Jan. 20, 1931. R. BIRMANN 1,789,861

CONTROLLING MEANS FOR TURBINES

Filed Oct. 16, 1928 4 Sheets-Sheet 1

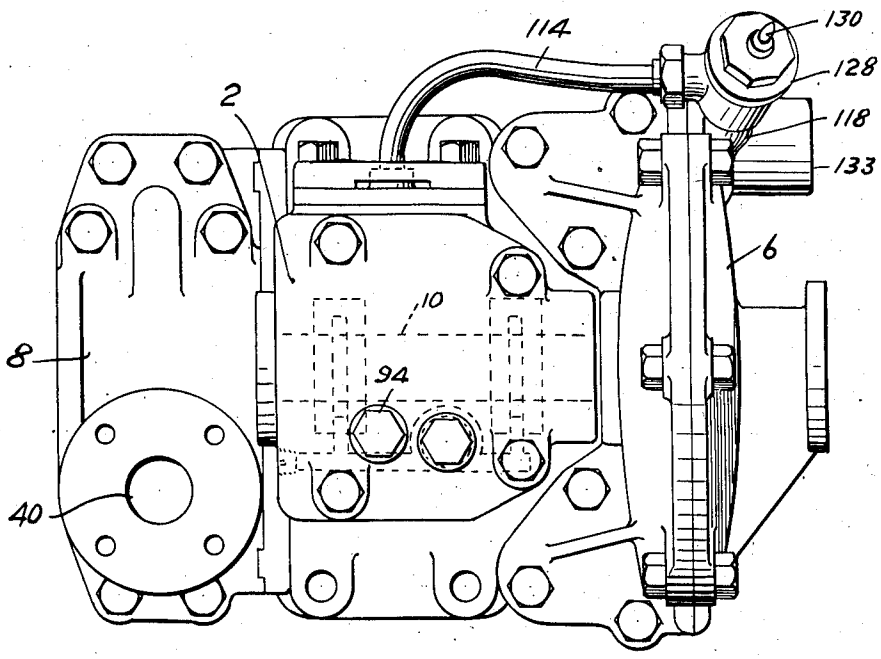



FIG. 1.

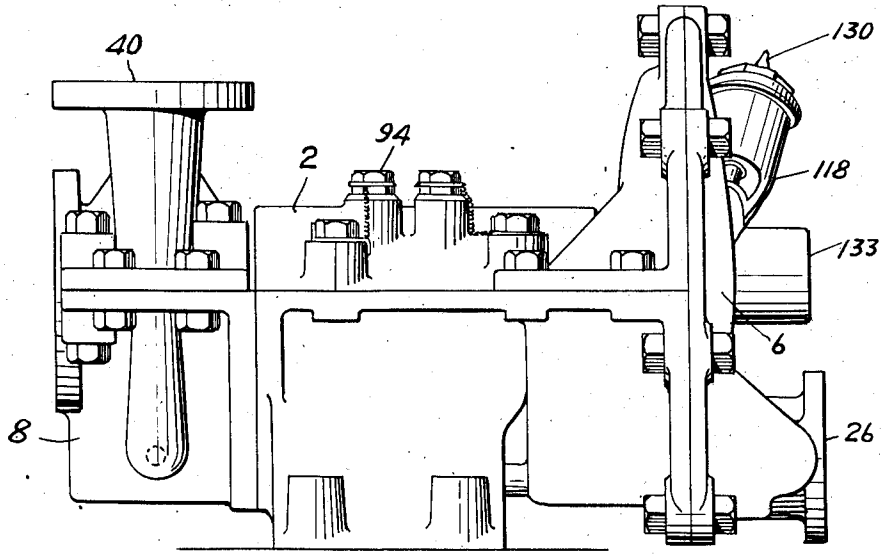



FIG. 2.

