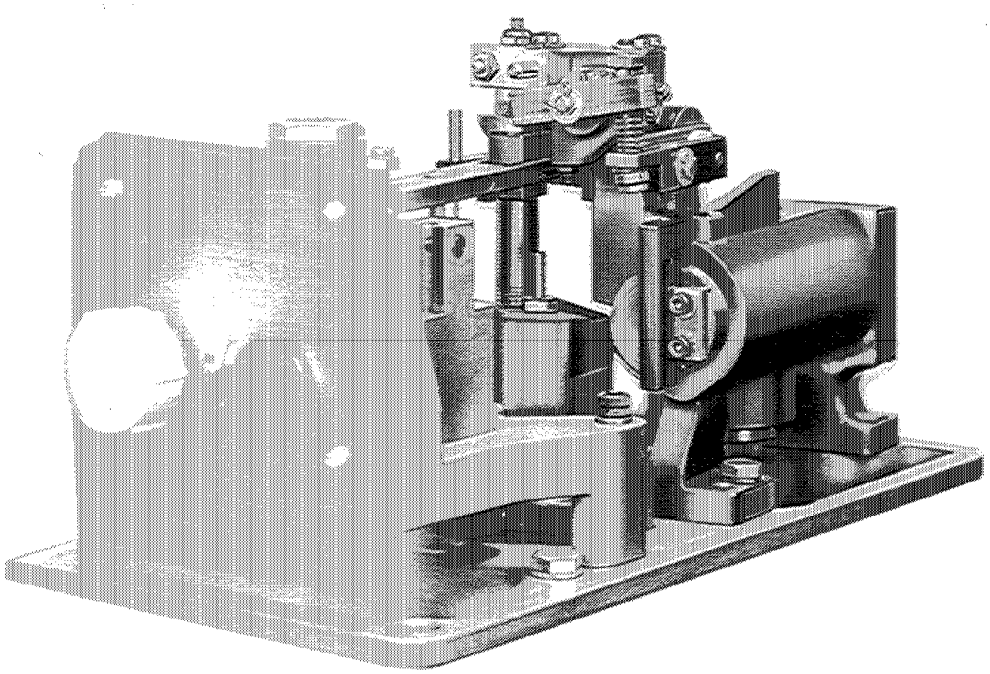
WOODWARD

Product Manual 36662
(Revision B)
Original Instructions



Torque Limit Control with Speed Droop

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

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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.

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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.

Torque Limit Control with Speed Droop

Introduction

This manual describes a torque limiting and speed droop arrangement often incorporated in PG governors used on marine propulsion engines.

The torque limiting feature limits fuel as a function of the engine speed at any instant. Speed droop permits division of load between engines operating in parallel to drive a generator or a common shaft.

