WOODWARD

Product Manual 36631
(Revision B)
Original Instructions

Two-slope Manifold Pressure Bias Load Control & Fuel Limiter for PG Governor with Torque Advance at Idle Speed

Operation Manual

General Precautions

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

Practice all plant and safety instructions and precautions.

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

Revisions

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

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

Proper Use

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

Translated Publications

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

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 Out-of-date translations are marked with ⚠.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

Warnings and Notices

Important Definitions

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

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

⚠WARNING

Overspeed / Overtemperature / Overpressure

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

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

⚠WARNING

Personal Protective Equipment

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

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

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

⚠WARNING

Start-up

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

⚠WARNING

Automotive Applications

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

NOTICE

Battery Charging Device

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

Electrostatic Discharge Awareness

NOTICE

Electrostatic Precautions

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

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

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

Follow these precautions when working with or near the control.

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

Two-slope Manifold Pressure Bias Load Control

Description

The basic load control system adjusts the load on an engine as a function of governor speed setting and fuel. Governors used on turbocharged engines are often equipped with more intricate load control systems. One such system, employed in a governor with pneumatically controlled speed setting, schedules load as a function of speed setting control air pressure, fuel, and the absolute pressure* of the manifold charging air.

*—"Absolute pressure" is the sum of the pressure indicated in an ordinary pressure gauge plus the atmospheric pressure outside of the gauge.

The schematic arrangement of this type of load control system is shown in Figure 1.

Manifold charging air pressure is brought into the upper bellows and tends to push the output case end down. The lower bellows is of the same size and has been evacuated. The force at the output case end is thus unaffected by atmospheric pressure changes and is, therefore, proportional to the absolute manifold charging air pressure.

The force produced by the absolute manifold charging air pressure is transmitted, through the output case end and bellows-to-valve lever, to the cone valve. This force is opposed at the cone valve by the force of the spring between the cone valve and the sensor piston.

The unrestricted flow of pressure oil applies constant pressure to the upper-side of the sensor piston. A series of orifices restricts the flow of pressure oil to the underside of the piston. Except while changes are occurring in the manifold charging air pressure, the bellows force tending to push the cone valve up is balanced or equaled by the spring force from the opposite direction. Thus, the cone valve normally "floats" just off its seat and continually bypasses to sump the oil admitted through the orifice stack to the underside of the piston. (This accounts for the continuous "bubbling" of oil from the top of the sensor when it is operating.)

If the bellows force is greater than the opposing spring force, the cone valve is forced upward, and oil flows out from under the piston at an increased rate. The pressure oil above the piston forces it down, compressing the spring until the spring force again equals the bellows force. If the absolute manifold charging air pressure is decreased, the bellows output force is reduced, and the spring pushes the cone valve onto its seat. The oil pressure under the piston will move the piston up and reduce the spring load on the cone valve until the opposing forces are again equal.

The load control pilot valve plunger is suspended from the floating lever. When the pilot valve plunger is "centered" (with its control lands exactly covering the control ports in the plunger bushing), no oil flows to or from the load regulator. If the pilot valve plunger is lifted above its centered position, pressure oil is directed to the load regulator to decrease engine load. If the pilot valve plunger is lowered below its centered position, pressure oil is directed to the load regulator to increase engine load.

