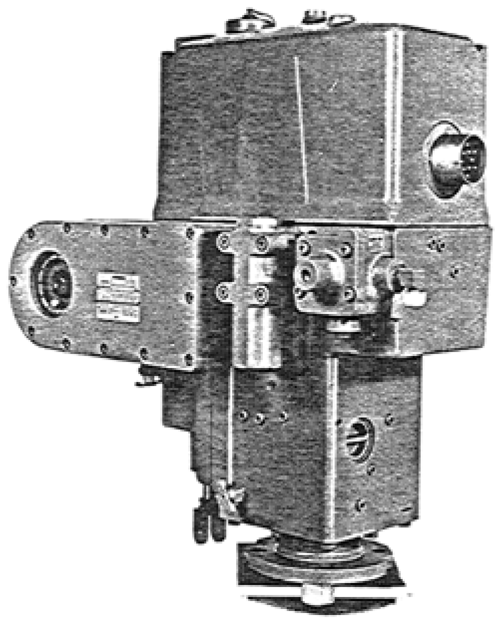
WOODWARD

Product Manual 36628
(Revision D)
Original Instructions



PGEV Governor

8559-910, 8570-687, 8573-463, 8573-494,
8573-580, 8573-581, 8574-650

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

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

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 Out-of-date translations are marked with ⚠.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

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

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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 PGE governor is a standard PG hydraulic governor which regulates engine speed with a number of special adaptations for locomotive and train operation. It includes an electro-hydraulic speed-setting mechanism for remote control of engine speed, a mechanical-hydraulic load-control device for automatic regulation of engine load to maintain a specific power output at each speed setting, and a 12 ft-lb (16 J) single-acting spring-return hydraulic power servo with tailrod. The power servo has a reciprocating or linear output. The governor has both a servomotor and a rheostat as an integral part of the governor to adjust the generator exciter rheostat.

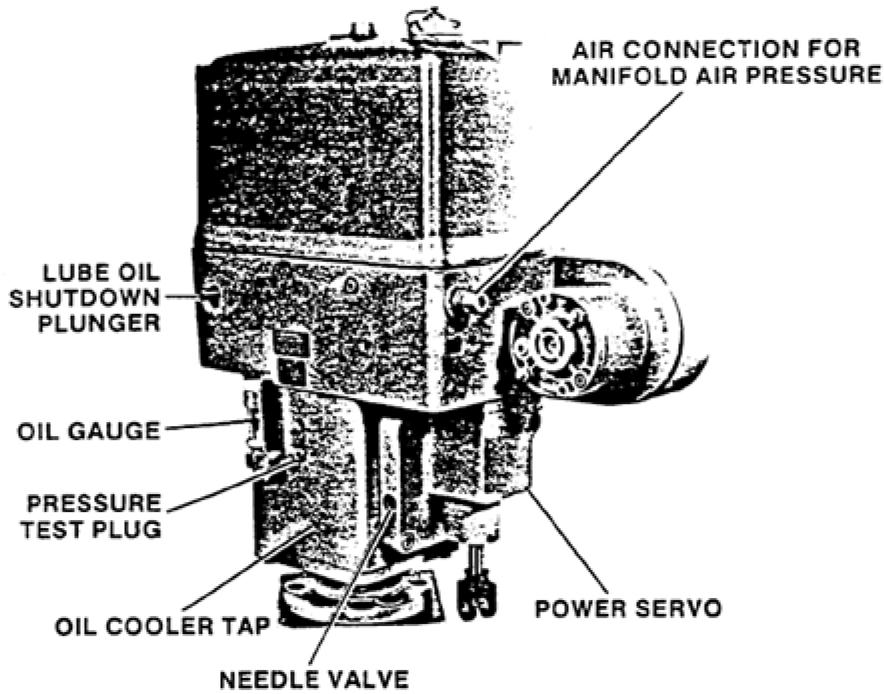

Figure 1-1. Front View of PGE Governor

Specifications

Mounting Base and Drive	See Figure 1-2
Mounting Attitude	Vertical
Drive Rotation	Fixed ccw (counterclockwise)
Drive Shaft	Keyed (8573-494 and 8570-687) 1 1/8” -48 Serrations (8573-463 and 8559-910)
Maximum Speed Range	200 to 1600
Speed Range	361 to 994 rpm (8573-494 and 8570-687) 430 to 1074 rpm (8573-463 and 8559-910)
Drive Power Requirement	1/2 hp (373 W) at maximum drive speed and normal hydraulic fluid viscosity

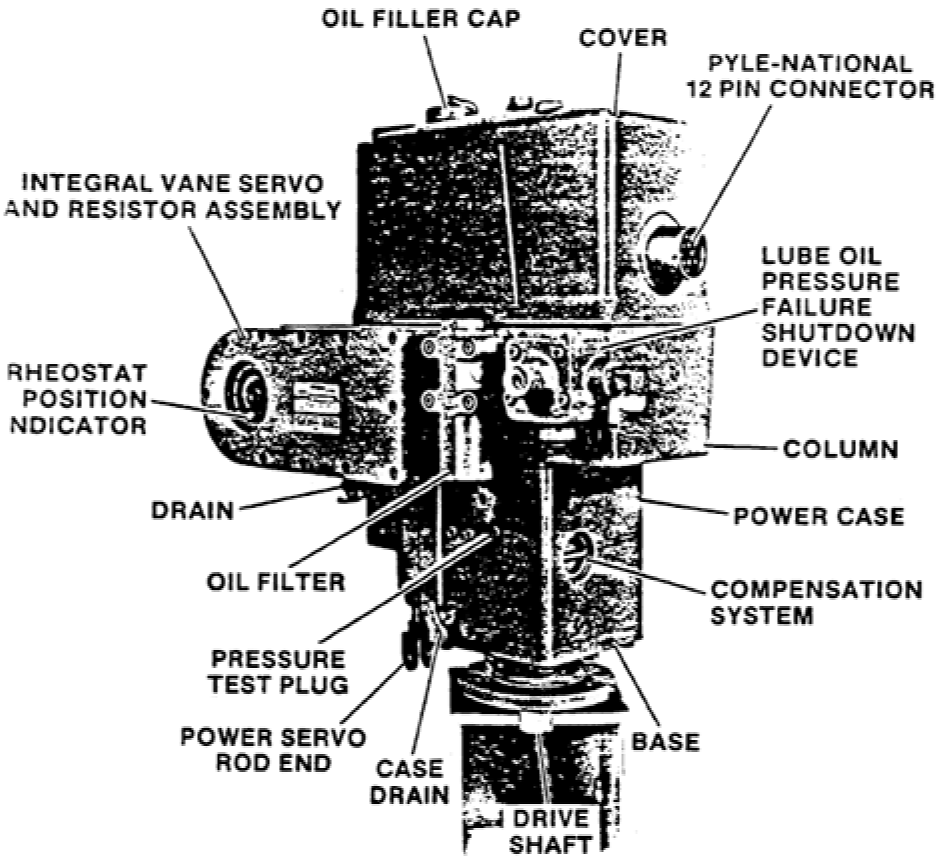

Figure 1-2. Right Rear View of PGE Governor
(Integral Vane Servo Applications)

Hydraulic Fluid	Petroleum base-lubricating oil (contact Woodward if other hydraulic fluids are to be used)
Recommended Viscosity Range	100 to 300 SUS (minimum of 50 to a maximum of 3000 SUS for wide range applications)
Recommended Oil Temperature for Continuous Governor Operation	140 to 200 °F (60 to 93 °C)
Ambient Temperature Range	–20 to +200 °F (–29 to +93 °C)

IMPORTANT **The primary concern is for the hydraulic fluid properties in the governor. See Chapter 2 for charts and graphs of recommended oils.**

Supply	Self-contained, 2 qt (1.9 L) capacity (approx.)
Pressure	Approximately 100 psi (690 kPa)

Output

Useful Work Capacity	8.0 ft-lb (11 J)
Maximum Work Capacity	12.0 ft-lb (16 J)
Stroke Linear-Reciprocating	
Output	1 inch (25 mm)
Weight	105 to 130 lb (48 to 59 kg) depending on optional features

The outline of the governor shown in Figure 1-4 has the standard PG base as used on 8573-463 and 8559-910. Figure 1-3 (the right hand view) shows the keyed shaft and extended base used on 8573-494 and 8570-687.

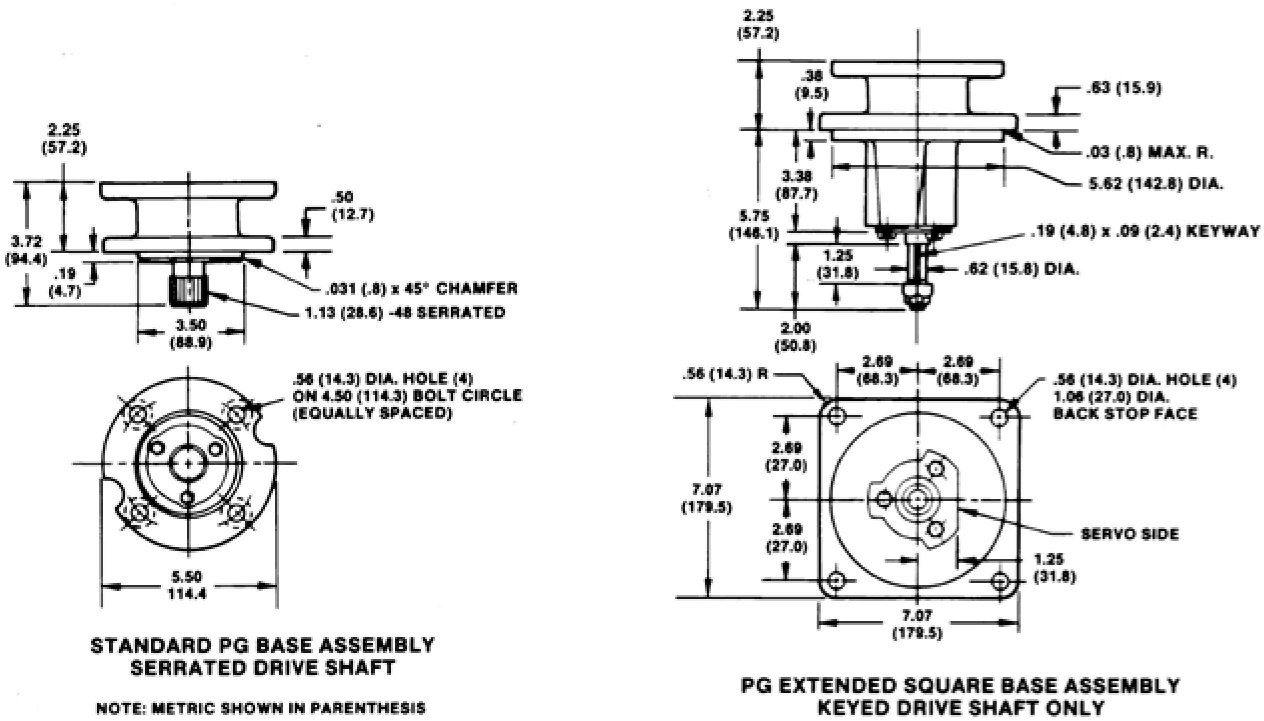

Figure 1-3. PG Bases

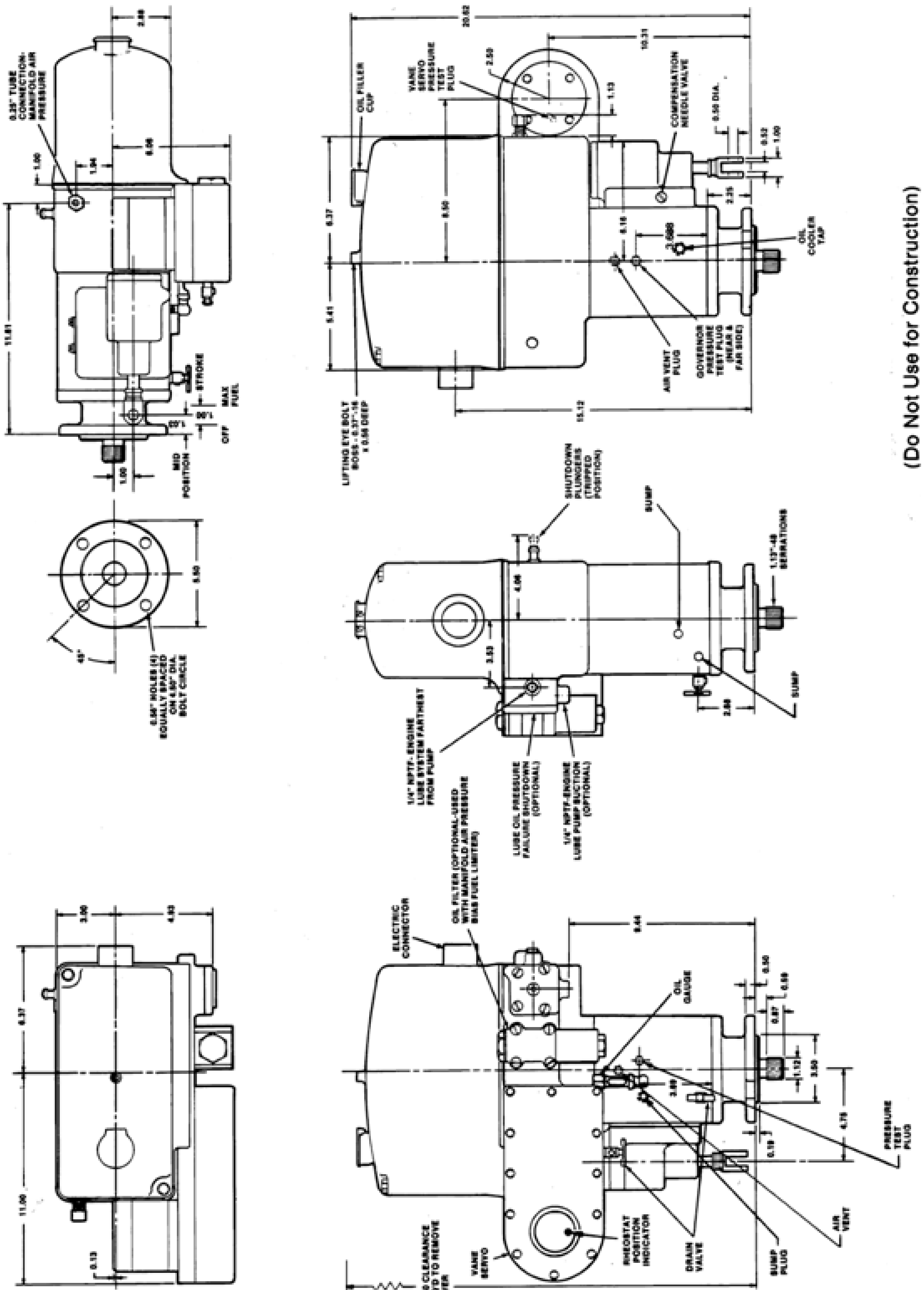

Figure 1-4. Outline Drawing of PGE Governor with Integral Vane Servo

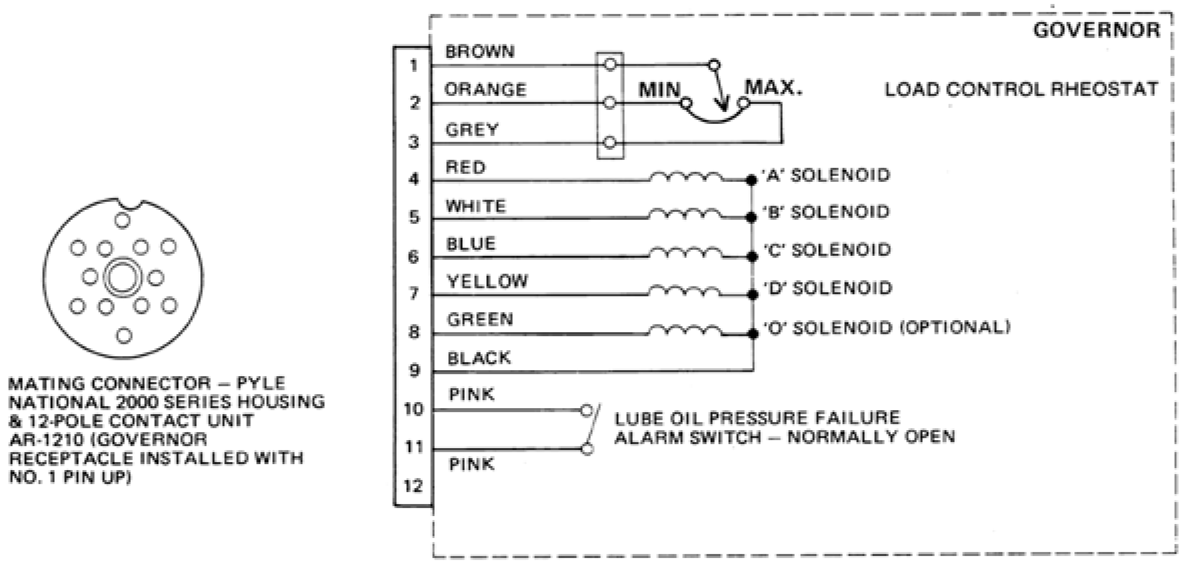

Figure 1-5. Wiring Diagram for 12 Pole Connector

Chapter 2.
Installation

General

Refer to Figure 1-4 for dimensions of the governor. Use care in handling the governor; be careful to avoid striking the drive shaft. Do not drop or rest the governor on its drive shaft, as this could damage the governor.

Installation

Be sure the governor is mounted squarely and the governor-drive connection to the engine drive is properly aligned. Do not use force when making this connection. Use a gasket between the governor base and mounting pad. Misalignment of the governor with respect to its mounting pad, or engine-drive connection, or too tight a fit between governor drive and drive coupling can result in excessive wear or seizure and can cause undesirable “jiggle” at the output shaft.

Align the linkage from the governor to the engine fuel system to eliminate binding or excessive backlash. The relationship of “piston gap” (see Figure 3-1) or terminal shaft angular position to rack position must be adjusted in accordance with the engine manufacturer’s specifications.

IMPORTANT

Due to the location of the compensation cutoff port in the power Cylinder wall, the governor/fuel rack linkage must be adjusted so that the power piston “gap” does not exceed 1-1/32 inches (26 mm) at idle speed no load.

Make the hydraulic and electrical connections required for the particular model governor being installed. Fill the governor with oil to the line on the sight gauge. Recheck with the ENGINE IDLING. Oil must be visible in glass on gauge during all other conditions. Oil must be clean and of a grade suitable for the particular operating conditions (see Specifications). Recheck oil level after engine is started and add oil as necessary. Do not overfill.

NOTICE

This governor is equipped with an integral vane servo. The cavity around the resistor pack (rheostat) must be completely filled with oil before putting a load on the unit. Without oil for cooling, sufficient heat can be generated to overheat the resistor wiring and insulation.

To fill the cavity when the governor is on a test stand, energize or de-energize the overriding solenoid. This lowers or raises the overriding valve plunger, raising or lowering the load-control pilot-valve plunger and releasing oil to the rheostat cavity. When tilling the rheostat cavities on the engine, move the throttle from the IDLE position to number two position. The load-control pilot-valve plunger changes position, allowing oil to enter the rheostat cavity. Changing load with the throttle should be done a few times to be sure the cavity is full. The cavity is full when the oil completely fills the area behind the indicator glass.

Check governor oil level and add oil if necessary.

⚠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.

Adjustments

Normally, the only requirement for putting a new or overhauled governor into service is adjusting the compensation needle valve to obtain maximum stability. All other operating adjustments are made during testing at the factory in accordance with the engine manufacturer's specifications and should not ordinarily require further adjustment. If it is necessary to change or readjust speed settings or other operating adjustments, refer to the engine manufacturer's instructions. Do not attempt internal adjustment of the governor unless thoroughly familiar with the proper procedures.

Compensation Needle Valve Adjustment

The compensation needle valve is an adjustable part of the compensation system. Its setting, which directly affects governor stability, depends upon the individual characteristics of the prime mover:

1. With the prime mover operating at IDLE, open the compensation needle valve several turns to cause the engine to hunt. In some cases, opening of the needle valve alone may not cause the engine to hunt, but manually disturbing the governor speed setting will induce the governor to move through its full stroke. Allow several minutes of hunting to remove trapped air in the hydraulic Circuits.

2. Close the compensation needle valve gradually until hunting is just eliminated. Keep the needle valve open as far as possible to prevent sluggishness in the governor response. The needle valve setting varies from 1/16 to 2 turns open. Never close it tight, the governor cannot operate satisfactorily when this condition exists.

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

Oils for Hydraulic Controls

This is a guide in the selection of a suitable lubricating hydraulic oil for governor use. Oil-grade selection is based on viscosity change over the operating temperature range of the governor.

This is NOT intended to be used in the selection of the engine, turbine, or other type of prime mover lubricating oil.

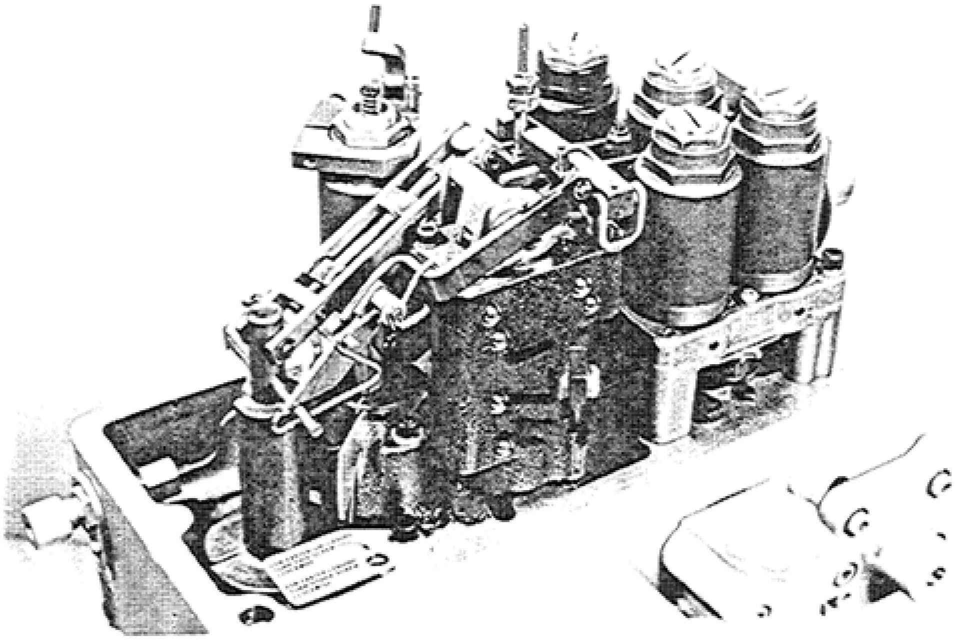

Figure 2-1. PGEV with Fuel Limiter

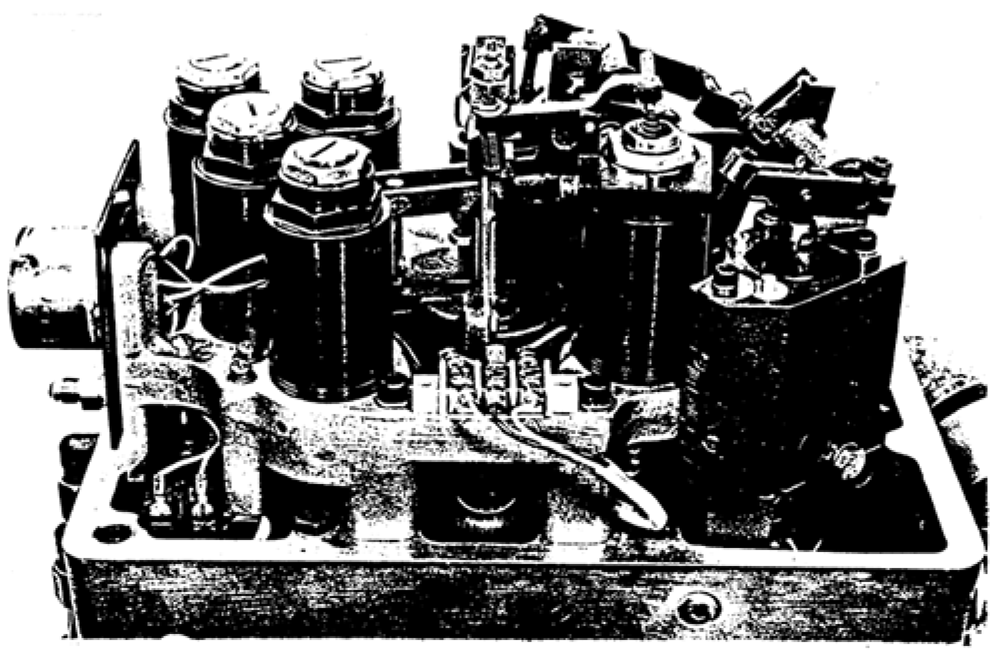

Figure 2-2. PGEV with Fuel Limiter and Altitude Compensation

For applications, where the Woodward Control shares the oil supply with the prime mover, use the oil recommended by the prime mover manufacturer.

Governor oil is both a lubricating oil and a hydraulic oil. It must have a viscosity index that allows it to perform over the operating temperature range and it must have the proper blending of additives that cause it to remain stable and predictable over this range. Governor fluid must be compatible with seal materials (nitrile, polyacrylic, and fluorocarbon). Many automotive and gas engine oils, industrial lubricating oils, and other oils of mineral or synthetic origin meet these requirements. Woodward governors are designed to give stable operation with most oils, if the fluid viscosity at the operating temperature span is within a 50 to 3000 SUS (Saybolt Universal Seconds) range. Ideally, at the normal operating temperature the viscosity should be between 100 to 300 SUS. Poor governor response or instability usually is an indication that the oil is too thick or too thin.

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

1. Insufficient lubrication caused by:
   a. An oil that flows slowly either when it is cold or during start-up.
   b. No oil in the governor.

2. Contaminated oil caused by:
   a. Dirty oil containers.
   b. A governor exposed to heating-up and cooling-down cycles, which create condensation of water in the oil.

3. Oil not suitable for the operating conditions caused by:
   a. Changes in ambient temperature.
   b. An improper oil level which creates foamy, aerated oil.

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

WARNING	**A loss of stable governor control and possible Prime Mover overspeed may result if the viscosity exceeds the 50 to 3000 SUS range.**

Specific oil viscosity recommendations are given on the chart. Select a readily available good brand of oil, either mineral or synthetic, and continue using it. Do not mix the different classes of oils. Oil that meets the API (American Petroleum Institute) engine service classification in either the “5” group or the “C” group, starting with “SA” and “CA” through “SF” and “CD” is suitable for governor service. Oils meeting performance requirements of the following specifications are also suitable. Ml L-L-21 04A, Ml L-L-21 04B, Ml L-L-21 04C, MIL-L-461 52, MIL-L-461 52A, MIL-L-46152B, Ml L-L-451 99B.

Replace the governor oil if it is contaminated. Also change it if it is suspected of contributing to governor instability. Drain the oil while it is still hot and agitated; flush the governor with a clean solvent having some lubricity before refilling with new oil.

NOTICE	**Be sure the solvent is compatible with seals. If in doubt contact Woodward.**

If drain time is insufficient for the solvent to completely drain or evaporate, flush governor with the same oil it is being refilled with to avoid dilution and possible contamination of the new oil.

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

⚠WARNING	**Observe manufacturers Instructions or restrictions regarding the use of solvents. If no instructions are available, handle with care. Use the cleaning solvent in a well ventilated area away from fires or sparks.**

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

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

The recommended oil temperature for continuous governor operation is 140 to 200 °F (60 to 93 °C). Measure the temperature of the governor or actuator on the outside lower part of the case. The actual oil temperature will be slightly warmer by approximately 10 °F (6 °C).The ambient temperature range is –20 to +200 °F (–29 to +93 °C).

IMPORTANT	**The primary concern is for the hydraulic fluid properties in the governor.**

Oil Level

Fill the governor with oil to the mark on the sight gauge, recheck with the engine idling. Oil must be visible in the glass on the gauge during all other conditions.

If additional information for oil properties is required send for our Publication of FEN 41346.

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

Figure 2-3. Viscosity Comparison Chart

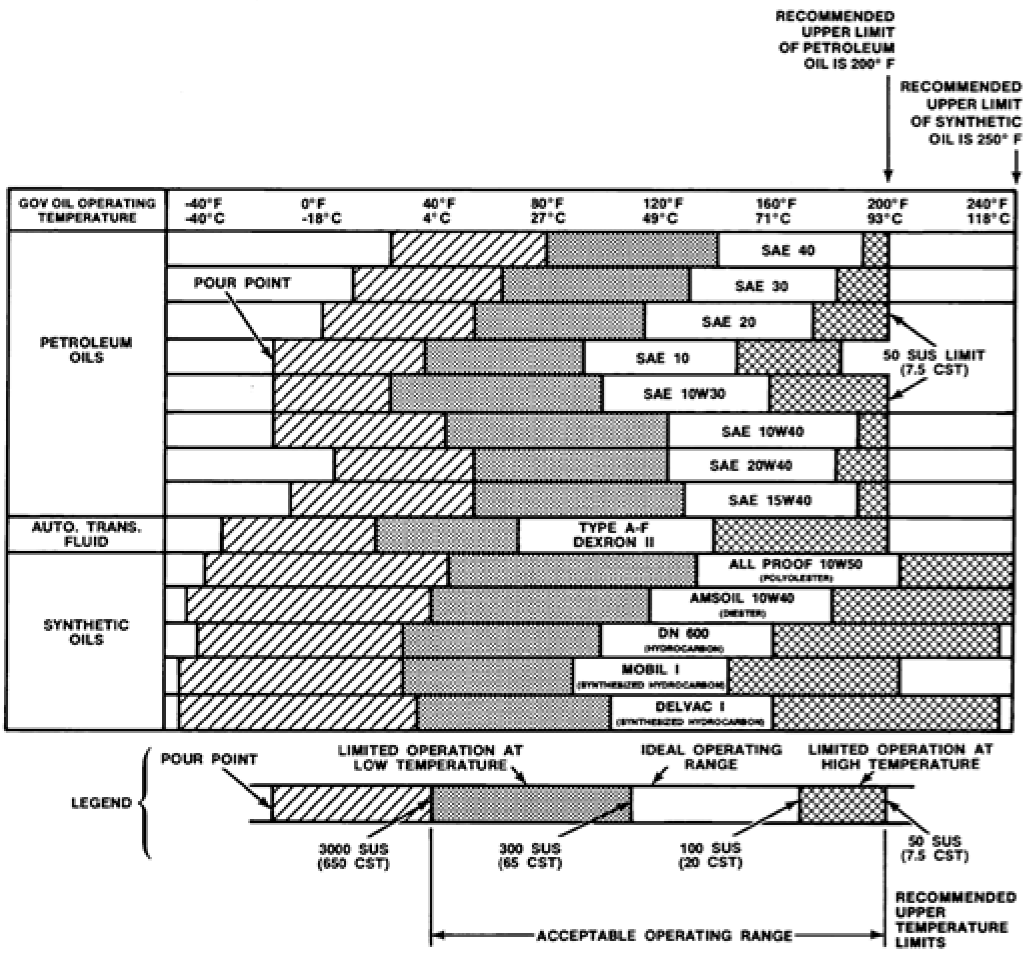

Figure 2-4. Oil Comparison Chart

Chapter 3.
Principles of Operation

Governor Sections

For purposes of description, the PGE governor has three functional sections: a basic governor section, a speed setting section, and a load control section.

Basic Governing Section

(Figure 3-1)

This section consists of an oil pump, two accumulators, a speeder spring, a flyweight head assembly, a thrust bearing, a pilot-valve plunger, a rotating bushing, a buffer-compensation system, and a power cylinder.

The governor drive shaft passes through the governor base and engages the oil pump. The pump supplies pressure oil for operation of the basic governor section, the speed-setting section, the load-control system (except where engine oil is supplied to the control system), and all other auxiliary features or devices.

A spring-loaded accumulator and relief-valve system maintains governor oil-operating pressure. When operating pressure is reached, the spring pressure is overcome and the oil is released to sump. Direction of rotation of the pump is fixed ccw.

The governor drive rotates the oil pump and pilot valve bushing. The flyweight-head assembly is driven by the rotating pilot-valve bushing. A thrust bearing rides on top of the flyweight-head toes permitting the rotational motion between the downward force of the speeder spring and the upward force of the flyweights.

The relative motion between the bushing and plunger minimizes static friction. A “spring driven” ballhead assembly is used to lessen vibration from the engine. These vibrations may originate from a source other than the drive itself, but reach the governor through the drive connection. Unless minimized or eliminated, these vibrations are sensed as speed changes and the governor will continually adjust the fuel rack in an attempt to maintain a constant speed.

The greater of two opposing forces moves the pilot-valve plunger up or down. Flyweight force tends to lift the plunger while speeder-spring force tends to lower the plunger. When the engine is on-speed at any speed setting, these forces are balanced and the flyweights assume a vertical position. In this position, the control land on the pilot-valve plunger is centered over the regulating port(s) in the rotating bushing. A change in either of these two forces will move the plunger from its centered position. The plunger will be lowered (1) when the governor speed setting is unchanged but an additional load slows the engine and governor (thereby decreasing flyweight force), or (2) when engine speed is unchanged but speeder spring force is increased to raise the governor speed setting. Similarly, the pilot-valve plunger will be raised (1) when the governor speed setting is unchanged but load is removed from the engine causing change in engine and governor speed (and hence, an increase in flyweight force), or (2) where engine speed is unchanged but speeder-spring force is reduced to lower the governor speed setting. When the plunger is lowered (an underspeed condition), pressure oil is directed into the buffer compensation system and power cylinder to raise the power piston and increase fuel. When lifted (an overspeed condition), oil is permitted to drain from these areas to sump and the power piston moves downward to decrease fuel.

The buffer piston, springs, and needle valve in the hydraulic circuits between the pilot-valve plunger and power cylinder make up the buffer-compensation system. This system functions to stabilize the governing action by minimizing overshoot or undershoot following a change in governor speed setting or a change in load on the engine. It establishes a temporary negative-feedback signal (temporary droop) in the form of a pressure differential which is applied across the compensation land of the pilot-valve plunger. The flow of oil into or out of the buffer system displaces the buffer piston in the direction of flow. This movement increases the loading on one spring while decreasing the load on the other and creates a slight difference in the pressures on either side of the piston with the higher pressure on the side opposite the spring being compressed. These pressures are transmitted to opposite sides of the plunger-compensation land and produce a net force, upward or downward, which assists in re-centering the plunger whenever a fuel correction is made.

Speed Setting or Load Increase

Increasing the speed setting or increasing load on the engine at a given speed setting have an identical effect. In either case, the flyweights move inward (underspeed) due to the increase in speeder-spring force or, to the decrease in centrifugal force caused by the decrease in engine speed as load is added. The movement of the flyweights is translated into a downward movement of the pilot-valve plunger. This directs pressure oil into the buffer system, causing the buffer piston to move to the right in the increase-fuel direction. The oil pressures on either side of the buffer piston are simultaneously transmitted to the plunger-compensation land with the higher pressure on the lower side. The net upward force thus produced is added to flyweight force and assists in restoring the balance of forces and re-centering the pilot valve plunger. In effect, this enables the governor to cut off the additional fuel needed for acceleration by stopping the power piston when it has reached a point corresponding to that amount of fuel required for steady-state operation at the new higher speed or load. As the engine continues to accelerate toward the set speed, the compensation force is gradually dissipated to offset the continuing increase in flyweight force. This is done by equalizing the pressures on each side of the compensation land through the needle valve at a rate proportional to the continued rate of acceleration. If the rate of dissipation is the same as the rate of increase in flyweight force, the pressure differential is reduced to zero at the instant flyweight force becomes exactly equal to speeder-spring force. This minimizes speed overshoot and permits the governor to quickly re-establish stable operation. The needle-valve setting determines the rate at which the differential pressure is dissipated and allows the governor to be “matched” to the characteristics of the engine. The compressed buffer spring returns the buffer piston to its centered position as the pressure differential is dissipated.

Whenever large changes in speed setting or load are made, the buffer piston will move far enough to uncover a bypass port in the buffer cylinder. This limits the pressure differential across the buffer piston and permits oil to flow directly to the power cylinder. Thus, the power piston is made to respond quickly to large changes in speed setting or load.

Speed Setting or Load Decrease

Decreasing the speed setting or decreasing load on the engine at a given speed setting also are identical in effect, and cause a reverse action to that described above. The flyweights move outward (overspeed), lifting the pilot-valve plunger and allowing oil to drain from the buffer-compensation system. The buffer piston moves away from the power cylinder, permitting oil to drain from the area under the power piston which then moves downward in the decrease-fuel direction. The differential pressures acting across the compensation land produce a net downward force tending to assist the speeder spring in re-centering the pilot-valve plunger slightly before the engine has fully decelerated. This stops power-piston movement when it has reached a point corresponding to that amount of fuel required for steady-state operation at the new lower speed or load. Dissipation of the compensation force occurs in the same manner as previously described and, in this instance, minimizes speed undershoot.

Compensation Cutoff

With large decreases in speed or load, the power piston will move to the “no fuel” position and block the compensation oil passage between the power cylinder and needle valve to prevent normal equalization of the compensation pressures. This holds the buffer piston off center and increases the level of the pressure transmitted to the upper side of the plunger-compensation land. The increased pressure differential, added to the effect of the speeder spring, temporarily increases the governor speed setting. The governor begins corrective action as soon as engine speed drops below the temporary speed setting and starts the power piston upward to restore the fuel supply in sufficient time to prevent a large underspeed transient. The above action is sometimes referred to as “compensation cutoff.” When the upward movement of the power piston again uncovers the compensation oil passage, normal compensating action will resume and stabilize engine speed at the actual speed setting of the governor.

IMPORTANT

Due to the location of the compensation cutoff port in the power cylinder wall, the governor/fuel rack linkage must be adjusted so that the power piston “gap” does not exceed 1.03 inches (26.2 mm) at idle speed no load.

Speed Setting Section

(Figure 3-1)

This section consists of a speed-setting cylinder, a speed-setting pilot-valve plunger housed within a rotating bushing, four speed-setting solenoids, a triangular plate, and a restoring-linkage mechanism.

General

The speed-setting section provides a method of changing the compression (force) of the speeder spring which opposes flyweight centrifugal force. It does this by controlling the position of the speed-setting piston in the speed-setting cylinder. When control oil is admitted to the cylinder, the piston moves downward, compressing the speeder spring and raising the speed setting. When oil is allowed to drain from the cylinder, the piston spring forces the piston upward, reducing speeder-spring force and lowering the speed setting. The flow of oil into or out of the speed-setting cylinder is regulated by the speed-setting pilot-valve plunger in the rotating bushing. The plunger is controlled by the solenoids which provide incremental control of speed in equally spaced steps. An integral gear on the governor flyweight head drives the bushing through a splined mating gear on the lower end of the bushing.

The rate of movement of the speed-setting piston over its full downward stroke (idle to maximum speed) is usually retarded to occur over some specific time interval to minimize exhaust smoke during accelerations. This is done by admitting governor pressure oil into the rotating bushing through an orifice which registers with the main supply port once in every revolution of the bushing. This retards the rate at which oil is supplied to the control port in the bushing and thus, the rate of oil flow to the speed-setting cylinder. The diameter of the orifice determines the specific time interval which may be anywhere within a nominal range of 1 to 50 seconds. Typical engine acceleration periods for switching and suburban service is approximately 5 seconds; for freight or passenger service, about 15 seconds; for turbo-supercharged engines the timing may be as much as 50 seconds to permit the supercharger to accelerate with the engine.

On turbo-supercharged units, the rate of movement of the speed-setting piston over its full upward stroke (maximum to idle speed) also is retarded to prevent compressor surge during decelerations. This timing may be anywhere within a nominal range of 1 to 15 seconds. In this case, a vertical slot in the drain land of the pilot-valve plunger registers with a second orifice in the rotating bushing once each revolution. This retards the rate at which the oil is allowed to drain from the speed-setting cylinder.

