

W. PAPE.
MIXED PRESSURE TURBINE.
APPLICATION FILED JUNE 18, 1913.

1,085,157.

Patented Jan. 27, 1914.

2 SHEETS—SHEET 1.

FIG. 1.

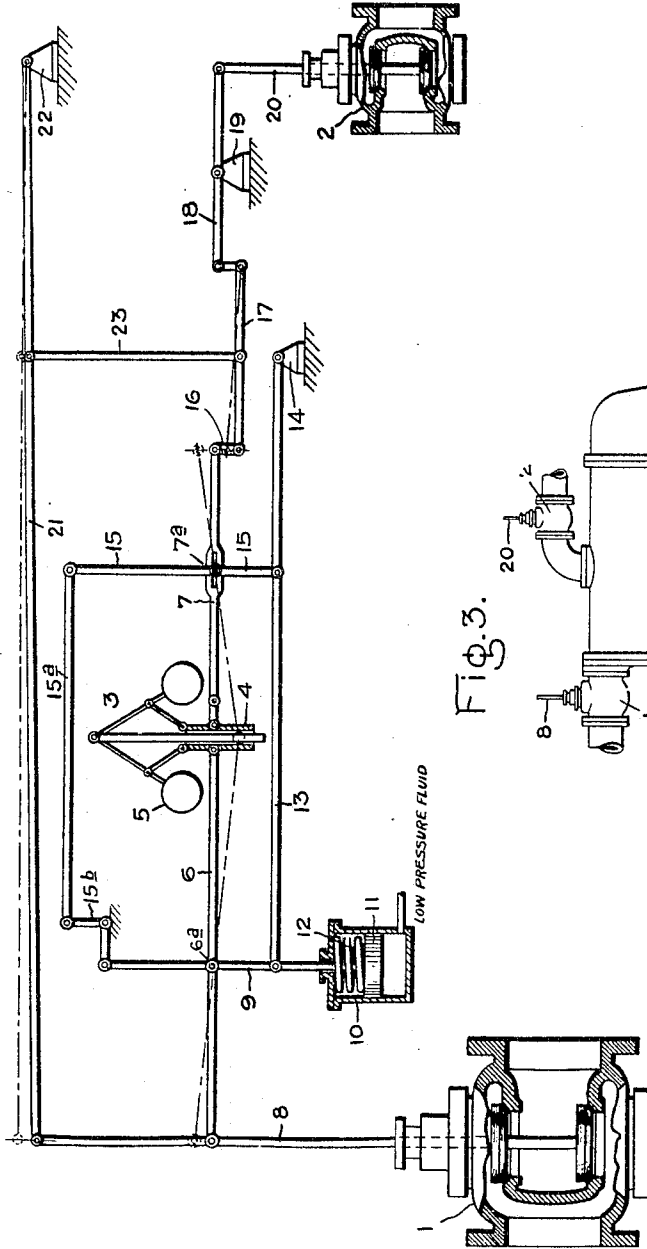
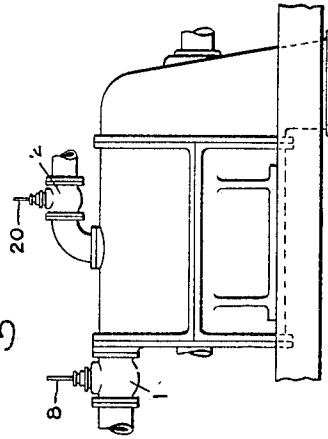


FIG. 3.



Witnesses:

Marcus L. Byng
J. E. E. E.

