltage regulator, if used, malfunctioning. | Readjust or repair regulator. |
| | Engine misfiring. | Check pyrometer readings of each cylinder and make necessary adjustments or repairs. Check fuel injectors. |
| | Slipping clutch or belts between prime mover and driven load. | Check and adjust or repair. |
| 6. No output from governor. | Manual speed setting knob turned to minimum speed position (reverse speed setting mechanism). | Turn knob fully clockwise to maximum speed position. |
| | No control air pressure (direct speed setting mechanism–governor adjusted to go to shutdown on loss of control air pressure). | Check control air pressure system, adjust or repair as necessary. |
| | Contaminated oil, sludge formation. Speeder valve plunger sticking. Speed setting valve plunger (direct speed setting mechanism) sticking. | Drain oil, flush with fuel oil or kerosene, Refill with clean oil, operate for a short time, drain and refill with new oil. Disassemble governor, if necessary, and clean. |
| | No or low governor oil pressure. | See item 3 above. |
| | Failure of drive to governor. | Repair accessory drive. |
| | Speeder spring broken. | Replace speeder spring. |
| | Damage no governor internal linkage. | Disassemble governor, replace damaged parts. |
| 7. Governor will not go to full high speed setting under pneumatic control (no load). | Low control air pressure (direct speed setting mechanism), high control air pressure (reverse speed setting mechanism). | Check control air pressure system for proper range, adjust or repair as necessary. |
| | Control air pressure range versus governor speed range not properly calibrated. | Readjust governor speed settings as instructed in Chapter 2. |
| | Maximum speed limiting valve maladjusted or leaking. | Readjust as instructed in Chapter 2. Clean or replace limiting valve if leaking. |
| | Speeder spring fatigued. | Replace speeder spring. |
| | Bellows ruptured. | Replace bellows. |
| 8. Governor will not go to full low speed setting under pneumatic control. | Manual speed setting knob not turned fully counterclockwise to minimum speed position (direct speed setting mechanism). | Turn knob fully counterclockwise no minimum speed position. |
| | Pneumatic low speed adjusting screw maladjusted. | Readjust as instructed in Chapter 2. |
| | Control air pressure range versus governor speed range not properly calibrated. | Readjust governor speed settings as instructed in Chapter 2. |
| | Bellows has taken a permanent set. | Replace bellows. |
| | Speed setting piston stop set screw maladjusted. | Adjust as instructed in Chapter 2. |
| 9. Excessive cranking required during starting. | Speed setting piston stop set screw maladjusted. | Readjust as instructed in Chapter 2. |
| | Cranking speed too low. | If necessary, install optional booster servomotor. |
| | Booster servomotor, if used, malfunctioning. | Check operation of booster servomotor. |

# Chapter 5.
# Maintenance

## Special Tools

Refer to manual 03504 for a listing of special tools required for maintenance or overhaul of the UG-8PL governor.

## Disassembly

### General Instructions

**NOTICE**

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

1. Drain oil, if any, from governor.
2. Clean exterior surfaces using a cloth moistened with cleaning solvent.
3. Do not remove or disturb the position of screws, brackets, etc., which function as adjustments; nor disassemble the various linkages further than required to effect removal unless replacement of component parts is necessary.
4. Do not remove interference-fit parts such as bearings, locating (dowel) pins, spring seats, check valves, pivot pins, etc., unless replacement is necessary or removal is required to effect disassembly or removal of other parts.
5. Discard (do not reuse) gaskets, preformed packing (O-rings), oil seals, copper sealing washers, retaining rings, cotter pins, roll or spirol pins, etc., removed in the process of disassembly.

**IMPORTANT**

**The governor consists of seven major sub-assemblies; pneumatic receiver, speed setting cylinder, column, case, ballhead, controlet, and base. Unless the governor is to be completely overhauled, do not disassemble to any greater extent than necessary to effect the immediate repair or adjustment. Refer to Figures 6-1, 6-2, and 6-3 for exploded view illustrations. Circled item numbers on the illustrations indicate parts which need not necessarily be removed or completely disassembled unless replacement is required. Observe the following special instructions and/or precautions during the process of disassembly.**

## Disassembly into Major Subassemblies

**Pneumatic Receiver (Figure 6-1)—**

1. Remove Cover (7).
2. Remove restoring spring (10) and, if used, loading spring (9).
3. Remove pin (12) and restoring lever (13).
4. Remove screw (16) and washer (17) which attach link (21) to speed setting plunger (104). The screw and washer are accessible through the square cutout in the lower front of receiver bracket (75).
5. Remove screws (18 and 19) and washers (20). Lift pneumatic receiver (21 through 75) straight upward to remove.
6. Remove O-ring (76) from the seat in the top of column (117).

**Speed Setting Cylinder (Figure 6-1)—**

1. Remove shutdown nuts (77), if used.
2. Remove screws (78), washers (79), and speed setting cylinder (95) together with miscellaneous parts (85 through 94).
3. Remove O-ring (96) from the seat in the top of the column.
4. Remove piston spring (80), seat (81), support spring (82), retaining ring (83), and spacer tube (84) as a unit.

**Column—**

1. Remove external oil tube (203 and 204, Figure 6-2).
2. Remove screws (97, Figure 6-1), washers (98), and column (117) together with miscellaneous parts (99 through 116). If necessary, tap column lightly to loosen gasket (118). Remove gasket.

**Case (Figure 6-2)—**

1. Slide speeder plug (213) upward on shutdown rod (214) and remove.
2. Disengage the shutdown rod, if used, from speeder rod nut (308, Figure 6-3) and remove.
3. Remove screws (207, Figure 6-2) and washers (208). Tap auxiliary plate (211) lightly to loosen gasket (212) and then lift upward to disengage bushing driveshaft (218) from the controlet and base assembly.
4. Remove nameplate (220), panel (225), and speeder spring (230). If necessary, tap the panel lightly to loosen gasket (229).
5. Remove bushing drive gear (324, Figure 6-3) through the panel opening in case (257).
6. Remove pins (232 and 233, Figure 6-2) connecting power lever (239) and compensation lever (241) to the power and compensation links of the controlet (see Figure 5-1). Use a bent wire or hook scriber to push the pins toward the center of case for removal.

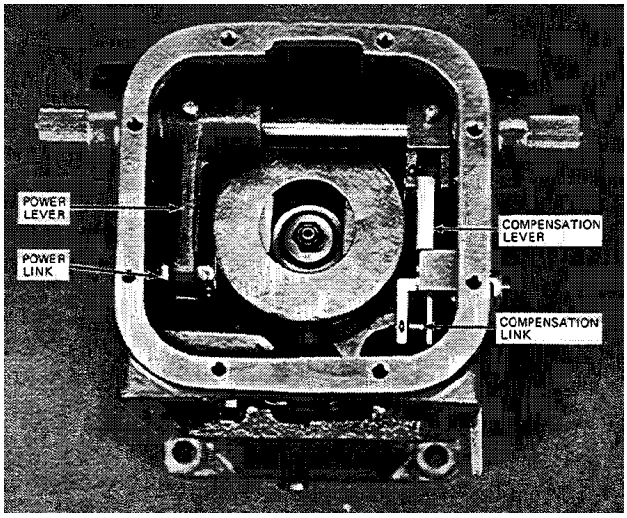


Figure 5-1. Top View of Case Assembly

7. Invert the governor and remove the four outer screws (234) and washers (235). Remove the controlet and base assembly from the case. If necessary, tap the base lightly to loosen gasket (236). Remove the gasket.

**Ballhead (Figure 6-3)—**

1. Remove the cotter pin from the inside end of speeder valve plunger pin (305). See Figure 5-2.

2. Lift the inner end of floating lever (306) while pushing downward on small compensation piston nut (347). See Figure 5-3.

3. Slide the floating lever toward the ballhead until the outer end of the lever disengages from the pin in the piston nut end, then remove the lever.

4. Lift ballhead (307 through 320) out of controlet (377).

**Controlet/Base (Figure 6-3)—**

1. Pull compensation link (339) upward and insert a 1/8-inch diameter straight pin or rod through the assembly hole in the center of the link to retain large compensation piston (337) in its bore. See Figure 5-2.

2. Invert the assembly and remove five inner screws (328) and washers (329). If the assembly is to be clamped in a vise, clamp at sides as shown in Figure 5-4 and do not use unnecessary force.

3. Tap the base lightly while lifting off the controlet. Use care to prevent inadvertent loss of plunger spring (330) or spring seat (331).

4. If the controlet is to be disassembled further, remove speeder valve plunger (332) and bushing (333) to prevent their dropping out when controlet is placed upright.

