W E S T I N G H O U S E

TURBINES FOR MECHANICAL DRIVE

TYPE AMD

(WITH SPECIAL GOVERNOR)

INSTRUCTION BOOK NO. 5744

In the event that it becomes necessary to return any part of this equipment to the South Philadelphia Works, it should be tagged with the Sender's name and address and the serial number of the unit. Shipments by freight, express or parcel post should be addressed to: Westinghouse E. & M. Co.
Essington, Pa.

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY

SOUTH PHILADELPHIA WORKS PHILADELPHIA, PA.

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WESTINGHOUSE TURBINES

FOR

MECHANICAL DRIVE - TYPE AMD.

(WITH SPECIAL GOVERNOR)

GENERAL DESCRIPTION

The Westinghouse steam turbine of the mechanical drive type consists of a single wheel with blades mounted upon its periphery as shown in Figure 2. The steam chest is bolted to the cylinder base and conducts the steam to the combined nozzle block and chamber which is bolted to it. The steam expands in the nozzle, transforming the heat energy into that of velocity. Having reached its maximum velocity at the mouth of the nozzle the steam impinges upon the blades, which causes them to move forward, thus revolving the turbine wheel. By the rotation of the wheel the heat energy of the steam is transformed into work at the turbine coupling.

The velocity of the steam at the nozzle mouth is much greater than that of the blades so that after passing through the blades from the nozzle it becomes advantageous to collect the steam in a reversing chamber "5" which re-directs the steam against the wheel a second time thereby adding the energy of another pass through the blades to the turbine shaft before the steam escapes into the exhaust.

TURBINE SUPPORT

The entire turbine unit is supported on two arms cast integrally with the cylinder base, one on either side at the horizontal joint. These arms are bolted to supporting members which are in turn bolted to the bedplate.

With the cylinder supported at the centerline, it is free to expand upward or downward while the shaft remains in its original position. The position of the coupling, therefore, does not change in going from hot to cold, and vice versa, with the result that misalignment troubles are brought to a minimum.

TURBINE CASING

The turbine casing is split horizontally, with the steam and exhaust connections attached to the base, so that only the gland piping must be disconnected to raise the cylinder cover. In raising the cylinder cover it should be lifted straight up to clear the turbine rotor. Before replacing, scrape the joints clean and make up with shellac. Be sure to pull the joint down tight before the shellac hardens.

ROTATING ELEMENT

The rotating element consists of a shaft carrying the rotor, supported by two ring oiled bearings. The rotor is pressed on and keyed to the shaft "11" by the key "23" and is held from axial movement by nuts "17" (Fig. 2) which in turn are locked by lock washer "22".

One end of the shaft supports the coupling. The automatic trip and the governor are supported on the other end of the shaft overhanging the governor end bearing. The governor hub contains the automatic stop device.

NOZZLES AND REVERSING CHAMBERS

The nozzle block "1" and the reversing chamber "5" are located in the cylinder base. When assembling the turbine or checking the adjustments, the rotor should be set centrally between the nozzle and the reversing chamber. The thrust bearing should then be adjusted to hold the rotor in this position axially. The nozzle "1" is bolted to the steam chest body "71". The reversing chamber "5" is bolted to the cylinder base "3". The reversing chamber should be flush with the nozzle block and in such a position as to catch all steam emerging from the blades.

BEARINGS

The bearings are of the single oil ring, horizontally split, babbitted type. The one next to the coupling is known as the coupling end bearing, and the one next to the governor is known as the thrust bearing (or governor end bearing). Both are of the same general type, the only difference being that the thrust bearing has the ends babbitted and grooved for oil passage, thus serving as a combined radial and thrust bearing. The thrust collars "25" are secured to the shaft by being threaded on the split screw "26" and bear against the ends of the thrust bearing to hold the rotor in its correct axial position. The axial clearance (or end play) of this thrust bearing should be between .005 and .008 of an inch. This clearance can be varied by adjusting the thrust collars "25" on the thrust screw "26". It is essential that these clearances be set properly in order to obtain the best results.

