Governor, Governing Valve and Oil Pump

Governor

This governor, shown in Figure 1, is of the hydraulic type in which a spring loaded operating piston is actuated by oil pressure discharged by a gear type pump. Its principal parts are:- the governing pump gears "18" and "21", the operating piston "28" and the spring "29".

The pump is driven from the main turbine shaft through the helical gears "22" and "25". It takes oil from the reservoir and discharges into the operating cylinder on the left hand side of the operating piston (as viewed in the illustration). Movement of the piston is transmitted to the governing valve by the rod "31" and lever "33" which is fulcrumed so that outward movement of the piston closes the governing valve and vice versa.

Being driven by the turbine shaft, the pressure delivered by the governing pump varies as the square of the turbine speed and thus provides a positive governing force. This discharge pressure, acting against the spring loaded operating piston, causes the piston and hence the governing valve to move in response to changes in speed. Therefore, if the speed increases, the oil pressure acting against the piston increases, thus moving the piston outward which closes the governing valve. Conversely, if the speed decreases the oil pressure acting against the piston decreases, thus allowing the spring to move the piston inward which opens the governing valve.

SPEED CHANGER

The speed maintained by the governor can be varied while the unit is in operation by means of the speed changer shown in section "B-B". This consists of the hand operated, piston type valve "11" which is located adjacent to the operating cylinder and connected by suitable passages, so as to control the flow of oil from the operating cylinder to the reservoir. Opening the speed changer valve decreases the oil pressure in the operating cylinder and therefore increases the speed. Closing the speed changer valve increases the pressure in the operating cylinder and therefore decreases the speed.

A speed changer indicator, consisting of items "2", "3" and "4" is provided to show the position of the speed changer valve. The plate "3" is graduated and the position of the pointer corresponding to normal full speed should be checked by means of a tachometer and recorded for the operator's information. Likewise the speed change corresponding to a handwheel movement of one division on the scale can readily be determined.

As shown in the illustration, the governor lever is fulcrumed on the pin "34" in hole "Y". Two additional holes, "X" and "Z" are provided to obtain the proper valve travel for various steam conditions, etc. If the mechanism is dismantled, it is of utmost importance to re-assemble it with the fulcrum pin in the same hole as found originally.

Governing Valve Servo-Motor

With the arrangement shown in the illustration, a hydraulic servo-motor (consisting of a relay controlled operating piston) is placed between the governor lever and the governing valve. Movements of the governor, in response to speed changes, are transmitted to the servo-motor relay "38" and the oil pressure acting against the operating piston "39" supplies the force required to move the governing valve. This servo-motor has

no effect on the governor either in the speed maintained or regulation, but is used merely to provide additional power for operating the valve.

High pressure oil discharged by the main oil pump is admitted to the servo-motor relay at the point indicated in the illustration. The relay operates within a ported sleeve, which in this case is integral with the operating piston, to control the flow of high pressure oil to and from the operating cylinder. This sleeve or piston is a sliding fit in the cylinder "45" and cover "37". The spring "36" exerts an outward force on the relay at all times thus causing it to follow all movements of the governor lever. With the turbine operating at normal speed, the relative positions of the relay and operating piston are such that the piston is balanced by oil pressure acting on the right hand side and oil pressure plus the spring compression acting on the left hand side. In this position all relay ports are practically closed and the relay is in its neutral position.

Movement of the governor in response to an increase in speed moves the relay toward the left. This uncovers ports which admit high pressure oil to the chamber on the right hand side of the operating piston and connect the chamber on the left hand side to drain. The piston, therefore, moves toward the left and closes the governing valve sufficiently to maintain the required speed. As the operating piston moves toward the left, the sleeve which is integral with it moves to its neutral position with relation to the relay.

Conversely, movement of the governor in response to a decrease in speed allows the spring "36" to move the relay toward the right. This uncovers ports which admit high pressure oil to the chamber on the left of the piston and connect the chamber on the right to drain. The piston, therefore, moves toward the right and opens the governing valve sufficiently to maintain the required speed. Movement of the piston toward the right returns the sleeve to its neutral position with relation to the relay.

From the above, it is seen that following any movement of the relay, the resulting movement of the operating piston and sleeve re-establishes the neutral relation of the relay and sleeve until another change in speed occurs.

GOVERNING VALVE

The governing valve "50" is of the double seated, balanced, poppet type and operates within the cage "51". The valve is pinned to the stem "52" which is guided by the cage at the inner end and by the bushings "44" and "49" at the outer end. This stem is rigidly connected to the servo-motor operating piston. The valve is spring loaded in the opening direction by the spring "40" acting against the operating piston. However, the piston is oil operated in both directions to insure positive action.

