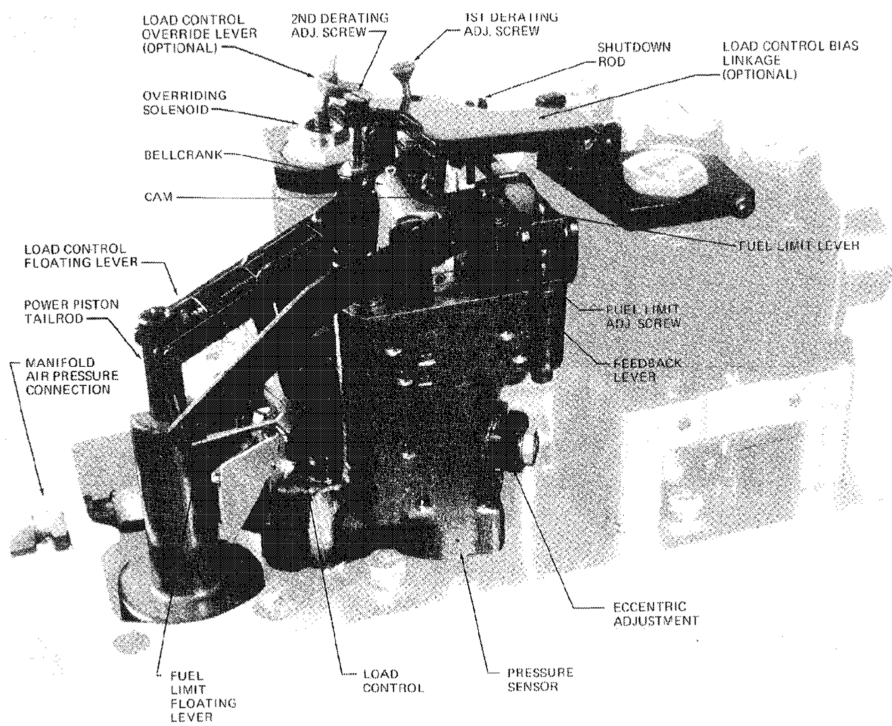
WOODWARD

Product Manual 36695
(Revision D)
Original Instructions



Manifold Air Pressure Bias Fuel Limiter for PG Governors (Single Barrel Model)

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 Out-of-date translations are marked with ⚠.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

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Important Definitions

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

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

⚠WARNING Overspeed / Overtemperature / Overpressure	**The engine, turbine, or other type of prime mover should be equipped with an overspeed shutdown device to protect against runaway or damage to the prime mover with possible personal injury, loss of life, or property damage.** **The overspeed shutdown device must be totally independent of the prime mover control system. An overtemperature or overpressure shutdown device may also be needed for safety, as appropriate.**

⚠WARNING Personal Protective Equipment	**The products described in this publication may present risks that could lead to personal injury, loss of life, or property damage. Always wear the appropriate personal protective equipment (PPE) for the job at hand. Equipment that should be considered includes but is not limited to:** • **Eye Protection** • **Hearing Protection** • **Hard Hat** • **Gloves** • **Safety Boots** • **Respirator** **Always read the proper Material Safety Data Sheet (MSDS) for any working fluid(s) and comply with recommended safety equipment.**

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

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

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

Electrostatic Discharge Awareness

NOTICE **Electrostatic Precautions**	**Electronic controls contain static-sensitive parts. Observe the following precautions to prevent damage to these parts:** • **Discharge body static before handling the control (with power to the control turned off, contact a grounded surface and maintain contact while handling the control).** • **Avoid all plastic, vinyl, and Styrofoam (except antistatic versions) around printed circuit boards.** • **Do not touch the components or conductors on a printed circuit board with your hands or with conductive devices.** **To prevent damage to electronic components caused by improper handling, read and observe the precautions in Woodward manual *82715*, *Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules*.**

Follow these precautions when working with or near the control.

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

Chapter 1.
General Information

Introduction

This manual describes the Manifold Air Pressure Bias Fuel Limiter (single barrel model), hereafter called fuel limiter. The fuel limiter is a mechanical load control override linkage, a mechanical two-slope load control bias linkage, and an attitude compensator.

The fuel limiter is an auxiliary system designed primarily for use on Woodward PG load control governors installed on turbo-supercharged locomotive engines. It may be used with either gauge or absolute manifold air pressure as a reference. Normally these governors are equipped with a load control overriding solenoid and provisions for fast unloading. The fuel limiter is also used in marine installations equipped with controllable pitch propellers.

The functions of the optional load control features are independent of the fuel limiter. They are related only through a common reference to gauge or absolute manifold air pressure. Figure 1-1 illustrates the basic fuel limiter, the optional load control override and bias linkages installed on a locomotive governor equipped with load control, an overriding solenoid, and solenoid speed setting.

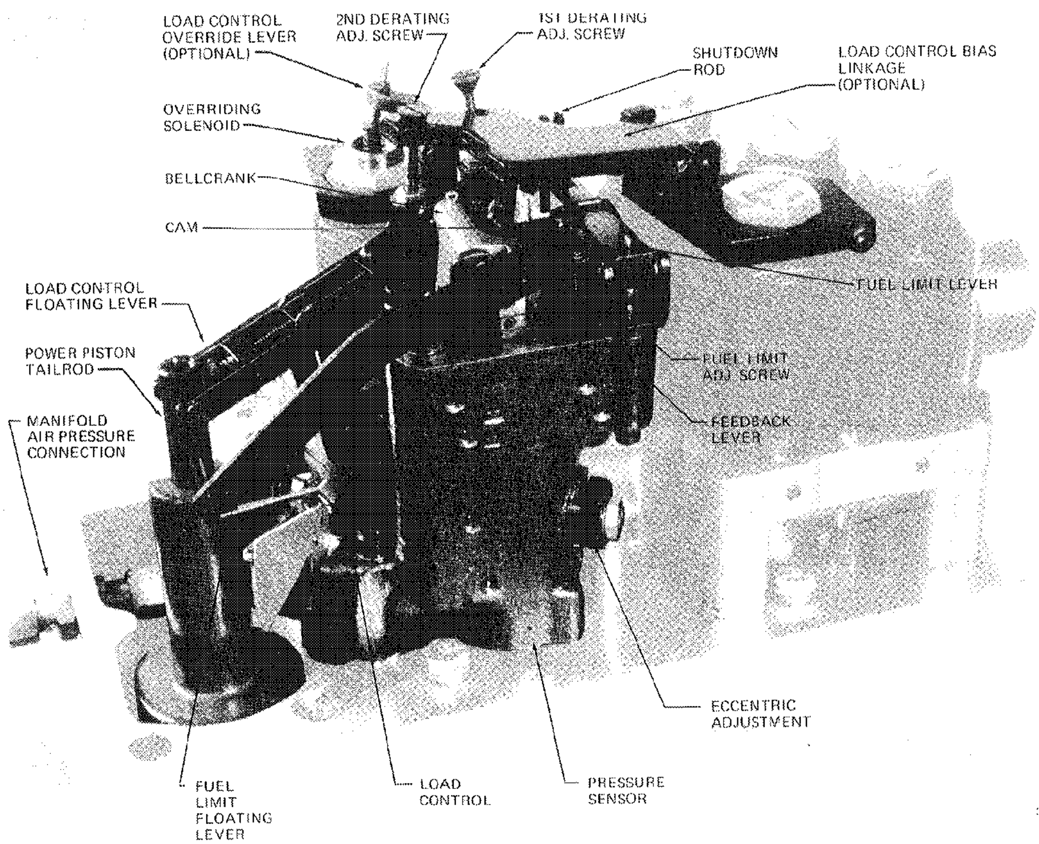

Figure 1-1. Fuel Limiter with Optional Load Control Override and Two-Slope Load Control Bias Linkages

Purpose

Fuel Limiter

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 towards the increase fuel direction, limiting engine fuel during accelerations 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 1-2 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.

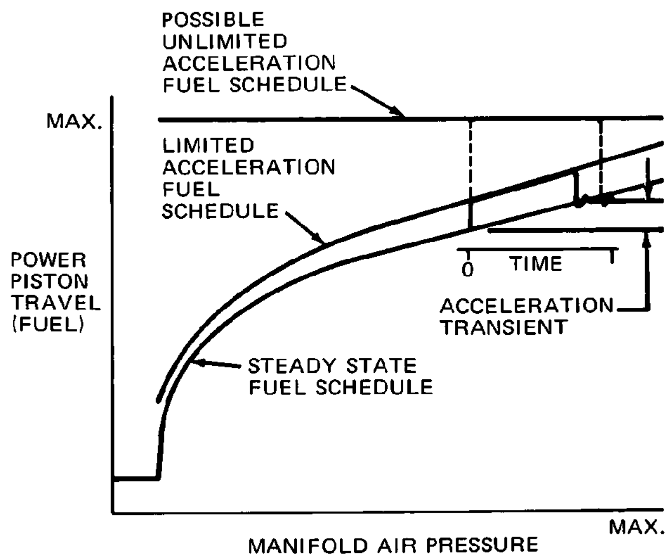

Figure 1-2. Typical Limited Acceleration Fuel Schedule Curve

Load Control Override Linkage (Optional)

The load control on the PGE governor responds to increases in engine speed by simultaneously increasing the load on the engine (increasing generator field excitation). See manual 36703, *PGE and PGEV Locomotive Governors*. Increasing the load on the engine during an acceleration transient when fuel is limited overloads the engine and causes a prolonged rate of acceleration. For this reason, the optional load control override linkage is generally always used in conjunction with the fuel limiter. This unloads the engine during acceleration transients, reduces or eliminates overloads, and permits a rapid rate of acceleration. The overriding solenoid used in this application is modified to permit either mechanical or electrical actuation. This mechanically reduces the load on the engine during acceleration and electrically reduces the load on the engine for starting, transition, wheel slip, etc.

