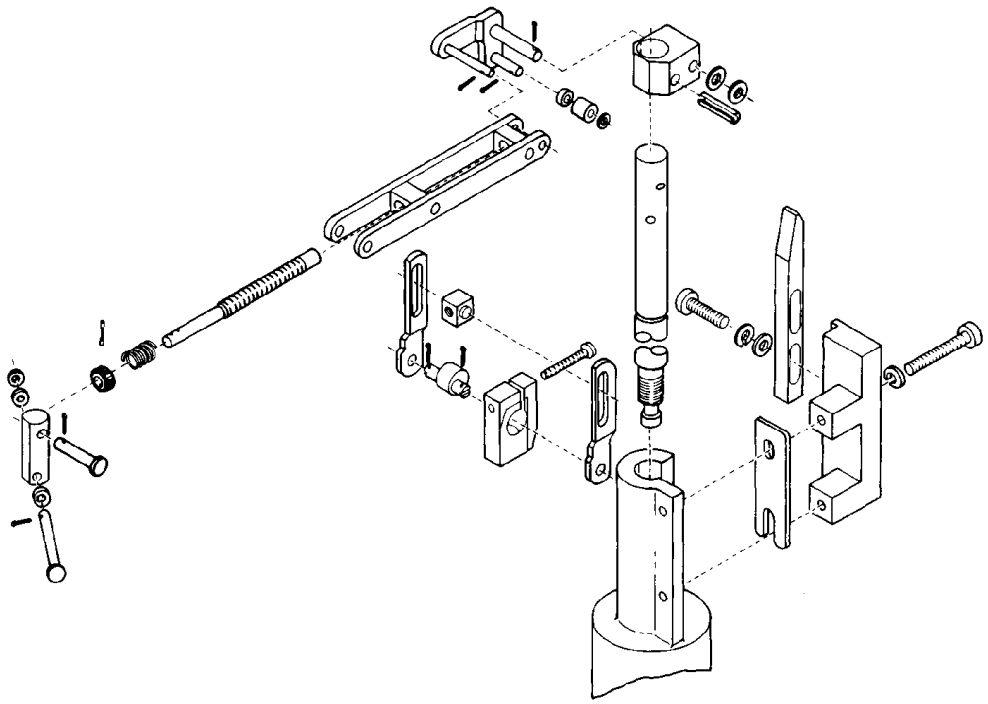
WOODWARD

Product Manual 36607
(Revision NEW)
Original Instructions



Two-Slope Load Control for PG Governors

Operation Manual

General Precautions

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

Practice all plant and safety instructions and precautions.

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

Revisions

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

www.woodward.com/publications

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

Proper Use

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

Translated Publications

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

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 Out-of-date translations are marked with ⚠.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

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

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 Load Control for PG Governors

General

This load control is a lever actuated servo system that has a cam to provide a second load control schedule slope. It adjusts engine load as a function of governor speed setting and fuel.

IMPORTANT **As used in this manual, “engine” refers to either engines, turbines, or other types of prime movers as applicable.**

The primary function of a governor is to schedule fuel to the engine to maintain a constant engine speed under varying toad conditions. In most locomotive governors and some marine governors, a secondary objective is to maintain a definite horsepower output of the engine for each specific speed setting of these governors. For each speed setting of the governor, a predetermined engine speed is desired as well as a predetermined amount of load/fuel for the engine.

The governor load control system adjusts the load on the engine to a predetermined value for each specific speed setting of the governor. For example, control of load on railroad engines is obtained by adjusting the strength of the generator field excitation current so that a definite, predetermined load is absorbed by the traction motors at each setting. In this instance, the load control system operates through a servo which adjusts a rheostat in the excitation circuit. In marine propulsion units having adjustable pitch propellers, the load control system acts through a servo which varies the propeller pitch to change the engine load.

A schematic of the PG governor with the two-slope load control system is shown in Figure 1. The speed setting servo piston position determines the loading on the speeder spring and hence the governor speed setting. The governor ballhead compares the actual governor speed (proportional to engine speed) with the established speed setting. If they are not equal, the governor pilot valve plunger is moved from its central position to initiate a repositioning of the governor power piston to which the engine fuel linkage is connected. If the engine speed is slower than desired, the power piston moves up to increase fuel; if the engine speed is faster than desired, the power piston moves down to decrease fuel.