Speed Setting

Three of the four speed setting solenoids, A, B, and C, actuate the speed setting pilot valve plunger by controlling the movement of the triangular plate which rests on top of the floating lever attached to the plunger.

The fourth solenoid, D, controls the position of the rotating bushing with respect to the plunger. Energizing the A, B, and C solenoids, singly or in various combinations, depresses the triangular plate a predetermined distance for each combination. The downward movement of the plate is transmitted through the floating lever to un-center the plunger. This directs intermittent oil pressure to the speed-setting cylinder, forcing the speed-setting piston downward to increase the governor speed setting. Energizing the D solenoid pushes the rotating bushing downward and opens the control port to drain oil from the speed-setting cylinder and thus decrease the speed-setting. An identifying letter will be found on the solenoid bracket adjacent to each solenoid.

Figure 3-2 is an additional aid in understanding the various governor components. The oil passages are simplified and coded for ease in following the oil flow through the system. The lower half of the governor functions to maintain constant engine speed by controlling fuel flow to the engine cylinders. The upper half of the governor consists of the column and cover and internal related parts for changing governor speed setting, the control valve for the load regulator, and shutdown and protective devices.

Advancing or retarding the throttle control from one step to the next energizes or de-energizes the solenoids in various combinations to increase or decrease engine speeds in approximately equal increments. A common solenoid energizing sequence in relation to engine speed is given in Table 3-1. In the arrangement shown, all solenoids are de-energized at IDLE and first position (or notch). Energizing A increases speed by one increment; B adds four increments, C adds two increments, and D reduces speed two increments when used in combination with A, B, And C. When the throttle is moved to the STOP position, solenoid D only is energized.

Whenever a change in speed setting is made, the movement of the speed-setting piston, downward or upward, is transmitted or fed back through the restoring linkage and floating lever to re-center the pilot-valve plunger. This stops the flow of oil into or out of the speed-setting cylinder at a position corresponding to that speed setting.

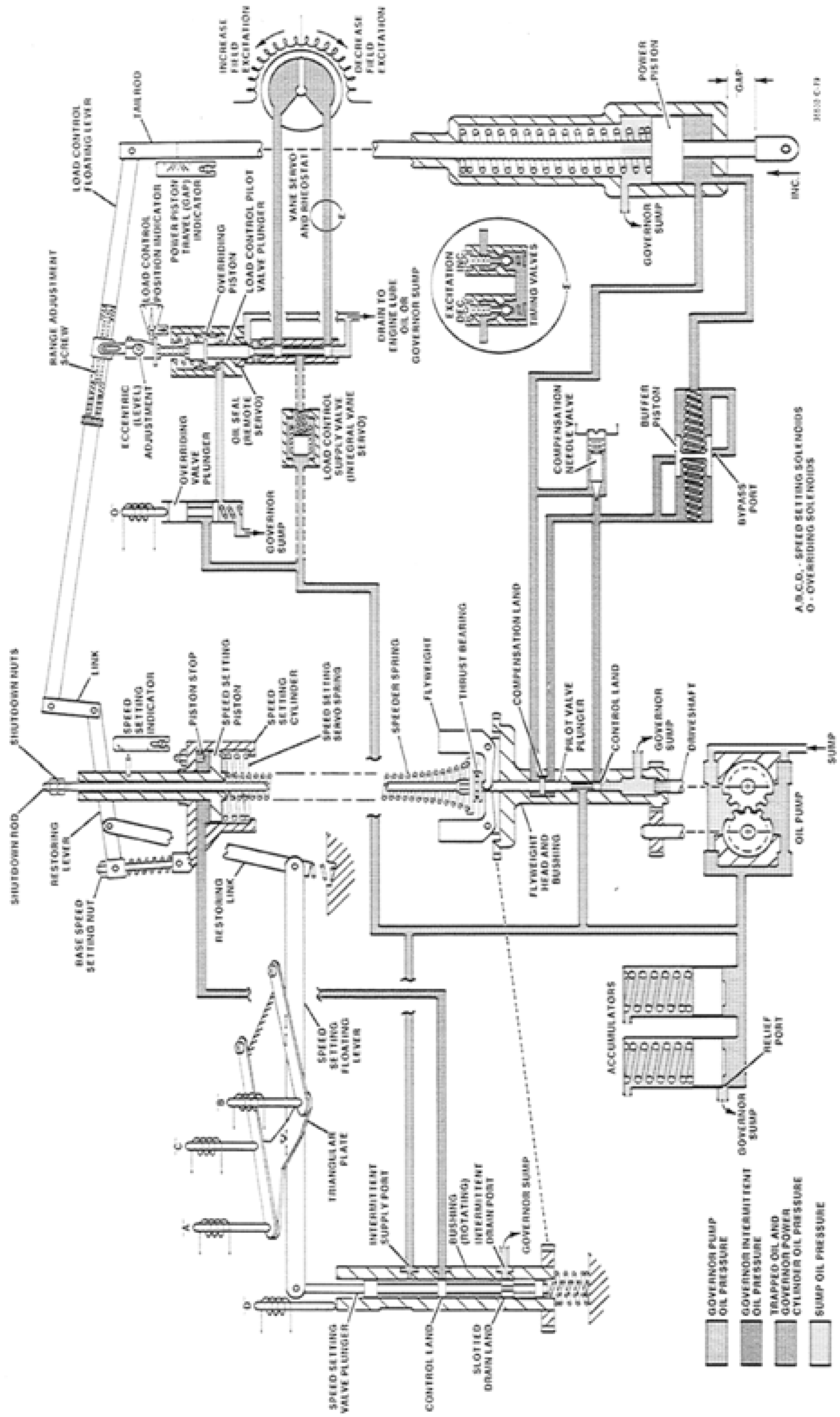

Figure 3-1. Schematic Diagram of Typical PGE Governor

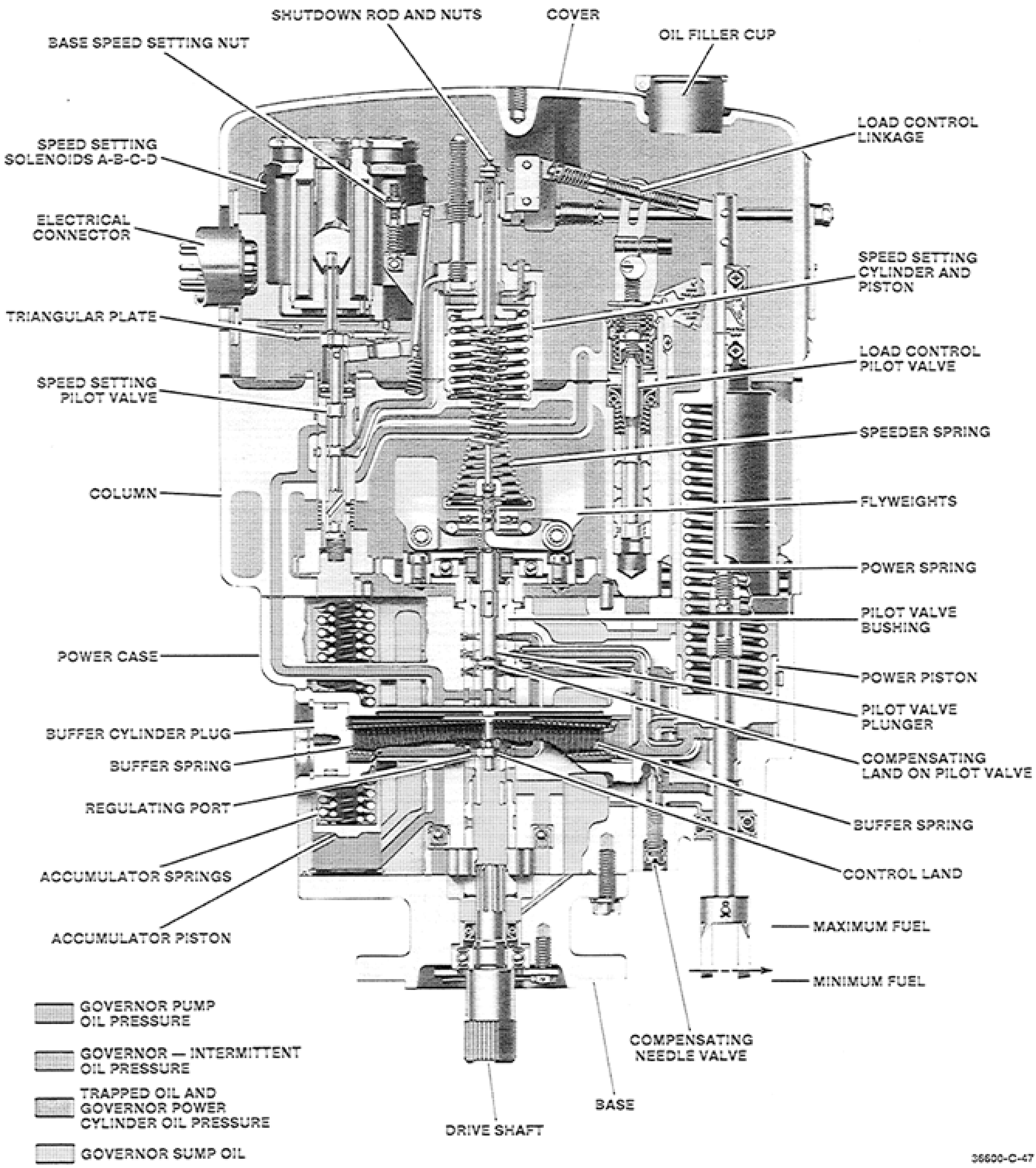

Figure 3-2. Sectional Diagram PGE Governor

THROTTLE POSITION	SOLENOIDS ENERGIZED				SPEED (RPM)			
	A	B	C	D	GOVERNOR	ENGINE	GOVERNOR	ENGINE
STOP				*	0	0	0	0
IDLE					361	400	430	400
1					361	400	430	400
2	*				452	500	522	486
3			*		542	600	613	571
4	*		*		633	700	706	657
5		*	*	*	723	800	798	743
6	*	*	*	*	813	900	890	829
7		*	*		904	1000	982	914
8	*	*	*		994	1100	1074	1000
GOVERNOR PART NUMBER					8570-687		8573-463	
					8573-494		8559-910	

Table 3-1. Typical Engine Speed Chart

Adjust the speed-setting solenoids in the order shown in Table 3-2.

Alco Engines		
Order of Adjustment	Throttle Position	Item or Solenoid
1	6	Base speed setting nut
2	8	D
3	7	A
4	4	B
5	Idle and 1	C

Table 3-2. Solenoid Adjustment

Speed Setting Increase

When one or more of the solenoids is energized (or de-energized) by moving the throttle to a higher step, the solenoid plungers move downward and depress the triangular plate and in turn the floating lever. Since the right end of the lever is attached to the lower end of the restoring link, the left end of the lever is forced downward to un-center (lower) the pilot-valve plunger. This directs intermittent pressure oil to the speed-setting cylinder which forces the piston downward to further compress the speeder spring and thereby increase the speed setting.

The downward movement of the piston is transmitted through the restoring linkage to the right end of the floating lever and causes it to move downward a proportional amount. This allows the loading spring under the pilot-valve plunger to raise the plunger, with the floating lever pivoting about the triangular plate. This action will continue until the plunger is again re-centered, stopping the flow of oil to the speed-setting cylinder at the instant the piston reaches the new lower position corresponding to the increased speed setting.

Speed Setting Decrease
Moving the throttle to a lower step de-energizes (or energizes) one or more of the solenoids and causes a reverse action to that of speed-setting increase. The triangular plate moves upward, being held in contact with the solenoid plungers by a loading spring. This allows the loading spring under the pilot-valve plunger to un-center (raise) the plunger which allows oil to drain from the speed-setting cylinder. The upward movement of the speed-setting piston is transmitted through the restoring linkage to re-center the plunger.

Normal Shutdown (See Figure 3-1)
Under normal operating conditions, the engine is shut down by moving the throttle to the STOP position. This energizes the D solenoid pushing the rotating bushing down and opening the control port to drain the oil from the speed-setting cylinder. The speed-setting piston then moves up lifting the shutdown nuts and shutdown rod in the process. This lifts the governor pilot-valve plunger, draining oil from the buffer-compensation system and allowing the power piston to move down to the shutdown (no fuel) position. The upward movement of the speed-setting piston is limited by the stop screw.

The speed-setting piston-stop screw (Figure 3-1) limits piston rod travel. Restarting the engine is easier because less oil volume is required to move the speed-setting piston down.

Load Control Section

(Figure 3-1)

In most governor applications, the primary function of the governor is to automatically maintain a specific engine speed under varying load conditions by controlling the fuel flow to the engine. With the locomotive governor, a secondary function is included to maintain a constant engine power output at each specific speed setting. Thus, for throttle setting, there is both a constant engine speed and a predetermined, fixed rate of fuel flow required. To satisfy both conditions, the load on the engine must be adjusted as the locomotive operating conditions (speed and locomotive auxiliaries) vary and it is the function of the load-control mechanism in the governor to do this.

IMPORTANT	**It should be understood that maintaining a constant engine speed does not mean that locomotive road speed also will be constant.**

Control of engine load is achieved by regulating engine speed and fuel setting. This is done by adjusting the generator field excitation current through the use of a vane servo controlled variable resistance in the generator-field circuit. The vane servo is controlled by the load-control pilot valve and related linkage in the governor. The load-control linkage is so arranged that for each speed setting there is only one fuel setting (engine power output) at which the load-control pilot-valve plunger will be centered.

An increase or decrease in either governor speed setting or engine load will change fuel flow. The power piston moving in either the increase-or decrease-fuel direction will (through the floating lever linkage) move the load-control pilot-valve up or down, respectively. The vane servo decreases or increases field excitation and in turn engine load.

The vane servo is a rotary type, is integral with the governor, and uses governor oil for its operation. It consists of a commutator about which a set of moveable brushes rotate to change the value of the resistance in the generator field excitation circuit. The brushes are driven by the servomotor which, in turn, is controlled by the load-control pilot valve.

The load-control pilot-valve plunger is suspended from the load-control floating lever. The lever is connected to the power-piston tailrod at one end and to the speed-setting-piston rod at the other end. Any movement of either or both pistons causes a corresponding movement of the plunger which is housed within a non-rotating bushing. Pressure oil is supplied to the plunger internally from the governor oil pump. Two lands on the plunger control the flow of oil to or from the vane servo. Governor oil is used for operation of the vane servo, and a supply (cutoff) valve is provided in the oil supply passage to the load-control valve. The supply valve is closed during starting so that all available oil from the governor oil pump is delivered to the speed-setting and power pistons to quickly open the fuel racks and thus minimize cranking time. After the engine starts, the increase in governor oil pressure opens the supply valve and restores normal load-control system operation. This valve also serves a secondary function, reducing the oil pressure in the load-control system to control the vane-servo-response rate (timing).

Operation with Load Increase

Assuming that the train is in motion and that the electrical load is balanced with the desired engine fuel (power output) at the existing governor-speed setting, the load-control system will be stationary with the pilot-valve plunger centered. When a compressor turns on (or any situation increasing load) electrical load on the generator is increased and transmitted to the engine. Engine speed decreases and the governor increases fuel flow to bring the engine back to the preset speed while still carrying the added load.

The power piston moves upward simultaneously raising the right end of the load-control floating lever, which, in turn, lifts the pilot-valve plunger above center. This directs pressure oil through the upper control port in the bushing to the decrease excitation side of the vane servo while opening the lower port in the bushing to drain. With a reduction in load, the engine will overspeed and the governor will then act to reduce fuel. The reduction in field-excitation current and engine fuel will continue until the power piston and floating lever have returned to their original position. This re-centers the pilot-valve plunger and stops the servomotor. Consequently, the electrical load is reduced sufficiently to again balance the required engine power output (fuel flow). At this point, the engine will have also returned to an on-speed condition.

Operation with Load Decrease

Under the same conditions as stated above, a decrease in electrical load will reduce engine load and cause the engine to decrease fuel and, in the process, lower the right end of the floating lever. This moves the pilot-valve plunger below center and directs pressure oil through the lower control port in the bushing to the increase excitation side of the vane servo. With an increase in load, the engine will underspeed and the governor will act to increase fuel. This increase in field excitation current and engine fuel will continue until the power piston and floating lever have returned to their original positions. This re-centers the pilot-valve plunger and stops the servomotor. Consequently the electrical load is increased sufficiently to again balance engine power output with the engine on-speed.

Operation with Speed Setting Increase

Advancing the throttle to a higher step causes the speed setting piston to move downward. This lowers the left end of the load-control floating lever which displaces the load-control pilot-valve plunger below center. Pressure oil is directed to the increase excitation side of the vane servo. The governor acts to increase fuel to compensate for both the increase in speed setting and the simultaneous increase in electrical load. As the power piston moves upward, it raises the right end of the floating lever to return the pilot-valve plunger to its centered position. This stops the servomotor as the power piston reaches its new higher position corresponding to the increased speed setting. At this point, the electrical load has been sufficiently increased to balance the increase in engine power output.

Operation with Speed Setting Decrease

Moving the throttle to a lower speed setting causes the speed-setting piston to move upward. This raises the left end of the load-control floating lever and lifts the pilot-valve plunger above center. Pressure oil is directed to the decrease excitation side of the vane servo. The governor acts to decrease fuel to compensate both for the decrease in speed setting and the simultaneous decrease in electrical load. As the power piston moves downward, it lowers the right end of the floating lever to return the pilot-valve plunger to its centered position. This stops the servomotor as the power piston reaches its new lower position corresponding to the decreased speed setting. At this point, the electrical load has been sufficiently decreased to balance the decrease in engine power output.

Load Control Balancing

The rate of vane servo movement (timing) must be controlled to effect a controlled rate of load application and to provide stability of the overall system. Several methods are commonly used to provide a balanced action and are identical in that they restrict the flow of oil to and from the vane servo and thus determine its rate of movement.

The timing-valve assembly consists of two adjustable ball check valves in series. (See Figure E, 3-1). The ball valves are individually housed and internally installed in the top of the governor column. The valves are individually adjustable to provide the desired maximum rate of movement over the full travel of the servomotor in either the increase-or decrease-excitation direction.

Minimum or Maximum Field Start Adjustment

The load control system in the governor may be set up for either “Minimum” or “Maximum” field start.

MINIMUM FIELD START builds up engine load slowly, providing a smooth take-up of slack in the train. The load-control pilot valve is mechanically set above center with the throttle in IDLE position. Field excitation is retarded due to the retarded position of the pilot-valve plunger. The vane servo rheostat remains in the minimum-excitation position until the throttle is moved in the increase-speed direction. This lowers the load-control pilot valve to the re-center position and beyond to increase excitation.

MAXIMUM FIELD START enables the engine load to build up immediately, for rapid acceleration. The load-control pilot valve is mechanically set below center with the throttle in IDLE position. Field excitation is advanced due to the advanced position of the pilot-valve plunger. The vane-servo rheostat remains in the maximum-excitation position until the throttle is moved in the increase-speed direction to raise the load-control pilot valve.

Load Control Override

Under certain conditions of locomotive operation (transition, maximum field start and wheel slip), it is sometimes desirable or necessary to override the normal action of the governor load-control mechanism to cause a reduction in generator-excitation current when it would normally respond by increasing excitation current.

The load-control-override mechanism in the governor consists of an overriding solenoid (ORS), a two-position overriding control valve, and an overriding piston within a cylinder which surrounds the upper end of the load-control pilot-valve plunger. See Figure 3-1. Energizing the ORS pushes the overriding valve plunger down, closing the drain to sump and allowing pressure oil to flow into the overriding cylinder. The overriding piston moves upward, contacting the spring collar on the stem of the pilot-valve plunger and lifting the plunger above its centered position. The slot in the link connecting the pilot-valve plunger to the floating lever permits the plunger to rise independently of the lever. This directs pressure oil to the decrease-excitation side of the vane servo, thus reducing generator output. When the ORS is de-energized, the overriding valve plunger moves upward, closing the pressure port and allowing the oil to drain from the overriding cylinder. This restores normal load-control system operation.

TRANSITION is a condition where the electrical circuits between the generator and traction motors are automatically changed, as road speed changes, to provide more efficient transmission of electrical power. Overriding is used in this circumstance to protect the switchgear from arcing which would occur during transition if high current existed in the traction motor circuits.

WHEEL SLIP is when rail and load conditions cause drive wheel slip, an immediate decrease in load occurs at the traction motors and generator. The resulting increase in engine speed would normally cause the load-control system to respond by increasing generator output at a time when there is no demand. Overriding is used in this circumstance in conjunction with wheel slip relays, if the locomotive is so equipped, to cause a reduction in generator output until wheel slippage ceases.

Operation of the ORS is done through automatic switching devices.

Integral Vane Servo Assembly

IMPORTANT — **Contact Woodward for details and actual limits.**

The integral vane servo is used with low-wattage pilot or amplifier-type excitation systems. It functions in conjunction with the load-control mechanism in the governor to automatically regulate generator output and thereby maintain a constant engine power output at each throttle setting. The vane servo consists of a vane-type rotary servo-motor, a rotating contact-brush assembly, and a stationary commutator connected to a resistor pack (Figure 3-3). Drain oil from the vane servo is circulated through the cover of the unit to provide necessary cooling for the resistor pack. The commutator and resistor pack are electrically insulated from the unit. The vane-servo-output shaft has external serrations with one missing tooth which keys with a locating pin in the brush drive shaft to fix the positional relationship between the vane, contact brushes, and commutator. The previously discussed load-control-supply (cutoff) valve and the two timing (balancing) valves (if used) are considered a part of the vane servo.

The component parts of the cutoff valve are located in the side of the governor column under the side plate.

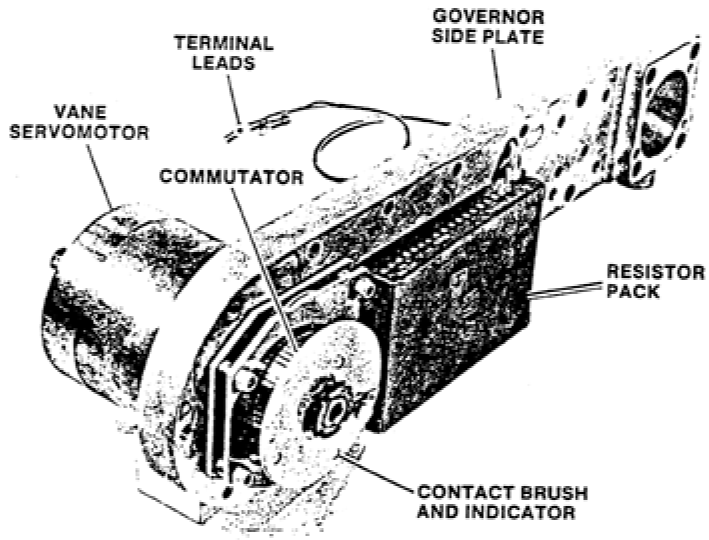

Figure 3-3. Integral Vane Servo and Resistor Assembly (cover removed)

Whenever the load-control pilot valve in the governor column is un-centered, pressure oil is directed to one or the other side of the vane servo while the opposite side is opened to drain. This causes the vane to rotate which, in turn, rotates the contact-brush assembly about the commutator. The position of the brushes on the commutator segments determines the circuit resistance and thereby the generator field-excitation current.

Lube Oil Pressure Shutdown and Alarm
(See Figure 3-4)

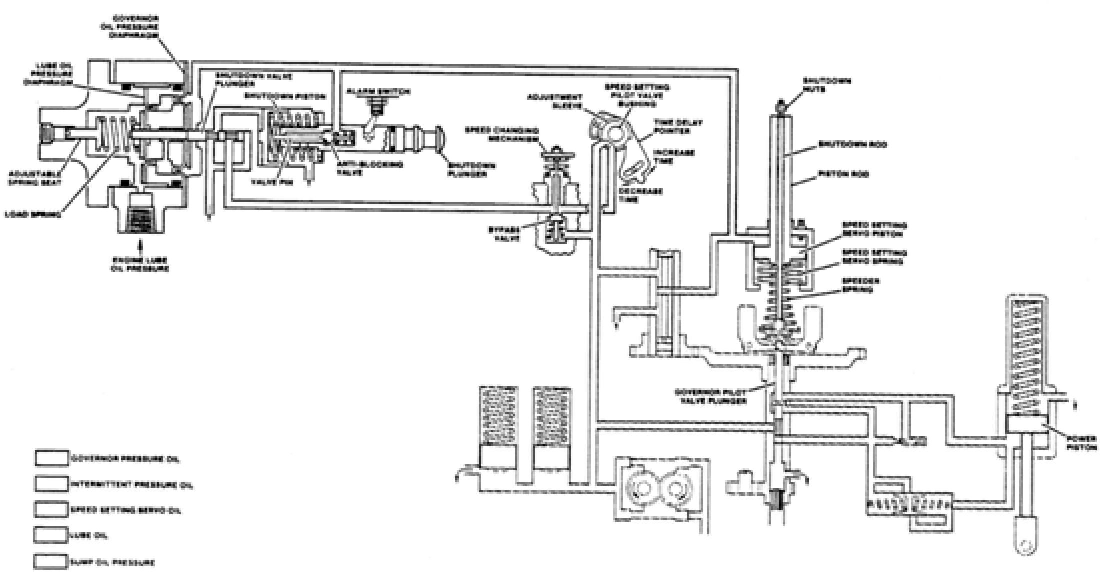

Figure 3-4. Lube Oil Pressure Shutdown and Alarm

Engine oil pressure is directed to the oil pressure diaphragm. The shutdown-valve plunger is connected to the diaphragm which has three forces acting on it; load-spring and engine-oil pressures act to move it to the right, governor speed-setting servo oil acts to move it to the left. Normally, load-spring and engine-oil pressures hold the diaphragm and shutdown-valve plunger to the right, permitting oil to the left of the shutdown piston to drain to sump. When engine lube oil pressure drops below a safe level, speed-setting-servo oil pressure (which is dependent on the speed setting and on the rate of the speed-setting servo spring) overcomes the load spring and engine-oil pressure forces and moves the diaphragm and shutdown-valve plunger to the left. Governor pressure oil is directed around the shutdown-valve plunger to the shutdown piston and moves it to the right. The shutdown piston moves the inner spring and shutdown plunger to the right. The differential piston allows a high engine-lube oil-pressure trip point without a corresponding increase in the speed-setting-servo oil pressure. The engine-lube oil pressure required to initiate shutdown is increased. When the shutdown plunger moves sufficiently, it trips the alarm switch. In addition, oil trapped above the governor speed-setting-servo piston flows around the smaller diameter on the left end of the shutdown plunger and drains to sump. This action allows the speed-setting servo spring to raise the speed setting servo piston. When the piston moves up sufficiently, the piston rod lifts the shutdown nuts and rod. The shutdown rod lifts the governor pilot-valve plunger. When it is lifted above its centered position, oil trapped below the power piston drains to sump and the power piston moves to the fuel off position.

IMPORTANT **The shutdown plunger must be pushed back in to restart the engine.**

Adjustment of the spring seat in the field is not recommended. This adjustment biases the lube oil pressure required for shutdown. Adjust the spring seat on a test stand during testing after an overhaul. No further adjustment should be necessary.

Bypass Valve

Governor pressure oil is supplied to the shutdown piston in one of two ways, depending on the speed setting. At rated speed settings, the bypass valve is moved down off its seat by the speed-changing mechanism. Governor pressure oil passes directly to the shutdown piston and immediately initiates engine shutdown in the event of lube-oil failure.

When starting and at idle speeds, the bypass valve is closed and governor pressure oil travels through an intermittent-flow orifice in the rotating-speed-setting-pilot-valve bushing. With each rotation of the bushing, a slot in the bushing registers with an oil-supply passage in the governor column and a hole in the adjustment sleeve. Thus, intermittent pressure oil is passed to the shutdown-valve plunger. The adjustment sleeve may be turned (by readjusting the time-delay pointer) so the cross-sectional area of the oil passage is increased or decreased. Thus, the volume of oil supplied with each rotation of the bushing is increased or decreased. Turning the pointer cw increases volume and decreases the time required to pass sufficient oil to initiate shutdown.

Fuel Limiter

General

The fuel limiter is an auxiliary system designed primarily for use on Woodward PG load control governors installed on turbo-supercharged locomotive engines. It is used with absolute manifold air pressure as a reference. This governor is equipped with a load-control-overriding solenoid and provisions for fast unloading.

The function of the load control is independent of the fuel limiter. They are related only through a common reference to absolute manifold air pressure. Figure 3-6 illustrates the basic fuel limiter, the load-control override and bias linkages installed on a locomotive governor equipped with load control, an overriding solenoid, and solenoid speed setting.

During acceleration, on turbo-supercharged engines, it is possible to supply more fuel to the engine than can be burned with the available air. This results from the normal lag of supercharger speed, and consequently manifold air pressure decreases with respect to engine speed.

The fuel limiter restricts the movement of the governor power piston toward the increase-fuel direction, limiting engine fuel during acceleration as a function of manifold air pressure (an approximation of the weight of air available at any instant). Fuel limiting improves the fuel-to-air ratio and, during acceleration, allows complete combustion. This improves acceleration and reduces smoke. Fuel limiting also protects the engine if the turbo-supercharger fails or reductions in engine air supply occur.

Figure 3-5 illustrates the unlimited, limited, and steady-state fuel schedules for a typical engine together with a typical acceleration transient from one steady-state condition to another.

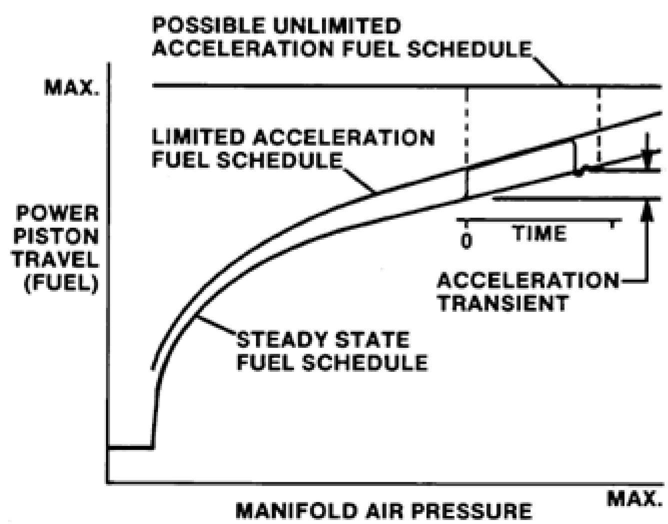

Figure 3-5. Typical Limited Acceleration Fuel Schedule Curve

Description

The fuel limiter (Figure 3-6) is essentially a floating lever, a bellcrank, a pressure sensor and cam, and a hydraulic amplifier together with a feedback lever and a fuel-limit lever. The right end of the floating lever is connected to the tailrod of the governor power piston and pivots about one leg of the bellcrank. The left end of the floating lever rests on the right end of the hydraulic-amplifier-feedback lever. The position of the bellcrank, and therefore the position of the floating-lever pivot point, is determined by the position of the fuel-limit cam. Raising the floating-lever pivot as manifold air pressure increases, allows the governor power piston to move upward a proportionally greater distance before fuel limiting occurs.

The pressure sensor is a force-balance device consisting of an inlet check valve, an orifice-pack restriction, a piston-and-cam assembly, a restoring spring, a bleed valve, and either a gauge pressure or an absolute-pressure bellows arrangement. The sensor establishes a corresponding piston (and cam) position for each different manifold air pressure. The relationship between manifold air pressure and governor power-piston position (fuel flow) where limiting occurs is determined by the profile and angular tilt of the cam. Cam profiles are either linear or non-linear depending on engine and turbo-supercharger characteristics.

The hydraulic amplifier is a pilot-operated, single-acting hydraulic cylinder. The amplifier provides the force necessary to overcome the resistance of the speeder spring, lift the shutdown rod and re-center the governor pilot-valve plunger when the fuel limit is reached for a given manifold air pressure.

Operation

Pressured oil enters the fuel limiter through the inlet check valve. Oil is directed to the upper side of the sensor piston and through the orifice-pack restriction to the under side of the sensor piston. The inlet check valve prevents siphoning of the oil from the limiter housing during shutdown periods and omits the time lag to refill the orifice pack and piston cylinder. This prevents the sensor piston from going to maximum-fuel position during startup. The bleed valve regulates the rate of oil flow from the area under the sensor piston to sump as a function of manifold air pressure. When the bleed valve bypasses a greater flow of oil from this area than is admitted through the orifice pack, the sensor piston moves downward. Conversely, reducing the bypass oil flow to less than that admitted causes the sensor piston to rise. When the inflow and outflow of oil are equal, the piston remains stationary.

The sensing element of the absolute-pressure-type fuel limiter consists of two opposed, flexible, metallic bellows of equal effective area. The upper bellows is evacuated, and the lower bellows senses manifold air pressure. A spacer joins the bellows at the center while the outer end of each bellows is restrained to prevent movement. Manifold air pressure acting internally on the sensing bellows produces a force causing the spacer to move toward the evacuated bellows. The evacuated bellows provides an absolute reference, therefore, the sensing-bellows force is directly proportional to the absolute manifold air pressure. Movement of the bellows spacer is transmitted through an output strap and a bleed-valve pin to the bleed-valve diaphragm.

The sensing element of the gauge-pressure-type fuel limiter consists of a single, flexible, metallic bellows. Movement of the gauge-pressure bellows is transmitted directly to the bleed-valve pin. The bellows force tends to open the bleed valve while the restoring-spring force tends to close the valve.

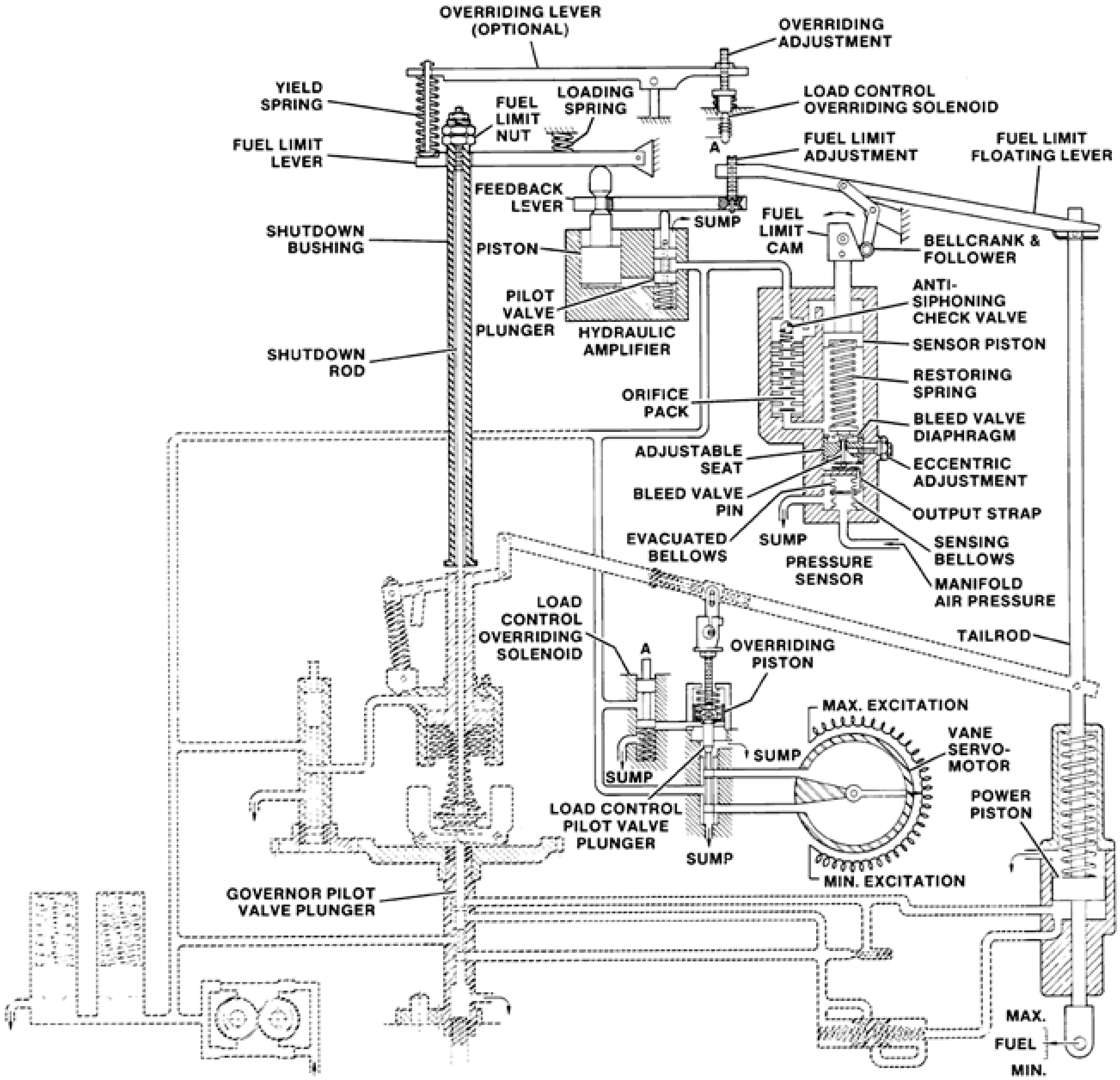

Figure 3-6. Schematic Diagram, Fuel Limiter and Linkage

When these opposing forces balance, the bleed-valve diaphragm floats just off of its seat bypassing oil to sump. This rate of oil flow maintains a constant volume of oil in the area under the sensor piston.

Assume that the governor speed setting is advanced to a higher speed setting and a higher manifold air pressure. The governor power piston moves upward supplying the additional fuel required for engine acceleration. Since manifold air pressure lags engine acceleration, the fuel-limiter cam and bell-crank initially remain stationary until manifold air pressure rises. As the governor power piston moves upward increasing fuel, the fuel-limit floating lever pivots about the upper leg of the bellcrank and depresses the right end of the feedback lever on the hydraulic amplifier. This pushes the amplifier pilot-valve plunger below center, allowing pressured oil to flow into the area under the amplifier piston, causing the piston to rise. As the piston rises, it simultaneously lifts the left ends of both the fuel-limiter lever and the feedback lever. When the fuel limit contacts the fuel-limit nut on the shutdown bushing, it begins lifting the shutdown rod to re-center the governor pilot-valve plunger. The upward movements of the fuel-limit and feedback levers continue until the left end of the feedback lever raises far enough to re-center the amplifier-pilot-valve plunger and stop the flow of oil to the amplifier piston. At this point, the fuel-limit lever re-centers the governor pilot-valve plunger, stopping the upward movement of the governor power piston. This limits the amount of fuel to provide a proper fuel/air ratio for efficient burning. Although the governor flyweights are in an underspeed condition at this time, the power piston remains stationary until manifold air pressure rises.

As engine speed and load increases, manifold air pressure rises after a short time lag. The increase in manifold air pressure produces a proportionate increase in the sensing-bellows force. The bellows force, now greater than the restoring-spring force, causes the bleed-valve diaphragm to move further off its seat. This allows a greater flow of oil to sump than is admitted through the orifice pack. Governor oil pressure acting on the upper side of the sensor piston forces the piston (and cam) downward and, in the process, further compresses the restoring spring. The piston continues its downward movement until the net increase in restoring-spring force equals the net increase in bellows force. This restores the bellows and bleed-valve diaphragm to their original positions. At this point, the outflow of oil is again equal to the inflow, and movement of the piston is halted.

As the sensor piston and cam move downward in response to a rise in manifold air pressure, the bellcrank rotates in a cw direction. This allows the floating-lever pivot point, the left end of the lever, and in turn the hydraulic-amplifier pilot-valve plunger to rise.