Two-Slope Load Control Bias Linkage

The load control system on the PGE governor adjusts the load on the engine as a function of governor speed setting and power piston position to maintain a definite engine power output (fuel flow) for a given speed setting.

A constant amount of fuel is supplied to the engine for a given speed without respect to the actual air available. This results in an excess amount of fuel supplied to the engine when manifold air pressure falls below the optimum value for the speed setting. Prolonged operation of the engine with a rich fuel/air mixture ratio results in excessive engine operating temperatures, excessive smoke and excessive fuel consumption.

The two-slope load control bias linkage biases the basic load control system and reduces the load on the engine as a function of manifold air pressure. The governor reduces engine fuel to provide a proper fuel/air ratio for efficient burning. Figure 1-3 illustrates a typical two-slope load biasing (derating) curve. Note in Figure 1-3, derating occurs along two different slopes which generally parallel the normal power (load) curve.

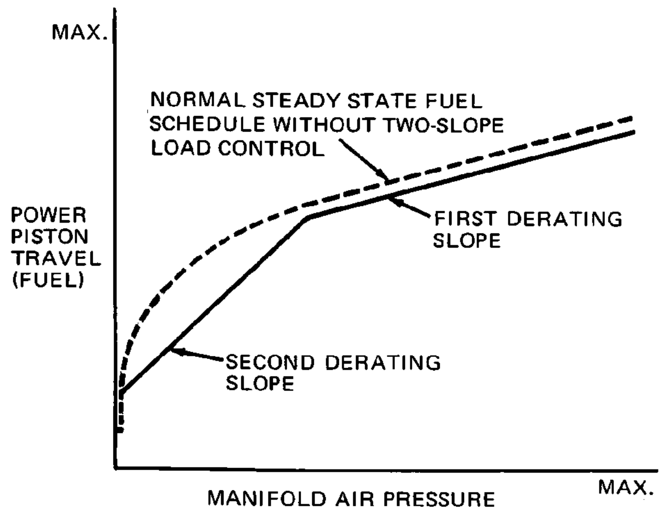

Figure 1-3. Typical Two-Slope Load Derating Curve

Chapter 2. Principles of Operation

Fuel Limiter

Description

The fuel limiter (Figure 2-1) 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 start-up. 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.

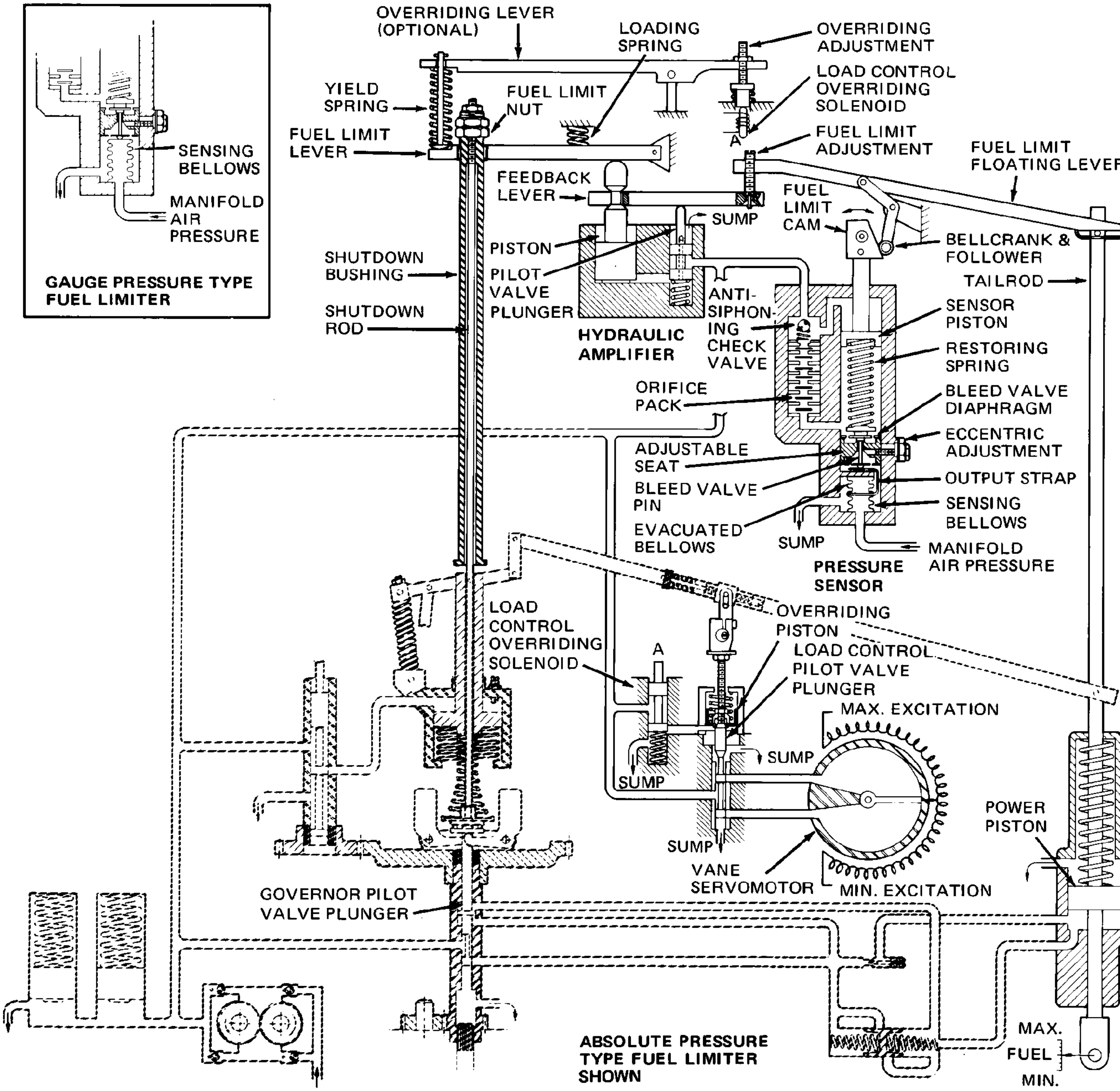

Figure 2-1. Schematic Diagram, Fuel Limiter and Optional Load Control Override Linkage

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 towards 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. When these opposing forces balance, the bleed valve diaphragm floats just off 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 bellcrank 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 lever 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 rises 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 increase, manifold air pressure begins to rise 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 clockwise 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 value 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.

Conversely, a drop in manifold air pressure rotates the bellcrank in a counterclockwise 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 (optional)

The load control override linkage (Figure 2-1) 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 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 (or other remote servomotor) begins to unload prior to an acceleration lag, reducing overload and poor acceleration. Depending on engine and turbo-supercharger characteristics, premature unloading may 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 servomotor-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.

Two-Slope Load Control Bias Linkage (optional)

The two-slope load control bias linkage (Figure 2-2) functions during periods of steady-state operation where the manifold air pressure is less than the minimum required for safe operation of the engine at its rated load for a given speed. The bias lever linkage rests on top of the fuel limiter cam and is connected through an adjusting screw to the upper left end of the load control floating lever. A telescoping link connects the lower left end of the floating lever to the right end of the restoring lever on the governor speed setting piston rod.

