CONTROL AND OIL SYSTEM

The relation of the various elements which comprise the complete governing (or control) system, is shown diagramatically in Figure 1. The throttle valve, overspeed trips, governing valves, emergency trip, exhaust pressure regulators, auxiliary pumps and regulators (all of which are shown on the diagram) are described in separate leaflets. In order to simplify the description, the oil system can be divided into two parts; namely:

1. High pressure oil system
2. Lubrication system.

Three oil impellers (or pumps) are mounted on the turbine shaft. In figure 1 the main oil pump is shown on the left, while one governing oil impeller is shown adjacent to it on the right, and the other is mounted on the right of the #1 bearing. These impellers are described in detail in the Governor I.B. Leaflets 6290 and 6329.

As shown in the diagram, the two governing impellers are so connected that through the closing of one valve and the opening of another either impeller may be used to supply governing oil to both governors.

High Pressure Oil

The oil discharged by the main oil pump is used for the following purposes.

1. To operate the ejector which supplies the main pump impeller suction.

2. To operate the throttle valve and the automatic closing valve which is installed in the steam line connecting the exhaust of the main turbine to the feed heating turbine. The line supplying the throttle valve and the pilot valve on the automatic closing valve is in turn connected to both the main and feed heating turbine overspeed trip valves and the governing valve emergency trip. An orifice is used in the supply line to the throttle valve and the automatic closing valve pilot valve to reduce the actual flow in order to insure positive action of the trip mechanisms.

3. To operate the governor servo-motor operating pistons which open and close the governing (steam inlet) valves.

4. To supply oil through the coolers to the bearings. An orifice bypassed with a valve is used in this line to reduce the flow to the proper amount.

5. To drive the hydrogen seal main oil pump. The discharge from this hydraulic turbine is led into the bearing supply line.

6. To operate the auxiliary oil pump regulator.

7. As a control medium for:

   a - Governing Impellers
   b - Governor Transformers
   c - Exhaust Pressure Regulators
   d - Governing Valve Emergency Trip
   e - Steam Flow Limit Valves

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Lubrication System

The oil supplied to the lubrication system (as noted above) passes through the oil cooler and thence to the main bearings, thrust bearings and turning gear. A fixed orifice bypassed with a valve giving a variable orifice effect, is used in this line to reduce the flow to the proper amount. This valve should be opened enough to give a bearing pressure of 10 to 12 lb/in^2 and should then be locked in this position to prevent its being closed. A relief valve in the bearing oil line is set to limit the bearing oil pressure to 10 to 12 lb/in^2.

A connection from the bearing supply line is led to the auxiliary oil pump regulator to actuate the regulator. This regulator serves also as a relief valve and bypasses oil to the reservoir, when necessary, to maintain the desired bearing supply pressure.

Provision is made for cartridge type strainers to be installed in the oil supply line to the bearings, for use when preparing the unit for service after a general inspection or major repair. At such times, these strainers should be installed and used while circulating oil through the system preparatory to starting, but they must be removed before the unit is actually operated.

During the starting and stopping periods, all oil pressure requirements are supplied by the steam driven auxiliary oil pump. This pump is connected to the system by suitable check valves as shown in the diagram. It is controlled automatically and starts up whenever the bearing line pressure drops below that for which the regulator is set.

The auxiliary pump discharge is connected to the impeller suction through a check valve and a stop valve. During the initial operation (after installation or a major overhaul) the stop valve in this line should be adjusted to maintain 40 lbs. pressure at the impeller suction, with the turbine rolling slowly. This setting should maintain at least 8 to 10 lbs in the impeller suction at all times during the starting cycle. If the impeller suction drops below this value (when the impeller begins pumping but the discharge pressure is still too low to operate the ejector) the above mentioned stop valve should be opened just enough to maintain at least 8 to 10 lbs. pressure at the impeller suction. This is strictly an initial adjustment. After the correct setting is obtained, the stop valve should be locked and no further change made during normal operation.

In addition a motor driven oil pump is provided to supply lubrication to the bearings and turning gear when the unit is being rolled at low speed by the turning gear during shutdown periods. In case of an emergency such as a failure of the steam driven auxiliary oil pump, this motor driven oil pump will supply sufficient lubrication for shutting down the unit. However, it is manually controlled and has no automatic connection. Consequently it must not be depended upon as a substitute for the steam driven auxiliary pump. It should also be noted that the motor driven pump does not have sufficient capacity for starting the unit.

A check valve is placed in the oil supply line from the main impeller to the oil cooler so that if necessary the governor or throttle valve can be dismantled while the motor driven auxiliary oil pump is in operation.

Enough oil should be provided so that when the turbine is operating at full speed the oil level in the reservoir as shown by the gauge, is within the limits given on the indicator plate. Although there is a strainer in the oil system, it is desirable as a precaution to strain ghe oil through a fine mesh screen or cloth just before putting it into the reservoir.

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The amount of water circulated through the oil cooler should be regulated to maintain the temperature of the oil leaving the cooler between 100° and 110° F. The correct criterion of oil cooler water supply is, of course, the temperature of the oil leaving the hottest bearing. This temperature will vary with different units and operating conditions. However, in general, oil return temperatures of 140° to 150° F. are considered good practice. When starting a turbine, the oil cooler water should not be turned on until the oil temperature has increased to the approximate limits given above.

