GOVERNOR AND SPEED CHANGER

Figure 1 shows the governor, which is of the vertical shaft, centrifugal type in which the centrifugal force of the weights is opposed by the compression force of the governor spring. The governor hub which holds the weights is driven from the end of the turbine rotor shaft by bevel gears. The governor weights are secured to a strap of spring steel mounted across the diameter of a ring held by the governor hub. This spring is bent into an inverted U shape at the center and carries a spherically seated button which transmits the flexure of the spring through the governor spring seat to the governor spring and relay stem. Hence, with the governor at rest, the spring "22" holds the governor weights in their innermost position.

The complete rotating element is carried in two bearings. The upper bearing "9" is a combined radial and thrust bearing and is centered in and bolted to the main turbine bearing housing. The vertical position of the governor and also the clearance in this thrust bearing can be adjusted by means of the liners "7" which are provided back of the thrust collars. In addition, liners "16" are provided back of the governor gear (driver) for the purpose of obtaining correct alignment of the two gears. The lower bearing (not shown in the accompanying illustration) is located at the lower end of the governor spindle, in the oil pump case.

The relay "25" operates within a ported sleeve "26" so as to control the flow of high pressure oil to and from the operating cylinder. The sleeve "26" is a sliding fit in the governor housing and is connected through the follow-up linkage to the operating piston "33". Therefore, movement of the operating piston moves the sleeve "26" so as to return the relay to its neutral position after a change in speed.

The operation of the governor is as follows: - With the turbine at rest, the governor weights are held in their innermost position by the spring "22" and the governing valves are held wide open by the operating piston which is held in its lowest position by the spring "31". When the turbine speed increases to normal, the centrifugal force of the governor weights "2" exceeds the force of the governor spring "22" and the weights begin to move outward. The unit is then under control of the governor.

If the load increases, the speed decreases and the centrifugal force on the weights decreases. The governor spring, therefore, moves the weights inward and allows the relay "25" to move downward. This downward movement of the relay opens the ports which admit high pressure oil above the operating piston and connects the space below the piston to drain. The piston therefore moves downward, opening the governing valves sufficiently to maintain the required speed. As the piston moves downward, the follow-up lever moves the sleeve "26" downward, thus restoring the neutral position of the relay with respect to the sleeve.

If the load decreases, the reverse movements occur, in that the governor weights move outward, compress the governor spring "22" and move the relay upward. This uncovers the ports which admit high pressure oil below the operating piston and connect the space above to drain. The piston therefore moves upward, closing the governing valves sufficiently to maintain the required speed. Upward movement of the piston, acting through the follow-up lever, moves the relay sleeve upward until balance has again been restored.

Thus it is seen that following any relay movement the resulting movement of the operating piston moves the sleeve "26" so as to re-establish the relative position of the relay and sleeve at neutral until another change in speed (or load) occurs.

Speed Changer

The hand or motor operated speed changer, by means of which the speed or load can be varied, is shown in Figure 2. As shown, it is in its mid-position with the follow-up lever "55" in a horizontal position. The principal parts of the electrically operated portion are:- The motor "87", shaft "85", worm "84", and worm wheel "80". The principal parts of the hand operated portion are:- The handwheel "82" and shaft "78". Both the electrically operated and hand operated portions act to regulate the speed through the worm "76" and worm wheel "73" which is threaded on the support stud "75". The position of the relay sleeve "26" (Fig. 1) regulates the point at which the relay ports are opened or closed to control the speed. This sleeve is attached to the follow-up lever "55" which is fulcrumed on the yoke "72". Thus it can be seen that movement of the fulcrum point will also move the bushing a proportional amount. The support stud "75" carries the worm wheel "73" in which it is threaded, and the yoke "72".

For hand operation, rotation of the handwheel is transmitted directly through the shaft "78" to the worm "76" which meshes with the worm wheel "73", thereby moving the worm wheel and yoke "72" upward or downward on the stud "75". For motor operation, the worm "84" meshes with the worm wheel "80" and drives through the collar "81" and the handwheel "82" to the second worm "76" and worm wheel "73". The faces on the handwheel and collar "81" form a friction type clutch which is held in engagement by the spring "77". This clutch slips when the hand operated feature is used.

Exhaust Pressure Control

When either an exhaust pressure or an extraction pressure regulator is used with this governor, the regulating oil pressure delivered by the pressure regulator is connected to the governor just above the relay (as shown in section B-B, Figure 1). It therefore exerts a force downward on the relay. Hence changes in exhaust or extraction steam pressures are converted by the regulators into oil pressure changes acting above the relay, thereby changing the opening of the turbine governing valves to compensate for the changes in exhaust or extraction steam demand.

Adjustments

The governor is thoroughly tested and adjusted at the factory and should operate satisfactorily as received. However, when re-assembling the parts after an inspection or if it should become necessary to check the accuracy of the adjustments, the following points should be noted.