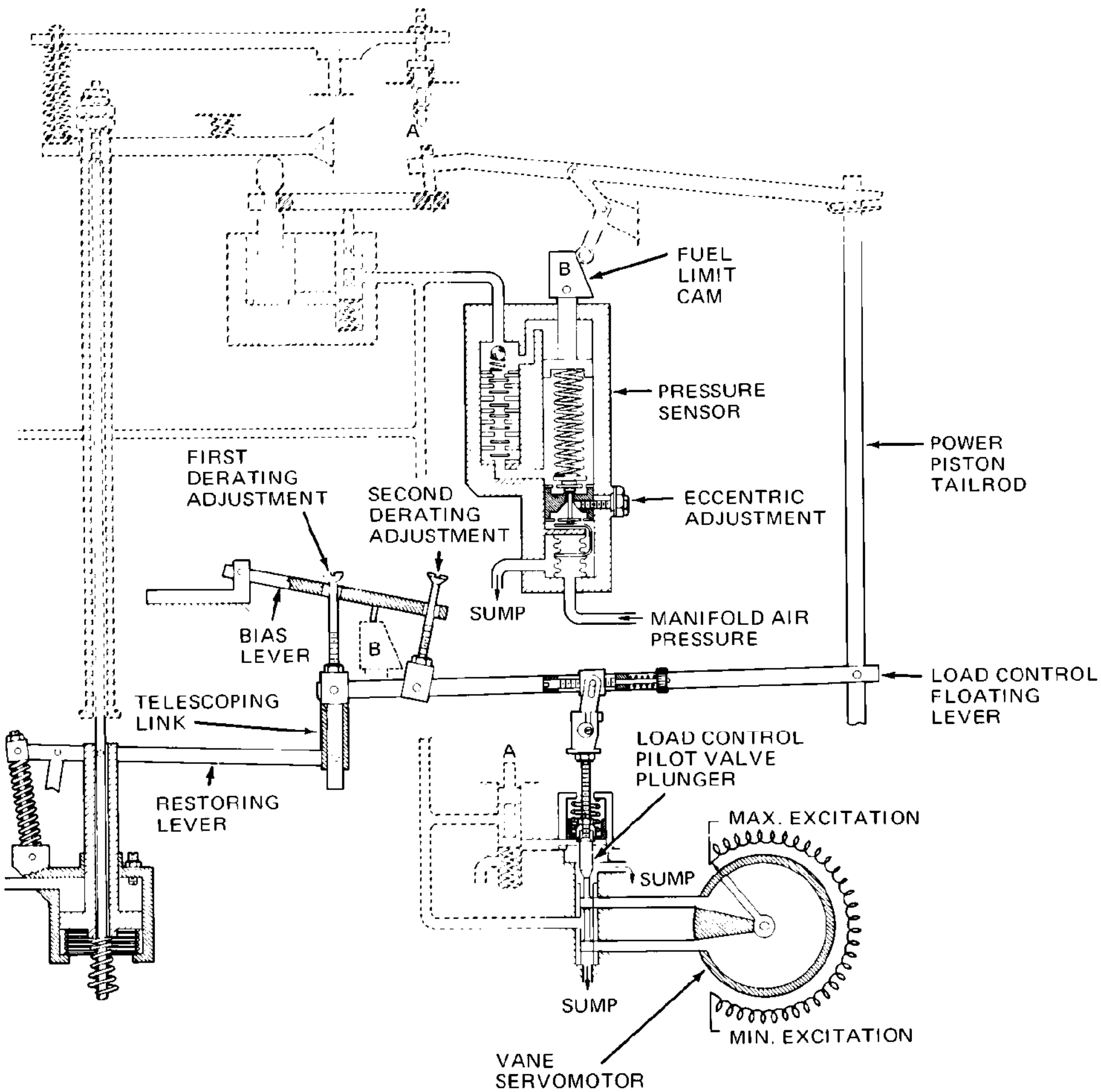

Figure 2-2. Schematic Diagram, Optional Two-Slope Load Control Bias Linkage

Figure 2-2 illustrates the load control bias linkage and associated governor components in their normal positions at rated speed and load with normal manifold air pressure. Note the lowered position of the fuel limiter cam. This allows the bias lever to move downward, compressing the telescoping link to a solid height. In this position the bias lever does not contact the derating adjustment screws. The load control system adjusts the load on the engine as a function of governor speed setting and power piston position. If the manifold air pressure drops below the minimum required for safe engine operation at rated load, the fuel limit cam raises the bias lever an equivalent amount. The bias lever picks up the first derating screw and, through extension of the telescoping link, lifts the left end of the floating lever. The telescoping link permits the floating lever to move independent of the speed setting. Increases in speed setting may be made without affecting the load control.

Raising the left end of the floating lever lifts the load control pilot valve plunger and directs pressure oil to the decrease side of the vane servomotor. With reduced load, engine speed increases, and the governor acts to reduce fuel.

The governor power piston moves downward until the load control pilot valve plunger is re-centered and the engine is operating at reduced load and fuel at full rated speed. Derating occurs in the same manner as described above at all intermediate speed settings (except idle) where a condition of abnormally low manifold air pressure exists.

Figure 1-3 shows the derating slope to be more acute along the lower one-third of the normal power curve than along the upper two-thirds. This is due to the different ratios of bias lever movement transmitted through the derating adjustment screws to different points on the load control floating lever.

Figure 2-3 illustrates the effective range of each derating adjustment screw and the ratios of bias lever movement transmitted through each adjusting screw. A greater ratio of bias lever movement is transmitted through the second derating screw than through the first derating screw. When transfer from the first to second derating screw (or vice versa) occurs, the effective length of the load control floating lever also changes.

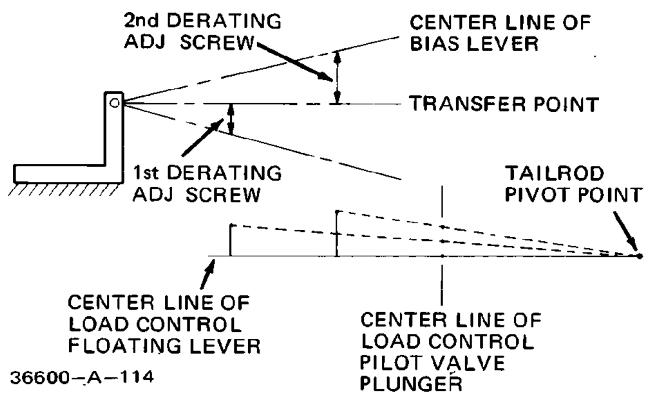

Figure 2-3. Effective Ranges and Ratios of First and Second Load Derating Adjustments (Typical)

For a given movement of either derating screw, the second derating screw lifts the left end of the floating lever further than the first derating screw. This combination of bias lever ratios and floating lever lengths reduce load (derate) more rapidly along the lower one-third of the normal power curve than along the upper two-thirds.

During acceleration, the downward movement of the governor speed setting piston extends the telescoping link between the restoring lever and load control floating lever.

Manifold air pressure does not increase immediately, and the left end of the floating lever remains stationary while the right end moves upward with the governor power piston. The load control pilot valve plunger unbalances in the reduce load direction. When manifold air pressure increases, the downward movement of the fuel limiter cam lowers, allowing the bias lever to lower the load control floating lever. Unloading stops, and the load control pilot valve plunger move up, increasing load on the engine in proportion to the rate of increase in manifold air pressure. When the engine comes on speed again and if the manifold air pressure is normal, the bias lever moves down, collapsing the telescoping link to a solid height and restoring the load control system to normal operation.

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 2-4 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. The bleed valve regulates the rate of flow from the area under 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 towards 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 6000 feet (1200 to 1800 m) elevation is required before this unit affects the load control.

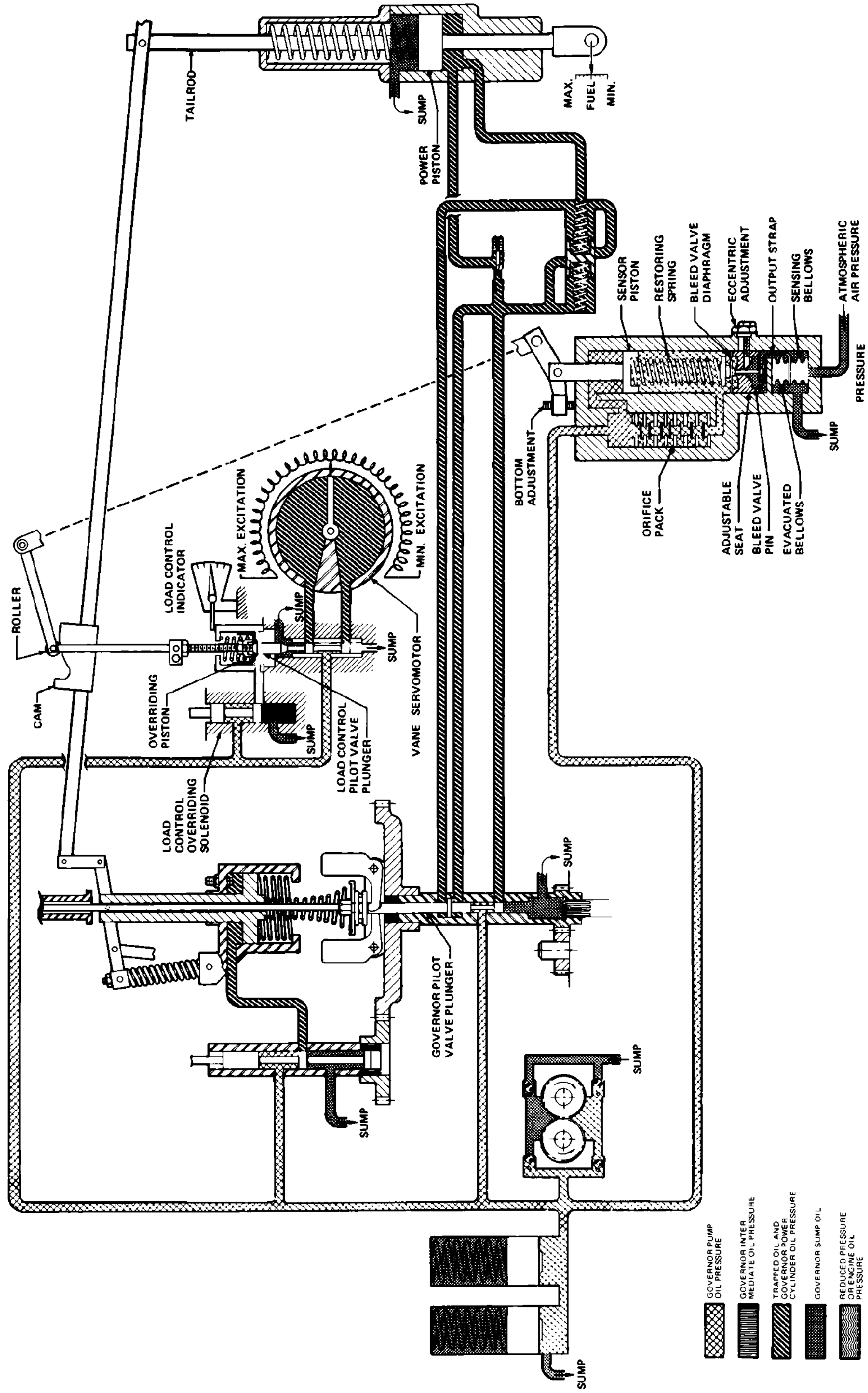

Figure 2-4. Schematic Diagram of Altitude Compensation

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 3. Adjustments

Introduction

Adjustment of the fuel limiter, load control override linkage, two-slope load control bias linkage, and altitude compensator involves governor speed setting, power piston position, engine fuel, and load on the engine. The various systems of the governor are interrelated and an adjustment to one system generally requires adjustments in related systems. Since many variables are involved, adjustment of the governor is recommended on a test stand equivalent to Woodward test stand part number 8909-001.