GLANDS

The leakage of steam at the points where the rotor shaft passes through the cylinder is prevented by glands of the conventional carbon ring type. The gland case is split horizontally to facilitate dismantling and assembling.

The carbon rings are made in three segments to insure a good fit on the shaft and the ends are fitted so that a radial clearance of approximately .003 exists between the carbon and the shaft when cold. It is essential that the joints of the ends of the segments be perfectly square and radial to prevent leakage at these points. Each ring is carried in a separate groove and is held around the shaft by a garter spring which holds the ends of the segments tightly together. The ring is prevented from rotating by a key "16" in the casing which engages a slot in the carbon ring. If the gland is dismantled, it is important to re-assemble the segments in the same position as found originally.

When fitting the packing rings, every precaution must be taken to see that they are free to move radially in their individual grooves. If the rings are tight in the grooves, they will wear rapidly and in extreme cases may injure the shaft. The axial clearance necessary to insure this freedom of movement is approximately .017 inch.

A leak-off is provided between the two outer rings to prevent the leakage of steam past the outer ring to the atmosphere.

AUTOMATIC STOP GOVERNOR

The function of the automatic stop governor is to automatically shut down the turbine if the speed increases to approximately 10% above normal. It consists of a plunger (or weight) "50" which is set in the governor hub, perpendicular to the rotor axis. This weight is placed with its center of gravity slightly off-set so that the centrifugal force exerts

an unbalanced force tending to throw it outward. Normally, it is held in its inner position by the compression spring "52" and retainer "49".

If the speed increases to the tripping point (approximately 10% above normal), the centrifugal force of the weight overcomes the compression of the spring and the weight flies outward and strikes the trip lever "53". Movement of this lever disengages the latch plates "54" and "55". When the rod latch plate "55" is released by the trip lever, the compression spring "60" slides the rod inward, which, acting through the pin "57" and governor lever "61", closes the governor valve "69", thus shutting off the flow of steam to the turbine.

This trip can be reset by hand when the weight returns to its inner position, which occurs when the speed returns to normal or slightly below. It can be reset by pulling outward on the hand lever (which is attached to the governor lever "61") until the trip lever plate "54" again engages the latch plate "55" on the rod "59" as to hold this rod in its running position.

The turbine should be overspeeded occasionally to check the speed at which the weight flies out and disengages the trip rod. When the driven apparatus, to which the turbine is connected, is such that the load cannot be removed, it may be found difficult (or even impossible) to increase the speed to 10% above normal. In such cases it is advisable to disconnect the driven apparatus when running the overspeed test. In order to increase the speed, gradually pull outward on the lower end of the lever "61" and at the same time push inward on the governor end cover "41". The speed should be watched carefully so that it does not go much above 10% overspeed.

The trip lever "53" projects outward through the housing and forms a convenient hand trip. By merely striking this lever, the trip rod latch is released and the governor valve closes instantly, thus shutting down the turbine.

Adjustment

In order to increase the tripping speed, insert thin liners or washers "51" (.005 to .010 inch thick) between the spring retainer "49" and the end of the spring "52" so as to increase the spring compression.

In order to decrease the tripping speed, remove liners from between the retainer and the spring. In case there are no liners, grind the end of the spring squarely, just enough to obtain the desired decrease in compression.

When making these adjustments, it is important to place the liners between the retainer "49" and the spring and not between the spring and the collar on the end of the weight "50". Before making any change in the liners, the weight should be examined to see that it works freely in the housing and is not stuck by dirt or excessive wear. The linkage should be inspected to see that all parts work freely. The linkage pins should receive a few drops of oil occasionally to prevent rust and consequent sticking.

GOVERNOR

The governor is of the horizontal weight, centrifugal type, in which the centrifugal force of the weights is opposed by the compression force of the governor springs. This same principle has been used for many years but the detail construction of this governor differs materially from older types.