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CONTROLLING MEANS FOR TURBINES

Filed Oct. 16, 1928 4 Sheets-Sheet 2

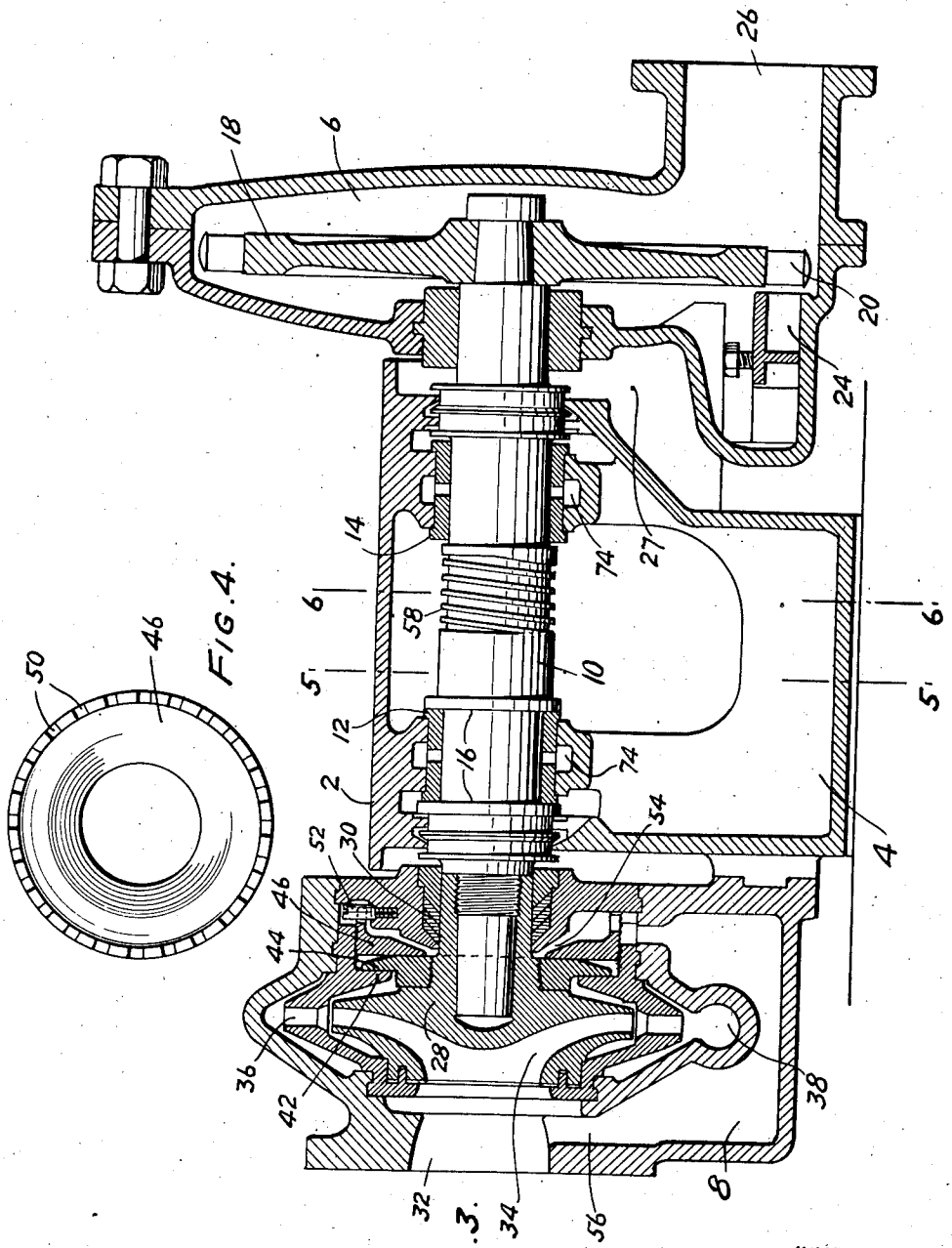



FIG. 3.




FIG. 4.

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CONTROLLING MEANS FOR TURBINES