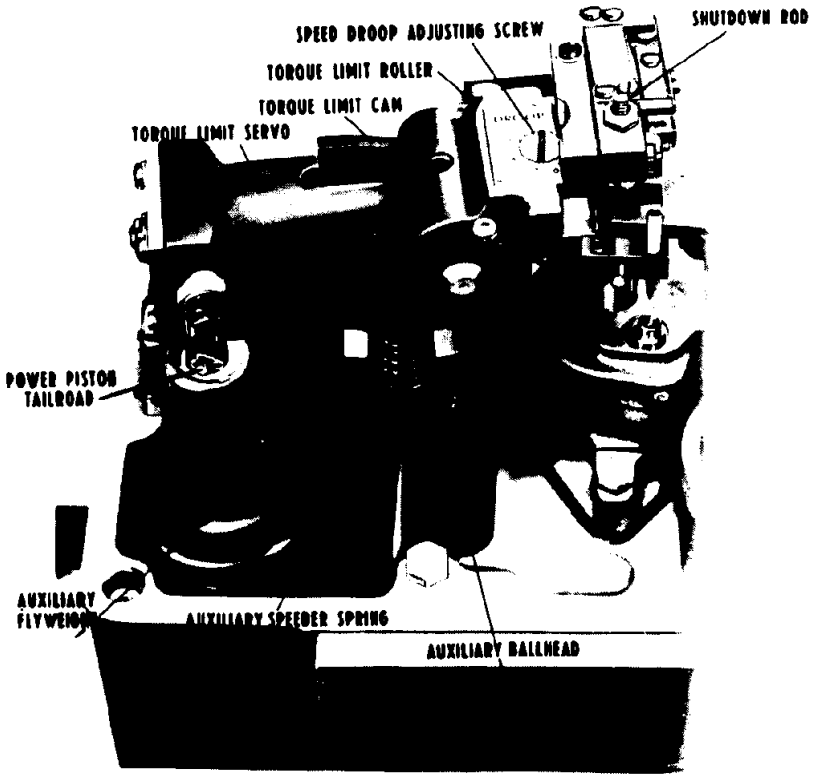

Figure 1. Torque Limiter with Speed Droop

Operation

(See Figure 2.)

Torque Limiter

The components comprising the torque limiting mechanism are the auxiliary ballhead, the torque limit piston, the cam, and the linkage connecting these elements and the tailrod of the power cylinder assembly.

With the engine running on-speed under steady-state conditions, the upward force created by the centrifugal force of the auxiliary flyweights equals the downward force of the auxiliary speeder spring, the pilot valve plunger is centered, and the control land blocks the control port in the bushing. The piston and cam are to a position which is a function of engine speed.