The loading spring under the pilot-valve plunger maintains a positive contact between the plunger, levers, bellcrank, and cam. When the pilot-valve plunger rises above center, the oil under the amplifier piston bleeds to sump through a drilled passage in the center of the plunger. The passage in the plunger restricts the rate of oil flow to sump and decreases the rate of movement of the amplifier piston to minimize hunting. As the amplifier piston moves downward, the left end of the fuel-limit lever also moves downward. This lowers the shutdown rod which in turn lowers the governor pilot-valve plunger and increases engine fuel.

The sequence of events described above occurs in a continuous and rapid sequence. Normal governor operation is overridden during an acceleration transient and engine fuel is scheduled as a function of manifold air pressure, regardless of governor speed setting. To prevent interference with normal governing action during steady-state operation, the sensor piston and cam continue their downward movement until sufficiently below the effective limiting point.

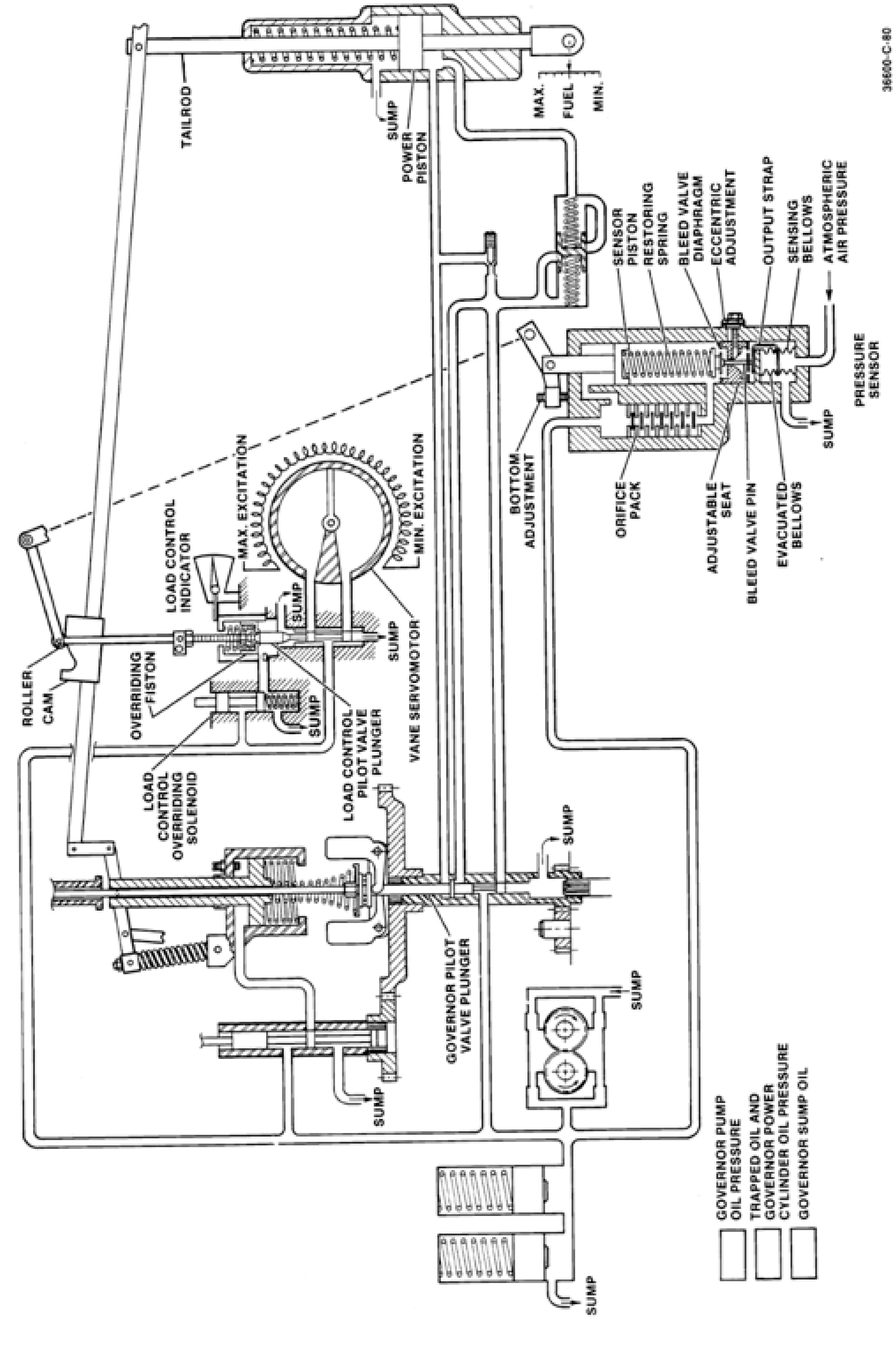

Figure 3 7 Schematic Diagram, Fuel Limiter and Linkage

Conversely, a drop in manifold air pressure rotates the bellcrank in a ccw direction. This lowers the fuel-limit lever, depressing the pilot-valve plunger, and releases pressured oil to the underside of the amplifier piston. The shutdown rod and governor pilot-valve plunger are raised, releasing oil from the power-piston cylinder to sump, and decreasing fuel to the engine. The left end of the fuel-limit floating lever pivots upwards releasing the hydraulic amplifier pilot-valve plunger upward. As the control land of the pilot-valve plunger opens the port from the piston cylinder, oil is bled to sump through a hole in the pilot-valve-plunger shaft. The shutdown rod is lowered, allowing the governor pilot-valve plunger to re-center.

Load Control Override Linkage

The load-control-override linkage (Figure 3-6) consists of an overriding lever which connects the left end of the fuel-limit lever to the load-control-overriding solenoid through a pin-and-yield spring combination. The overriding solenoid adjustment set screw must be adjusted to fully depress the overriding-solenoid plunger completely, at a point just before the fuel-limit lever contacts the fuel-limit nut. Pressured oil is released to the underside of the overriding piston, lifting the load-control pilot-valve plunger in the decrease-load direction. During acceleration transients, when fuel limiting occurs, the integral-vane servomotor begins to unload prior to an acceleration lag, reducing overload and poor acceleration. Depending on engine and turbo-supercharger characteristics, premature unloading can permit the engine to accelerate quickly and raise the manifold air pressure rapidly enough to prevent any fuel limiting to take place.

IMPORTANT — **On this governor application, load on the engine is adjusted through a servo-motor-operated rheostat in the field-excitation circuit of a generator. The servomotor, in turn, is controlled through the governor's load-control system.**

As engine speed nears the new setting, and manifold air pressure rises, a downward movement of the fuel-limit lever permits the overriding-solenoid plunger to rise. Oil is released from under the load-control-overriding piston to sump, lowering the load-control pilot-valve plunger. The load-control pilot-valve plunger moves down, releasing pressured oil to the vane servomotor, and increases excitation. This increases load on the engine in proportion to the increase in engine speed.

Altitude Compensation

Description

Altitude compensation limits fuel similar to manifold air-pressure fuel limiting. Fuel is limited with reference to the atmospheric air pressure instead of manifold air pressure. Figure 3-7 is a schematic diagram of the altitude compensator. The altitude compensator also consists of a force-balance pressure sensor, containing an orifice pack, a piston, a restoring spring, a bleed valve, and a sensing bellows. Linkages connect the altitude compensator to the load-control pilot-valve plunger. The altitude compensator controls the load-control pilot-valve plunger through a cam arrangement.

Operation

Pressured oil enters the altitude compensator and is directed to the upper side of the sensor piston and through the orifice pack to the underside of the sensor piston to sump as a function of atmospheric air pressure. When the bleed valve bypasses a greater flow of oil from under the sensor piston than is admitted through the orifice pack, the sensor piston moves downward. Conversely, reducing the bypass oil flow to less than that admitted causes the sensor piston to rise. When the inflow and outflow of oil are equal, the piston remains stationary.

The sensing element consists of two opposed, flexible, metallic bellows of equal effective area. The upper bellows is evacuated, and the lower bellows senses atmospheric air pressure. A spacer joins the bellows at the center while the outer end of each bellows is restrained to prevent movement.

Atmospheric air pressure acting internally on the sensing bellows produces a force causing the spacer to move toward the evacuated bellows. The evacuated bellows provides an absolute reference, therefore the sensing bellows force is directly proportional to the atmospheric air pressure. Movement of the bellows spacer is transmitted through an output strap and a bleed valve diaphragm.

The engine manufacturer's requirements determine the starting point of the altitude compensator. Normally, 4000 to 5000 feet (1200 to 1500 m) elevation is required this unit affects the load control.

Assume that the locomotive has increased its altitude, and atmospheric pressure is less than the set starting point. This decrease in atmospheric pressure allows the evacuated bellows to expand, closing the bleed valve. The oil pressure on the bottom of the piston increases and forces the sensor piston up. This upward force rotates the linkage and in turn the cam roller moves to the right, taking a higher position on the cam. This raises the load-control pilot-valve plunger, releasing pressured oil to the vane servomotor, and decreasing the excitation to the generator. This decrease in load requires a decrease in fuel, providing a better fuel-to-air ratio for good combustion.

Chapter 4. Troubleshooting

Introduction

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

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

Oil

Fill the governor with oil to the mark on the oil level gauge with the engine idling. Oil must be visible in the glass on the gauge during all other conditions.

Dirty oil causes approximately 50% of all governor troubles. Use clean new or filtered oil. Containers used to fill governors from bulk containers should be perfectly clean. Oil contaminated with water breaks down rapidly, causes foaming and corrodes internal governor parts.

Compensating Needle Valve

The compensating needle valve must be correctly adjusted with the governor controlling the engine or turbine, even though the compensation may have been previously adjusted at the factory or on governor test equipment. Although the governor may appear to be operating satisfactorily because the unit runs at constant speed without load, the governor still may not be correctly adjusted.

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

Definitions

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

Terms used in the chart are defined as follows:

Hunt
A rhythmic variation of speed which can be eliminated by blocking governor operation manually, but which will recur when returned to governor control.

Surge
A rhythmic variation of speed, always of large magnitude, which can be eliminated by blocking governor action manually and which will not recur when returned to governor control, unless speed adjustment is changed or the load changes.

Jiggle
A high-frequency vibration of the governor fuel-rod end (or terminal shaft) and fuel linkage. Do not confuse this with normal controlling action of the governor.

Preliminary Inspection

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

1. Check the load to be sure the speed changes are not the result of malfunctions in the vane servo, generator control circuits, switchgear, etc.

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

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

4. Check setting of governor compensation needle valve.

5. Check speed-setting circuits for voltage level and sequencing.

6. Check for fuel-pressure changes.

7. Check governor oil pressure. A test port is provided in two sides of the governor power case for this purpose.

8. The source of most troubles in any hydraulic governor stems from dirty oil. Grit and other impurities can be introduced into the governor with the oil, or form when the oil begins to break down (oxidize) or become sludgy. The internal moving parts are continually lubricated by the oil within the unit. Valves, pistons, and plungers will stick and even “freeze” in their bores, due to excessive wear caused by grit and impurities in the oil. If this is the case, erratic operation and poor response can be corrected by flushing the unit with fuel oil or kerosene. The use of commercial solvents is not recommended as they may damage seals or gaskets.

   Change the oil and flush the governor twice a year if possible. Remove the cover, open the drain cock and drain out the oil. Flush the governor by filling it with fuel oil, and with the engine running at low speed, cycle the governor. Cycle the governor by opening the needle valve two or three turns. Let the governor hunt for a minute or two and then stop engine and drain the governor. Flush the governor once again. Fill the governor with oil, pouring it over all the internal parts that are visible. Start the engine and reset the compensation needle valve.

9. Check drive to governor for any evidence of misalignment, roughness, excessive backlash, etc.

Table 4-1 Troubleshooting

Trouble	Cause	Correction
1. Engine hunts or surges.	A. Needle valve adjustment incorrect.	Adjust needle valve as described in Chapter 2.
	B. Buffer springs too light. This may occur on a new installation—or an old installation as a result of a radical change in load conditions.	Install heavier buffer springs (consult Woodward).
	C. Lost motion in engine linkage, fuel pumps, or gas valve,	Repair linkage, fuel pumps, or gas valve.
	D. Binding in engine linkage, fuel pumps, or gas valve,	Repair and re-align linkage, fuel pumps or gas valve.
	E. Governor stroke too short. This may occur on a new installation, Should be at least 50 percent of total governor travel between idle and full load.	Redesign or rework the fuel linkage to require more governor stroke. (Consult manufacturer of engine and Woodward).
	F. Low oil level. No harm will be done if top of oil is visible in gauge glass.	Add oil slowly to the correct level in gauge.
	G. Dirty oil or foaming oil in governor.	Drain governor oil, flush governor to clean, and refill with proper clean oil. Bleed air and adjust the needle valve.
	H. Governor worn or not correctly adjusted.	Try spare governor or repair and adjust governor. a. Check flyweight pins and bearings for wear. b. Check flyweight toes for wear and/or flat spots. c. Check flyweight head thrust bearing, also centering bearing. d. Pilot-valve plunger may be sticking, clean and polish if necessary. **NOTICE** **Do not break corners of control land.** e. Check vertical adjustment of pilot valve plunger and correct if necessary. f. Clean and polish all moving parts to ensure smooth and free operation.
	I. Spring too weak in telescopic link.	Install heavier spring so that link stays solid at all times.
2. Fuel pump racks do not open quickly when cranking engine.	A. Low oil pressure in governor	a. Check governor pump gears and gear pockets for excessive wear. No correction except to replace worn parts. b. Flush governor and refill with clean oil to remove dirt in pump check valves. c. Examine pump check valves. If not seating tight, install new ones.
	B. Cranking speed too low.	Install a booster servomotor (consult Woodward Governor Company).
	C. Booster servomotor (if used) not functioning properly.	a. Check action of automatic air starting valve. b. Check air and oil connections.
	D. Solenoid shutdown not wired properly.	Check wiring for the de-energize-to shutdown type. A small voltage must be applied for starting.
	E. Shutdown nuts not adjusted correctly.	Loosen nuts and start engine. Readjust nuts for proper clearance at idle.

Trouble	Cause	Correction
3. Jiggle at governor rod end or terminal shaft.	A. Rough engine drive.	Inspect drive mechanism: a. Check alignment of gears. b. Inspect for rough gear teeth, eccentric gears, or excessive backlash in gear train. c. Check gear keys and nuts or set screws holding drive gears to shafts. d. Tighten chain between crankshaft and camshaft (if used). e. Check engine vibration dampener (if used). f. If governor has serrated drive shaft, check for wear of shaft and serrated coupling.
	B. Failure of flexible drive in fly-weight head.	Remove, disassemble, and clean fly weight head parts. Check spring and install new spring coupling assembly if necessary. Center the coupling for equal travel in opposite directions.
	C. Governor not bolted down evenly on engine mounting pad.	Loosen screws, disconnect fuel linkage and turn governor 45° cw and ccw on its mounting pad a few times. Tighten screws.
4. Engine is slow to recover from a speed deviation resulting from a change in load or slow to respond to a change in speed setting.	A. Incorrect buffer springs in governor.	Install correct buffer springs (consult Woodward).
	B. Governor oil pressure is low.	See item 2A of this table.
	C. Fuel supply restricted.	Clean fuel filters and fuel supply lines.
	D. Engine may be overloaded.	Reduce the load.
	E. Supercharger does not come to new speed quickly to supply sufficient air to burn the added fuel.	No simple field correction. Consult engine manufacturer and Woodward or overhaul the supercharger.
5. Engine does not pick up rated full load.	A. Fuel racks do not open far enough.	a. Check fuel-pump stops and adjust as necessary. b. Check linkage between governor and fuel pumps and adjust if necessary. c. Oil pressure may be too low, see item 2A of this table.
	B. Supercharger does not supply sufficient air.	Overhaul supercharger.
6. Engine overspeeds on starting.	A. Governor too slow.	Adjust needle valve for highest opening. Install lighter buffer springs, if possible.
	B. Speed setting too high.	Decrease starting-speed setting.
	C. Governor admits too much fuel for starting.	a. Limit travel of booster servomotor. b. Readjust speed setting or manifold pressure torque limiter (consult engine manufacturer).
	D. Compensation bypass retarded.	Install short buffer piston.
7. Engine stalls on deceleration to minimum speed.	A. Governor too slow.	Adjust needle valve for maximum opening. Install lighter buffer spring. Try shorter buffer piston.
	B. Minimum speed too low.	Raise minimum speed.
	C. Compensation not being cut off at idle.	Consult Woodward to check how governor is built

Fuel limiter troubles such as erratic operation or slow response to changes in manifold air pressure are usually the result of oil contamination. Correct this type of trouble by flushing the governor with fuel oil or kerosene.

> **NOTICE** **To prevent damage to oil seals or gaskets, do not use non-petroleum-base solvents.**

Trouble	Cause	Correction
8. Hard starting and/or excessive smoke for short duration during starting after a relatively long shutdown period.	The fuel limiters' anti-siphoning check valve leaking—sensor piston goes to maximum-fuel position at start-up and then returns to minimum-fuel position as housing refills with oil.	Replace check valve.
9. Excessive smoke during acceleration.	Fuel-limiter orifice pack clogged - sensor piston goes to and remains at maximum-fuel position.	Drain governor oil, flush with fuel oil or kerosene. Refill with clean oil, operate for a short time, drain, and refill. If necessary, remove fuel limiter orifice pack, disassemble, and clean.
	Fuel limiter not adjusted correctly.	Adjust as instructed in Chapter 6.
	Restoring spring fatigued or broken.	Replace restoring spring.
10. Engine bogs during accelerations.	Load control override linkage improperly adjusted.	Adjust as instructed in Chapter 6.
11. Erratic operation.	Contaminated or foamy oil. Sludge formation.	Drain governor oil, flush with fuel oil or kerosene. Refill with clean oil, operate for a short time, drain, and refill. If necessary, remove fuel limiter, disassemble, and clean.
	Low governor oil level-air entrainment.	Add oil to correct level as indicated on sight gauge glass. Check for leakage, particularly at governor drive-shaft oil seal. Check manifold air-pressure line for presence of oil which would indicate leakage at fuel-limiter bellows.
	Leakage in manifold air pressure lines or fittings.	Repair leaks.
	Fuel-limiter bellows leaking.	Replace bellows.
12. Dead band at low or high end of fuel-limiting schedule.	Fuel-limiter-sensor piston travel not properly calibrated with manifold air-pressure range.	Adjust as instructed in Chapter 6.

Chapter 5. Maintenance

Introduction

This chapter provides information about disassembly, cleaning, and assembly.

Disassembly

Place the governor on some type of stand to protect the driveshaft and hold the governor in position to be worked on.

1. Remove cover (2 screws)

2. Remove overriding solenoid (ORS) bracket Figure 5-1).

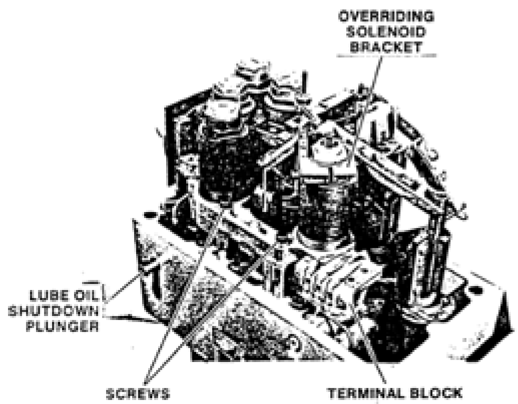

Figure 5-1. PGEV with Fuel Limiter

3. Remove solenoid pack (Figure 5-2).
   a. Disconnect wires from terminal block.
   b. Remove three screws that secure the solenoid pack to the column.
   c. Lift off solenoid pack.
   d. Pull out lube oil shutdown plunger.

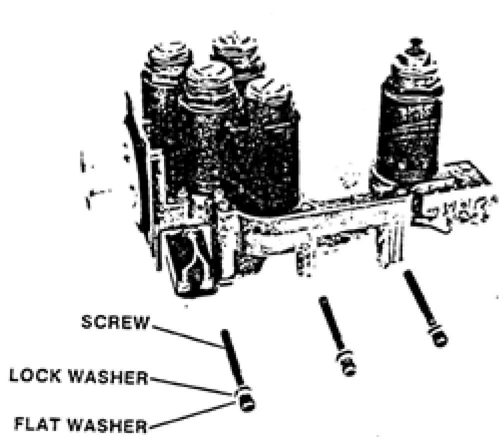

Figure 5-2. Solenoid Pack

4. Remove fuel limiter (Figure 5-3).
   a. Remove shutdown nut, limiter nuts and bushing.
   b. Remove loading spring.
   c. Remove 2 screws.
   d. Disconnect load-control floating lever from tailrod.
   e. Disconnect load-control floating lever from load-control link.

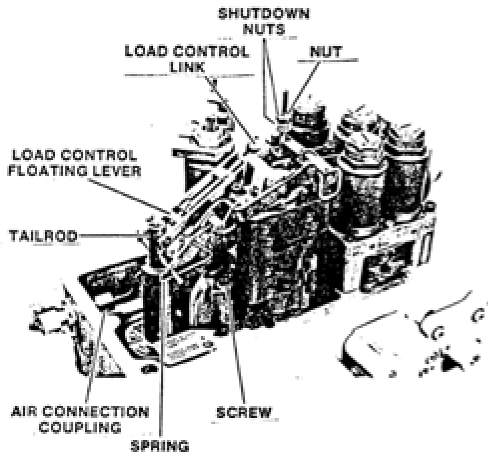

Figure 5-3. Fuel Limiter Installed

   f. Disconnect air connection coupling.
   g. Lift off the fuel-limiter assembly (Figure 5-4).

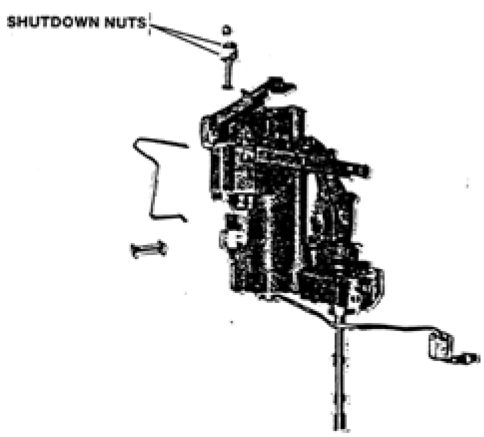

Figure 5-4. Fuel Limiter Assembly

   h. Lift out the ORS spring and piston (Figure 5-5).

Figure 5-5. ORS Spring and Piston

j. Lift out the load-control bushing, spring, and gasket (Figure 5-6).

Figure 5-6. Load Control Bushing, Spring, and Gasket

5. Remove triangular plate and speed-setting cylinder (Figure 5-7).
   a. Remove 2 screws.
   b. Remove pin that connects restoring link to restoring lever.

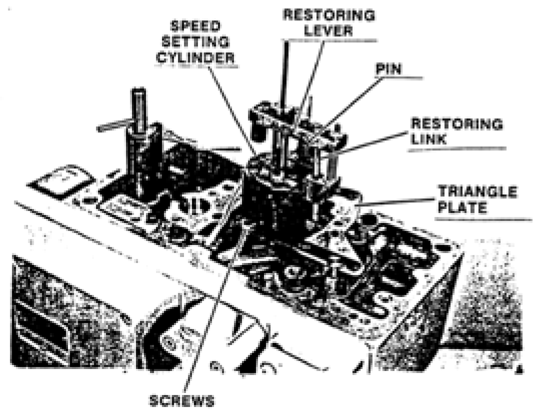

Figure 5-7. Triangular Plate and Speed Setting Cylinder Installed on Column

c. Lift off speed-setting (Figure 5-8).

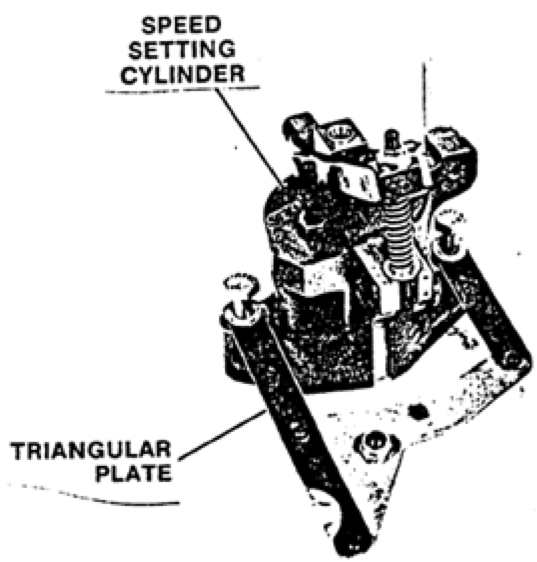

Figure 5-8. Speed Setting Cylinder and Triangular Plate

6. Remove 2 screws and lift off time-delay mechanism (Figures 5-9 and 5-10).

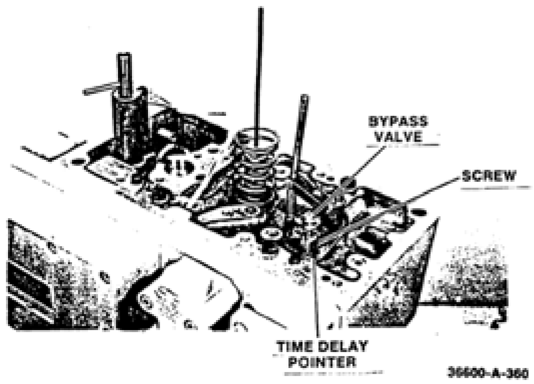

Figure 5-9. Time Delay Mechanism Installed

7. Lift out speed-setting plunger, bushing, floating lever and load spring (Figure 5-10).

8. Remove the bypass valve (Figures 5-9 and 5-11).

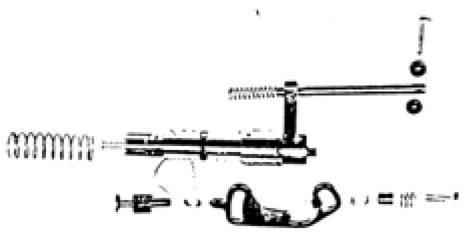

Figure 5-10. Time Delay Mechanism and Speed Setting Pilot Valve Assembly

Figure 5-11. Bypass Valve

9. Remove vane-servo cover, 12 screws (Figure 5-12).

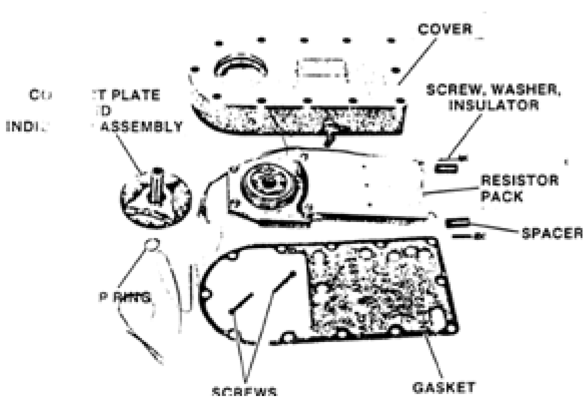

Figure 5-12. Vane Servo

10. Remove vane-servo plate (Figure 5-13).

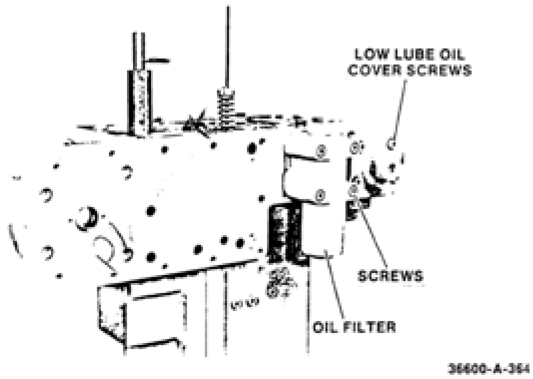

Figure 5-13. Vane Servo and Oil Filter

11. Remove snap ring and lift out contact plate and indicator assembly (Figure 5-12).

12. Remove 2 screws under contact plate and 2 screws and spacers from end of resistor pack and remove resistor pack (Figure 5-12).

13. Remove 4 screws and oil filter (Figure 5-13).

14. Remove low-lube oil cover, spring, gasket, and bellofram (Figures 5-13 and 5-14).

IMPORTANT — **If cover will not come off, remove adjustment screw from center of cover.**

NOTICE — **Be careful of bellofram when removing it.**

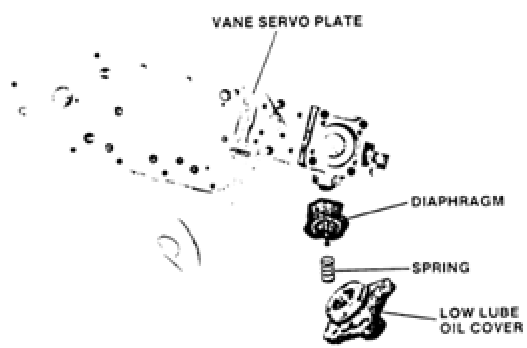

Figure 5-14. Low Lube Oil Cover 366O0.A365~

15. Remove vane servo plate and gasket, along with pressure-reducing valve sleeve, plunger, and spring from the column (Figure 5-15).

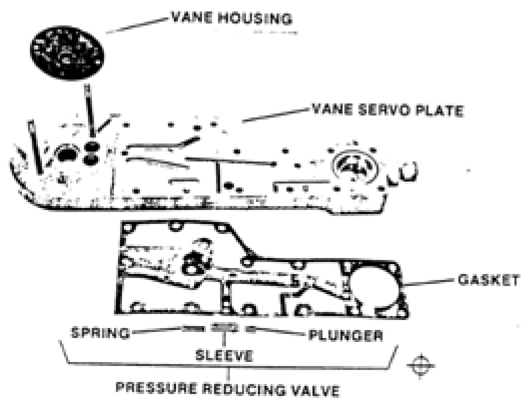

Figure 5-15. Vane Servo Plate

16. Remove low-lube-oil valve bushing, piston, spring, and gasket (Figure 5-16).

17. Remove screw and plates and lift out two timing valves.

18. Remove 4 screws and separate column from power case (Figure 5-16).

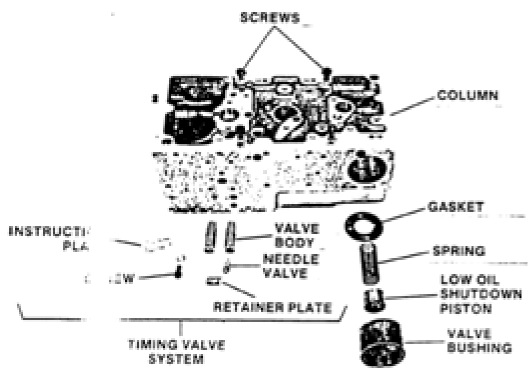

Figure 5-16. Low-Lube-Oil System and Timing Valve System

19. Lift ballhead assembly out of power case (Figure 5-17).

20. Remove Spring, spring seat, and seal (Figure 5-17).

21. Remove 4 screws and separate power servo from power case.

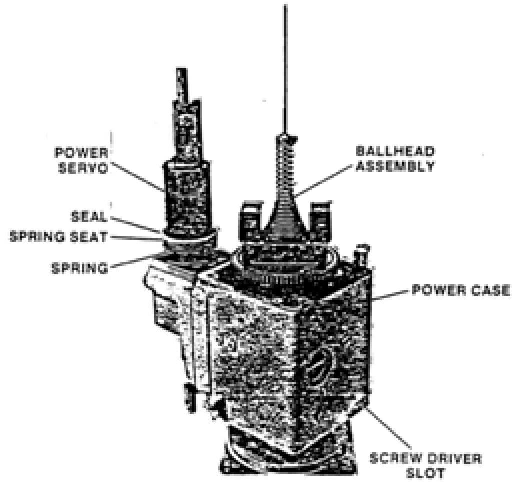

Figure 5-17. Power Case and Power Servo

22. Remove spring seat and spring from power servo side of the power case (Figure 5-18).

23. Remove snap ring, plug, O-ring, spring, and buffer piston (Figure 5-18).

24. Turn power case upside down, remove 8 screws and lift off base (Figure 5-17).

IMPORTANT	If base does not separate easily from power case, use a screw driver in slots to pry apart.

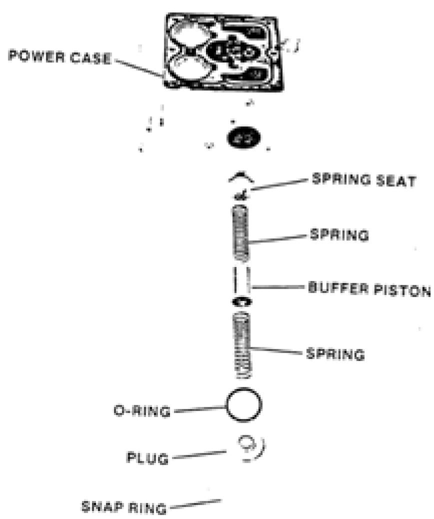

Figure 5-18. Compensation System

25. Remove 3 screws and retainer plate. Lift out driveshaft seal and gasket (Figure 5-19).

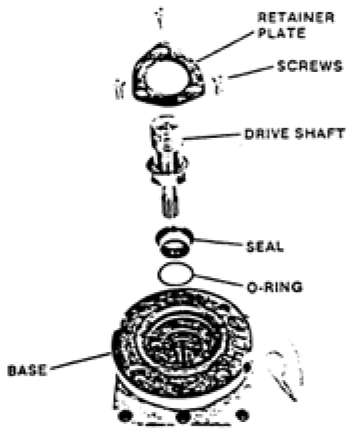

Figure 5-19. Drive Shaft

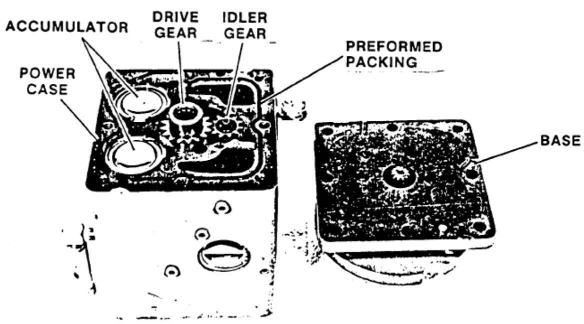

Figure 5-20. Power Case and Base

26. Remove drive gear and idler gear from power case (Figure 5-20).

27. Ballhead disassembly (Figure 5-21).
    a. Turn speeder spring and remove spring and check plug from spring seat.
    b. Loosen PVP (pilot-valve plunger) nut and remove the shutdown rod.
    c. Lift off spring seat, thrust bearing, washer, and adjusting spring.
    d. Remove 4 pins and flyweights.
    e. Remove screw and spring coupling.
    f. Remove 8 screws and flyweight head.
    g. Take out O-ring and bearing.
    h. Remove snap ring, bushing, and pilot-valve plunger.

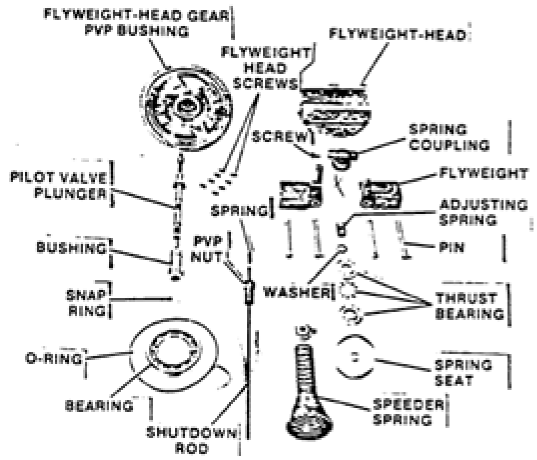

Figure 5-21. Ballhead Assembly

CAUTION **You can be Injured because accumulator springs are under compression. Use an arbor press and be careful when removing them.**

28. Power Case Disassembly
    a. Use an arbor press to hold the spring and remove the snap ring. Slowly release the compressed accumulator spring and spring seat (Figure 5-22).
    b. Remove oil gauge.
    c. Remove all plugs.
    d. Remove drain.

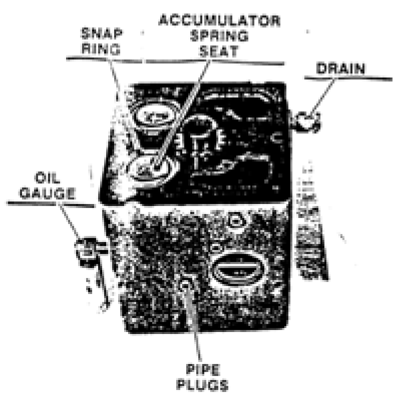

Figure 5-22. Power Case

29. Solenoid Pack Disassembly (Figures 5-23 and 5-24).
    a. Disconnect wires and remove switch from receiver assembly.
    b. Remove nut from solenoid.
    c. Screw plunger stop out of case.
    d. Screw case out of receiver assembly.
    e. Remove load spring, insulator, and plunger.
    f. Remove soldered wires from solenoid coil.
    g. Remove guide, bushings, and shield washers.
    h. Disassemble all solenoids.

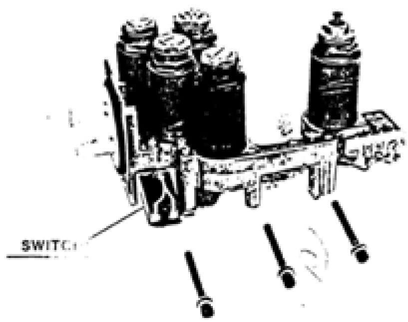

Figure 5-23. Solenoid Pack on Receiver

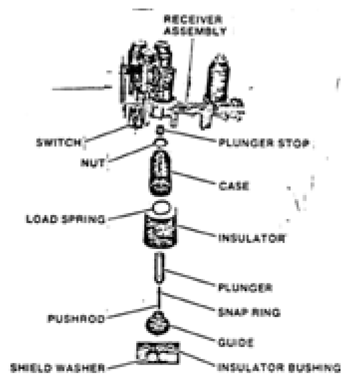

Figure 5-24. Solenoid and Receiver Assembly

30. Speed-Setting Cylinder Disassembly.
    a. Remove nut and pin from fulcrum screw.
    b. Remove headed pin and separate restoring lever into 2 pieces.
    c. Press piston rod out of fulcrum block, being careful not to drop piston.
    d. Remove stop screw.

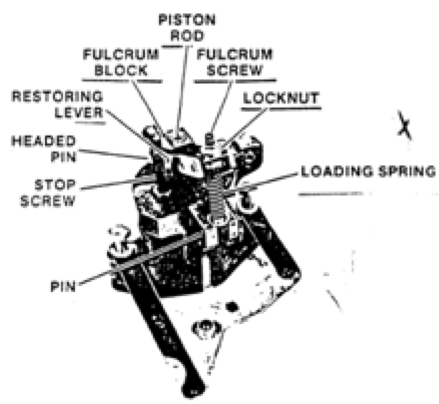

Figure 5-25. Speed Setting Cylinder

31. Fuel-Limiter Disassembly.
    a. Remove snap ring and lift out pivot and adjusting screw (Figure5-26).
    b. Take out loading spring.
    c. Remove cotter pin, fuel-limit-lever pivot pin and fuel-limit-lever.
    d. Remove feedback lever.
    e. Remove screws (2 on top and 1 from bottom) and lift off bracket.

f. Remove cotter pins trim top of bellcrank and remove bellcrank.
g. Remove pin from bellcrank.
h. Remove cotter pin, pin, and bearing from bellcrank.

