LUBE AND CONTROL OIL SYSTEM

OIL CHARACTERISTICS

There is no one component or system that contributes more to the successful operation of a turbine-gear set than the lubrication system. The system should supply clean, air-free oil in proper quantities to lubricate the bearings and to actuate the governing mechanism. Contaminated oil, or oil with poor characteristics, will result in costly maintenance and outage time.

Clean oil is a requisite. A minute particle of foreign matter flowing into the small clearance of a bearing or through the governing mechanism can cause scoring of the parts. The oil filtration system should be effective in separating out small particles, and the filters should be inspected frequently to determine what is being filtered out.

Rust takes place on the ferrous metal parts of the lubricating system, and is one of the worst offenders in the operation of a turbine. It accumulates very gradually and builds up with time. If it comes loose, it may plug orifices and result in damaged bearings and rotors. It can accumulate in pilot valves and operating cylinders and cause erratic operation of the governing mechanism. It is necessary that the oil have a preferential metal-wetting ability to coat the ferrous metals of the system with a film of oil that will resist any deposit of entrained moisture.

The viscosity of lubricating oil is an important characteristic contributing to the proper operation of the turbine. If the viscosity of the oil is too high, flow of oil through the bearings is reduced and overheating results. If the viscosity is too low, film thickness may be decreased to the point where boundary lubrication results. Therefore, oil of the proper viscosity should be used to ensure free and uniform flow under all conditions of change in temperature, pressure, and load.

All lubricating oils are subject to deterioration by the action of oxygen, producing petroleum acid and then sludge. This action is normally slow, but the rate of oxidation depends upon various factors, such as degree of refining, temperature, and the catalytic action of metals. Heat has the greatest influence on oxidation of petroleum oils. The rate of oxidation increases rapidly with increases in temperature. High resistance to oxidation is a desirable characteristic of a lubricating oil.

The responsibility for supplying the proper oil for the lubricating system rests with the oil vendor and the turbine operator. This responsibility includes specifications for flushing, purifying, inspecting, and treating the oil during operation and maintenance to ensure successful performance of the equipment in service.

OIL SPECIFICATIONS

An oil with the following physical properties should prove satisfactory for use in both the turbines and reduction gears.

Saybolt viscosity, seconds at 100 F	380-560
Saybolt viscosity, seconds at 210 F	54-70
Flash point	360 F min.
Neutralization number	0.20 max.
Viscosity before starting, seconds	800 max.
Rust-resistance test	Shall pass
Oxidation test, hours	1000

LUBE AND CONTROL OIL DIAGRAM

The Lube and Control Oil Diagram shows the connections to the various components furnished with the turbines. The low bearing-oil-pressure switch shown in the diagram may be connected to a device to shut down the turbine, or to an alarm, or both.

The temperature of the oil should not be less than 90 F at the time for getting underway. The oil cooling system need not be put in service until it is necessary to control the temperature of the oil from the cooler to between 110 F and 120 F. The temperature of the oil at any bearing discharge should not exceed 180 F. The temperature rise of the oil passing through any bearing should not exceed 50 F.

LOW BEARING-OIL-PRESSURE PROTECTION

The low bearing-oil-pressure switch shown in the Lube and Control Oil Diagram is electrically connected to a solenoid dump valve located inside the front standard of the high-pressure turbine, as shown in Fig. 1.

The solenoid valve is normally de-energized and the valve is in the closed position. Low oil pressure at the most remote bearing will cause the pressure switch to close and energize the coil in the solenoid dump valve. The valve will open and dump oil from the ahead operating cylinder, thereby closing the ahead steam control valves. This protection is not available during astern operation. The solenoid valve is not manufactured by the General Electric Company. Literature on the valve is included in Section 6, Accessory Equipment.