To Disassemble Governor:-

(a) Remove the governor linkage and follow-up linkage.

(b) Remove the sleeve "26" and relay "25".

(c) Remove the housing "1", lifting it straight upward until it clears the spring nut "24".

(d) Remove the screws on the bearing "9".

(e) Since the shaft "13" is connected to the pump gear by a spline fit, the entire rotating element can now be lifted straight up and out.

To Assemble Governor:-

The governor is assembled by the reverse order of the steps given above.

To Adjust the Governor Relay Mechanism:-

1. The bevel gears "12" and "15" are lapped together in the finishing process and three mating teeth are punch marked. When re-assembling the governor, it is important to see that the single marked tooth on one gear is meshed between the marked teeth on the other gear. (An access hole is provided in the housing through which these punch marks can be observed.)

2. Adjust the thickness of the liners "7" back of the upper collar "8" and liners "16" to bring the bevel gears "12" and "15" into correct alignment. This alignment is correct when the ends of the teeth (at the point "Y") are flush and with 3 to 5 mils back lash in the gear teeth.

3. Adjust the thickness of liners "7" back of the collar "8" to obtain 3 to 5 mils vertical clearance in the governor spindle thrust bearing. The radial clearance in this bearing also should be between 3 and 5 mils on the diameter.

4. Set the speed changer in mid-position - that is, with the lower edge of the worm wheel "73" approximately 3/64 above the shoulder on the support stud "75"; then adjust the set screw "69" so that there is a clearance of approximately 3/64 between the top of it and the lower side of the cover plate "59".

5. With the operating piston connected to the governing valves, measure the total travel of the piston. This total travel should be one and one quarter times the lift specified for the last valve to be opened. (See valve setting diagram.)

6. Then adjust the length of the follow-up rod "62" so that the lever "55" is horizontal when the piston is in its mid-position of travel.

7. Secure the lock nuts in this position.

8. Turn the speed changer handwheel counter-clockwise to the low speed limit of its travel - that is, until the lower edge of wormwheel "73" is against the shoulder on the support stud "75".

9. Admit steam to the turbine and let it operate at low speed. At this speed the operating piston should be in its lowest position.

10. Raise the sleeve "26" by loosening the relay connection nut "28" and turning the sleeve "26" in a counter-clockwise direction when looking downward, until it is assured that the piston "33" is in its lowest position.

11. Keeping the turbine speed at approximately 600 RPM, move the sleeve "26" downward (by screwing it in a clockwise direction when looking downward) until the piston "33" just starts to rise.

12. Secure the relay connection nut "28" in this position.

To Adjust the Governor:-

13. Set the speed changer in mid-position - that is, with the lower edge of the worm wheel "73" approximately 3/64 above the shoulder on the support stud "75" - then adjust the set screw "69" so that there is a clearance of approximately 3/64 between the top of it and the lower side of the cover plate "59".

14. Bring the turbine up to speed slowly, under control of the throttle valve, and note the speed maintained when under control of the governor.

15. The governor should then maintain a speed of approximately 4% above normal at no load.

16. If the speed is not correct, change the tension of the spring "22". This can be done by means of the adjusting nut "24".

NOTE: To gain access to the spring adjusting nut "24", remove the rectangular cover "37" on the side of the governor housing.

To decrease the speed, turn the nut to the right. To increase the speed, turn the nut to the left.

One complete turn of the nut will change the speed approximately 6%. It is not advisable to give this nut more than one complete turn at a time without first observing the results.

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

FIGURE 1

Item No.	Name
1	Governor Housing
2	Governor Weight
3	Governor Case Cover
4	Governor Spring Seat Button
5	Governor Weight Support (Complete)
6	Governor Hub Locknut
7	Liners
8	Governor Spindle Thrust Collar
9	Governor Spindle Bearing (Upper)
10	Cover
11	Gasket
12	Governor Gear (Driven)
13	Governor Spindle
14	Nut and Lock-Washer
15	Governor Gear (Driver)
16	Governor Gear Liners
17	Governor Hub Spacer
18	Governor Hub
19	Governor Spring Seat (Lower)
20	Governor Relay Seat
21	Governor Relay Seat Lock
22	Governor Spring
23	Governor Case
23-A	Governor Weight Stop
24	Governor Spring Adjusting Nut
25	Relay
26	Relay Sleeve
27	Relay Sleeve Connection
28	Relay Sleeve Connection Lock Nut
29	Operating Piston Rod Head
30	Gasket