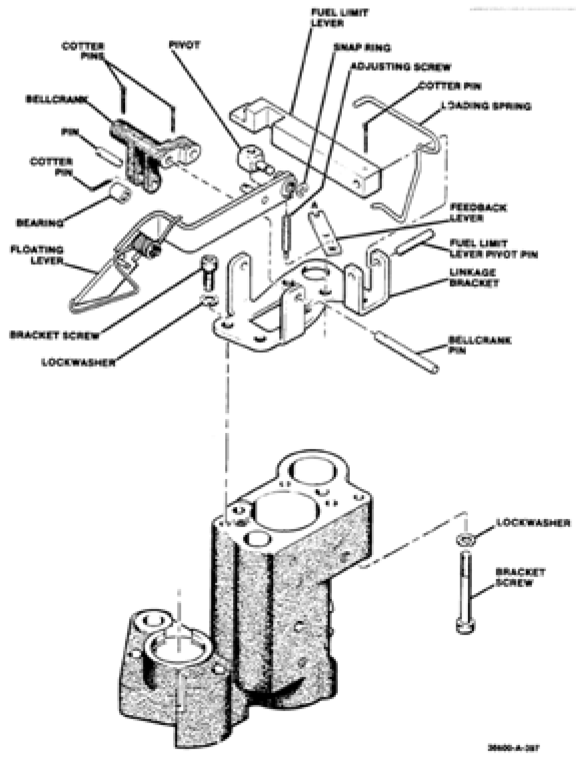

Figure 5-26. Fuel-Limit Bracket and Linkage

i. Lift out amplifier piston, pilot-valve plunger and load spring.
j. Lift out sensor-piston sleeve, piston and fuel-limit cam assembly.

IMPORTANT — **Do not separate cam from piston unless cam is damaged or worn.**

k. Lift out spring and seats, and bleed valve.
I. Remove 2 Nylok screws and take out bellows, spacer, and valve seat.
m. Remove eccentric.
n. Remove O-ring, screen, O-ring, and check-valve.
o. Remove snap ring and washers, gaskets, orifice plates, and spring from the orifice body.

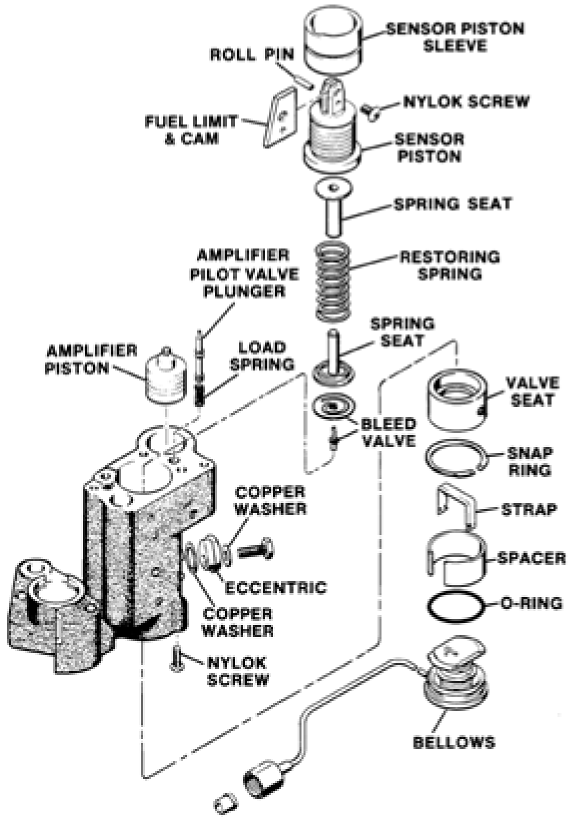

Figure 5-27. Fuel-Limiter Sensor and Bellows

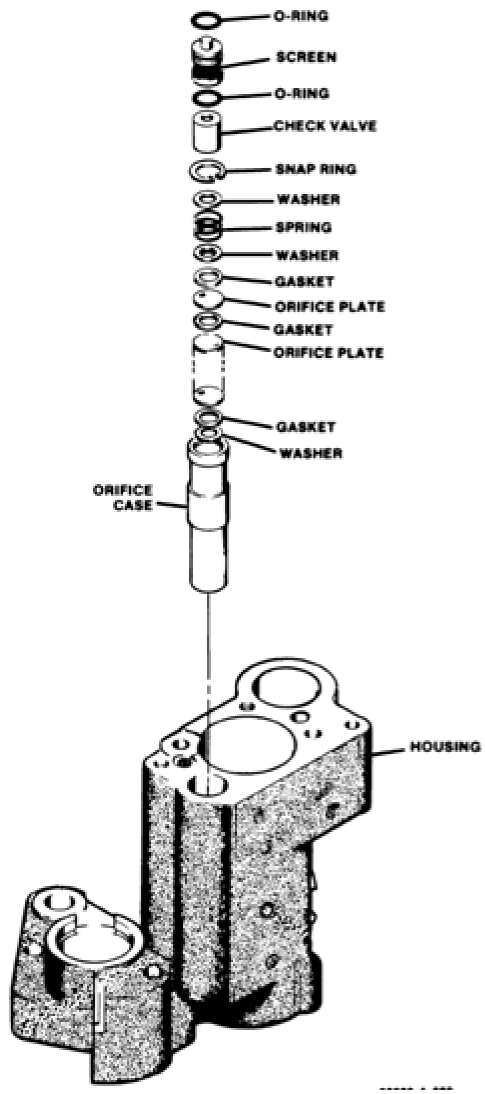

Figure 5-28. Fuel-Limiter Orifice

32. Power servo disassembly (Figure 5-29).

> **⚠ CAUTION** — **The power servo is spring loaded. Use some type of press or jack screws when dismantling the servo.**

a. Remove spring, seal ring, and seal.
b. Use jack screws or some type of press to hold spring guard while loosening screws.
c. Remove pin and separate rod end from piston.
d. Remove 2 seals.

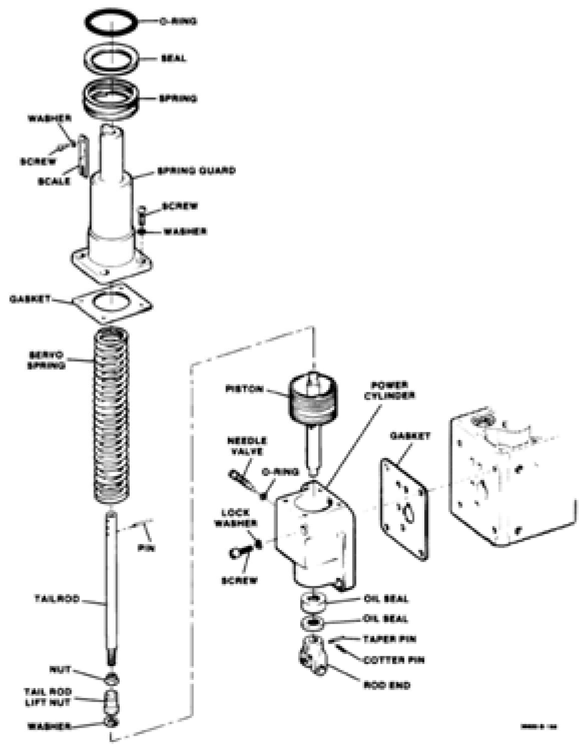

Figure 5-29. Power Servo

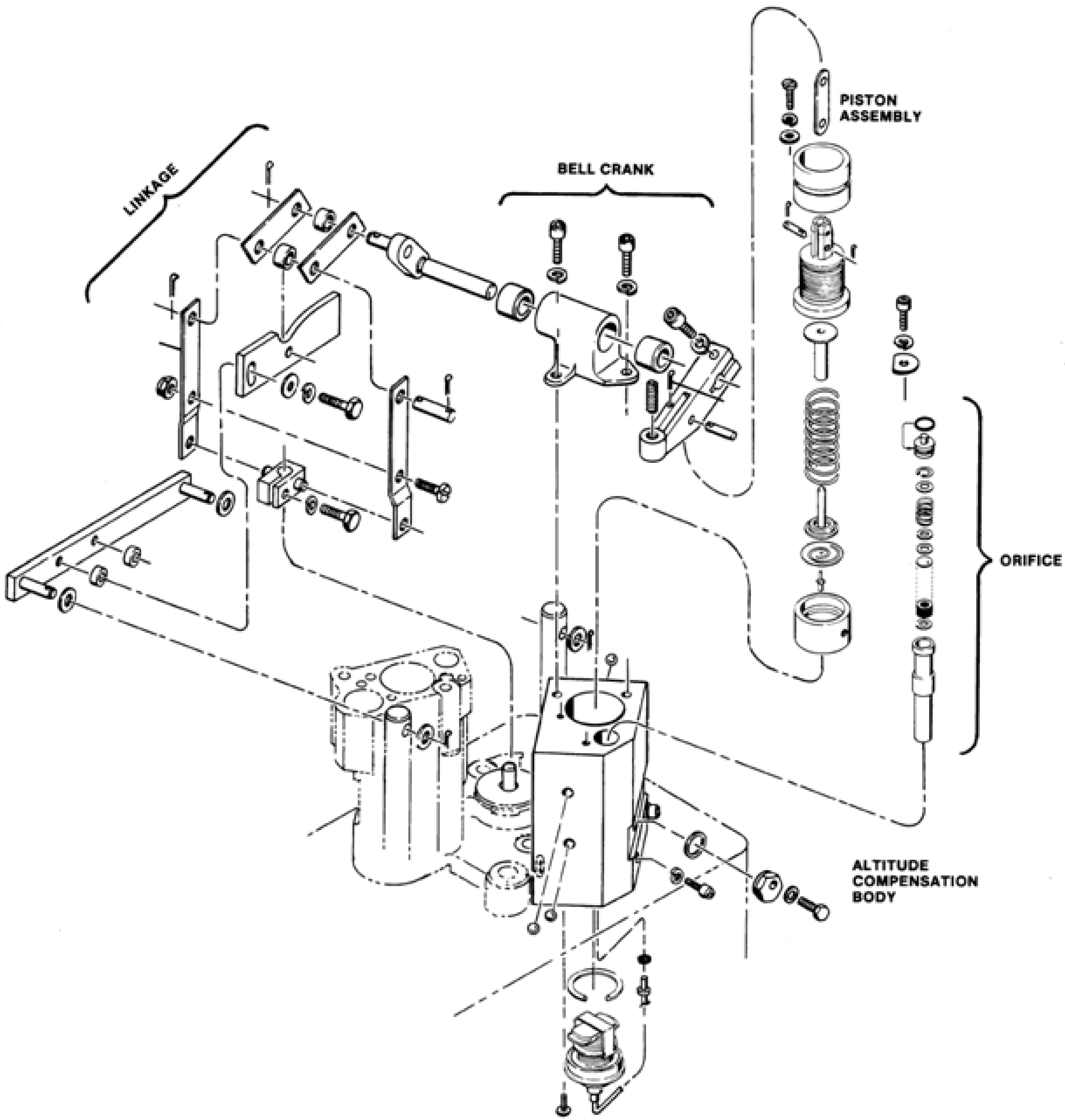

Figure 5-30. Altitude Compensation

33. Altitude Compensation Disassembly (governor designation 8570-687 only).

    Disassembly of the altitude-compensation system is similar to the fuel limiter (Figure 5-30).

Cleaning

1. Clean critical parts by hand.
   a. Pilot-valve plungers.
   b. Pilot-valve bushings.
   c. Compensation piston.

d. Servo piston.
e. Low-oil shutdown piston.
f. Needle valves.
g. Bypass valve.
h. Load-Control bushing.
i. ORS piston.

2. Clean resistor pack by submerging it in clean solvent and shaking it around. Blow dry with a jet of dry air.

3. Pressure wash castings and other parts.

Assembly

Replace any damaged or worn parts with new parts.

Replace O-rings, cotter pins, bellofram, and gaskets with new.

Lubricate, with petrolatum, all O-rings, and seals before installing. Also, lubricate any press-fit parts, bearings, and seals before installing.

Ballhead

1. Check the toe wear on the flyweights. Flyweight toes support the thrust bearing. Replace flyweights if there is a flat spot larger than 1/32 inch (0.8 mm) wide.

2. Check flyweight pins. Wear on pins indicate bad bearings in the flyweights. Replace both pins and bearings.

3. Check the thrust bearing by placing the bearing between the races and rotating it in your hand. If the bearing feels rough, replace it.

4. Check the main bearing by inserting two fingers inside the inner race and apply pressure while spinning the outer race with your other hand.

5. Check the pilot-valve plunger for nicks and wear. Replace the PVP if it has any nick in the control land larger than 0.001 inch (0.03 mm).

6. Use a light and check inside the PVP bushing. Be sure there are no nicks on the control port.

7. Check the spring coupling by twisting slightly. The spring should not be loose. (See Figure 7-2.)

8. Insert PVP and bushing in gear-bushing assembly and secure with snap ring.

9. Install spring coupling in flyweight head. The spring coupling has a missing tooth in its gear and fits in one position only.

10. Put bearing in gear-bushing assembly.

11. Lubricate O-ring and place it on gear bushing.

12. Place small spring and shutdown rod on PVP and secure with PVP nut.

13. Fasten flyweight head to gear-bushing assembly with eight screws.

14. Install flyweights in flyweight head.

15. Place adjusting spring and washer on shutdown rod.

16. Adjust PVP nut until PVP control land is centered in the control port of the PVP bushing. See Figure 5-31 and adjust the PVP nut until dimensions 'A' and 'B' are equal. Make the adjustment (Figure 5-32) while keeping a slight pressure on the flyweights in both directions. Pin nut in position once adjustment is correct.

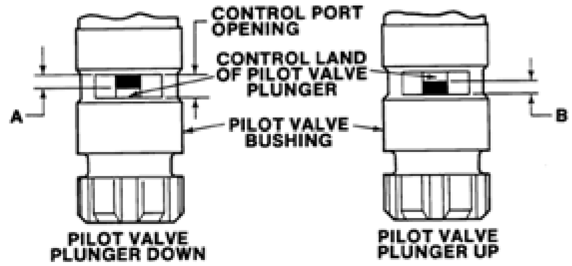

Figure 5-31. PVP Adjustment

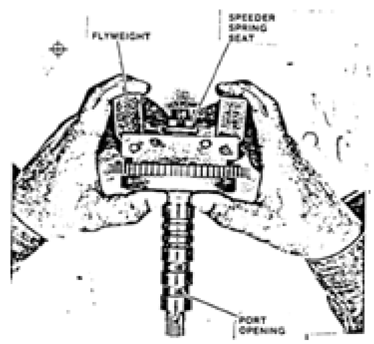

Figure 5-32. Flyweight Pressure

17. Place thrust bearing on shutdown rod with race having largest hole on bottom.

18. Fit speeder spring in spring seat and place it on shutdown rod.

19. Place plug on top of speeder spring. This completes the ballhead assembly.

Power Servo (Figure 5-33)

1. Check piston and lightly remove any nicks or burrs with a small stone. Check shaft for wear and lightly polish with emery cloth if necessary.

2. Check cylinder for wear and remove nicks with emery cloth as required.

3. Insert piston in cylinder.

4. Press on oil seals just below flush, and press rod end on piston shaft. Secure with taper pin.

5. Put nut on tailrod and thread tailrod lift nut onto tailrod and fit the slotted end on piston shaft. Thread tailrod in until there is just enough clearance so tailrod lift nut can turn on piston. Tighten nut on tailrod lift nut to secure it in position.

6. Place gasket on cylinder and spring in cylinder.

7. Use jack screws or some type of guarded press to compress the spring guard on to cylinder and secure it with screws and washers.

8. Install scale.

9. Install spring, seal, and O-ring.

10. Check needle-valve seat for wear and install needle valve and washer. Screw in needle valve until it just bottoms and back off 2 turns.

NOTICE **Do not overtighten the needle valve as this damages the seat.**

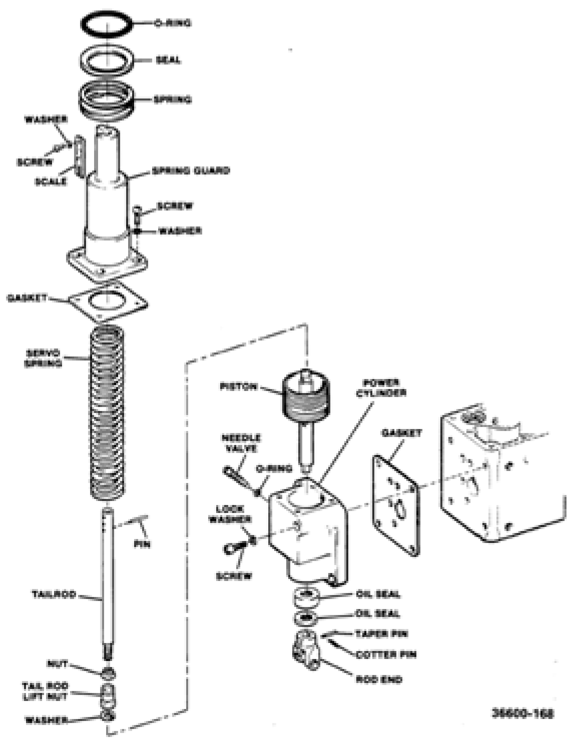

Figure 5-33. Power Servo

Power Case (Figure 5-34) and Base (Figure 5-35)

1. Check for wear in gear pockets. Shiny spots indicate a side load on driveshaft.

2. Check surface (base and column) for burrs, and stone if required.

3. Install both accumulator pistons and secure with snap rings.

4. Use an arbor press and install accumulator springs and seats, and secure with snap rings.

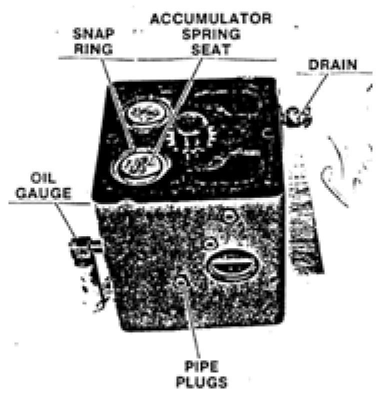

Figure 5-34. Power Case

5. Install all pipe plugs, oil drain and oil gauge. Use Loctite on all threads.
6. Install idler gear and check for free movement.
7. Install pump gear and check for free movement.
8. Lubricate and install preformed packing on base end of power case.
9. Place base in position on power case and with 4 screws in center holes on each side of base, secure base to power case. Tighten screws evenly a little at a time.

   Check alignment by placing driveshaft in position and turn it to check oil pump for free movement. If pump does not move freely, loosen screws in base and reposition slightly until driveshaft turns freely.
10. Insert the other 4 screws in base and tighten. Torque to 90 lb-in (10.2 N·m) nominal.
11. Check driveshaft for wear in area where seal fits.
12. Replace bearing on driveshaft with a new bearing unless none is available and the old bearing is not damaged too badly. See Figure 5-35.

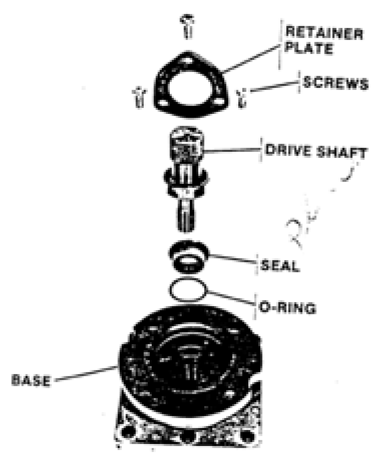

Figure 5-35. Drive Shaft and Base

13. Install gasket on seal and place into base.

14. Install driveshaft and secure with retainer plate and screws. Torque screws to 63 lb-in (7.1 N·m) nominal.

15. Lockwire these 3 screws.

16. Put new O-ring on plug (Figure 5-36) and insert spring and plug into compensation cylinder in power case. Secure plug with snap ring.

17. Lay power case on its side and insert piston spring and spring seat in compensation cylinder on servo side of power case. Be sure both springs fit into ends of buffer piston.

18. Install gasket and power servo.

IMPORTANT	**When governor is on test stand and is at operating temperature, torque screws to 40 lb-ft (54 N·m).**

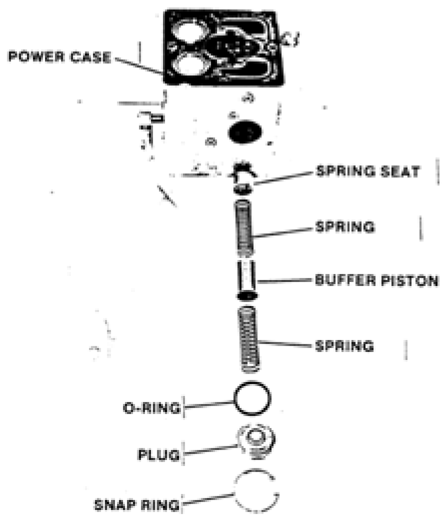

Figure 5-36. Compensation System

19. Put small gasket in top of power case (Figure 5-37).

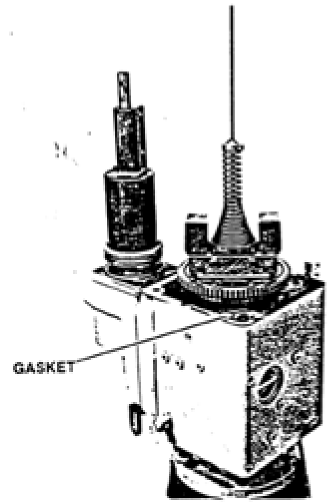

Figure 5-37. Power Case Assembly

20. Insert ballhead assembly in position in power case.

Column (Figures 5-38 through 5-73)

1. Check ballhead drive gear teeth. If gear is okay, place in position in bottom of column.

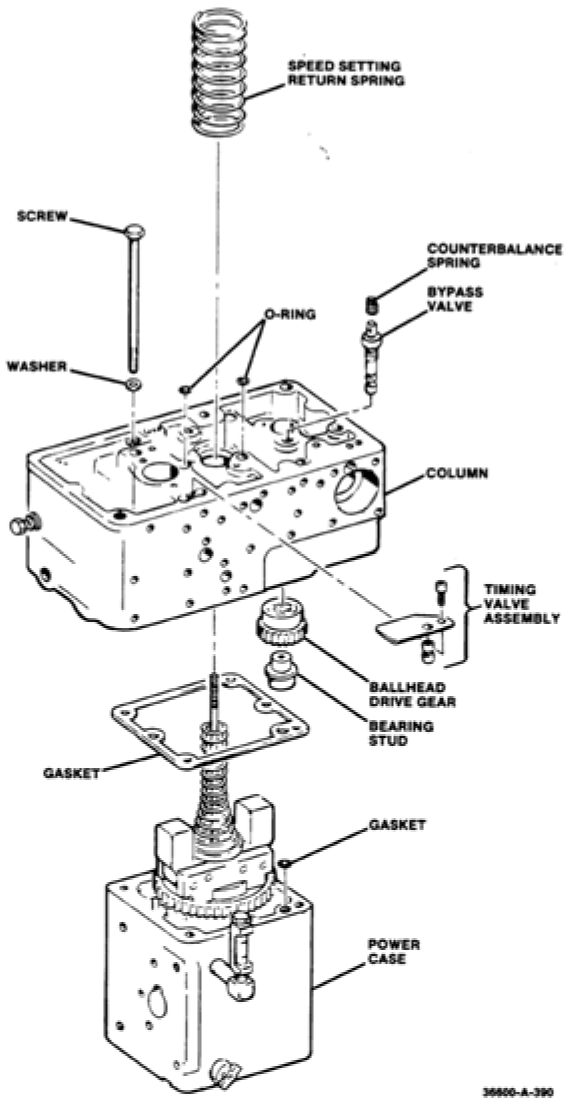

Figure 5-38. Column to Power Case Assembly

2. Clean both timing valves, replace O-rings on needle valves, insert in column, and secure with retainer plate, instruction plate, lockwasher and screw (Figure 5-39).

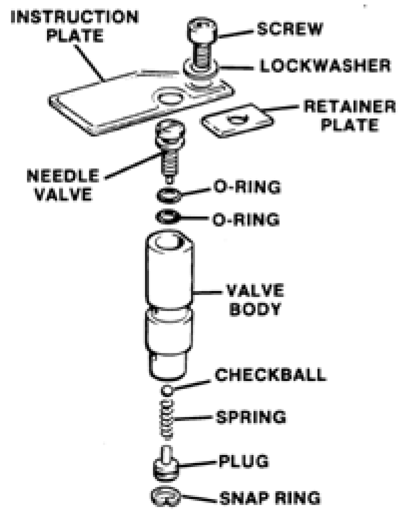

Figure 5-39. Timing Valves

3. Install bulkhead union assembly as shown in Figure 5-40.

4. Insert gasket, spring, piston, and bushing into hole for low-oil shutdown (Figure 5-40).

5. Assemble diaphragms, piston, O-ring, spacer, and washer on plunger in order as shown in Figure 5-40.

IMPORTANT **Do not let the diaphragm twist or buckle while tightening the nut.**

6. Tighten nut on plunger to secure assembly.

7. Roll diaphragm into area around piston inside of spacer. Do not use a sharp tool to start the diaphragm; usually it can be started with your finger.

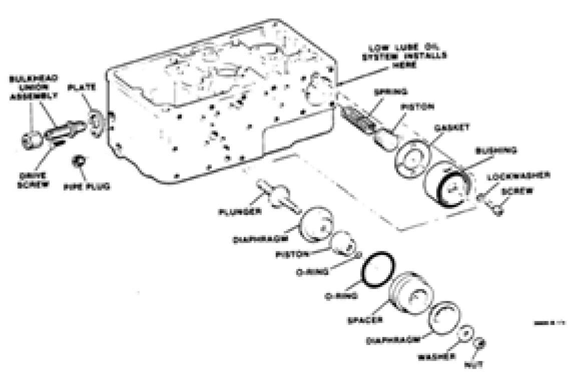

Figure 5-40. Lube Oil Shutdown

8. Insert diaphragm assembly into cylinder for lube-oil system.

9. Install load-control supply valve in order as shown and in correct hole in column.

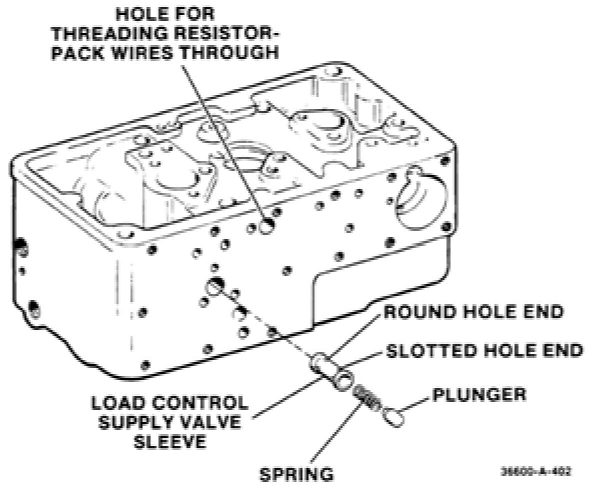

Figure 5-41. Load Control Supply Valve

10. Replace bearings, if required, in end plate. See Figure 5-42. Use a brass punch through bearing end to remove end cap. Then reverse end plate and drive out bearing. Press fit new bearings into both end plates.

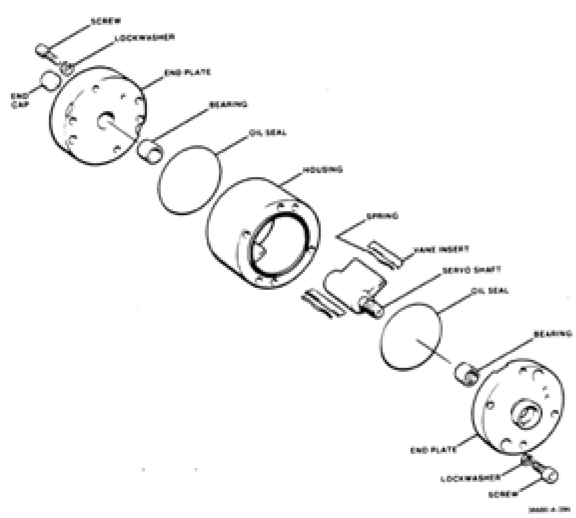

Figure 5-42. Vane Assembly

11. Assemble servo shaft, vane inserts, and springs into housing.

IMPORTANT	**Use new springs with vane inserts.**

12. Put oil seals in place on housing and secure end caps to housing with screws and lockwashers.

13. Install three O-rings, shown in side plate, Figure 5-43.

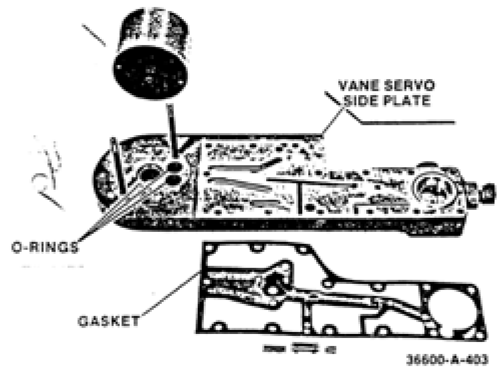

Figure 5-43. Side Plate

14. Secure commutator plate, and wire retainer to resistor pack with screws and nuts (Figure 5-44).

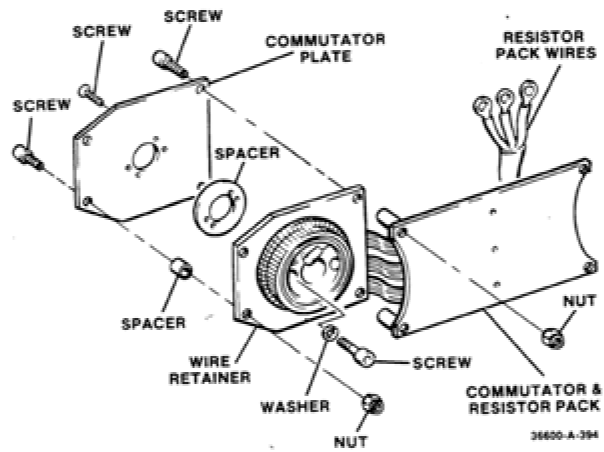

Figure 5-44. Resistor Pack

15. Place gasket in position on side of column.

16. Attach side plate to column with 10 screws.

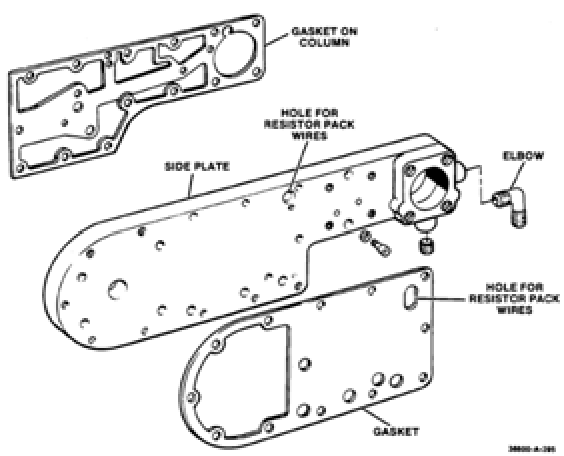

Figure 5-45. Side Plate

17. Thread resistor pack side plate, gasket, and wires through gasket, hole in column (Figures 5-45, 5-46).

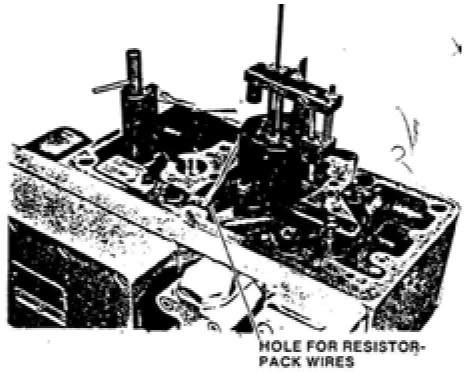

Figure 5-46. Wires Threaded into Column

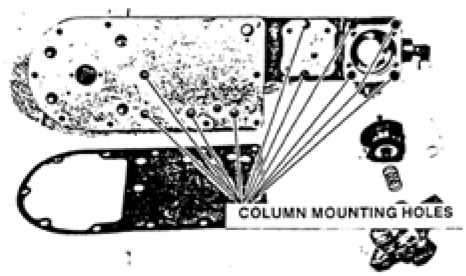

Figure 5-47. Side Plate

18. Attach resistor pack to side plate. First, use 2 screws through commutator, but do not tighten. Second, in order as shown on Figure 5-48, secure right-hand side of resistor pack to column. Tighten screws on left-hand side in commutator.

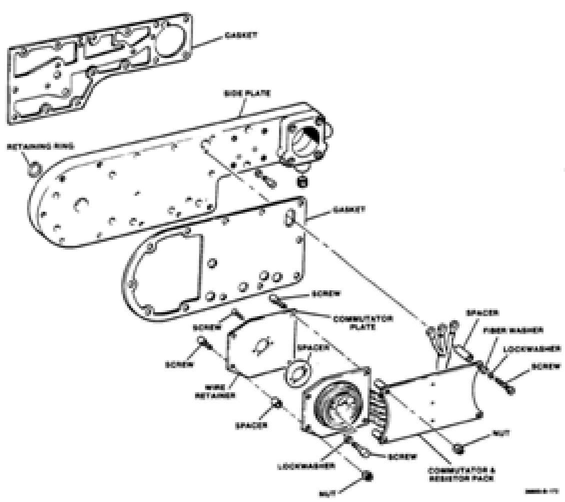

Figure 5-48. Resistor Pack and Side Plate Assembly

19. Insert end of shaft in contact plate assembly (Figure 5-49), through commutator and side plate, and secure with retaining ring. Lift up gently on contact so it slides over commutator.

NOTICE	**Do not bend contact on plate as you slide the plate in position.**

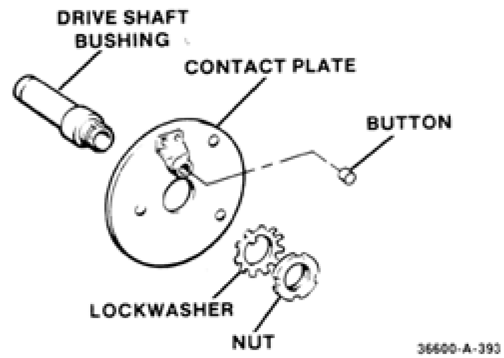

Figure 5-49. Contact Plate Assembly

20. Make sure the vane has maximum amount of travel. If necessary, pull contact plate out slightly and rotate positioning of teeth to obtain maximum travel.
21. Secure contact-plate shaft with snap ring.
22. Attach vane assembly to side plate with lockwashers and nuts.
23. Attach vane servo cover to side plate. Holes in top right (Figure 5-50) need four 3-inch-long screws. Eight other holes require 2 1/8-inch screws.

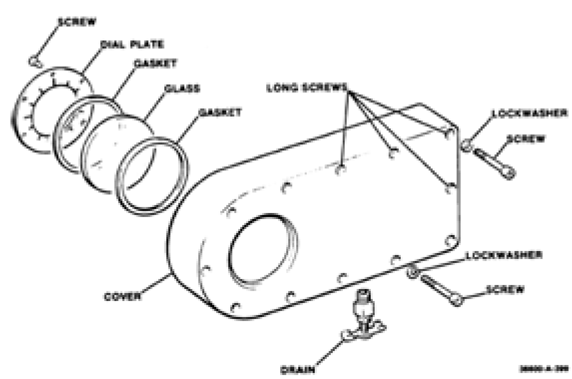

Figure 5-50. Vane Servo Cover

24. Assemble oil filter after cleaning it and mount it in position on vane servo side plate (Figure 5-51).
25. Install load spring, spring seat, O-ring, and end cap. Secure with lockwashers and screws (Figure 5-52).

IMPORTANT	**During test on test stand, adjust shutdown point and then install plug in end cap. Use Loctite 242 on outside diameter of plug.**

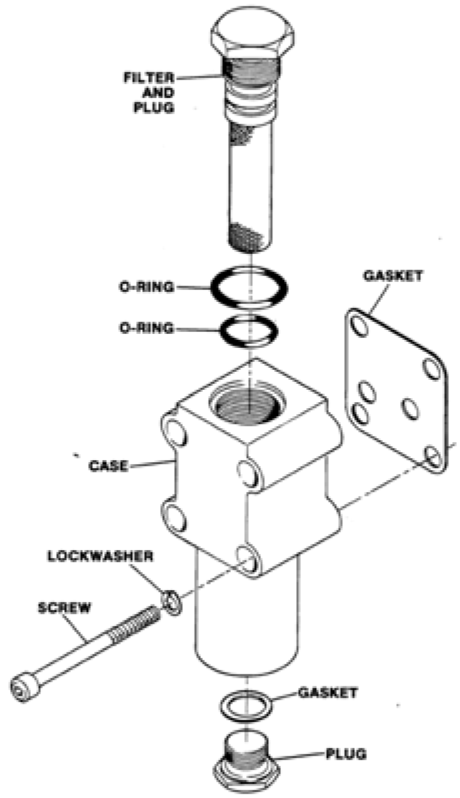

Figure 5-51. Oil Filter

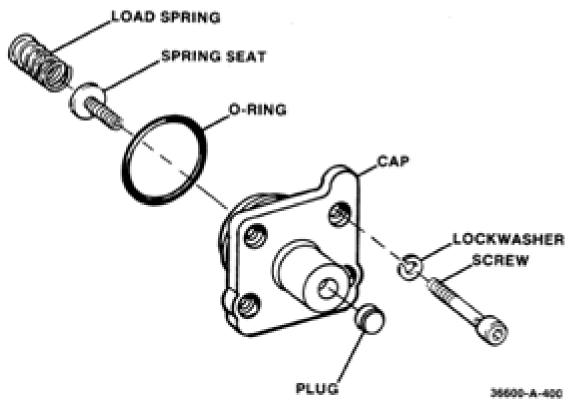

Figure 5-52. Lube Oil Shutdown Cap

26. Clean and assemble lube oil shutdown plunger parts and install in column (Figure 5-53).

27. Clean, assemble, and install bypass valve in position as shown in Figure 5-53.

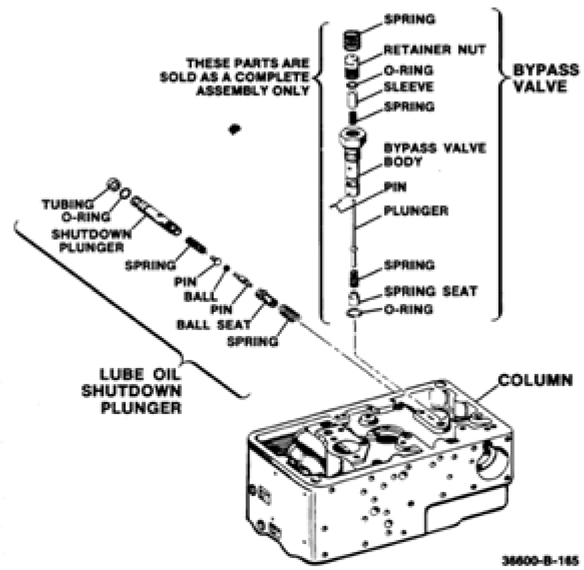

Figure 5-53. Lube Oil Shutdown Plunger and Bypass Valve

28. Assemble load-control linkage as follows:
    a. Install snap ring in load control bushing (Figure 5-54).
    b. Put load control bushing into column bore; install load-control pilot-valve plunger, spring, gasket, and spacer.
    c. Press the cylinder head into cylinder, (Figure 5-55).
    d. Place O-ring in counterbore in column; slip cylinder over pilot-valve stem and tighten down with screws and washers.
    e. Install overriding piston.