The specific adjustment and test parameters vary with the governor and its intended application. Therefore, the procedures given below are descriptive rather than specific and are intended for use with the governor mounted on a test stand. Contact Woodward to obtain the specific adjustment and test parameters for the particular governor involved. Include the model and serial number of the governor with the request.

Adjust the governors base speed setting, speed setting piston stop, load control system balance and timing, electric operation of the overriding solenoid, low lubricating oil pressure shutdown bypass valve, etc., except the shutdown bushing, prior to any adjustment of the fuel limiter, load control override linkage, or two-slope load control bias linkage, and altitude compensator. Back off the shutdown bushing, fuel limit nut, fuel limit adjustment screw, and overriding lever adjustment screw (f used) sufficiently to prevent interference when making adjustments to the basic governor and load control system. If the two-slope load control bias option is provided, disengage the two derating adjustment screws from the pivot blocks and lay the bias lever back to gain access to the top of the fuel limit cam for positioning a dial indicator. If desired, remove the lever and bracket for convenience.

Separate adjustment and test procedures are given for use with the basic fuel limiter and fuel limiters equipped with the optional two-slope load control bias linkage. Adjustment procedures for the optional load control override linkage are included in proper sequence in each procedure. Ignore the procedural steps for the override linkage when this option is not provided.

IMPORTANT **Perform adjustments and tests with the fuel limiter at normal operating temperature to minimize drifting during temperature changes.**

Fuel Limiters without Two-Slope Load Control Bias

Refer to Figures 1-1 and 2-1 as required when making adjustments to the basic fuel limiter and load control override linkage.

1. Operate the governor at the idle speed setting.

2. Adjust the clearance between the bottom of the shutdown bushing and the top of the speed setting piston to 0.032 ±0.005 inch (0.81 ±0.13 mm). Secure the bushing with a jam nut. Recheck clearance and readjust if necessary, making certain the governor shuts down properly.

3. Operate the governor at a speed setting above mid-range.

4. Connect air pressure to the engine manifold air pressure fitting on the governor column. Regulate air pressure to the lowest value of manifold air pressure specified in the fuel limiting schedule, normally 0” Hg (0 kPa) gauge pressure.

5. Determine the sensor piston travel using a dial indicator with its plunger contacting the top of the fuel limit cam.

6. Loosen the lock screw in the eccentric adjustment and turn the eccentric clockwise until the sensor piston (and fuel limit cam) travels to the top of its stroke. Zero the dial indicator or note the indicator reading.

7. Tighten the locking screw slightly and then turn the eccentric counterclockwise until the fuel limit cam travels the specified distance downward (0.150 inch/3.81 mm). Tighten the locking screw.

8. Make certain the sensor piston travels to the bottom of its stroke with increasing manifold air pressure. Reset manifold air pressure to the value specified at the low end of the schedule.

9. Reposition the dial indicator with the plunger contacting the top of the governor power piston tailrod. Zero the indicator with the power piston in the full down position (power piston travel is 1.000 inch/25.40 mm).

10. Adjust the test stand speed control so the power piston travels upward the specified distance (mid-point of tolerance range) corresponding to the given manifold air pressure at the low end of the schedule.

11. Turn the fuel limit adjustment screw clockwise until the hydraulic amplifier piston lifts the fuel limit lever to a horizontal position (determined visually).

12. Adjust the fuel limit nut on the shutdown bushing to obtain the specified clearance (mid-point of tolerance range) between the bottom of the nut and the top surface of the fuel limit lever. Secure with a jam nut.

13. Turn the overriding adjustment screw, in the overriding lever, clockwise until the load control pilot valve plunger just begins to rise to the fast unloading position.

14. Cycle the power piston and check the clearance of the fuel limit nut. Cycle the piston downward and then slowly upward, stopping when the load control pilot valve plunger just begins to rise. Readjust as required until the clearance between the shutdown nut and fuel limit lever is within the specified tolerance range.

15, Adjust the test stand speed control so the power piston travels upward the specified distance (mid-point of tolerance range) corresponding to a given manifold air pressure at the low end of the schedule.

16. Turn the fuel limit adjustment screw clockwise until governor speed drops to ±5 rpm. The power piston travels down slightly but must remain within the specified tolerance range. If the power piston travels too far, adjust the test stand speed control so the piston rises to the mid-point of the tolerance range (speed drop will increase), then turn the fuel limit adjustment screw counterclockwise to obtain a 10 rpm drop in speed.

17. Operate the governor at the maximum speed setting and regulate air pressure to the highest value of manifold air pressure specified in the fuel limiting schedule.

18. Manipulate the test stand speed control so the power piston travels downward (governor should be running on-speed), then slowly upward to the point where a 10 ±5 rpm drop in speed occurs. Governor power piston travel (gap) must be as specified for that manifold air pressure.

19. If power piston travel is not within the specified limits, loosen the fuel limit cam locking screw, and tilt the top of the cam toward the bellcrank to decrease power piston travel, or away from the bellcrank to increase travel. Tighten the locking screw and repeat step 18.

20. Following adjustment of the fuel limit cam, the low end of the fuel limiting schedule must be rechecked and readjusted as necessary. Repeat steps 15 through 19 until no further adjustment is required at either end of the fuel limiting schedule.

    Figure 3.1 illustrates the interrelationship and individual effects of the fuel limit adjustment screw and fuel limit cam angle (tilt) on the fuel limiting schedule. An adjustment of the fuel limit screw raises (or lowers) the schedule a like amount over its entire length. An adjustment of the fuel limit cam alters the slope of the schedule, with the greatest change occurring at the high end. The contour of the schedule is a reflection of the cam profile and may be non-linear as illustrated or linear (straight line).

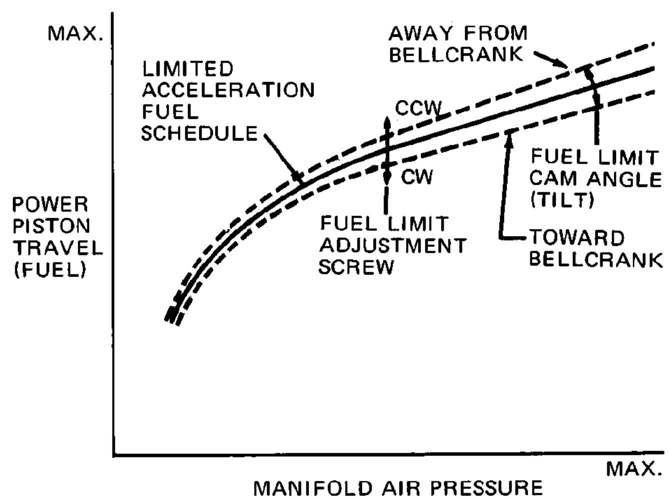

Figure 3-1. Typical Effects of Fuel Limit Adjustment Screw and Fuel Limit Cam Angle (Tilt) on Fuel Limiting Schedule

IMPORTANT

In some instances, particularly where a non-linear cam is used, the extreme limit of cam adjustment may be reached before attaining the specified power piston travel at either or both ends of the schedule. In such case, reposition the sensor piston (steps 3 through 8) and then repeat all subsequent steps. With many non-linear cams, the lower portion changes profile very rapidly and therefore the starting position of the sensor piston affects establishment of the desired fuel limiting schedule. The dimension in step 7 is not critical as long as it is within the active range of the sensor piston travel. Repositioning the sensor piston affects the fuel limiting schedule in the same manner as the fuel limit adjustment screw. Shorten the dimension given in step 7 to decrease power piston travel; lengthen the dimension to increase travel.

Fuel Limiters with Two-Slope Load Control Bias

Refer to Figures 1-1, 2-1, and 2-2 as required when making adjustments to the basic fuel limiter, load control override linkage, and two-slope load control bias linkage.

IMPORTANT **Disengage the two derating adjustment screws from the pivot blocks and lay the bias lever back so access can be gained to the top of the fuel limit cam for positioning a dial indicator. If desired, the lever and bracket may be removed for convenience.**

1. Operate the governor at the idle speed setting.

2. Adjust the clearance between the bottom of the shutdown bushing and the top of the speed setting piston rod to 0.032 ±0.005 inch (0.81 ±0.13 mm). Secure the bushing with a jam nut. Recheck clearance and readjust if necessary, making certain the governor shuts down.

3. Operate the governor at a speed setting above mid-range.

4. Connect air pressure to the engine manifold air pressure fitting on the governor column. Regulate air pressure to the value specified for adjustment of the sensor piston, normally 65” Hg (220 kPa) absolute pressure.

5. Determine sensor piston travel using a dial indicator with its plunger contacting the top of the fuel limit cam.

6. Loosen the lock screw in the eccentric adjustment and turn the eccentric fully counterclockwise. Sensor piston (and fuel limit cam) travel downward until the piston bottoms on the adjustable seat of the bleed valve.

