THROTTLE VALVE

This valve is of the hydraulic type and is operated by oil (or other suitable fluid). In a description, it can be divided conveniently into parts; namely, the main steam valve and the operating mechanism. To avoid confusion, the mechanism is described below with oil as the operating medium. Figure 1 shows the throttle valve complete.

Steam Valve

The steam valve is a simple arrangement, commonly called the "Double Plug Type." It consists of two single seated unbalanced valves "7" and "8", the one placed within the other. When in the closed position, as shown in Figure 1, the steam pressure above the valves combines with the operating mechanism spring load to hold each valve tightly on its seat. As shown in the enlarged view to the right of the main illustration, the valve stem "11" is machined to form a pilot valve within the inner valve. Consequently, as the stem is lifted to open the valve, this small pilot valve is opened first, substantially equalizing the pressure above and below the inner valve. Further movement of the valve stem causes the pilot valve to engage the nut "7-B" and lift the inner valve "7". When the inner valve has been lifted through its full travel, it engages the cover plate "6", and any further movement of the stem then lifts the outer valve "8". The size and lift of the inner valve are proportioned to pass sufficient steam to bring the turbine up to full speed with no load. When full speed is reached, the governing (or steam inlet) valves close sufficiently to practically balance the steam force above and below the outer valve. Very little force is required, therefore, to lift it through its entire travel.

The valve stem packing consists of closely fitting bushings with suitable leak-off openings. On valves built for pressures up to and including 400 lb. one leak-off is used and should be led to a point at atmospheric pressure where a small amount of escaping steam is not objectionable. On valves built for pressures above 400 lb., two leak-off openings are provided. The upper one should be connected to a point of lower pressure determined by the operating steam conditions, while the lower one should be connected to a point at atmospheric pressure. The bushings are made of a special material, suitable for the purpose, and are carried in mild steel sleeves "12" and "13" (as shown in the illustration) in order to facilitate their withdrawal. In general, the bushings should be installed in the sleeves at the factory and the complete assembly of sleeve and bushings should be replaced as a unit when replacement becomes necessary.

The steam strainer "5" is cylindrical in shape and is placed around the outer steam valve. This strainer can be removed for cleaning after removing the blind flange "2".

The following points should be noted in connection with re-seating these valves. The seating surfaces of the outer valve "8" and the seat "10" are machined spherically and then lapped a very small amount which gives a narrow, continuous surface of contact. If the valve and seat are in good condition but leaking slightly, they can be made tight by additional lapping provided the width of the contacting surfaces does not exceed 1/16 inch. If the width of these contacting surfaces exceeds 1/16 inch, both the valve and seat must be machined, using the same radii as on the original pieces. When machining the seat "10", after finding the correct radius, the center should be moved downward (as viewed in the illustration) in a line parallel with the axis of the seat so as to take the cut off the top and not increase the diameter of the opening through the seat. After this machining, the parts should be lapped just enough to make them tight. It should also be noted that there is no gasket between the seat "10" and the valve body. These surfaces must be ground to a steam tight joint. The seating surfaces of the inner valve and of the pilot valve are beveled and can be ground to a tight seat in the usual manner.

Operating Mechanism

The principal parts of the operating mechanism are: the operating piston "25" which is attached to the piston rod "17-A", the closing spring "24", the oil by-pass valve "23" and valve plate "29", the handwheel "37" and the handwheel shaft and bevel gears. The operating piston rod is connected to the steam valve stem by the coupling consisting of items "14", "15", "16" and "17". Consequently, the operating piston and steam valve move as a single piece. The handwheel is connected to the operating nut "21" by a shaft and bevel gear so that rotation of the handwheel gives a positive rotation of the operating nut just as if the handwheel were connected to it directly. The oil by-pass valve (shown enlarged at the right hand side of the illustration) consists of a plate type valve seat by means of which movements of the handwheel control the oil pressure acting below the operating piston. It will be noted that the valve plate "29" has two seating surfaces: The seat "X" between the valve plate and the oil by-pass valve "23" and seat "Y" between the plate and the piston cover "28". This valve plate has approximately 1/4 inch vertical movement and normally is held in its upper position by three springs "30". High pressure oil is supplied to the space below the operating piston "25". This oil is supplied by either the auxiliary or main oil pump through an orifice to restrict the flow to the proper amount.