The bushings "44" and "49" serve also to reduce to a minimum the steam leakage along the stem. A leak-off connection is provided between the two bushings so that any steam that does leak past the inner one can be led to a point at atmospheric pressure where a small amount of escaping steam is not objectionable. No other form of stem packing is used and excessive leakage should be corrected by installing new bushings. In installing these bushings, they should be pressed into the cover and reamed in place. The surface of the stem should be kept smooth and free of galled spots, paint, rust or dirt. Any binding or sticking of the stem will cause unstable governor action.

VALVE ADJUSTMENT

The valve travel (or lift) is very important and is set accurately at the factory when the turbine is tested. Therefore, it is recommended that the travel (or lift) be checked on each new machine when first received, and this travel recorded in a permanent record. Then at any future time, the travel can be checked against the original setting.

In order to check the setting, proceed as follows:

1 - With the turbine at rest, pull outward on the governor end of the lever "33" to hold the valve on its seat. Then measure the distance which the operating piston sleeve "39" protrudes beyond the plate on the cover "37". This distance is indicated by the letter "P" in the illustration.

2 - Operate the turbine at approximately half speed with no load. At this speed the governing valve will be open wide. Then, measure the distance "P" again.

3 - The difference between the two measurements "P" is the valve travel (or lift) and is the figure to be recorded.

Note: - It is advisable to go through the above checking process a second time to insure a correct reading.

It is also recommended that the position of the governor lever fulcrum pin "34" be recorded; that is, whether it is in hole "X", "Y" or "Z". If the mechanism is dismantled, this pin must be re-assembled in the same hole as originally found.

It will be noted that the valve and seats form line contacts and not surface contacts. Therefore, this valve cannot be "ground-in" to stop leakage. A test to determine whether or not the valve is leaking too badly for use may be applied as follows:-

1 - With the turbine operating at no load, pull outward on the governor end of the lever "33" to hold the governing valve on its seat.

2 - If the steam leakage is sufficient to keep the turbine rotating, it is evident that the valve is leaking too badly for practical use.

If it should be found necessary to reseat the valve, remachine the valve and cage as follows (refer to Figure 2): Chuck the valve cage in a lathe with a compound slide rest and center the cage so that its axis runs true. Remove sufficient metal from the face "C" at an angle of 45 deg. until a clean surface is obtained. Next, remove sufficient metal from the face "K" until a clean surface is obtained. Do not increase the bore "E" because any increase in this diameter will unbalance the valve. Mount the valve in a lathe by the valve stem at one end and support and center the other end in a steady rest. Remove sufficient metal from the face "J" to obtain a clean surface and then machine surface "A" at an angle of 45 deg. until all markings are removed. Do not decrease the diameter "F" because any decrease in this diameter will unbalance the valve. Insert the valve in the cage and determine whether "A" makes contact with "B" or "D" with "C". Machine sufficient metal off "A" if "A" and "B" are contacting, or off "J" if "C" and "D" are contacting until "A" and "B" are in contact at the same time that "C" and "D" are in contact. A piece of thin paper placed between the valve and seats while the valve is turned a little will help to determine where the metal is to be removed. If the above conditions are fulfilled, the valve will be balanced for pressure and give good service. Any "grinding-in" however little, will cause an unbalanced condition.

When removing the cage, the steam chest should be heated by turning steam into it, and the cage cooled by ice or water (preferably ice). The cage can then be pulled out of the steam chest. Likewise, the steam chest should be heated when installing the cage in order to avoid galling the press fit.

OIL PUMP

The main oil pump, consisting of items "12" to "14" inclusive, is likewise of the gear type and is driven by the same shaft as the governing pump. This pump takes oil from the reservoir and discharges at a pressure which is ample to supply all oil requirements of the unit. A part of the high pressure oil is led to the servo-motor to operate the governing valve. A relief valve in the discharge line is set to maintain a pressure of 30 lbs/sq.in. for this purpose. The remainder passes through the oil cooler and thence to the bearings. A by-pass from the outlet side of the cooler to the reservoir contains an orifice which maintains approximately 5 lbs/sq.in. pressure at the bearings.

The pipe plug at the top of the governor housing is provided for use in priming the pumps. However, priming should not be necessary except when starting up for the first time or if the turbine has been out of service for a considerable length of time. It is important to replace the pipe plug securely after priming as leaks around the priming plug will cause unstable operation of the governor.

The following list has been compiled to facilitate ordering spare or renewal parts by name and item number, together with the serial number of the turbine.