Referring to Figure 2, the governor hub "29" is a tight fit on the rotor shaft and is further secured to the shaft by the auto stop governor weight retainer. This hub carries the weight fulcrum blocks "30" which support the governor weights "34". Each weight "34" is made in a single piece and has machined on it the knife edge about which it pivots and a knife edge seat which works against the knife edge on the strut "31". The other knife edge on the strut works against the strut seat "33". All of these knife edges and seats are properly hardened to withstand the service to which they are subjected.

With the machine at rest, the governor weights are held in their inner position by the force exerted by the compression springs "38". These springs are secured to the shaft at the outer end and exert a force which is transmitted to the toe of each governor weight through the spring seat "45", the bearing retainer sleeve "37", the inner race of the ball bearing "35", the strut seat "33" and the struts "31".

As the speed of the turbine increases, the governor weights move outward due to the increased centrifugal force and, being fulcrumed on the blocks "30", this movement compresses the governor springs and moves the ball bearing "35" outward. As the speed decreases, the spring force moves the sleeve "37" and adjacent parts inward with the weights moving inward a corresponding amount. Therefore, the axial position of the ball bearing "35" varies with the speed. In order to transmit this governor movement to the governor valve, which controls the steam inlet, the sleeve "40" is threaded in the bearing housing so as to clamp the outer race of the ball bearing. The outer end of the sleeve is connected to the governor lever by the pin "44", thus completing the linkage. The ball bearing carries any thrust which may be exerted by the steam valve and transmits the governor movement with a minimum of friction. The governor lever is fulcrumed so that outward movement of the governor weights closes the steam valve while inward movement of the weights opens them.

Lubrication

The governor ball bearing is lubricated by oil placed in the sleeve "40". The end cap "41" should be removed and the housing filled up to the level at which it overflows past the inner ring which holds the end cap snap spring. A good grade of turbine oil should be used. Periodically (say once a week or once a month, depending on the nature of the service) the oil lever should be checked and more oil added if the level is not up to the overflow point.

To Dismantle Governor

1. Remove the governor lever "61" by removing the nut "63", pin "57" and pin "44". (Note that the spacer "43" is loose and will fall out when the pin is removed).

2. Remove the bearing and governor cover "32".

3. Loosen the set screw and unscrew the sleeve "40".

4. Mark the nut "39" and the shaft, and count the number of threads exposed so the nut can be tightened to the same point when reassembled.

5. Loosen the nut "39" until all compression of springs "38" is relieved. Note: In some cases the inner spring is omitted.

6. As the springs "38" become loose, lift out the governor weights "34". As soon as the weights are removed the struts "31" must be removed to insure their not being lost. These weights "34", struts "31" and the hub "29" should be marked so they can always be assembled in their original positions.

7. Take the nut "39" all the way off. Then the springs "38" sleeve and bearing parts can easily be taken off the end of the shaft. Note: In rare instances it may be necessary to remove the strut retainer "33"; however, in order to do this the stop screws "47" must first be removed.

To Assemble Governor

1. If the strut retainer "33" has been removed install it together with the stop screws "47".

2. Assemble on the end of the shaft in the following order: The bearing housing "36", the bearing "35", the sleeve "37", the ring "46" and the spring seat "45".

3. Then assemble the springs "38" and start the nut "39".

4. Install the struts "31", place the weights "34" in position and push inward on the spring to hold them. Note: To see if these parts operate properly, press inward on the governor spring, and at the same time pull one weight outward. Release the weight suddenly, still maintaining pressure on the spring. If the weight snaps back freely, it is correct. If a rub occurs, it can be felt. Repeat this test for the other weight, and then for both weights.

5. Tighten the nut "39" the same amount as originally found.

6. Install the sleeve "40" and lock it with the set screw.

7. Install the governor lever "61".

Adjustment

Before making any change in the governor setting, be sure that the governor valve is set correctly according to instructions under "Governor Valve".