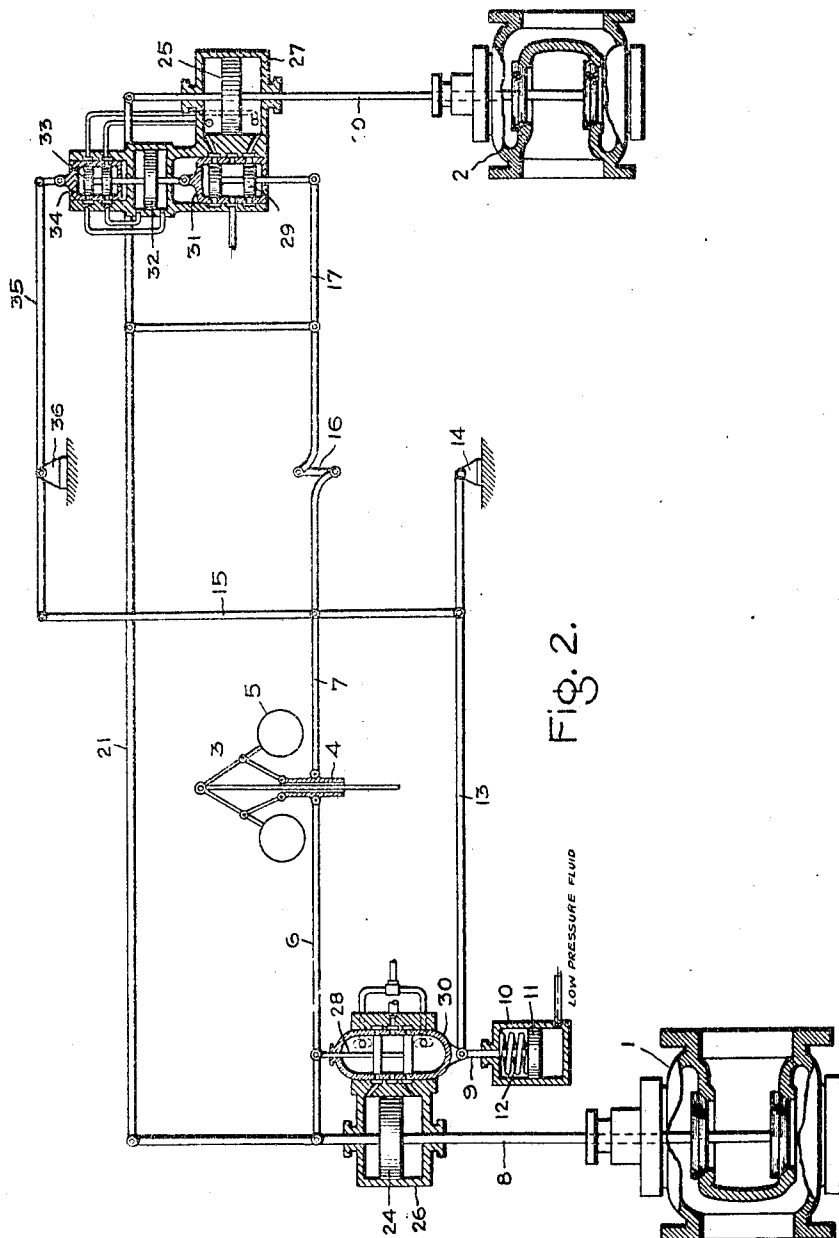
Inventor,
Wilhelm Pape,
by *Alfred E. E.*
Att'y.

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2 SHEETS-SHEET 2.



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J. H. H. H.

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UNITED STATES PATENT OFFICE.

WILHELM PAPE, OF CHARLOTTENBURG, GERMANY, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

MIXED-PRESSURE TURBINE.

1,085,157.

Specification of Letters Patent.

Patented Jan. 27, 1914.

Application filed June 18, 1913. Serial No. 774,293.

To all whom it may concern:

Be it known that I, WILHELM PAPE, a subject of the Emperor of Germany, residing at Charlottenburg, Germany, have invented certain new and useful Improvements in Mixed-Pressure Turbines, of which the following is a specification.

This invention relates to elastic fluid turbines, and its object is to furnish a system of regulation for what are known as mixed pressure turbines, in which exhaust or low pressure steam is utilized for motive power so far as possible, and high pressure or boiler pressure steam is supplied to make up for any deficiency in the quantity of the low pressure steam available at any given instant.

In regulating systems heretofore proposed, certain disadvantages have cropped out in practice, and the purpose of my present invention is to overcome these difficulties and provide a regulating mechanism that operates satisfactorily under all conditions of service.

In carrying out the invention I make use of two controlling or throttle valves, one for the low pressure steam and the other for the high pressure steam; a speed governor running in synchronism with the shaft of the turbine, a pressure-responsive device exposed to the pressure of the low pressure steam, and a system of interconnecting levers by means of which the two valves are caused to open and close at the proper times and to the proper extent to meet varying demands of load.

The chief characteristic of my invention is that while the low pressure steam valve can be controlled by both the speed governor and the pressure regulator independently of each other, yet the high pressure steam valve can only be operated by a co-operative action of both the speed governor and the pressure-regulator.

The details of the invention will appear from the following description taken in connection with the accompanying drawings, in which—

Figure 1 is a diagrammatic representation of one form of my invention; Fig. 2 shows a similar view of a modification, and Fig. 3 is a small view of a mixed pressure turbine.

Referring first to Fig. 1, the valve 1 controls the admission of the exhaust or low pressure steam to the turbine and the valve 2 controls the high pressure or live steam.

Each valve is arranged to be opened by an upward movement and to be closed by a downward movement. A speed governor 3 comprises a sleeve 4 which is moved up and down by the fly balls 5; though any suitable form of speed governor may be used, provided it affords a means for effecting the movement of the two levers 6 7, which are here shown as pivotally connected to the sleeve 4. The other end of the lever 6 is pivoted to the stem 8 of the low pressure valve 1, and is fulcrumed at an intermediate point 6^a upon a stem 9 which is capable of movement transverse to the lever, by reason of changes in the pressure of the low pressure steam. A conventional showing is made in the drawing of a device for accomplishing this result, to wit; a cylinder 10 containing a piston 11 attached to the stem 9 and urged upwardly by the steam pressure against the tension of a downwardly acting spring 12.