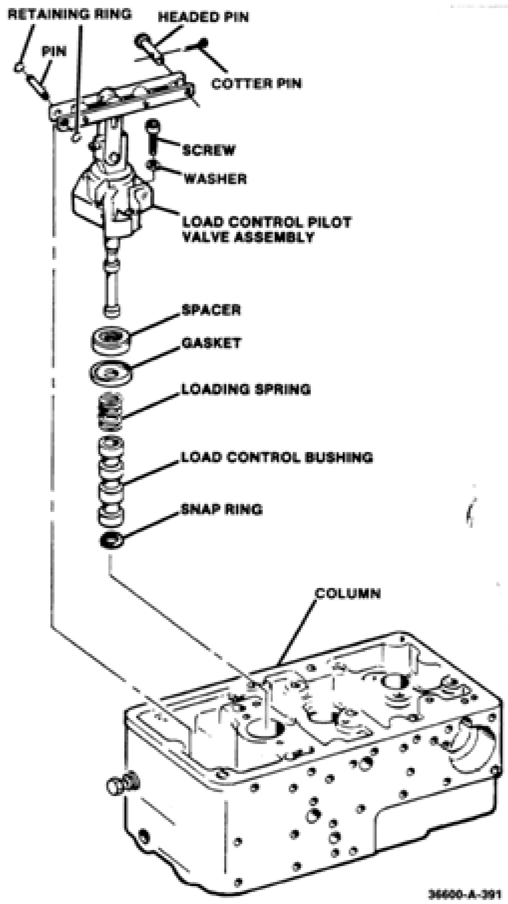

Figure 5-54 Load Control Bushing

f. Hold pilot-valve plunger down against snap ring and use Woodward tool 360692 or equivalent (Figure 5-56) to thread spring Seat onto plunger stem. Turn spring seat down until it touches overriding piston; then back off 1/4 turn. (Plunger will begin to rise if spring is turned down further on thread after touching piston.)

g. Lift pilot-valve plunger sufficiently far to permit holding spring collar with a wrench while locking in position with locknut.

NOTICE	**Do not lift plunger higher than necessary, to avoid damaging oil seal.**

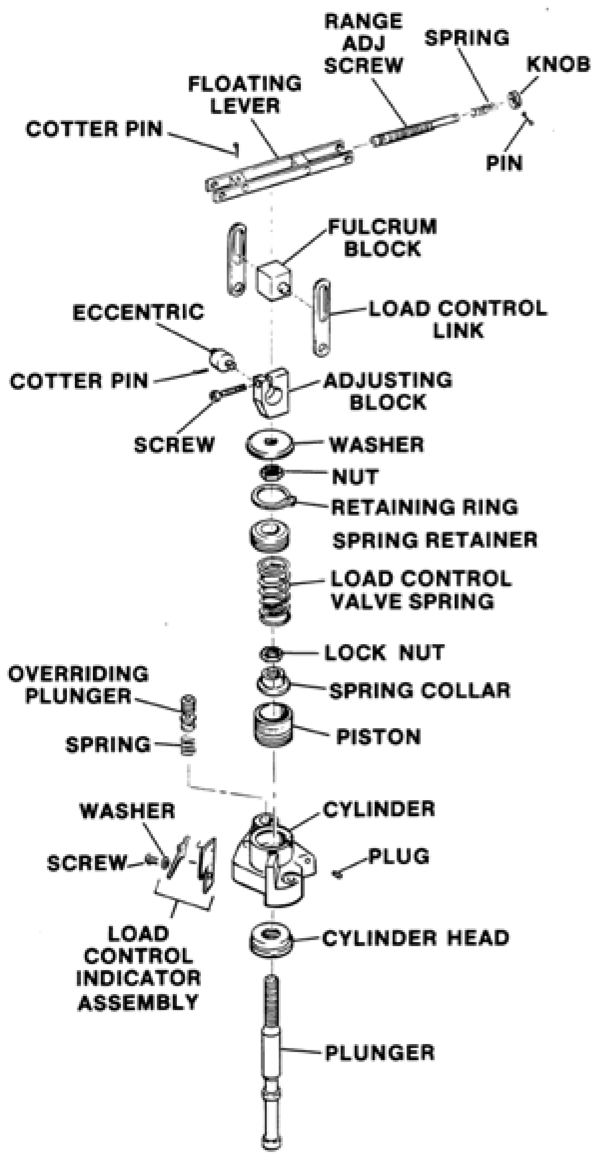

Figure 5-55. Load Control Pilot Valve Assembly

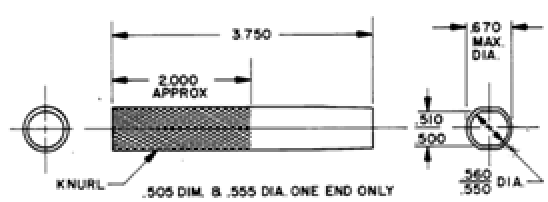

Figure 5-56. Spring Seat Tool

h. Install spring, spring retainer, and retaining ring.

i. Thread locknut onto pilot-valve plunger stem and install washer.

j. Assemble block, eccentric, load-control link, fulcrum block, floating lever, range-adjustment screw, spring, and knob.

k. Thread adjusting block of the floating-lever assembly about 10 turns onto the pilot-valve plunger; lock in place with locknut.

29. Check thrust bearing for wear and replace if necessary.

30. Check pilot-valve plunger and rotating bushing for damage or wear and repair or, replace if necessary. Be sure there are no nicks or burrs on any lands. Lightly stone any nicks or burrs with a hard arkansas stone.

31. Insert loading spring, rotating bushing, regulating bushing, small pilot-valve loading spring, pilot-valve plunger, and thrust bearing (Figure 5-57).

32. Fit 'D' solenoid cup (opening toward speed-setting servo) and regulating-bushing retainer in position on top of thrust bearing and secure with washer, collar, spring and hex head screw.

33. Install washer and retainer screw, set pointer to punch mark in column surface, and tighten retainer screw.

34. Attach indicator with screw and washer.

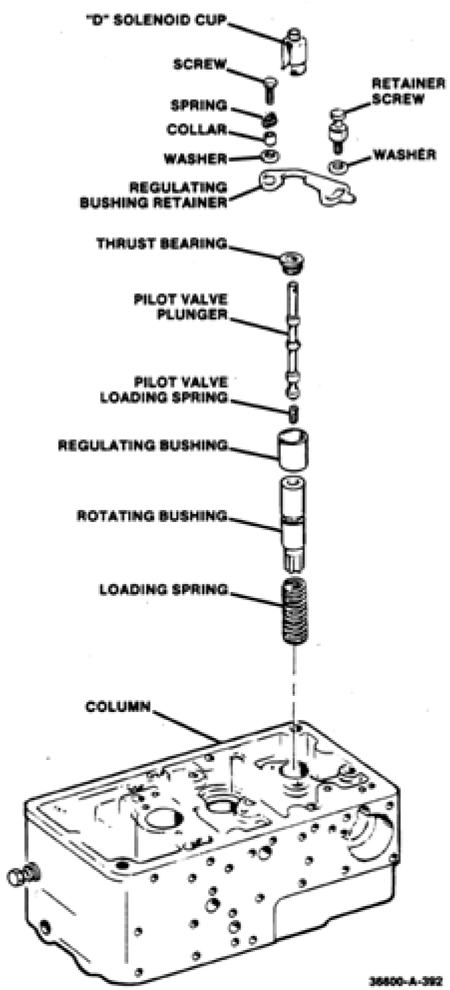

Figure 5-57. Speed Setting Valve

35. Assemble speed-setting servo (Figure 5-58).
    a. Insert piston through cylinder and fulcrum block.
    b. Place both fulcrums in position between restoring-lever straps.
    c. Place restoring link and spacers between restoring levers and secure assembly together with pin and cotter pins.

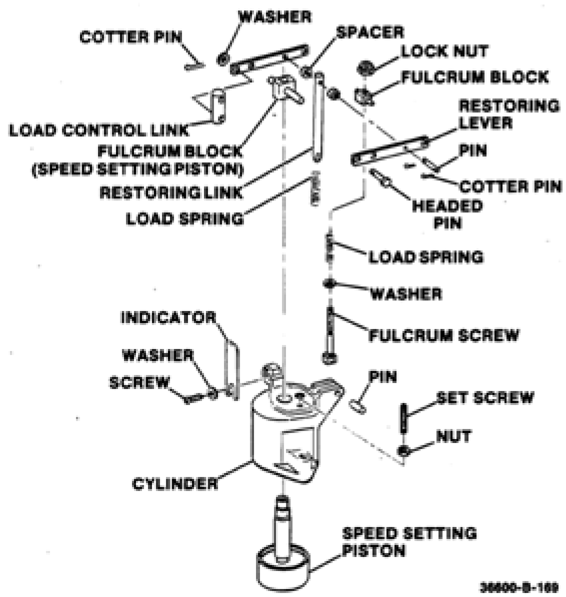

Figure 5-58 Speed Setting Servo

    d. Install fulcrum screw, washer, spring, and secure with nut.
    e. Attach square end of fulcrum screw with pin.
    f. Install setscrew and nut.
    g. Attach load-control link with headed pin and secure with cotter pin.

36. Set speed-setting cylinder assembly in place and fit triangular plate under top of retaining screw. Secure both to column with screws and washers (Figure 5-59).

NOTICE **Be careful not to warp flat springs on triangular plate while you tighten screws.**

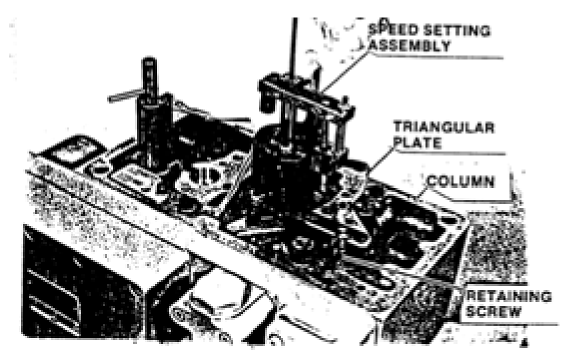

Figure 5-59. Speed Setting and Triangular Plate

37. Install fuel limiter/load control assembly (Figure 5-60) in column.

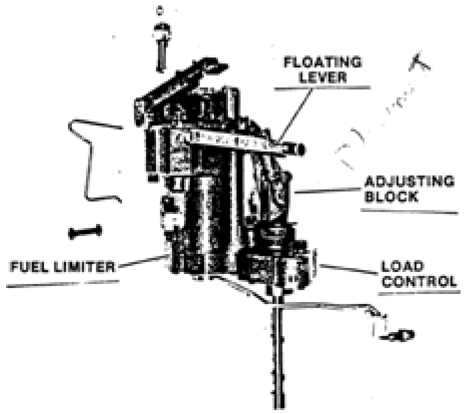

Figure 5-60. Fuel Limiter and Load Control Assembly

38. Attach linkage of fuel limiter, load control, and speed setting as shown in Figure 5-61.

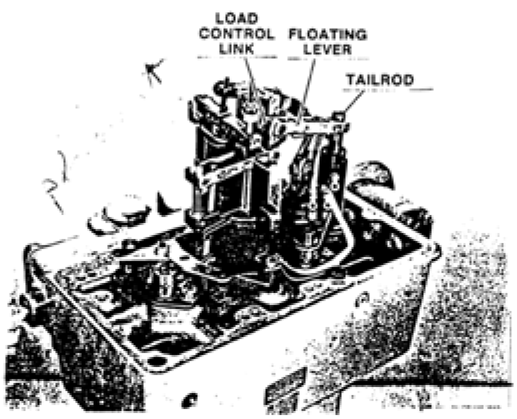

Figure 5-61. Floating Lever Connection

39. Limiter assembly (Figures 5-62, 5-63, 5-64). This applies to governors with designations 8559-910, 8573-463, and 8573-494.
    a. Clean orifice screen.
    b. Replace old check valve, O-rings, and gaskets with new ones.
    c. Orifice plates must have holes 1800 out of phase when assembled in case.
    d. After assembled in case, install in limiter housing.
    e. Lubricate and put new O-ring on bellows.
    f. Check bleed valve in valve-seat contact areas for nicks or burrs. If either of these critical areas are damaged, replace it with a new part.
    g. Put valve seat in housing (with seat up) and install snap ring.
    h. Install spacer and bellows, and secure with new Nylok screws.
    i. Use new copper washers and install eccentric in housing.
    j. Insert bleed valve, spring seat, restoring-spring seat, sensor piston, and sleeve (Figure 5-63).

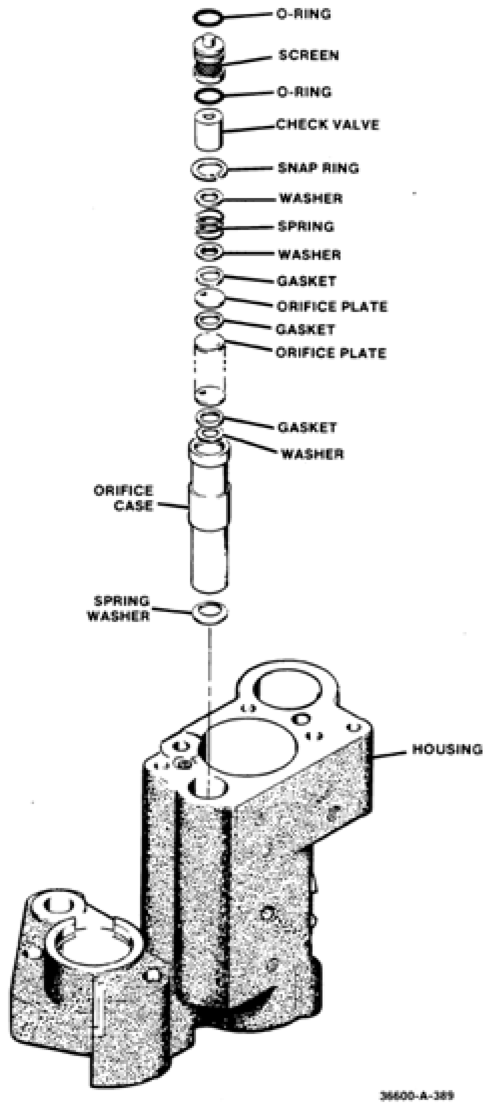

Figure 5-62 Fuel Limiter Orifice

k. Insert loading spring, pilot-valve plunger, and amplifier piston.
l. Assemble bearing in bellcrank and secure bellcrank to linkage bracket with pin and cotter pin.
m. Turn in adjusting screw. Place feedback lever in position and secure floating lever to bellcrank with cotter pin.
n. Place fuel-limit lever in place on the bracket and secure with pin and cotter pin.
o. Attach fuel-limit lever to bracket and secure with cotter pin.
p. Attach linkage assembly to housing with 3 screws.
q. Assemble overriding solenoid (OHS) bracket and attach it to overriding solenoid (Figure 5-65).

IMPORTANT — **See Figures 5-66 and 5-67 which show linkage arrangement of fuel limiter.**

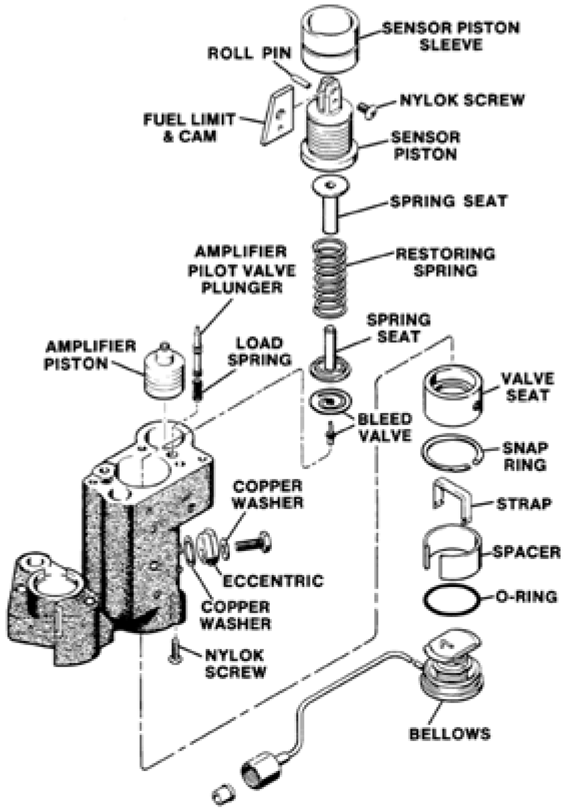

Figure 5-63. Fuel Limiter Sensor and Bellows

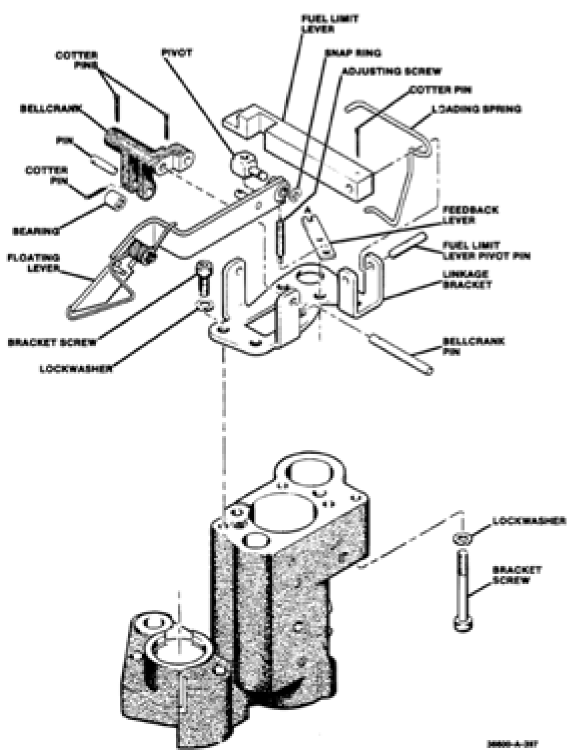

Figure 5-64. Fuel Limit Bracket and Linkage

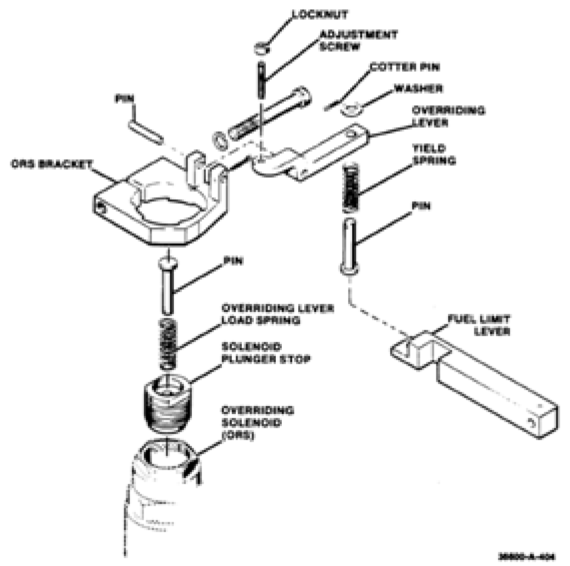

Figure 5-65. ORS Bracket

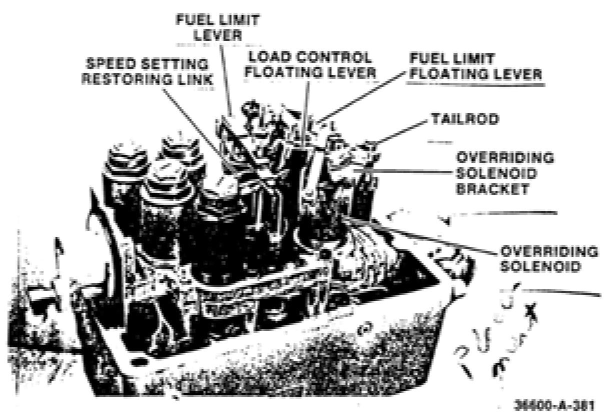

Figure 5-66. Linkage Arrangement

40. Fuel Limiter/Altitude Compensation. This applies to the governor designated 8570-687.

    Assemble the fuel limiter the same as before. The altitude compensation is assembled similarly to the fuel limiter. Figure 5-68 is an illustrated parts view of the altitude compensation. Figures 5-69, 5-70, 5-71, and 5-72 show linkage arrangement after the solenoid pack is installed.

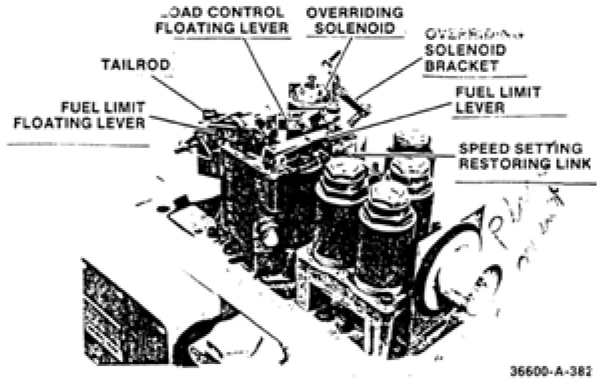

Figure 5-67. Linkage Arrangement

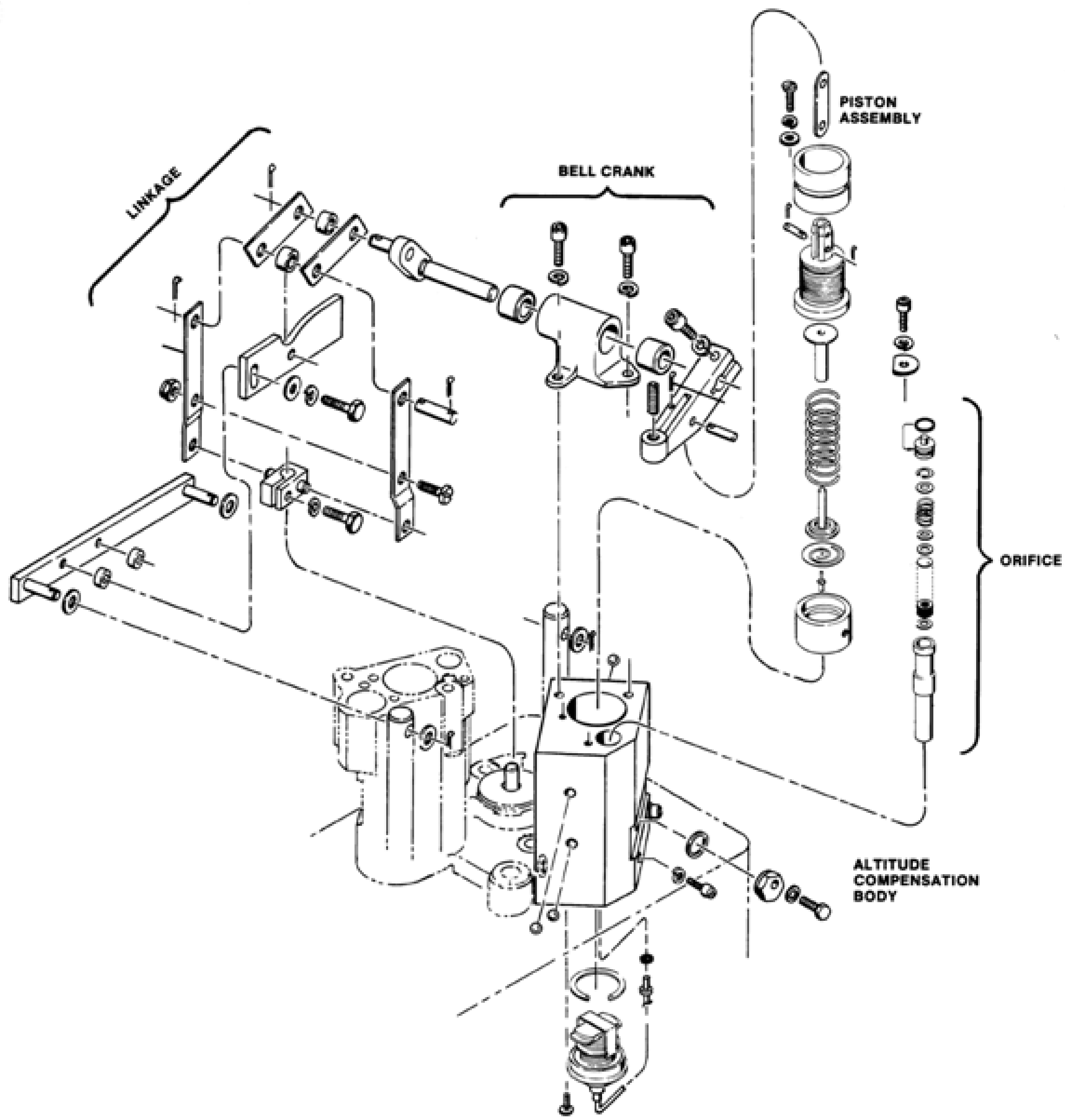

Figure 5-68. Altitude Compensation

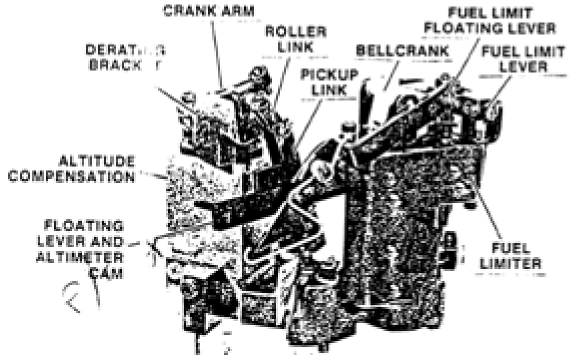

Figure 5-69. Fuel Valve/Altitude Compensation Assembly

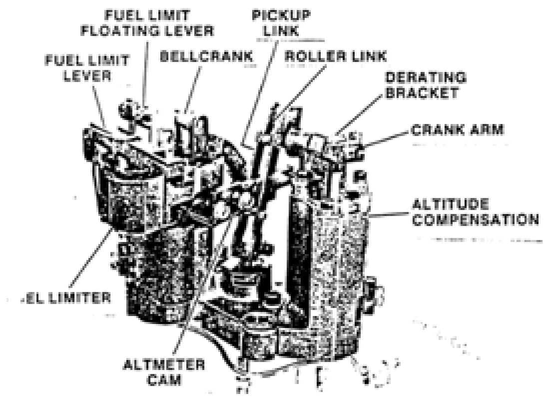

Figure 5-70. Fuel Limiter/Altitude Compensation Assembly

41. Install solenoid pack. Be sure 'D' solenoid pin enters into hole in 'D' solenoid cup (Figure 5-57). Also, be sure the switch handle enters into hole in low-lube oil plunger. Push and pull shutdown plunger and check switch for full travel. Adjust switch position if necessary, to get full travel.

42. Install pin and spring in top of ORS.

43. Install pin (flush on inside) in tailrod (lower hole).

44. Connect floating lever, from altitude compensation, to tailrod (Figure 5-73).

45. Connect spring as shown in Figure 5-73.

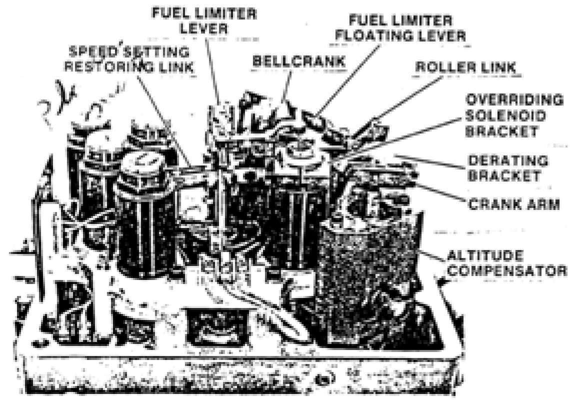

Figure 5-71 Fuel Limiter/Altitude Compensation Linkage Arrangement

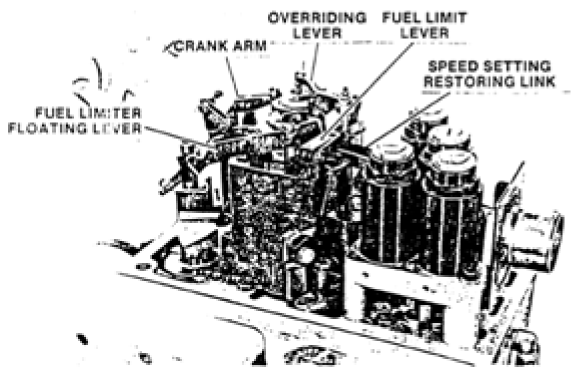

Figure 5-72. Fuel Limiter/Altitude Compensation Linkage Arrangement

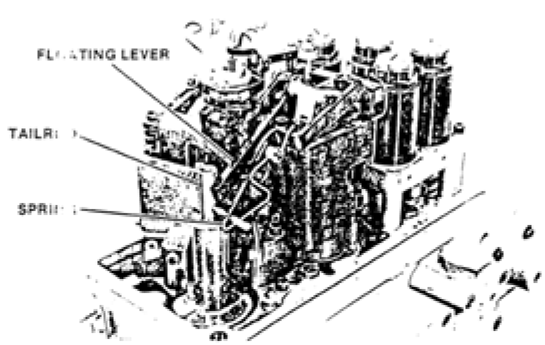

Figure 5-73. Completed Assembly

Chapter 6.
Test and Adjustment

Introduction

This chapter covers four governors. Before each test the governor part number is given.

Record serial number, date of test, name of tester, and barometric pressure in inches of mercury (Hg) at the time of the test.

IMPORTANT	**Barometric pressure must be true barometric pressure and not "sea level" corrected barometric pressure.**

Test (Governor 8570-687)

The following test procedure applies to PGEV governor 8570-687.

Test the governor at 180 to 200 °F (82 to 93 °C) case temperature. Use a magnetic thermometer on the lower part of the power case. Use 20 W 40 oil.

1. Make the following settings on the test stand prior to starting the test.
   a. Turn heater switch to "ON."
   b. Turn oil pump switch to "OFF."
   c. Set air gauges to zero.
   d. Close valves.
   e. Set direction of rotation ccw.

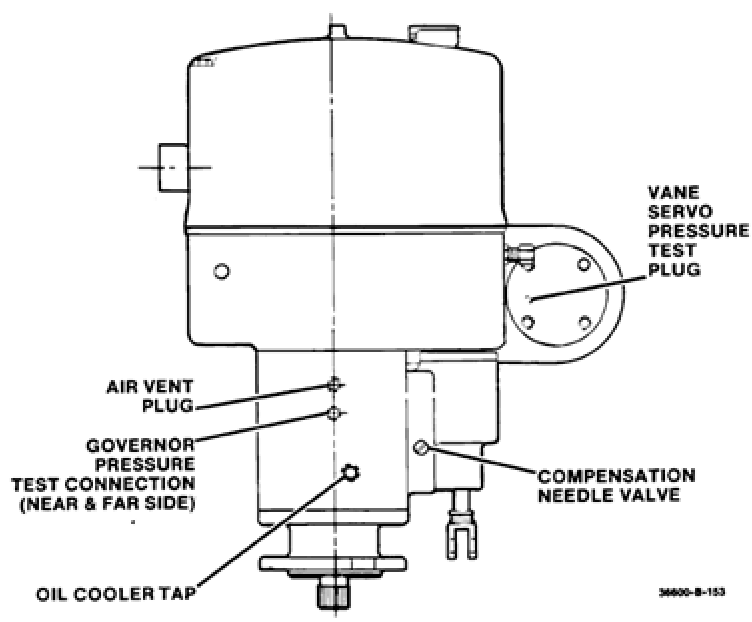

Figure 6-1. PGEV Test Connections

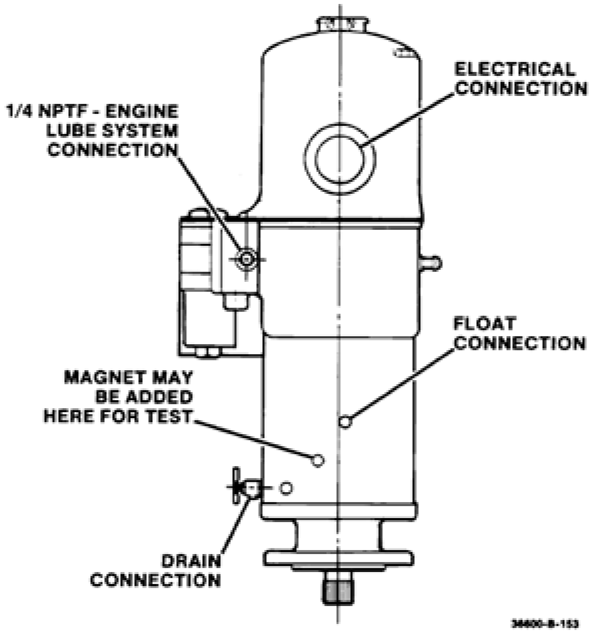

Figure 6-2. PGEV Test Connections

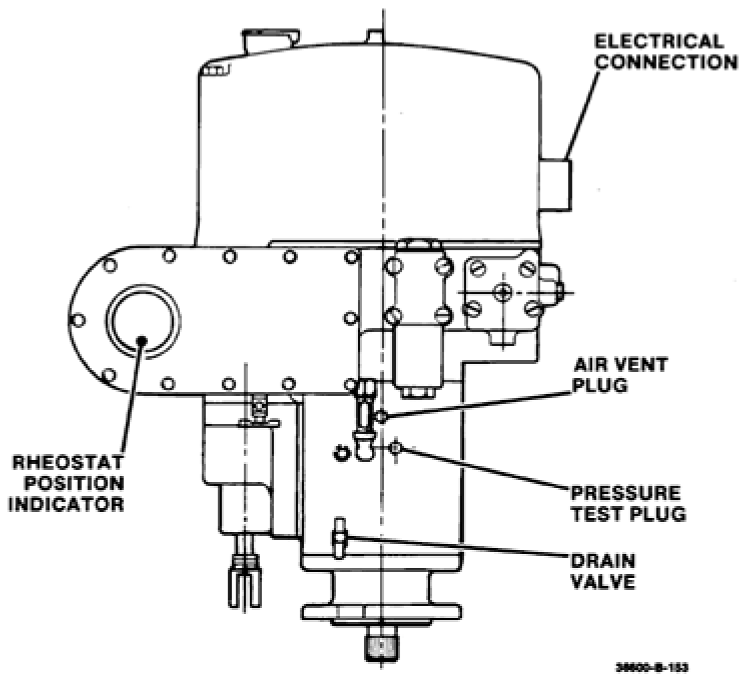

Figure 6-3. PGEV Test Connections

Mount governor on test stand. See Figures 6-1, 6-2, and 6-3 and make the following connections:

a. Electrical (remove cover first).
b. Governor oil pressure gauge.
c. Drain
d. Fill
e. Float
f. Fuel limiter pressure

g. Altitude pressure/vacuum
h. Low lube oil pressure (air or oil)
i. Servo rod end to test stand.

3. Set the low lube oil pressure to 70 psi.

4. As an initial setting, set base speed setting nut down 0.5 inch (13 mm) from top of threads on fulcrum screw. See Figure 6-4.

5. Loosen locknut on over-riding solenoid and turn over-riding plunger stop down until it bottoms. Turn it 2.5 turns back off bottom and secure it with locknut. See Figure 6-5.

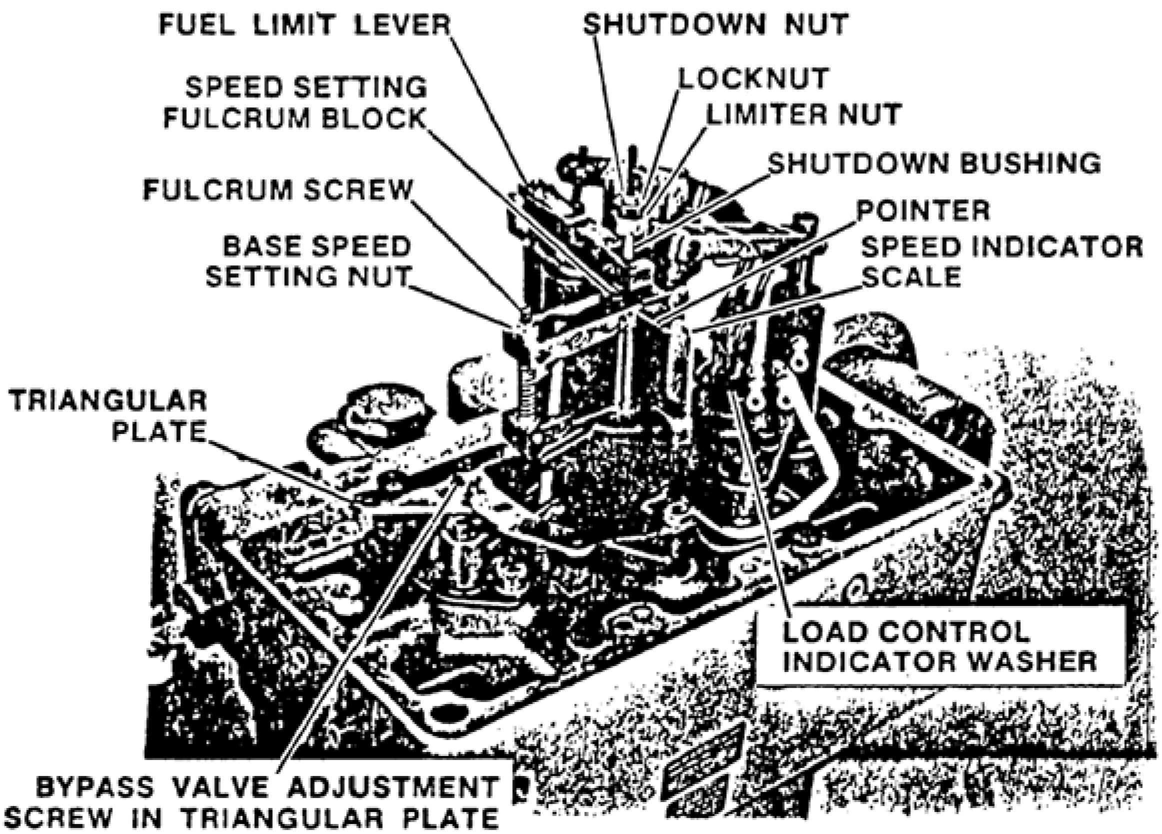

Figure 6-4. Speed Setting Assembly

6. Turn both timing valves in until valve gently bottoms. See Figure 6-6.

7. Test stand
a. Open valve for governor drain all the way.
b. Open valve for governor fill 0.5 to 1.0 turn from closed.
c. Open valve for pressure supply 0.5 to 1.0 turn from closed.
d. Close valve for pressure bleed.
e. Use pressure regulator to obtain 90 to 110 psi (621 to 759 kPa) test stand oil pressure when pump is on.

