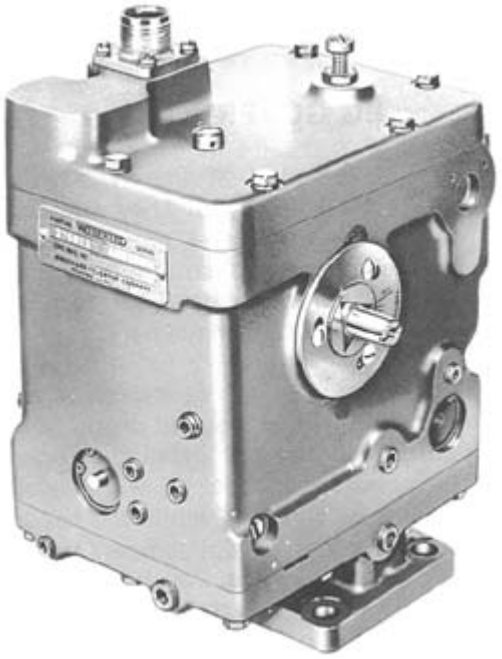
WOODWARD

Product Manual 37709
(Revision L)
Original Instructions



EGB-2C Governor/Actuator

Installation and Operation Manual

General Precautions

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

Practice all plant and safety instructions and precautions.

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

Revisions

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

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 Out-of-date translations are marked with ⚠.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

Contents

Illustrations and Tables

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.

Chapter 1.
General Information

EG Governors

The governors included in the Woodward EG series are of the electric type. They are designed to control the speed of diesel, gas, and dual fuel engines or steam and industrial-commercial gas turbines driving alternators, dc generators, pumps, compressors, or paper mill machinery.

The EG governor can be operated as an isochronous governor or as a speed droop governor. As an isochronous governor installed on an engine or turbine operating alone, it will maintain a constant speed for all loads within the capacity of the engine or turbine except momentarily at the time a load change occurs. Paralleled with other EG governors on units driving alternators, it will render proportional load division with isochronous control. Paralleled with dissimilar governors or with an infinite bus (commercial power), the EG governor can be operated as a conventional speed droop governor, and the load carried by the engine or turbine will be a function of governor speed setting and speed droop setting.

The EG governor consists essentially of three separate assemblies: a control box, a speed adjusting potentiometer, and a hydraulic actuator. Depending on the control box and the type of service in which it is used, a load signal box and a resistor box may also be required. The resistor box, if needed, can be obtained from the Woodward Governor Company or supplied by others.

The output signal of the EG control box serves as the input signal to the EG hydraulic actuator; the actuator in turn controls the flow of energy medium to the engine or turbine.

The flexibility of the EG governor system makes it adaptable to many special as well as standard arrangements. We will be glad to offer our recommendations for the operating scheme you propose.

As is the case with any governor of any type, the engine should be equipped with a separate overspeed device to prevent runaway in the event of any failure which may render the governor inoperative.

EG Actuators

Two basic types of EG hydraulic actuators are available. One type has incorporated within it a conventional centrifugal speed sensing flyweight head assembly which provides control during starting, and permits the actuator to serve as a “back-up” governor in case the electrical signal is interrupted. The other type of actuator does not include a centrifugal flyweight head assembly; such units require that the engine or turbine be controlled manually or by other means during starting.

Actuators without the centrifugal head assembly have a stalled work capacity of 4.5, 10, or 20 ft-lb (6.1, 14, or 27 J). Actuators with the centrifugal head assembly are available with stalled work capacities of 1.7, 2.5, 10, 35, or 50 ft-lb (2.3, 3.4, 14, 47, or 68 J). This manual describes the EGB-2C governor/actuator. Separate manuals describe the EG control boxes and other types of hydraulic actuators.

The EGB-2C governor/actuator work output is transmitted through a serrated terminal shaft extending from both sides of the case.

See Figure 1-1 for maximum work output for the EGB-2C governor/actuator and recommended terminal shaft travel.

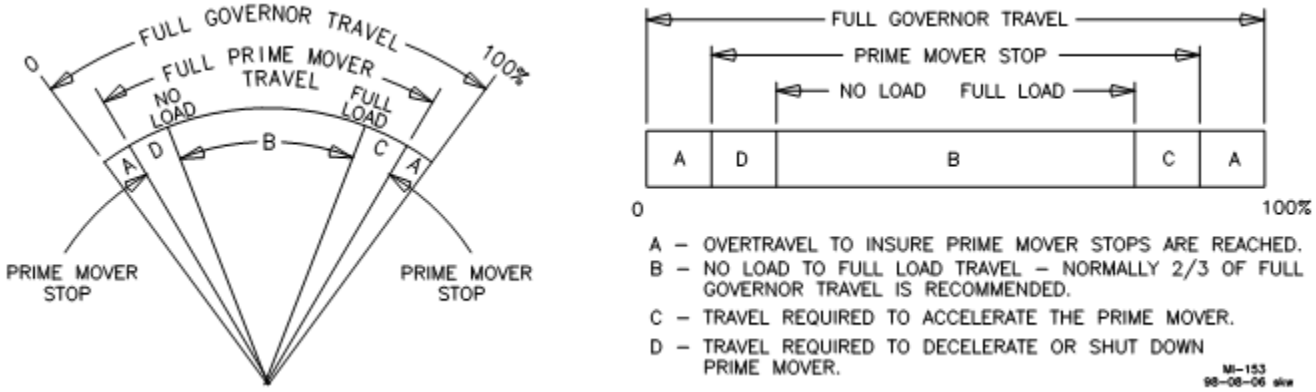

Figure 1-1. Terminal Shaft Travel

IMPORTANT

Maximum work capacity over full governor travel of 32° is 3.1 ft-lb (4.2 J). See above for recommended governor output travel. In special applications, min and max prime mover stops may be outside the governor stops.

EGB-2C Governor/Actuator

General

The EGB-2C has a centrifugal head assembly to control the engine or turbine during starting; also, it will limit maximum engine or turbine speed if the control box signal is interrupted or if it fails in such a fashion as to call for maximum fuel.

Used with the EG control box, the EGB-2C provides, in effect, two governors in one: an electric governor and a mechanical governor, each independently capable of positioning the terminal (output) shaft. During normal operation, the electric governor controls fuel to the engine or turbine. The actuator is adjusted so that, if the electric control signal is interrupted, the actuator moves the fuel linkage to maximum fuel. When the speed reaches the level for which the mechanical governor is set—always a level higher than that for which the actuator is set—the mechanical governor assumes and maintains control of the engine. Speed can then be reduced if desired, by lowering the speed setting on the mechanical governor. (Should the control box fail in such a way as to emit a continuous signal calling for a decrease in fuel, the unit would shut down.)

The essential element of the actuator is an electromechanical transducer which directs pressure oil to and from the power piston which actuates the fuel or steam control mechanism. The transducer consists of a polarized solenoid to which is attached the pilot valve plunger controlling oil flow to and from the power piston. The solenoid responds to the push-pull output of the electronic control box and, in so doing, moves the pilot-valve plunger up or down. Through connecting linkage, the power piston moves the terminal (output) shaft of the actuator. The engine or turbine fuel linkage attaches to the actuator terminal shaft.

While strict linearity of terminal-shaft travel versus load is not required, the linkage should be arranged to give the same degree of linearity afforded conventional speed-sensing governors to obtain optimum steady-state and transient performance.

The actuator section of the EGB-2C requires two internal adjustments at the time it is tested and has one external adjustment, the needle valve used to match the operation of the actuator to the operating characteristics of the engine (or turbine) and load being controlled.

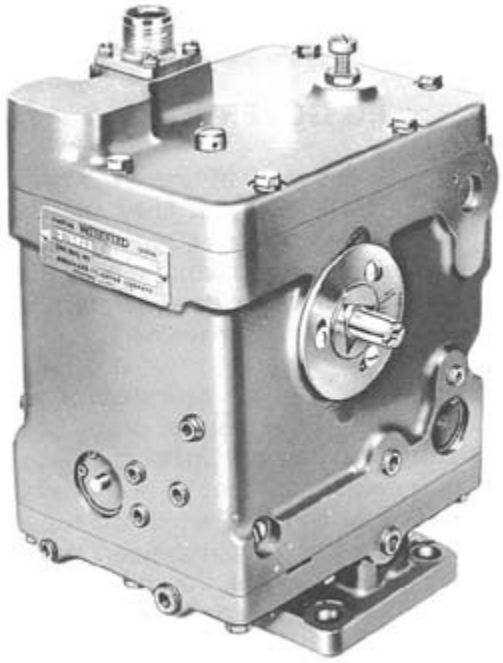

Figure 1-2. EGB-2C Governor/Actuator

The mechanical governor section of the EGB-2C has three operating adjustments:

- Speed setting, an external adjustment used to set the speed at which the mechanical governor will control;
- Speed droop, an internal adjustment used to permit parallel operation of units controlled by the mechanical governor;
- Needle valve, an external adjustment used to stabilize the mechanical governor.

Once set, these adjustments do not usually require further adjustment.

The EGB-2C uses oil from the engine lubricating system or from a separate sump (not furnished by Woodward). It does not have a self-contained sump.

EGB-2C actuators are available with the terminal shaft extending from either or both sides of the actuator case. The actuators can be furnished with the speed adjusting shaft (for the mechanical governor section) extending on either side. However, most units use a speed adjusting screw in the top cover and omit the speed-adjusting shaft entirely.

Special Auxiliaries

Speed Adjusting Motor
The EGB-2C actuator can be fitted with a speed adjusting motor. This motor permits changing the speed setting of the mechanical governor from a remote point. The speed-adjusting motor would be used only if the actuator section were inoperative. It would be used to match the frequency of an alternator with that of other units or a system before synchronizing or to change load distribution after synchronizing.

The speed-adjusting motor used is of the split-field, series-wound, reversible type. It is available in all standard voltages.

A manual speed-adjusting knob with a friction clutch assembly is included on units fitted with a speed-adjusting motor.

Spring Driven Ballhead
A spring-driven flyweight head is available to filter undesirable torsional vibrations transmitted from the engine drive to the centrifugal speed-sensing flyweight head.