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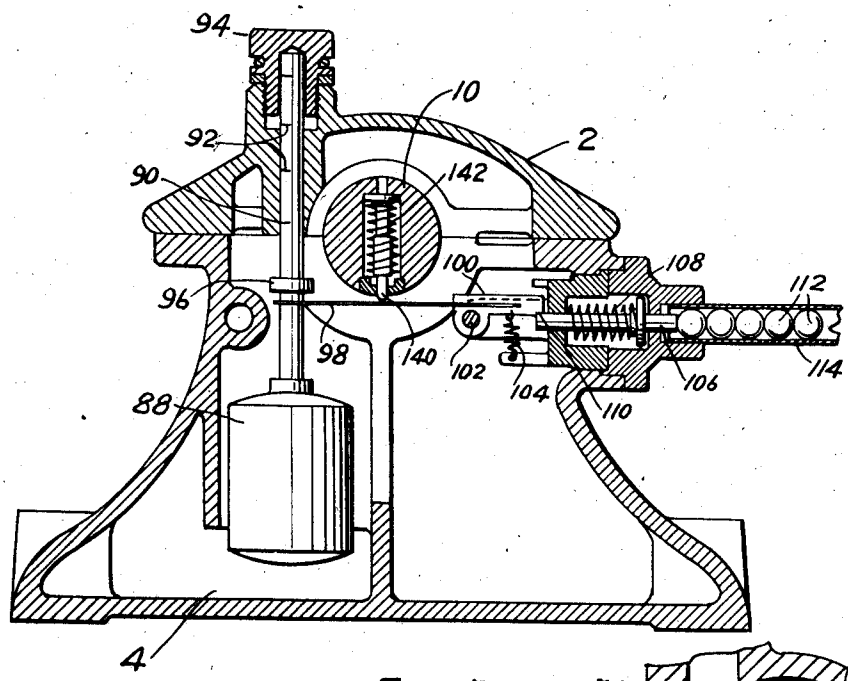



FIG. 5.

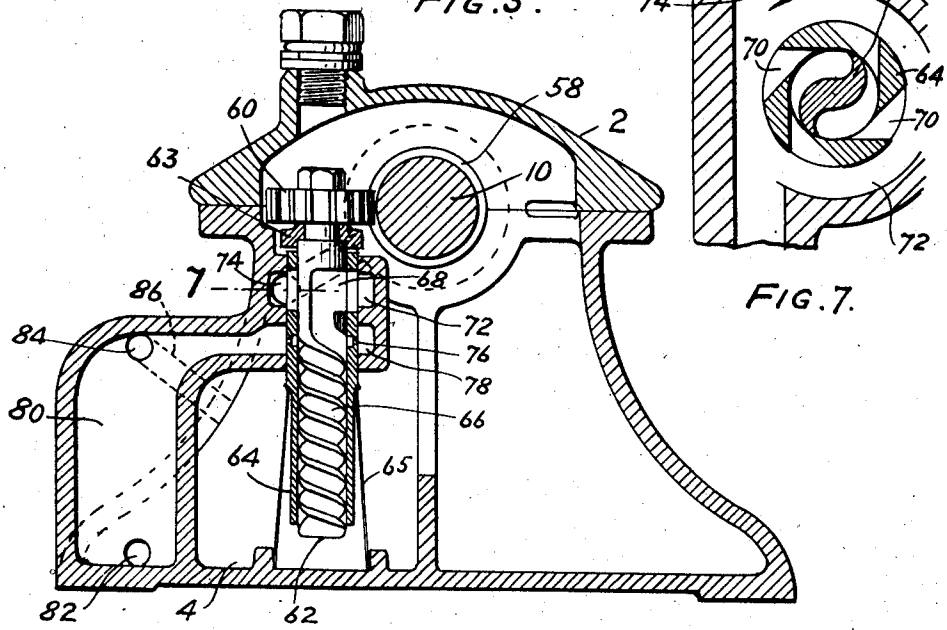



FIG. 6.




FIG. 7.

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CONTROLLING MEANS FOR TURBINES