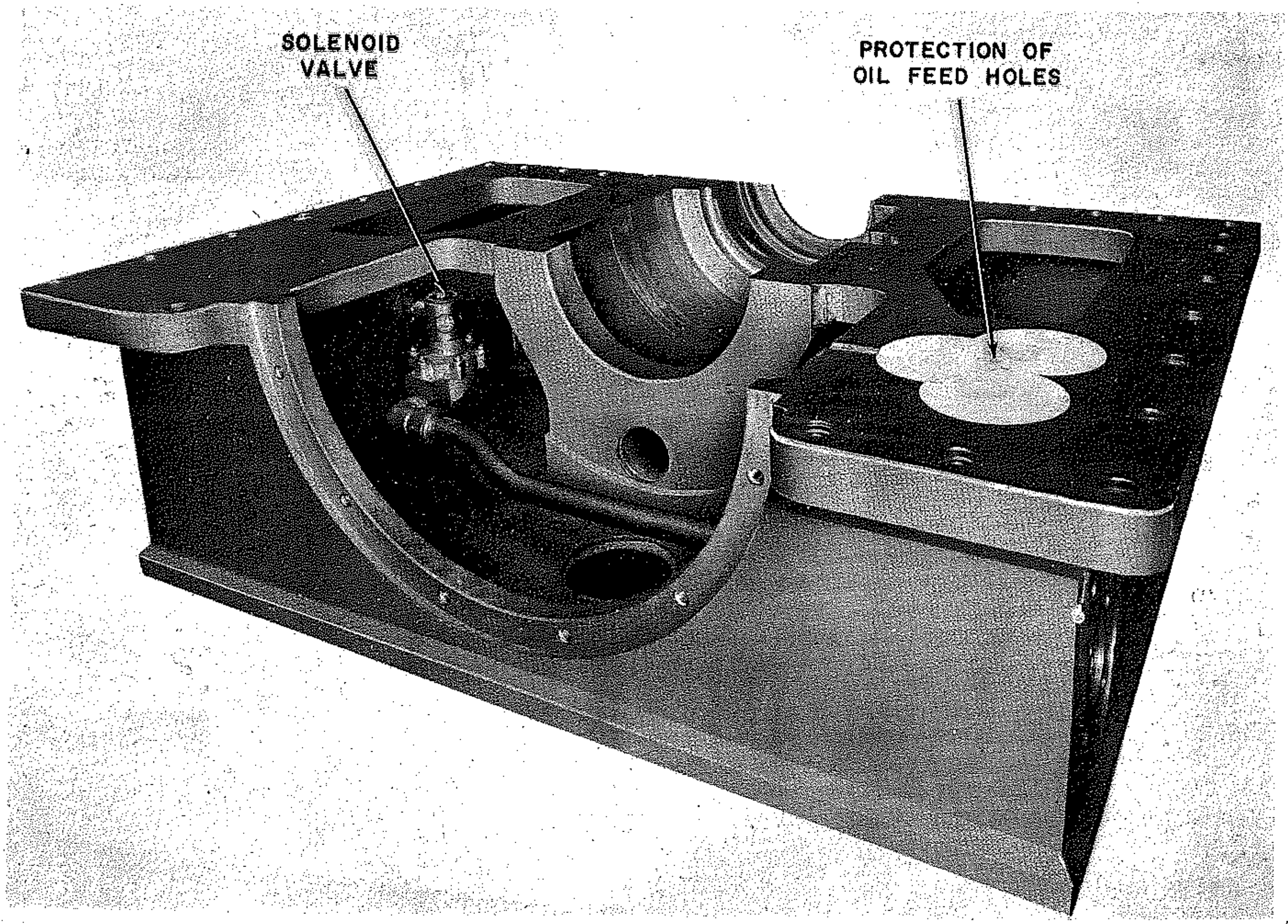

Fig. 1 Solenoid valve for low bearing-oil-pressure protection

OVERSPEED GOVERNOR SYSTEM

GOVERNOR PUMPS

An overspeed governor pump is located in the forward bearing bracket of each turbine.

The pump impeller is assembled on the forward end of the turbine rotor. The oil inlet to the pump comes from the bearing header; the outlet from the pump is piped to the overspeed relay. See Fig. 1.

If a condition develops that causes the turbine to overspeed, the output of the governor pump will increase and operate an overspeed relay. The action of the relay will cause the steam control valves to move in the closing direction and limit the speed of the turbine.

NOTE: This system is not an overspeed trip arrangement. The steam control valves do not close completely, but are held at a governing point.