Item No.	Name
1	Speed Changer Handwheel
2	Speed Changer Indicator Collar
3	Speed Changer Indicator Plate
4	Speed Changer Indicator Collar Set Screw
5	Speed Changer Valve Stem Packing Sleeve
6	Speed Changer Valve Stem Packing
7	Speed Changer Valve Stem Packing Nut
8	Speed Changer Valve Bushing
9	Speed Changer Valve Bushing Retainer
10	Speed Changer Valve Bushing Dowel Pin
11	Speed Changer Valve and Stem
12	Key
13	Oil Pump Gear (Driver)
14	Oil Pump Gear (Idler)
15	Oil Pump Drive Shaft Bushings (Inner)
16	Oil Pump Drive Shaft
17	Oil Pump Idler Shaft
18	Governing Pump Gear (Idler)
19	Oil Pump Drive Shaft Bushing (Outer)
20	Key
21	Governing Pump Gear (Driver)
22	Oil Pump Shaft Gear (Driven)
23	Oil Pump Shaft Gear Nut
24	Key
25	Oil Pump Shaft Gear (Driver)
26	Oil Pump and Governor Case Cover (Inner)
27	Oil Pump and Governor Case
28	Governor Operating Piston

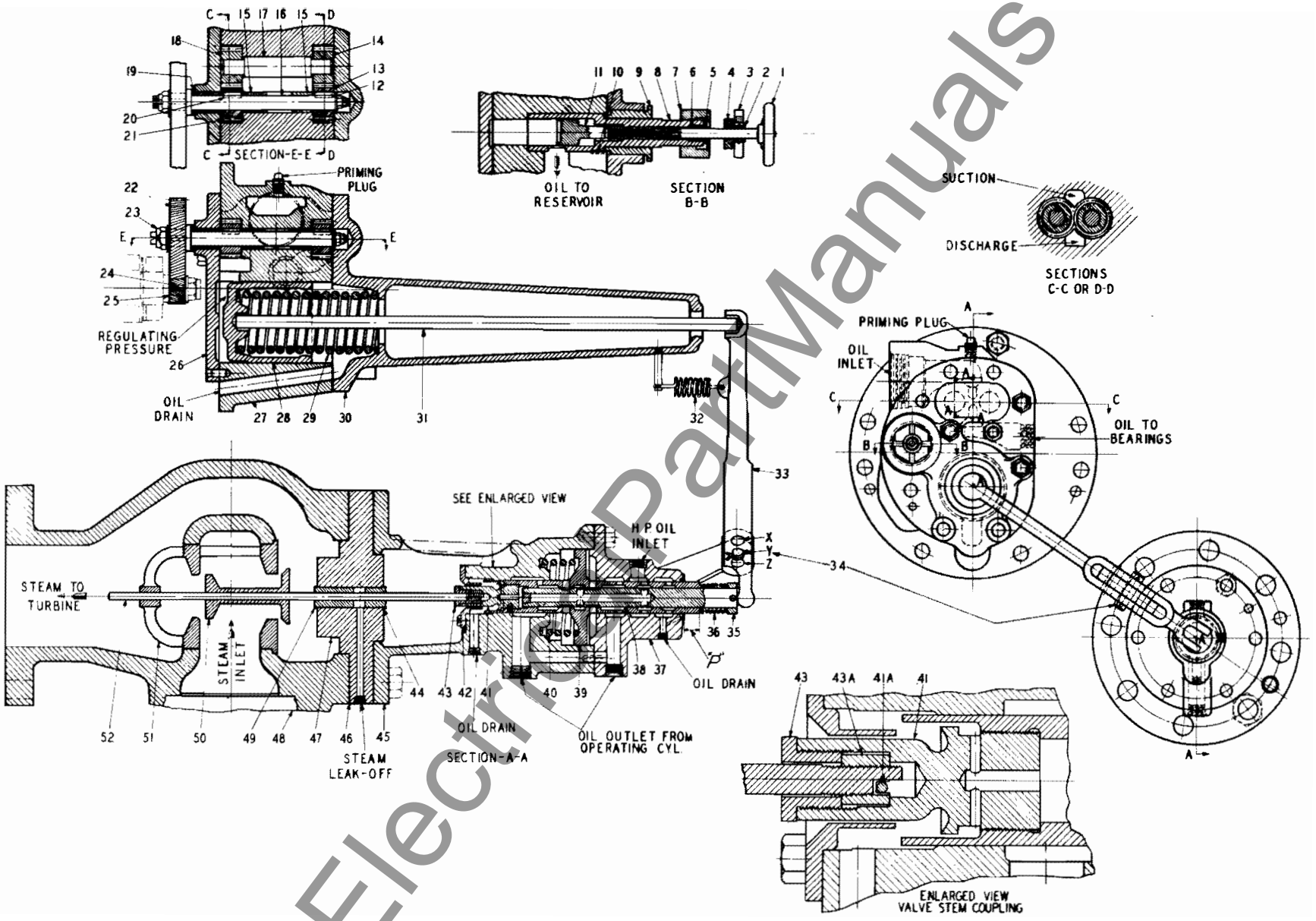