With the operating mechanism in its closed position as shown in the Figure, high pressure oil acts upward on the operating piston "25", the valve plate "29" and the oil by-pass valve "23". However, with the handwheel in its closed position, oil by-pass valve "23" seats on the valve plate "29" thus compressing spring "30" and opening the seat "Y". Therefore, the oil flows through port openings in the valve plate, and through the seat "Y" to the drain. As the handwheel is turned counter-clockwise, the oil by-pass valve operating nut "21" rotates and moves the oil by-pass valve "23" upward. The springs "30" cause the valve plate "29" to follow the by-pass valve, keeping the seat "X" closed and also closing seat "Y". The oil pressure below, therefore, raises the operating piston, compressing the closing spring "24". During this opening movement, both seats "X" and "Y" remain closed. If the oil pressure should tend to raise the operating piston more rapidly than the oil by-pass valve is being raised, the seat "Y" will open, allowing the high pressure oil to flow to the space above the piston and thence to the drain. Therefore, the piston can rise only as fast as the by-pass valve "23" is raised. If the oil by-pass valve should be raised at a rate of speed so great that the high pressure oil supplied through the orifice is unable to raise the operating piston at the same rate, the seat "X" will open, which will allow the high pressure oil under the piston to flow to drain. The valve will, therefore, drop to its closed position. If such a case is experienced, the handwheel should be turned to its closed position, and the valve opened again more slowly.

To close the valve by hand, the handwheel is turned in a clockwise direction causing the oil by-pass valve "23" to move downward. This downward movement of the oil by-pass valve moves the valve plate "29" downward, compressing springs "30" and opening the seat "Y". This allows the high pressure oil to flow to the top and thence to the drain. With the pressure below the piston released, the closing spring "24" lowers the operating piston and steam valve. It will be noted that this feature serves also as an automatic stop in case of loss of oil pressure. If for any reason, the oil pressure should drop below a predetermined point, the spring "24" will automatically close the valve, shutting down the turbine. Also, it is impossible to open the valve until oil pressure is established, thus insuring proper lubrication of all bearings.

The closing spring "24" is sufficiently strong to overcome any friction which may be experienced and exerts a closing force on the operating piston at all times. However in case of necessity the valve can be closed manually without the help of the closing spring. The application of force at the rim of the handwheel results in the development of a greatly increased, positive, downward force in the valve operating mechanism.

It should be noted that it is not practical to take the load off the unit by closing the throttle valve. As the valve approaches its seat, the unbalanced steam force across the valve increases and at some point becomes so great that the valve will drop to its seat suddenly, thus dropping the remainder of the load. Due to this same design characteristic, this valve may drop shut if an attempt is made to open it with more than about 10% load on the generator (a condition which might be encountered if the throttle valve trips shut and the generator remains on the line). Consequently, if the throttle trips, it is advisable to open it wide before applying more than approximately 10% load.

The automatic closing is accomplished by releasing the oil pressure below the operating piston "25". As stated before, the high pressure oil supply to the piston is regulated by an orifice. Thus high pressure is established but actual oil flow is restricted. The space below the operating piston is connected to our standard overspeed trip valve, which, under normal operating conditions remains closed and maintains the high pressure oil below the piston. However, if the overspeed trip functions, the valve is opened, releasing the pressure under the operating piston "25". The line connecting the high pressure oil chamber to the drain tank through the overspeed trip valve is of considerably greater capacity than the high pressure inlet line, which fact insures a drop of pressure below the operating piston. The closing spring "24" then closes the valve in the same manner as described above. After the first downward movement of the piston, the seat "X" opens, which provides another outlet for the high pressure oil, thus further reducing the pressure under the piston and insuring a more positive closing force.

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

FIGURE 1

Item No.	Name of Part
1	Steam Strainer Body Blind Flange Stud
2	Steam Strainer Body Blind Flange
2-A	Gasket (1/32 thick)
3	Throttle Valve and Steam Strainer Body
4	Throttle Valve Stem Bushing
5	Steam Strainer Complete
6	Throttle Valve Cover
7	Inner Valve Complete
7-A	Inner Valve Seat
7-B	Inner Valve Nut
8	Throttle Valve
9	Throttle Valve Ring
10	Throttle Valve Seat

FIGURE 1 - Continued

Item No.	Name of Part
11	Throttle Valve Stem
12	Throttle Valve Stem Leakoff Bushing (Upper)
13	Throttle Valve Stem Leakoff Bushing (Lower)
14	Throttle Valve Stem Nut
15	Operating Piston Rod Coupling (Female)
16	Operating Piston Rod Deflector
17	Operating Piston Rod Coupling (Male)
17-A	Operating Piston Rod
18	Operating Cylinder Cover
18-A	Gasket (1/32 Thick)
19	Handwheel Bevel Gear Support
20	Operating Cylinder
21	Oil By-pass Valve Operating Nut
21-A	Ball Bearing
22	Oil By-pass Valve Operating Nut Lock-Nut
23	Oil By-pass Valve
24	Operating Piston Spring
25	Operating Piston
26	Operating Piston Snap Ring
27	Operating Piston Ring
28	Operating Piston Cover
28-A	Gasket (1/32 Thick)
29	By-pass Valve Plate
30	By-pass Valve Plate Spring
30-A	Gasket (1/32 Thick)
31	Handwheel Bevel Gear (Driver)
32	Handwheel Bevel Gear Washer
33	Handwheel Bevel Gear Shaft Bushing (Inner)
33-A	Gasket (1/32 Thick)
34	Handwheel Bevel Gear Shaft
35	Handwheel Support
36	Handwheel Bevel Gear Shaft Bushing (Outer)
37	Handwheel
38	Handwheel Nut
38-A	Gasket (1/32 Thick)
39	Operating Piston Rod Bushing
40	Thermometer Well