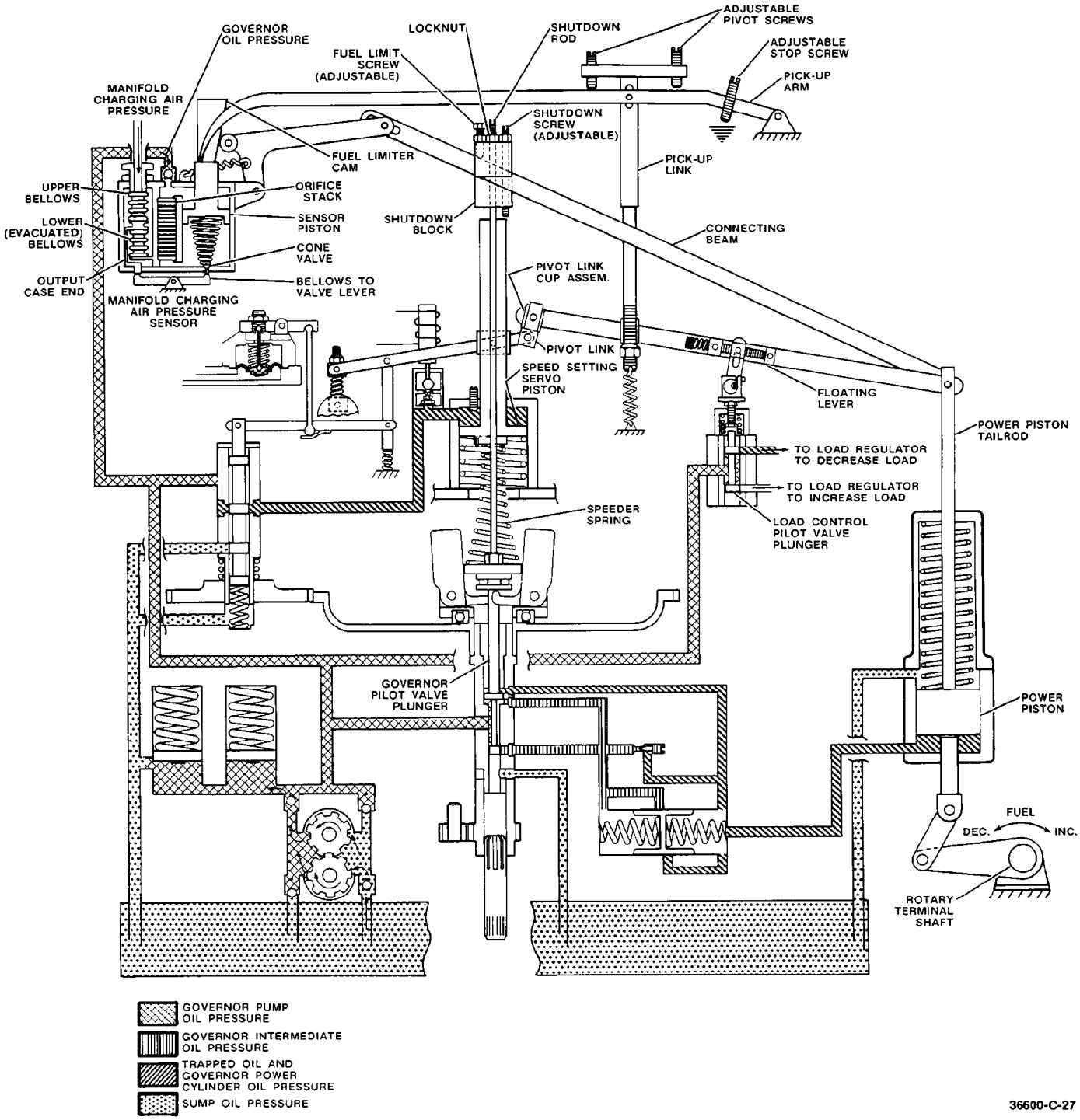

Figure 1. Schematic View

One end of the floating lever is connected to the power piston tailrod; the other end is attached to linkage from the governor speed-setting mechanism. The floating lever and pilot valve plunger are nominally positioned as functions of speed setting and fuel. However, attached to the floating lever at a point between the pilot valve plunger and the connection to the speed setting linkage is a slotted pick-up link which takes a position proportional to the sensor piston position. The pick-up link can, after the free movement in the slot is taken up, raise the left end of the floating lever by moving the pivot link up away from the pivot link cup assembly. At the same time, the load control pilot valve plunger is also raised. Thus, the pressure sensor decreases engine load and fuel as charging pressure decreases.

The slot in the pick-up link will allow a loss in the absolute value of the charging air pressure particularly at low speed and load settings without any resulting derating. This feature is useful for applications for which the engine and turbocharger combination have been rated for altitude operation.