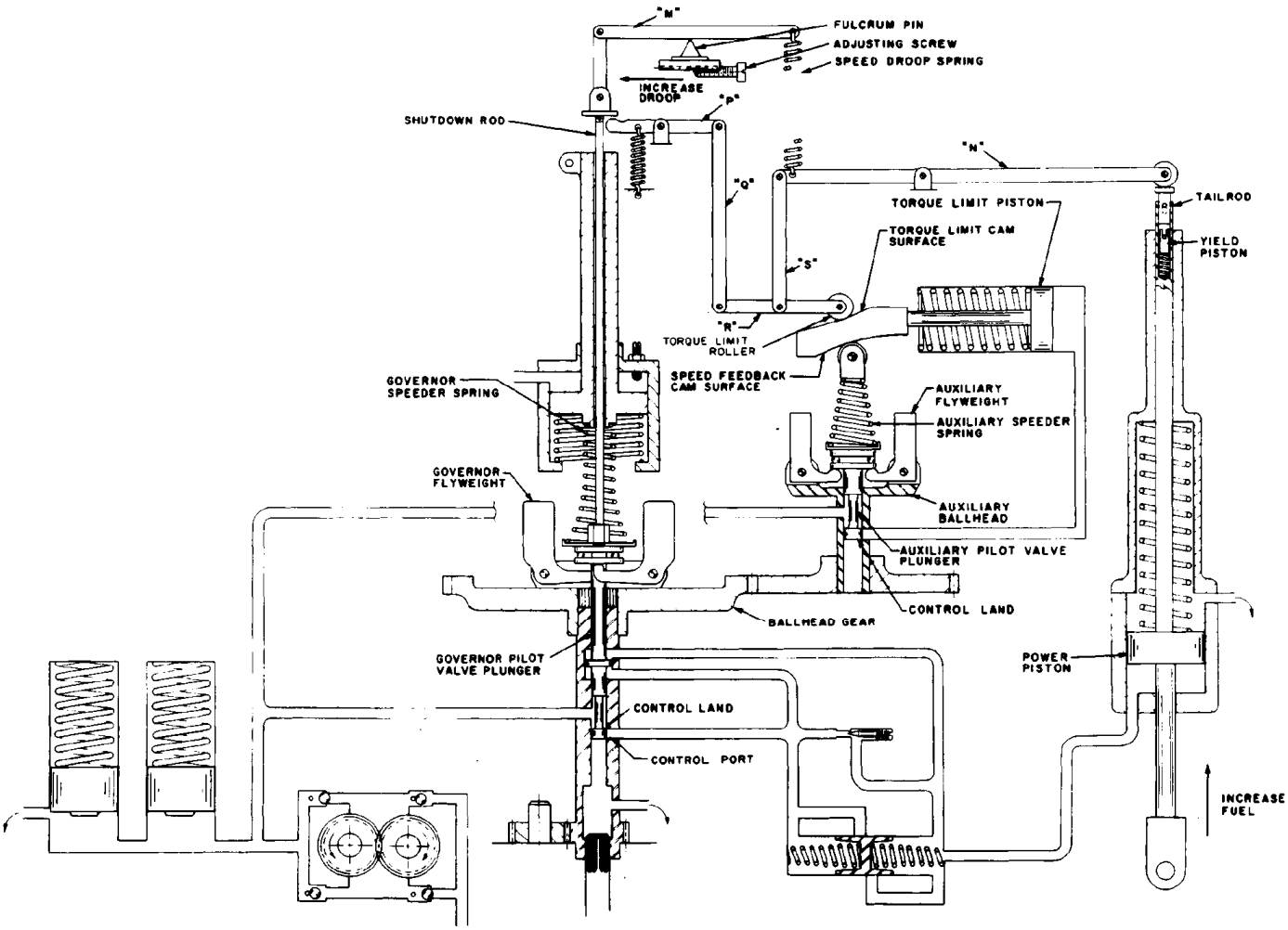

Figure 2. Torque Limiter Schematic

The torque limit cam surface becomes a pivot point in the torque limit linkage when the desired torque limit would otherwise be exceeded.

The torque limit cam is repositioned for different engine speeds in this manner. When engine speed increases, the auxiliary flyweights move out, lifting the pilot valve plunger and porting the oil at the right of the piston to sump. The torque limit piston spring moves the piston and the cam to the right. Loading on the auxiliary speeder spring is increased until it is equal to the increased force of the flyweights; at this point, the plunger has been moved down until the control land again blocks the port, thereby stopping the piston and cam.

When engine speed decreases, the auxiliary flyweight force also decreases. The speeder spring force moves the flyweights in, lowering the pilot valve plunger and the control land ports oil at pump pressure to the right side of the torque limit piston. The piston and cam move to the left, decreasing the loading on the speeder spring. When the decreasing speeder spring force equals the lower flyweight force, the pilot valve plunger is moved up until the control land blocks the port. The piston and cam stop.

When load increases, the engine speed decreases; the governor flyweights move in, and the governor pilot valve plunger is moved down. Oil at pump pressure is ported under the power piston.

When the power piston and tailrod move upward, links “N” and “S” move the torque limit roller down. If the power piston moves up to the point at which the engine would be getting the maximum amount of fuel desired for that particular engine speed, the roller contacts the cam and becomes a pivot point in the linkage. Continued upward movement of the power piston and tailrod under this condition results in upward movement of the left end of lever “P” which lifts the shutdown rod and governor pilot valve plunger. When the pilot valve plunger is lifted sufficiently, the control land will block the control port and stop the flow of oil to the power piston. With the power piston stopped, no additional fuel increase can be given to the engine. With fuel thus limited, engine speed decreases, thus decreasing the ship propeller speed and thereby decreasing engine load.

The torque limit system is designed so that fuel can be increased sufficiently to maintain set engine speed under normal loads. Under conditions of excessive load, the torque limit system will prevent the engine from getting too much fuel.

Speed Droop

Each of the governors on marine propulsion engines operating in parallel usually runs with some amount of speed droop to permit division of load among all of the engines. The portion of a load change that one engine takes—or gives up—with respect to another in the paralleled system depends upon the speed droop settings of the units.