The normal speed maintained by the governor is determined by the compression of the springs "38" and can be adjusted by means of the nut "39".

To increase the speed, tighten the nut "39".

To decrease the speed, loosen the nut "39".

One complete turn of the nut "39" will change the speed approximately 70 rpm.

GOVERNOR VALVE

The steam chest "71" which encloses the governor valve is located below and to one side of the governor and is bolted and doweled to the cylinder base.

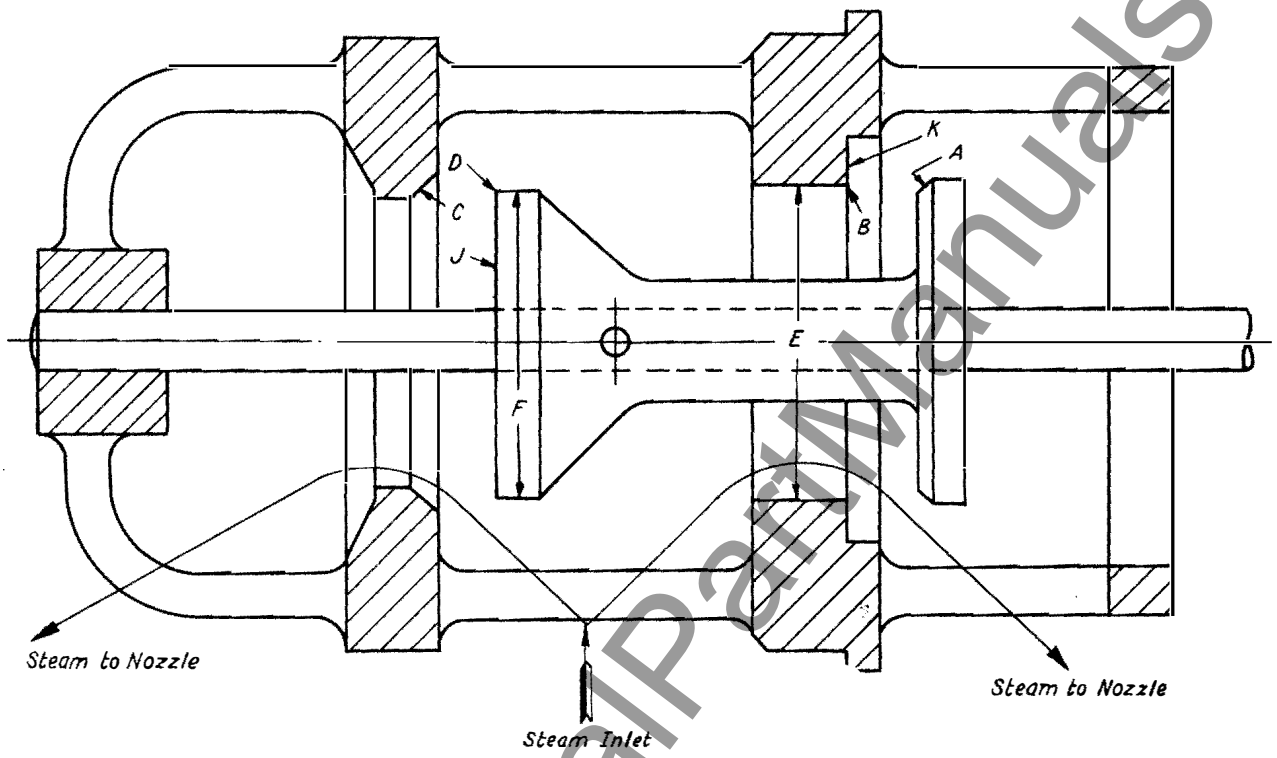

Fig. 1

The governor valve "69" is of the double seated, balanced poppet type and operates within the cage "70". The valve is pinned to the stem "62" which is guided by the cage at the inner end, and by the bushings "66" and "67" at the outer end. The spool and nut on the end of the stem engage a yoke on the governor lever so that the valve "69" opens and closes in response to movements of the governor. The valve stem spring "65" tends to eliminate lost motion between the valve and lever by constantly exerting a force in one direction. It also serves to prevent spinning of the valve.