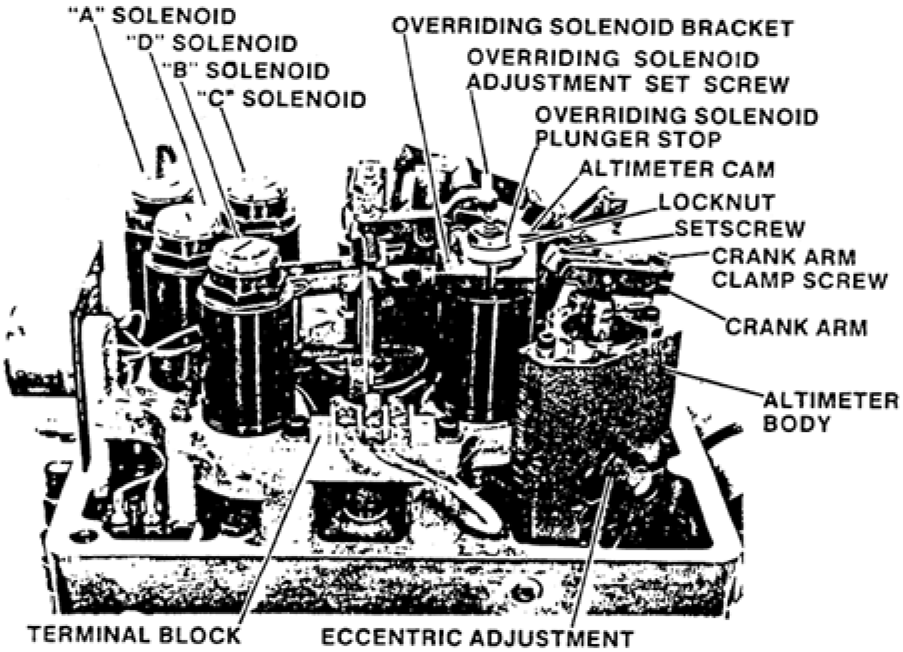

Figure 6-5. Solenoid Pack

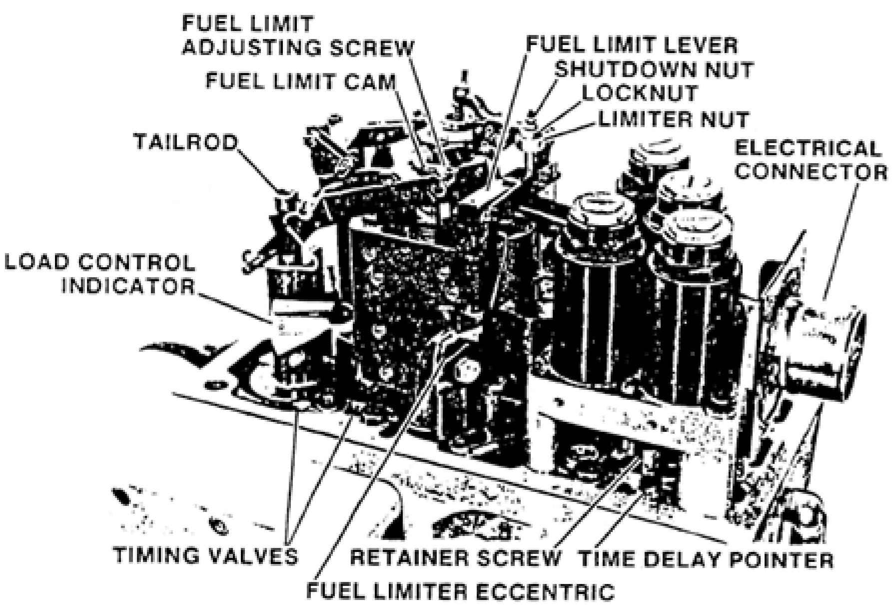

Figure 6-6. PGEV

8. Speed settings

IMPORTANT	Be sure the governor is controlling test stand speed during speed setting calibration. The servo should not be against either the minimum or maximum stop.

a. Turn speed selector to step 6 (A, B, C, and D solenoids energized) and turn test stand speed adjusting knob to increase speed to start governor.
b. Adjust base speed setting nut (Figure 6-4) to obtain speed of 813 rpm nominal. Tolerance is 809 to 817 rpm.
c. Turn speed selector to step 8 (A, B, and C solenoids energized), loosen locknut on solenoid "D" and adjust stop to get a nominal speed of 994 rpm. Tolerance is 990 to 998 rpm. Tighten locknut. See Figure 6-5.
d. Turn speed selector to step 7 (B, and C solenoids energized), loosen locknut on solenoid 'A" and adjust stop to get a nominal speed of 904 rpm. Tolerance is 900 to 908 rpm. Tighten locknut.
e. Turn speed selector to step 4 (A and C solenoids energized), loosen locknut on solenoid "B" and adjust stop to get a nominal speed of 633 rpm. Tolerance is 629 to 637 rpm. Tighten locknut.
f. Turn speed selector to step 1 (no solenoids energized), loosen locknut on solenoid 'C" and adjust stop to get a nominal speed of 361 rpm. Tolerance is 357 to 365 rpm. Tighten locknut.
g. Check speeds at steps 2, 3, and 5. Tolerances are:
Step 2 - 437 to 467 rpm, Nominal speed is 452 rpm.
Step 3 - 527 to 557 rpm Nominal speed is 542 rpm.
Step 5 - 708 to 738 rpm, Nominal speed is 723 rpm.

IMPORTANT **If these speeds are not in tolerance, try adjusting "set" speeds to tolerance extremes to bring "non-set" speeds within tolerance.**

h. Turn speed selector, on test stand, to step 1.

9. Normal shutdown setting
a. Thread shutdown bushing on shutdown rod to obtain 0.032 ±. 0.005 inch (0.81 ± 0.13 mm) clearance between bottom of shutdown bushing and top of speed setting fulcrum block. Lock in position with small locknut. See Figure 6-4.
b. Adjust speed setting stop by turning it down until it contacts speed setting piston then back it out 2 turns and tighten locknut. See Figure 6-4.
c. Loosen set screw on speed indicator scale and adjust scale to align idle line with pointer on speed setting fulcrum block.
d. Turn speed selector to OFF" ("D" solenoid energized), governor servo should go to minimum position (fully down) and fulcrum block pointer should align with 'stop" line on speed indicator scale.

10. Speed setting timing
a. Turn speed selector to step 1. Move selector to step 8 and check time elapsed when pointer starts and stops. Time should be from 11 to 21 seconds.
b. Scribe a mark on speed indicator scale in line with fulcrum block pointer while governor is at step 8 speed.
c. Turn speed selector from step 8 to step 1 and record time elapsed for pointer to return to idle position.

11. Load Control and Barometric Biasing (Altimeter)

> **IMPORTANT**
>
> **All pressure readings are in inches of mercury (Hg) absolute. Since the test stand gauges do not show inches of Hg absolute directly, true barometric pressure must be considered to determine test stand settings. If the absolute pressure required is greater than the true barometric pressure, then a positive pressure equal to the difference between the absolute pressure and barometric pressure should be applied to the altimeter fitting. If the absolute pressure required is less than true barometric pressure, then a negative pressure (vacuum) equal to the difference between absolute and barometric should be used.**

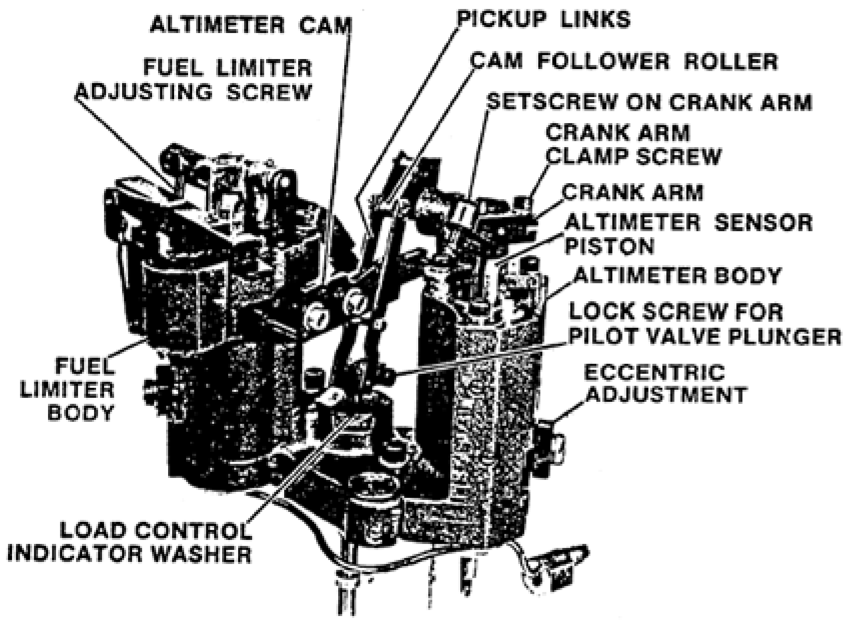

Figure 6-7. Fuel Limiter and Altitude Compensator

a. Adjust set screw in crank to mid-position. At 26.8 inches of Hg absolute (90.7 kPa absolute) adjust eccentric on altitude compensation (Figure 6-5) until space between set screw on crank arm and top of altimeter body is about 0.020 inch (0.51 mm).

   One way of doing this is to set a dial indicator on set screw in crank arm, turn eccentric adjustment until screw contacts altimeter body, set indicator to zero and adjust eccentric until screw is about 0.020 inch (0.51 mm) from zero setting. Lock eccentric in place.

b. Starting from below 24 inches (81 kPa) of Hg absolute, slowly increase pressure until set screw contacts top of altimeter body. Record pressure. It should be between 26.0 and 27.8 inches of Hg absolute (88.0 to 94.1 kPa absolute).
c. Record pressure at which altimeter sensor piston reaches its upward stop. Pressure should be less than 17.6 inches of Hg absolute (59.6 kPa absolute). If you can not get 17.6 inches Hg absolute or less, then replace spring under altimeter piston.
d. Adjust washer on load control pilot valve plunger so corners of pickup links do not interfere during movement of roller cam through its full arc. Lock washer in place with nut directly under it.

e. Set governor speed setting at step 1. Place a 0.820 inch (20.83 mm) gap block between rod end and servo housing. See Figure 3-1 for gap location. Adjust test stand speed to hold gap block by reducing speed about 20 to 50 rpm from step 1 speed.
f. Place a dial indicator on load control indicator washer. See Figure 6-7.
g. Adjust altimeter cam up or down until dial indicator does not move more than 0.003 inch (0.08 mm) while cam roller is moved through its full arc.

IMPORTANT **If cam roller can not move, loosen crank arm clamp screw so shaft can turn.**

h. Loosen pilot valve plunger lock screw (Figure 6-7). With speed selector at step 1 and 0.820 inch (20.83 mm) gap block in place move load control pilot valve up or down with load control indicator washer until vane servo is balanced.

IMPORTANT **The vane servo is balanced when there is no movement of the vane servo indicator and the vane servo indicator is not at either the minimum or maximum excitation stop positions. Tighten pilot valve plunger lock screw.**

Check that corners of pickup links do not interfere with movement of roller cam through its full arc. If they do, adjust washer on load control pilot valve plunger so corners of links do not interfere. Lock washer in place after adjusting.

i. Install load control indicator so pointer aligns with zero on scale. Lock in place with clamp screw (Figure 6-6).
j. Set governor speed to step 8 and install a 0.220 inch (5.59 mm) gap block in place between rod end and servo housing.
k. Apply 29 to 33 inches (98 to 112 kPa) of Hg absolute pressure to the altimeter to drive crank arm set screw down against top of altimeter body.
l. Adjust cam follower roller on cam until vane servo is balanced. When balanced lock shaft in position with crank arm clamp screw.
m. Set governor speed setting at step 8 and supply 17.6 inches (59.6 kPa) Hg absolute to altimeter.
   (1) Set a dial indicator on tailrod and adjust so “gap” readings can be determined with dial indicator. Correlate dial indicator readings to gap by using a 1 inch (25.4 mm) gap block between servo housing and top of rod end.
   (2) Determine ‘gap” to balance vane servo indicator. It should be 0.365 to 0.395 inch gap (9.27 to 10.03 mm). If in tolerance, altimeter calibration is complete.
   (3) If the balanced gap is not in tolerance, loosen the crank arm clamp screw and adjust the cam follower roller to balance the vane servo at a gap which is just in tolerance. That is: If the original balanced gap was larger than 0.395 inch (10.03 mm) adjust cam roller to balance at about 0.390 inch (9.91 mm) gap.

   If the original balanced gap was smaller than 0.365 inch (9.27 mm), adjust cam roller to balance at about 0.370 inch (9.40 mm) gap.

   Tighten crank arm clamp screw. Change to 29 to 33 (98 to 112 kPa) of Hg absolute pressure to altimeter. Place a 0.220 inch (5.59 mm) gap block in place between servo housing and top of rod end and adjust crank arm set screw to balance vane servo.

Starting from below 24 inches (81 kPa) of Hg absolute, slowly increase pressure until set screw contacts top of altimeter body. Record pressure. If pressure is between 26.0 and 27.8 inches of Hg absolute (88 to 94 kPa absolute) altimeter calibration is complete. If pressure is out of tolerance, install a new sensor spring in altimeter and repeat altimeter calibration, step 11.

12. Manifold Pressure Fuel Limiting

IMPORTANT **Limiter calibration is in gauge pressure not absolute, and no barometric correction is needed.**

a. Adjust fuel limit nut on shutdown bushing so fuel limit lever is approximately horizontal when it contacts bottom of fuel limit nut. Secure fuel limit nut with locknut.
b. Set a dial indicator on tailrod and adjust so gap" readings can be determined with dial indicator. Correlate dial indicator readings to gap by using a 1 inch (25.4 mm) gap block between servo housing and top of rod end.
c. For this calibration, set governor speed setting to step 8. Determine fuel limit gap by slowly adjusting test stand speed control in decrease speed direction until tailrod stops due to fuel limiter action and speed decreases 7 to 13 rpm from normal step 8 speed.
d. Set a dial indicator on top of fuel limiting sensor piston. As an initial setting adjust eccentric so sensor piston moves down 0.165 inch (4.19 mm) from its upward stop at zero inches of Hg gauge pressure.
e. With zero air pressure to fuel limiter adjust fuel limiter adjusting screw to obtain a fuel limit gap of 0.790 to 0.800 inch (20.07 to 20.32 mm).
f. Check fuel limit gap at 35.1 inches of Hg gauge pressure (118.8 kPa) to fuel limiter. Gap should be 0.207 to 0.237 inch (5.26 to 6.02 mm). If gap is too large, adjust top of fuel limit cam away from tailrod then tighten cam clamp screw. Move cam toward tailrod if gap is to small.

   Repeat steps 12e and 12f until tolerances are attained.
g. Check fuel limit gap at 4 inches of Hg gauge pressure (13.5 kPa) to fuel limiter. It should be 0.600 to 0.630 inch (15.24 to 16.00 mm).

   Check fuel limit gap at 20.1 inches of Hg gauge pressure (68.1 kPa) to fuel limiter. It should be 0.360 to 0.390 inch (9.14 to 9.91 mm).

   If both are in tolerance fuel limiter calibration is complete.

   If either is out of tolerance change sensor piston position.

   If either gap is too large, set a dial indicator on top of fuel limiting sensor piston. Adjust eccentric so sensor piston moves down 0.155 inch (3.94 mm) instead of 0.165 from its upward stop at zero inches of Hg gauge pressure, as in step 12d. Recalibrate from step 12e on.

   If gap is too small start at a setting of 0.175 inch (4.44 mm).

13. Load Control Override Linkage
a. Install over-riding solenoid bracket on ORS solenoid if not already in place.
b. Set pressure to fuel limiter to zero inches Hg gauge pressure.
c. Adjust speed control on test stand to attain fuel limit.
d. Turn over-riding adjustment set screw down until ORS piston activates, then turn set screw down one-half turn more.

e. Move test stand speed control and slowly bring governor to fuel limit point. Watch dial indicator (on tailrod) and note distance traveled from tailrod position at which ORS piston activates until fuel limiting occurs. Distance should be 0.005 to 0.015 inch (0.13 to 0.38 mm). Adjust set screw if required to attain 0.005 to 0.015 inch setting.

14. Low Lube Oil Shutdown

> **IMPORTANT** — **The simulated lube oil pressure provided to the governor may be either air pressure or test stand oil pressure. The vane servo should be approximately balanced when determining low lube oil shutdown pressures, at step 8 and step 1.**

a. At step 8 speed setting, low lube oil pressure should be 58 to 62 psig (400 to 427 kPa) to cause a governor shutdown. Slowly decrease pressure to check shutdown. If not in tolerance, turn adjustable spring seat cw to lower shutdown pressure. Turn seat ccw to raise pressure. See Figure 3-4.
b. At step 1 speed setting, adjust bypass valve adjustment screw to attain "instant" shutdown (less than 3 seconds) when low lube oil pressure is reduced to zero. The adjustment is accessible with a long 3/32 inch hex wrench between "C" and "0" solenoids. Turn screw cw to attain "instant" shutdown, if required.
c. At step 1 speed setting, low lube oil pressure should be 15 to 20 psig (103 to 138 kPa) to cause a governor shutdown. Slowly decrease pressure and check shutdown. If not in tolerance readjust shutdown pressure at step 8 speed setting until both step 1 and step 8 speed settings are within tolerance. If tolerance cannot be attained, replace the speed setting servo spring in governor. See Figure 3-1.
d. At step 1 speed setting, turn bypass valve adjustment screw ccw 2 to 3 turns to attain time delay on shutdown. Reduce lube oil pressure to zero, turn bypass valve adjustment screw in (cw) until "instant" shutdown is attained, then back out screw (turn ccw) one-half turn. Verify the half turn setting provides time delayed shutdown with zero lube oil pressure at step 1 speed setting and "instant" shutdown at step 2 speed setting.
e. Set time delay to 35 to 45 seconds.
   (1) Set governor to step 1 speed setting.
   (2) Reduce lube oil pressure to zero.
   (3) Record time required for (time delay) governor to shutdown.
   (4) Loosen retainer screw and move pointer towards electrical connector to increase time or away from connector to decrease time until 35 to 45 seconds time delay is attained.
f. Verify that shutdown indicator switch turns "ON" during shutdown and "OFF" when shutdown plunger is reset.
g. Verify that governor shuts down when shutdown plunger is pulled out and when plunger is pushed in beyond its normal position.
h. Install plug, in end of cap, with Loctite 242 on outside diameter of plug.

15. Check ORS for proper functioning.
a. Energize ORS (using switch on test stand) and ORS piston should activate.
b. De-energize ORS and piston should return to normal position.

16. Load Control Timing
a. At step 8 speed setting adjust speed control on test stand until load control indicator pointer is slightly above maximum field start mark on scale.

b. Turn both timing valve adjusting screws fully clockwise. Place a screwdriver under load control washer and raise washer until load control indicator pointer is slightly below minimum field start mark on scale.
   (1) Record time involved for vane servo indicator to move from maximum to minimum (8 seconds maximum).
   (2) Remove screwdriver and record time for vane servo indicator movement from minimum to maximum (8 seconds maximum).

c. Turn timing valve adjusting screws counter clockwise (ccw) to increase the time required for vane servo rotation. Adjust the timing valve closest to the tailrod to attain a maximum to minimum vane servo time of 8.5 to 11 seconds. Adjust the other timing valve to attain a minimum to maximum time of 25 to 35 seconds.

d. At step 8 speed setting adjust speed control on test stand until load control indicator pointer is slightly above maximum field start mark on scale. Energize ORS solenoid with test stand switch and record time for vane servo indicator to move from maximum to minimum (7 to 10 seconds). If too fast “quick-dump” hole in column has not been plugged but should be.

17. Excitation Resistor

a. Disconnect electrical connection from test stand to governor. This places governor in a step 1 speed setting.

b. Adjust test stand speed control to position servo gap at about 1 inch (25 mm). This causes vane servo indicator to rest at maximum excitation stop.

c. Connect an ohmmeter to governor electrical connector pins 2 and 3. Resistance reading should be 27.5 to 33.5 ohms. Connect ohmmeter to pins 1 and 3, resistance should be less than 0.15 ohm.

d. Manually push pin in top of ORS down to activate ORS piston. Resistance across pins 1 and 3 should quickly increase to 27.5 to 33.5 ohms.

e. Release pin in top of ORS solenoid and resistance across pins 1 and 3 should slowly decrease with no sign of a short or open circuit.

f. Any problem with above procedures indicate a wiring or resistor pack problem.

18. Final Check

a. Check set speeds and adjust if necessary. Reference step 8.

b. Check fuel limit points at 0.795 inch (20.19 mm) gap and 0.222 inch (5.64 mm) gap. Reference step 12.

c. Check vane servo balance points at 0.820 inch (20.83 mm) gap and 0.220 inch (5.64 mm) gap. Reference step 11.

d. Check time delay. Reference step 14.

e. Install cover.

f. Verify all speeds.

Test (Governors 8559-910, 8573-463, and 8573-494)

The following test procedure applies to PGEV governors 8559-910, 8573-463, and 8573-494.

Test the governors at 180 to 200 °F (82 to 93 °C) case temperature. Use a magnetic thermometer on the lower part of the power case. Use 20 W 40 oil.

Make the following settings on the test stand prior to starting the test.

a. Turn heater switch to ‘ON.”

b. Turn oil pump switch to “OFF”.

c. Set air gauges to zero.

d. Close valves.

e. Set direction of rotation ccw.

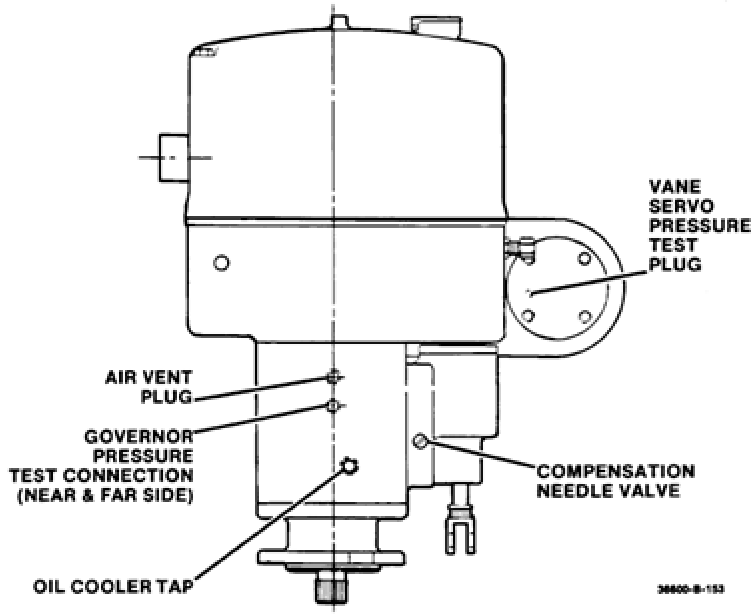

Figure 6-8. PGEV Test Connections

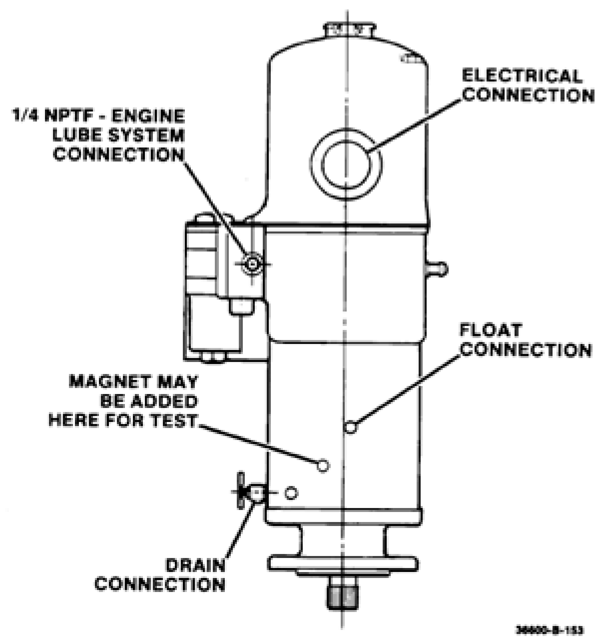

Figure 6-9. PGEV Test Connections

2. Mount governor on test stand. See Figures 6-8, 6-9, and 6-10 and make the following connections:
   - a. Electrical (remove cover first).
   - b. Governor oil pressure gauge.
   - c. Drain
   - d. Float
   - e. Fill
   - f. Fuel limiter pressure
   - g. Altitude pressure/vacuum

h. Low lube oil pressure (air or oil).
i. Servo rod end to test stand.

3. Set the low lube oil pressure to 70 psi.

4. As an initial setting set base speed setting nut down 0.5 inch (12.7 mm) from top of threads on fulcrum screw. See Figure 6-1 1.

5. Loosen locknut on over-riding solenoid and turn over-riding plunger stop down until it bottoms. Turn it 2.5 turns back off bottom and secure it with locknut. See Figure 6-12.

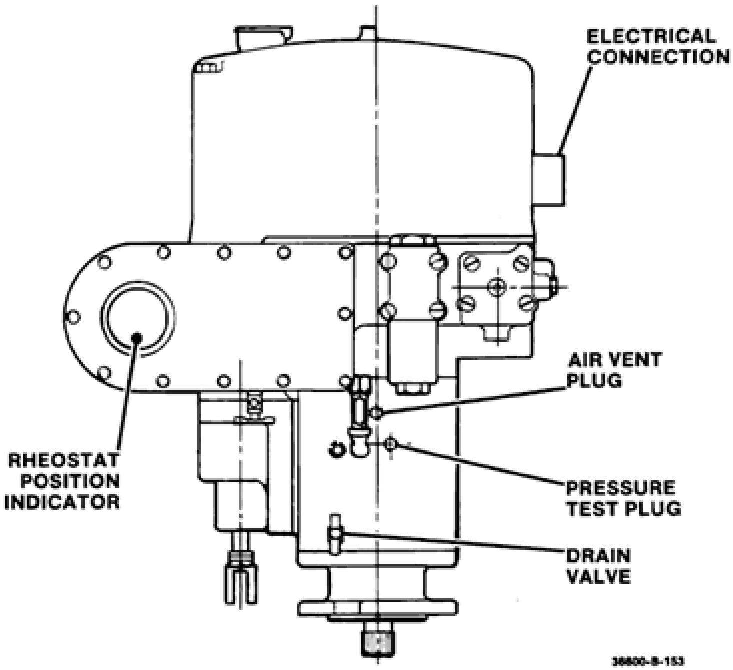

Figure 6-10. PGEV Test Connections

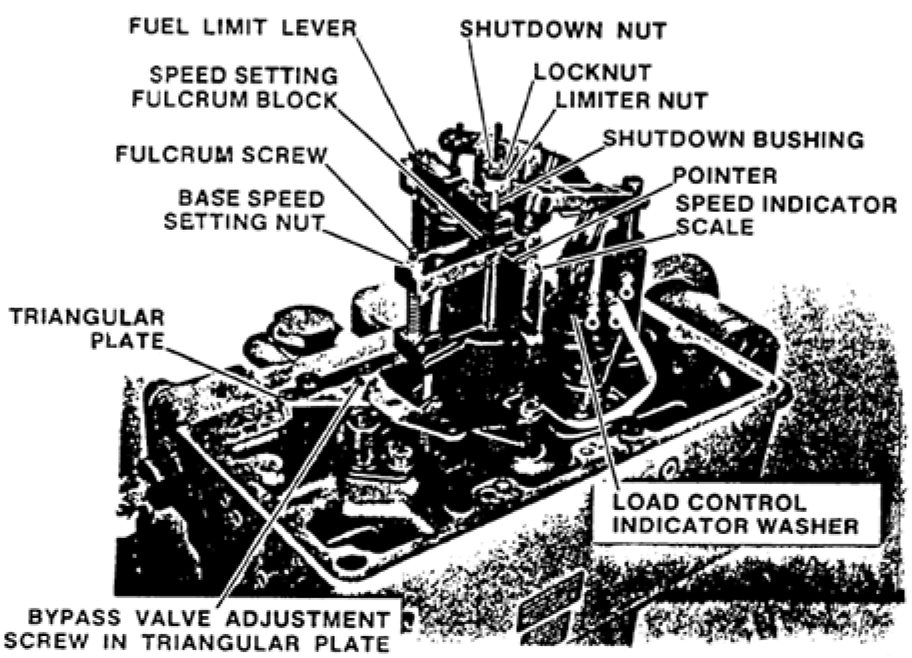

Figure 6-11. Speed Setting Assembly

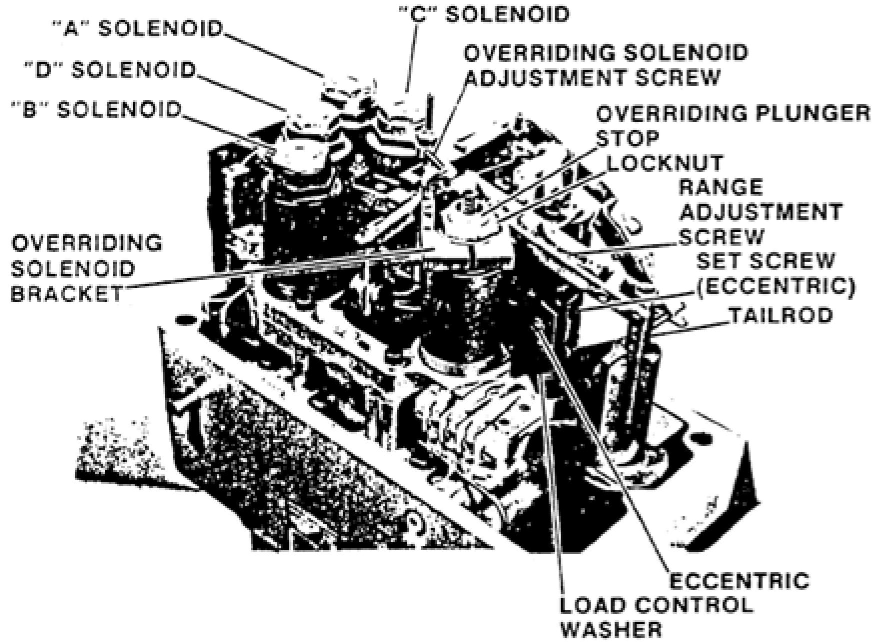

Figure 6-12. Solenoid Pack

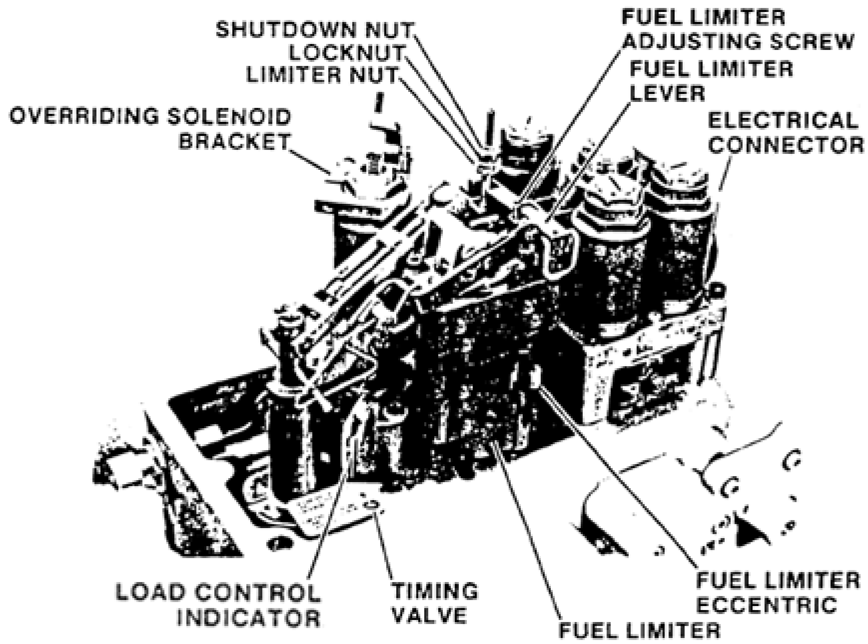

Figure 6-13. PGEV Fuel Limiter

6. Turn both timing valves in until valve gently bottoms. See Figure 6-13.

7. Test stand
   a. Open valve for governor drain all the way.
   b. Open valve for governor fill 0.5 to 1.0 turn from closed.
   c. Open valve for pressure supply 0.5 to 1.0 turn from closed.
   d. Close valve for pressure bleed.
   e. Use pressure regulator to obtain 90 to 110 psi (621 to 759 kPa) test stand oil pressure when pump is on.

8. Speed settings

IMPORTANT **Be sure the governor is controlling test stand speed during speed setting calibration. The servo should not be against either the minimum or maximum stop.**

a. Turn speed selector to step 6 (A, B, C, and D solenoids energized) and turn test stand speed adjusting knob to increase speed to start governor.

b. Adjust base speed setting nut (Figure 6-4) to attain a speed of:

Governor	Nominal Speed (rpm)	Tolerance (rpm)
8573-494	813	809 to 817
8559-910	890	886 to 894
8573-463	890	886 to 894

c. Turn speed selector to step 8 (A, B, and C solenoids energized), loosen locknut on solenoid "D" and adjust stop to get a nominal speed of:

Governor	Nominal Speed (rpm)	Tolerance (rpm)
8573-494	994	990 to 998
8559-910	1074	lO7Oto 1078
8573-463	1074	lO7Oto 1078

d. Turn speed selector to step 7 (B, and C solenoid energized), loosen locknut on solenoid "A" and adjust stop to get a nominal speed of:

Governor	Nominal Speed (rpm)	Tolerance (rpm)
8573-494	904	900 to 908
8559-910	982	978 to 986
8573-463	982	978 to 986

e. Turn speed selector to step 4 (A and C solenoids energized), loosen locknut on solenoid "B" and adjust stop to get a nominal speed of:

Governor	Nominal Speed (rpm)	Tolerance (rpm)
8573-494	633	629 to 637
8559-910	706	702 to 710
8573-463	706	702 to 710

f. Turn speed selector to step 1 (no solenoids energized), loosen locknut on solenoid "C" and adjust stop to get a nominal speed of:

Governor	Nominal Speed (rpm)	Tolerance (rpm)
8573-494	361	357 to 365
8559-910	430	426 to 434
8573-463	430	426 to 434

g. Check speeds at step 2, 3, and 5.

Governor	Step	Nominal Speed (rpm)	Tolerance (rpm)
8573-494	2	452	437 to 467
	3	542	527 to 557
	5	723	708 to 738
8559-910 8573-463	2	522	507 to 537
	3	613	598 to 628
	5	798	783 to 813

IMPORTANT **If these speeds are not in tolerance, try adjusting "set" speeds to tolerance extremes to bring "non-set" speeds within tolerance.**

h. Turn speed selector, on test stand, to step 1.

9. Normal shutdown setting.
a. Thread shutdown bushing on shutdown rod to obtain 0.032 ±. 0.005 inch (0.81 ±. 0.13 mm) clearance between bottom of shutdown bushing and top of speed setting fulcrum block. Lock in position with small locknut. See Figure 6-11.
b. Adjust speed setting stop by turning it down until it contacts speed setting piston then back it out 2 turns and tighten locknut. See Figure 6-1 1.
c. Loosen set screw on speed indicator scale and adjust scale to align idle line with pointer on speed setting fulcrum block.
d. Turn speed selector to “OFF” (“D” solenoid energized), governor servo should go to minimum position (fully down) and fulcrum block pointer should align with “stop” line on speed indicator scale.

10. Speed setting timing.
a. Turn speed selector to step 1. Move selector to step 8 and check time elapsed when pointer starts and stops. Time should be from 11 to 21 seconds.
b. Scribe a mark on speed indicator scale in line with fulcrum block pointer while governor is at step 8 speed.
c. Turn speed selector from step 8 to step 1 and record time elapsed for pointer to return to idle position.

11. Load Control
Set governor to step 8 speed setting and place a 0.220 inch (5.59 mm) gap block between servo housing and rod end. Adjust test stand speed to hold gap block by reducing speed about 20 to 50 rpm from step 8 speed. See Figure 6-12.

IMPORTANT **The vane servo is balanced when there is no movement of the vane servo indicator and the vane servo indicator is not at either the minimum or maximum excitation stop positions.**

a. Use a screw driver and turn eccentric until slot is approximately horizontal. Lock in place with clamp screw.
b. Loosen locknut under load control washer and turn load control pilot valve plunger in or out of eccentric block until vane servo is approximately balanced. Turn plunger by lifting eccentric block with a screwdriver then use a wrench to turn spring collar locknut. After rough adjustment, tighten locknut under load control washer.
c. Use eccentric to balance vane servo at 0.220 inch (5.59 mm) gap and step 8 speed setting.
d. Adjust load control indicator so pointer aligns with zero on scale. Lock in place with clamp screw.
e. Set governor to step 1 speed setting and adjust test stand control to balance vane servo. Balanced gap should be 0.815 to 0.825 inch (20.70 to 20.96 mm). If the gap at balance is too small, adjust range adjustment screw in load control floating lever to move. Lift block for load control links away from tailrod. Move link toward tailrod if gap at balance is to large. Repeat steps 11c and 11e until 0.215 to 0.225 inch (5.46 to 5.72 mm) gap at step 8 speed setting and 0.815 to 0.825 inch (20.70 to 20.96 mm) gap at step 1 speed setting are both attained.
f. Lockwire load control floating lever in position.

12. Manifold Pressure fuel Limiting

IMPORTANT **Limiter calibration is in gauge pressure not absolute, and no barometric correction is needed.**

a. Adjust fuel limit nut on shutdown bushing so fuel limit lever is approximately horizontal when it contacts bottom of fuel limit nut. Secure fuel limit nut with locknut.
b. Set a dial indicator on tailrod and adjust so gap readings can be determined with dial indicator. Correlate dial indicator readings to gap by using a 1 inch gap (25.4 mm) block between servo housing and top of rod end.
c. For this calibration, set governor speed setting to step 8. Determine fuel limit gap by slowly adjusting test stand speed control in decrease speed direction until tailrod stops due to fuel limiter action and speed decreases 7 to 13 rpm from normal step 8 speed.
d. Set a dial indicator on top of fuel limiting sensor piston. As an initial setting adjust eccentric so sensor piston moves down 0.165 inch (4.19 mm) from its upward stop at zero inches of Hg gauge pressure.
e. With zero air pressure to fuel limiter adjust fuel limiter adjusting screw to obtain a fuel limit gap of 0.790 to 0.800 inch (20.07 to 20.32 mm).
f. Check fuel limit gap at 35.1 inches of Hg gauge pressure (118.8 kPa) to fuel limiter. Gap should be 0.207 to 0.237 inch (5.26 to 6.02 mm). If gap is too large, adjust top of fuel limit cam away from tailrod, then tighten cam clamp screw. Move cam toward tailrod if gap is to small. Repeat steps 12e and 12f until tolerances are attained.
g. Check fuel limit gap at 4 inches of Hg gauge pressure (13.5 kPa) to fuel filter. It should be 0.600 to 0.630 inch (15.24 to 16.00 mm).

   Check fuel limit gap at 20.1 inches of Hg gauge pressure (68.1 kPa) to fuel limiter. It should be 0.360 to 0.390 inch (9.14 to 9.91 mm).

   If both are in tolerance fuel limiter calibration is complete.

   If either is out of tolerance change sensor piston position.

   If either gap is too large, set a dial indicator on top of fuel limiting sensor piston. Adjust eccentric so sensor piston moves down 0.155 inch (3.94 mm) instead of 0.165 from its upward stop at zero inches of Hg gauge pressure, as in step 12d. Recalibrate from step 12e on.

   If gap is too small start at a setting of 0.175 inch (4.44 mm).

13. Load Control Override Linkage
a. Install over-riding solenoid bracket on ORS solenoid if not already in place.
b. Set pressure to fuel limiter to zero inches Hg gauge pressure.
c. Adjust speed control on test stand to attain fuel limit.
d. Turn over-riding adjustment set screw down until ORS piston activates, then turn set screw down one-half turn more.
e. Move test stand speed control and slowly bring governor to fuel limit point. Watch dial indicator (on tailrod) and note distance traveled from tailrod position at which ORS piston activates until fuel limiting occurs. Distance should be 0.005 to 0.015 inch (0.13 to 0.38 mm). Adjust set screw if required to attain 0.005 to 0.015 inch setting.

14. Low Lube Oil Shutdown

IMPORTANT

The simulated lube oil pressure provided to the governor may be either air pressure or test stand oil pressure. The vane servo should be approximately balanced when determining low lube oil shutdown pressures, at step 8 and step 1.

a. At step 8 speed setting, low lube oil pressure to cause a governor shutdown should be:

Governor	Low Oil Pressure (psig)	Low Oil Pressure (kPa)
8573-494	58 to 62	400 to 427
8559-910 8573-463	55 to 59	379 to 406

Slowly decrease pressure to check shutdown. If not in tolerance, turn adjustable spring seat cw to lower shutdown pressure. Turn seat ccw to raise pressure. See Figure 4-5.

b. At step 1 speed setting, adjust bypass valve adjustment screw to attain "instant" shutdown (less than3seconds) when low lube oil pressure is reduced to zero. The adjustment is accessible with a long 3/32 inch hex wrench between "C" and "D" solenoids. Turn screw cw to attain "instant" shutdown, if required.

c. At step 1 speed setting, low lube oil pressure to cause a governor shutdown should be:

Governor	Low Oil Pressure (psig)	Low Oil Pressure (kPa)
8573-494	15 to 20	103 to 138
8559-910	19 to 23	131 to 158
8573-463	28 to 32	195 to 220

Slowly decrease pressure and check shutdown. If not in tolerance readjust shutdown pressure at step 8 speed setting until both step 1 and step 8 speed settings are within tolerance. If tolerance can not be attained, replace the speed setting servo spring in governor. See figure 4-1.

d. At step 1 speed setting, turn bypass valve adjustment screw ccw 2 to 3 turns to attain time delay on shutdown. Reduce lube oil pressure to zero, turn bypass valve adjustment screw in (cw) until "instant" shutdown is attained, then back out screw (turn ccw) one-half turn. Verify the half turn setting provides time delayed shutdown with zero lube oil pressure at step 1 speed setting and "instant" shutdown at step 2 speed setting.

e. Set time delay to 35 to 45 seconds.
   (1) Set governor to step 1 speed setting.
   (2) Reduce lube oil pressure to zero.
   (3) Record time required for (time delay) governor to shutdown.
   (4) Loosen retainer screw and move pointer towards electrical connector to increase time or away from connector to decrease time until 35 to 45 seconds time delay is attained.

f. Verify that shutdown indicator switch turns "ON" during shutdown and "OFF" when shutdown plunger is reset.

g. Verify that governor shuts down when shutdown plunger is pulled out and when plunger is pushed in beyond its normal position.

h. Install plug, in end of cap, with Loctite 242 on outside diameter of plug.