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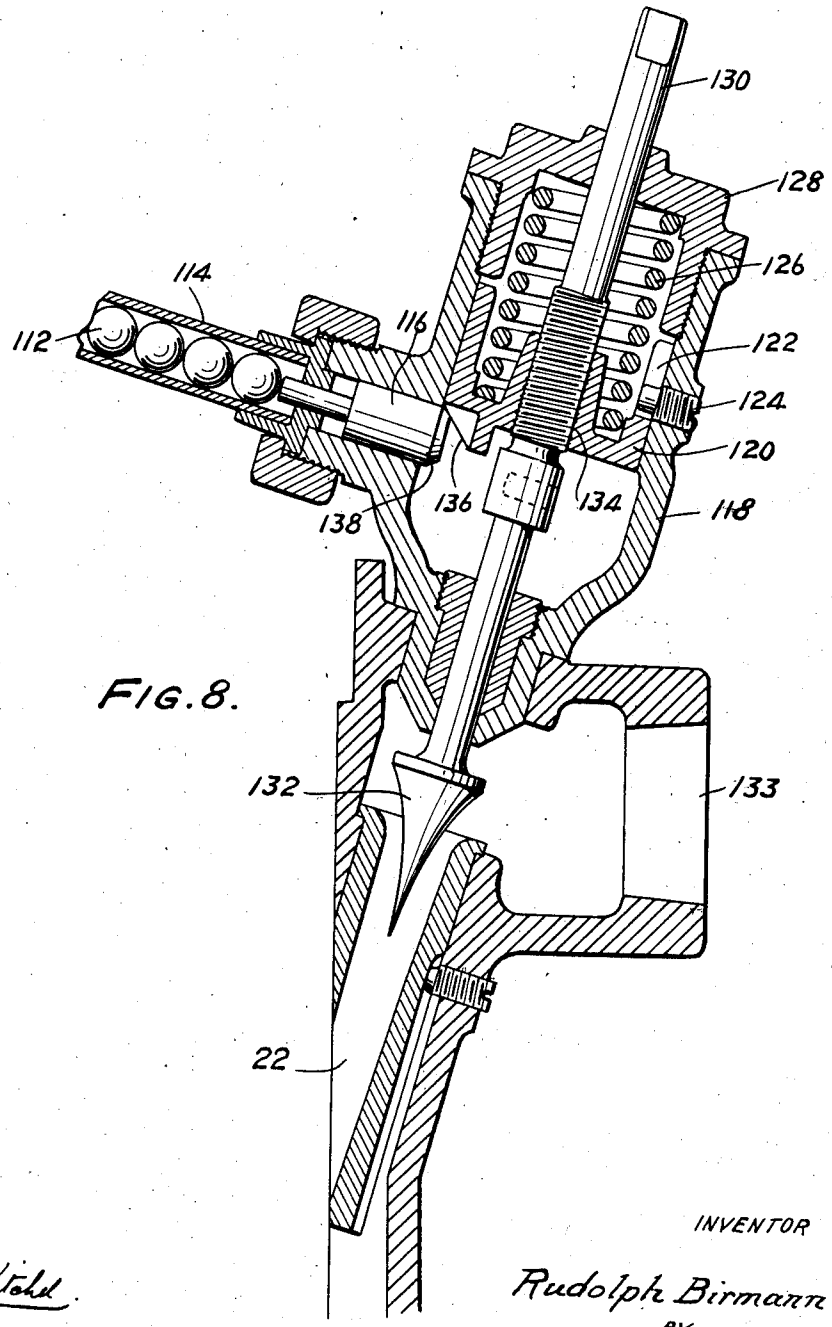



FIG. 8.

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Patented Jan. 20, 1931 1,789,861

# UNITED STATES PATENT OFFICE

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## CONTROLLING MEANS FOR TURBINES

Application filed October 16, 1928. Serial No. 312,767.

This invention relates to a boiler feed pump particularly adapted to locomotives and controllable from the cab thereof. More specifically, it refers to a turbine driven impeller adapted to impart to feed water the pressure necessary to feed the boiler. While various improvements are described with reference to a feed pump of this character their broader application to turbines in general, or other machines, will be obvious.

Heretofore turbines have been provided with means in the throats of their nozzles for properly relating the throat area and expansion ratio, the means employed being fixed and governing being accomplished by a valve in the steam line.

One object of the present invention is, accordingly, the provision of means which may be used not only for regulating the flow through the nozzle to obtain maximum efficiency but also for governing thus eliminating losses due to throttling in the ordinary governing valve.

A further object relates to an emergency tripping mechanism adapted to stop the turbine and more particularly to a tripping mechanism particularly adapted to close the valve referred to above. The provisions of means for effecting such tripping both manually, upon diminution of the oil supply and at excessive speed, form more specific objects of the invention.

Another object is the provision of a combined oil gauge and tripping device.

Further objects relating to improvements of specific portions of the mechanism will be apparent from the following description read in conjunction with the accompanying drawings.

In the drawings:

Fig. 1 is a plan view of the pump;

Fig. 2 is a front elevation thereof;

Fig. 3 is a vertical section through the main shaft;

Fig. 4 is an elevation of the adjustable leak-off ring;

Fig. 5 is a section on line 5—5 of Fig. 3;

Fig. is a section on line 6—6 of Fig. 3;

Fig. 7 is a section on line 7 of Fig. 6; and

Fig. 8 is a section through the steam nozzle and governing means therefor.