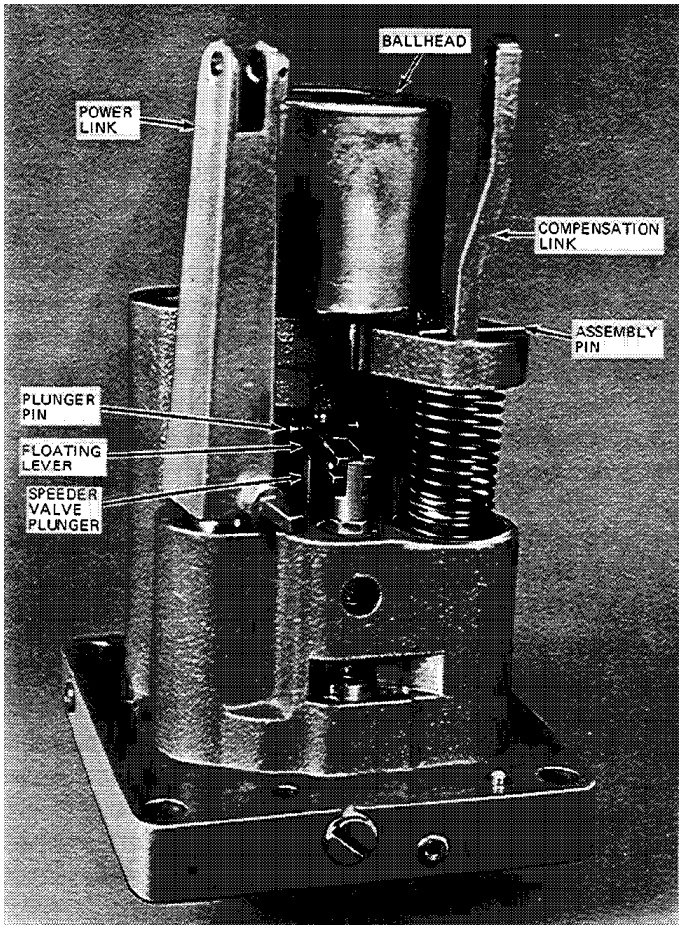


Figure 5-2. Controlet and Base Assembly

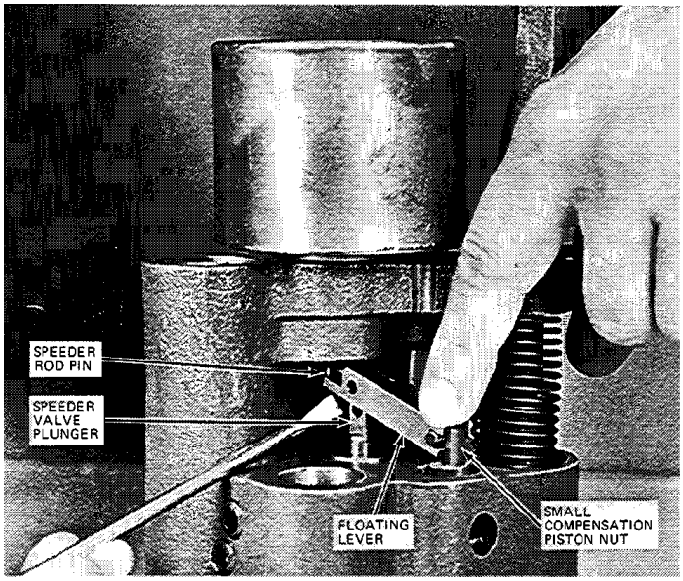


Figure 5-3. Removal of Ballhead from Controlet

**Disassembly of Pneumatic Receiver (Figure 6-1)—**

1. Remove plunger link (21), bellows spring (24), if used, and bellows coupling (25).

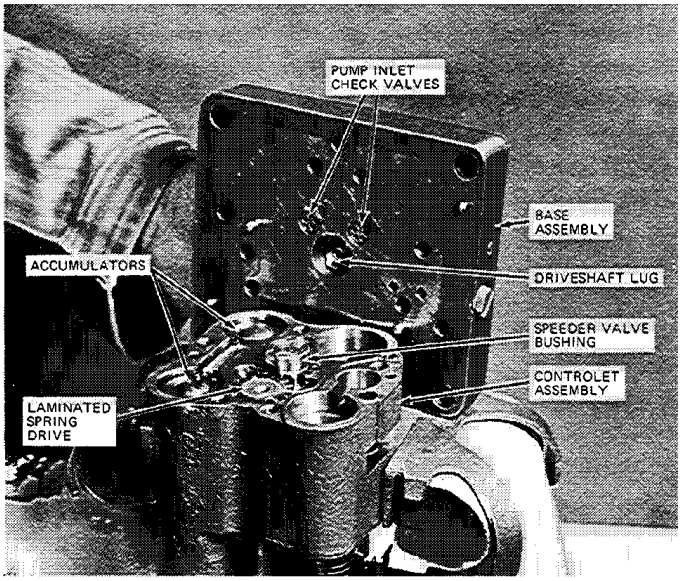


Figure 5-4. Removal of Base from Controlet

2. Remove dial plate (38) and, if necessary, knob (45).

3. Loosen set screw (26) and then remove passage screw (27) and washer (28).

4. Push receiver cup and bellows assembly (30 through 34) downward and remove from receiver bracket (78). Remove gasket (29). Disassemble as follows: Loosen set screw (33) and then remove retaining ring (30), bellows (31), and O-ring (32) from cup (34).

5. If necessary, disassemble the manual speed setting mechanism as follows:
   a. Remove screws (49) and washers (50). Lift off guide (60), speed adjusting nut (59), pivot bracket (68), and speed setting screw (70) as a unit. Remove stop pin (51).
   b. Remove dial plate (36) and friction spring (38). Drive roll pin (39) out of lead screw (47).
   c. Unscrew the lead screw from nut (57) and remove. Remove miscellaneous parts (52 through 56) as a unit. Remove stop washer (40), spring washer (41), and plain washer (42) from the cavity in receiver bracket (75).

**Disassembly of Speed Setting Cylinder (Figure 6-1)—**
If necessary to remove piston (93) from cylinder (95), remove adjusting screw bracket (91) together with adjusting screw (89) from fulcrum (92). Press the piston rod out of the fulcrum. Do not remove check valve (94) from the cylinder unless replacement is necessary.

**Disassembly of Column (Figure 6-1)—**
1. Remove screws (99), washers (100), and retainer (101).

2. Invert column and remove washer (102), thrust bearing (103), speed setting plunger (104), bushing (106), spring (107), and gear (108).

**Disassembly of Case (Figure 6-2)—**
1. Remove pin (233) connecting compensation link (241) to compensation lever (240). Remove link and fulcrum (245).

2. Remove pointer (248) and compensation adjusting lever (250).

3. Drive out taper pins (237) and remove output shaft (238), power lever (239), and compensation lever (240).

4. If oil seals (242) only are to be replaced, pry them out using a screwdriver or other suitable tool. Take care not to damage the bores in case (257). If both oil seals and bearings (244) are to be replaced, remove set screws (243) and drive out each bearing and related oil seal from the opposite side of the case.

**IMPORTANT** **If bearings are to be removed for a purpose other than replacement and are to be reused, mark the outer end of each bearing and identify for RH or LH installation.**

**Disassembly of Ballhead (Figure 6-3)—**

1. Remove nut (308), thrust bearing (309), washer (310), spring (311), and speeder rod (312).

2. Invert the ballhead assembly and support on a tube or rod of an OD which will sup between the toes of flyweights (318). Press cover (313) off sub-ballhead (314) using a large tube or pipe of suitable ID.

3. Carefully separate the sub-ballhead from ballhead (320) and remove bearing (315).

4. To remove flyweights (318), if necessary, pull spirol pin (316) at one end of each flyweight pin (317). Push out the flyweight pins and remove the flyweights.

**Disassembly Of Controlet (Figure 6-3)—**

1. Remove speeder valve plunger (332) and bushing (333) from controlet (377), if not previously accomplished.

2. Remove power link (303) and power piston (334).

3. Remove the pin or rod previously inserted in compensation link (339) (Figure 5-2) and remove the link together with large compensation piston (337) and piston spring (335).

4. Remove small compensation piston nut (347), jam nut (348), collar (349), springs (350), and piston (351). Use floating lever (306) as a wrench for holding the piston nut.

5. Remove gear plate (323) and gear (325).

6. Remove cotter pin (340), ballhead drive gear (341), and laminated-spring drive (342 through 346).

7. Using a tube or rod of suitable diameter and an arbor press, depress washers (356) to compress accumulator springs (355) while removing upper retaining rings (353). Allow the springs to expand at a controlled rate until all tension is relieved and then remove washers, springs, and pistons (354).

**Disassembly of Base (Figure 6-3)—**

1. Remove compensation needle valve (361) from the base.

2. If the driveshaft is of the keyed type, remove nut (372), spacer (373), and key (370).

3. Invert the base and clamp in a vise.

4. Remove screws (362) and retainer (363).

5. Pull out driveshaft (369 or 374) together with bearing (364).

6. Remove retaining ring (367), if used, as shown in Figure 5-5 and then press the driveshaft out of the bearing.

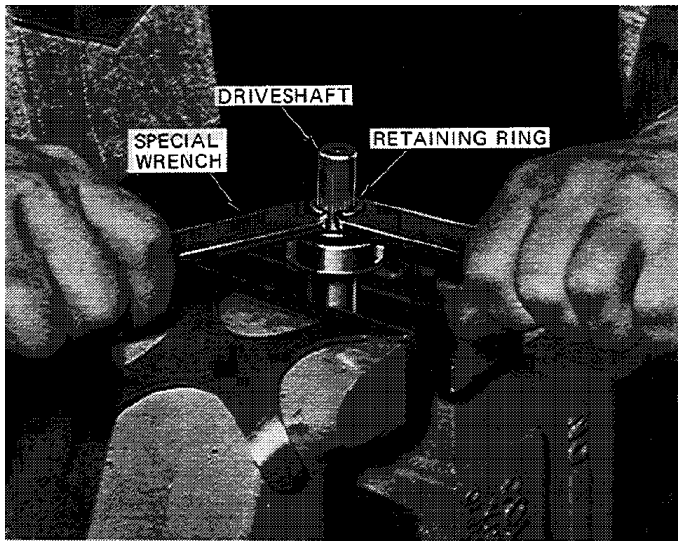


Figure 5-5. Removal of Driveshaft Retaining Ring

7. Remove oil seal (364), retainer (365), and gasket (366). Press the oil seal out of the retainer.

## Cleaning

Wash all parts ultrasonically or by agitation while immersed in cleaning solvent. Use a non-metallic brush or a jet of compressed air to clean slots, apertures, and internal oil passages. Dry all parts after cleaning with a jet of clean, dry compressed air.

Apply a light film of lubricating oil to all finely machined surfaces. Store parts in dust-free, moisture-proof containers until reassembled.

## Inspection

Visually inspect all parts for damage or wear, paying particular attention to the following.

1. Inspect all needle, thrust, and ball bearings for detectable roughness, scoring, or brinelling in balls, needles, or races. Replace bearings if any defects are found.

2. Mating surfaces must be free of nicks, burrs, cracks, or other damage.

3. Screws, plugs, and internal threads must be free of corrosion, cracks, burred slots or rounded corners, or damaged threads.

4. All linkages must be free of corrosion and must move freely without excessive play. Pistons, plungers, etc., must move freely in their respective bores.

5. All threaded areas, apertures, and passages must be free of foreign matter.

6. Check the springs listed in Table 1 for squareness and compression. Ends of springs should be square with the spring axis within 7°. All springs not listed in Table 1 should be replaced as a matter of practice at time of overhaul.

7. Dimensionally inspect the parts listed in Table 2 for wear. Where a maximum operating clearance is specified, replace only those parts necessary to bring the clearance within limits. Plastigage, as commonly used for determining automotive crankshaft bearing clearances, can be used to advantage in determining oil pump gear side clearance. Assemble the gears, controlet, and base with a small strip of Plastigage between each gear and the controlet. Tighten the base screws, then disassemble and measure the thickness of the Plastigage strip.

8. Inspect the oil pump check valves in the bottom of the controlet (pressure side) and top of base (suction side) for cleanliness, freedom of operation, and proper seating.

9. Inspect the maximum speed limiting check valve in the speed setting cylinder for cleanliness, freedom of operation, and proper seating. Refer to Repair and Replacement instructions should replacement of check valve be necessary.

Table 5-1. Spring Inspection Data

| Part Name | Load | Compressed Height |
|---|---|---|
| Restoring Lever Loading Spring (9, Figure 6-1) (Direct mechanism only) | 2.0 lb (8.9 N)<br>3.0 lb (13.3 N)<br>3.2 lb (14.2 N) ** | 1.550 (–0.100, +0.120) in./39.37 (–2.54, +3.05) mm *<br>1.894 (–0.010, +0.020) in./48.11 (–0.51, +0.51) mm * |
| Speed Setting Piston Spring (80, Figure 6-1) | 14.0 lb (62.3 N)<br>15.0 lb (66.7 N) | 1.500 (–0.040, +0.030) in./38.10 (–1.02, +0.76) mm<br>1.383 (–0.025, +0.015) in./35.13 (–0.64, +0.38) mm |
| Support Spring (82, Figure 6-1) | 3.0 lb (13.3 N) | 0.380 (–0.030, +0.020) in./9.65 (–0.76, +0.51) mm |
| Bushing Loading Spring (107, Figure 6-1) | 3.85 lb (17.12 N) | 0.625 (–0.035, +0.025) in./15.88 (–0.89, +0.64) mm |
| Speeder Rod Spring (311, Figure 6-3) | 1.0 lb (4.4 N) | 0.600 (–0.060, +0.050) in./15.24 (–1.52, +1.27) mm |
| Plunger Spring (330, Figure 6-3) | 0.29 lb (1.29 N)<br>0.41 lb (1.82 N) | 1.170 (–0.040, +0.030) in./29.72 (–1.02, +0.76) mm<br>0.952 (–0.030, +0.020) in./24.18 (–0.76, +0.51) mm |
| Large Compensation Piston Spring (335, Figure 6-3) | Compression check not required. | |
| Centering Spring (2) (350, Figure 6-3) | 1.0 lb (4.4 N)<br>2.0 lb (8.9 N) | 1.000 (–0.020, +0.015) in./25.40 (–0.51, +0.38) mm<br>0.750 (–0.015, +0.010) in./19.05 (–0.38, +0.25) mm |
| Accumulator Spring (2) (355, Figure 6-3) | 125.0 lb (556.0 N)<br>140.0 lb (622.7 N) ** | 3.640 (–0.150, +0.140) in./92.46 (–3.81, +3.56) mm<br>— |

*—Value listed is spring extension under given load in tension.
**—Replace spring if indicated load is exceeded during checking.