7. Tighten the lock screw tightly. Slowly turn the eccentric clockwise while observing the dial indicator for a sudden change in the rate of sensor piston travel in the upward direction. This indicates that the sensor piston has moved off the adjustable seat and into the active range of its travel. Note the approximate point that the change in rate occurred and continue turning the eccentric clockwise until the sensor piston travels 0.010 to 0.015 inch (0.25 to 0.38 mm) above the point where the change in rate occurred. If the sensor piston travels a minimum of 0.005 inch (0.13 mm) downward with an increase in air pressure, the adjustment is satisfactory. Fully tighten the lock screw.

8. Make certain the sensor piston travels to the top of its stroke with decreasing air pressure.

9. Reposition the dial indicator with the plunger contacting the top of the power piston tailrod. Zero the indicator with the power piston in the full down position (power piston travel is 1.00 inch/25.4 mm).

10. Operate the governor at the maximum speed setting.

11. Regulate air pressure to the lowest value of manifold air pressure specified for fuel limiter adjustment.

12. Adjust the test stand speed control so the governor power piston travels the specified distance (mid-point of tolerance range) corresponding to the given manifold air pressure.

13. Turn the fuel limit adjustment screw clockwise until the hydraulic amplifier piston lifts the fuel limit lever to a horizontal position.

14. Adjust the position of the fuel limit nut on the shutdown bushing to obtain the specified clearance (mid-point of tolerance range) between the bottom of the nut and the top surface of the fuel limit lever. Secure with a jam nut.

15, Turn the overriding adjustment screw in the overriding lever clockwise until the load control pilot valve just begins to rise to the fast unloading position.

16. Check the fuel limit nut clearance and power piston travel by cycling the power piston, first downward and then slowly upward to the point where the load control pilot valve plunger just begins to rise. The fuel limit nut clearance and power piston travel must be within their respective tolerance ranges at the given manifold air pressure.

17. Regulate air pressure to the highest value of manifold air pressure specified for fuel limiter adjustment.

18. Cycle the power piston, first downward and then upward to a point where the load control pilot valve plunger just begins to rise to the fast unloading position. Power piston travel must be within the specified tolerance range for the specified manifold air pressure (step 17).

19. If power piston travel is not within the specified limits, loosen the fuel limit cam locking screw and tilt the top of the cam toward the bellcrank to decrease power piston travel or away from the bellcrank to increase travel. Tighten the locking screw and repeat step 18.

20. Following adjustment of the fuel limit cam, recheck and readjust the fuel limit adjustment screw as necessary. Repeat steps 11 through 19 until no further adjustment of the fuel limit adjustment screw or fuel limit cam is necessary. Figure 3-1 illustrates the interrelationship and individual effects of the fuel limit adjustment screw and fuel limit cam angle (tilt) on the fuel limiting schedule. An adjustment of the fuel limit adjustment screw raises (or lowers) the schedule a like amount over its entire length. An adjustment of the fuel limit cam alters the slope of the schedule, with the greatest change occurring at the high end. The contour of the schedule is a reflection of the cam profile and may be non-linear as illustrated or linear (straight-line).

21. Reinstall the load control bias lever and bracket if previously removed, and thread the two derating screws several turns into their respective pivot blocks.

22. Regulate air pressure to the specified (higher) value of manifold air pressure where derating along the first slope is to begin (see Figure 1-3). Position the power piston at the specified travel corresponding to that air pressure.

23. Balance the load control and adjust the first derating screw in the bias lever to pick up the left end of the load control floating lever just enough to start the load control servomotor moving toward minimum position.

24. Regulate air pressure to the specified (lower) value where load derating along second slope is to begin.

25. Adjust the second derating screw in the bias lever to balance load control at the specified power piston travel corresponding to that air pressure.

Altitude Compensator

Refer to Figures 2-4 and 5-3 as required when making adjustments to the altitude compensator. All adjustments should be made on a test stand.

1. The overriding solenoid switch must be off and the screw in the top must be at least two turns off bottom.

2. Operate the governor at the notch one (idle) speed setting. The tailrod position must be as specified for that particular governor. Block the servo piston to hold the correct tailrod position.

3. Loosen screws 211 and 193 (Figure 5-3).

4. Adjust cam 207 until load control pilot valve movement is less than 0.003” (0.08 mm). To check plunger movement, pivot derating shaft 198 until bearing 202 swings through its complete arc.

5. Tighten screws 211 to lock cam 207 in position.

6. Center the load control pilot value plunger by balancing the vane servo. Loosen screw 217 and turn pilot valve plunger in or out of block 215 until the vane servo is balanced. The vane servo is balanced when its indicator is away from its end points of travel and not moving. Tighten screw 217.

7. Adjust the load control position indicator to zero.

8. Loosen set screw 168 and turn eccentric 166 until piston 174 is at its lowest position.

9. Adjust set screw 188 to touch the housing.

10. Turn eccentric 166 to obtain 0.050 to 0.060” (1.27 to 1.52 mm) clearance between set screw 188 and the housing. This places the piston off bottom.

IMPORTANT

The altitude compensator should begin operating at the altitude recommended in the specifications for that particular governor. Verify the barometric pressure for the altitude at which the governor is being adjusted and tested. Use this as a reference point for the settings which follow. If the barometric pressure at the altitude of the test position is greater than the required starting point. evacuate the bellows. If the test position’s altitude is less than the starting point, pressurize the bellows.

11. Adjust set screw 188 to pressurize the bellows to 0.5” Hg (1.7 kPa) greater than the specified starting point. To do this, loosen set screw 168. Place a 0.0015 to 0.0020” (0.038 to 0.051 mm) feeler gauge under set screw 188 and adjust eccentric 166 until pressure can be felt on the feeler gauge. Tighten set screw 168. Gradually reduce pressure to the bellows until the feeler gauge just comes free. This should be 0.5” Hg (1.7 kPa) greater than the specified starting point. Readjust the eccentric if required.

12. With set screw 168 against the housing, set governor speed to the notch 8 setting.

13. Loosen lock screw 43 and adjust derating shaft 198 and therefore cam bearing 202 until the vane servo is balanced again. Tighten lock screw 193.

14. Recheck the bellows and evacuate it to high altitude pressure as given in the specifications for that particular governor.

15. Record the balance point of the vane servo. The balance point must agree with the specified value, otherwise change the restoring spring to a different scale to balance the vane servo.

Chapter 4. Maintenance

Introduction

If a complete disassembly is made during repair, refer to Chapter 3 for adjustment and test procedures after reassembly.

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.**

Troubleshooting

A troubleshooting chart is provided for use in determining the probable causes and corrective action for fuel limiter troubles which may be encountered in the field. Every possible trouble which may be experienced cannot be anticipated, and in some instances, may be due to faulty operation of the basic governor or other equipment used in conjunction with the governor.

Table 4-1. Troubleshooting

Trouble	Probable Cause	Correction
Hard starting and/or excessive smoke for short duration during starting after a relatively long shutdown period.	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.
Excessive smoke during accelerations.	Orifice pack clogged—sensor piston goes to and remains at maximum fuel position. Fuel limiter not adjusted correctly. Restoring spring fatigued or broken.	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. Adjust as instructed in Chapter 3. Replace restoring spring.
Engine bogs down during accelerations.	Load control override linkage improperly adjusted	Adjust as instructed in Chapter 3.

Trouble	Probable Cause	Correction
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.
Excessive engine operating temperatures (governor with two-slope load control bias).	Two-slope load control bias linkage not adjusted properly.	Adjust as instructed in Chapter 3.
Dead band at low or high end of fuel limiting schedule.	Sensor piston travel not properly calibrated with manifold air pressure range.	Adjust as instructed in Chapter 3.

Special Tools

Special tools are not required for maintenance of the fuel limiter, load control override linkage, two-slope load control bias linkage, or altitude compensator.

Disassembly

Fuel Limiter

The removal and disassembly procedure for the fuel limiter varies depending on the optional features it is equipped with and the extent of maintenance required. Complete removal and disassembly involves partial disassembly of the basic governor and should be performed in the sequence given below as well as in the order of reference numbers assigned to the exploded views (Figures 5-1 and 5-2). Discard performed packings (O-rings), gaskets, copper sealing washers, retaining rings, cotter pins, etc., removed during disassembly.

IMPORTANT

It is assumed during the following procedure that the fuel limiter is equipped with both the load control override and two-slope load control bias options. Omit those steps which do not apply to the particular fuel limiter being serviced.

1. Loosen nuts 101 (Figure 5-2) and back derating adjustment screws 102 out of pivot blocks 113 and 116. Loosen screws 103 and lift off bracket 108 together with bias lever 107 and adjustment screws.

2. Loosen screw 1 (Figure 5-1) and lift off bracket 3 together with attached parts 4, and 6 through 12. Remove headed pin 4 and spring 5 from overriding solenoid.

3. Remove component parts of load control floating lever 109 through 122 (Figure 5-2). Push knob 119 toward spring 120 to release pin 118 for removal. If two-slope load control bias is not used, refer to the applicable governor manual for removal of the standard load control floating lever.

IMPORTANT **Refer to the applicable governor manuals for removal of basic governor parts or assemblies as required in the following steps.**

4. Remove component parts of the governor load control valve from sensor housing 80 (Figure 5-1).

5. Remove the governor speed setting mechanism and bracket assembly.

6. Remove the overriding valve plunger and spring from the sensor housing.

7. Remove the fuel limit lever and attaching parts 18 through 21.

8. Remove the fuel limit floating lever and attaching parts 22, 23, and 24. Hold pivot 25 stationary while removing the lever and then remove the pivot together with adjusting screw 26. Remove feedback lever 27.