Fig. 1

Item No.	Name
29	Governor Operating Piston Spring
30	Oil Pump and Governor Case Cover (Outer)
31	Governor Operating Piston Rod
32	Governor Lever Spring
33	Governor Lever
34	Governor Lever Fulcrum Pin
35	Relay Spring Seat
36	Relay Spring
37	Operating Cylinder Cover
38	Relay
39	Operating Piston
40	Operating Piston Spring
41	Governing Valve Stem Coupling
41A	Governing Valve Stem Coupling Pin
42	Operating Cylinder Oil Baffle
43	Governing Valve Stem Coupling Nut (Outer)
43A	Governing Valve Stem Coupling Nut (Inner)
44	Governing Valve Stem Bushing (Outer)
45	Operating Cylinder
46	Gasket
47	Governing Valve Body Cover
48	Governing Valve Body
49	Governing Valve Stem Bushing (Inner)
50	Governing Valve
51	Governing Valve Cage
52	Governing Valve Stem

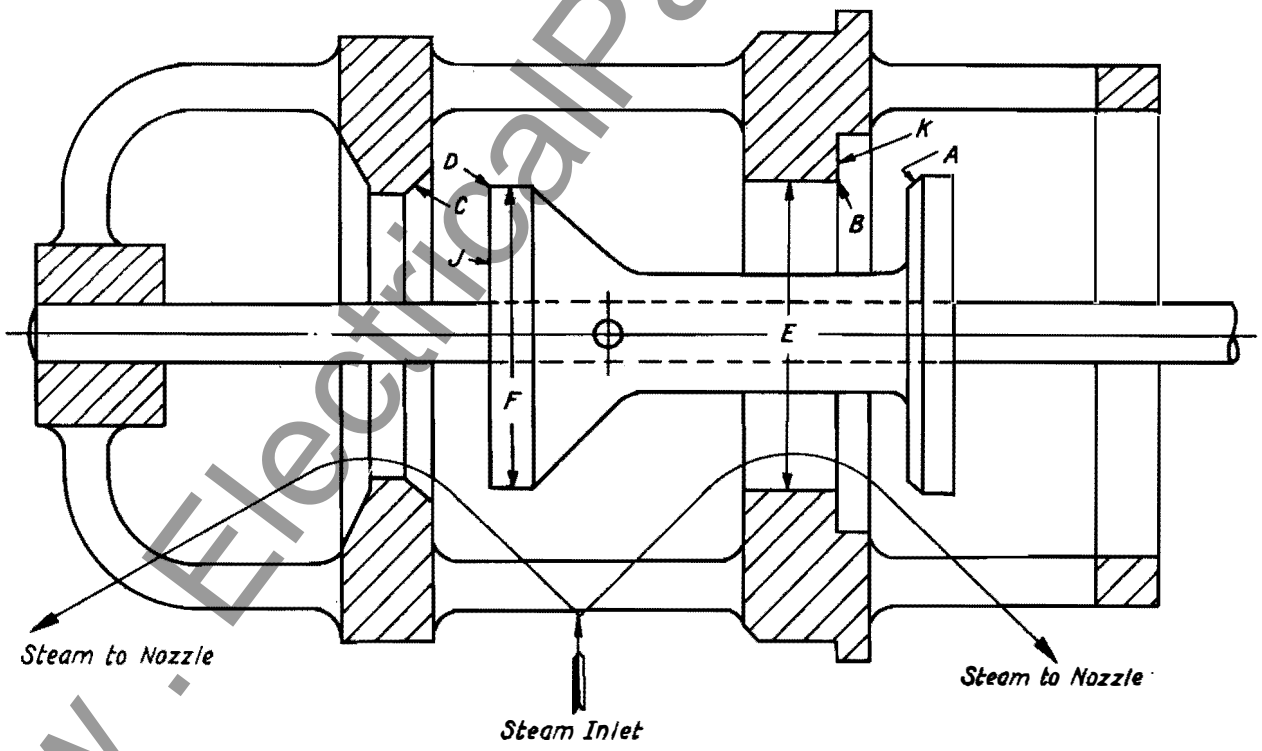

Fig. 2 - Valve and Valve Cage

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