The load control pilot valve controls a servo which can adjust the load on the engine. The servo may be built into the PG governor or mounted remotely and hydraulically connected to the governor. The load control pilot valve plunger is suspended from the floating lever. One end of the floating lever is positioned relative to the governor speed setting and the other end is positioned relative to the governor power piston or fuel setting.

The speed setting end of the floating lever is connected through linkage to the speed setting servo piston rod. This end of the floating lever is lowered as the speed setting servo moves downward to increase the governor speed setting.

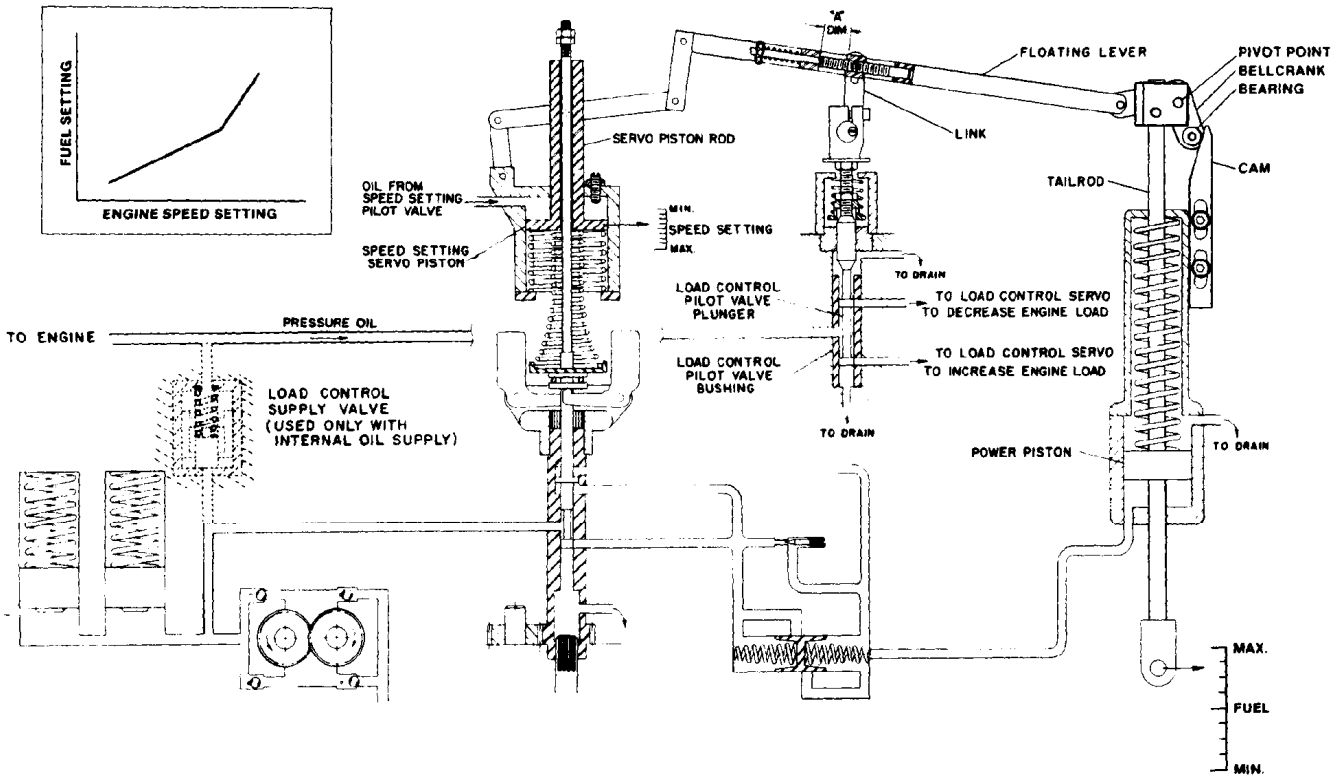


Figure 1. Schematic of PG Governor with Two-Slope Load Control

The fuel setting end of the floating lever is connected to one end of a pivotable bellcrank. The bellcrank pivots in a block mounted on the tailrod of the governor power piston. A bearing on the other end of the bellcrank rides on the two-slope cam which is mounted adjacent to the tailrod. When the bellcrank bearing is on the vertical cam surface, the up and down motion of the fuel setting end of the floating lever is identical to that of the tailrod. When the bellcrank bearing is on the sloped cam surface, however, the up and down motion of the fuel setting end of the floating lever is less than that at the tailrod as the bell crank rotates. The tailrod moves upward with increasing fuel setting. For each speed setting, there is one fuel setting at which the load control pilot valve plunger is centered.