The bushings "66" and "67" serve also to reduce to a minimum the leakage of steam along the stem. A leak-off connection is provided between the two bushings so any steam which does leak past the inner one can be led to a point where it will not be 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 must be kept smooth and free of galled spots, paint, rust and dirt. Any binding or sticking of this stem will cause unstable governor action.

Valve Adjustment

The valve travel (or lift) is very important and should never be more than 13/32 inch. In order to check this setting, remove the nut "63" and push the valve stem inward (by hand) until the valve is on its seat. Then measure the distance from the contacting face of the spool "64" to the contacting surface of the governor lever. In order to change the setting, remove the cotter pin and screw the spool "64" inward or outward to give the correct valve travel. As stated above, this travel should never be more than 13/32 inch and may be less, depending on the steam conditions. Each unit is tested and the valve travel set correctly before shipment. Therefore, it is recommended that the travel 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 set at the original factory figure.

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. Leakage is excessive if, upon being tripped by the auto stop governor, the valve permits enough steam to enter the turbine to prevent its coming to rest without load. If it should be found necessary to re-seat the valve, the following procedure should be followed (refer to Figure 1):- 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° 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 between lathe centers and remove sufficient metal from the face "J" to obtain a clean surface and then machine surface "A" at an angle of 45° 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" and "D" with "C". Machine sufficient metal off "A" if "A" and "B" are contacting; or off "C" 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 easily be bumped out of the steam chest. Likewise, the steam chest should be heated when installing the cage in order to avoid galling the press fit.

CARE OF THE TURBINE

1. Keep machine clean.
2. Keep bearing reservoirs well filled with good quality, clean oil.
3. Keep governor sleeve filled to the proper lever with good quality, clean oil.
4. Wash out bearing cavities with kerosene and refill with clean oil every three or four months.
5. If steam is contaminated with boiler compound or sludge, clean off governor valve stem as often as necessary to keep it working freely.
6. The automatic stop should be tripped occasionally to see that it is in working order.

INSPECTION

A thorough inspection of all parts of the turbine should be made once a year, renewing such parts as may show undue wear. If heavy wear of any part is evidenced, the cause of the wear should be ascertained if possible, and in any case replacement of the part should be made before failure, as this will be cheaper than a future shut down.

CAUSES FOR GOVERNOR HUNTING

1. Too great a travel of governor valve.
2. Sticking of governor valve stem in bushings.
3. Sticking of governor spindle.
4. Bent valve stem.
5. Broken governor weight knife edge.
6. Distorted or bent governor linkage.
7. Weakening of governor spring.

CAUSES FOR FAILURE OF TURBINE TO COME UP TO SPEED

1. Low boiler pressure.
2. Steam line clogged.
3. Nozzle throat plugged by foreign matter.
4. Governor speed set too low.
5. Too small valve travel or valve stem binding.
6. Wet steam.

CAUSES FOR VIBRATION

1. Misalignment or worn coupling.
2. Steam and exhaust pipe straining turbine.
3. Bent shaft.
4. Coupling running out of true.
5. Governor running out of true.
6. Bearings badly worn.

REPAIR PARTS

The list of parts shown on the following pages are made up for your convenience in ordering repair parts. To order a spare part, give the serial number of turbine, and name and number of the part desired. Due to the necessity of avoiding interruption in service, it is well to carry a number of spare parts on hand. Carrying such a stock will also avoid a delay in shipment at a time when parts are most needed.

We recommend that the following spare parts be carried for each machine:

1 - Set of bearings.

1 - Governor thrust bearing.

1 - Governor valve and cage.

1 - Set of gland packing.