Table 5-2. Wear Limits

| Part Name | Where Measured | Mfg. Tolerance | Maximum Wear Limits |
|---|---|---|---|
| Speed Setting Piston (93, Fig. 6-1)<br><br>Speed Setting Cylinder (95, Fig. 6-1) | OD, piston<br><br>ID, piston bore | 1.7484–1.7487” (44.409–44.417 mm)<br>1.7490–1.7496” (44.425–44.440 mm) | 0.0024” (0.061 mm) (clearance) |
| Speed Setting Piston (93, Fig. 6-1)<br><br>Speed Setting Cylinder (95, Fig. 6-1) | OD, rod<br><br>ID, rod bore | 0.4982–0.4985” (12.654–12.662 mm)<br>0.4992–0.4997” (12.680–12.692 mm) | 0.0030” (0.076 mm) (clearance) |
| Speed Setting Valve Plunger (104, Fig. 6-1)<br><br>Speed Setting Valve Bushing (106, Fig. 6-1) | OD, upper two lands<br><br>ID (from 0.250 to 1.3438” [6.35 to 34.133 mm] depth) | 0.3745–0.3748” (9.512–9.520 mm)<br>0.3749–0.3752” (9.522–9.530 mm) | 0.0020” (0.051 mm) (clearance) |
| Speed Setting Valve Bushing (106, Fig. 6-1)<br><br>Column (117, Fig. 6-1) | OD<br><br>ID, bushing bore | 0.7495–0.7498” (19.037–19.045 mm)<br>0.7500–0.7510” (19.050–19.075 mm) | 0.0035” (0.089 mm) (clearance) |
| Bushing Gear 1108, Fig. 6-1)<br><br>Bearing Stud (109, Fig. 6-1) | ID<br><br>OD | 0.6250–0.6260” (15.875–15.900 mm)<br>0.6230–0.6240” (15.824–15.850 mm) | 0.0050” (0.127 mm) (clearance) |
| Bearing Stud (109, Fig. 6-1) | Thickness, shoulder | 0.0520–0.0720” (1.321–1.829 mm) | 0.0470” (1.194 mm) |
| Bushing (209, Fig. 6-2)<br><br>Driveshaft (218, Fig. 6-2) | ID<br><br>OD | 0.3750–0.3755” (9.525–9.538 mm)<br>0.3718–0.3720” (9.444–9.449 mm) | 0.0070” (0.178 mm) (clearance) |
| Driveshaft (218, Fig. 6-2)<br><br>Gear Plate (323, Fig. 6-3) | OD<br><br>ID | 0.3718–0.3720” (9.444–9.449 mm)<br>0.3725–0.3735” (9.462–9.487 mm) | 0.0040” (0.102 mm) (clearance) |
| Speeder Plug (213, Fig. 6-2)<br><br>Panel (225, Fig. 6-2) | OD<br><br>ID, plug bore | 0.8740–0.8743” (22.200–22.207 mm)<br>0.8745–0.8755” (22.212–22.238 mm) | 0.0040” (0.102 mm) (clearance) |
| Output Shaft (235, Fig. 6-2)<br><br>Bearing (2) (244, Fig. 6-2) | OD<br><br>ID | 0.5610–0.5615” (14.249–14.262 mm)<br>0.5620–0.5630” (14.275–14.300 mm) | 0.0050” (0.127 mm) (clearance) |
| Speeder Rod (316, Fig. 6-3)<br><br>Ballhead gear (314, Fig. 6-3) | OD, land<br><br>ID | 0.3710–0.3720” (9.423–9.449 mm)<br>0.3745–0.3755” (9.512–9.538 mm) | 0.0070” (0.178 mm) (clearance) |
| Ballhead gear (314, Fig. 6-3)<br><br>Controlet (377, Fig. 6-3) | OD, gear shaft<br><br>ID, ballhead bore | 0.8110–0.8115” (20.599–20.612 mm)<br>0.8120–0.8130” (20.625–20.650 mm) | 0.0040” (0.102 mm) (clearance) |
| Controlet (377, Fig. 6-3) | Depth, ballhead gear pocket | 0.2450–0.2500” (6.223–6.350 mm) | 0.2650” (6.731 mm) |
| Idler Gear (325, Fig. 6-3)<br><br>Gear Pin (326, Fig. 6-3) | ID<br><br>OD, major | 0.3750–0.3755” (9.525–9.538 mm)<br>0.3745–0.3749” (9.512–9.522 mm) | 0.0030” (0.076 mm) (clearance) |
| Speeder Valve Plunger (332, Fig. 6-3)<br><br>Speeder Valve Bushing (333, Fig. 6-3) | OD, land<br><br>ID | 0.3741–0.3744” (9.502–9.510 mm)<br>0.3745–03752” (9.512–9.530 mm) | 0.0025” (0.064 mm) (clearance) |
| Speeder Valve Bushing (333, Fig. 6-3)<br><br>Controlet (337, Fig. 6-3) | OD, lands above gear<br><br>ID, shaft bore (upper 1/3) | 0.8113–0.8116” (20.607–20.615 mm)<br>0.8120–0.8130” (20.625–20.650 mm) | 0.0030” (0.076 mm) (clearance) |

| Part Name | Where Measured | Mfg. Tolerance | Maximum Wear Limits |
|---|---|---|---|
| Speeder Valve Bushing (333, Fig. 6-3)<br><br>Base (376, Fig. 6-3) | OD, Land below gear<br><br>ID, shaft bore (upper 1/3) | 0.8110–0.8113" (20.599–20.607 mm)<br>0.8120–0.8130" (20.625–20.650 mm) | 0.0040" (0.102 mm) (clearance) |
| Power Piston (334, Fig. 6-3)<br><br>Controlet (377, Fig. 6-3) | OD, minor<br><br>ID, piston bore (minor) | 0.9362–0.9366" (23.779–23.790 mm)<br>0.9372–0.9377" (23.805–23.818 mm) | 0.0030" (0.076 mm) (clearance) |
| Power Piston (334, Fig. 6-3)<br><br>Controlet (377, Fig. 6-3) | OD, major<br><br>ID, piston bore (major) | 1.3735–1.3742" (34.887–34.905 mm)<br>1.3747–1.3752" (34.917–34.930 mm) | 0.0030" (0.076 mm) (clearance) |
| Large Compensation Piston (337, Fig. 6-3)<br><br>Controlet (377, Fig. 6-3) | OD, below slot<br><br>ID, piston bore | 1.1860–1.1865" (30.124–30.137 mm)<br>1.1870–1.1880" (30.150–30.175 mm) | 0.0040" (0.102 mm) (clearance) |
| Ballhead Drive Gear (341, Fig. 6-3)<br><br>Controlet (377, Fig. 6-3) | OD, shaft<br><br>ID, gear bore | 0.7485–0.7490" (19.012–19.025 mm)<br>0.7495–0.7500" (19.037–19.050 mm) | 0.0030" (0.076 mm) (clearance) |
| Pump Driven Gear (346, Fig. 6-3)<br><br>Controlet (377, Fig. 6-3) | OD, land<br><br>ID, gear bore | 0.7490–0.7495" (19.025–19.037 mm)<br>0.7500–0.7505" (19.050–19.063 mm) | 0.0030" (0.076 mm) (clearance) |
| Collar (349, Fig. 6-3)<br><br>Controlet (377, Fig. 6-3) | OD, shoulder<br><br>ID, small comp. piston bore | 0.7485–0.7492" (19.012–19.030 mm)<br>0.7500–0.7505" (19.050–19.063 mm) | 0.0040" (0.102 mm) (clearance) |
| Small Compensation Piston (351, Fig. 6-3)<br><br>Controlet (377, Fig. 6-3) | OD<br><br>ID, piston bore | 0.7490–0.7495" (19.025–19.037 mm)<br>0.7500–0.7505" (19.050–19.063 mm) | 0.0030" (0.076 mm) (clearance) |
| Accumulator Piston (2) (354, Fig. 6-3)<br><br>Controlet (377, Fig. 6-3) | OD<br><br>ID, piston bore (2) (lower 3 inches/75 mm) | 1.1862–1.1865" (30.129–30.137 mm)<br>1.1870–1.1875" (30.150–30.162 mm) | 0.0026" (0.066 mm) (clearance) |
| Driveshaft (364/374, Fig. 6-3)<br><br>Base (376, Fig. 6-3) | OD, major (upper 1/2)<br>ID, shaft bore (lower 2/3) | 0.8105–0.8110" (20.587–20.599 mm)<br>0.8120–0.8130" (20.625–20.650 mm) | 0.0050" (0.127 mm) (clearance) |
| Controlet (377, Fig. 6-3)<br><br>Speeder Valve Bushing, Pump Driven Gear (333/346, Fig. 6-3)<br><br>Base (376, Fig. 6-3) | Depth, pump gear pockets<br><br>Width, gear<br><br>Wear groove | 0.2490–0.2495" (6.325–6.337 mm)<br><br>0.2480–0.2485" (6.299–6.312 mm)<br><br>— | 0.2515" (6.388 mm)<br><br>0.2470" (6.274 mm)<br><br>0.0030" (0.076 mm)* |
| Total accumulated side clearance of gears not to exceed 0.0050-inch (0.127 mm). | | | |

*—Face of base may be surface ground or lapped to reduce or remove wear groove so that total accumulated side clearance can be maintained within the specified limit. Base may be progressively resurfaced over a period of time provided the base flange thickness is not reduced below 0.8650 inch (21.971 mm).

10. Inspect the flyweight assemblies for freedom of movement and detectable roughness in bearings. Replace flyweight assemblies if any roughness in bearings is evident or flyweight pins are brinelled, scored, or worn. Flyweight assemblies should be replaced in pairs.

11. The lands on the speed setting and speeder valve plungers must have sharp corners. If corners are nicked, scored, or rounded off, replace plungers.

12. If wear, in the form of a detectable step, is found on mating surfaces of gear teeth, replace affected gears.

## Repair or Replacement

Repair of small parts of the governor should be limited no removal of nicks and burrs from mating surfaces and to light polishing of mating parts. Rework or repair to any other extent is impractical, and the part should be replaced.