Shutdown Device
A separate electrical signal can be introduced into the hydraulic actuator circuit to cause the unit to shutdown. This electric signal can be actuated by any of a number of remote signals (such as low lube-oil pressure). Write to the Woodward Governor Company for instructions on how to add the shutdown signal to your particular system.

Drive

Since the EG8-2C has a centrifugal speed-sensing flyweight head, the actuator drive shaft must be driven directly by the engine. The drive from the engine should be designed to rotate the drive shaft in the range of 2400 rpm to 4000 rpm at normal speed. The EGB-2C requires 1/2 hp (373 W) to drive it at 3600 rpm under normal operating conditions.

The drive to the governor/actuator must be smooth. A rough, irregular drive imparts false speed change signals to the flyweight head which then attempts to correct for these “changes”. The result is a continual vibration of the terminal shaft and engine fuel linkage when operating under control of the mechanical governor.

The drive shaft can be rotated in either direction without making any changes in or to the governor/actuator.

Chapter 2. Operation

General

The schematic arrangement of the EGB-2C is shown in Figure 2-1 with parts in relative positions assumed during normal operation. Oil enters the EGB-2C through either of the two inlet holes in the side of the base (see Figure 4-4). The oil passes from the suction to the pressure side of the pump. After filling the oil passages, the pump builds up the oil pressure. When the pressure is great enough to overcome the relief-valve spring force and push the relief-valve plunger back to uncover the bypass hole, the oil recirculates through the pump.

Were the pump rotated in the opposite direction from that shown in Figure 2-1, the open check valves would be closed and the closed check valves would be open.

The loading piston positions the terminal shaft. Constant oil pressure is applied to the upper side of the loading piston always tending to move it in the “decrease fuel” direction. Either the mechanical governor power piston or the actuator power piston can move the loading piston in the ‘increase fuel” direction since the effective area on which the control oil pressure acts is greater on the power piston than on the loading piston.

Electric Governor

Consider first the actuator operation when the electric governor is controlling (the normal mode of operation). At such time the mechanical governor power piston is at top of its stroke (for reasons to be discussed later).

The actuator pilot-valve plunger controls the flow of oil to and from its power piston. The pilot-valve plunger is connected to an armature magnet which is spring-suspended in the field of a two-coil polarized solenoid. The output signal from the EG control box is applied to polarized coil, and produces a force, proportional to the current in the coil, which moves the armature magnet—and pilot-valve plunger—up or down. The pilot-valve plunger is lowered by the control box signal resulting from a decrease in speed or an increase in speed setting of the control box; it is raised by the signal resulting from an increase in speed or a decrease in speed setting. The centering springs return the armature magnet and pilot-valve plunger to their steady-state, centered positions when the electric control signal returns to its on-speed voltage value.

With the pilot-valve plunger “centered” (the control land exactly covering the control port in the pilot-valve bushing), no oil flows to or from the power piston. If the pilot-valve plunger is lowered, pressure oil flows to the power piston and moves it up; the power piston carries the loading piston up and moves the terminal shaft in the “increase fuel” direction. The oil in the outer annulus above the power piston is forced out into the passage leading to the buffer piston and to the lower side of the compensation land on the pilot valve. The buffer piston moves to the left, as viewed in Figure 2-1, partially relieving the compression of the right-hand buffer spring and increasing the compression of the left-hand buffer spring. The force of the left-hand buffer spring tending to resist this movement results in a slightly higher oil pressure on the right side of the buffer piston than on the left. The pressure on the right side of the buffer piston is transmitted to the underside of the compensation land of the pilot-valve plunger; the pressure on the left side of the buffer piston is the same as the pressure on the upper side of the compensation land. The difference in pressures on the two sides of the compensation land produces a force which acts to push the pilot-valve plunger back to its centered position.

When the terminal shaft has been rotated far enough to satisfy the new fuel requirement, the force of the pressure differential on the compensation land is just enough to balance the force produced by the control box signal which lowered the pilot-valve plunger, hence the pilot-valve plunger re-centers although the engine speed is not yet back to normal. The power piston and terminal shaft movement is thereby stopped.

The continued increase of speed to normal results in a continued decrease in downward force of the pilot-valve plunger as the control box signal returns to its on-speed voltage value. Leakage of oil through the needle valve orifice equalizes the pressures above and below the compensation land at a rate proportional to the return of the engine speed to normal. Because the reduction in control box signal and the equalization of pressures above and below the compensation land occur at the same rate, the pilot-valve plunger remains centered.

As the pressures above and below the compensation land become equal, the buffer springs return the buffer piston to its normal, central position.

If the pilot-valve plunger is raised, the oil under the power piston is opened to sump and the constant pressure above the loading piston moves it down and forces the power piston down. This movement reduces the fuel to meet the new requirement. Again, differential pressure is produced across the buffer piston and across the compensation land of the pilot-valve plunger, causing the plunger to re-center and keep the pilot-valve ports closed while speed decreases to normal.

The centering springs of the standard actuator are set so that the actuator pilot-valve plunger is moved below its centered position if the electric control signal is interrupted. In such an event, the actuator power piston moves up and positions the terminal shaft at the maximum-fuel position. It should be noted that, should the EG control box fail in such a way as to emit a continuous signal calling for a decrease in fuel, the actuator will move the fuel linkage to the “fuel off” position. (Upon special request, the centering springs can be adjusted so that the power piston moves the fuel linkage to the “fuel off” position if the electric signal is lost.)

Mechanical Governor

The mechanical governor pilot-valve plunger controls the flow of oil to its power piston. If the plunger is centered, no oil flows through the pilot valve and the power piston is stationary. The greater of two opposing forces moves the pilot-valve plunger: the speeder spring force tends to push it down; the centrifugal force developed by the rotating flyweights is translated into an upward force which attempts to raise the plunger. With the pilot valve centered, there is but one speed at which the centrifugal force of the flyweights is equal and opposite to the speeder spring force.

With the speed setting of the mechanical governor set slightly higher than that of the actuator, the centrifugal force of the rotating flyweights is not sufficient to lift the pilot-valve plunger to its centered position. Consequently, with the actuator controlling, pressure oil is continually directed to the underside of the mechanical governor power piston to hold it up against its stop. It is for this reason that the power piston of the mechanical governor is up against its stop when the electric governor is controlling.

Consider now the actuator operation when, for any reason, the electric control signal to the actuator is interrupted. As explained in the previous section, the centering springs of the actuator are set to move its pilot-valve plunger below the centered position when the control signal is lost. This causes the actuator power piston to move up and remain at its maximum-fuel position.

Initially, this positions the terminal shaft at the maximum-fuel position and engine speed increases until it is greater than the speed setting of the mechanical governor. The mechanical governor power piston then moves down (details of operation explained below) and the terminal shaft is moved in the direction to decrease fuel so that the engine runs at the speed setting of the mechanical governor.

With the unit running on-speed with the mechanical governor controlling, the pilot-valve plunger is centered. If a load is added to the engine, the engine and governor speeds decrease. The pilot-valve plunger is lowered by the speeder spring force which is now greater than the centrifugal force of the flyweights. Pressure oil flows to the buffer piston and moves it towards the power piston. The oil displaced by the buffer piston forces the power piston upward; the loading piston is raised, and the terminal shaft rotated in the direction to provide the additional fuel needed for the new load.

The movement of the buffer piston towards the power piston partially relieves the compression of the left-hand buffer spring and increases the compression of the right-hand buffer spring. The force of the right-hand buffer spring tending to resist this movement results in a slightly higher oil pressure on the left side of the buffer piston than on the right. The pressure on the left of the buffer piston is transmitted to the underside of the compensation land of the pilot-valve plunger; the pressure on the right of the buffer piston is fed to the upper side of the compensation land. The difference in pressures on the two sides of the compensation land produces a force which acts to push the pilot-valve plunger back to its centered position.

When the terminal shaft has been rotated far enough to satisfy the new fuel requirement, the force of the pressure differential on the compensation land plus the centrifugal force of the rotating flyweights will have re-centered the pilot-valve plunger, even though engine speed is not yet completely back to normal. The power piston—and terminal shaft—movement is thereby stopped.

The continued increase of speed to normal results in continued increase in the centrifugal force developed by the rotating flyweights. However, this increase of speed to normal does not cause the flyweights to lift the pilot-valve plunger above center because the leakage of oil through the needle valve orifice equalizes the pressure above and below the compensation land at a rate proportional to the return of the engine speed to normal. Consequently, as the centrifugal force increases, the compensating force decreases.

With the pressures above and below the compensation land equalized, the buffer springs return the buffer piston to its normal, central position.

Were the engine load decreased, the resultant increase in governor speed would cause the flyweights to move outward and raise the pilot-valve plunger. With the pilot-valve plunger raised, the area to the left of the buffer piston would be connected to sump. The loading piston, continually being urged downward by oil pressure from the governor pump, would move down and force the mechanical governor power piston down. This movement would reduce the fuel to meet the new requirement. Again, differential pressure across the compensation land would assist in re-centering the pilot-valve plunger, and keep the pilot-valve ports closed while speed decreases to normal.

The speed at which the mechanical governor controls the engine is determined by the loading or compression of the speeder spring which opposes the centrifugal force of the flyweights. The standard EGB-2C has a speed-adjusting screw in the top cover.

Speed droop is used in mechanical governors to automatically divide and balance load between engines or turbines driving the same shaft or paralleled in an electrical system. (Speed droop is defined as the decrease in governor speed as its output connection to the engine fuel linkage moves from its extreme minimum to extreme maximum positions.)

Speed droop is incorporated in the EGB-2C through linkage which varies the loading on the speeder spring as a function of the power-piston position. The change in speeder spring force for a given movement of the power piston is determined by the position of the adjustable pin in the linkage between the power piston and speeder spring. If the pin is on the same centerline as the speed droop lever pivot arm, there is no change in speeder spring force as the power piston moves and the mechanical governor responds as an isochronous (constant speed) control. The further the adjustable pin is moved away from the pivot arm centerline, the greater is the change in compression of the speeder spring for a given power-piston movement.

With the actuator section operating under control of the electric governor, the speed droop feature is, in effect, inoperative. This is due to the fact that during such operation the mechanical governor power piston remains in the same position for all engine or turbine loads (except possibly momentarily during transients). Thus the speed droop linkage does not alter the speeder spring compression when the electric governor is controlling.