9. Disconnect coupling nut 28 and then back fitting 31 out of the governor column far enough to clear the end of the connecting tube from sensor bellows 67. Do not bend or place any strain on the tube during removal of the sensor assembly.

10. Remove screws 32 and 33, and washers 34. Lift sensor assembly 35 through 80 off the governor column. Remove O-ring 82 from the seat in the governor column.

11. Disassemble the sensor assembly in the order of the reference numbers assigned to Figure 5-1.

12. Cylinder head 78 is press fit with housing 80.

Altitude Compensator

Normally in is not necessary to disassemble the altitude compensator. If the unit stops operating, check the linkage to be sure it is free and not binding. If there is no binding, remove orifice assembly 151 through 162, and check that it is not plugged. Callouts on Figure 5-3 are numbered in assembly sequence. Disassembly is in the opposite sequence.

Cleaning

Immerse all parts in solvent and wash ultrasonically or by agitation. Use a non-metallic brush or jet of compressed air to clean slots and holes. Dry parts after cleaning with a jet of clean, dry air.

Flush the orifice pack with a pressurized stream of filtered solvent. Disassemble the orifice pack for more thorough cleaning if clogging or sludge build-up is evident.

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

Inspection

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

1. Mating surfaces must be free of nicks, burrs, tracks or other damage.

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

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

4. All linkages must be free of corrosion and must move freely without excessive play.

5. Inspect sensor piston 51 (Figure 5-1), amplifier piston 46, and amplifier pilot valve plunger 44 for scuffing, scoring. or wear. If scuffing or scoring is evident, inspect the respective piston or plunger bores for similar damage. Replace all parts which are scuffed or scored. Wear on highly polished areas is generally acceptable if less than one-third the length of the piston or plunger land is affected. If excessive wear is suspected, check the worn area for an out-of-round condition. Replace the pistons if the worn area is more than 0.001 inch (0.03 mm) out-of-round. Replace the plunger if the worn areas on the lands are more than 0.005 inch (0.13 mm) out-of-round.

6. Corners of plunger lands must be sharp. Replace the plunger if corners of lands are nicked or rounded off to any extent.

7. Piston and plungers must move freely in their respective bores.

8. Bleed valve diaphragms 54 and 71 (Figure 5-1) must be flat within 0.040 inch (1.02 mm). Any damage such as nicks, creases, or other deformities, scratches in excess of 0.001 inch (0.03 mm) in depth, etc., in the necked area of the diaphragm center section is cause for replacement of the part.

9. Examine sensor bellows 67 for evidence of distortion, cracks, or other damage. The longitudinal length of the bellows assembly, as measured on the bellows centerline without strap 70, and barometric pressure at time of factory assembly are marked on the upper end of the bellows. If this length has increased more than 0.015 inch (0.38 mm) at the specified barometric pressure, the evacuated bellows is leaking and the assembly must be replaced. Plug the tube and immerse the bellows assembly in hot water (200 °F/93 °C). If bubbles are observed, the sensing bellows is leaking and the assembly must be replaced.

10. Check needle bearing 42 for freedom of rotation. Replace the bearing if there is any detectable roughness.

Repair or Replacement

Limit repair of parts to removal of minor nicks, burrs, or corrosion from mating surfaces. Polish slightly corroded areas in mating surfaces using a fine 1600 grit abrasive cloth or paper and oil. Repair or rework to any other extent is impractical and the part should be replaced.

> **NOTICE**
>
> **Handle critical parts with extreme care to prevent damage to mating edges and surfaces. Maintain sharp edges of plunger lands, piston grooves, metering ports, etc. Rounded edges. nicks, or other damage to such edges results in excessive internal leakage and decreased control sensitivity.**

Lubrication

Lubricate metal parts liberally with lubricating oil at time of reassembly. Lubricate O-rings with petrolatum before installation.

Reassembly

Use a dust-free work area for reassembly. Reassemble and install the fuel limiter and load control override linkage in reverse order of the disassembly instructions. Pay particular attention to the following:

1. Obtain new O-rings, gaskets, sealing washers, retaining rings, cotter pins, etc., to replace those removed during disassembly.

2. Install retaining rings with sharp edge in the direction of the applied force.

3. If the orifice pack was disassembled for any reason, alternately install gaskets 62 (Figure 5-1) and orifice plates 63. Be sure to install a gasket between the orifice plate and washer at each end of the stack. Plates must be alternated so that adjacent orifice holes are diametrically opposite.

Chapter 5.
Replacement Parts

This chapter provides replacement parts information for the fuel limiter and load control override linkage (Figure 5-1), two-slope load control bias linkage (Figure 5-2), and altitude compensator (Figure 5-3).

When ordering replacement parts, include the following information:

- Governor serial number and part number shown on nameplate
- Manual number (this is manual 36695)
- Parts reference number in parts list and description of part or part name

Parts List For Figure 5-1

Fuel Limiter And Load Control Override Linkage

Ref. No.	Part Name	Quantity
36695-1	Screw, soc. hd., 10-32 x 1-1/4 (MS24678-15)	1
36695-2	Washer, lock, #10 (MS35338-43)	1
36695-3	Overriding solenoid bracket	1
36695-4	Headed pin, drilled	2
36695-5	Overriding lever loading spring	1
36695-6	Cotter pin. 1/16 x 3/8 (MS24665-130)	2
36695-7	Washer, plain, #10 (MS27183-8)	1
36695-8	Overriding lever yield spring	1
36695-9	Straight pin, drilled	1
36695-10	Overriding lever	1
36695-11	Nut, hex, 8-32 (MS35649-282)	1
36695-12	Setscrew, soc. hd., oval pt., 8-32 x 1 (MS51981)	1
36695-13	Solenoid plunger stop	1

Fuel Limiter Assembly

Ref. No.	Part Name	Quantity
36695-14	Nut, hex., 8-32 (MS35469-282)	1
36695-15	Nut, hex., 5/16-24 (MS35692-522)	1
36695-16	Nut, hex. 5/16-24 (fuel limit) (MS35690-522)	1
36695-17	Shutdown bushing	1
36695-18	Cotter pin, 1/16 x 5/8 (MS24665-152)	1
36695-19	Pivot pin (fuel limit lever)	1
36695-20	Loading spring	1
36695-21	Fuel limit lever	1
36695-22	Cotter pin, 1/16 x 3/8 (MS24665-130)	1
36695-23	Retaining ring. E-type (MS16633-1014)	1
36695-24	Fuel limit floating lever	1
36695-25	Pivot	1
36695-26	Adjusting screw (fuel limit)	1
36695-27	Feedback lever	1
36695-28	Coupling nut 1/2-20	1
36695-29	Ferrule, 1/4 tube	1
36695-30	Nut, hex., 1/2-20 (MS35691-822)	1
36695-31	Ballhead union, 1/4 tube	1
36695-32	Screw, soc. hd., 1/4-28 x 1-1/8 (MS35458)	1
36695-33	Screw, soc. hd,, 1/4-28 x 1-3/4 (MS35458-28)	1
36695-34	Washer, lock. 1/4 (MS51848)	2
36695-35	Screw soc. hd., 10-32 x 1/2 (MS24678-20)	2
36695-36	Screw, soc. hd., 10-32 x 1-1/2 (MS24678-16)	1
36695-37	Washer, lock, #10 (MS35338-43)	3
36695-38	Cotter pin, 1/16 x 5/8 (MS24665- 152)	2
36695-39	Pivot pin (bellcrank)	1
36695-40	Bellcrank	1
36695-41	Straight pin, drilled	1
36695-42	Needle bearing	1
36695-43	Linkage bracket	1
36695-44	Amplifier pilot valve plunger	1
36695-45	Pilot valve loading spring	1
36695-46	Amplifier piston	1
36695-47	Sensor piston sleeve	1
36695-48	Screw, button soc. hd., Nylok, 8-32 x 3/8	1
36695-49	Roll pin, 1/8 x 3/8 (MS171524)	1
36695-50	Fuel limit cam	1
36695-51	Sensor piston	1
36695-52	Restoring spring	1
36695-53	Restoring spring seat	1
36695-54	Bleed valve diaphragm	1
36695-55	Filter screen	1
36695-56	Preformed packing, 1/2 OD (NAS1593-012)	2
36695-57	Check valve assembly	1
36695-58	Retaining ring, internal (MS16625-1037)	1
36695-59	Washer, 9/64 ID x 3/8 (max.) OD x 1/32	1
36695-60	Orifice pack spring	1
36695-61	Washer, 3/16 ID x 3/8 (max.) OD x 1/16	2
36695-62	Gasket	33
36695-63	Orifice plate	32
36695-64	Orifice case	1
36695-65	Not Used	
36695-66	Screw, button soc. hd., Nylok, 8-32 x 3/8	2
36695-67	Sensor bellows (absolute pressure type)	1
36695-68	Preformed packing, 1-1/4 OD (NAS1593-024)	1
36695-69	Bellows spacer (used with item 67 only)	1
36695-70	Bellows output strap (used with item 67 only)	1
36695-71	Not Used	
36695-72	Retaining ring, internal (MS16627-1125) (used with item 67 only)	1
36695-73	Screw, hex. hd., 1/4-28 x 3/4 (MS35298-6)	1
36695-74	Washer, soft copper 1/4 ID x 1/2 OD x 1/32	1
36695-75	Eccentric	1
36695-76	Gasket, copper	1
36695-77	Valve seat	1
36695-78	Cylinder head (overriding)	1
36695-79	Taper screw	9
36695-80	Housing	1
36695-81	Straight pin (tailrod)	1
36695-82	Preformed packing. 0.338 OD (NAS1593-011)	1
36695-83	Pilot valve plunger nut	1
36695-84	Loading spring	1
36695-85	Sensor bellows (not shown) (gauge pressure type, optional, see item 67)	1
36695-86	Spring seat	1
36695-87	Pin, 0.059 x 0.082 dia. x 0.782 OAL	1