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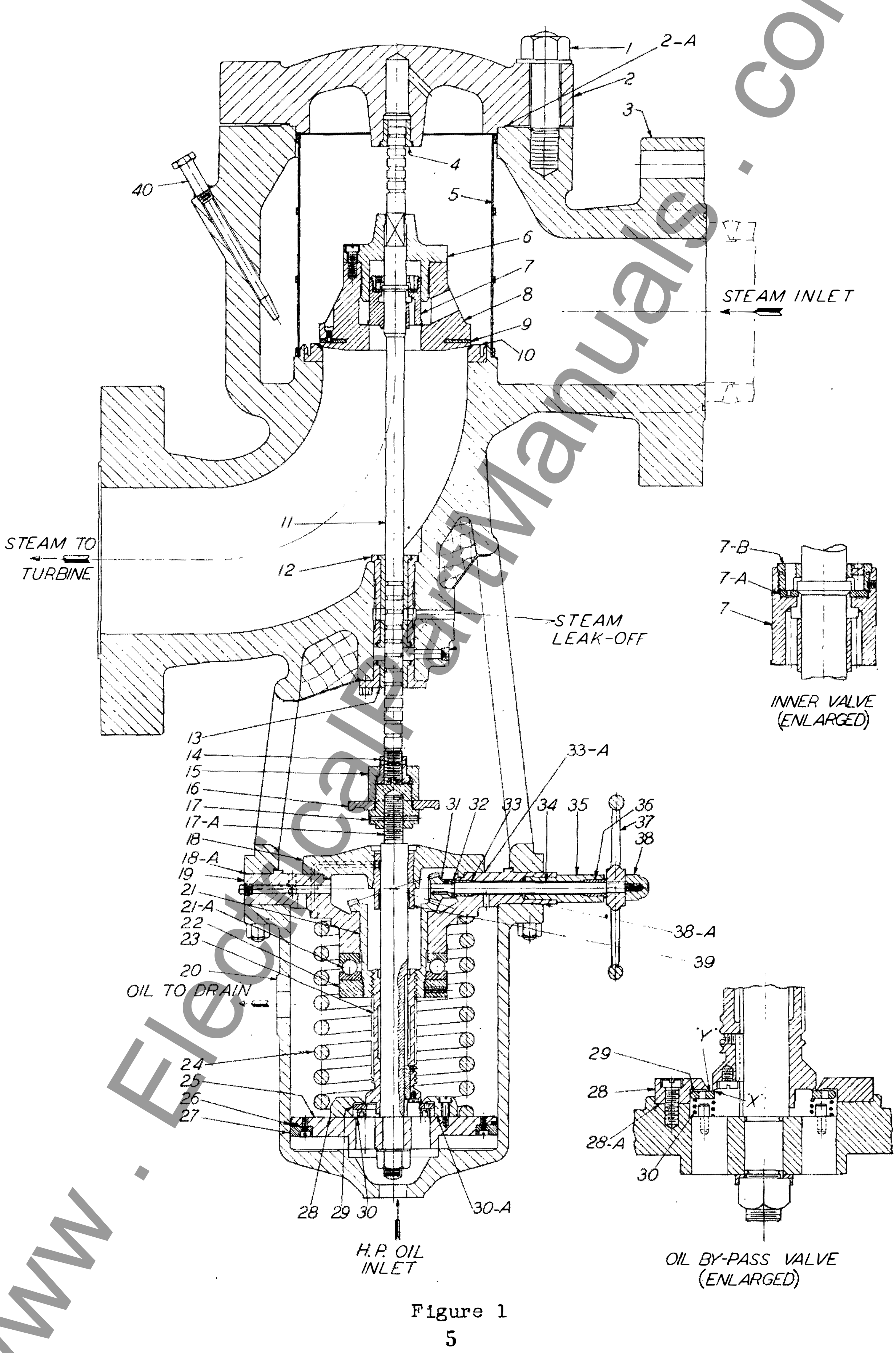

1
2-A
2
3
4
5
40
6
7
8
9
10
STEAM INLET
11
STEAM TO TURBINE
12
STEAM LEAK-OFF
13
14
15
16
17
17-A
18
18-A
19
21
21-A
22
23
20
OIL TO DRAIN
24
25
26
27
28
29
30
30-A
H.P. OIL INLET
31
32
33
33-A
34
35
36
37
38
38-A
39
7-B
7-A
7
INNER VALVE (ENLARGED)
29
28
28-A
30
Y
X
OIL BY-PASS VALVE (ENLARGED)

Figure 1