A portion of the torque limiter linkage is used for the speed droop function. As the power piston and tailrod move up—indicating an increase in load—the left end of lever “N” is moved down and the speed droop spring is stretched. This spring applies an upward force on the governor pilot valve plunger through lever “M” and the shutdown rod. This upward force opposes the force of the governor speeder spring and has the effect of lowering the speed setting. Thus, an increase in load results in a lower speed setting. The amount of upward force for a given power piston movement is adjustable by means of movable fulcrum pin under lever “M”.

Paralleled units must run at the same speed. Therefore, the governor power piston must move just enough to change the speed setting of its governor exactly the same as the speed setting change made in the other governors with which it is paralleled. The distance the piston moves represents the load change on its unit, and is dependent upon the total load change on the system and the speed droop setting of its governor.

Adjustments

The governor and all auxiliaries are calibrated at the factory. Adjustment of the torque limiter requires the use of a test stand. Specifications for adjusting and testing the governor are available upon request. Send the governor serial number when requesting information. The speed droop adjustment may be changed and is accessible by removing the cover. Turning the gear (Figure 3, pc. 11) clockwise increases the speed droop; the name plate (pc. 9) is marked to show the relative droop setting.

Maintenance

It is advisable 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.

Disassembly

(See Figure 3.)

1. After removing the cover, remove nut (69) and two bolts (13).

2, Lift the entire torque limit assembly off column (112), being careful not to disturb adjusting screw (80) and nut (79) in roller retainer (81). This adjustment must be maintained.

3. Remove cotter pin (22) and slide piston (91) out of the cylinder. Do not disturb the position of cam (95) on the piston.

4. Remove snap ring (26), piston stop rod (17), and springs (16 & 88).

5. Using the exploded view (Figure 3) as a guide, disassemble the remainder of the assembly only as far as necessary to replace worn or damaged parts. If gear (11) or rack (8) are removed, mark the location of the gear teeth to facilitate reassembly with the same relationship between the gear teeth.

6. Lift ballhead (76) and associated parts (75 through 81) from the column. Do not disturb the relationship between adjusting screw (80), nut (79). and roller retainer (81).

7. Remove gear (114).

8. Remove side plate (99), tubing (102), and disc (104).

Cleaning and Inspection

Discard old cotter pins, lockwire, gaskets, and O-rings. Clean remaining parts with cleaning solvent. Dry the parts using clean, dry compressed air. Store parts in clean containers until reassembled.

Examine all parts for wear, rust, pitting, scoring, or nicks. Use crocus cloth and oil to polish slightly corroded, scored, or nicked parts. Discard excessively corroded or worn parts.

Examine the teeth on gear (114) for wear. Check the toes of flyweights (77) for wear. If stud (113) is worn, remove it from the column by pressing it up from the bottom.

Assembly

The assembly procedure is essentially the reverse of disassembly. The following hints are given to help possible questionable areas:

1. The larger race of bearing (74) must be used as the bottom race.

2. Spring (71) must be installed so that it retains roller retainer (81).

3. Be sure all bearings, rollers, and linkage operate freely.

4. Gear (11) must be meshed with rack (8) so that the relationship between the two pacts is the same as it was before disassembly. This relative position should have been marked during disassembly (see step 5).

5. Tighten nut (87) so a torque of 5 lb-in (0.6 N·m) is required to turn gear (11).

6. Nut (65) should be turned down past the meter pin hole, then backed off just far enough to permit installation of the cotter pin.