Consider the load control system in a governor when the load control pilot valve plunger is “centered” (its control lands exactly cover the ports in the pilot valve bushing). This condition occurs whenever the load on the engine is equal to the power output of the engine as programmed for the existing speed setting. Assume that the load on the engine increases. The engine slows down, the ballhead lowers the governor pilot valve, and the power piston moves up to give the engine the additional fuel needed to carry the increased load at the set speed. As the power piston moves up, it lifts one end of the floating lever, lifting the load control pilot valve plunger above its centered position.

Pressure oil now flows to the load control servo to decrease engine load (in a railroad governor, the field coil excitation is decreased to decrease generator load; in a marine propulsion unit, the pitch of the adjustable propeller is decreased to reduce load). With the load reduced, the new, higher power piston position now provides more fuel to the engine than is needed to maintain the set speed. Consequently, the engine speed rises above the set speed and the governor ballhead effects a lowering of the power piston and a decrease in fuel, at the same time lowering the load control pilot valve plunger.

The reduction in engine load and of fuel to the engine occurs simultaneously until the engine speed has returned to the set speed and the power piston has returned to its original position, thereby centering the load control pilot valve plunger again. With the pilot valve re-centered. movement of the load control servo is stopped.

In responding to the increased load and the resulting underspeed of the engine, by temporarily increasing the fuel setting, the governor has operated the load control pilot valve in the direction to reduce the engine load so that the horsepower demand on the engine has returned to the designed value for the existing speed setting of the governor. The governor action described has taken place entirely because of the increase in load with no change having been made in governor speed setting.

When the engine load decreases, similar movements occur, but in the opposite directions.

When an increase in governor speed setting is made, the speed setting servo piston moves down and lowers the left-hand end of the floating lever, also lowering the load control pilot valve plunger. This causes pressure oil to flow to the load control servo at the same time that the increase in governor speed setting is causing the power piston to move up to increase fuel to raise the engine speed. As the power piston moves up, it raises the right hand end of the floating lever and also raises the load control pilot valve plunger. This action continues until the power piston is at its proper new position for fuel required at the higher speed setting and the load control pilot valve plunger is re-centered after changing the load control servo to its new position to provide the desired engine load at the higher engine speed.

Similar movements occur, but in the opposite direction, when the governor speed setting is decreased.

A typical fuel setting versus engine speed setting schedule is shown in the inset of Figure 1. The slope of the lower line of the schedule is determined by the “A” DIM adjustment of the load control pilot valve link connection point. During this portion of the schedule, the bellcrank bearing is riding on the vertical portion of the two slope load control cam. The corner on the schedule is determined by the position of the cam corner relative to the total tailrod stroke. The slope of the upper line of the schedule is determined by the angle of the cam surface in addition to the floating lever setting. The bellcrank bearing is riding on the sloped cam surface during this portion of the schedule. The steeper upper line of the schedule will allow larger increases in fuel settings versus speed at the higher engine speeds as may be desired on a turbocharged engine.

Within the allowed range of the load control servo, the load control system will maintain the desired fuel setting versus speed setting relationship throughout the entire speed range except momentarily during transients.

Replacement Parts Information

This section provides replacement parts information for the Two Slope Load Control.