In the event that it becomes necessary to return any part of this equipment to the South Philadelphia Works, it should be tagged with the sender's name and address, and serial number of the unit and shipped by freight, express or parcel post to:

Westinghouse Electric & Manufacturing Company
South Philadelphia Works
Essington, Pa.

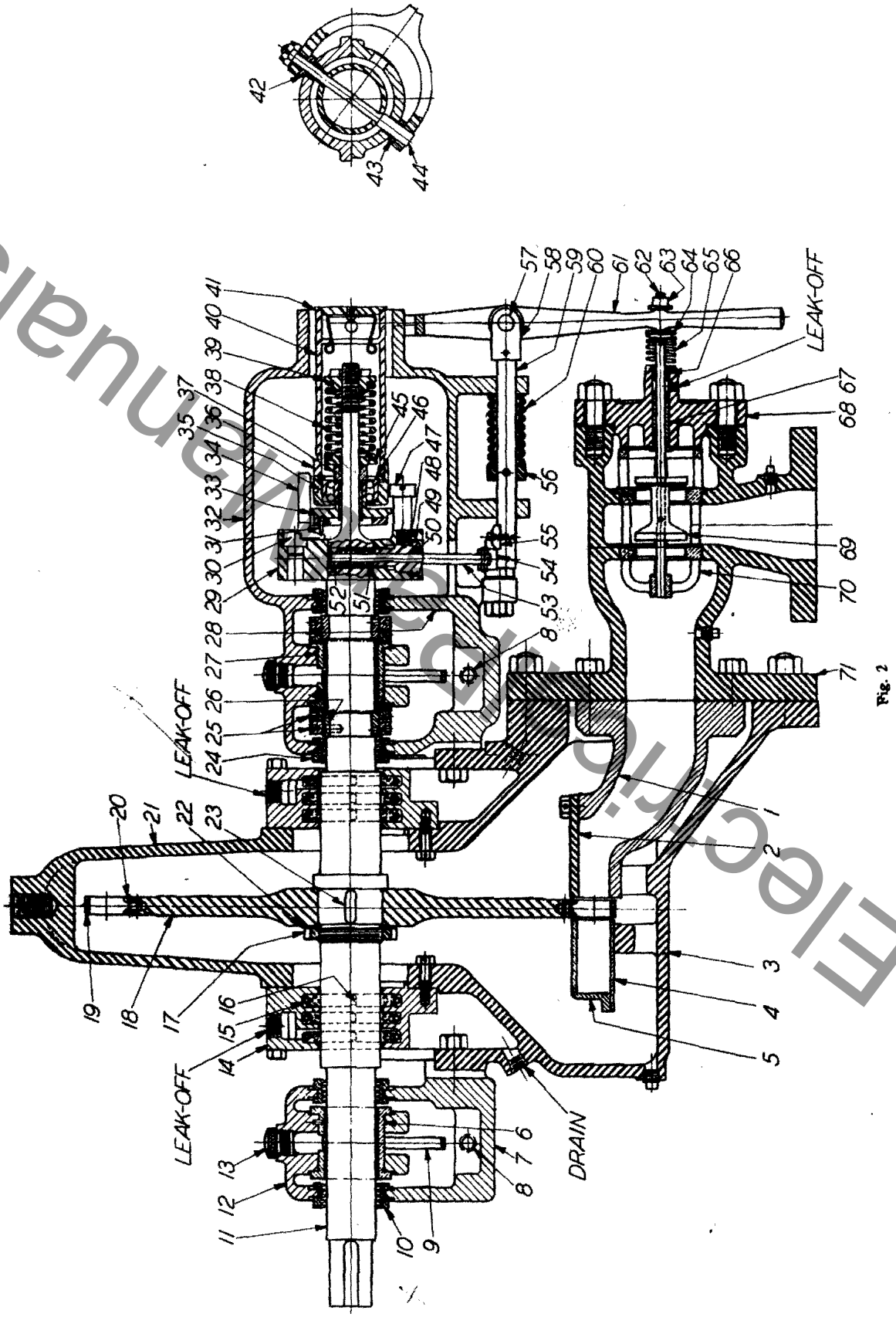

Fig. 2

LIST OF PARTS

Item No.	Name of Part
1	Turbine Nozzle Block
2	Turbine Nozzle Block Cover
3	Turbine Cylinder Base
4	Turbine Reversing Chamber Cover
5	Turbine Reversing Chamber
6	Turbine Bearing (In Halves) (Coupling End)
7	Turbine Bearing Bracket (Coupling End)
8	Turbine Bearing Bracket Oil Gauge With Drain Cock
9	Turbine Bearing Oiling Ring
10	Turbine Bearing Bracket Oil Seal Ring (In Halves) (Coupling End)
11	Turbine Rotor Shaft
12	Turbine Bearing Bracket Cover
13	Turbine Bearing Bracket Cover Sight Hole Plug
14	Turbine Cylinder Gland Case (Complete)
15	Turbine Cylinder Gland Packing Ring (Complete)
16	Turbine Cylinder Gland Packing Ring Stop
17	Turbine Rotor Nut
18	Turbine Rotor
19	Turbine Rotor Blade
20	Turbine Rotor Blade Pin
21	Turbine Cylinder Cover
22	Turbine Rotor Shaft Lock Washer
23	Turbine Rotor Shaft Key
24	Turbine Bearing Bracket Oil Seal Ring (In Halves) (Governor End)
25	Turbine Rotor Shaft Thrust Collar
26	Turbine Rotor Shaft Thrust Screw
27	Turbine Bearing (In Halves) (Governor End)
28	Turbine Bearing Bracket (Governor End)
29	Turbine Governor Hub
30	Turbine Governor Weight Fulcrum Block
31	Turbine Governor Weight Strut
32	Turbine Bearing Bracket Cover (Governor End)
33	Turbine Governor Weight Strut Seat and Retainer (Complete)