Parts Replacement

When ordering actuator replacement parts, it is essential that the following information be given:

- Governor serial number (shown on governor name plate)
- Manual number (this is manual 36662)
- Manual part reference number, name of part, or description of part

Ref. No.	Part Name	Quantity
36662-1	Screw	1
36662-2	Pin	1
36662-3	Screw	1
36662-4	Lever	1
36662-5	Roller	1
36662-6	Nut	1
36662-7	Pin	1
36662-8	Rack	1
36662-9	Droop Nameplate	1
36662-10	Drive Screw	2
36662-11	Gear	1
36662-12	Spring	1
36662-13	Hex Head Bolt	2
36662-14	Lock Washer	2
36662-15	Dowel Pin	2
36662-16	Spring	1
36662-17	Piston Stop Rod	1
36662-18	Gasket	1
36662-19	Cylinder Head	1
36662-20	Lock Washer	4
36662-21	Screw	4
36662-22	Cotter Pin	1
36662-23	O-ring	1
36662-24	Washer	1
36662-25	Spring Seat	1
36662-26	Retaining Ring	1
36662-27	Bushing	1
36662-28	Cylinder	1
36662-29	Screw	4
36662-30	Needle Bearing	1
36662-31	Lever	1
36662-32	Shoulder Screw	1
36662-33	Retaining Ring	1
36662-34	Seat	1
36662-35	Cotter Pin	1
36662-36	Lever	1
36662-37	Screw	1
36662-38	Pin	1
36662-39	Not Used	
36662-40	Washer	1
36662-41	Lever	1
36662-42	Tailrod	1
36662-43	Cotter Pin	2
36662-44	Pin	1
36662-45	Cotter Pin	1
36662-46	Washer	1
36662-47	Needle Bearing	1
36662-48	Nut	1
36662-49	Washer	1
36662-50	Screw	1
36662-51	Spring	1
36662-52	Pin	1
36662-53	Roller	1
36662-54	Spring	1
36662-55	Lever Assembly	1
36662-56	Strap	2
36662-57	Cotter Pin	1
36662-58	Washer	1
36662-59	Seat	1
36662-60	Block	1
36662-61	Screw	2
36662-62	Spring	1
36662-63	Screw	1
36662-64	Cotter Pin	1
36662-65	Nut	1
36662-66	Limit Pin	1
36662-67	Nut	1
36662-68	Block	1
36662-69	Nut	1
36662-70	Spring	1
36662-71	Spring	1
36662-72	Speeder Spring	1
36662-73	Pilot Valve Plunger	1
36662-74	Thrust Bearing	1
36662-75	Pin	2
36662-76	Ballhead	1
36662-77	Flyweight	2
36662-78	Not Used	
36662-79	Adjusting Nut	1
36662-80	Adjustment Screw	1
36662-81	Cam Roller Retainer	1
36662-82	Pin	1
36662-83	Adjustment Slop	1
36662-84	Ball Bearing	1
36662-85	Cylinder	1
36662-86	Tension Washer	1
36662-87	Nut	1
36662-88	Spring	1
36662-89	Spring Seal	1
36662-90	Retaining Seal	1
36662-91	Piston	1
36662-92	Lock Washer	2
36662-93	Screw	2
36662-94	Wedge	1
36662-95	Cam	1
36662-96	Not Used	
36662-97	Screw	10
36662-98	Lock Washer	10
36662-99	Plate	1
36662-100	Gasket	1
36662-101	O-ring	1
36662-102	Tube	1
36662-103	O-ring	1
36662-104	Disc	1
36662-105	O-ring	1
36662-106	Plug	1
36662-107	O-ring	1
36662-108	Screw	1
36662-109	Washer	1
36662-110	Plug	1
36662-111	Rod	1
36662-112	Column	1
36662-113	Stud	1
36662-114	Gear	1
36662-115	O-ring	1
36662-116	Bushing	2
36662-117	Threaded Insert	2
36662-118	Lock Washer	4
36662-119	Screw	4
36662-120	Spring Guard	1
36662-121	Spring Guard Seal O-ring	1
36662-122	Ring	1
36662-123	Spring	1
36662-124	Spring	1
36662-125	Tailrod Detent	1
36662-126	Spring	1
36662-127	Spring	1
36662-128	Power Piston	1
36662-129	Lock Washer	1
36662-130	Nut	1
36662-131	Nut	1