OVERSPEED RELAYS

The Control Setting Diagram shows the arrangement of the overspeed relays used in this installation as well as the procedure for setting the relays to operate at the specified overspeed point.

Figure 1 explains the operation of the overspeed relay. The relays used in each installation are identical and operate in the same manner. Pressure oil from the output of the governor pump is piped to the underside of the relay piston. During normal operating speeds the piston will not move because the force of the relay piston spring overcomes the hydraulic force from the governor pump.

During an overspeed condition, the output pressure of the governor pump increases, overcomes the force of the relay piston spring, and causes the relay piston to rise. This results in dumping the oil from the operating cylinder to which the relay is connected, and moving the steam control valves in the closing direction.

The overspeed system is self-restoring. That is, when the overspeed condition has been corrected and normal turbine speed is resumed; the output pressure of the governor pump will drop and the action described in the previous paragraph will be reversed. The steam control valves will be restored to their previous open position.

Each overspeed relay has a pilot valve that may be repositioned (either manually or electrically depending on the relay design) to simulate an overspeed condition, and thereby test the overspeed system. In order to simulate an overspeed condition (see Fig. 1) the pilot valve must be raised to allow additional oil pressure under the relay piston at "A". This additional pressure on the relay piston will be enough to overcome the relay piston spring force and lift the piston. The resulting action will be the same as an actual overspeed, and the steam control valves will move in the closing direction. Release of the pilot valve will restore the system to normal.

The overspeed relays should be tested, one at a time, when operating at greater than 90 percent of ahead speed. This is to ensure that the system is in working condition. The ahead relays will move the ahead valves in a closing direction. Some installations are equipped with an astern overspeed relay. Since the astern valve will be closed during ahead operation, testing of the astern overspeed relay will indicate that the astern system is functioning only by the travel of the astern operating cylinder pilot valve.