One oil cooler is sufficient for normal operation. The piping connecting the coolers is arranged so that either cooler can be used.

Air vents from the top of the coolers to the reservoir are used when there is a drop in the main oil line from the cooler. If this piping can be arranged to eliminate all possibility of trapping air, the separate vent lines are not required.

The oil used in the generator hydrogen seals is supplied from an auxiliary reservoir which is built integrally with the main reservoir but separated from it by suitable baffles. A small part of the oil returning to the main reservoir is led to the auxiliary reservoir through a trap. This arrangement insures a supply for the hydrogen seals, free of entrained air or hydrogen gas. Two pumps are provided for supplying oil to the hydrogen seals. One hydraulically driven by high pressure oil from the turbine main pump is for use during normal operation; and the other, motor driven, is for use when the main unit is shut down. These pumps are described in separate leaflets.

Load on Steam Flow Limit Valves

An adjustable load or steam flow limiting device is provided for each turbine, with which it is possible to make adjustments so that under no condition of system frequency swing, can the turbine governors open and increase the steam flow beyond a desired point. The valve for controlling the main turbine is a high grade oil pressure regulating valve, described in detail in I.B. 6337, while that for the feed heating turbine is a simple needle valve. Both are shown on the diagram.

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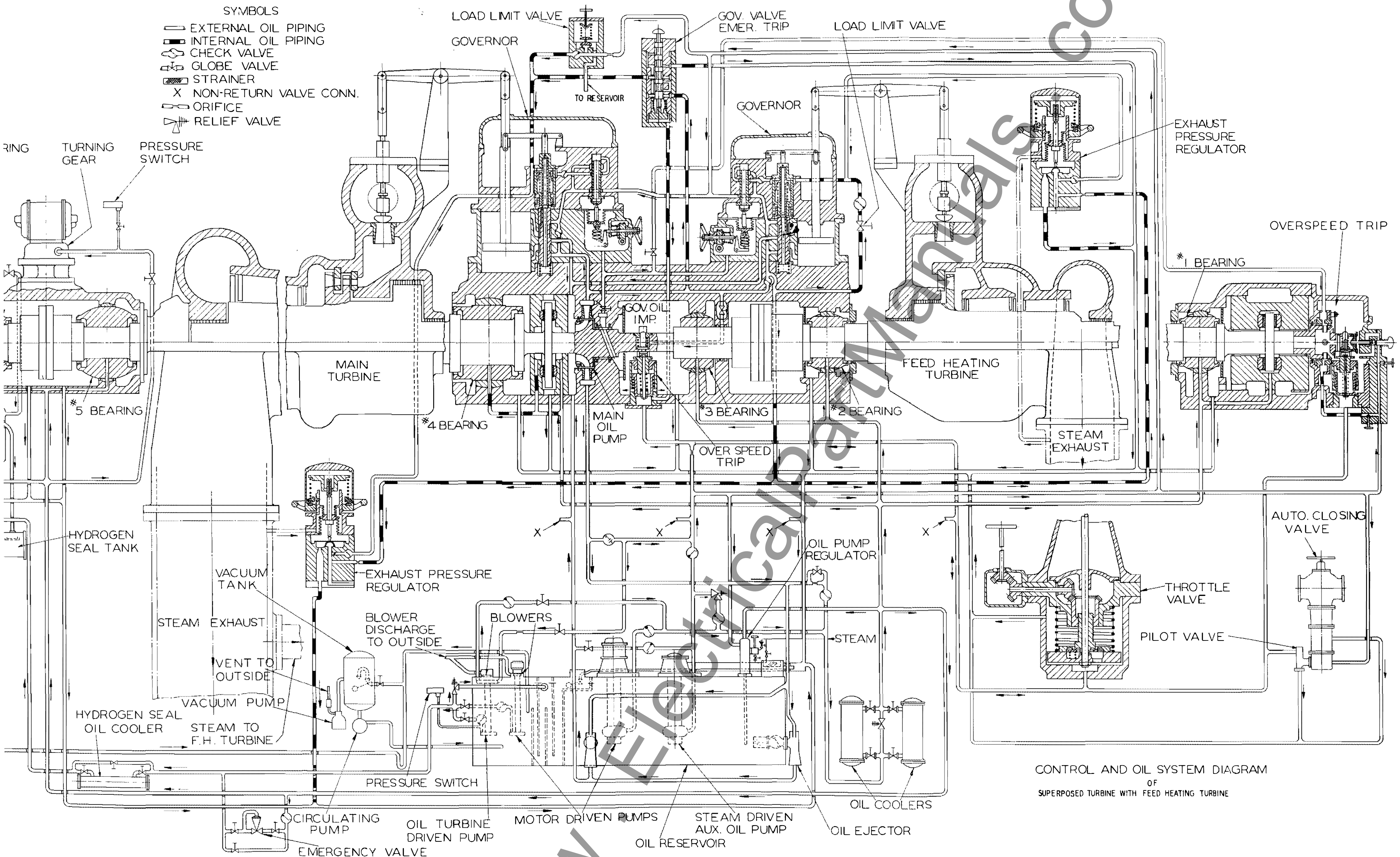

CONTROL AND OIL SYSTEM DIAGRAM
OF
SUPERPOSED TURBINE WITH FEED HEATING TURBINE

Figure 1

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