**NOTICE**

**Handle critical parts with extreme care so that mating edges and surfaces will not be damaged. Sharp edges on lands or grooves must be maintained.**

1. Replace any damaged thread inserts.

2. Polish slightly corroded areas in mating surfaces using a fine (600 grit) abrasive cloth or paper and oil.

3. Replace flyweights and thrust bearing if flat spotting is visibly apparent on toes of flyweights.

4. Touch up defects in painted surfaces using oil-resistant epoxy paint. The part should be repainted where defects are numerous and widespread, where the surface has been severely eroded or weathered, or where the paint is loose.

5. If necessary to replace the maximum speed limiting check valve, proceed as follows.
   a. Remove the speed setting piston from the cylinder as instructed under the disassembly procedure for the speed setting cylinder.
   b. Invert the cylinder and press out the check valve.
   c. Press the new check valve into the cylinder until seated against the shoulder in the bore. The check ball must be upward.

6. If the mating face of base is not perfectly flat, has perceptible scratches, or is grooved from oil pump gears, it must be resurfaced. Drive out dowel pins and surface grind or lap on a flat plate. Remove only as much material as necessary to eliminate the defect. Do not reduce the thickness of the flange below the value specified in the Note following Table 2.

**IMPORTANT**

**Mating parts such as the pneumatic receiver bracket, column, auxiliary plate, case, controlet, and base are located, finish drilled, and dowel pinned at time of assembly. Replacement of any one or both mating parts will require that the part or parts be relocated and the dowel pin holes re-drilled at time of assembly to accept larger diameter dowel pins. This type of repair should be limited to one time only. Relocation of dowel pin holes is not recommended unless it is absolutely certain that wall thickness or internal oil passages will not be adversely affected.**

### Lubrication

1. Lubricate all parts liberally with lubricating oil at time of reassembly.
2. Lubricate O-rings and preformed seals with petrolatum before installation.

## Reassembly

### General Instructions

**IMPORTANT**

**Reassembly should be performed in a dust-free work area.**

1. When installing O-rings over threaded surfaces, use an appropriate size thimble or tape the threaded surface to prevent damage to the O-rings.
2. Obtain new gaskets, O-rings, seals, retaining rings, cotter pins, etc, to replace those removed during disassembly.
3. Retaining rings must be installed with the sharp edge in the direction of the applied force.

**NOTICE**

**Count out only the required number of small parts such as screws, washers, retaining rings, pins, etc, before proceeding with the operation an hand. When a sufficient number of parts is not available, the missing part(s) must be located before performing the next operation. If the part(s) cannot be located, it is essential to disassemble the unit to such a point as is necessary to ensure that the missing part(s) has not fallen into an internal cavity. Any parts which are not properly secured or in place can cause jamming and render the governor inoperative.**

### Reassembly of Base (Figure 6-3)

1. Press oil seal (364) into retainer (365) until flush with or slightly below the rim. The lip of the oil seal must be toward the minor ID of the retainer.
2. Install the retainer in base (376) using gasket (366). The lip of the oil seal in the retainer must be toward the top of the base.
3. Press driveshaft (369 or 374) into bearing (369) and seat against the shoulder. Install retaining ring (367), if used (see Figure 5-5).
4. Install the driveshaft assembly in the base. Do not use a press.
5. Install retainer (363). Do not overtighten screws (362) as this may bend the retainer. There should be approximately 1/8-inch (3.2 mm) space between the retainer and base. Secure screws with lockwire.
6. Replace compensation needle valve (361). Do not insert the blade of a screwdriver in the deep slot as this may result in damage to the needle valve or threads in the base. Back out the needle valve approximately 3/8-turn after initial contact with the seat.

7. Replace spacer (373) and nut (372) on the keyed driveshaft, if used. Place key (370) in a small envelope or bag and attach to the base to prevent loss.

## Reassembly of Controlet (Figure 6-3)

1. Install accumulator pistons (354), springs (355), and washers (356) in controlet (377) using an arbor press.

2. Install laminated-spring drive (342 through 346) and ballhead drive gear (341). Secure with cotter pin (340).

3. Install gear (325) and gear plate (323).

4. Install small compensation piston (351), centering springs (350), collar (349), jam nut (348), and piston nut (347).

5. Adjust centering spring preload by turning the jam nut down until the upper edge of the piston is 1/8-inch (3.2 mm) above the lower edge of the inspection port in the controlet (see Figure 5-6). Do not apply any external force on nuts while making pre-load measurements. Lock the jam nut in position with the piston nut after making the final adjustment.

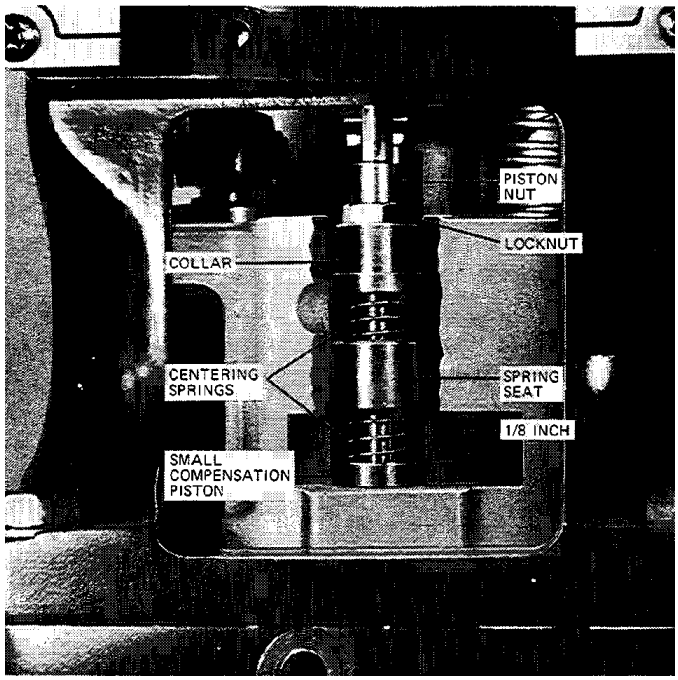


Figure 5-6. Adjusting Small Compensation Piston Centering Spring Preload

6. Install large compensation piston assembly (336 through 339) and spring (335). Secure in place by insetting a pin or rod through the assembly hole in the center of link (339). See Figure 5-2.

7. Install power piston (334) and power link (303).

8. Make certain all pistons move freely in their bores.

9. Install component parts of the load limit control, if used.

## Reassembly of Ballhead (Figure 6-3)

1. Assemble flyweights (318) no ballhead (320), if previously removed. Drive retaining pins (316) in until flush with or slightly below (preferred) the lower surface of the ballhead.

2. Carefully install the ballhead and flyweight assembly and bearing (315) in sub-bullhead (314). The tang of torsion spring on the ballhead must engage the axial hole in the counterbore of the sub-bullhead.

3. Place cover (313) over the ballhead and carefully press onto the sub-ballhead until the cover seats against the vertical vanes on the sub-ballhead. The rim of the cover must not project below the lower edge of the sub-bullhead. A minimum force of 90 lb (400 N) should be required to reinstall a used cover, or a minimum of 100 lb (445 N) for a new cover. Take care not to buckle or otherwise distort the top or walls of cover.

4. Install speeder rod (312), spring (311), washer (310), thrust bearing (309), and nut (308). The large end of the spring (tapered) must be toward the thrust bearing. The flat race of the thrust bearing must face toward the spring.

## Reassembly of Case (Figure 6-2)

1. If original bearings (244) are to be reused, insert in case (257) as previously identified for RH or LH installation and with the marked end outward. See the Note following step 4 of the case disassembly instructions. Secure bearings in place with set screws (243).

**IMPORTANT**

**If new bearings are to be installed, partially insert them into the case (until flush with inside face of boss) at this time. Do not install set screws or oil seals (242) until the controlet has been assembled to the case and output shaft, and linkages checked for freedom of movement.**

2. Carefully install oil seals (242) over the end of the output shaft and drive it in until flush with the outside surface of the boss. Apply Boretite to OD of seals prior to installation.

3. Install output shaft (238), power lever (239), and compensation lever (240) in the case. The flat in the center of the shaft must face toward the rear of the case. Secure levers to the shaft with taper pins (243).

4. Install compensation adjusting lever (250), pointer (248), fulcrum (245), and compensation link (241). Connect the link to the compensation lever on the output shaft with straight pin (233) and cotter pin (231).

## Reassembly of Column (Figure 6-1)

1. Place bushing gear (108) on stud (109) in the base of column (117) and then set the column upright.

2. Insert spring (107) and bushing (106). Make certain the spline on the lower end of the bushing fully engages the gear.

3. Insert speed setting plunger (104) in the bushing and then install thrust bearing (103), washer (102), and retainer (101).

## Reassembly of Speed Setting Cylinder (Figure 6-1)

1. Insert piston (93) in cylinder (95).

2. Press fulcrum (92) onto the rod of the piston until seated against the shoulder. The pivot pin hole for the floating lever in the fulcrum must be off-center toward the cylinder.

3. Reinstall adjusting screw bracket (91) and adjusting screw (69) on the mounting pin in the fulcrum. Position the bracket so that the adjusting screw is centered over the check valve in the cylinder.

4. Install guide pin (86) and piston stop set screw (87), if previously removed. Hold the piston against the top of the cylinder and turn the set screw in until initial contact is made, and then turn two turns further and temporarily lock in position.

## Reassembly of Pneumatic Receiver (Figure 6-1)

1. If necessary, assemble the manual speed setting mechanism as follows:
   a. Assemble knob (45) to lead screw (47), if previously removed. Install belleville washer (44) with the concave surface toward the knob. Tighten nut (43) approximately seven turns.
   b. Insert the lead screw into receiver bracket (75), installing washer (42), collar, link and nut assembly (52 through 57), spring washer (41) and stop washer (40) as the screw is inserted. The flanged end of the stop washer should be toward the spring washer.

**IMPORTANT** **The position of the stop washer may be reversed, if necessary, to eliminate lead screw end play.**

   c. Secure the lead screw in position with roll pin (39) and friction washer (38). Washer (42) must be between the receiver bracket and roll pin. The roll pin should project approximately 3/32” (2.4 mm) from each side of the lead screw.
   d. Assemble ball bearing (67) to pivot bracket (68), if previously removed, and install the bracket on the arm of speed setting screw (70). Locate the bracken at approximate mid-point of the adjustment range and temporarily lock in position with knurled nuts (62).
   e. Insert stop pin (51) in the lower end of the speed adjusting screw and then insert the screw through collar (52) into the boss on the receiver bracket.
   f. Install guide (60) and speed adjusting nut (59).
   g. Replace dial plate (36).

2. Insert bellows (31) in receiver cup (34) using a new O-ring (32) and secure with retaining ring (30). The notch in the end piece of the bellows must be aligned with set screw (33). The opening in the retaining ring must also be aligned with the set screw.

**IMPORTANT** **Install receiver cup with opening in bellows downward on direct speed setting mechanisms. Install cup with bellows opening upward on reverse speed setting mechanism.**

3. Install the receiver cup in the receiver bracket using gasket (29). Install passage (hollow) screw (27) using a new copper washer (26). Tighten set screw (26).

4. Insert bellows coupling (25) in the bellows and loosely install plunger link (21) on the receiver bracket so that the slots in the lower (or upper) arm engage the tangs on the bellows coupling. On reverse speed setting mechanisms, install bellows spring (24) between the bottom of the receiver cup and the lower arm of the link.