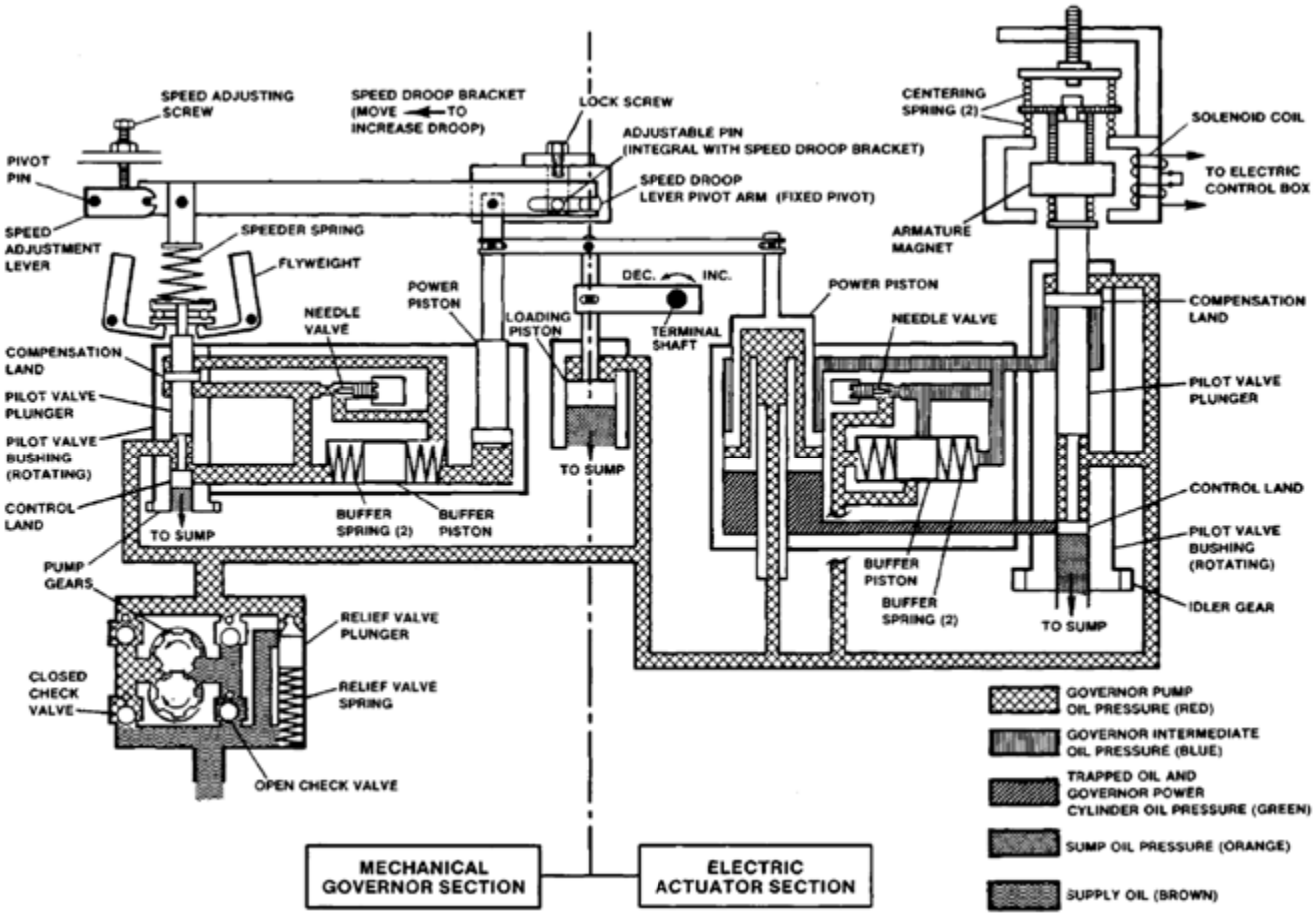

Figure 2-1. Schematic

Chapter 3.
Installation and Adjustments

General

Take particular care to mount the governor actuator squarely with the engine linkage and in line with the drive to the governor actuator. Place gasket between the base of the actuator and the base mounting pad. Allow for unrestricted flow of oil draining through the drive shaft bore and annulus within the base mounting pilot (see Figure 4-4). Adjust the fuel linkage to use at least 2/3 travel of the actuator terminal shaft from the no-load to full-load fuel positions.

⚠WARNING

Do not use the physical minimum stop of actuator terminal shaft to align fuel linkage since minimum-fuel position may not be reached when operating. Use the terminal-shaft pointer as reference for the actuators terminal-shaft minimum position.

The splined drive shaft must fit into the drive with a free, slip fit; no tightness is permitted. The actuator must drop onto the mounting pad of its own weight without any force being applied.

The engine linkage must be free of binding but without excessive backlash. If there is a collapsible member in the linkage, it must not yield each time the actuator moves the linkage rapidly.

Oil Supply

A 3/8 inch OD tubing oil line must be connected from the oil supply to either of the two 1/8 inch pipe tapped inlet holes of the actuator (see Figure 4-4). A minimum of 5 psi (34 kPa) oil pressure is required at the actuator end of the line. If a separate sump is used (rather than engine lubricating oil), the lift head should not exceed 12 inches (30 cm), and a foot valve should be used.

Oil from the engine lube system can be used in the actuator. If this oil is used, a 2 US gal/min (7.6 L/min), 20 µm filter should be installed in the oil supply line.

Adjustments

Starting the Engine for the First Time

Before starting the prime mover for the first time, disconnect the input terminals indicated below:

EG-A Control Box

Disconnect terminals 1 through 10 at the control box (Figure 3-1).

EG-M Control Box

1. Disconnect terminals 1 through 10 at the control box (Figure 3-2).

2. Disconnect terminals 1, 2, and 3 at the load signal box, if used (Figure 3-3).

Be sure to mark the wires so that they can be correctly reconnected later. Fasten the disconnected wires to a spare terminal block for later electrical checks, or, if a spare terminal block is not available, separate and tape the wires to a wooden board or a piece of cardboard.

⚠WARNING

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

Figure 3-1. EG-A Control

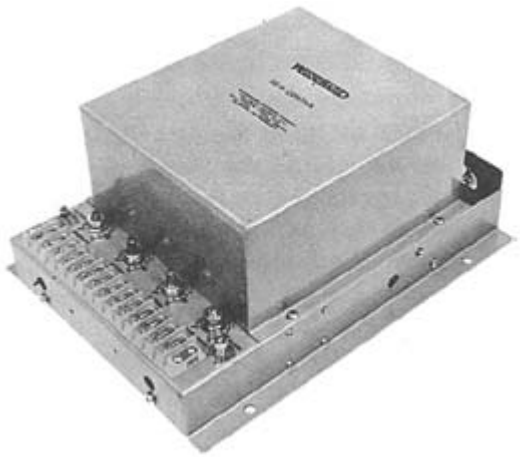

Figure 3-2. EG-M Control

Figure 3-3. Load Signal Box

Start the engine following engine manufacturer's instructions. The mechanical governor section of the EGB-2C will control speed at the level set by the speed adjusting screw. Turn the screw counterclockwise, when viewed from above, to decrease the speed setting. When shipped from the factory, the speed adjusting screw is set for a speed approximately 4.5% above rated speed at no load. (The usual factory droop setting of 3% will reduce the speed to approximately 1.5% above rated speed at full travel of mechanical governor power piston.) With the speed adjusting screw at this setting during normal operation (with the electric governor controlling), the mechanical governor power piston will be held in its maximum-fuel position.

Mechanical Governor Needle Valve Adjustment

When starting the engine for the first time, it is necessary to eliminate any air which may be trapped in the actuator oil passages. This can be done in the following manner:

Open the needle valve of the mechanical governor section (see Figure 3-4) until the unit hunts or surges. After a half-minute, gradually close the needle valve until the engine speed just settles out. Closing the needle valve farther than necessary will make the governor slow to return to normal speed after a load change. The needle valve should never be closed tight.

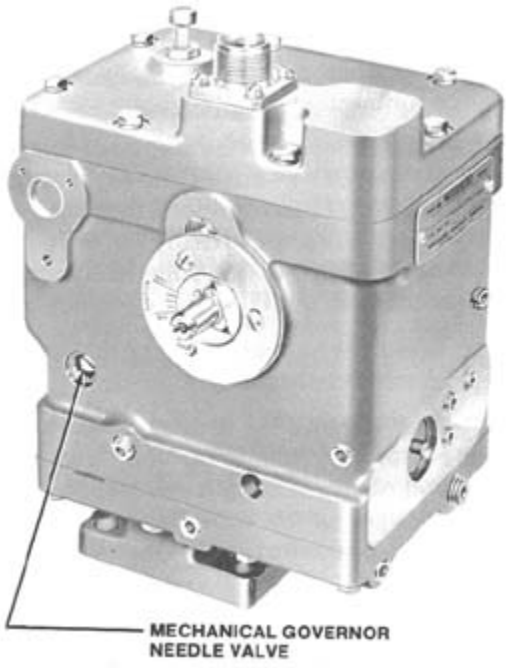

Figure 3-4. Governor Needle Valve

Test the action by manually disturbing the speed of the unit. The unit should promptly return to its original steady-state speed with only a small overshoot or undershoot.

Speed Droop Adjustment

The governor is set with approximately 3% droop when shipped from the factory. When the actuator section is controlling the engine, the speed droop adjustment has no effect on operation and should be left as factory set. When, for some reason the mechanical governor section is controlling the engine, the speed droop setting can be adjusted, if necessary, to suit the operating requirements. Note that the governor should never be set at “zero” droop unless the unit is maintaining frequency of paralleled alternators or is operating as a single, isolated unit. Not more than one unit in a system of paralleled alternators with engines controlled by mechanical governors can be operated on “zero” droop.

Electrical Checks

With the unit running without load and at approximately normal speed under control of mechanical governor, make these electrical checks before reconnecting wires to terminals 1, 2, and 3 of the control box and (if used) the load signal box:

EG-A Control Box

1. The voltage between the wires normally connected to terminals 1 and 2, 2 and 3, and 1 and 3 should be approximately 120, 208, or 240 volts as marked on the control box nameplate.