15. Check ORS for proper functioning.

a. Energize ORS (using switch on test stand) and ORS piston should activate.

b. De-energize ORS and piston should return to normal position.

16. Load Control Timing

a. At step 8 speed setting adjust speed control on test stand until load control indicator pointer is slightly above maximum field start mark on scale.

b. Turn both timing valve adjusting screws fully clockwise. Place a screwdriver under load control washer and raise washer until load control indicator pointer is slightly below minimum field start mark on scale.
   (1) Record time involved for vane servo indicator to move from maximum to minimum (8 seconds maximum).
   (2) Remove screwdriver and record time for vane servo indicator movement from minimum to maximum (8 seconds maximum).

c. Turn timing valve adjusting screws counter clockwise (ccw) to increase the time required for vane servo rotation. Adjust the timing closest to the tailrod to attain a maximum to minimum vane servo time of 8.5 to 11 seconds. Adjust the other timing valve to obtain a minimum to maximum time of 25 to 35 seconds.
d. At step 8 speed setting adjust speed control on test stand until load control indicator pointer is slightly above maximum field start mark on scale. Energize ORS solenoid with test stand switch and record time for vane servo indicator to move from maximum to minimum (7to 10 seconds). If too fast, “quick-dump” hole in column has not been plugged but should be.

17. Excitation Resistor
a. Disconnect electrical connection from test stand to governor. This places governor in a step 1 speed setting.
b. Adjust test stand speed control to position servo gap at about 1 inch (25 mm). This causes vane servo indicator to rest at maximum excitation stop.
c. Connect an ohmmeter to governor electrical pins 2 and 3. Resistance reading should be 27.5 to 33.5 ohms. Connect ohmmeter to pins 1 and 3, resistance should be less than 0.15 ohms.
d. Manually push pin, in top of ORS, down which activates ORS piston. Resistance across pins 1 and 3 should quickly increase to 27.5 to 33.5 ohms.
e. Release pin, in top of ORS, solenoid and resistance across pins 1 and 3 should slowly decrease with no sign of a short or open circuit.
f. Any problem with above procedure indicates a wiring or resistor pack problem.

18. Final Check
a. Check set speeds and adjust if necessary. Reference step 8.
b. Check fuel limit points at 0.795 inch (20.19 mm) gap and 0.222 inch (5.64 mm) gap. Reference step 12.
c. Check vane servo balance points at 0.820 inch (20.83 mm) gap and 0.220 inch (5.59 mm) gap. Reference step 11.
d. Check time delay. Reference step 14.
e. Install cover.
f. Verify all speeds.

Chapter 7. Replacement Parts

This chapter provides replacement parts information for the PGEV governor. When ordering replacement parts, include the following information:

- Governor serial number and part number shown on nameplate
- Manual number (this manual 36628)
- Parts reference number in parts list and description of part or part name

Parts List for Figure 7-1

Ref. No.	Part Name	Quantity
36628-1	Screw, hex. hd., drilled 5/16-24 x 7-1/4	2
36628-2	Plain washer, 5/16 x 1/2 x 1/32	2
36628-3	Oil filler cup (Press Fit)	1
36628-4	Cover dowel bushing (Press Fit)	1
36628-5	Cover	1
36628-6	Cover gasket	1
36628-7	Screw, soc. hd., 1/4 - 28 x 2-3/8	3
36628-8	Lockwasher, split, 1/4	3
36628-9	Washer	3
36628-10	See Figure 7-2	
36628-11	See Figure 7-2	
36628-12	Electrical receiver assy (see Figure 7-14)	1
36628-13	"D" solenoid cup	1
36628-14	Screw, hex. hd., .250-28 x .750	1
36628-15	Regulating bushing retainer spring	1
36628-16	Retaining spring collar	1
36628-17	Washer, .328 x .562 x .064 thick	1
36628-18	Screw, retaining	1
36628-19	Washer, .265 x .500 x .032 thick	1
36628-20	Regulating bushing retainer	1
36628-21	Straight pin, 0.1245 x 9/16	1
36628-22	Straight pin, drilled 1/8 x 47/64	1
36628-23	Cotter pin, 1/16 x 3/8	2
36628-24	Floating lever (speed setting)	1
36628-25	Thrust bearing	1
36628-26	Pilot valve plunger (speed setting)	1
36628-27	Loading Spring (55 PV plunger)	1
36628-28	Time delay mechanism	1
36628-29	Rotating bushing (SS PV plunger)	1
36628-30	Loading spring (SS PV bushing)	1
36628-31	Integral vane servo	1
36628-32	Nameplate	1
36628-33	Drive screw, .2 x .188	2
36628-34	Lockwasher, split, 5/16	8
36628-35	Screw, hex. hd., 5/16-18 x 1	8
36628-36	Base assy. (Std. PG) (see Figures 7-3 and 7-4)	1
36628-37	Oil seal (Preformed)	1
36628-38	Power case assy	1
36628-39	Seal ring	1
36628-40	Gasket (column/case)	1
36628-41	Gasket (power cylinder/case)	1
36628-42	Lockwasher, split, 3/8	4
36628-43	Screw, soc. hd., 3/8-16 x 1	4
36628-44	Power servo assy. (12 ft-lb) spring return, reciprocating motion w/tailrod	1
36628-45	Bearing stud (Drive gear, Press fit)	1
36628-46	Drive gear (SS PV bushing)	1
36628-47	Setscrew, soc. hd., cup pt. 1/4-28 x 1/4 (Plug)	2
36628-48	Vane-Servo timing valve assy. (used with item 31; see Figure 7-10)	2
36628-49	Thread insert, 5/16-24 x 5/8, mid-grip	2
36628-50	Not used	
36628-51	Lockwasher, split, 5/16	4
36628-52	Screw, hex. hd., Grade 5, 5/16-24 x 5	4
36628-53	O-ring, 3/8 OD	4
36628-54	O-ring, 3/8 OD	1
36628-55	Pipe plug, soc. hd., 1/8-27 NPTF	2
36628-56	Bypass valve assy.	1
36628-57	Solenoid counterbalance spring	1
36628-58	Retaining ring, internal	1
36628-59	Load control bushing	1
36628-60	Loading spring (Load control bushing)	1
36628-61	Gasket (oil seal/spacer)	1
36628-62	Oil seal (used with remote load regulator applications)	1
36628-63	Load control pilot valve assembly (see Figure 7-9)	1
36628-64	Lockwasher, split, 1/4	2
36628-65	Screw, soc. hd., 1/4-28 x 1.125	1
36628-66	Screw, soc. hd., 1/4-28 x 1.750	1
36628-67	Retaining ring	2
36628-68	Pin	1
36628-69 through 71		Not Used
36628-72	Speed setting servo assy (see Figure 7-11)	1
36628-73	Return spring (Speed setting piston)	1
36628-74	Plain washer, 1/4	2
36628-75	Triangular plate	1
36628-76	Screw, hex. hd., 1/4-28 x 1-3/8	2
36628-77	Headed pin	1
36628-78	Cotter pin	1
36628-79	Column	1
36628-80 through 100		Not Used

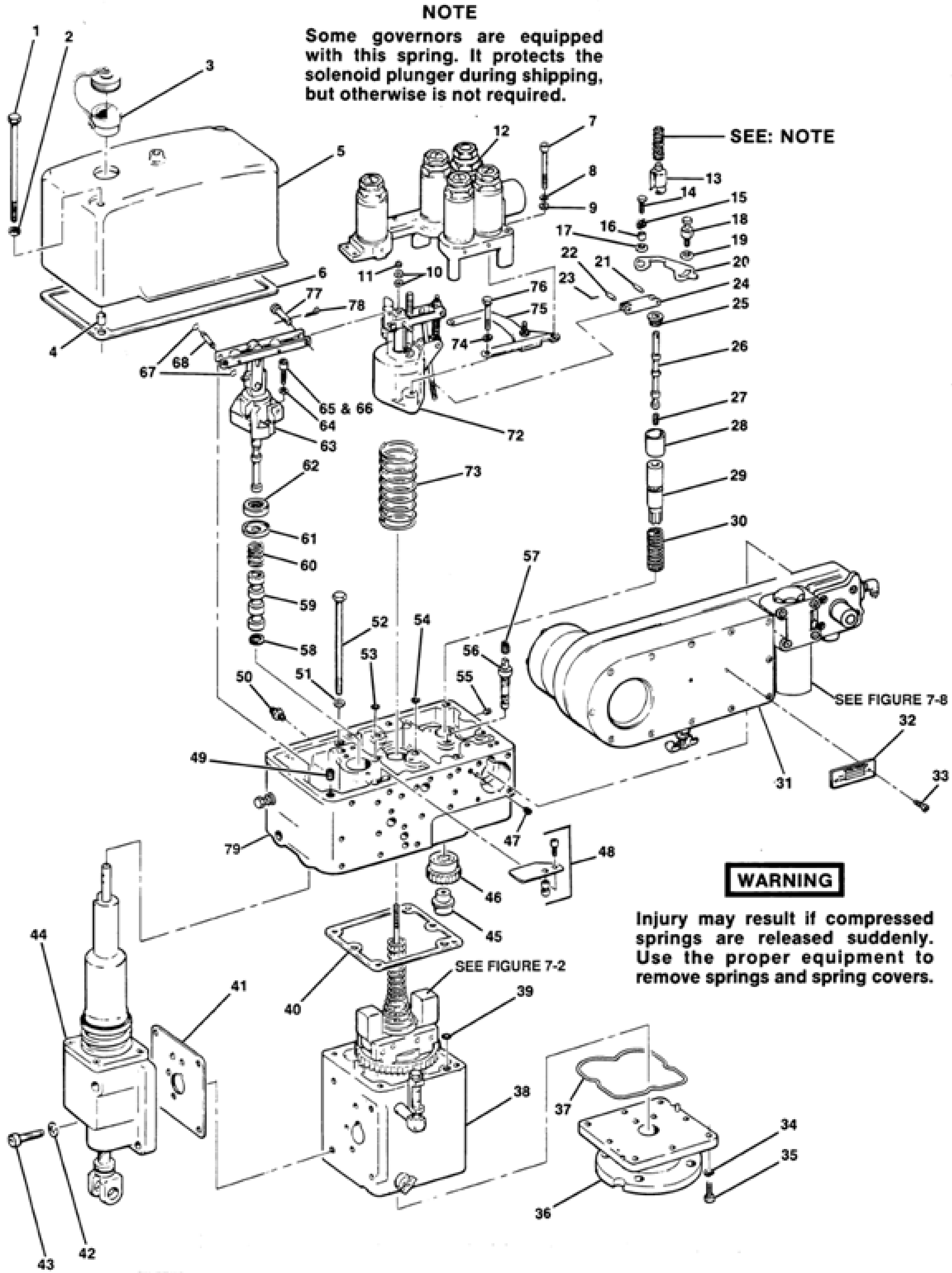

Figure 7-1. Illustrated Parts of PGEV Section Assemblies

Parts List for Figure 7-2

Ref. No.	Part Name	Quantity
36628-101	Idler gear	1
36628-102	Idler gear stud	1
36628-103	Snap ring	4
36628-104	Drain cock	1
36628-105	Elbow	1
36628-106	Oil level gauge, see Figure 7-15	1
36628-107	Pipe plug, 1/8 in.	7
36628-108	Drive gear	1
36628-109	Accumulator piston	2
36628-110	Check plug	2
36628-111	Power case	1
36628-112	Case-to-column dowel pin	2
36628-113	Accumulator spring (small)	2
36628-114	Spring seat	2
36628-115	Accumulator spring (large)	2
36628-116	Gasket	1
36628-117	Spring seat	1
36628-118	Buffer springs	2
36628-119	Plug	1
36628-120	O-ring	1
36628-121	Snap ring	1
36628-122	Buffer piston	1
36628-123	Speeder spring check plug	1
36628-124	Speeder spring	1
36628-125	Pilot valve plunger nut	1
36628-126	Cotter pin	1
36628-127	Spring	1
36628-128	Speeder spring seat	1
36628-129	Thrust bearing	1
36628-130	Nut 8-32, reduced hex	1

Ref. No.	Part Name	Quantity
36628-131	Jam nut, hex., 5/16-24	1
36628-132	Nut, hex, .312-24	1
36628-133	Bushing, shutdown	1
36628-134	Shutdown rod	1
36628-135	Adjusting spring washer	1
36628-136	Adjusting spring	1
36628-137	Flyweight	2
36628-138	Flyweight bearing	4
36628-139	Screw, rd. hd., split, 8-32 x 5/16 in	1
36628-140	Lockwasher, split, No. 8	1
36628-141	Spring coupling assembly	1
36628-142	Screw, fil. hd, 5-40 x 9/32 in	8
36628-143	Lock washer, No. 5	8
36628-144	Flyweight head	1
36628-145	Flyweight pin - limit pin	4
36628-146	Cotter pin	8
36628-147	Snap ring	1
36628-148	Compensating bushing	1
36628-149	Pilot valve plunger	1
36628-150	Centering bearing	1
36628-151	Oil seal ring	1
36628-152	Flyweight head gear	1
36628-153	Pipe plug, 1/16	5
36628-154	O-ring	1
36628-155	Male elbow fitting	1
36628-156	Copper tubing 1/4 in. O.D.	as req.
36628-157	Male compression connector 0.250 tube x 0.125 NPTF	1
36628-158	Oil gauge (weatherproof)	1
36628-159 and 160		Not Used

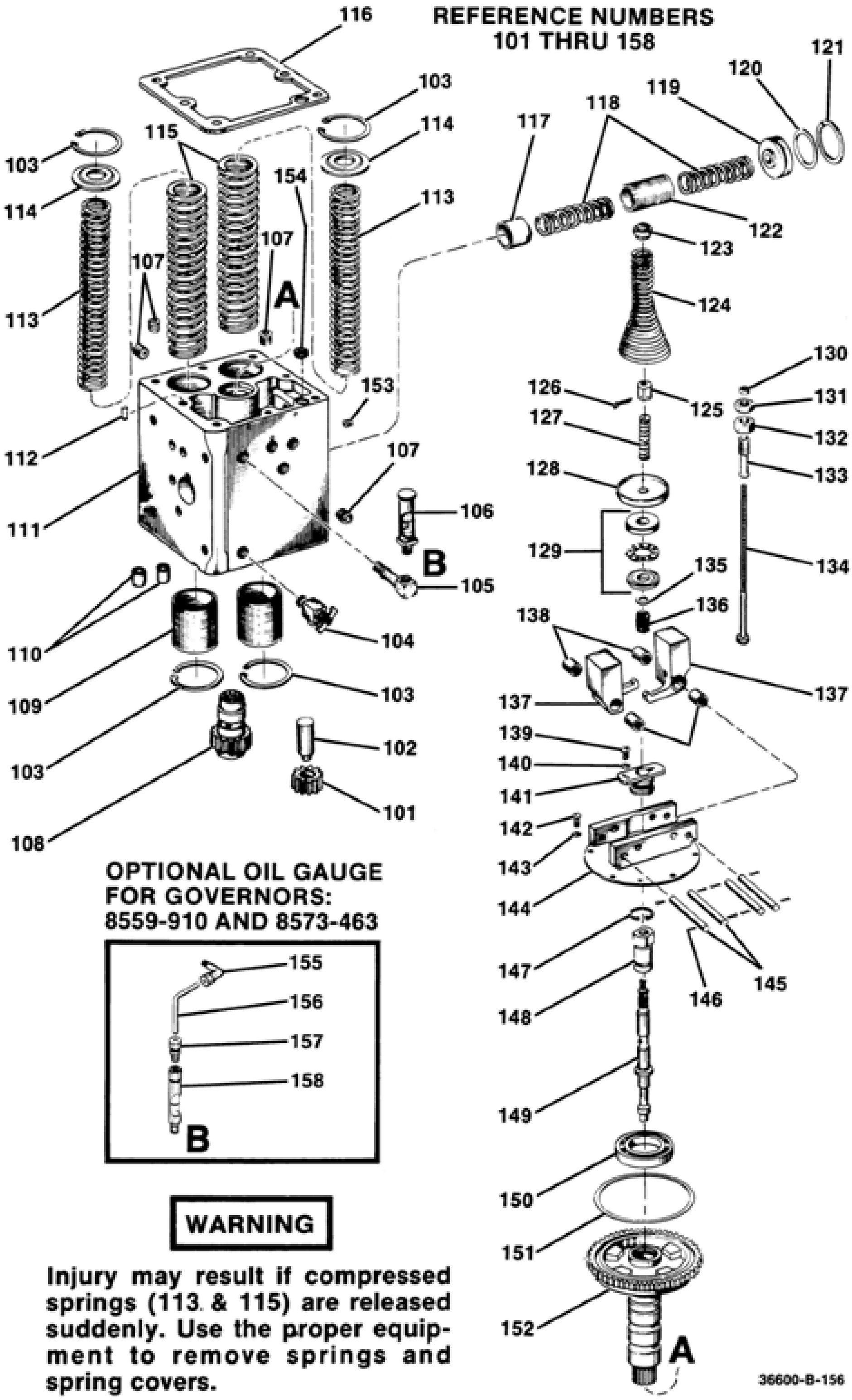

Figure 7-2. Illustrated Parts of Power Case and Pilot Valve Assembly

Parts List for Figure 7-3

Ref. No.	Part Name	Quantity
36628-161	Base	1
36628-162	Pin	2
36628-163	Gasket	1
36628-164	Oil seal retainer	1
36628-165	Oil seal	1
36628-166	Retaining ring	1
36628-167	Bearing	1
36628-168	Drive shaft	1
36628-169	Bearing retainer	1
36628-170	Screw, cap, hex. hd., 1/4-28 x 5/8	1
36628-171	Lockwire	3
36628-172 through 180		Not Used

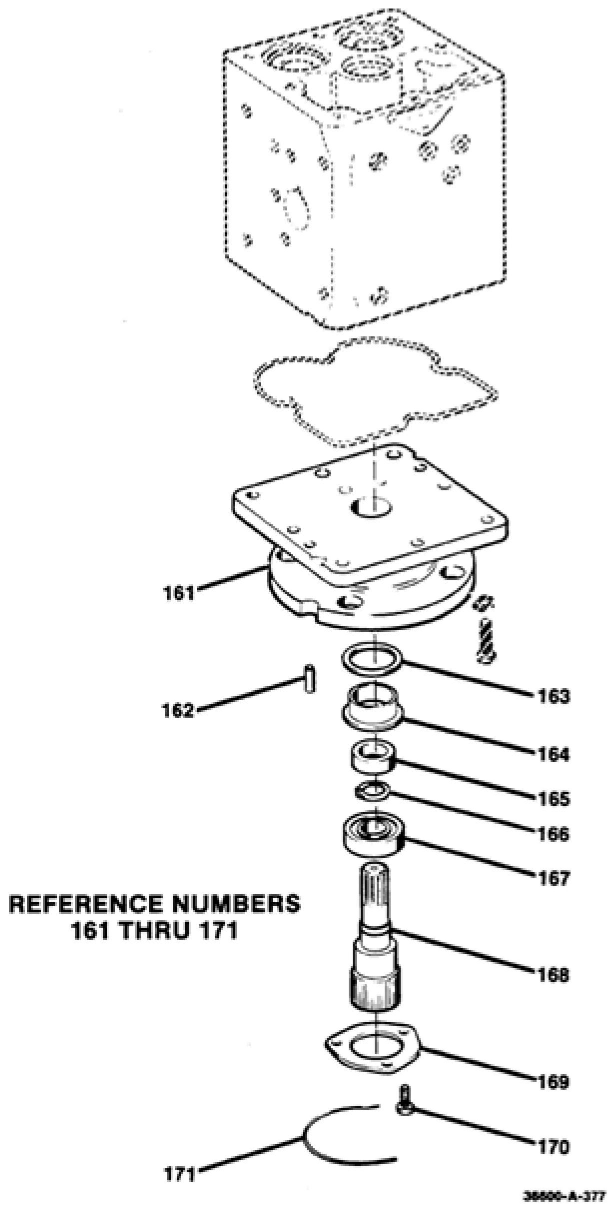

Figure 7-3. Illustrated Parts of Standard Base

Parts List for Figure 7-4

Ref. No.	Part Name	Quantity
36628-181	Base, PG-Extended Square	1
36628-182	Pin	2
36628-183	Gasket	1
36628-184	Oil seal	1
36628-185	Oil seal retainer	1
36628-186	Drive shaft (keyed)	1
36628-187	Cotter pin	1
36628-188	Key	1
36628-189	Bearing	1
36628-190	Spacer	1
36628-191	Nut, castellated, 1/4-28	1
36628-192	Bearing retainer	1
36628-193	Screw, cap, hex. hd., 1/4-28 x 5/8	3
36628-194	Lockwire	4
36628-195	Plug	1
36628-196 through 200		Not Used

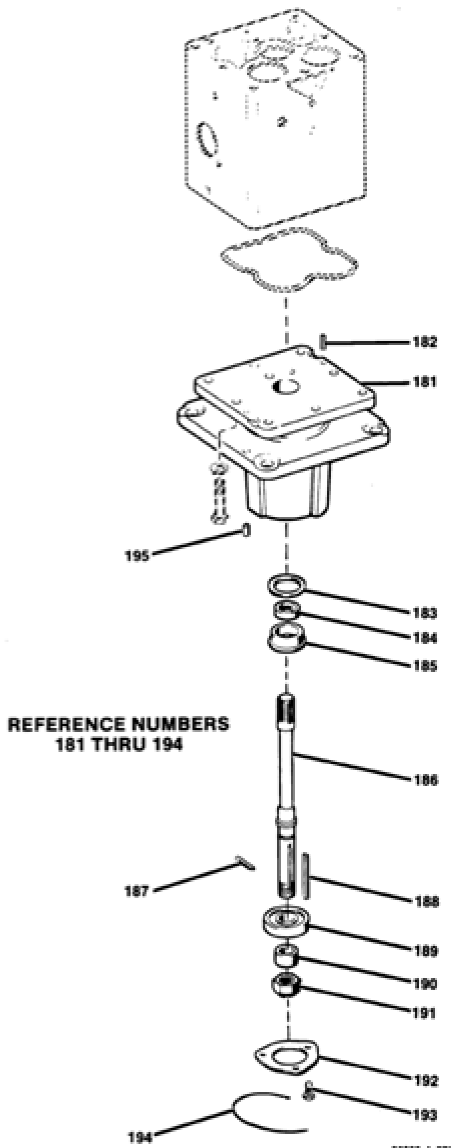

Figure 7-4. Illustrated Parts of PG Extended Base

Parts List for Figure 7-5

Ref. No.	Part Name	Quantity
36628-201	O-ring	1
36628-202	Ring, spring guard seal	1
36628-203	Spring, spring guard seal	1
36628-204	Screw, fil. hd., 10-32 x 3/8	2
36628-205	Washer, No. 10	2
36628-206	Scale, piston gap	1
36628-207	Screw, cap, soc. hd., 1/4-28 x 1/2	4
36628-208	Washer, shake-proof, 1/4	1
36628-209	Spring guard	1
36628-210	Gasket, spring guard	1
36628-211	Spring, power	1
36628-212	Pin, fuel indicator	1
36628-213	Tailrod, power piston	1
36628-214	Nut, tailrod, flex-bc, 3/8-24	1
36628-215	Nut, tailrod, lift	1
36628-216	Washer, shake-proof, 3/8	1
36628-217	Power piston and rod assembly	1
36628-218	Valve, needle	1
36628-219	O-ring	1
36628-220	Power cylinder assembly	1
36628-221	Seal, oil, type P	1
36628-222	Seal, oil, type G	1
36628-223	Pin, taper	1
36628-224	Pin, cotter, 1/16 x 3/8	1
36628-225	Rod end	1
36628-226 through 250		Not Used

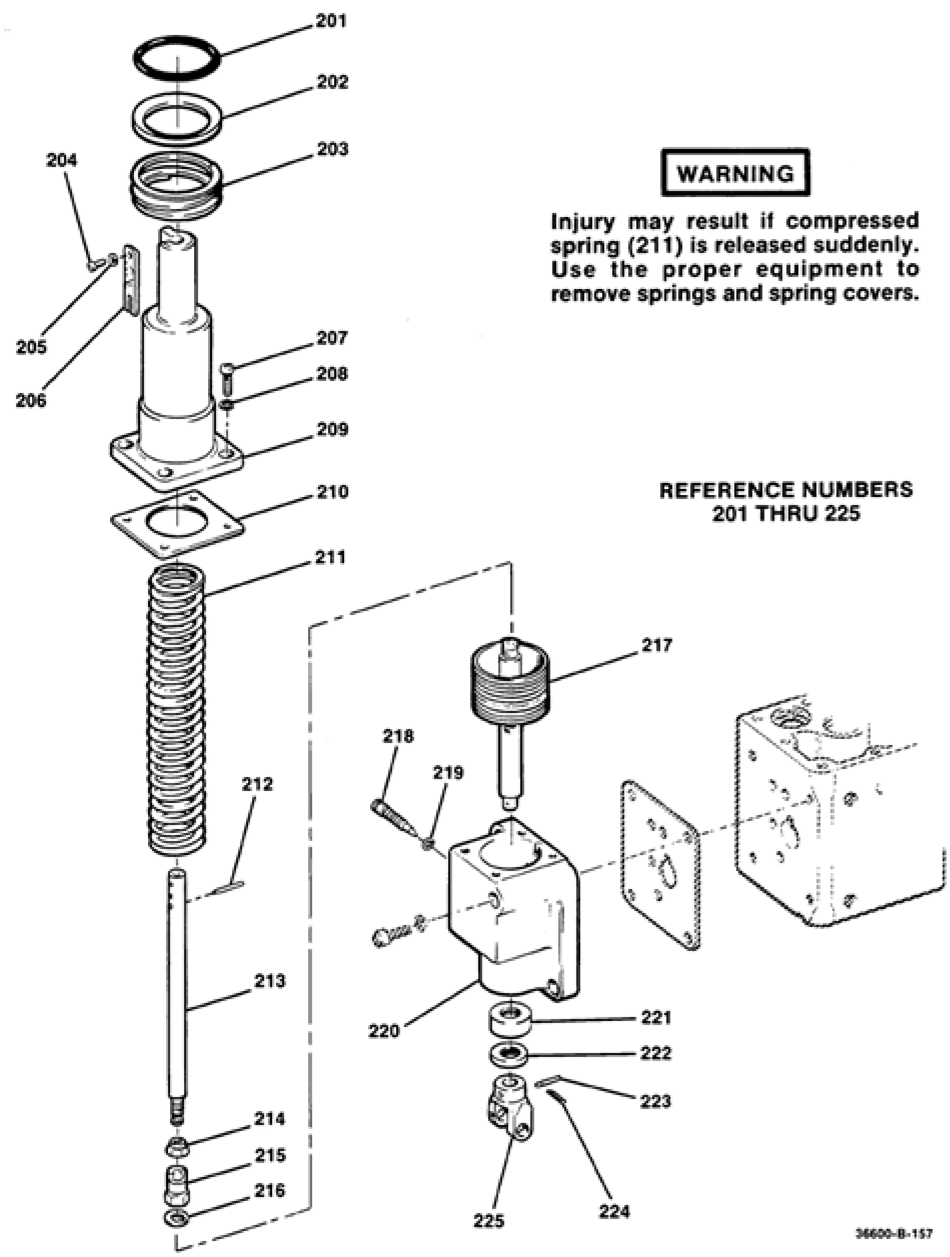

Figure 7-5. Illustrated Parts of Power Servo

Parts List for Figure 7-6

Ref. No.	Part Name	Quantity
36628-251		Not Used
36628-252	Union Assy - limiter bulkhead	1
36628-253	Lock-nut, Union assembly	1
36628-254	Screw - Type U drive, 6 x 3/8	1
36628-255	Plug	1
36628-256	Piston spring	1
36628-257	Shutdown piston	1
36628-258	Valve bushing gasket	1
36628-259	Valve bushing	1
36628-260	Washer	1
36628-261	Screw, soc. hd., 1/4-28 x 3/8	1
36628-262	Shutdown valve plunger	1
36628-263	Diaphragm	1
36628-264	Differential piston	1
36628-265	O-ring, .316 OD	1
36628-266	O-ring, 2.012 OD	1
36628-267	Bellofram spacer	1
36628-268	Diaphragm	1
36628-269	Diaphragm washer	1
36628-270	Nut, hex, 10-32 (special)	1
36628-271	Load spring	1
36628-272	Spring seat (adjustment screw)	1
36628-273	O-ring, 2.012 OD	1
36628-274	Diaphragm cap	1
36628-275	Plug	1
36628-276	Washer, split lock, 17/64	14
36628-277	Screw, soc. hd., 1/4-28 x 2	4
36628-278 through 300		Not Used

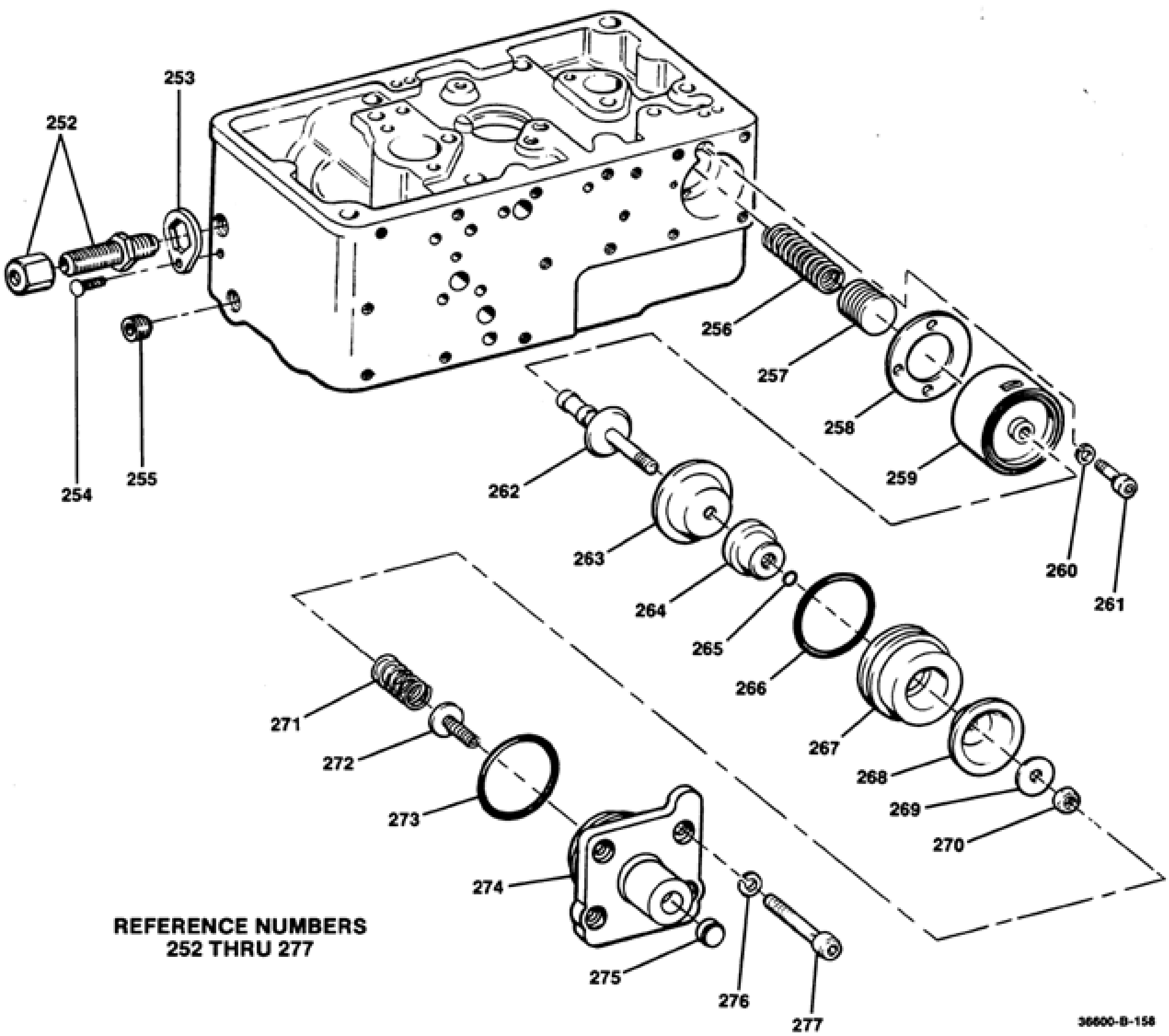

Figure 7-6. Illustrated Parts of Low Lube Oil Shutdown

Parts List for Figure 7-7

Ref. No.	Part Name .... Quantity	Ref. No.	Part Name .... Quantity
36628-301	Shutdown plunger tubing 1	36628-315	Bypass valve body............ 1
36628-302	O-ring............1	36628-316	Retainer spring 1
36628-303	Shutdown plunger............1	36628-317	Retainer sleeve............ 1
36628-304	Anti-blocking ball spring............1	36628-318	O-ring............ 1
36628-305	Headed pin............1	36628-319	Nut, seal retainer 1
36628-306	Anti-blocking ball............1	36628-320	Counterbalance spring (solenoid speed setting only)............ 1
36628-307	Anti-blocking pin............1		
36628-308	Anti-blocking ball seat............1	36628-321	Adjustment sleeve 1
36628-309	Shutdown plunger spring 1	36628-322	Time delay pointer 1
36628-310	O-ring............1	36628-323	Retainer spring washer............ 1
36628-311	Bypass valve spring seat 1	36628-324	Retainer spring collar............ 1
36628-312	Bypass valve spring............1	36628-325	Bushing retainer spring............ 1
36628-313	Bypass valve plunger............1	36628-326	Screw, hex. hd., 1/4-28 x 3/4............ 1
36628-314	Roll pin............1	36628-327	through 340 .... Not Used

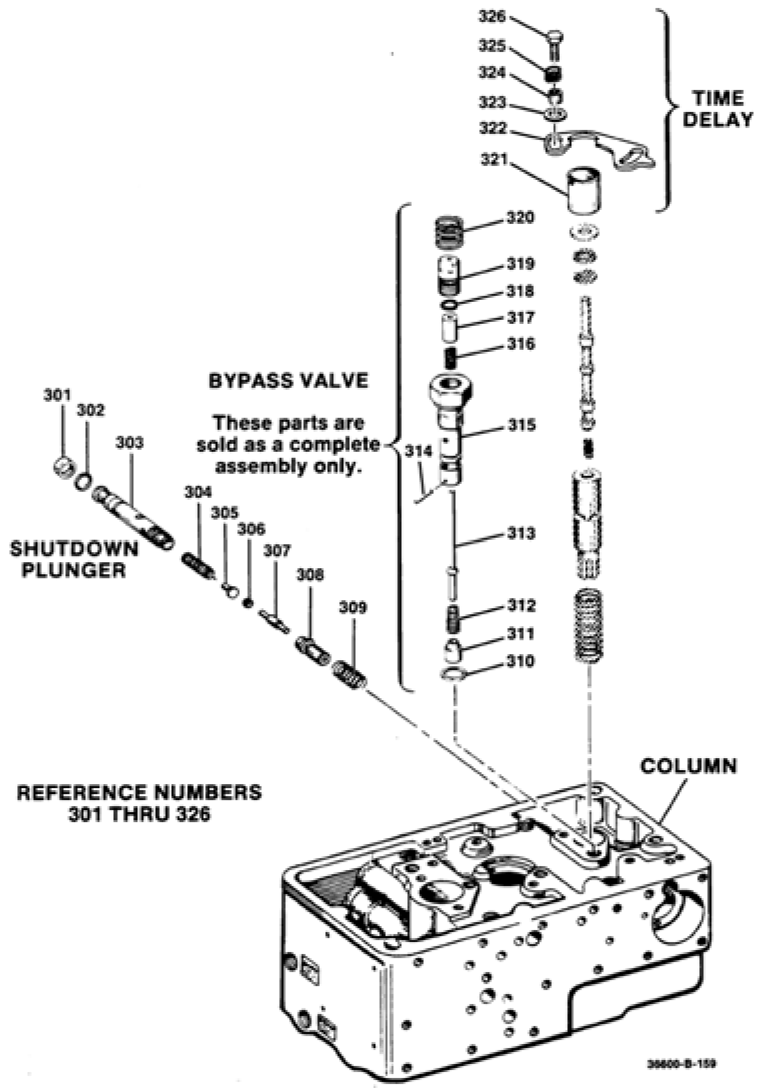

Figure 7-7. Illustrated Parts of Time Delay, Bypass Valve, & Shutdown Plunger

Parts List for Figure 7-8

Ref. No.	Part Name	Quantity
36628-341	Plug and filter assembly	1
36628-342	O-ring, 1-1/4 OD	1
36628-343	O-ring, 11/16 OD	1
36628-344	Gasket	1
36628-345	Case, 4 hole	1
36628-346	Gasket, soft copper	1
36628-347	Plug	1
36628-348	Lockwasher, split, 1/4	4
36628-349	Screw, soc. hd., 1/4-28 x 2-3/4	4
36628-350 through 360		Not Used

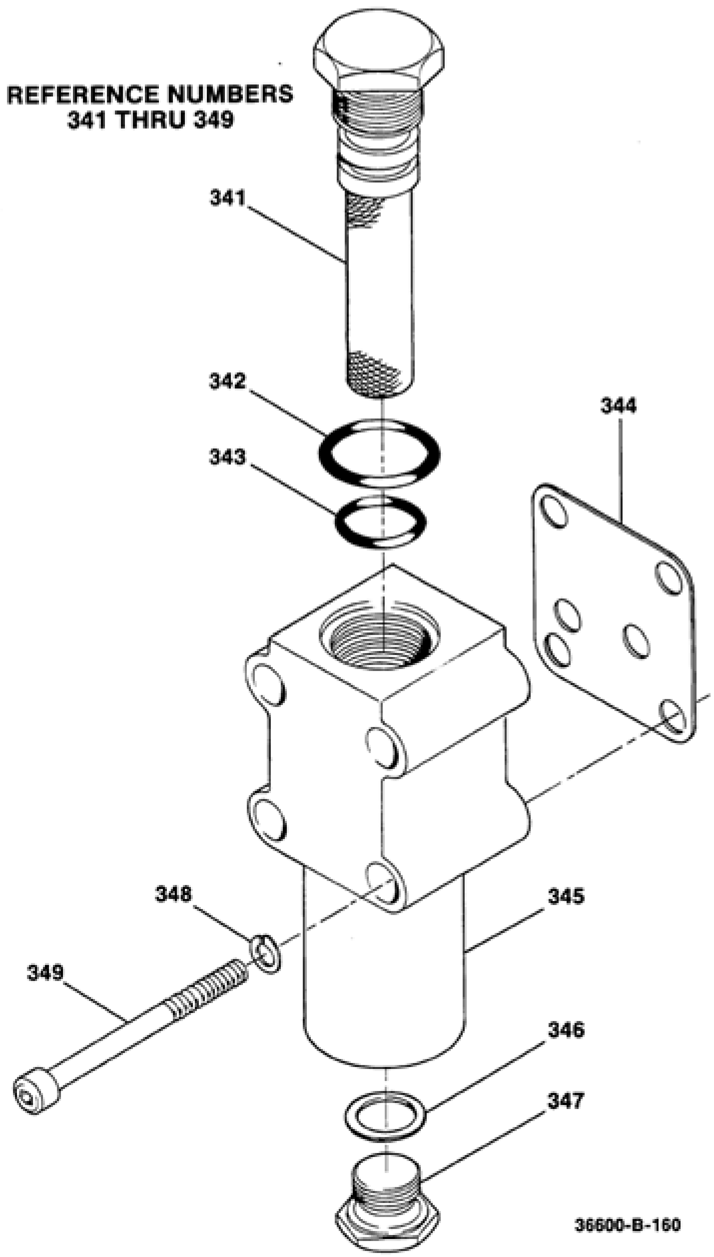

Figure 7-8. Illustrated Parts of Oil Filter

Parts List for Figure 7-9

Ref. No.	Part Name	Quantity
36628-361	Knob	1
36628-362	Knob pin	1
36628-363	Knob spring	1
36628-364	Range adjustment screw	1
36628-365	Load control floating lever	1
36628-366	Cotter pin, 1/16 x 1/2	1
36628-367	Fulcrum block (Load control)	1
36628-368	Load control link (right)	1
36628-368A	Load control link (left)	1
36628-369	Eccentric	1
36628-370	Cotter pin, 1/16 x 3/8	2
36628-371	Screw, soc. hd., 1/4-28 x 3/4	1
36628-372	Connecting block	1
36628-373	Indicator actuating washer	1
36628-374	Nut, 5/16-24	1
36628-375	Retaining ring	1
36628-376	Spring retainer	1
36628-377	Load control valve spring	1
36628-378		Not Used
36628-379	Nut, 5/16-24	1
36628-380	Spring collar	1
36628-381	Overriding piston	1
36628-382	Overriding valve plunger	1
36628-383	Return spring (overriding valve plunger)	1
36628-384	Plain washer, No. 10	1
36628-385	Screw, Phil rd. hd., 10-32 x 1/4	1
36628-386	Load control indicator assy	1
36628-387	Overriding cylinder	1
36628-388	Tapered plug, 1/4-28 (Special)	1
36628-389	Cylinder head (Press-fit)	1
36628-390	Pilot valve plunger (load control)	1
36628-391 through 400		Not used