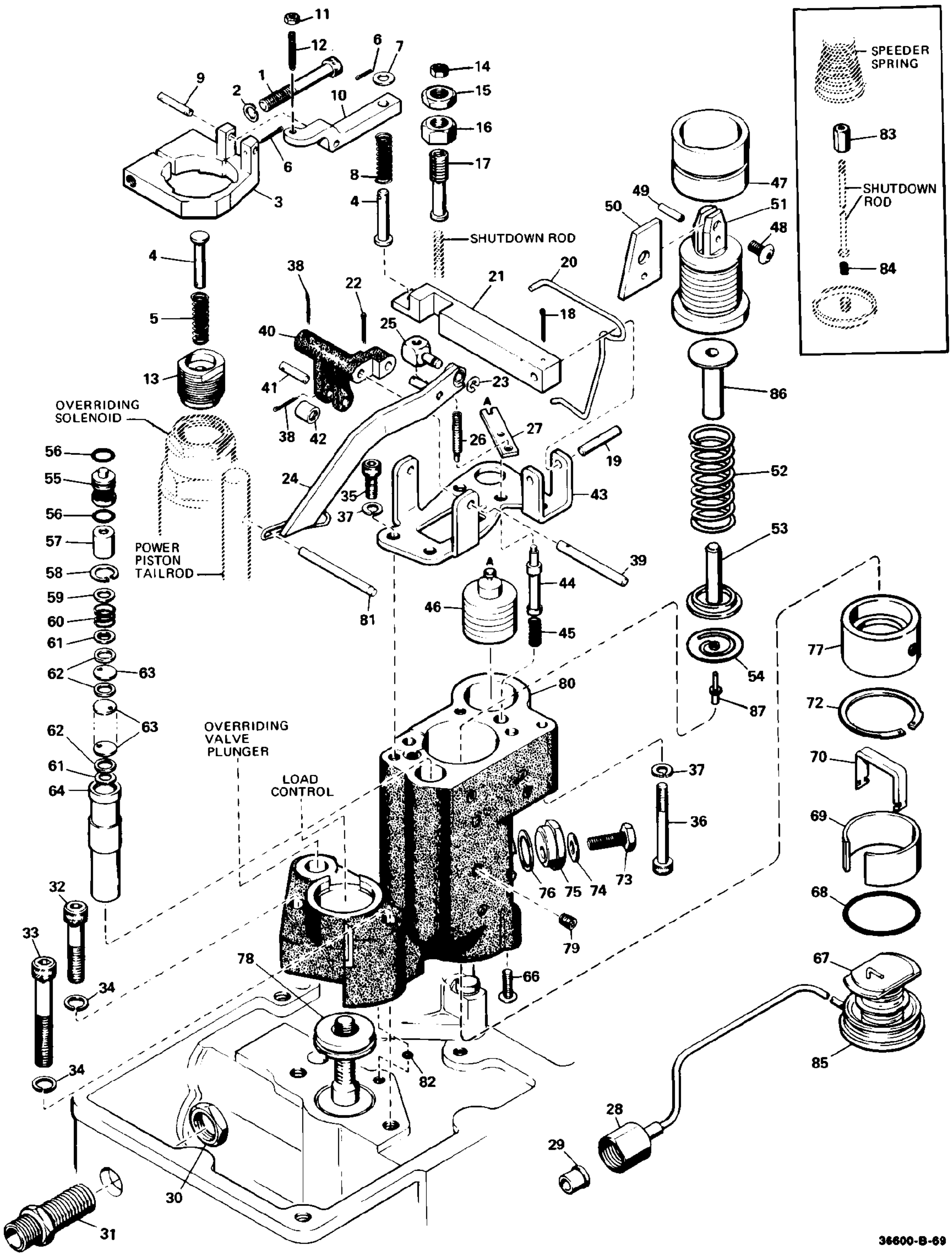

Figure 5-1. Exploded View, Fuel Limiter and Optional Load Control Override Linkage

Parts List For Figure 5-2

Two-Slope Load Control Bias Linkage (optional)

Ref. No.	Part Name	Quantity
36695-101	Nut, hex., 8-32 (MS35649-282)	2
36695-102	Adjustment screw (derating)	2
36695-103	Screw, soc. hd., 10-32 x 1-1/4 (MS24678-15)	1
36695-104	Washer, lock, #10 (MS35338-43)	1
36695-105	Cotter pin, 1/16 x 1/2 (MS24665-132)	1
36695-106	Pivot pin (bias lever)	1
36695-107	Load control bias lever	1
36695-108	Pivot bracket	1
36695-109	Cotter pin, 1/16 x 3/8 (MS24665-130)	4
36695-110	Washer, plain. #10 (AN960-10L)	2
36695-111	Headed pin, drilled	2
36695-112	Pivot block (1st derating adjustment)	1
36695-113	Inner telescoping link	1
36695-114	Cotter pin. 1/32 x 1/2 (MS24665-5)	1
36696-115	Pivot pin	1
36695-116	Pivot block (2nd derating adjustment)	1
36695-117	Cotter pin, 1/16 x 5/8 (MS24665-152)	1
36695-118	Adjusting screw pin	1
36695-119	Adjusting screw knob	1
36696-120	Knob spring	1
36695-121	Floating lever adjusting screw	1
36695-122	Load control floating lever	1
36695-123	Outer telescoping link	1