2. There should be no voltage at no-load between the wires to terminals 5 and 6, 7 and 8, and 9 and 10 of the control box.

EG-M Control Box

AC Power Supply
Single Phase

1. The voltage between wires to terminals 1 and 2 should be 120 volts.

When the indicated readings are obtained, the unit may be shut down and the wires are again connected to the terminal blocks.

Electric Control Box

Before restarting the engine, recheck to be sure that all electrical connections to the control box, the load signal box (if used), and the actuator are made in accordance with the wiring diagram furnished for the installation. Then set the control box adjustments as follows:

EG-A Control Box

Amplifier Gain Adjustment—Turn to extreme counterclockwise position.

Stability Adjustment—Turn to extreme clockwise position.

Droop Adjustment—Set in mid position.

Load Pulse Adjustment (if the box is equipped with this adjustment)—Turn to extreme counterclockwise position; then turn clockwise 1/4 turn.

Load Gain Adjustment—Set in mid position.

EG-M Control Box with Load Signal Box

Amplifier Gain Adjustment—Turn to extreme counterclockwise position.

Stability Adjustment—Turn to extreme clockwise position.

Load Signal Box

Droop Adjustment—Set in mid position.

Load Pulse Adjustment—Turn to extreme counterclockwise position; then turn clockwise 1/4 turn.

Load Gain Adjustment—Set in mid position.

EG-M Control Box without Load Signal Box

Amplifier Gain Adjustment—Turn to extreme counterclockwise position.
Stability Adjustment—Turn to extreme clockwise position.

Running the Engine Under Control of the Electric Governor for the First Time

With the electric control box adjusted as outlined above and before starting the engine, set the electric actuator needle valve (Figure 3-5) 1/8 turn open.

⚠WARNING

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

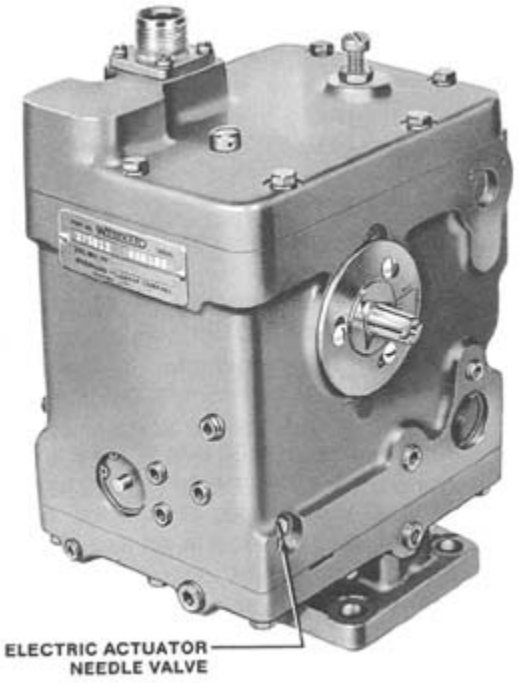

Figure 3-5. Actuator Needle Valve

Set the speed-setting potentiometer for the electric governor at maximum-speed position (full clockwise). Start the engine in accordance with the engine manufacturer's instructions. The mechanical governor will control speed during starting.

If the speed settles at a value lower than the mechanical governor setting, turn the speed-setting potentiometer counterclockwise. If the speed increases, shut the engine down and interchange the wires to terminals 13 and 15 of the EG-A control box or to terminals 6 and 8 of the EG-M control box. Again set speed potentiometer at maximum-speed position.

Now use the speed-setting potentiometer to decrease the electric governor speed setting. When the speed setting is less than that of the mechanical governor, the electric governor will assume control of the engine. Turn the speed-setting potentiometer control knob counterclockwise to reduce engine speed to normal.

Further adjustments of the control box should now be made. The objective of this procedure is to set the AMPLIFIER GAIN adjustment as far in the clockwise direction as possible while at the same time opening the electric actuator needle valve as far as possible. A recording frequency meter is a valuable aid in judging the effect of the various adjustments. If a recording frequency meter is not available, a voltmeter across terminals 17 and 18 on an EG-A control box or across terminals 4 and 5 on the EG-M control box will be useful in judging the effect of the adjustments.

Proceed in this manner:

A. If the unit is stable:

1. Turn the AMPLIFIER GAIN adjustment clockwise until the unit begins to hunt. Now turn the STABILITY adjustment counterclockwise to stabilize the unit.

   If the unit cannot be stabilized by turning STABILITY adjustment, reset the STABILITY adjustment to its maximum clockwise position, and turn the AMPLIFIER GAIN adjustment counterclockwise until the unit becomes stable.

   Reset the speed-setting potentiometer to obtain rated speed.

   When the unit is stable, disturb the system by changing the load on the engine, by making a quick speed-setting change, or by moving the engine fuel racks or control valve. Observe the speed change.

2. Now open the electric actuator needle valve in 1/8 turn increments until the unit again begins to hunt. Next turn the STABILITY adjustment to achieve stability.

   If the unit will not settle down, reset the STABILITY adjustment to its maximum clockwise position and close the electric actuator needle valve 1/8 turn. Use STABILITY adjustment (if necessary) to stabilize unit.

   Repeat the process of opening the electric actuator needle valve until a slight hunt develops and then turning the STABIL1TY adjustment to stop the hunting until no further improvement in transient response can be achieved. (As noted previously, use of a recording frequency meter is recommended when making these adjustments.) Do not open the needle more than 1 1/2 to 2 turns.

   Typical final settings are: AMPLIFIER GAIN mid position to maximum clockwise: STABILITY mid position to maximum clockwise; needle valve 3/4 to 1 turn open.

B. If the unit is unstable:

1. Close the needle valve until the unit becomes stable.
   a. When the unit becomes stable, follow the adjustment procedure outlined in “A” above.
   b. If the unit does not become stable, the cause of the problem likely lies outside of the control box and actuator.

   Make sure that:
   – the linkage is arranged to use at least 60% of the available output of the actuator;
   – the linkage is not sloppy or binding:
   – the oil supply to the governor/ actuator is not filled with air bubbles;
   – the unit voltage regulator is functioning properly;

– the voltage supply is correct;
– the speed signal supplied to an EG-M control box is correct.

The AMPLIFIER GAIN, STABILITY, and electric actuator needle valve should not require further adjustment.

Additional checks should be made as listed below on units equipped with an EG-A control box or an EG-M control box with a load signal box:

EG-A Control Box
Insert a dc voltmeter into the test jacks on the control box. (The red jack is positive.) The voltmeter should have a minimum rating of 10 kΩ/V. Load the unit as near to 100% as possible. The phase loading should be balanced within 10%. At 100% load, the load voltage should be adjustable from ±0.5 to 6 volts and at 500/0 load it should be adjustable to 3 volts, etc. If polarity is reversed but the voltage amplitude is correct, each of the three pairs of current inputs at the control box terminals 5 and 6, 7 and 8, and 9 and 10 must be reversed. This will give the correct polarity. For proper load sharing, EG-A control boxes to be paralleled must be set at the same voltage at the same percentage of full load based on 6 volts at full load.

⚠WARNING **HIGH VOLTAGE—Don't disconnect any wires at the resistor box. The current transformer can develop dangerously high voltage when open-circuited.**

If the above voltages cannot be obtained, check the phase relationships. Proceed in this manner:

1. Disconnect the load-signal resistor leads at the control box, terminals 5 through 10. (Observe the warning note above.)

2. Set the LOAD GAIN adjustment on the control to maximum clockwise position.

3. If there is a LOAD PULSE adjustment on the control box, set it fully counterclockwise.

4. Load the unit to rated load or as much load as is available. The load must be at a power factor greater than 0.9. The loads on all phases must be equal within 5%.

5. Measure the ac voltage across the load resistors at the control box end of the leads. These voltages must be equal within 10%, and at 100% load should be from 0.75 volt to a little over 2 volts. These voltages are directly proportional to the phase loads. For example, at 50% load the range will be half as much. The load must be kept constant during the phase-checking procedure.

6. Touch the pair of wires from one of the load resistors to terminals 7 and 8 on the control box and observe the dc voltage at the test jacks. If the polarity is reversed, reverse the wires and observe voltage.

7. Repeat step 6 with the pairs of wires from each of the other load resistors; observe the dc voltage at the test jacks.

8. Of the three load resistors, one will yield a dc voltage larger than the other two. Connect this resistor to terminals 7 and 8 permanently. The correct polarity must be maintained.

9. Touch the wires from a second load resistor to terminals 5 and 6 and then to 9 and 10. Connect these wires to the terminals that yield the highest dc voltage.

10. Connect the remaining two wires to the remaining terminals to give the maximum dc voltage across the test jacks.

11. The LOAD GAIN should now be adjustable from ±0.5 to 6 volts or more at full load. If it is, proceed to step 14; if it is not proceed with step 12.

12. In step 9, the difference in voltage between touching the resistor leads to terminals 5 and 6 and 9 and 10 is always small. Because of this small difference, the pairs of wires to terminals 5 and 6 and 9 and 10 may be connected to the wrong terminals. If they are not connected correctly, the voltages in step 11 cannot be obtained.

    Return the LOAD GAIN adjustment to maximum and the procedure outlined in the next step will correct the wiring.

13. Reconnect the wires from terminals 9 and 10 to terminals 5 and 6; reconnect the wires from terminals 5 and 6 to terminals 9 and 10. In each case the connections should be made to give the maximum dc voltage across the test jacks.

14. The load gain will now be adjustable from ±0.5 to 6 volts or more at full load and the proper setting may now be made.

EG-M Control Box with Load Signal Box

Insert a dc voltmeter into the test jacks on the load signal box. (The red jack is positive.) The voltmeter used should have a rating of 10 kΩ/V. Load the unit as near to 100% load as possible. The phase loading should be balanced within 10%. At 100% load, the load voltage should be adjustable from 0 to 9 volts and at 50% load, it should be adjustable to 4.5 volts, etc. If polarity is reversed, but the voltage amplitude is correct, each of the three pairs of current inputs at the control box terminals 5 and 6, 7 and 8, and 9 and 10 must be reversed. This will give the correct polarity.

For proper load sharing, EG-M load signal boxes to be paralleled must be set at the same voltage at the same percentage of full load based on 9 volts at full load.