The casing in which the operating parts are enclosed is designated generally by numeral 2 and consists of three chambers, namely, an oil chamber 4, a turbine chamber 6, and an impeller chamber 8. The body portions of these chambers are preferably formed as a single casting, chambers 4 and 8 being provided with top covers and chamber 6 being provided with an end cover carrying the steam nozzle.

Shaft 10 on which the turbine and impeller wheels are mounted, is carried in split bearings 12 and 14 within the oil chamber, these bearings being provided with suitable oil grooves supplied with oil under pressure in a manner described below. Rings 16 on shaft 10 engage the ends of bearing 12 preventing excessive endwise play of the shaft while permitting a slight movement to allow balance of the parts at the impeller in a manner to be described.

Secured on one end of shaft 10 within chamber 6 is a wheel 18 provided with blades 20 of the usual type, receiving steam through nozzle 22. A reentry nozzle 24 is carried by the casing to redirect steam through the blades and exhaust 26. A suitable packing, not shown in detail, is of course used to prevent escape of steam where the shaft passes through the casing wall. It will be noted that a space 27 open to the atmosphere is provided between chambers 4 and 6 to minimize leakage of steam into the oil chamber. Suitable oil collecting rings are provided on shaft 10 where it leaves chamber 4 to prevent loss of oil.

Threaded on the end of the shaft opposite the turbine is an impeller wheel 28, the hub of which is rotatable within packing 30 held in place by a suitable gland. The impeller wheel draws water through a supply conduit 32 into passages 34 and discharges through diffusing ring 36 into volute 38 communicating with the exit 40. The diffusing ring, which is held stationary in the casing, has an inwardly extending annular flange 42 forming a stationary fixed balancing disk. Facing this disk is a revolving balancing ring 44,

carried by the hub of the impeller wheel, which at its opposite face cooperates with an adjustable stationary leak-off ring 46, shown in elevation in Fig. 4. This leak-off ring is threaded into the stationary diffusing ring 36, as shown in Fig. 4, and is provided with a cylindrical flange 48 provided with slots 50. A set screw 52 is arranged to pass through a suitable slot into a fixed portion of the casing to prevent rotation of the ring.

During operation of the impeller, the intake suction and steam pressure tend to move the impeller wheel, shaft and turbine wheel to the left as viewed in Fig. 3. As will be noted from this figure, the discharge of the impeller communicates with the opposed plane faces of disk 42 and ring 44, so that these faces will be forced apart by the discharge pressure causing movment of the impeller to the right and permitting escape of water over the periphery of ring 44. When such escape takes place, pressure may build up at the right of ring 44 balancing the pressure at the left thereof and permitting movement of the impeller to the left. As soon as such movement takes place, the liquid to the right of ring 44 leaks between the opposed plane faces of rings 44 and 46 and through passages 54 and 56 to the discharge. An equilibrium position is thus attained, the distances between rings 42 and 44 and rings 44 and 46 becoming so related as to maintain a continuous flow of liquid therethrough thus maintaining ring 44 out of contact with ring 42 and providing a thrust bearing for the impeller and its associated rotating parts. In order to permit this balancing, the clearance between bearing 12 and rings 16 is made larger than the range of axial movement of ring 44.

The adjustable construction of ring 46 provides for ready and exact initial assembling and adjustment for wear. In order to obtain proper clearance in assembling, ring 46 may be screwed inwardly until the three rings are brought into engagement. By then backing off ring 46 by turning it a distance corresponding to a definite number of notches 50 and inserting screw 52, the proper clearance is obtained. A turn of the ring through an angle corresponding to that between adjacent notches corresponds to a definite axial movement of the ring so that the clearance may be readily determined.

In order to supply lubricant under pressure to the bearings, an oil pump is enclosed within the lubricant chamber and driven from the main shaft. To this end, the shaft is provided with a worm 58 meshing with a worm wheel 60 to which the rotor 62 of the pump is secured, being journalled in a suitable bearing 63. A pump housing 64 consisting of a tube, is mounted in spaced relationship to the bottom of the chamber and is surrounded at its lower end by a filter screen 65. The pump rotor has its lower portion formed as a screw 66 rotatable within the tube while its upper portion is formed with impeller blades 68 adapted to discharge through diverging passages 70 in tube 64 into an annular passage 72 formed in a boss in the wall of the lubricant chamber. Passage 72 communicates through passages 74 in the chamber casting with holes in bearings 12 and 14, as shown in Fig. 3, which serve to distribute the oil in the lubricant grooves.