## Final Assembly

**Controlet/Base (Figure 6-3)—**

1. Insert controlet assembly and lightly clamp in a vise (see Figure 5-4).

2. Insert speeder valve bushing (333) and plunger (332) in the controlet and then install spring seat (331) and loading spring (330). The crown on the seat must be toward the plunger.

3. Install the base assembly on the controlet. Rotate the driveshaft until the lug engages the notches in the bushing. Install five inner screws (328) and washers (329). Tighten the screws evenly and in similar sequence as for a cylinder head.

4. Check the driveshaft for freedom of rotation. If the driveshaft does not turn freely, loosen screws slightly and tap the corners of the base lightly until the driveshaft turns freely. If this does not free the driveshaft, remove the base and turn the driveshaft 180° and reinstall.

5. Remove the controlet/base assembly from the vise and place in an upright position. Remove the assembly pin from the compensation link.

**Ballhead (Figure 6-3)—**

1. Place the ballhead assembly on the controlet. Engage the end of floating lever (306) over the pin in the lower end of the speeder rod with the lever straddling the speeder valve plunger. Push downward on the small compensation piston nut and engage the other end of the floating lever over the pin in the nut (see Figure 5-3).

2. Insert pin (305) connecting the floating lever to the speeder valve plunger. If the pin will not enter easily, remove the lever and turn the speeder valve plunger 180°. Reinstall the lever and insert the pin. Do not install the cotter pin at this time.

3. Check the floating lever for freedom of movement as follows:
   a. Push lightly downward on top of the speeder rod with a finger tip while moving one of the flyweights through its full travel several times (see Figure 5-7). The floating lever should move smoothly with no evidence of sticking or binding.
   b. Depress the small compensation piston nut approximately 1/4” (6 mm) using a screwdriver and repeat step a (see Figure 5-8).

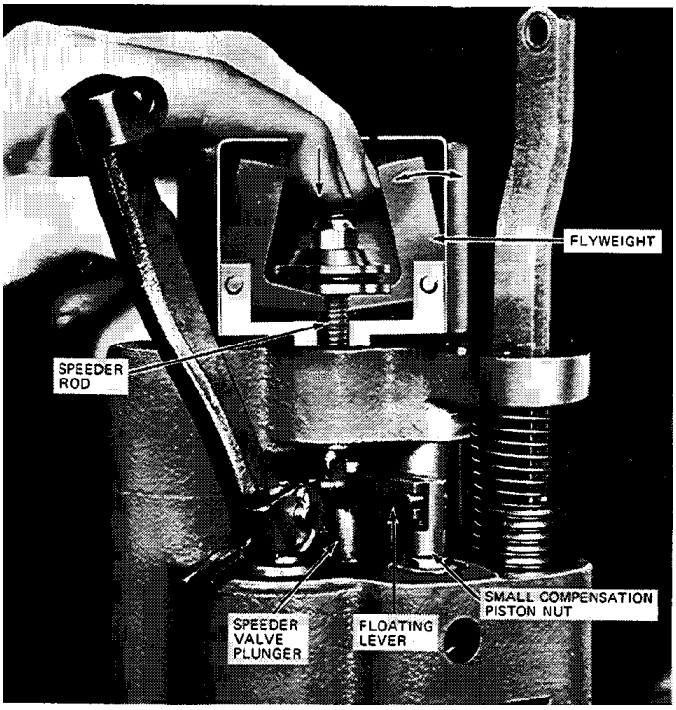


Figure 5-7. First Check for Binding of Floating Lever

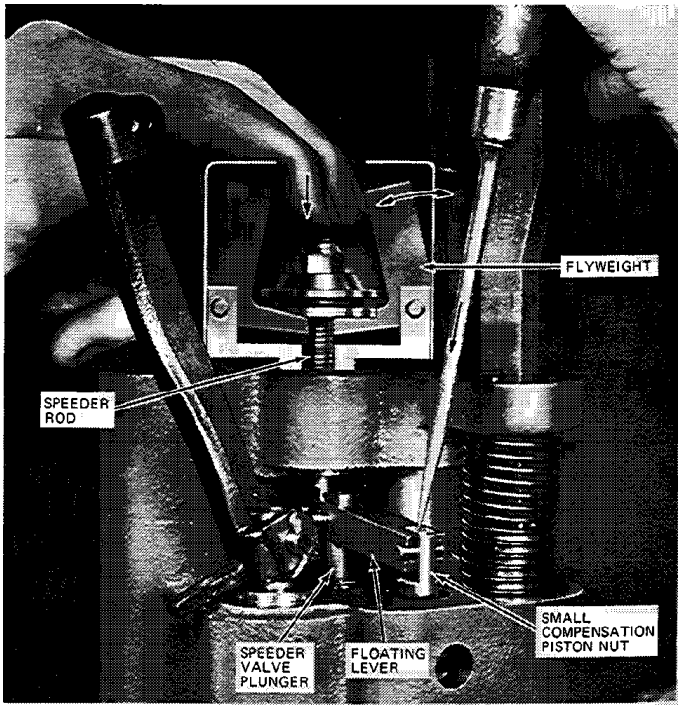


Figure 5-8. Centering Speeder Valve Plunger

c. Lift the small compensation piston nut approximately 1/4” (6 mm) and repeat step a (see Figure 5-9).

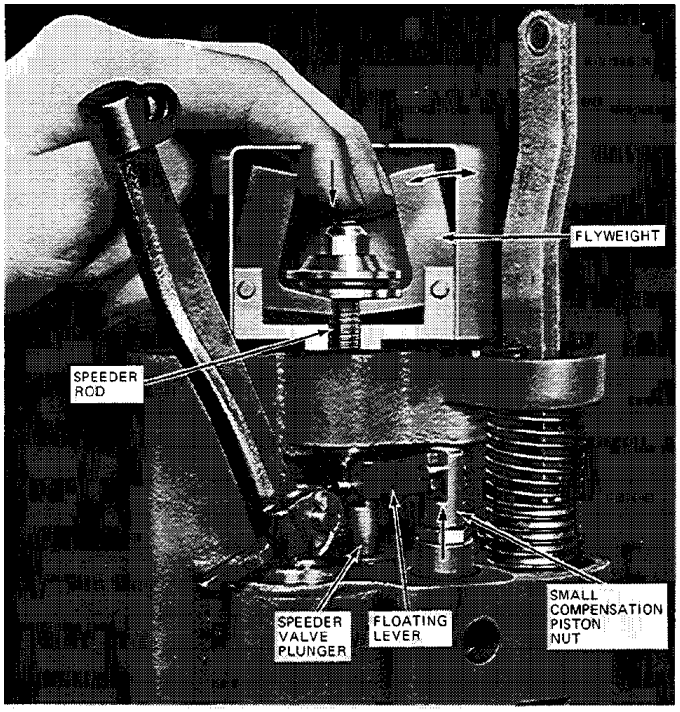


Figure 5-9. Third Check for Binding of Floating Lever

4. If evidence of sticking or binding is noted under any of the conditions given in step 3 above, alter the individual positions of the speeder rod, floating lever, speeder valve plunger, and piston nut in various combinations and repeat step 3 after each change.
   a. Invert the floating lever and recheck.
   b. If unsatisfactory, turn the speeder valve plunger 180° and/or invert the floating lever again.
   c. If still unsatisfactory, turn the piston nut or speeder rod 180° and/or invert the floating lever again.
   d. Continue trying various positional combinations until free action is obtained.

5. After satisfactorily completing steps 3 and 4 above, install cotter pin (304) in speeder valve plunger pin (305).

6. Center (null) the speeder valve plunger as follows:
   a. Remove the plug from the controlet so that the control land may be observed (see Figure 5-10).
   b. Push the speeder rod downward as far as possible, moving the flyweights to their innermost position.
   c. Using a flashlight, observe the position of the upper edge of the control land on the speeder valve plunger with respect to the metering port in the bushing. Note the amount of port opening (see Figure 5-10, A).
   d. Hold the speeder rod in contact with the toes of the flyweights while pushing the flyweights to their outermost position. Observe the position of the lower edge of the control land with respect to the metering port. Note the amount of port opening (see Figure 5-10, B).

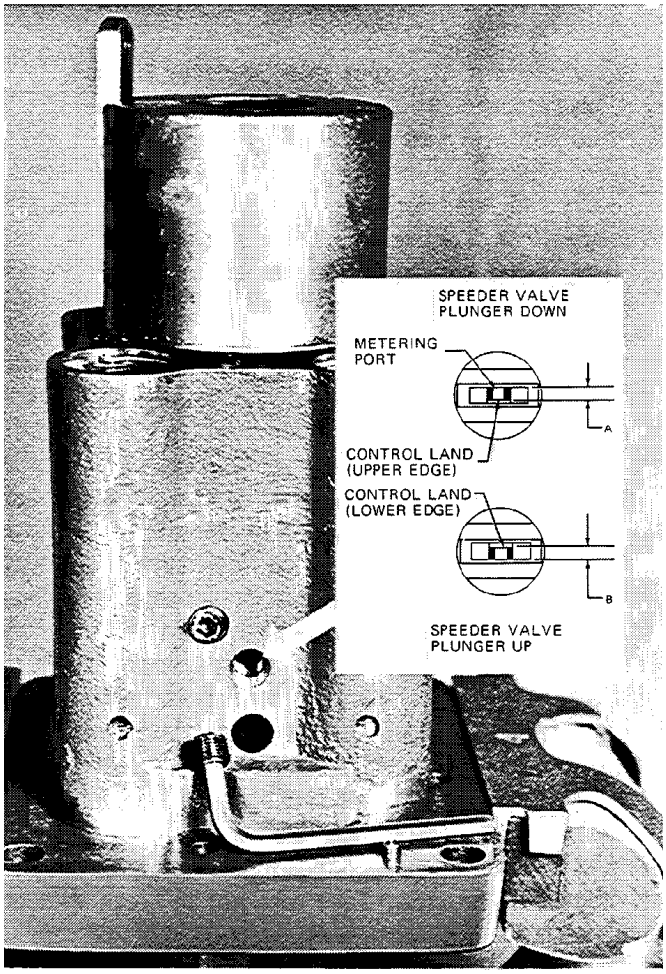


Figure 5-10. Centering Speeder Valve Plunger

e. Openings A and B should be equal within 0.005” (0.13 mm) or as nearly as can be determined by visual observation. If openings A and B are not approximately equal, turn the speeder rod nut clockwise to raise the speeder valve plunger or counterclockwise to lower the plunger as required, Recheck A and B openings after each adjustment.
f. Replace the plug in the inspection port using a thread sealing compound.

**Case (Figure 6-2)—**

1. Invert case (257) and install the controlet and base assembly using a new gasket (236) and four washers (235) and screws (234).

2. Set the assembly upright and install pins (232 and 233) connecting power lever (239) and compensation adjusting link (241) to the power and compensation links of the controlet (see Figure 5-1).

3. Rotate output shaft (238) several times throughout its full range of travel using the special serration wrench (or governor lever). There should be no perceptible drag or binding.