IMPORTANT

When paralleling a unit equipped with an EG-A control box to a unit having an EG-M control and load signal box, the load voltage on the EG-A control box is set at a value based on 6 volts at full load while load voltage on the load signal box used with the EG-M control box is set at a value based on 9 volts at full load.

⚠WARNING

HIGH VOLTAGE—Don't disconnect any wires at the resistor box. The current transformer can develop a dangerously high voltage when open-circuited.

If the above voltages cannot be obtained, check the phase relationships. Proceed in this manner:

1. Disconnect the load-signal resistor leads at the load signal box, terminals 5 through 10. (Observe warning note above).

2. Set the LOAD GAIN adjustment on the load signal box to maximum clockwise position.

3. If there is a LOAD PULSE adjustment on the load signal box, set it fully counterclockwise.

4. Load the unit to rated load or as much load as is available. The load must be at a power factor greater than 0.9. The loads on all phases must be equal within 5%.

5. Measure the ac voltage across the load resistors at the load signal box end of the leads. These voltages must be equal within 10%, and at 100% load should be from 0.75 volt to a little over 2 volts. These voltages are directly proportional to the phase loads. For example, at 50% load the range will be half as much. The load must be kept constant during the phase-checking procedure.

6. Touch the pair of wires from one of the load resistors to terminals 5 and 6 on the load signal box and observe the dc voltage at the test jacks. If the polarity is reversed, reverse the wires and observe voltage.

7. With the same pair of wires, repeat step 6 on terminals 7 and 8 and on 9 and 10.

8. Of the three pairs of terminals, one pair will yield a larger dc voltage than the other two. Connect the wires to this pair.

9. Touch the pair of wires from a second load resistor to each of the two pairs of terminals remaining. Connect to the pair yielding the largest dc voltage.

10. Connect the remaining two wires to the remaining terminals to give the maximum dc voltage across the test jacks.

11. The load gain will now be adjustable from zero to at least 9 volts at full load an& the proper setting may now be made.

Operating Adjustments

The LOAD GAIN, AMPLIFIER GAIN, and STABILITY settings should not require adjustments other than these made during initial start-up.

The LOAD PULSE adjustment can usually be left at the setting made before the unit was started. This adjustment controls the load pulse decay time, and can be used to improve transient performance. It is necessary to use a recorder to establish the optimum setting of this adjustment. It can be set only after the LOAD GAIN adjustment has been made.

The DROOP adjustment is used when the unit is paralleled with an infinite bus or with dissimilar units. The DROOP switch (see plant wiring diagram or typical wiring diagram shown in an EG control box manual) must be in the correct position to complete the droop circuit in the control box. When operating in parallel, turn the SPEED SETTING adjustment clockwise (increase speed direction) to increase the load on the unit. Turning the DROOP adjustment clockwise increases droop, thereby improving paralleled stability.

Chapter 4.
Maintenance

General

When requesting information concerning governor operation and maintenance, or when ordering parts, it is essential that the following information be included:

- Serial number of the control box and actuator
- Manual number (this is manual 37709)
- Part reference number and name or description of part

Troubleshooting

Governor faults are usually revealed in speed variations of the engine, but it does not mean that all such speed variations indicate governor faults. Therefore, when improper speed variations appear, the following procedure should be carried out:

1. Check the load to be sure that the speed changes observed are not the transient result of continuing load changes.

2. On a diesel or gas engine, check engine operation to be sure that all cylinders are firing properly, and that the injectors or spark plugs are in good operating condition.

3. See that the operating linkage between the actuator and engine or turbine is free from binding or lost motion.

4. Check the voltage regulator to be sure it is functioning properly. If these checks do not reveal the cause of the speed variation, the cause may be in the governor.

5. With the unit set for isochronous operation and governing at normal speed, check the voltage input to the actuator. This may be checked at terminals 17 and 18 of the EG-A control box or terminals 4 and 5 of the EG-M control box. The dc voltage reading should:

   A. Be between +0.9 and +0.7 or –0.7 and –0.9 volt.

      (1) If the voltage is within this range, proceed to step 5B below.

      (2) If the voltage is not within this range, remove screw (part 8, Figure 4-3) in the actuator cover. Insert a 1/8 inch hex wrench into the null voltage (part 57, Figure 4-3) and turn it slowly to adjust the voltage across terminals 17 and 18 of the EG-A control box or terminals 4 and 5 of the EG-M control box to be between +0.75 and +0.4 volt.

IMPORTANT

Positive meter lead must be connected to terminal 18 of the EG-A box or terminal 4 of the EG-M box if the governor is of the type adjusted to go to maximum fuel when the electric signal to the actuator is interrupted. Turn null voltage screw (57) counterclockwise—when viewed from above—to decrease voltage.

(If the governor is of the type which is adjusted to shut down the engine when the electric signal to the actuator is interrupted, the positive meter lead should be connected to terminal 17 of the EG-A box or terminal 5 of the EG-M box. In this case adjust the voltage across terminals 17 and 18 to be between +0.4 and +0.75 volt. Turn null voltage screws (57) clockwise—when viewed from above—to decrease voltage.)

a. When the voltage has been adjusted as directed, go to step 5B below.
b. If the voltage cannot be adjusted to the value specified, the control box may be defective. See the applicable control box manual for further electrical checks or replace the entire box.

B. Not fluctuate more than ±0.25 volt.

(1) If it does not, proceed to step 6 below.

(2) If it does, reset the AMPLIFIER GAIN and STABILITY adjustments as outlined in the EG Control Box section under the section entitled “Running the Engine Under Control of the Electric Governor for the First Time”.

a. When the fluctuations are within the range specified, proceed to step 6 below.

b. If the fluctuations cannot be reduced to the range given, the control box may be defective. See the applicable control box manual for further electrical checks or replace the entire box.

6. If with droop switch set in the normal or isochronous position, the trouble is reflected by a change in unit steady-state speed as load is changed, take two dc voltage readings (across terminals 17 and 18 of an EG-A control box or terminals 4 and 5 of an EG-M control box) under different load conditions.

A. If the voltage is the same at each of these readings, the control box may be defective. See the applicable control box manual for further electrical checks or replace the entire box.

B. If the voltage readings differ by more than 0.2 Vdc, the trouble lies within the actuator. Replace or repair the actuator.

EG Control Box

Properly installed, the EG control box should have little if any trouble. The use of conservatively rated components, most of which are sealed in an encapsulated package, assures long life for this assembly. Should trouble develop within the control box, the simplest, cheapest, easiest, and quickest remedy is to replace the encapsulated unit, or, in rare instances the chassis assembly.

Hydraulic Governor/Actuator

The source of most trouble in any hydraulic actuator or governor stems from dirty oil. Grit and other impurities can be introduced into the governor with the oil, or form when the oil begins to break down (oxidize) or become sludgy. The moving parts within the governor are continually lubricated by the oil within the governor. Thus, grit and other impurities will cause excessive wear of valves, pistons, and plungers, and can cause these parts to stick and even “freeze” in their bores.

It is virtually impossible to re-center the armature magnet—and hence, pilot-valve plunger—without the use of special equipment. Unless such equipment is available, we do not recommend that any attempt be made to service the electric actuator section of the EGB-2C. Those having a governor test stand can likely adapt their stand for testing and setting the EGB-2C including the electric actuator section.

Contact Woodward for complete information regarding the test stand adaptation and new auxiliary test equipment needed. We also will supply, at that time, the necessary instructions for properly centering the armature magnet. The mechanical governor section of the EGB-2C can be overhauled if necessary. It should be understood that, unless the special test equipment referred to above is available, the objective of such an overhaul should be to restore the mechanical governor to first class condition, and that the EGB-2C will be operated as a mechanical governor.

Much of the repair work consists of cleaning and polishing of the governor parts. All pistons, plungers, valves and rods should move freely without binding or catching.

Be extremely careful when polishing the pilot-valve plunger lands; broken corners on the land will ruin this part. Polish the plunger with a fine hard stone using a speed lathe and holding the stone across lands of equal diameter. Do not break the sharp corners of the control land.

If a solvent is used to clean the parts, it must be a type which does not damage oil seals or gaskets. Solvents must be thoroughly removed from the parts before reassembly, to avoid contaminating the oil supply.

The procedure for disassembly of the actuator follows.

Actuator Disassembly

It is suggested that the best mechanic available (preferably one experienced with small parts assembly) be permanently assigned to all governor repair work. Cleanliness of tools and work space is essential. A work bench, vise, arbor press, speed lathe, air line, and containers for cleaning solvents should be provided if possible. The usual small hand tools are required, and a few special Woodward tools are desirable if sub-assemblies are to be disassembled.

The numbers in parentheses in the following steps refer to the identification numbers shown in Figure 4-3.

1. Remove screws (1) and washers (2). Lift off cover (9) and gasket (10).

2. Remove screws (92) to free connector (93).

3. Remove cotter pin (38) and pin (39).

4. Remove screw (30), washers (31) and (32), and speed droop-bracket (33).

5. Remove screws (84) from right hand and left hand dial plates (82) and (91). Remove snap rings (85) and pointers (83) and (90). Remove felt washers (81) and oil seals (80) from each end of terminal shaft.

6. Remove snap rings (73) and speed droop lever pivot pins (74) with O-rings (75) from each side of the case. Lift out speed droop lever (35).

NOTICE

Do not perform steps 6 through 8 unless necessary to replace parts in the electric actuator section. If necessary, get instructions for resetting transducer before disassembling.

7. Insert a 3/32 inch Allen wrench through the hole in the null voltage screw (57) and unscrew the centering screw socket head (55) to release it from the electric actuator section pilot-valve plunger (129).

8. Remove screws (51) and washers (32). Lift off the transducer bracket (53) with the null voltage screw (57) intact.

9. Lift out the coil cover assembly (58). The socket head screw (55) and washer (56) will come out with the coil cover assembly if they were not removed in step 6.

10. Remove screw (36). Put in a plain No. 10 washer over the threaded end of the taper screw (37) and turn a No. 10-32 nut onto the thread. Continued turning of the nut will “break” the taper pin loose so it can be removed.

11. Remove snap ring (68) and take out terminal shaft (78). (If necessary, remove burr around taper pin hole in terminal shaft.)