The combination of the screw lift 66 with the centrifugal impeller 68 is found to be of particular advantage in an oil pump. Because of the high speed of operation, centrifugal pumps for lubricating oil heretofore used in turbines have been found very unreliable because of the tendency to "dig themselves dry" or to stop delivering oil because of foaming. In such pumps the oil was drawn in under vacuum.

In the construction disclosed, on the other hand, the oil is delivered to the impeller under pressure, the pressure being increased by the impeller to the necessary degree to insure proper lubrication. It is found that, by the use of the screw lift, whereby the production of a vacuum is prevented at the intake of the impeller, not only is the pump positively self-priming, but the objections to the use of a centrifugal pump above referred to are completely avoided, there being no tendency to draw air from the surface of the oil or to produce foaming.

Besides operating as a pump, the device just described is made to function as a separator of water from the oil in case any steam should leak in from the turbine and condense therein. For this purpose, an annular groove 76 is formed in the interior of tube 64 at the top of the screw 66. A plurality of small holes connect this groove with an outer passage 78 communicating with a receptacle 80. As a mixture of oil and water is pumped upwards by the screw a rotary motion is imparted thereto. Water being heavier than oil, it is thrown outwardly to the walls of the tube and passes into groove 76 and thence into receptacle 80 where it separates by gravity from the oil and may be drawn off by opening a stopcock connected to a passage 82. The oil overflows from the receptacle through passage 84 back to the lubricant chamber as indicated at 86.

Since the mechanism must not operate without lubricant, a combined means for giving visual indication of the amount of oil in the chamber and for automatically stopping the machine in case of excessive diminution of the oil supply is provided. This means comprises a float 88 provided with an upwardly guided stem 90 containing indicating marks 92 and normally pressed down by and received within a cap 94. Upon removal of the cap, the float will rise in the oil until floating on the surface and the amount of oil

may be ascertained by observation of the mark on the stem at a determined height. To effect stopping of the pump when the oil level drops to a dangerous degree which might result in failure of the pump to properly lubricate the bearings, a collar 96 is provided on stem 90, normally positioned above a spring arm 98, the bifurcated end of which embraces the stem. Arm 98 is carried by a latch member 100 pivoted at 102 to the casing and urged by spring 104 in a clockwise direction as viewed in Fig. 5. Upon drop of oil level below a predetermined degree the weight of the float through collar 96 will depress arm 98 and trip latch 100.

Slidably mounted in the casing wall is a rod 106 which is urged outwardly by means of a spring 108 and is normally prevented from inward movement by engagement within a notch 110 in latch member 100. The outer end of rod 106 contacts with the first of a series of balls 112 contained in a tube 114 which, as shown in Figs. 1 and 8, extends to the housing of the turbine nozzle valve The last ball of the series contacts with the outer end of a plunger 116 which is mounted to slide in the wall of valve housing 118.

Within a cylindrical bore in housing 118 slides a bushing 120 provided with a slot 122 in which engages a pin 124 to prevent its rotation. A spring 126 between the bushing and cap 128 tends to move the bushing inwardly. A valve stem 130 carrying a needle valve 132, for controlling the flow of steam from 133 through the nozzle, is threaded as at 134 through the bushing. The underside of the bushing is provided with a cam face 136 engaging the bevelled edge of plunger 116.

Attention may be called to the nozzle and needle valve associated therewith. Heretofore it has been customary to use a valve arrangement of this type which simultaneously changes the throat area and the expansion ratio, but such valve has been used for permanently changing the throat area and expansion ratio, a separate valve being used for governing. Since the ordinary governing valve always more or less throttles the steam there was always a loss of useful energy.

In the present construction the nozzle regulating valve is used directly as a governing valve, being operated through a series of shafts and universal joints connected to stem 130 and leading to the engineer's cab. The use of a single valve in the steam line to the turbine results in maximum steam economy at all loads with greatest simplicity of operation, since full steam pressure is maintained at the throat of the nozzle.

A further advantage of the valve which makes it particularly adapted for emergency tripping is its lightness since the steam at the nozzle has a high velocity and consequently the valve may be small without producing throttling such as occurs when a separate small governing valve is used in the steam line. In fact, for anything approaching satisfactory operation with a separate governing valve, the valve must be seven to ten times the size of the valve described herein.