4. Repeat step 3 with a 5 to 10 lb (22 to 44 N) force alternately applied to each end of the output shaft. If drag or binding is noted, check output shaft end play. Output shaft end play should not be less than 0.002” (0.05 mm) nor more than 0.010” (0.25 mm). Adjust output shaft end play, if necessary, as follows:

**IMPORTANT** **Adjustment of output shaft end play is essentially identical whether the original or new output shaft bearings (244) are used.**

   a. If the original bearings are to be reused, remove as instructed under disassembly of case. Drive, do non pry, out oil seals if they are to be reused. Rotate bearings 90° and partially reinstall as for new bearings (see reassembly instruction for case).
   b. Reinstall the output shaft and connect linkages.
   c. Determine output shaft end play and, if necessary, drive each bearing inward in small increments until approximately 0.008” (0.20 mm) end play is obtained. Check output shaft rotation alter each adjustment. Take special care not to drive one bearing further inward than the other and cause misalignment of levers and links.
   d. After bearings have been positioned, use a 1/4-25 cone point set screw to mark each bearing for drilling. Remove bearings from case.
   e. Drill a 5/32” (3.97 mm) diameter hole to a point depth of 1/8” (3.2 mm) in each bearing to accept the point of half-dog point set screw. Take care not to break through the ID of bearing.
   f. Reinstall bearings, set screws, output shaft, and linkage pins. Recheck output shaft rotation.
   g. Install oil seals using the special oil seal inserter designed to slip over the projecting ends of the output shaft.

5. Place bushing drive gear (324, Figure 6-3) in position under gear plate (323) on the controlet. Install speed setting bushing driveshaft (218, Figure 6-2) to hold the gear in place, if necessary.

6. Insert speeder spring (230) through the top of the ballhead cover and rest on the top of the speeder rod thrust bearing.

7. Install panel (225) using a new gasket (229). Make certain the top of the speeder spring enters the speeder plug boss of the panel.

8. Install nameplate (220).

9. Complete installation of the speed setting bushing driveshaft, gasket (212),. auxiliary plate (211), and drive gear (206).

10. Engage shutdown rod (214) in the speeder rod nut and install speeder plug (213).

**Column—**

1. Install column (117, Figure 6-1) on top of the case using a new gasket (118) and secure with screws (97) and washers (98).

2. Install external oil tube (203 and 204, Figure 6-2).

**Speed Setting Cylinder (Figure 6-1)—**

1. Assemble spacer tube (84), retaining ring (83), support spring (82), seat (81), and piston spring (80). Slide the assembly down over the shutdown rod until the spacer tube seats on the speeder plug in the case.

2. Install O-ring (96) in the seat in the top of the column.

3. Install speed venting cylinder assembly (85 through 95) over the shutdown rod and secure to the column with screws (78) and washers (79).

4. Install shutdown nuts (77), if used. Temporarily position the nuts at the top of the shutdown rod.

**Pneumatic Receiver (Figure 6-1)—**

1. Install new O-ring (76) in the seat in the top of the column.

2. Turn speed setting valve plunger (104) so that the threaded hole faces directly toward the center front of the column.

3. Install pneumatic receiver assembly (21 through 75) on the column and secure with screws (18 and 19) and washers (20). The top of the speed setting valve plunger must project into the hole in the bottom leg of link (21).

4. Install screw (16) and washer (17) through the square cutout in the lower front of receiver bracket (75),

5. Connect restoring lever (13) to fulcrum (92) using pin (12). Secure with cotter pin (11).

6. Install restoring spring (10). The pointed seat on the lower end of the spring must engage the socket in the bottom surface of the pin which projects from the upper arm of the link.

7. Install loading spring (9), if used.

8. Install cover (7).

## Testing

Refer to Initial Operation and Adjustment, Chapter 2.

# Chapter 6.
# Replacement Parts

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

- Governor model, serial number, and part number (shown on nameplate), needed since a manual reference number does not identify the exact part required for any one governor
- Manual number (this is manual 03025)
- Part reference number as given in the parts list, figure number illustrating part, and name or description of the part

Circled reference numbers on the exploded view illustrations indicate items which need not necessarily be disassembled to effect repair or overhaul unless replacement of the part or parts is required. Figure 6-1 illustrates and locates parts for the column (speed setting mechanism), Figure 6-2 the case (output shaft, compensation linkage, speeder spring, etc.), and Figure 6-3 the controlet (speed sensing, compensation mechanism and base). A separate parts list is provided for use with each figure.

## Parts List for Figure 6-1

| Ref. No. | Part Name | Quantity |
|---|---|---|
| 03025-1 | Screw, hex hd., 5/16-24 x 5-13/32 | 2 |
| 03025-2 | Washer, lock, 5/15 (MS35338-45) | 2 |
| 03025-3 | Washer, plain, 5/16 (MS27183-12) | 2 |
| 03025-4 | Nameplate | 1 |
| 03025-5 | Screw, drive, #2 x 3/16 (AN535-2-3) | 4 |
| 03025-6 | Oil filler cup | 1 |
| 03025-7 | Cover | 1 |
| 03025-8 | Cover gasket | 1 |
| 03025-9 | Loading spring | 1 |
| 03025-10 | Restoring spring | 1 |
| 03025-11 | Cotter pin, 1/16 x 3/8 (MS24665-130) | 3 |
| 03025-12 | Pivot pin (restoring lever) | 1 |
| 03025-13 | Restoring lever | 1 |
| 03025-14 | Pin (loading spring) | 1 |
| 03025-15 | Stop pin (low speed-pneumatic) | 1 |
| 03025-16 | Screw, soc. hd., 5-40 x 1/2 | 1 |
| 03025-17 | Washer, lock #5 (AN935-5) | 1 |
| 03025-18 | Screw, soc. hd., 1/4-28 x 1-1/4 (MS16998-46) | 1 |
| 03025-19 | Screw, soc. hd., 1/4-28 x 2 (MS16998-49) | 1 |
| 03025-20 | Washer, lock 1/4 (MS35338-44) | 2 |
| 03025-21 | Plunger link | 1 |
| 03025-22 | Adjusting screw (low speed—pneumatic) | 1 |
| 03025-23 | Nut, hex., 10-32 (MS35650-302) | 1 |
| 03025-24 | Bellows spring | 1 |
| 03025-25 | Bellows coupling | 1 |
| 03025-26* | Setscrew, soc. hd., cone pt., 8-32 x 5/16 (MS51973-30) | 1 |
| 03025-27 | Passage screw | 1 |
| 03025-28 | Washer, soft copper | 1 |
| 03025-29 | Receiver cup gasket | 1 |
| 03025-30 | Retaining ring, int. (MS16625-1150) | 1 |
| 03025-31 | Bellows | 1 |
| 03025-32 | Packing, preformed, 1-1/2 OD (NAS1593-028) | 1 |
| 03025-33 | Set screw, soc. hd., cone pt., 5-40 x 1/4 | 1 |
| 03025-34 | Pneumatic receiver cup | 1 |
| 03025-35 | Screw, Phillips, rd. hd., 6-32 x 3/8 (MS35206-25) | 4 |
| 03025-36 | Dial plate | 1 |
| 03025-37 | Spacer | 4 |
| 03025-38 | Friction spring | 1 |
| 03025-39 | Roll pin, 3/32 x 5/8 (MS9048-071) | 1 |
| 03025-40 | Stop washer | 1 |
| 03025-41 | Spring washer, 1/4 | 1 |
| 03025-42 | Washer, plain, 25/64 ID x 5/8 OD (AN960-616) | 1 |
| 03025-43 | Nut, hex, slflkg, 1/4-28 (M521083N4) | 1 |
| 03025-44 | Belleville washer, 1/4 | 1 |
| 03025-45 | Knob (manual speed adjusting) | 1 |
| 03025-46 | Clutch spring | 1 |
| 03025-47 | Lead screw | 1 |
| 03025-48 | Receiver bracket gasket | 1 |
| 03025-49* | Screw, soc. hd., 10-24 x 1/2 (MS16997-44) | 2 |
| 03025-50* | Washer, lock, #10 (MS35338-43) | 2 |
| 03025-51 | Stop pin (high speed) | 1 |
| 03025-52 | Collar | 1 |
| 03025-53 | Pivot pin | 4 |
| 03025-54 | Link | 1 |

## Parts List for Figure 6-1 (continued)

| Ref. No. | Part Name | Quantity |
|---|---|---|
| 03025-55 | Setscrew, soc. hd., dog pt., 8-32 x 3/8 (MS51977-31) | 1 |
| 03025-56 | Thread insert, scr lkg, 8-32 x 1/4 (MS21209C0815) | 1 |
| 03025-57 | Nut (lead screw) | 1 |
| 03025-58 | Thread insert, 7/16-20 x 7/16 (MS124659) | 1 |
| 03025-59 | Speed adjusting nut | 1 |
| 03025-60* | Guide | 1 |
| 03025-61 | Setscrew, soc. hd., oval pt,, 10-32 x 1 (MS51982) | 1 |
| 03025-62 | Nut, knurled | 2 |
| 03025-63 | Screw, soc. hd., 10-32 x 1-1/8 | 1 |
| 03025-64 | Washer, lock, hi-collar, #10 (MS51848) | 2 |
| 03025-65 | Screw, soc. button hd., 10-32 x 1 | 1 |
| 03025-66 | Spacer | 1 |
| 03025-67 | Ball bearing | 1 |
| 03025-68 | Pivot bracket | 1 |
| 03025-69 | Thread insert, scr lkg, 10-32 x 3/8 (MS21209F1-20) | 1 |
| 03025-70 | Speed setting screw | 1 |
| 03025-71 | Pin (loading spring anchor) | 1 |
| 03025-72 | Friction spring seat | 1 |
| 03025-73* | Dowel pin | 2 |
| 03025-74* | Thread insert, scr lkg, 8-32 x 1/4 (MS21209C0815) | 1 |
| 03025-75* | Receiver bracket | 1 |
| 03025-76 | Packing, preformed, 3/8 OD (NAS1593-010) | 1 |
| 03025-77 | Nut, hex,, 8-32 (MS35649-282) | 2 |
| 03025-78 | Screw, hex. hd., 1/4-28 x 1-3/16 (MS90726-9) | 2 |
| 03025-79 | Washer, plain, 1/4 (AN960-416L) | 2 |
| 03025-80 | Speed setting piston spring | 1 |
| 03025-81 | Spring seat | 1 |
| 03025-82 | Spacer tube support spring | 1 |
| 03025-83 | Retaining ring, ext., (MS16624-1075) | 1 |
| 03025-84 | Spacer tube | 1 |
| 03025-85 | Nut, hex, 10-32 (MS35650-302) | 2 |
| 03025-86 | Guide pin | 1 |
| 03025-87 | Setscrew, soc. hd, oval pt, 10-32 x 7/8 (MS51982) | 1 |
| 03025-88 | Screw. soc. hd., 10-32 x 3/8 (MS16998-26) | 1 |
| 03025-89 | Adjusting screw (limiting valve) | 1 |
| 03025-90 | Thread insert, scr lkg. 10-32 x 9/32 (MS21209F1-15) | 1 |
| 03025-91 | Adjusting screw bracket | 1 |
| 03025-92 | Fulcrum | 1 |
| 03025-93 | Speed setting piston | 1 |
| 03025-94 | Check valve assembly (max. speed limiting) | 1 |
| 03025-95 | Speed setting cylinder | 1 |
| 03025-96 | Packing, preformed, 3/8 OD (NAS1593-010) | 1 |
| 03025-97 | Screw, hex. hd,. 5/16-24 x 5 (MS90726-52) | 4 |
| 03025-98 | Washer, lock, mt. tooth, 5/16 (MS35333-41) | 4 |
| 03025-99 | Screw, Phillips, rd. hd., 10-32 x 3/8 (MS35207-53) | 2 |
| 03025-100 | Washer, lock, #10 (MS35338-43) | 2 |
| 03025-101 | Retainer | 1 |
| 03025-102 | Washer, plain, 3/8 ID x 3/4 OD | 1 |
| 03025-103 | Thrust bearing | 1 |
| 03025-104 | Speed setting plunger | 1 |
| 03025-105 | Plug | 1 |
| 03025-106 | Speed setting bushing | 1 |
| 03025-107 | Bushing loading spring | 1 |
| 03025-108 | Bushing gear | 1 |
| 03025-109 | Bearing stud | 1 |
| 03025-110 | Elbow, 90° | 1 |
| 03025-111 | Dowel pin | 2 |
| 03025-112 | Cover dowel | 2 |
| 03025-113 | Dowel bushing | 2 |
| 03025-114 | Thread insert, 5/16-24 x 5/8 (MS 124737) | 2 |
| 03025-115 | Pipe plug, soc. hd, 1/16-27 NPTF (AN932S1) | 5 |
| 03025-116 | Taper Screw (not used with solenoid or pressure actuated shutdown option) | 1 |
| 03025-117 | Column | 1 |
| 03025-118 | Case gasket | 1 |
| 03025-119 | Dowel pin | 2 |

*—Furnished only as an assembly.