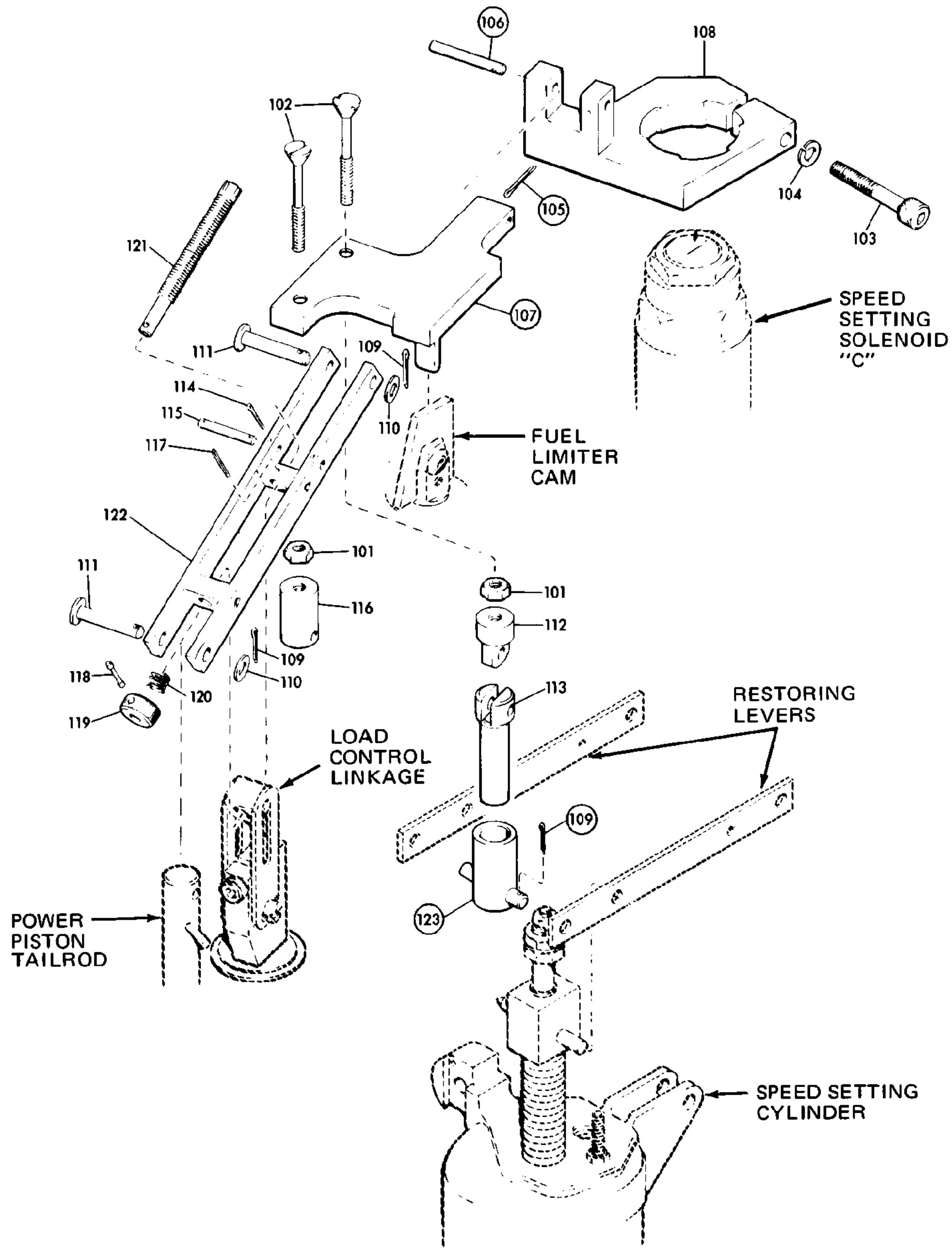

Figure 5-2. Exploded View, Optional Two-Slope Load Control Bias Linkage

Parts List For Figure 5-3

Altitude Compensator

Ref. No.	Part Name	Quantity	Ref. No.	Part Name	Quantity
36695-151	Orifice case	1	36695-189	Crank arm	1
36695-152	Gasket	33	36695-190	Drilled pin	1
36695-153	Orifice plate	32	36695-191	Cotter pin, 00625 x 0.625	1
36695-154	Washer, 0.375 OD	1	36695-192	Splitlock washer, #10	1
36695-155	Washer 0.360 OD	2	36695-193	Soc. hd. cap screw, 10-32 x 0500	1
36695-156	Oil seal compression spring	1	36695-194	Needle bearing	2
36695-157	Retaining ring	1	36695-195	Derating bracket	1
36695-158	Plug	1	36695-196	Splitlock washer, #10	2
36695-159	O-ring	1	36695-197	Soc. hd. cap screw, 10-32 x 0.625	2
36695-160	Washer	1	36695-198	Derating shaft	1
36695-161	Splitlock washer, #10	1	36695-199	Roller link	2
36695-162	Soc. hd. cap screw, 10-32 x 0375	1	36695-200	Bushing	1
36695-163	Retainer ring	1	36695-201	Cotter pin 0.060 x 0.375	5
36695-164	Valve seat	1	36695-202	Needle bearing	1
36695-165	Washer, 0.567 x 0745 x 0.030-0.034	1	36695-203	Pin	1
36695-166	Eccentric	1	36695-204	Pickup link	2
36695-167	Washer, 0.250 x 0.500 x 0.031	1	36695-205	Floating lever	1
36695-168	Cap screw, 0.250-28 x 0.750	1	36695-206	Washer, 0.360 OD	2
36695-169	Pin, 0.059 x 0.082 dia. x 0.787 OAL	1	36695-207	Altimeter cam	1
36695-170	Diaphragm	1	36695-208	Washer	1
36695-171	Spring seat	1	36695-209	Washer, 0.203 x 0.438 x 0.064 thick	2
36695-172	Spring	1	36695-210	Splitlock washer, #10	2
36695-173	Spring seat	1	36695-211	Hex. hd. cap screw	2
36695-174	Piston	1	36695-212	Washer	1
36695-175	Piston sleeve	1	36695-213	Fil. hd. screw, 6-32 x 0.750	1
36695-176	Piston link	1	36695-214	Elastic hex nut, 6-32	1
36695-177	Drilled straight pin	1	36695-215	Block	1
36695-178	Cotter pin, 0.030 x 0.375	2	36695-216	Splitlock washer, #10 0.190	1
36695-179	Washer, 0.310 OD	1	36695-217	Soc. hd. cap screw, 10-32 x 0.500	1
36695-180	Splitlock washer, #6	1	36695-218	Vac test line block	1
36695-181	Fil. hd. screw. 6-32 x 0375	1	36695-219	Splitlock washer, #10	1
36695-182	Bellows output strap	1	36695-220	Soc. hd. cap screw	1
36695-183	Vac test bellows	1	36695-221	O-ring, 0070 x 0.254 OD	1
36695-184	Altimeter drain plug	1	36695-222	Altimeter body	1
36695-185	Shakeproof washer 0.375 ID	1	36695-223	Taper screw	2
36695-186	Hex nut, 375-24	1	36695-224	High collar lockwasher, 0.250 ID	2
36695-187	Nylok button head screw	2	36695-225	Soc. hd. cap screw, 0.250-28 x 2.000	2
36695-188	Soc. hd. screw, 10-32 x 0.750	1	36695-226	O-ring, 0.375 OD	1

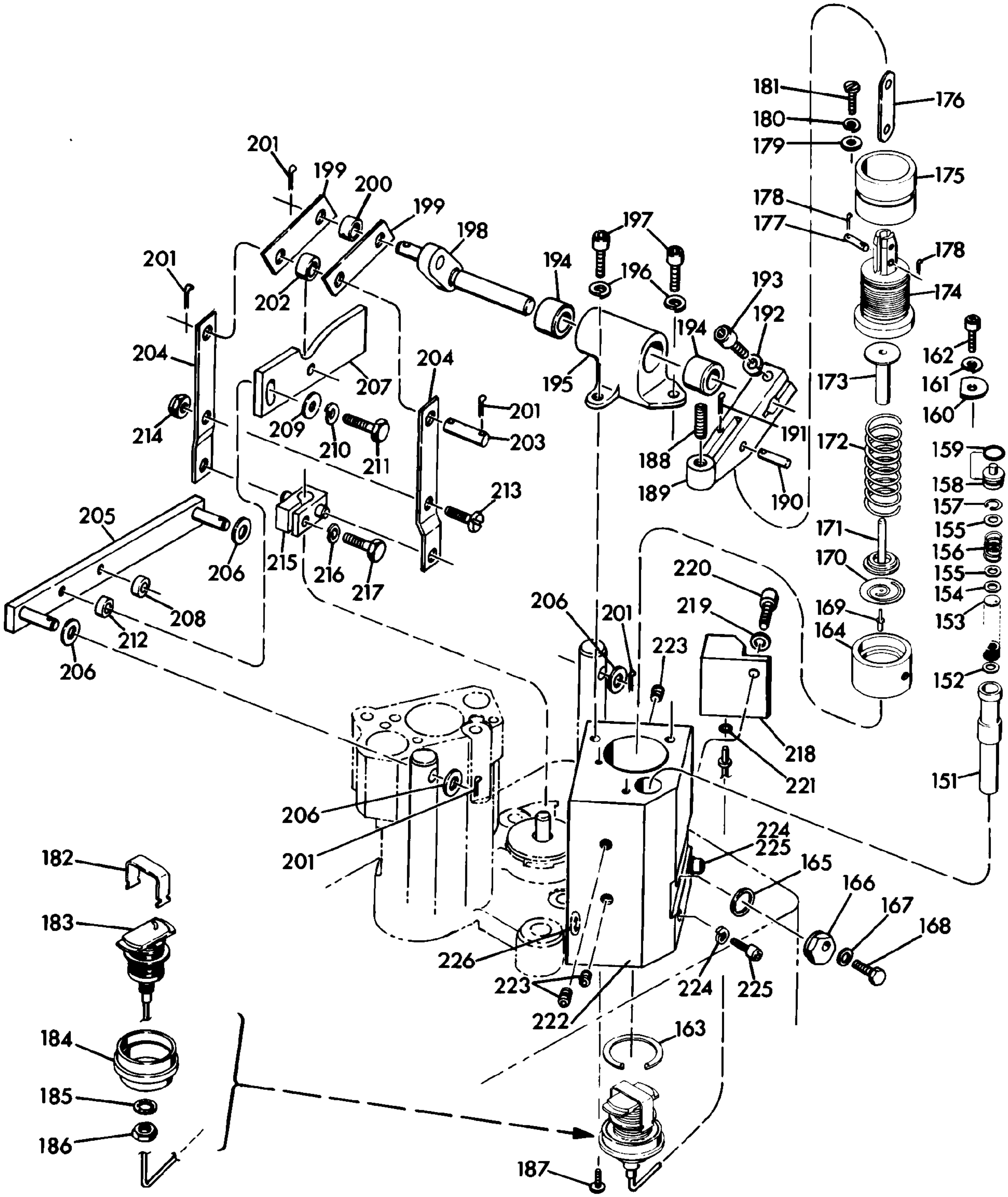

Figure 5-3. Altitude Compensator

Chapter 6. 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		Products Used In Engine Systems		Products Used In Industrial Turbomachinery Systems	
Facility	**Phone Number**	**Facility**	**Phone Number**	**Facility**	**Phone Number**
Brazil	+55 (19) 3708 4800	Brazil	+55 (19) 3708 4800	Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727	China	+86 (512) 6762 6727	China	+86 (512) 6762 6727
Germany:		Germany	+49 (711) 78954-510	India	+91 (129) 4097100
Kempen	+49 (0) 21 52 14 51	India	+91 (129) 4097100	Japan	+81 (43) 213-2191
Stuttgart	+49 (711) 78954-510	Japan	+81 (43) 213-2191	Korea	+82 (51) 636-7080
India	+91 (129) 4097100	Korea	+82 (51) 636-7080	The Netherlands	+31 (23) 5661111
Japan	+81 (43) 213-2191	The Netherlands	+31 (23) 5661111	Poland	+48 12 295 13 00
Korea	+82 (51) 636-7080	United States	+1 (970) 482-5811	United States	+1 (970) 482-5811
Poland	+48 12 295 13 00				
United States	+1 (970) 482-5811				

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

Technical Assistance

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

General

Your Name

Site Location

Phone Number

Fax Number

Prime Mover Information

Manufacturer

Engine Model Number

Number of Cylinders

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

Power Output Rating

Application (power generation, marine, etc.)

Control/Governor Information

Control/Governor #1

Woodward Part Number & Rev. Letter

Control Description or Governor Type

Serial Number

Control/Governor #2

Woodward Part Number & Rev. Letter

Control Description or Governor Type

Serial Number

Control/Governor #3

Woodward Part Number & Rev. Letter

Control Description or Governor Type

Serial Number

Symptoms

Description

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

We appreciate your comments about the content of our publications.

Send comments to: icinfo@woodward.com

Please reference publication 36695D.

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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.

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