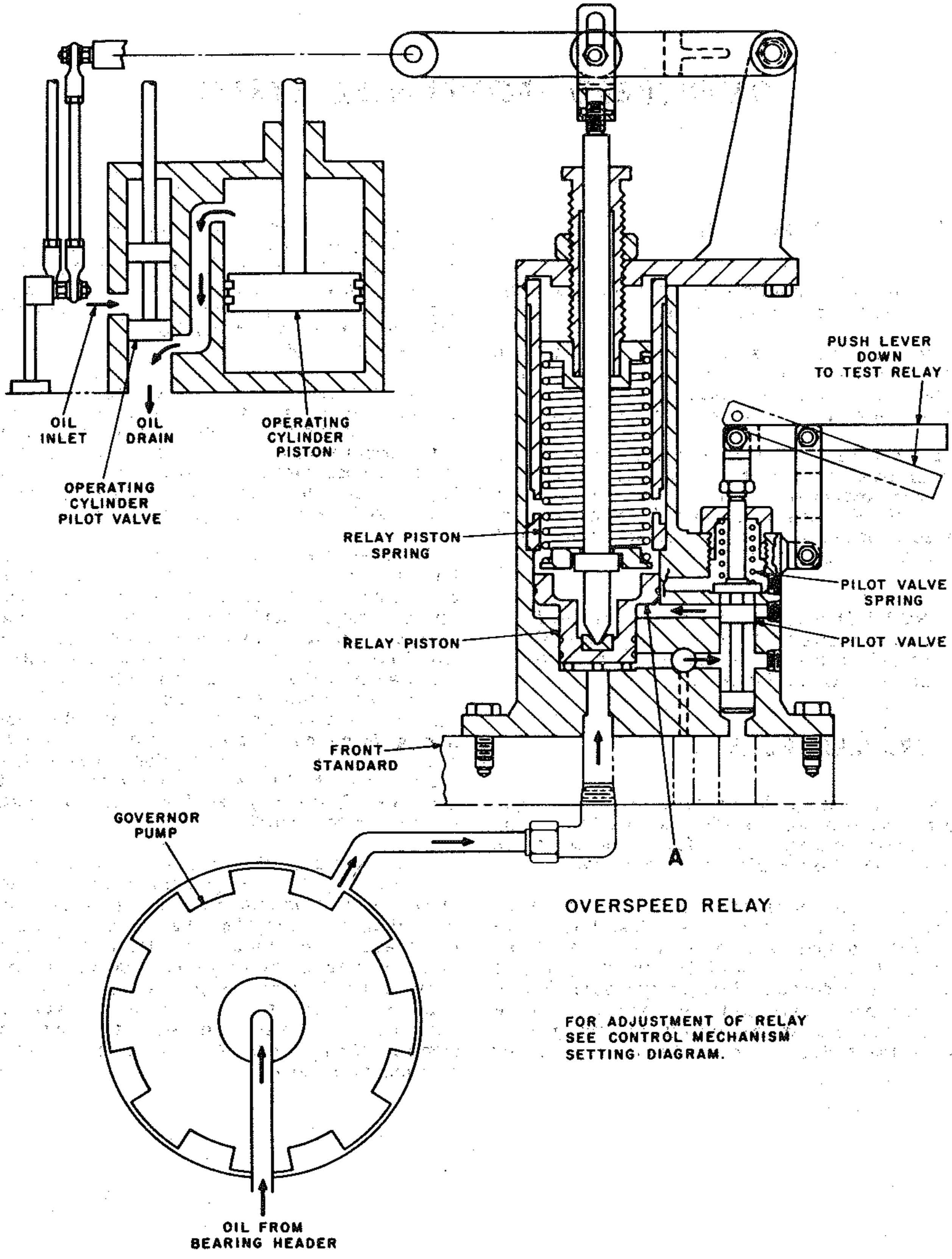

Fig. 1 Overspeed relay and speed governing system

SHAFT SEALING SYSTEM

SHAFT SEALING

The steam seal and drain system is the arrangement by which the ends of the shaft of each turbine are sealed to prevent steam flow from the turbines, or the admission of air into the turbines. The packing boxes at the ends of the turbines have pipe connections for the admission of sealing steam during standby and low-load conditions, and connections from the packing boxes to a gland exhauster system, or to a point of lower pressure than that in the packing box. The arrangement of the seal and drain system is shown on the Seal and Drain Diagram.

During startup, standby, and low-load conditions, sealing steam must be piped into the packing boxes to maintain a pressure inside the boxes slightly above that of the atmosphere. The packing box pressure is usually maintained at between 2 and 4 psig which is sufficient to prevent air from entering the turbines. As the load increases, the steam pressure inside the turbine increases to the point where some packing boxes will become self-sealing and require no external sealing steam. At full power, the steam pressure will be excessive inside the forward and aft packing boxes of the high-pressure turbine and the aft packing box of the low-pressure turbine. The steam must be vented from these boxes to prevent blow to the engine room. The forward packing box of the low-pressure turbine always requires external sealing steam during ahead operation as this end of the low-pressure turbine has a sub-atmospheric pressure near the main condenser opening.

The seal system table on the Seal and Drain Diagram shows the steam flows to and from the packing boxes under various load conditions. A value in the tabulation preceded by a plus (+) sign designates flow to the packing box, or flow necessary for sealing. A value preceded by a minus (-) sign designates flow from the packing box, or excess flow that is being vented. Thus, it will be seen from the table that as the load on the turbines varies, the sealing and venting of the packing boxes fluctuates. To compensate for these fluctuations, and to provide for a constant sealing pressure within the packing boxes, a steam seal regulator is used to control the steam flow automatically to and from the packing boxes.

STEAM SEAL REGULATOR

The steam seal regulator is the device used to control the steam flow to and from the packing boxes. The pipe connections to the regulator are shown on the Seal and Drain Diagram. The details of the regulator mechanism are shown on the Steam Seal Regulator drawing. This drawing should be referred to when ordering replacement parts. However, for a simplified explanation of how the regulator functions refer to the steam seal regulator schematic, Figure 1.

Figure 1 shows the regulator in a steady-state condition. The regulator is oil actuated and pressure requirements are shown on the Lube and Control Oil Diagram. Before the regulator is put into service the expansion tank (10) and bellows chamber are filled with water to the top of the sensing line. The filter plug (9) is located on top of the expansion tank. This water leg prevents the steam in the sensing line from acting directly on the bellows (11). A dashpot (14) is incorporated in the design to provide an adjustment for over-all response characteristics of the