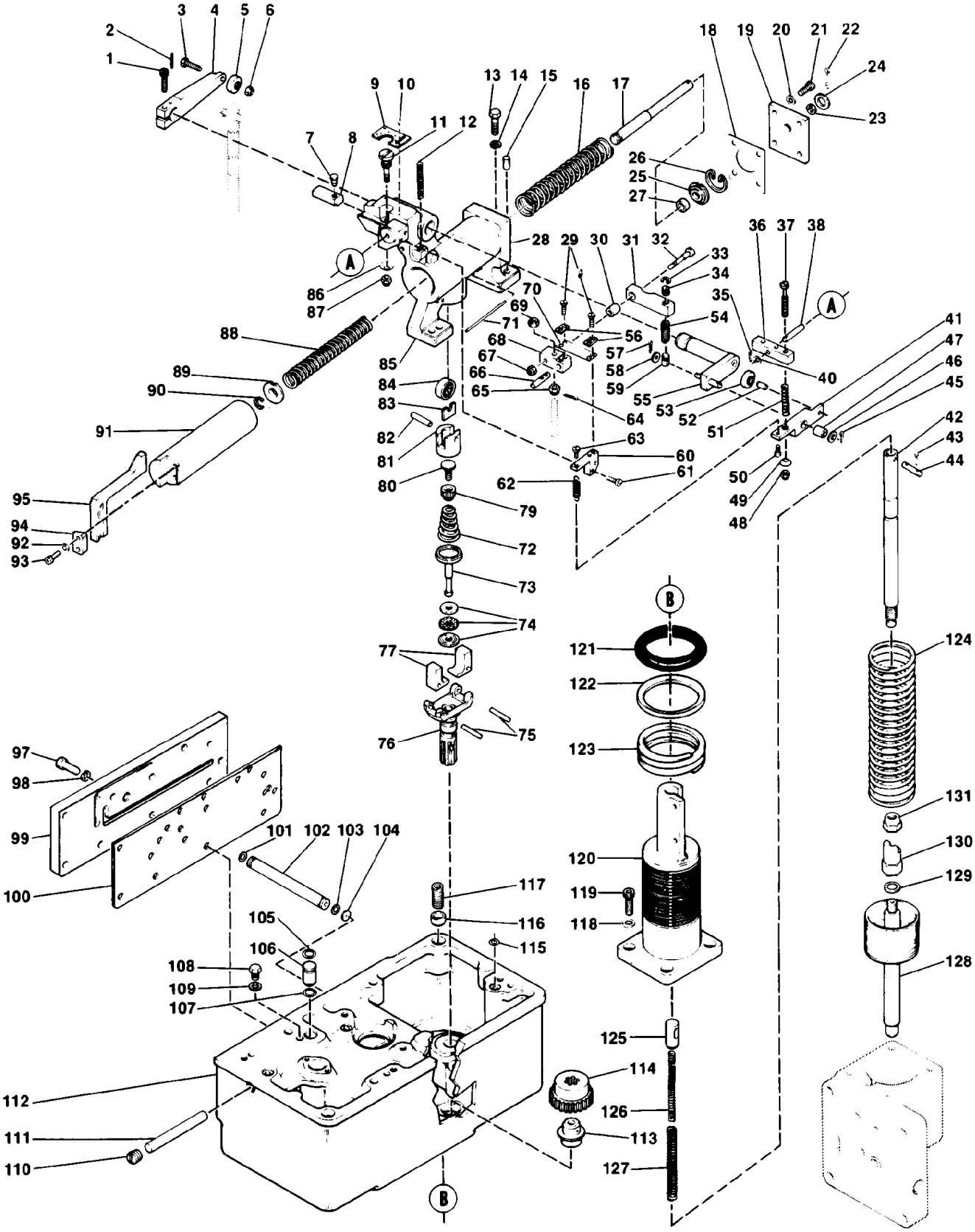

Figure 3. Torque Limiter Exploded View

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Send comments to: icinfo@woodward.com

Please reference publication 36662B.

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