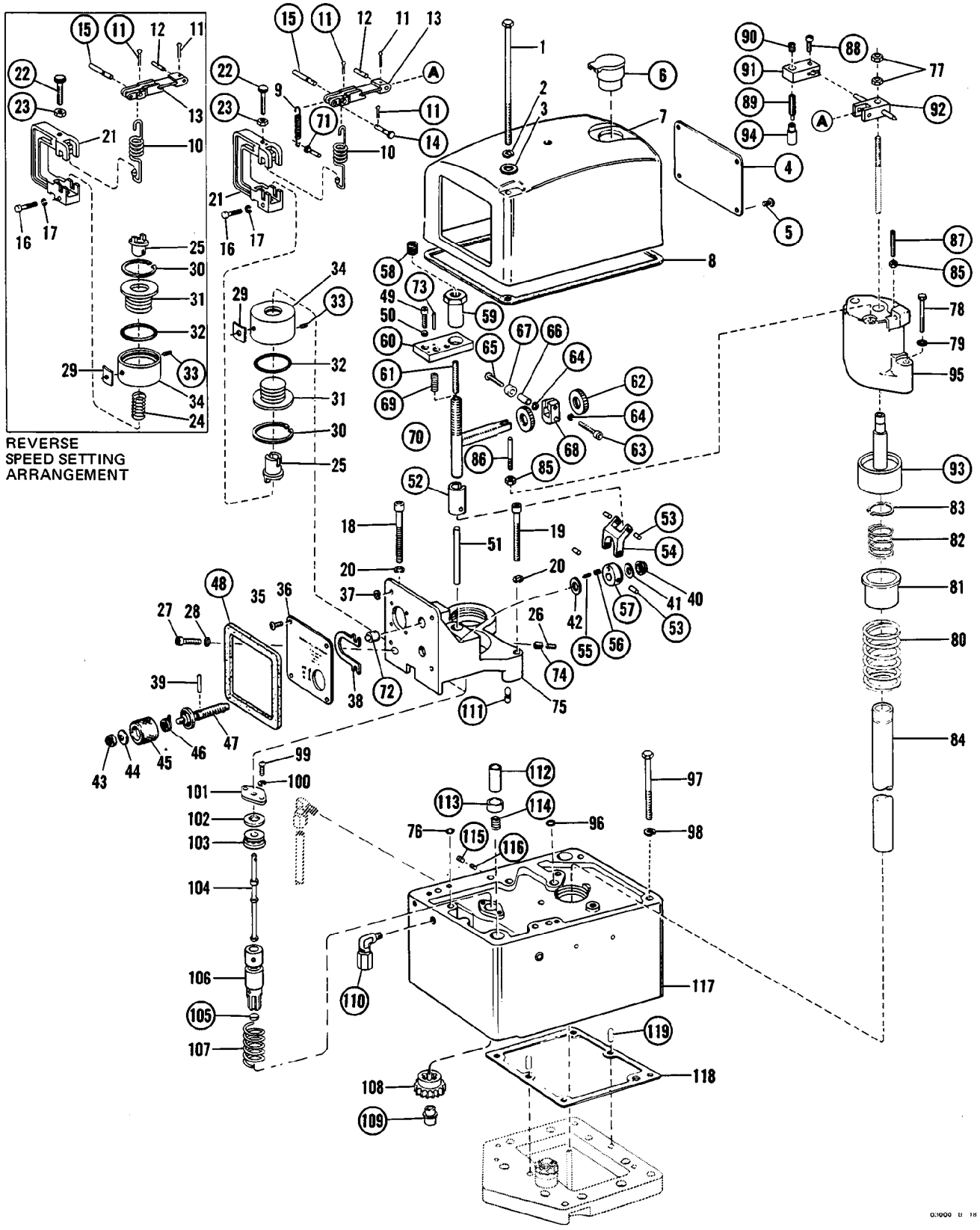


Figure 6-1. Exploded View of Column

## Parts List for Figure 6-2

| Ref. No. | Part Name | Quantity |
|---|---|---|
| 03025-201 | Screw, Phillips, rd. hd., 8-32 x 3/8 (MS35206-40) | 1 |
| 03025-202 | Clamp | 2 |
| 03025-203 | Tuba, copper, 1/4 OD | 1 |
| 03025-204 | Elbow, 90° | 2 |
| 03025-205 | Retaining ring, ext. (MS16624-1037) | 2 |
| 03025-206 | Drive gear (speed setting bushing) | 1 |
| 03025-207 | Screw, Phillips, fil. hd., 10-32 x 5/8 (MS35256-64) | 8 |
| 03025-208 | Washer, lock, #10 (MS35338-43) | 8 |
| 03025-209 | Bushing | 1 |
| 03025-210 | Thread insert, 5/16-24 x 5/16 (MS124657) | 4 |
| 03025-211 | Auxiliary plate | 1 |
| 03025-212 | Case gasket | 1 |
| 03025-213 | Speeder plug | 1 |
| 03025-214 | Shutdown rod | 1 |
| 03025-215 | Bronze washer | 1 |
| 03025-216 | Oil wick | 1 |
| 03025-217 | Roll pin, 3/16 x 1/2 (MS9048-162) | 1 |
| 03025-218 | Driveshaft (Speed setting bushing) | 1 |
| 03025-219 | Screw, Phillips. rd. hd., 8-32 x 3/8 (MS35206-40) | 6 |
| 03025-220 | Nameplate | 1 |
| 03025-221 | Plug | 1 |
| 03025-222 | Packing, preformed. 11/16 OD (NA51593-112) | 1 |
| 03025-223 | Screw, Phillips, fil, hd., 10-32 x 5/8 (MS35266-64) | 8 |
| 03025-224 | Washer, lock, #10 (MS35338-43) | 8 |
| 03025-225 | Panel | 1 |
| 03025-226 | Set screw, soc. hd., cup pt., 3/8-16 x 3/4 (MS51963-105) | 1 |
| 03025-227 | Screw, Hex. hd., 5/16-18 x 5/8 (MS90725-31) | 1 |
| 03025-228 | Washer, plain, 5/16 (MS27183-12) | 1 |
| 03025-229 | Panel gasket | 1 |
| 03025-230 | Speeder spring assembly | 1 |
| 03025-231 | Cotter pin, 1/16 x 3/4 (MS24665-134) | 3 |
| 03025-232 | Straight pin, drilled | 1 |
| 03025-233 | Straight pin, drilled | 2 |
| 03025-234 | Screw, hex. hd., 1/4-25 x 1 (MS90726-8) | 4 |
| 03025-235 | Washer, soft copper, 1/4 ID x 1/2 OD | 4 |
| 03025-236 | Base gasket | 1 |
| 03025-237 | Taper pin, #3 x 1-1/4 (MS24692-251P) | 2 |
| 03025-238 | Terminal (output) shaft | 1 |
| 03025-239 | Power lever | 1 |
| 03025-240 | Compensation lever (output shaft) | 1 |
| 03025-241 | Compensation lever | 1 |
| 03025-242 | Oil seal | 2 |
| 03025-243 | Set screw, soc. hd, half-dog pt, 1/4-28 x 5/16 | 2 |
| 03025-244 | Terminal shaft bearing | 2 |
| 03025-245 | Compensation adjusting fulcrum | 1 |
| 03025-246 | Nut, hex., slflkg, 5/16-24 (MS21083) | 1 |
| 03025-247 | Washer, plain, 5/16 (AN960-516) | 1 |
| 03025-248 | Compensation adjusting pointer | 1 |
| 03025-249 | Washer, copper, fully annealed | 1 |
| 03025-250 | Compensation adjusting lever | 1 |
| 03025-251 | Packing, preformed, 7/16 OD (NA51593-011) | 1 |
| 03025-252 | Oil level gauge assembly | 1 |
| 03025-253 | Elbow | 1 |
| 03025-254 | Dowel pin | 2 |
| 03025-255 | Stop pin (compensation adjusting) | 2 |
| 03025-256 | Pipe plug, 1/5-27 NPTF (AN935-2) | 2 |
| 03025-257 | Case | 1 |