12. Remove pins (15), (28) and (14). Lift out floating lever (29).

13. Separate the speeder spring (142) from the spring seat (18) by tilting the spring in the direction of the open end of the bottom coil while at the same time “unscrewing” the spring from the seat. Remove the speeder spring assembly (142).

IMPORTANT

Use special wrench—Woodward tool 370109—to hold spring seat (18) while loosening spring.

14. While holding the spring collar (18) (use special wrench Woodward tool 370109), loosen and remove nut (17). Remove spring collar (18) and thrust bearing (19).

15. Remove snap ring (22). Lift off flyweight head assembly consisting of items 20, 21, 23, and 24. Disassemble flyweight head assembly by first removing retaining ring (20).

16. Remove snap ring (25). Lift out pilot-valve plunger (106); the compensating bushing (26) will come out with the pilot-valve plunger.

17. Remove pin (115), washer (116) (optional), and pin (114). Lift out link (41).

18. Drive out roll pin (27). Punch a hole in one of the two Welch plugs (65) and extract the Welch plug. Now, using a soft (brass) rod and hammer, drive the speed adjusting shaft (66) in the direction to drive out the other Welch plug (65) out of the case. Remove the shaft (66).

19. Turn the case upside down and remove the base screws (125) and washers (124). Remove base (122).

NOTICE

Be careful that none of the gears or other parts are pulled from the case and fall when the base is taken off.

Remove O-ring (118) and base seal ring (108).

20. Remove servo seal oil tube (140), O-ring (141), and spring washer (139). Remove relief-valve parts (131, 132,133, and 134).

21. Remove the electric actuator pilot-valve bushing and gear (130).

    Remove the idler gear (111).

    Remove the mechanical governor pilot-valve bushing and gear (107).

22. Remove snap ring (127) to disassemble the components within the electric actuator pilot-valve bushing (items 128 and 129).

23. Remove nut (121). The pivot (120) and linkage return piston (119) can now be taken out of the case.

    Remove piston assembly (117) and servo pin (48).

24. Remove cotter pin (46) and pin (47). Remove pivot link (49). Lift free end of floating lever (45) and turn it and power piston (136) to a position so that pin (135) can be driven out with a small brass rod. Discard snap ring (50). Remove power piston (136).

    Remove servo sleeve (137).

25. Remove snap ring (98) to gain access to the buffer parts (items 94, 95, 96, and 97).

26. Remove snap ring (104) to gain access to buffer parts (99, 101 102, and 103).

27. Remove the needle valves (76) and O-rings (77).

28. Discard old gaskets, O-rings, cotter pins, and snap rings.

Actuator Assembly

When assembling the parts into the governor, be sure that no lint (from wiping rags) or other foreign matter is present on the parts. The governor may be assembled dry. When replacing pipe plugs removed from the governor case, use a good joint compound on the threads of the plug—NOT IN THE HOLE. After the governor is assembled but before replacing the cover, apply a liberal amount of clean lubricating oil over all the moving parts to ensure initial lubrication.

In general, the assembly procedure is the reverse of the disassembly sequence. All pistons and plungers must move freely without dragging or binding. Give particular attention to these areas during assembly:

1. Assemble O-ring (138) on servo sleeve (137) and insert into governor case (86). Assemble power piston (136) from bottom of case. Lay snap ring (50) in counterbore in floating lever (45) and assemble into slotted end of power piston. Using a brass rod, drive pin (135) into power piston and lever, tapered end first, until snap ring (50) contracts into groove in pin (135).

   Attach pivot link (49) to floating lever using pin (47) and cotter pin (46).

   Assemble servo piston assembly (117), servo pin (48), and linkage return piston (119). Slip the pivot (120) into place and start the nut (121) onto the threaded end of pivot link.

   Lay the governor case on its side. Lift up on the floating lever (45) to raise the servo pistons (117 and 136) to the upper end of their strokes. While holding the floating lever up, thread the stop nut (121) onto the pivot link (49).

2.. Remove all play in the piston linkage assembly according to the following instructions:

   a. First tighten elastic nut (121) until a rocking motion is obtained when pushing alternately on pistons (136) and (117) in a teeter-totter motion. See Figure 4-1.

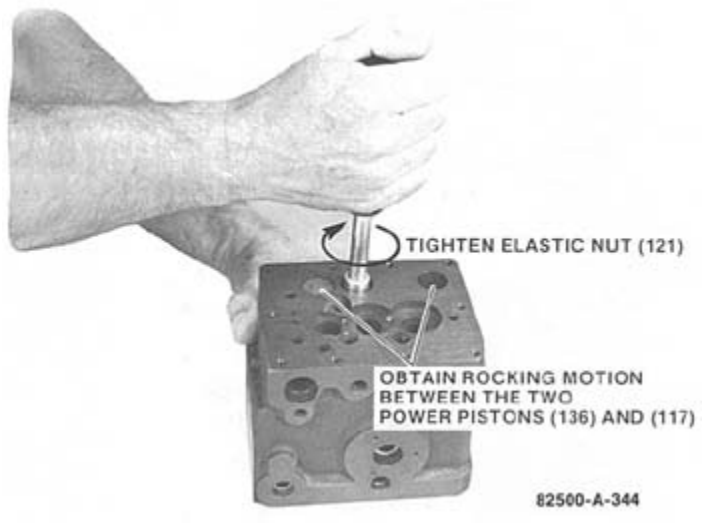

Figure 4-1. Obtaining Rocking Motion in Power Pistons

   b. Apply pressure on elastic nut (121) with index finger and raise both pistons (136) and (117) with inside hand. See Figure 4-2. Remove inside hand quickly to allow piston linkage assembly to drop sharply in order to remove all stickiness and insure proper seating. See Figure 4-3. Repeat this step three or four times.

IMPORTANT **Make sure the piston linkage assembly is hanging free and is not hanging up anywhere inside the actuator case.**

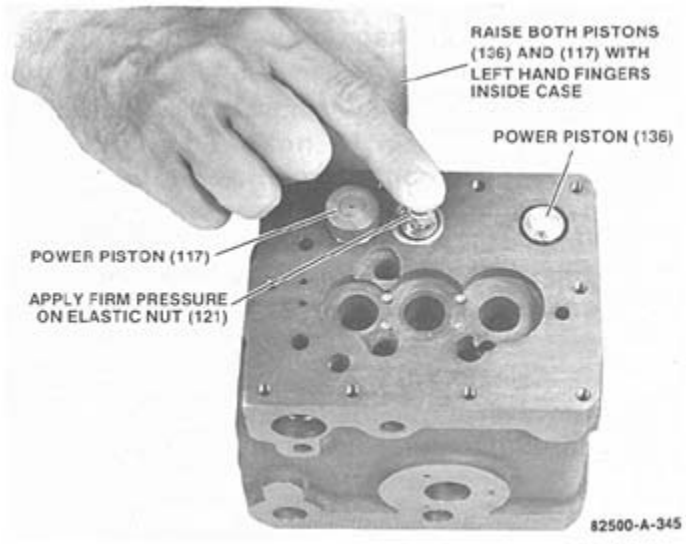

Figure 4-2. Raising Power Pistons

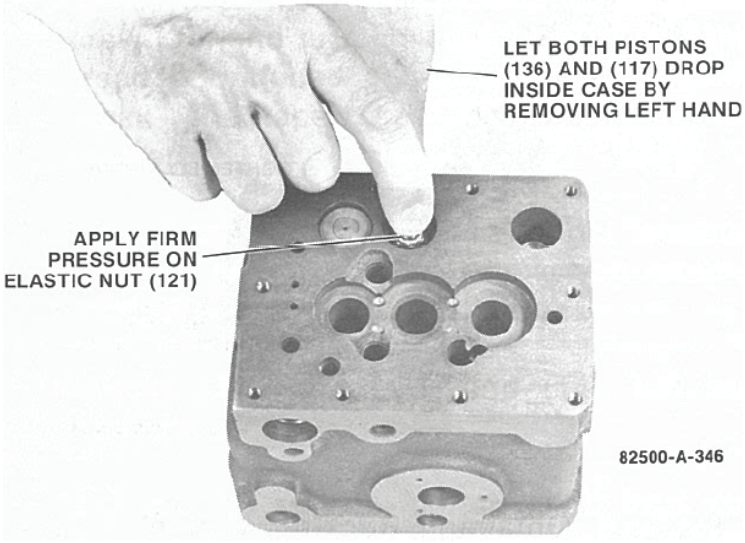

Figure 4-3. Dropping Power Pistons

c. Fit speed handle to elastic nut (121) and holding speed handle with firm pressure, start turning elastic nut (121) ccw 1/4 of a turn or so at a time to remove play in the piston linkage assembly. Remove speed wrench each time while maintaining firm pressure with the finger on the elastic nut, to see how much play has been removed by pushing alternately on pistons (136) and (117) as in step (a) above. See Figure 4-4. Each time this step is repeated, turn elastic nut (121) ccw in progressively smaller amounts as the amount of play in the piston linkage assembly decreases. See Figure 4-5. When nearing complete removal of play in the piston linkage assembly, turn the elastic nut (121) ccw only one degree at a time until all play has been removed.