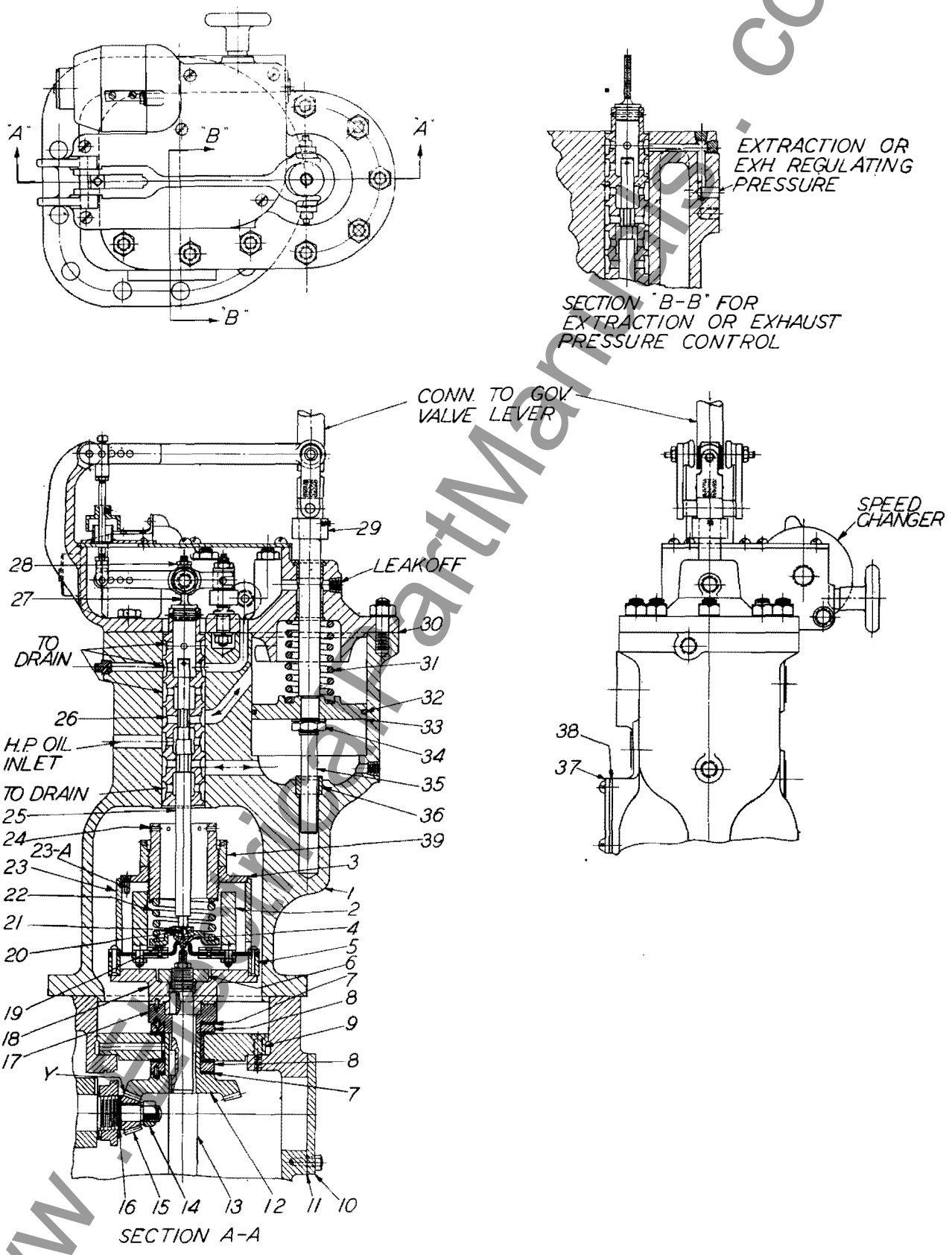

Figure 1

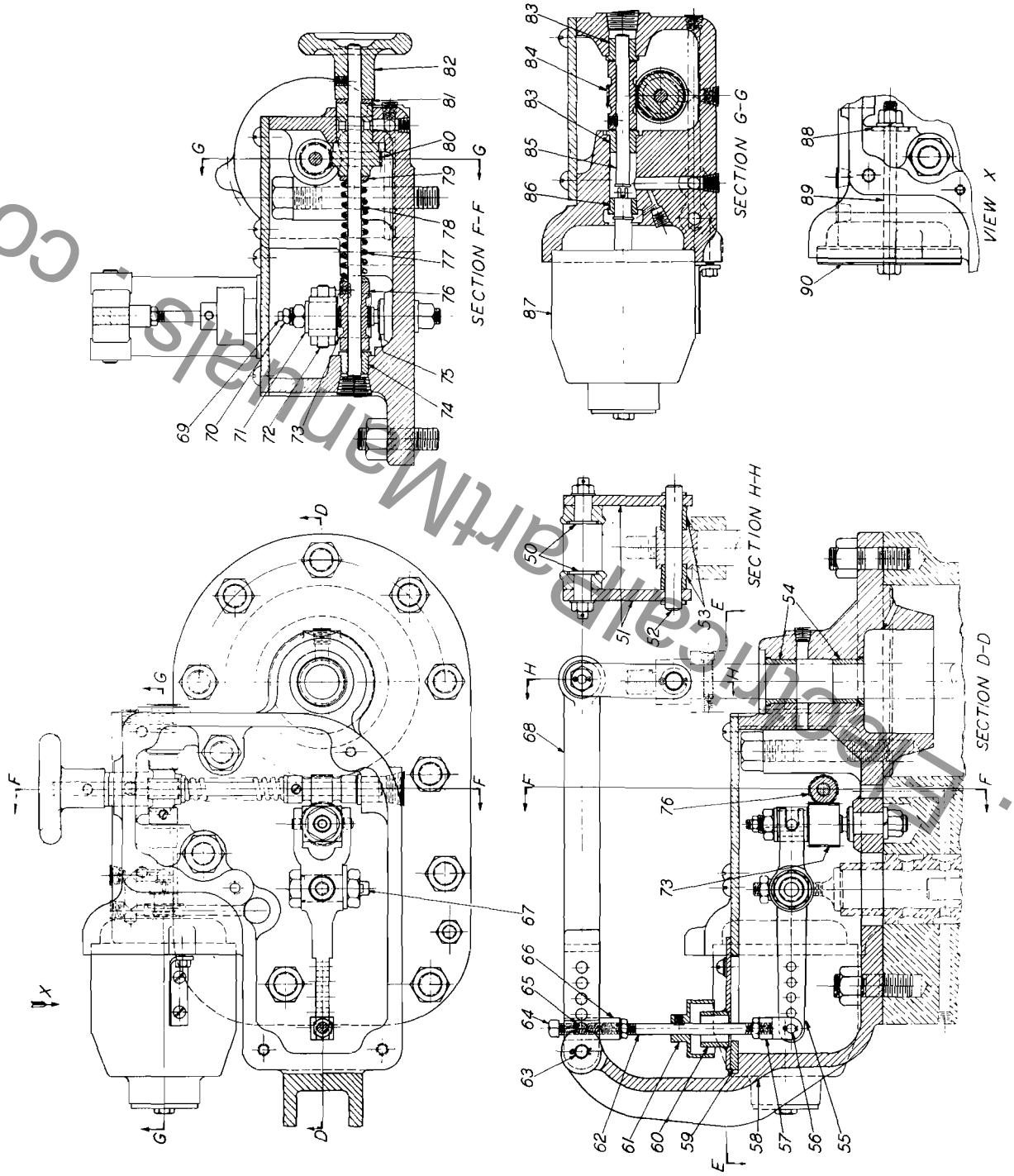

Fig. 2

FIGURE 1 - Continued

Item No.	Name
31	Operating Piston Spring
32	Operating Piston Ring
33	Operating Piston
34	Operating Piston Nut
35	Operating Piston Rod
36	Operating Piston Rod Bushing
37	Adjusting Hole Cover
38	Gasket
39	Locknut

FIGURE 2

Item No.	Name
50	Follow-up Lever Pin
51	Follow-up Lever Link
52	Follow-up Lever Link Pin
53	Follow-up Lever Link Spacer
54	Operating Piston Rod Bushing
55	Follow-up Lever (Lower)
56	Follow-up Lever Pin (End)
57	Follow-up Rod Clevis
58	Speed Changer Housing
59	Speed Changer Housing Cover
60	Follow-up Rod Adjusting Hole Cover
61	Follow-up Rod Oil Guard
62	Follow-up Rod
63	Follow-up Lever Fulcrum Pin
64	Follow-up Lever Crosshead Set Screw
65	Follow-up Lever Crosshead Pin
66	Follow-up Lever Crosshead
67	Follow-up Lever Pin (Center)
68	Follow-up Lever (Upper)
69	Speed Changer Stop Set Screw
70	Speed Changer Stop Set Screw Lock Nut
71	Follow-up Lever Yoke Support Stud Washer
72	Follow-up Lever Yoke
73	Speed Changer Worm Wheel (Low Speed)
74	Speed Changer Shaft Bushing
75	Follow-up Lever Yoke Support Stud
76	Speed Changer Worm (Low Speed)
77	Speed Changer Handwheel Clutch Spring
78	Speed Changer Shaft (Low Speed)
79	Speed Changer Handwheel Clutch Spring Seat
80	Speed Changer Worm Wheel (High Speed)
81	Speed Changer Worm Handwheel Clutch Plate
82	Speed Changer Handwheel
83	Speed Changer Shaft Bushing (Outer)
84	Speed Changer Worm (High Speed)
85	Speed Changer Shaft (High Speed)
86	Speed Changer Shaft Bushing (Inner)
87	Speed Changer Motor
88	Washer
89	Tap Bolt
90	Blank Plate