The ratio or proportion of pick-up link movement for a given sensor piston movement depends on which of the two pivot screws on the top end of the pick-up link is in contact with the pick-up arm.

The two pivot screws, each of which is adjustable, permit establishment of a two-slope derating curve which enables close matching of the system with the normal blower characteristics while still derating sufficiently, in the extreme case of complete loss of turbocharger, to allow continued running of the engine without exceeding exhaust temperature limitations.

The closing of the extensible pivot link cup assembly determines the point beyond which an increase in absolute manifold charging air pressure no longer affects the load control system. This assists good acceleration, while allowing for some scatter in manifold pressures between engines.

A typical two-slope derating curve, plotting fuel versus absolute manifold charging air pressure at constant engine speed, is shown in Figure 2. The “flat” at the top of the curve is reached when the pivot link cup assembly closes or, in some cases, when the adjustable stop screw in the pick-up arm touches ground.

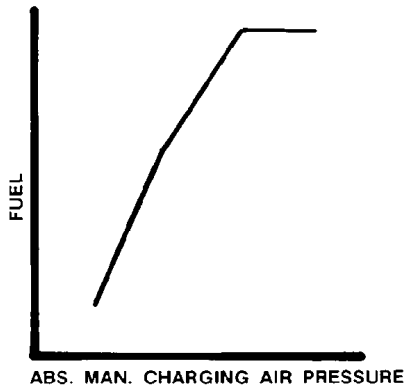

Figure 2. Typical Two-slope Derating Curve

The curve shows graphically the effect of the alternate pivot points on the pick-up link. Such a system acts to prevent excessive exhaust temperatures by reducing the rack setting of the engine at load balance during periods of low turbocharger discharge.

A typical load control curve (with the turbine blowers operating normally) resulting from the absolute manifold pressure is shown in Figure 3. The vertical rise at the start of the curve shows the effect of changing the control air signal below the pressure required to advance speed above the minimum speed level (i.e., the period of torque advance at idle speed).

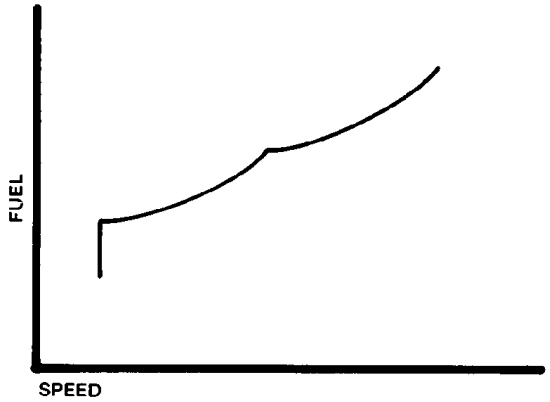

Figure 3. Typical Load Control Curve

Thus, a combination of three signals determines the engine load: (1) the control air pressure, (2) the governor fuel setting, and (3) the absolute pressure of the manifold charging air.

If is of interest to note that, though the speed setting servo piston shown in Figure 1 takes a position proportional to control air pressure, the governor speed setting is unaffected by control air pressure changes below a certain level. The upper spring seat can move up (decreasing governor speed) as the servo piston moves up (due to lower control air pressure signals) only until the large diameter shoulder of the spring seat hits its stop. This will be equivalent to idle speed. Above the control air pressure corresponding to idle speed, the upper spring seat moves down to increase the governor speed setting as the servo piston moves down.

Figure 4 shows a typical load control curve (plotting fuel versus control air pressure) which might be obtained in a governor with a yield linkage assembly attached to the floating lever.