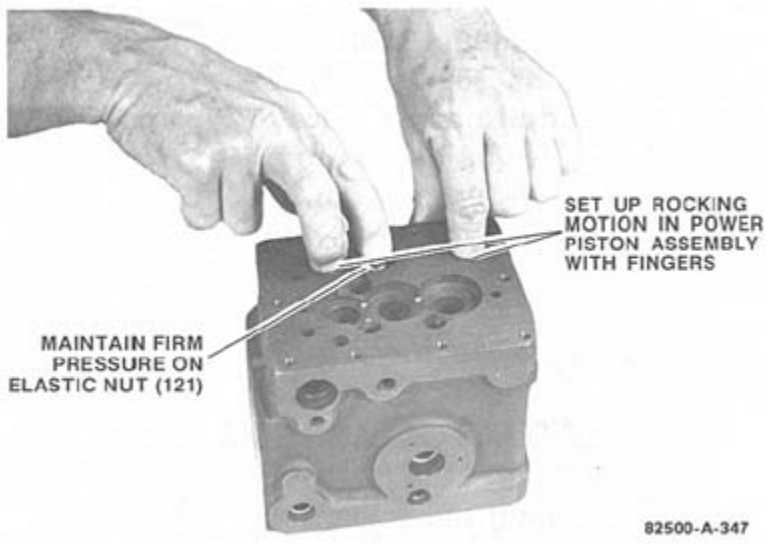

Figure 4-4. Setting up Rocking Motion

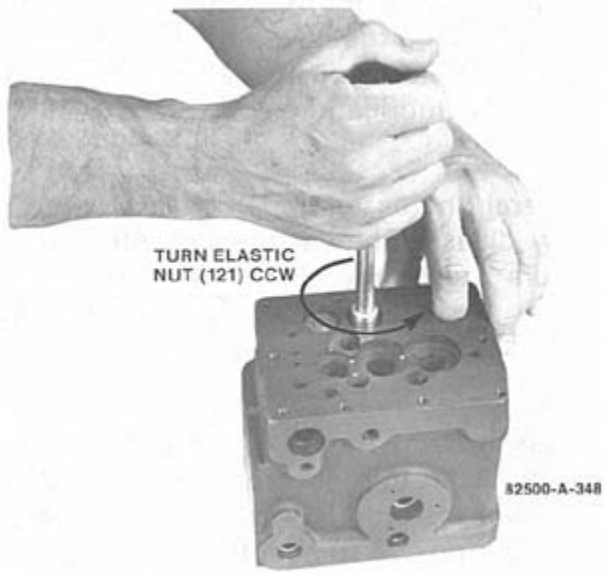

Figure 4-5. Removing Play in Power Piston Assembly

d. If play is left in the piston linkage assembly, sluggish operation of the actuator will result. Optimum adjustment is just at the point where all play is removed. Do not turn elastic nut (121) ccw beyond that point or minimum to maximum travel of the actuator output shaft will be shortened.

3. Should it be necessary to install a new terminal shaft (78), put a piece of 0.005 inch (0.13 mm) shim stock between the retaining ring (68) and the governor case and between the terminal lever (40) and governor case before tightening the socket head screw (36) in the lever. Then drill and ream for the taper pin (37). Remove all chips.

4. Be sure that the base (122) and case (86) are properly aligned so that the gears will turn freely. Before tightening the base screws (125), slip coupling (126) into place and use it to turn the pilot-valve bushing (107) to see that base and case are aligned. After tightening base screws, recheck alignment.

   If the pilot-valve bushing does not rotate freely, loosen the base screws slightly and tap the edge of the base with a soft (plastic, rubber, etc.) hammer to shift it about until the bushing turns freely. Tighten screws and recheck.

5. After installing the mechanical governor pilot-valve plunger (106), compensating bushing (26), and flyweight head and other components including items 17 through 25, the pilot-valve plunger must be centered. Proceed in this manner.

   a. Remove the 1/16 inch pipe plug in the side of the base opposite part 123.

      Use a small flashlight to observe through this hole the position of the control land of the pilot-valve plunger with respect to the port in the bushing (107).

   b. Push the pilot-valve plunger down as far as possible—this will move the flyweights to inner position. Through the pipe plug hole, check the amount of port opening above the edge of the pilot-valve plunger control land (see Figure 4-6).

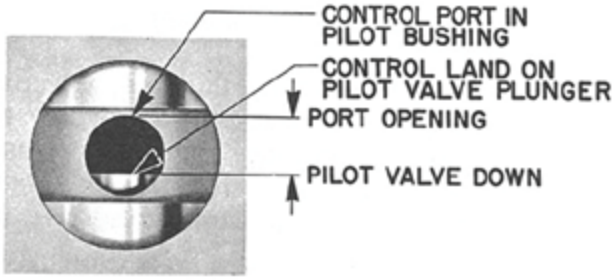

Figure 4-6. Port Opening, Pilot Valve Plunger Down

   c. Holding the pilot-valve plunger down against the flyweight toes, move the flyweights outward as far as they will go, and check the amount of port opening now appearing below the edge of the control land of the pilot valve plunger (see Figure 4-7).

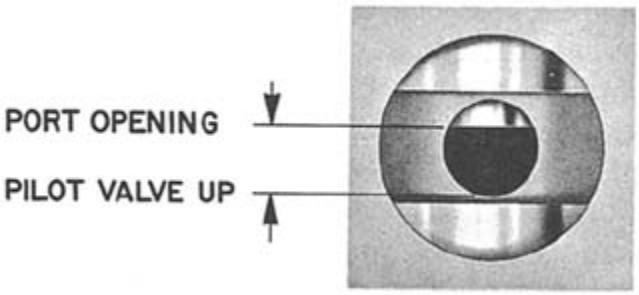

Figure 4-7. Port Opening, Pilot Valve Plunger Up

d. The amount of port opening with the fly-weights at extreme inner and outer positions should be equal within).010 inch (0.25 mm).

e. If the pilot-valve plunger is too low, hold the spring seat stationary, and turn the pilot-valve plunger counterclockwise to raise it. If the pilot-valve plunger is too high, hold the spring seat and turn the pilot valve plunger clockwise to lower it.

f When the pilot valve appears to be centered tighten the locknut down on the spring seat; recheck the pilot valve setting

g. The 1/16 inch pipe plug can now be installed, using a sealing compound to prevent leakage of oil.

6. Turn the socket head screw (55) down “snug-tight” into the electric actuator pilot-valve plunger (129).

Storage

If an actuator is to be stored over 90 days, seal the unit and fill to top with a light grade oil. When installing, drain storage oil before connecting actuator to normal oil supply.

Chapter 5.
Replacement Parts

When ordering EGB-2C replacement parts, it is essential that the following information be given:

- EGB-2C serial number (shown on nameplate); needed since the manual reference numbers do not identify the exact part required for any one governor/actuator
- Manual number (this is manual 37709.
- Part reference number, name of part, or description of part

Ref. No.	Part Name	Quantity
37709-1	Hex. Hd. Screw (10-32 x 1)	7
37709-2	Lock Washer (10)	7
37709-3	Speed Adjusting Screw	1
37709-4	Nut (1/4 - 28)	1
37709-5	Fil. Hd. Screw (6-32 x 7/16)	4
37709-6	Washer	4
37709-7	Receptacle	1
37709-8	Vent Screw	1
37709-9	Cover	1
37709-10	Gasket	1
37709-11	Jones Socket	1
37709-12	Truss Hd. Screw (6-32 x 3/8)	2
37709-14	Pivot Pin	2
37709-15	Cotter Pin (1/16 x 5/8)	3
37709-17	Nut	1
37709-18	Speeder Spring Seat	1
37709-19	Thrust Bearing	1
37709-20	Retaining Ring	1
37709-21	Ballarm Assembly (includes Needle Bearings)	2
37709-22	Snap Ring	1
37709-23	Ballhead	1
37709-24	Ballarm Pin	2
37709-25	Snap Ring	1
37709-26	Compensating Bushing	1
37709-27	Roll Pin	1
37709-28	Pivot Pin	1
37709-29	Floating Lever	1
37709-30	Hex. Hd. Screw (10-32 x 1/2)	1
37709-31	Lock Washer, (No. 10)	1
37709-32	Washer	1
37709-33	Speed Droop Adj. Bracket	1
37709-34	Speed Adjusting Lever	1
37709-35	Speed Droop Lever	1
37709-36	Socket Hd. Cap Screw (10-32 x 5/8)	1
37709-37	Taper Pin	1
37709-38	Cotter Pin (1/16 x 3/8)	1
37709-39	Speed Droop Lever Pin	1
37709-40	Terminal Lever	1
37709-41	Servo Link	1
37709-42	Pin	2
37709-43	Terminal Lever Link	1
37709-44	Roll Pin	2
37709-45	Floating Lever	1
37709-46	Cotter Pin (1/16 x 3/8)	1
37709-47	Headed Pin	1
37709-48	Servo Piston Pin	1
37709-49	Pivot Link	1
37709-50	Snap Ring	1
37709-51	Socket Hd. Screw (10-32 x 1 7/8)	2
37709-53	Transducer Bracket (With Helicoil)	1
37709-54	Pin	1
37709-55	Centering Screw (socket head)	1
37709-56	Washer	1
37709-57	Null Voltage Screw	1
37709-58	Coil Cover Assembly	1
37709-59	Gasket	1
37709-60	Magnet	1
37709-61	Washer	1
37709-62	Magnet Adjusting Spring	1
37709-63	Transducer Assembly	1
37709-64	Transducer Temperature Compensating Ring	1
37709-65	Tapered Plug	2
37709-66	Speed Adjusting Shaft	1
37709-67	Oilite Bushing	2
37709-68	Snap Ring	1
37709-69	Fil. Hd. Screw (10-32 x 1/4)	2
37709-70	Copper Washer	2
37709-71	Pipe Plug (1/8 N.P.T.F.)	2
37709-72	Spacer	1
37709-73	Retaining Ring	2
37709-74	Speed Droop Lever Pivot Pin	2
37709-75	O-ring	2
37709-76	Needle Valve	2
37709-77	O-ring	2