34	Turbine Governor Weight
35	Turbine Governor Thrust Bearing
36	Turbine Governor Thrust Bearing Housing
37	Turbine Governor Thrust Bearing Retainer Sleeve
38	Turbine Governor Spring
39	Turbine Governor Spring Adj. Nut
40	Turbine Governor Sleeve
41	Turbine Governor End Cover
42	Turbine Governor Lever Fulcrum Pin Spacer
43	Turbine Governor Lever Fulcrum Pin Spacer Ring
44	Turbine Governor Lever Fulcrum Pin
45	Turbine Governor Spring Seat
46	Turbine Governor Thrust Bearing Retainer Ring
47	Turbine Governor Stop Stud
48	Turbine Auto Stop Governor Retainer Lock
49	Turbine Auto Stop Governor Retainer
50	Turbine Auto Stop Governor Weight
51	Turbine Auto Stop Governor Spring Adjusting Liners
52	Turbine Auto Stop Governor Spring
53	Turbine Auto Stop Governor Trip Lever
54	Turbine Auto Stop Governor Trip Lever Latch Plate
55	Turbine Auto Stop Governor Lever Rod Latch Plate
56	Turbine Auto Stop Governor Lever Rod Collar

LIST OF PARTS - Continued

Item No.	Name of Part
57	Turbine Auto Stop Governor Lever Rod Fulcrum Pin
58	Turbine Auto Stop Governor Lever Rod Clevis
59	Turbine Auto Stop Governor Lever Rod
60	Turbine Auto Stop Governor Lever Rod Spring
61	Turbine Governor Lever
62	Turbine Governor Valve Stem
63	Turbine Governor Valve Stem Nut
64	Turbine Governor Valve Stem Spool
65	Turbine Governor Valve Stem Spring
66	Turbine Steam Chest Body Cover Bushing (Outer)
67	Turbine Steam Chest Body Cover Bushing (Inner)
68	Turbine Steam Chest Body Cover
69	Turbine Governor Valve
70	Turbine Governor Valve Cage
71	Turbine Steam Chest Body

MEMORANDUM

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