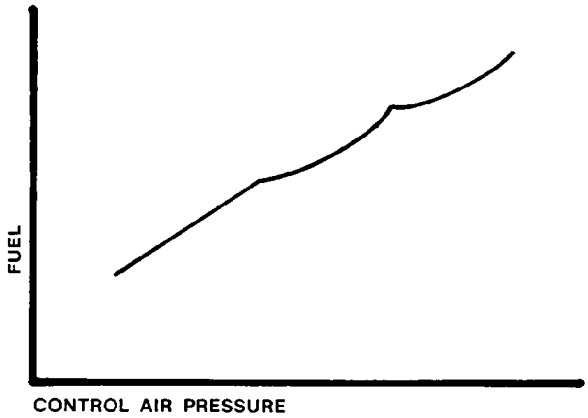

Figure 4. Typical Load Control Curve (fuel vs control air pressure)

Absolute Manifold Pressure Fuel Limiter

The normal lag of the turbo-supercharger speed to the engine speed during periods of acceleration makes it possible to supply, on large increases in load, more fuel to the engine than can be burned with the air available from the supercharger. The resulting unbalance of fuel and air leads to poor combustion and excessive smoke, and often retards the ability of the engine to return to normal speed after a load change. Restricting the governor power piston in the opening direction—and hence, limiting engine fuel—as a function of absolute manifold charging air pressure ensures that sufficient air is available for proper combustion of fuel.

The fuel limiter consists essentially of a pressure sensor, a cam, and a connecting beam. If the fuel limiter is incorporated in a governor which also has a form of pressure bias load control, a single pressure sensor can serve to fill the needs of each system. Such an arrangement is shown in Figure 1.

One end of the connecting beam is attached to the tailrod of the governor power piston; the other end is positioned as a function of the cam position. The beam passes under the shutdown block so that if the beam is raised sufficiently far, it will raise the shutdown block and with it the shutdown rod. The shutdown rod is an extension of the governor pilot valve plunger. Thus, lifting the shutdown rod lifts the pilot valve plunger and causes the power piston to move down and thereby decrease fuel to the engine.

Fuel may be increased until the upward movement of the power piston causes the connecting beam to lift the shutdown block. The cam position establishes the height to which the power piston may rise before the connecting beam lifts the shutdown block. Thus, the cam position determines the maximum fuel allowed the engine at any instant.

As shown in Figure 1, the cam is attached to the hydraulically operated piston in the pressure sensor. As explained above, the piston takes a position which is proportional to the absolute charging air pressure. The fuel limit at any instant is, therefore, a function of the absolute charging air pressure.

It should be noted that, though using common signals (sensor piston position and power piston position), the fuel limiter and pressure bias load control scheme are separate and independent systems.

Information and Parts Replacement

When requesting additional information concerning governor operation or when ordering parts, the following information must accompany the request:

- Governor serial number (shown on nameplate). The serial number is needed since the reference numbers shown in this manual do not identity the exact part number required for any one governor
- Manual number (this is manual 36631)
- Part reference number, name of part, or description of part