Ref. No.	Part Name	Quantity
37709-78	Terminal Shaft	1
37709-79	Bushing	2
37709-80	Oil Seal	2
37709-81	Felt Washer	2
37709-82	Left Hand Dial Plate	1
37709-83	Pointer	1
37709-84	Rd. Hd. Screw (5-40 x 1/4)	6
37709-85	Snap Ring	2
37709-86	Governor Case	1
37709-87	Nameplate	1
37709-88	Drive Screw	2
37709-89	Pipe Plug (1/16 N.P.T.F.)	11
37709-90	Pointer	1
37709-91	Right Hand Dial Plate	1
37709-92	Truss Hd. Screw (6-32 x 3/8)	2
37709-93	Jones Plug	1
37709-94	Buffer Piston Spring	2
37709-95	Buffer Piston	1
37709-96	O-ring	1
37709-97	Buffer Plug	1
37709-98	Snap Ring	1
37709-99	Buffer Spring	2
37709-101	Buffer Piston	1
37709-102	O-ring	1
37709-103	Buffer Cap	1
37709-104	Snap Ring	1
37709-106	Pilot Valve Plunger	1
37709-107	Pilot Valve Bushing	1
37709-108	Base Oil Seal Ring	1
37709-109	Check Valve Assembly	2
37709-110	Idler Gear Stud	1
37709-111	Idler Gear	1
37709-112	Check Valve Assembly	2
37709-113	Dowel Pin	2
37709-114	Headed Pin	1
37709-115	Cotter Pin (1/16 x 3/8)	1
37709-116	Washer [optional]	1
37709-117	Servo Piston Assembly	1
37709-118	O-ring	1
37709-119	Linkage Return Piston	1
37709-120	Pivot	1
37709-121	Thin Elastic Stop Nut	1
37709-122	Governor Base	1
37709-123	Pipe Plug (1/8 N.P.T.F.)	2
37709-124	Lock Washer	10
37709-125	Hex. Hd. Screw (10-32 x 7/8)	10
37709-126	Drive Coupling	1
37709-127	Retaining Ring	1
37709-128	Compensating Bushing	1
37709-129	Pilot Valve Plunger	1
37709-130	Pilot Valve Bushing	1
37709-131	Relief Valve Sleeve	1
37709-132	Relief Valve Plunger	1
37709-133	Relief Valve Spacer	1
37709-134	Relief Valve Spring	1
37709-135	Pin	1
37709-136	Power Piston	1
37709-137	Servo Sleeve	1
37709-138	O-ring	1
37709-139	Spring Washer	1
37709-140	Servo Seal Oil Tube	1
37709-141	O-ring	1
37709-142	Speeder Spring-Spring Fork Assembly	1
37709-143	Pipe Plug (1/16 N.P.T.F.)	2
37709-144	Pipe Plug (1/4-18 N.P.T.F.)	1
37709-145	Copper Washer, .265 I.D.	1

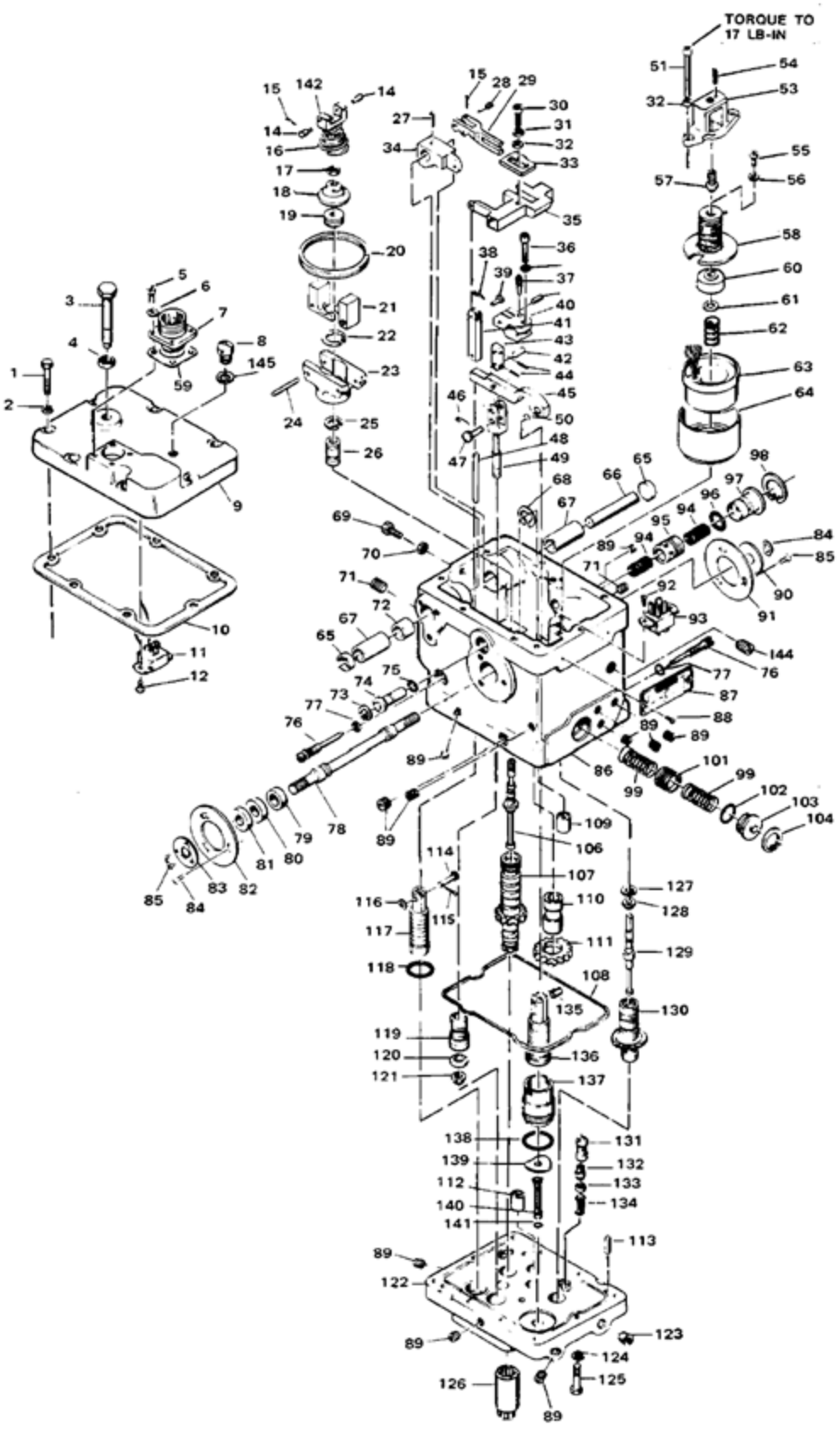

Figure 5-1. EGB-2C Parts

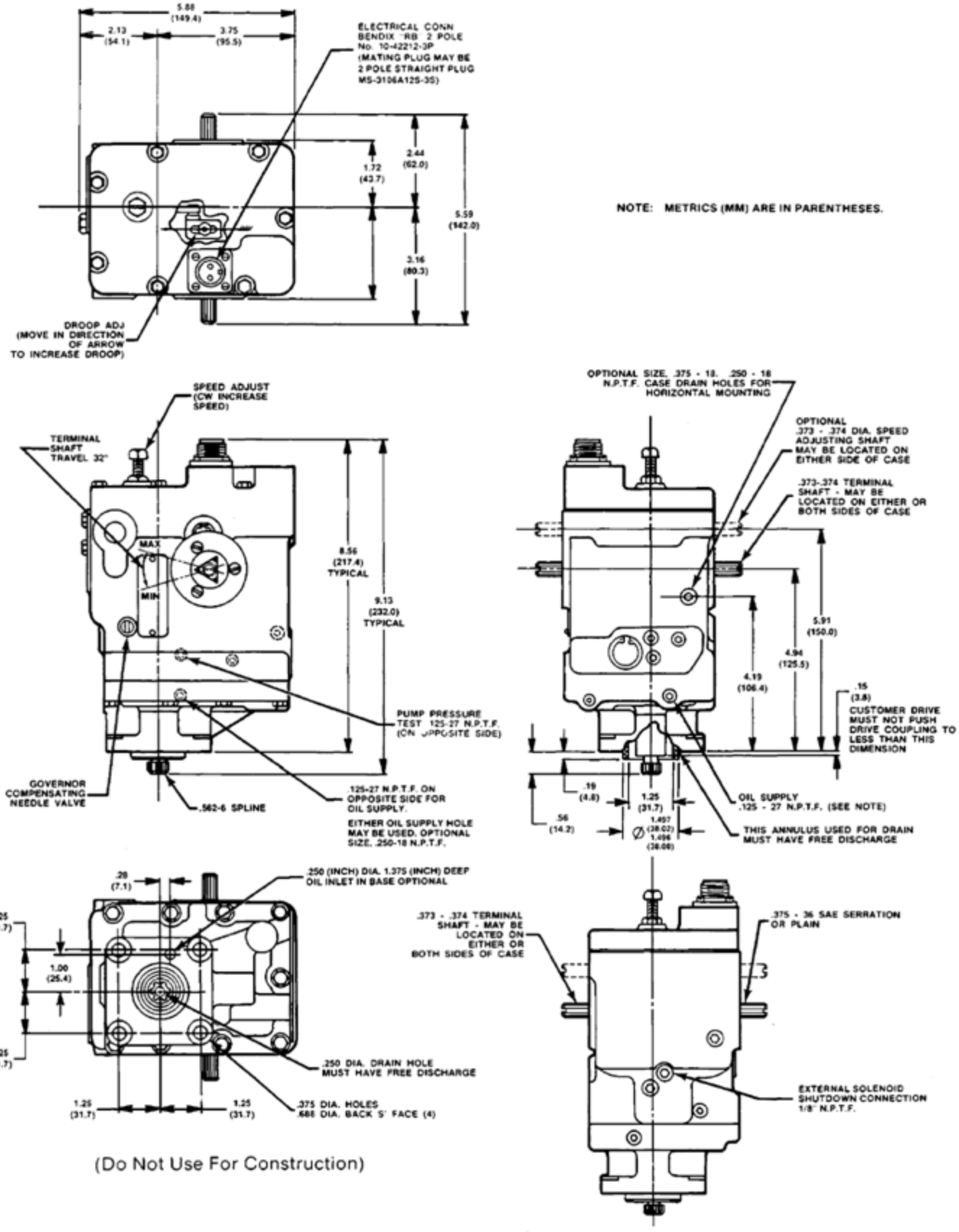

Figure 5-2. EGB-2C Governor/Actuator Outline Drawing

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

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

Products Used In Engine Systems

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

Products Used In Industrial Turbomachinery Systems

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

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

Technical Assistance

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

General

Your Name _____

Site Location _____

Phone Number _____

Fax Number

Prime Mover Information

Manufacturer _____

Engine Model Number _____

Number of Cylinders _____

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

Power Output Rating _____

Application (power generation, marine, etc.)

Control/Governor Information

Control/Governor #1

Woodward Part Number & Rev. Letter _____

Control Description or Governor Type _____

Serial Number

Control/Governor #2

Woodward Part Number & Rev. Letter _____

Control Description or Governor Type _____

Serial Number

Control/Governor #3

Woodward Part Number & Rev. Letter _____

Control Description or Governor Type _____

Serial Number

Symptoms

Description _____

_____

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 37709L.

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

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