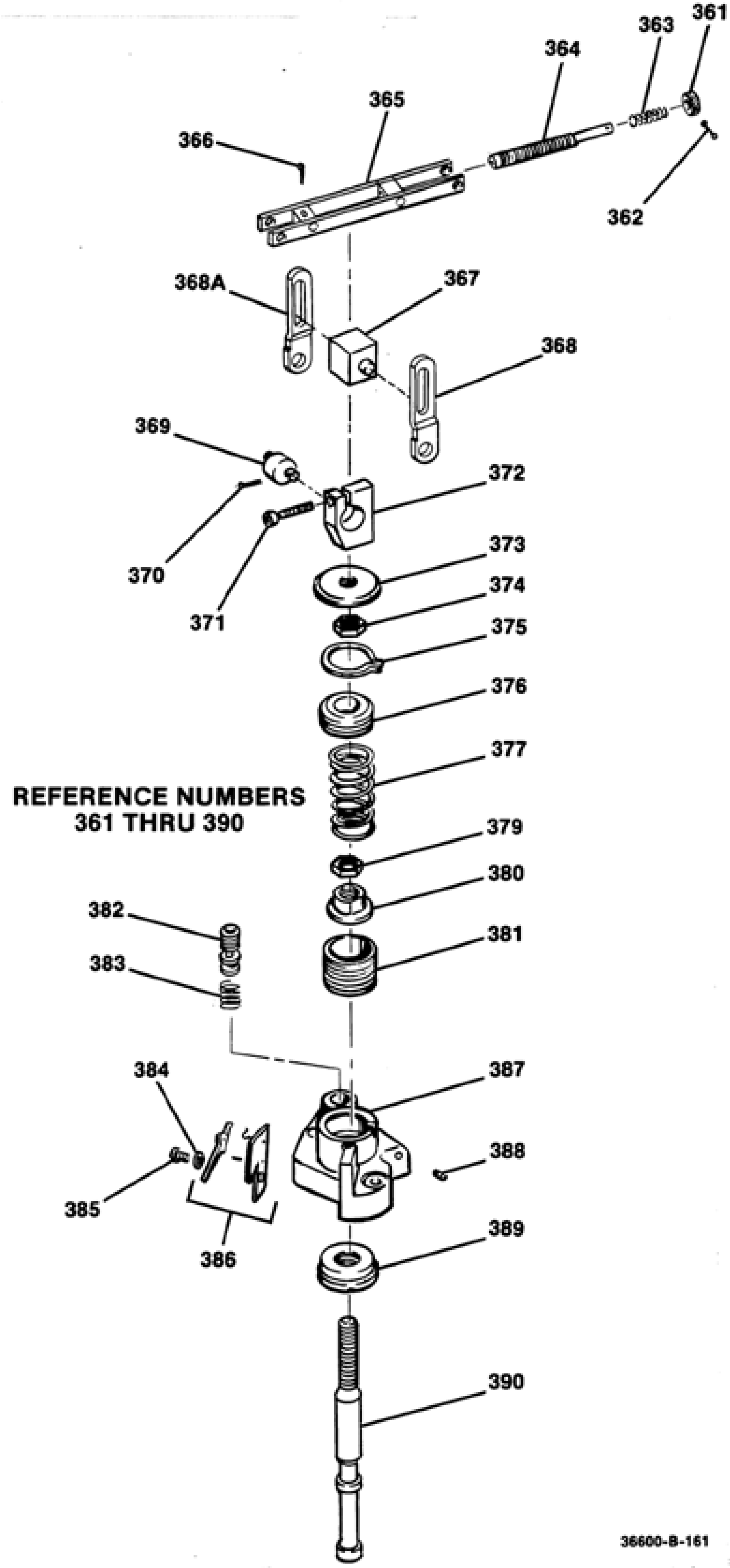

Figure 7-9. Illustrated Parts of Load Control System

Parts List for Figure 7-10

Ref. No.	Part Name	Quantity
36628-401	Pipe plug, soc. hd., 1/8 NPTF	1
36628-402	Dowel pin, 1/4 x 1	4
36628-403	Screw, soc. hd., 1/4-28 x 1	2
36628-404	Nut, 1/4 – 28	1
36628-405	Lockwasher, mt. tooth, 1/4	2
36628-406	Stud	2
36628-407	End plate plug	1
36628-408	Lock washer, split, 1/4	2
36628-409	End plate	1
36628-410	Needle bearing	2
36628-411	Oil seal ring	1
36628-412	Housing and divider assy	1
36628-413	Insert spring	2
36628-414	Vane insert	2
36628-415	Servomotor shaft	1
36628-416	Oil seal ring	1
36628-417	Supply valve sleeve	1
36628-418	Supply valve spring	1
36628-419	Supply valve plunger (load control)	1
36628-420	Needle bearing	2
36628-421	Back plate	1
36628-422	Lockwasher, split, 1/4	2
36628-423	Screw, soc. hd., 1/4-28 x 3/4	2
36628-424	Pin, straight, 1/4 x 3/4	4
36628-425	O-ring, 11/16 OD	2
36628-426	Retaining ring, external	1
36628-427	O-ring	1
36628-428	Side plate	1
36628-429	Side plate gasket	1
36628-430	Elbow 90°	1
36628-431	Plug, hex, socket .250 18	1
36628-432	Lockwasher, split, 1/4	1
36628-433	Screw, soc. hd. 1/4-28 x 3/4	10
36628-434	Cover gasket	1
36628-435	Screw, Ph. flat had., 8-32 x .375	2
36628-436	Screw, fil. hd., 8-32 x .750	2
36628-437	Screw, fil. hd., 8-32 x .750	2
36628-438	Commutator plate	1
36628-439	Spacer	1
36628-440	Spacer, .375 OD x .203 ID x .250	4
36628-441		Not Used

Ref. No.	Part Name	Quantity
36628-442	Lockwasher, No. 6	2
36628-443	Fibre washer	2
36628-444	Terminal block assembly	1
36628-445	Screw, Ph. Pan. Hd., 6-32 x 1/2	2
36628-446	Spacer, resistor pack .437 OD x .031 ID x 1.00	2
36628-447	Fibre Washer, extruded, insulating	2
36628-448	Lockwasher, mt tooth, No. 8	2
36628-449	Screw, soc hd, 8 - 32 x 3/8	2
36628-450	Commutator and resistor pack assy	1
36628-451	Nut, self-locking, 8-32	2
36628-452	Nut, hes., elastic, 8-32	2
36628-453	Screw cap, soc. hd., 8-32 x 1-1/8	2
36628-454	Lockwasher, split, No. 8	2
36628-455	Screw, soc. hd., 1/4-28 x 3	4
36628-456	Lockwasher, split, 1/4	2
36628-457	Screw, soc. hd., 1/4-28 x 3	8
36628-458	Drain valve	1
36628-459	Dial glass gasket	1
36628-460	Dial glass	1
36628-461	Dial plate	1
36628-462	Screw, Phil. flat hd., 6-32 x 3/8	6
36628-463	Spanner nut	1
36628-464	Keyed lock washer	1
36628-465	Indicator button	1
36628-466	Contact brush and indicator assy	1
36628-467	Brush drive shaft	1
36628-468		Not Used
36628-469	Screw, soc. hd., 1/4-28	1
36628-470	Instruction plate	1
36628-471	Lockwasher, split, 1/4	1
36628-472	Retainer plate	1
36628-473	Needle screw	2
36628-474	O-ring	4
36628-475	Body	2
36628-476	Check ball, 3/16 dia.	2
36628-477	Ball spring	2
36628-478	Plug	2
36628-479	Retaining ring, internal	2
36628-480	Cover	1
36628-481 through 500		Not Used

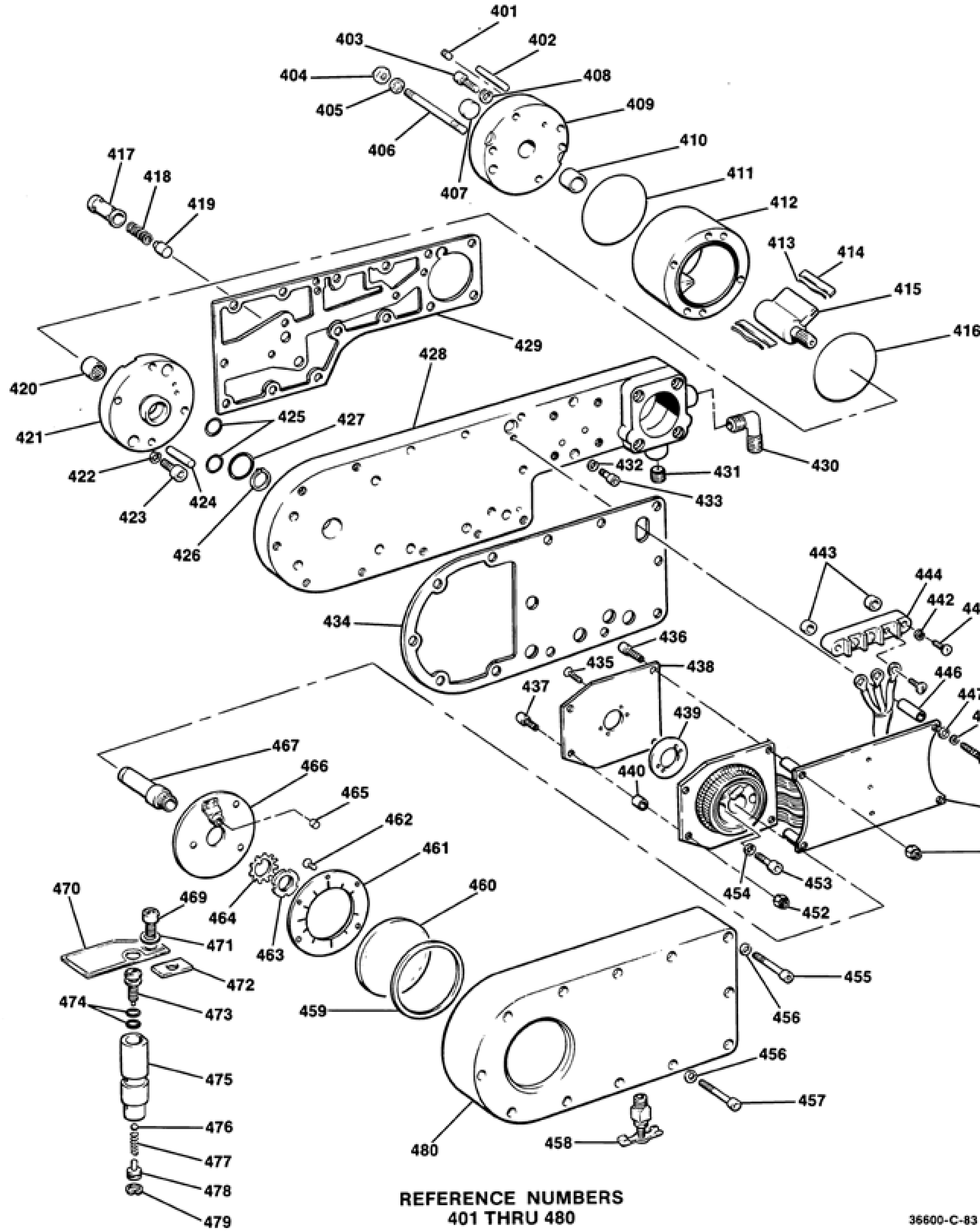

Figure 7-10. Illustrated Parts of Vane Servo

Parts List for Figure 7-11

Ref. No.	Part Name	Quantity
36628-501	Cotter pin, 1/16 x 3/8	1
36628-502	Washer .203 x .438 x .032 thick	1
36628-503	Load control link	1
36628-504	Fulcrum block (speed setting piston) (press fit)	1
36628-505	Spacer	2
36628-506	Nut, self-locking, 10-32 (base speed setting)	1
36628-507	Fulcrum block (speed setting)	1
36628-508	Restoring link	1
36628-509	Loading spring (restoring link)	1
36628-510	Restoring lever	2
36628-511	Straight pin, drilled, 1/8 x 63/64	1
36628-512	Cotter pin, drilled, 1/8 x 63/64	2
36628-513	Headed pin, 3/16 x 61/64	1
36628-514	Loading spring (speed setting fulcrum)	1
36628-515	Plain washer, #10	1
36628-516	Speed setting fulcrum screw	1
36628-517	Straight pin (Press fit to fulcrum screw)	1
36628-518	Setscrew, soc. hd., flat pt.	1
36628-519	Nut, 10-32	1
36628-520	Speed setting piston	1
36628-521	Speed setting cylinder	1
36628-522	Screw, fil. rd. hd., 10-32 x 3/8	1
36628-523	Plain washer, #10	1
36628-524	Speed indicator scale	1
36628-525 through 550		Not Used

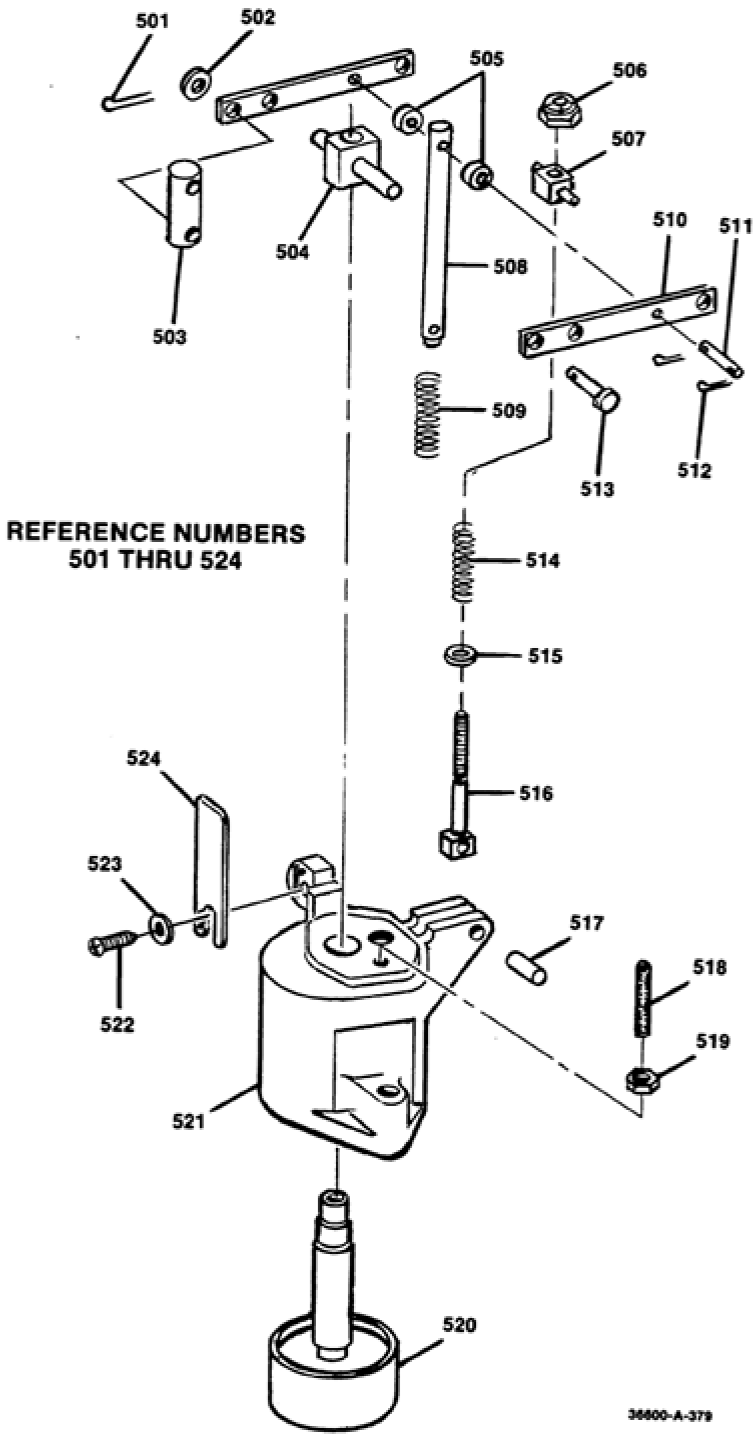

Figure 7-11. Illustrated Parts of Speed Setting Cylinder

Parts List for Figure 7-12

Ref. No.	Part Name	Quantity
36628-551	Sensor piston sleeve	1
36628-552	Sensor piston	1
36628-553	Screw, button soc. hd., Nylok, 8-32 x 3/8	1
36628-554	Roll pin, 1/8 x 3/8	1
36628-555	Fuel limit cam	1
36628-556	Spring seat	1
36628-557	Restoring spring	1
36628-558	Restoring spring seat	1
36628-559	Bleed valve diaphragm	1
36628-560	Pin, .059 x .082 dia. x 0.782, overall length	1
36628-561	Valve seat	1
36628-562	Retaining ring, internal (used with item 566 only)	1
36628-563	Bellows output strap	1
36628-564	Bellows spacer (used with item 566 only)	1
36628-565	O-ring, 1-1/4 OD	1
36628-566	Sensor bellows (absolute pressure type)	1
36628-567	Ferrule, 1/4 tube	1
36628-568	Lockwasher, #10	1
36628-569	Screw, soc. hd., 10-32 x 1-1/2	1
36628-570	Screw, hex. hd., 1/4-28 x 3/4	1
36628-571	Washer, soft copper	1
36628-572	Eccentric	1
36628-573	Gasket, copper	1
36628-574	Steel ball	1
36628-575	Screw, button, soc. hd. Nylok 8-32 x 3/8	2
36628-576	O-ring, 0.375 OD	1
36628-577	Cylinder head	1
36628-578	Lockwasher, 1/4	1
36628-579	Screw, soc. hd., 1/4-28 x 1-3/4	1
36628-580	Lockwasher, 1/4	1
36628-581	Screw, soc. hd., 1/4-28 x 1-1/8	1
36628-582		Not Used
36628-583	Orifice case	1
36628-584	Washer, 3/16 ID x 3/8 (max) OD x 1/16	2
36628-585	Gasket	33
36628-586	Orifice plate	32
36628-587	Orifice pack spring	1
36628-588	Washer, 9/64 ID x 3/8 (max) OD x 1/32	1
36628-589	Retaining ring, internal	1
36628-590	Check valve assembly	1
36628-591	O-ring, 1/2 OD	2
36628-592	Filter screen	1
36628-593	O-ring, 1/2 OD	2
36628-594	Solenoid plunger stop	1
36628-595	Overriding lever loading spring	1
36628-596	Headed pin, drilled	1
36628-597	Overriding solenoid bracket	1
36628-598	Cotter pin, 1/16 x 3/8	2
36628-599	Straight pin, drilled	1
36628-600	Lockwasher, #10	1
36628-601	Screw, soc. hd., 10-32 x 1-1/4	1
36628-602	Setscrew, soc. hd., oval pt., 8-32 x 1	1
36628-603	Nut, hex., 8-32	1
36628-604	Washer, plain, #10	1
36628-605	Overriding lever yield spring	1
36628-606	Headed pin, drilled	1
36628-607	Cotter pin 1/16 x 5/8	2
36628-608	Cotter pin 1/16 x 3/8	1
36628-609	Bellcrank	1
36628-610	Straight pin, drilled	1
36628-611	Cotter pin, 1/16 x 3/8	2
36628-612	Needle bearing	1
36628-613	Fuel limit floating lever	1
36628-614	Pivot	1
36628-615	Fuel limit lever	1
36628-616	Loading spring	1
36628-617	Cotter pin, 1/16 x 5/8	1
36628-618	Retaining ring, E-type	1
36628-619	Adjusting screw, fuel limit	1
36628-620	Feedback lever	1
36628-621	Pivot pin (fuel limit lever)	1
36628-622	Linkage bracket	1
36628-623	Screw, soc. hd., 10-32 x 1/2	2
36628-624	Lockwasher, #10	3
36628-625	Amplifier piston	1
36628-626	Pivot pin (bellcrank)	1
36628-627	Amplifier pilot valve plunger	1
36628-628	Pilot valve loading spring	1
36628-629	Housing	1
36628-630	Overriding lever	1
36628-631 through 700		Not Used

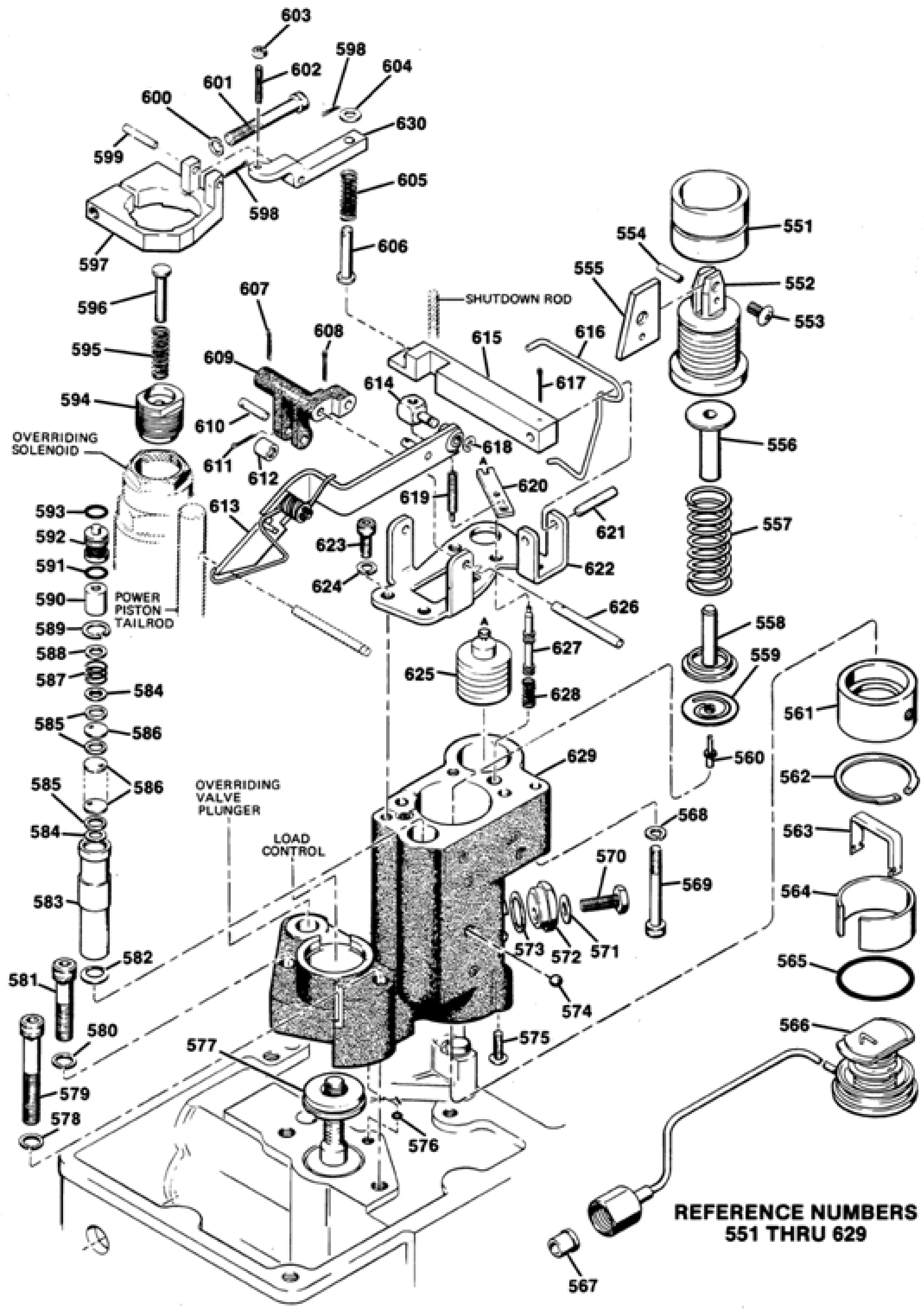

Figure 7-12. Illustrated Parts of Fuel Limiter

Parts List for Figure 7-13

Ref. No.	Part Name	Quantity
36628-701	Floating lever	1
36628-702	Washer	2
36628-703	Washer, .360 OD	2
36628-704	Block	1
36628-705	Splitlock washer, #10	1
36628-706	Washer, .360 OD	2
36628-707	Cotter pin .060 x .375	5
36628-708	O-ring, .375 OD	1
36628-709	Steel ball .250	3
36628-710	Altimeter body	1
36628-711	Nylok button head screw	2
36628-712	Retainer ring	1
36628-713	Lockwasher, high collar, .250 ID	2
36628-714	Soc. hd. cap screw, .250-28 x 2.000	2
36628-715	Cap screw, .250-28 x .750	1
36628-716	Washer, .250 x .500 x .031	1
36628-717	Eccentric	1
36628-718	Washer, .567 x .745 x .030 - .034	1
36628-719		Not Used
36628-720	O-ring, .375 OD	1
36628-721		Not Used
36628-722	Washer, .360 OD	2
36628-723	Cotter pin, .060 x .375	5
36628-724		Not Used
36628-725		Not Used
36628-726	Orifice case	1
36628-727	Gasket	33
36628-728	Orifice plate	32
36628-729	Washer, .375 OD	1
36628-730	Washer, .360 OD	2
36628-731	Oil seal compression ring	1
36628-732	Retaining ring	1
36628-733	Plug	1
36628-734	O-ring	1
36628-735	Washer	1
36628-736	Washer, splitlock, #10	1
36628-737	Soc. hd. cap screw, 10-32 x .375	1
36628-738	Valve seat	1
36628-739	Pin, and diaphragm	1
36628-740	Altitude compensation bellows	1
36628-741	Spring seat	1
36628-742	Spring	1
36628-743	Spring seat	1
36628-744	Piston	1
36628-745	Cotter pin, .030 x .375	2
36628-746	Drilled straight pin	1
36628-747	Piston sleeve	1
36628-748	Piston link	1
36628-749	Fil. hd. screw, 6-32 x .375	1
36628-750	Washer, splitlock, #6	1
36628-751	Washer, .310 OD	1
36628-752	Drilled pin	1
36628-753	Crank arm	1
36628-754	Soc. hd. screw, 10-32 x .750	1
36628-755	Cotter pin, .0625 x .625	1
36628-756	Washer, splitlock, #10	1
36628-757	Soc. hd. cap screw, 10-32 x .500	1
36628-758	Needle bearing	1
36628-759	Washer, splitlock, #10	2
36628-760	Soc. hd. cap screw, 10-32 x .625	2
36628-761	Derating bracket	1
36628-762	Needle bearing	1
36628-763	Derating shaft	1
36628-764	Roller link	2
36628-765	Bushing	1
36628-766	Cotter pin, .060 x .375	5
36628-767	Needle bearing	1
36628-768	Pickup link	2
36628-769	Elastic hex. nut, 6-32	1
36628-770	Altimeter cam	1
36628-771	Pin	1
36628-772	Hex. hd., cap screw	2
36628-773	Washer, splitlock, #10	2
36628-774	Washer, .203 x .438 x .064 thick	2
36628-775	Fil. hd. screw, 6-32 x .750	1
36628-776	Soc. hd. screw, 10-32 x .500	1
36628-777 through 800		Not Used

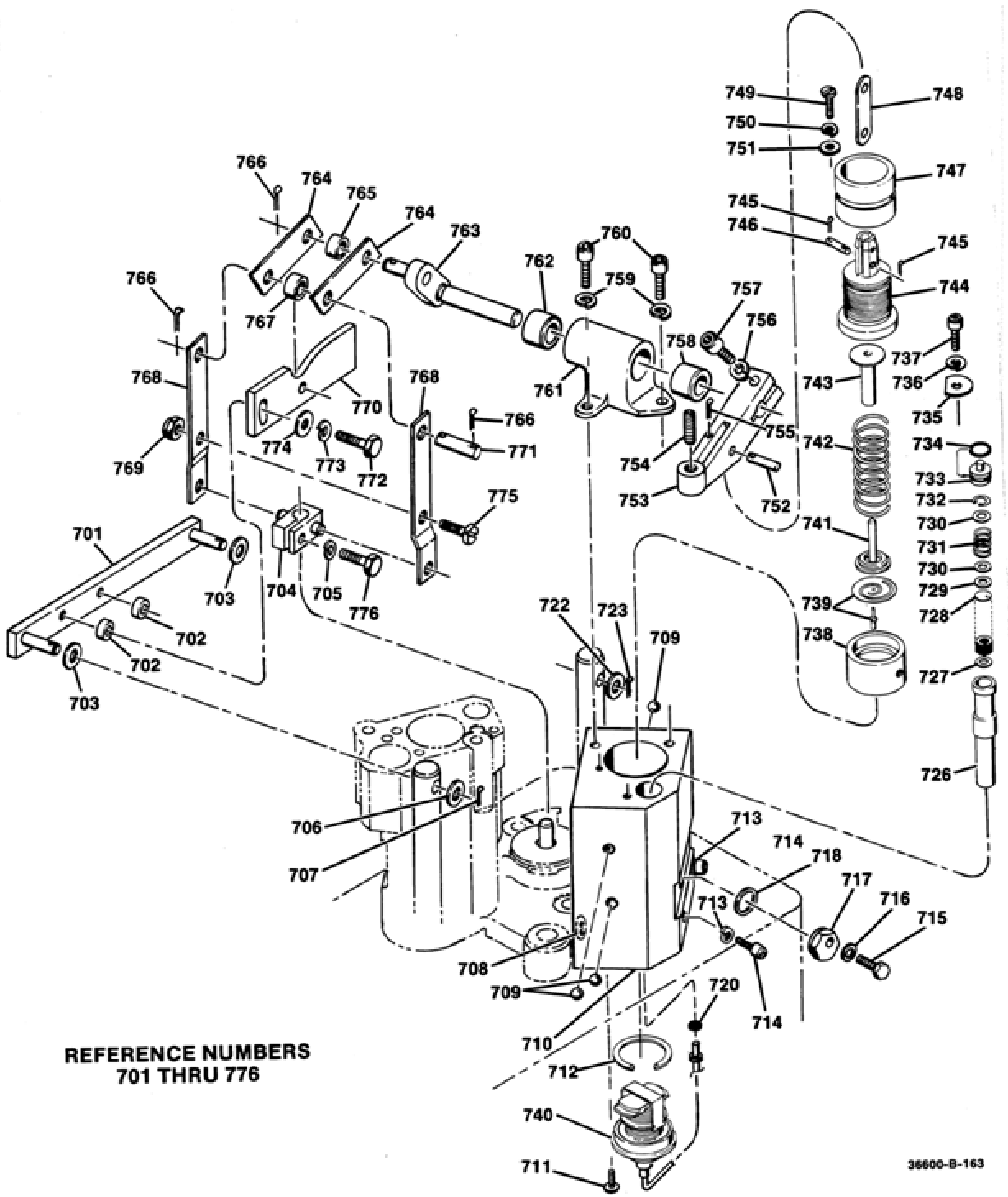

Figure 7-13. Illustrated Parts of Altitude Compensation

Parts List for Figure 7-14

Ref. No.	Part Name	Quantity
36628-801	Nut, 3/4-32	5
36628-802	Solenoid plunger stop	5
36628-803	Solenoid case	5
36628-804	Solenoid load spring	5
36628-805	Paper insulator	5
36628-806	Solenoid coil	5
36628-807	Solenoid plunger	5
36628-808	Snap ring	5
36628-809	Solenoid plunger pushrod	5
36628-810	Washer, Beryllium copper	5
36628-811	Soldering shield washer	10
36628-812	Solenoid guide	5
36628-813	Guide bushing (press fit)	10
36628-814	Screw, rd. hd., 8 x 1-1/4, type 2	3
36628-815	Plain washer, 13/16 x 7/16 x 1/32	3
36628-816	Screw, soc. hd., 10-32 x 2-1/4	2
36628-817	Washer, splitlock, #10	2
36628-818	Solenoid bracket	1
36628-819	Setscrew, soc. hd., cup pt., 10-32 x 1/4	5
36628-820	Speed nut, #8, type J	3
36628-821	Wiring shield	1
36628-822	Lube oil signal switch/jam nuts	1
36628-823	Switch mounting bracket	1
36628-824	Switch bracket clamp plate	1
36628-825	Connector plate (used with item 834)	1
36628-826	Electrical connector (Amphenol)	1
36628-827	Screw, fil. hd., 6-32 x 3/8	1
36628-828	Connector plate gasket (sq. hole)	1
36628-829	Lockwasher, mt. tooth, #6	4
36628-830	Screw, flat hd., 10-32 x 3/8	4
36628-831	Connector plate (used with item 834)	1
36628-832	Screw, flat hd., 10-32 x 3/8	4
36628-833	Connector plate gasket (rd. hole)	1
36628-834	Electrical connector (Pyle National)	1
36628-835	Tube	10

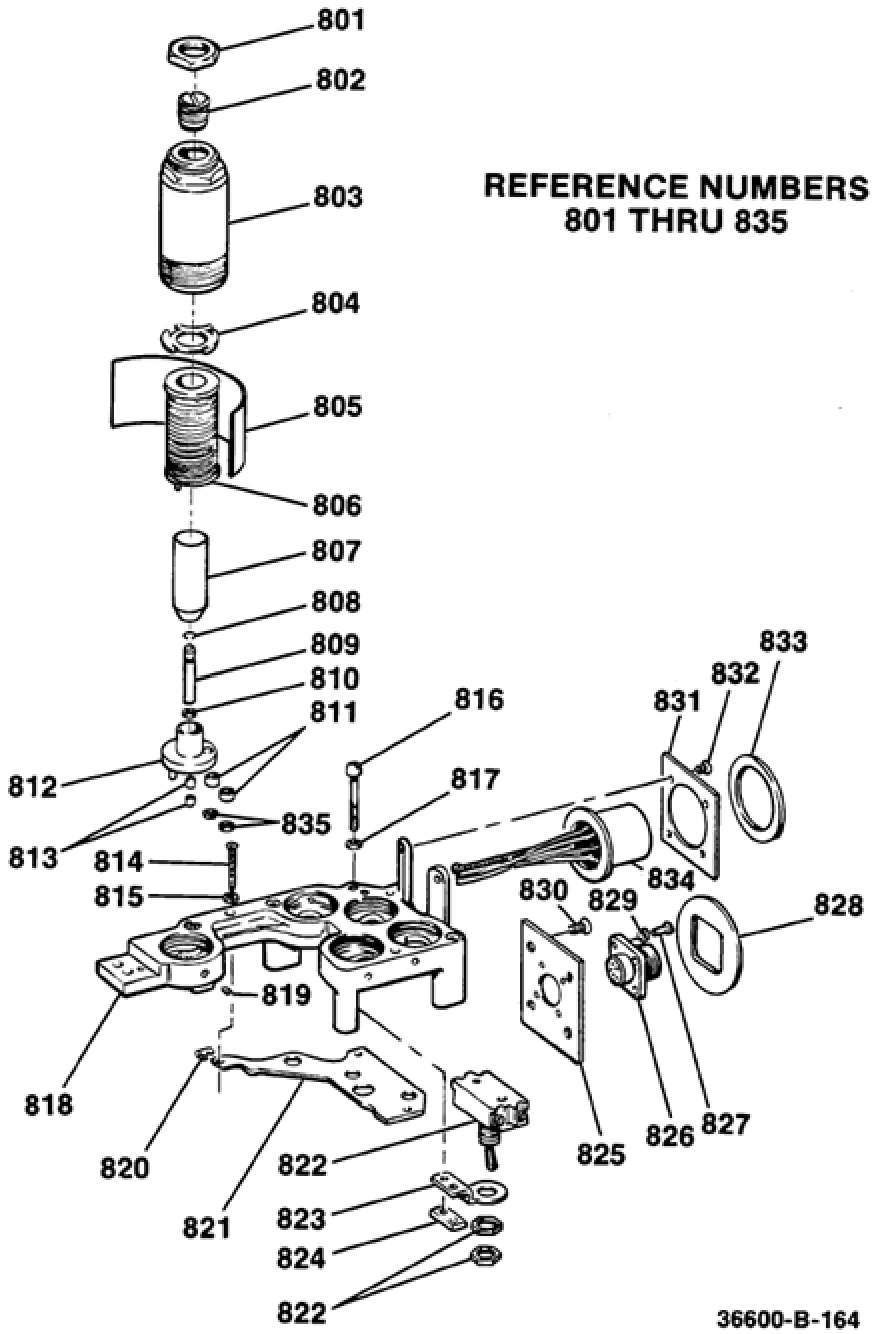

Figure 7-14 Electrical Receiver Assembly

Chapter 8.
Product Support and Service Options

Product Support Options

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

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

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

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

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

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

Product Service Options

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

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

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

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

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

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

Returning Equipment for Repair

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

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

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

Packing a Control

Use the following materials when returning a complete control:

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

NOTICE

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

Replacement Parts

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

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

Engineering Services

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

- Technical Support
- Product Training
- Field Service

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

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

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

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

Contacting Woodward's Support Organization

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

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

Products Used In Electrical Power Systems

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

Products Used In Engine Systems

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

Products Used In Industrial Turbomachinery Systems

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

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

Technical Assistance

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

General

Your Name ______________________

Site Location ______________________

Phone Number ______________________

Fax Number ______________________

Prime Mover Information

Manufacturer ______________________

Engine Model Number ______________________

Number of Cylinders ______________________

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

Power Output Rating ______________________

Application (power generation, marine, etc.) ______________________

Control/Governor Information

Control/Governor #1

Woodward Part Number & Rev. Letter ______________________

Control Description or Governor Type ______________________

Serial Number ______________________

Control/Governor #2

Woodward Part Number & Rev. Letter ______________________

Control Description or Governor Type ______________________

Serial Number ______________________

Control/Governor #3

Woodward Part Number & Rev. Letter ______________________

Control Description or Governor Type ______________________

Serial Number ______________________

Symptoms

Description ______________________

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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 36628D.

B36628:D

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Email and Website—www.woodward.com

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

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

2012/11/Colorado