Parts List for Figures 5, 6, 7

Ref. No.	Part Name
36631-1	Washer
36631-2	Power Piston Lever
36631-3	Stop Nut
36631-4	Floating Lever Link
36631-5	Adjustable Fulcrum Pin
36631-6	Link Adjusting Spring
36631-7	Washer
36631-8	Straight Pin
36631-9	Speeder Spring Power Cylinder
36631-10	Connector Clamp Plate
36631-11	Gasket
36631-12	Control Lever Slide
36631-13	Diaphragm Link Assembly
36631-14	Diaphragm Spring
36631-15	Floating Lever Link Assy.
36631-16	Speeder Spring Servo Spring
36631-17	Spring Seat
36631-18	Diaphragm Spring
36631-19	Diaphragm Washer
36631-20	Keyed Washer
36631-21	Diaphragm Nut
36631-22	Cotter Pin
36631-23	Pin
36631-24	Floating Lever Assembly
36631-25	Washer
36631-26	Thrust Bearing
36631-27	Pin
36631-28	Regulating Bushing
36631-29	Floating Lever Link Spring
36631-30	Pilot Bushing
36631-31	Pilot Bushing Spring
36631-32	Spring
36631-33	Speeder Spring Stop Clamp Ring
36631-34	Speeder Spring Stop Sleeve
36631-35	Bushing Spacer
36631-36	Soc. Hd. Screw
36631-37	Screw
36631-38	Washer
36631-39	Shutdown Rod
36631-40	Speeder Spring Seat
36631-41	Power Piston
36631-42	Power Piston Stop Screw
36631-43	Power Piston Fulcrum Assy.
36631-44	Pivot Link Cap Assembly
36631-45	Pin
36631-46	Latch Spring
36631-47	Nut
36631-48	Adjusting Screw
36631-49	Shutdown Block Assembly
36631-50	Power Piston Lever
36631-51	Pin
36631-52	Pivot Pin Link
36631-53	Adjusting Screw Pin
36631-54	Adjusting Screw Knob
36631-55	Link Adjusting Spring
36631-56	Adjusting Screw Pin
36631-57	Movable Fulcrum Pin
36631-58	Adjusting Screw
36631-59	Lower Fulcrum Pin
36631-60	Copper Tubing
36631-61	Power Piston Tailrod
36631-62	Pilot Valve Link
36631-63	Hex. Hd. Bolt
36631-64	Socket Hd. Cap Screw
36631-65	Eccentric Assy.
36631-66	Eccentric
36631-67	Pilot Valve Nut
36631-68	Spring Retainer
36631-69	Snap Ring
36631-70	Load Control Valve Spring
36631-71	Spring Collar
36631-72	Overriding Piston
36631-73	Load Control Spacer
36631-74	Oil Seal Gasket
36631-75	L.C. Pilot Valve Bushing Spring
36631-76	Load Control Pilot Valve Plunger
36631-77	Load Control Pilot Valve Bushing
36631-78	Retaining Ring
36631-79	Cam
36631-80	Pivot Link Pin
36631-81	Spacer
36631-82	Piston
36631-83	Washer
36631-84	Washer
36631-85	Pivot Pin
36631-86	Set Screw
36631-87	Speed Control Bracket Cap
36631-88	Nut
36631-89	Needle Bearing
36631-90	Speed Control Lever
36631-91	Hex Jam Nut
36631-92	Idle Speed Setting Screw
36631-93	Washer
36631-94	Screw
36631-95	Nut (#10-32)
36631-96	Adjustable Fulcrum Pin
36631-97	Headed Pin
36631-98	Speed Setting Stud
36631-99	Set Screw
36631-100	Power Piston Fulcrum Assy.
36631-101	Speeder Spring Power Cylinder Assy.
36631-102	Load Control Scale
36631-103	Washer
36631-104	Screw
36631-105	Washer
36631-106	Headed Pin
36631-107	Washer
36631-108	Pickup Lever
36631-109	Pin
36631-110	Pickup Lever Adjusting Screw
36631-111	Screw
36631-112	Pickup Link Assy
36631-113	Cotter Pin
36631-114	Hosting Lever Assy.
36631-115	Male Connector
36631-116	Screw
36631-117	Lockwasher
36631-118	Bracket Assy.
36631-119	Washer
36631-120	Cotter Pin

Ref. No.	Part Name
36631-121	Tailrod Pin
36631-122	Connecting Beam
36631-123	Cam Guide Bracket
36631-124	Fuel Limit Body
36631-125	Shim
36631-126	Bearing
36631-127	Headed Pin
36631-128	Spring Anchor Screw
36631-129	Fulcrum Pin
36631-130	Spring
36631-131	Bellows Locknut
36631-132	Banjo Pitting Body
36631-133	Banjo Fitting Screw
36631-134	Banjo Seal
36631-135	Nut
36631-136	Sleeve
36631-137	O-ring
36631-138	Bellows Assembly
36631-139	Lockwasher
36631-140	Nylok Screw
36631-141	Lever Support Lock Block
36631-142	Socket Hd. Screw
36631-143	Retaining Ring
36631-144	Lever Support And Plug
36631-145	Hex. Hd. Cap Screw
36631-146	Washer
36631-147	Lockwasher
36631-148	Pin
36631-149	Pipe Plug