Assuming the pump to be operating, the bushing being retained in the position of Fig. 8 by plunger 116 so as to maintain the valve open, if depression of arm 98 occurs, latch 100 releases rod 106 and plunger 116, balls 112, and rod 106 are moved to the left against light spring 108 by the cam action of 136 under spring 126. Bushing 120 moves downwardly carrying with it needle valve 132 thus closing the nozzle.

If it is now desired to reset the valve, the engineer turns stem 130 in the direction in which it would be turned to normally close the valve. Since the valve is already seated in the nozzle throat, the result of such turning will be raising of bushing 120. As soon as cam 136 clears plunger 138, the plunger will be moved inwardly by spring 108 which will be latched by member 100. If now the stem is rotated in a direction to open the valve, bushing 120 will be held up by plunger 138 and the valve may be opened to the desired degree.

The movable bushing has a further function in preventing excessive tightening of the needle valve on its seat which might result in its destruction, since the valve would not normally be tightened to a pressure greater than that of spring 126 unless, of course, excessive turning was resorted to.

The tripping mechanism may be set into operation manually by removing cap 94 and depressing rod 92 by hand.

The emergency tripping means described above may also be set into operation by a plunger 140, eccentrically weighted, and slidably mounted in shaft 10 overlying arm 98. This plunger will move outwardly at excessive speeds against the pressure of spring 142 to contact with arm 98 and thus trip latch 100.

The impeller balancing means disclosed herein forms the subject matter of an application filed by Arvid Peterson on October 3, 1928, Serial No. 309,909. The oil pump and lubricating system are described and claimed in a division of this application filed October 16, 1928, Serial No. 312,768.

What I claim and desire to protect by Letters Patent is:

1. In a turbine, a rotor, a nozzle for directing fluid to drive said rotor, a valve for controlling flow of fluid through the nozzle, a lubricant chamber, a float in said chamber, and means operable upon depression of the float to close said valve to stop the flow of fluid through the nozzle, said float having a stem extending outside said chamber to indi-

cate the lubricant level therein and adapted for manual actuation to depress the float.

2. In a turbine, a rotor, a nozzle for directing fluid to drive said rotor, a bushing capable of movement in the direction of the axis of the nozzle, said bushing being yieldingly urged towards the throat of the nozzle, a tapered plug valve adjustable in the bushing in the direction of the nozzle axis to control the flow of fluid through the nozzle, a cam surface carried by the bushing, a plunger movable across the path of said cam surface, and a latch normally holding said plunger in the path of said cam surface to limit movement of the bushing towards the throat of the nozzle, tripping of said latch permitting the bushing to force said plunger out of the path of said cam surface to permit the bushing to carry the plug valve to a seated position at the nozzle throat to stop the flow of fluid through the nozzle.

3. In a turbine, a rotor, a nozzle for directing fluid to drive said rotor, a bushing capable of movement in the direction of the axis of the nozzle, said bushing being yieldingly urged towards the throat of the nozzle, a tapered plug valve adjustable in the bushing in the direction of the nozzle axis to control the flow of fluid through the nozzle, a cam surface carried by the bushing, a plunger movable across the path of said cam surface, a latch normally holding said plunger in the path of said cam surface to limit movement of the bushing towards the throat of the nozzle, tripping of said latch permitting the bushing to force said plunger out of the path of said cam surface to permit the bushing to carry the plug valve to a seated position at the nozzle throat to stop the flow of fluid through the nozzle, and means automatically operable when the speed of the rotor increases beyond a predetermined limit to trip said latch.

4. In a turbine, a rotor, a nozzle for directing fluid to drive said rotor, a bushing capable of movement in the direction of the axis of the nozzle, said bushing being yieldingly urged towards the throat of the nozzle, a tapered plug valve adjustable in the bushing in the direction of the nozzle axis to control the flow of fluid through the nozzle, a cam surface carried by the bushing, a plunger movable across the path of said cam surface, a latch normally holding said plunger in the path of said cam surface to limit movement of the bushing towards the throat of the nozzle, tripping of said latch permitting the bushing to force said plunger out of the path of said cam surface to permit the bushing to carry the plug valve to a seated position at the nozzle throat to stop the flow of fluid through the nozzle, a lubricant chamber, and means automatically operable when the amount of lubricant in the chamber diminishes beyond a predetermined degree to trip said latch.

In testimony of which invention, I have hereunto set my hand, at Trenton, N. J., on this 10th day of Oct., 1928.

RUDOLPH BIRMANN.