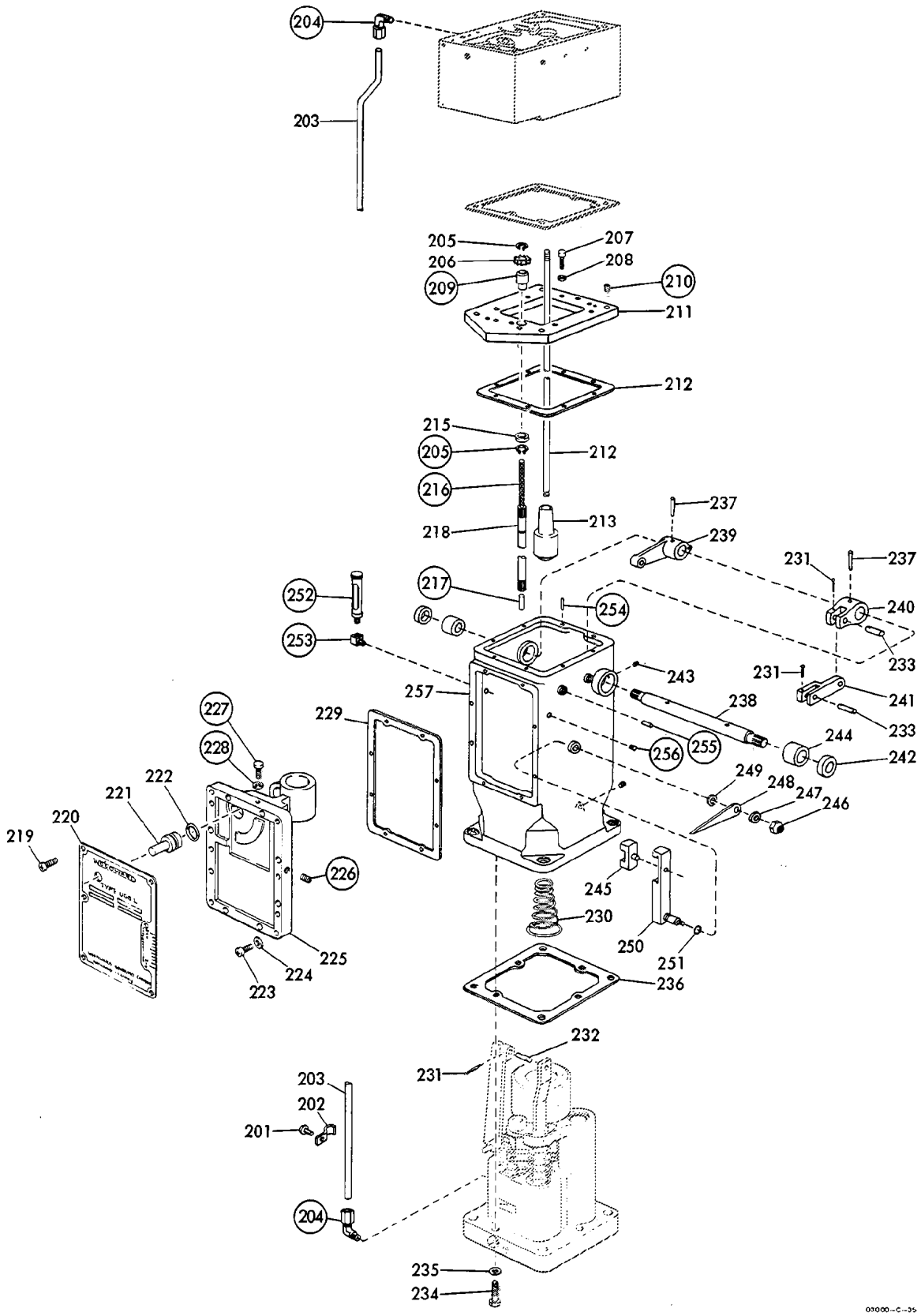


Figure 6-2. Exploded View of Case

## Parts List for Figure 6-3

| Ref. No. | Part Name | Quantity |
|---|---|---|
| 03025-301 | Cotter pin, 1/16 x 1/2 (MS24665-132) | 1 |
| 03025-302 | Washer, plain, 1/4 ID x 11/32 OD | 1 |
| 03025-303 | Power link | 1 |
| 03025-304 | Cotter pin, 1/32 x 3/8 (MS24665-3) | 2 |
| 03025-305 | Straight pin, drilled | 1 |
| 03025-306 | Floating lever | 1 |
| 03025-307 | Cotter pin, 1/16 x 1/2 (MS24665-132) | 1 |
| 03025-308 | Speeder rod nut | 1 |
| 03025-309 | Thrust bearing | 1 |
| 03025-310 | Washer, 5/16 ID x 1/2 OD x 1/32 THK | 1 |
| 03025-311 | Speeder rod spring | 1 |
| 03025-312 | Speeder rod | 1 |
| 03025-313 | Ballhead cover | 1 |
| 03025-314 | Sub-bullhead | 1 |
| 03025-315 | Ball bearing | 1 |
| 03025-316 | Spirol pin, 5/32 x 1/2 (MS51923-329) | 4 |
| 03025-317 | Flyweight pin | 2 |
| 03025-318 | Flyweight | 2 |
| 03025-319 | Needle bearing | 4 |
| 03025-320 | Bal head | 1 |
| 03025-321 | Screw, rd. hd., 6-32 x 1/2 (MS35206-42) | 3 |
| 03025-322 | Washer, lock, inn, tooth, #8 (MS35333-38) | 3 |
| 03025-323 | Gear plate | 1 |
| 03025-324 | Drive gear (speed setting bushing) | 1 |
| 03025-325 | Idler gear | 1 |
| 03025-326 | Idler gear pin | 1 |
| 03025-327 | Dowel pin | 2 |
| 03025-328 | Screw, hex. hd., 1/4-28 x 1 (MS90726-8) | 5 |
| 03025-329 | Washer, soft copper, 1/4 ID x 1/2 OD | 5 |
| 03025-330 | Plunger spring (speeder valve) | 1 |
| 03025-331 | Spring seat | 1 |
| 03025-332 | Speeder valve plunger | 1 |
| 03025-333 | Speeder valve bushing | 1 |
| 03025-334 | Power piston | 1 |
| 03025-335 | Large compensation piston spring | 1 |
| 03025-336 | Link pin | 1 |
| 03025-337 | Large compensation piston | 1 |
| 03025-338 | Bearing | 2 |
| 03025-339 | Compensation link | 1 |
| 03025-340 | Cotter pin, 1/16 x 3/4 (MS24665-134) | 1 |
| 03025-341 | Drive gear (ballhead) | 1 |
| 03025-342 | Spirol pin, 1/8 x 3/4 (MS39086-207) | 1 |
| 03025-343 | Retaining sleeve | 1 |
| 03025-344 | Spring lamination | 12 |
| 03025-345 | Ballhead gear driver | 1 |
| 03025-346 | Pump driven gear | 1 |
| 03025-347 | Small compensation piston nut | 1 |
| 03025-348 | Jam nut, hex., 1/4-28 (special) | 1 |
| 03025-349 | Collar | 1 |
| 03025-350 | Centering spring (small compensation piston) | 2 |
| 03025-351 | Small compensation piston | 1 |
| 03025-352 | Spring seat | 1 |
| 03025-353 | Retaining ring, int. (MS16625-1118) | 4 |
| 03025-354 | Accumulator piston | 2 |
| 03025-355 | Accumulator spring | 2 |
| 03025-356 | Washer, plain, 5/8 ID x 1-3/16 OD | 2 |
| 03025-357 | Check valve assembly | 4 |
| 03025-358 | Pipe plug, 1/8-27 NPTF (AN935-2) | 6 |
| 03025-359 | Plug, hex. hd., 5/16-24 | 1 |
| 03025-360 | Washer, copper, 1/2 hard, 21/64 ID x 17/32 OD | 1 |
| 03025-361 | Compensation needle valve | 1 |
| 03025-362 | Screw, hex. hd., drilled, 1/4-26 x 5/6 (MS51096-5) | 3 |
| 03025-363 | Bearing retainer | 1 |
| 03025-364 | Oil seal | 1 |
| 03025-365 | Oil seal retainer | 1 |
| 03025-366 | Oil seal retainer gasket | 1 |
| 03025-367 | Retaining ring | 1 |
| 03025-368 | Ball bearing | 1 |
| 03025-369 | Driveshaft (serrated) | 1 |
| 03025-370 | Key | 1 |
| 03025-371 | Cotter pin, 1/6 x 1-1/2 (MS24665-357) | 1 |
| 03025-372 | Castle nut, 5/8-18 (AN310-10) | 1 |
| 03025-373 | Gear spacer | 1 |
| 03025-374 | Driveshaft (keyed) | 1 |
| 03025-375 | Dowel pin | 4 |
| 03025-376 | Base | 1 |
| 03025-377 | Controlet | 1 |

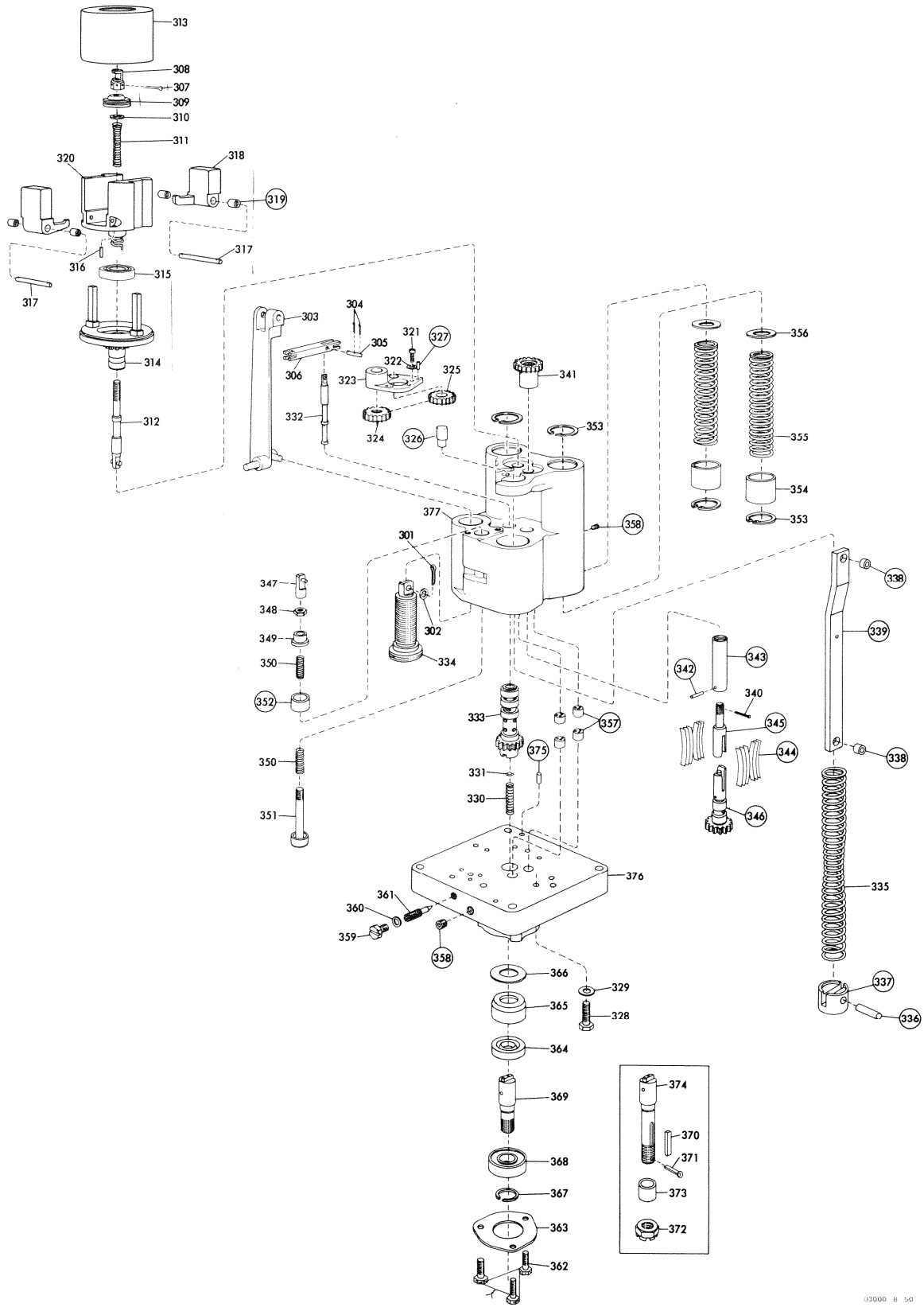


Figure 6-3. Exploded View of Controlet and Base

# 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 |
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| 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 |
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| 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 03025B.**

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