Ref. No.	Part Name
36631-150	Rocker Arm Assembly
36631-151	Valve Seat
36631-152	Valve Plunger
36631-153	Piston Spring
36631-154	Spring Seat
36631-155	Piston Sleeve
36631-156	Retaining Ring
36631-157	Spacer
36631-158	Cylinder Head
36631-159	Screw
36631-160	Washer
36631-161	Pointer Spring
36631-162	Load Control Scale
36631-163	Pointer Pivot
36631-164	Load Control Pointer
36631-165	Load Control Indicator Washer
36631-166	Washer Type Spring
36631-167	Orifice Case
36631-168	Washer
36631-169	Snap Ring
36631-170	Check Valve Assy.
36631-171	O-ring
36631-172	Snap Ring
36631-173	Plug and Screen Assy.
36631-174	Spring
36631-175	Washer
36631-176	Orifice Plate
36631-177	Gasket

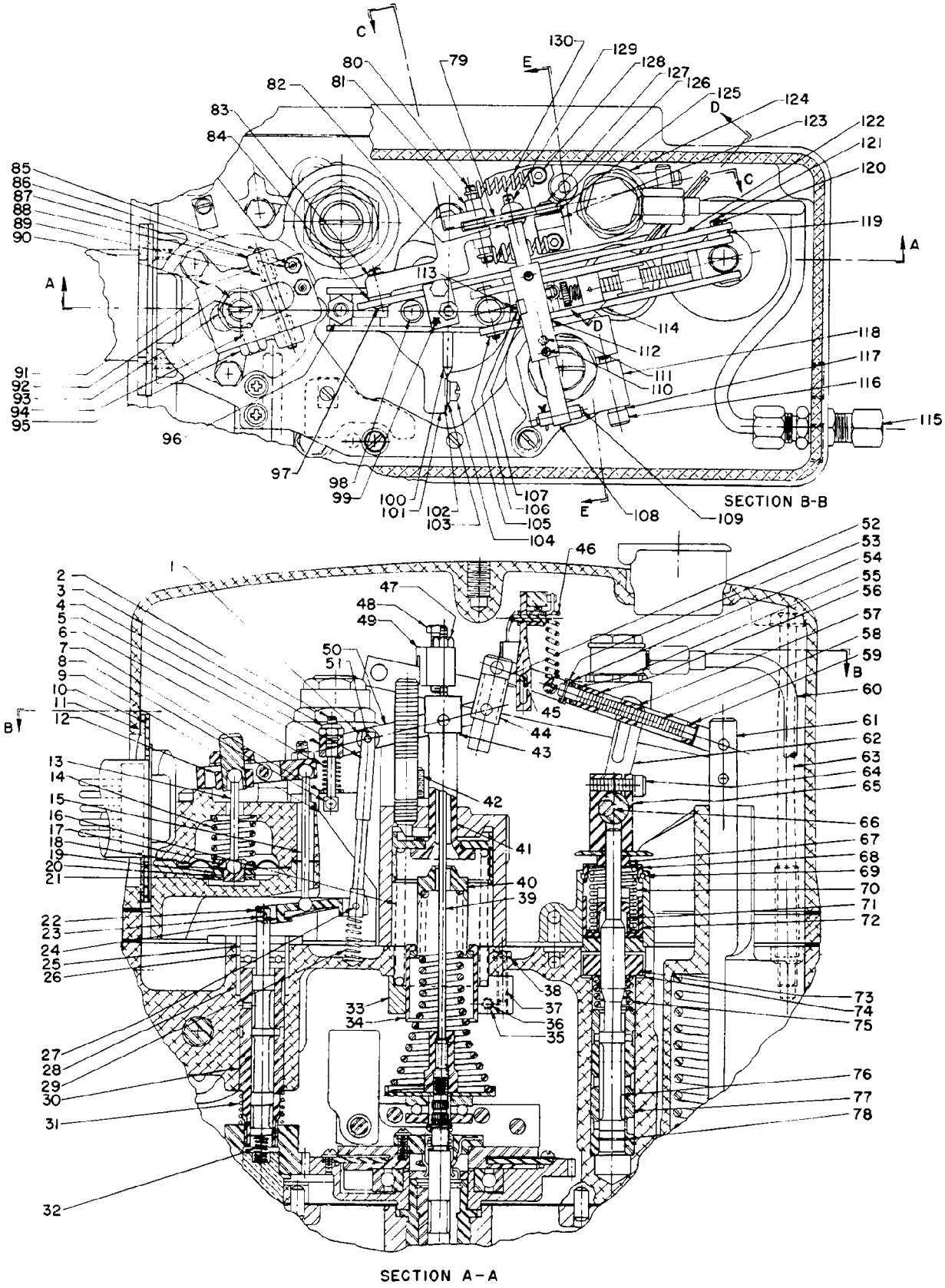

Figure 5. Parts Identification

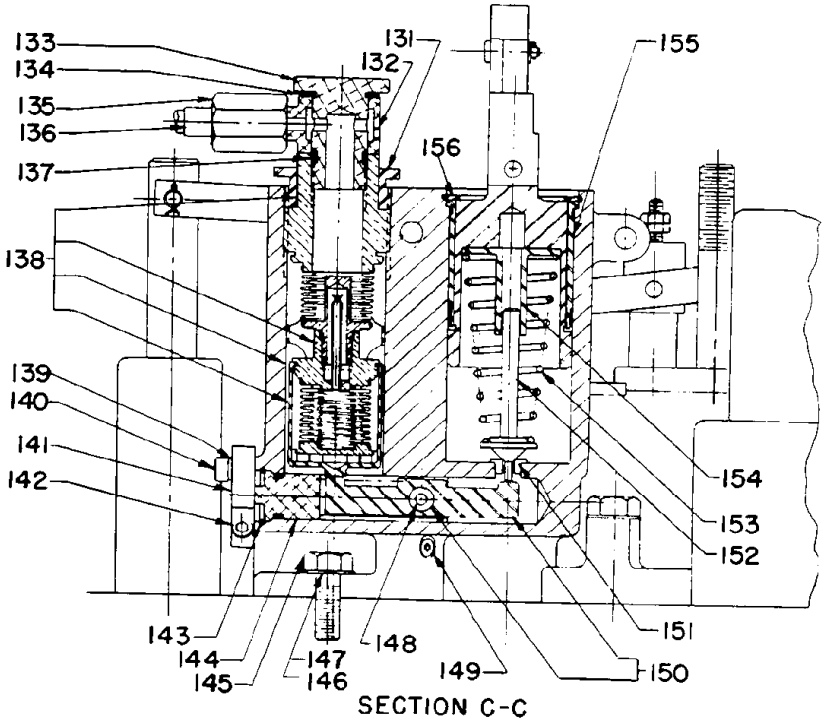

Figure 6. Parts Identification

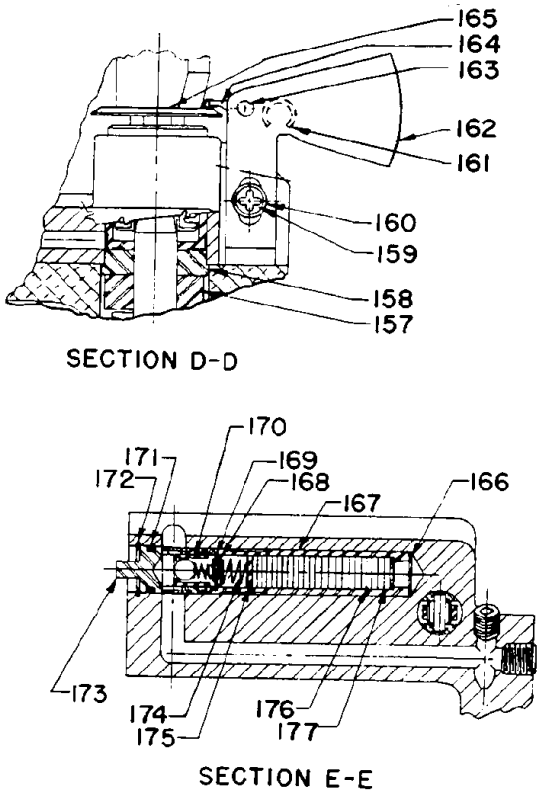

Figure 7. Parts Identification

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Send comments to: icinfo@woodward.com

Please reference publication 36631B.

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