When ordering replacement parts, include the following information:

- Governor serial number and part number shown on nameplate
- Manual number (this is manual 36607)
- Parts reference number in parts list and description of part or part name

Ref. No.	Part Name	Quantity
36607-1	Headed pin	1
36607-2	Cotter pin, 0.062 dia. x 0.375 long	6
36607-3	Spacer	2
36607-4	Headed pin	1
36607-5	Pivot pin link	1
36607-6	Washer, 0.375 OD x 0.195 ID x 0.031 thk	3
36607-7	Adjusting screw knob	1
36607-8	Adjusting screw pin	1
36607-9	Adjusting link compression spring	1
36607-10	Adjusting screw	1
36607-11	Floating lever	1
36607-12	Bellcrank	1
36607-13	Bearing spacer	1
36607-14	Needle bearing	1
36607-15	Bearing spacer	1
36607-16	Pivot block	1
36607-17	Cotter pin, 0.062 dia. x 0.312 long	1
36607-18	Roll pin 0.188 dia x 0.750 long	1
36607-19	Cam	1
36607-20	Soc. hd. cap screw, 10-32—0.750	2
36607-21	Spring lockwasher, 10, 0.190 ID	4
36607-22	Washer, 0.360 OD	2
36607-23	Cam bracket	1
36607-24	Soc. hd. cap screw, 10-32—1.250	2
36607-25	Piston gap scale	1
36607-26	Pilot valve link	1
36607-27	Soc. hd. cap screw, 8-32—0.875	1
36607-28	Adjusting block	1
36607-29	Eccentric	1
36607-30	Fulcrum pin	1
36607-31	Pilot valve link	1

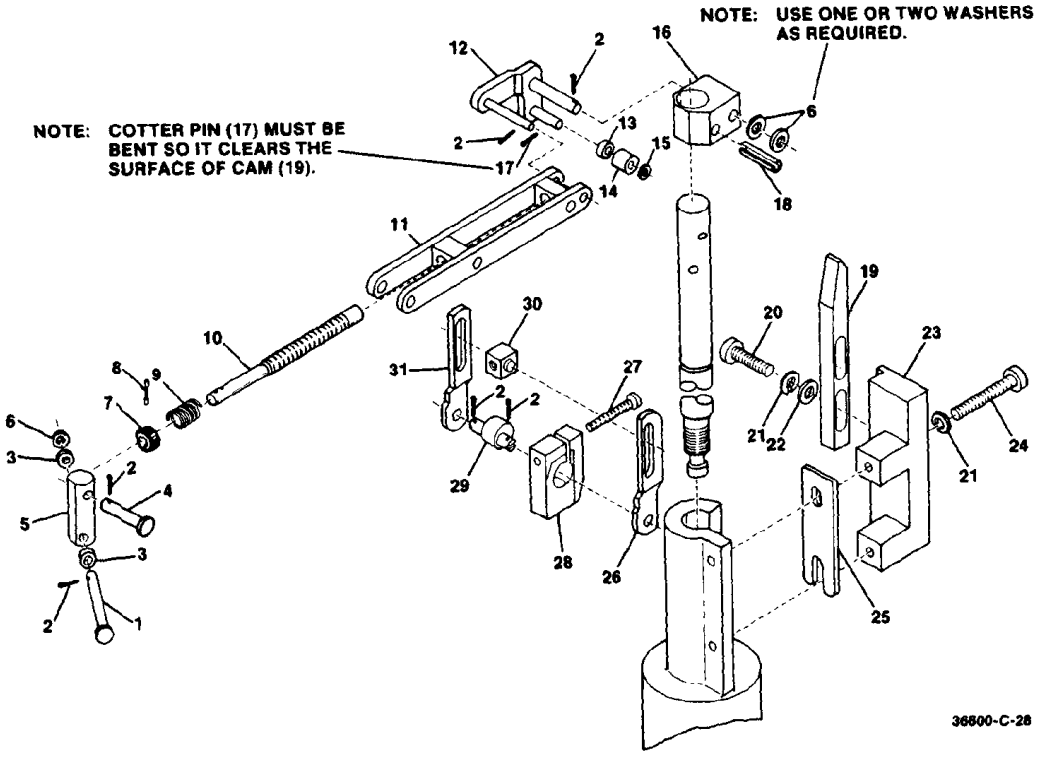


Figure 2. Two-Slope Load Control Exploded View

We appreciate your comments about the content of our publications.

Send comments to: icinfo@woodward.com

Please reference publication 36607.

PO Box 1519, Fort Collins CO 80522-1519, USA
1000 East Drake Road, Fort Collins CO 80525, USA
Phone +1 (970) 482-5811 • Fax +1 (970) 498-3058

Email and Website—www.woodward.com

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

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

2012/11/Colorado