Pivoted to the stem 9 is a lever 13 whose other end is fulcrumed on a stationary support 14. At an intermediate point thereon is pivoted a link 15 whose upper end carries a fulcrum 7^a. The right hand end of the lever 7 is pivoted to a short link 16 connecting it with a floating lever 17. Linked to the other end of the floating lever 17 is a lever 18, fulcrumed on a stationary support 19 and pivoted to the stem 20 of the high pressure valve 2. A long lever 21 fulcrumed on a stationary support 22 is connected at its extreme end to the stem 8 of the low pressure steam valve 1, while a link 23 is pivoted to it at an intermediate point and connects it with the middle of the floating lever 17.

With this arrangement, the speed governor and the pressure-regulator can influence the low pressure steam valve 1 independently of each other, but neither can influence the high pressure steam valve 2 without the co-operation of the other.

The operation is as follows assuming that the load on the engine increases: This slows down the speed governor and its sleeve 4 moves downward. The stem 9 of the pressure regulator being at rest, the lever 6 turns on its fulcrum 6^a and lifts the stem of the low pressure steam valve 1, thereby admitting more steam to the engine to meet the increase in load. At the same time, the lever 7 vibrates about the fulcrum 7^a carried by the link 15, raising the left hand end of the floating lever 17. If the link 23 remained sta-

tionary, this would result in opening the live steam valve 2, also but the lifting of the stem 8 raises the long lever 21, which pulls up the link 23 to such an extent that the floating lever fulcrums on the end of the lever 18 instead of actuating it, and thus the valve 2 is not affected. This position of the parts is indicated by the dotted lines. On the other hand, assume that the pressure of the low pressure steam drops to a point where it can no longer handle the load. This means that the high pressure steam valve must be opened to admit sufficient live steam to help carry the load or in some cases to carry all of the load. The drop in pressure of the low pressure steam permits the spring 12 to pull down the lever 6 and close the valve 1 more or less. At the same time, through the operation of the lever 13 and link 15 and pivot 7^a, the lever 7 is pulled down, which tends to force down the floating lever. But the downward movement of the stem 8 of the valve 1 also pushes down the link 23 and thus bodily lowers the floating lever 17 with the lever 7, so that this action alone does not affect the live steam valve. If, however, the low pressure valve is closed by the pressure regulator in response to a drop in pressure, the turbine tends to slow down and the high pressure steam valve must be opened at once to enable the turbine to carry the load. In order to make this possible, the movement of the pressure regulator, in addition to pulling down the fulcrum 7^a, as above described, is also utilized for increasing the ratio of lever transmission between the speed governor and the high pressure steam valve, in order that a small movement and in fact always only the same small movement, of the speed governor, can open the high pressure steam valve as far as may be necessary. Therefore, at the same time that the pressure regulator closes the low pressure steam valve, it must also shift the fulcrum 7^a toward the speed governor, in order to shorten the arm of the lever 7 pivoted to the sleeve of the governor and lengthen the arm pivoted to link 16, so that the floating lever 17 will not be simply lowered bodily as above described, but will actually operate the lever 18 and open the high pressure valve up to a certain extent. Fig. 1 is diagrammatic in its nature and is not intended to represent a practical embodiment of the invention, but to suggest one way of shifting the fulcrum 7^a I have shown the lever 7 as slotted lengthwise at the point where the fulcrum pin passes through it and the link 15 extended upwardly and connected by a rod 15^a with a bellcrank lever 15^b pivotally attached to an extension of the stem 9. So long as the pressure regulator remains inactive, the fulcrum 7^a is stationary in its slot. But when the pressure drops and the stem 9 moves

downward, the link 15 and fulcrum 7^a will be drawn toward the governor, and the ratio of transmission will be altered as required.

Fig. 2 shows the application of my invention to a system of regulation employing hydraulic motors for actuating the steam valves. To the stems 8 and 20 of said valves are attached pistons 24 25, working in cylinders 26 and 27. Hydraulic pressure is admitted to said cylinders by pilot valves 28 and 29. The pilot valve 28 is connected to the lever 6, and the pilot valve 29 to the floating lever 17. Between each pilot valve and its casing is a sleeve 30 31 containing ports, so that by shifting the positions of said sleeves the flow of oil or other medium to the cylinders 26 27 can be cut off. The sleeve 30 is connected to the stem 9 of the pressure regulator, and the sleeve 31 to an auxiliary motor, such as a piston 32 working in a cylinder whose upper and lower ends are connected respectively with the upper and lower ends of the cylinder 27. The flow of oil between these two cylinders is controlled by a slide valve 33 connected to the piston 32 and having between it and its casing a sleeve 34 attached to a lever 35, fulcrumed at 36 and connected also to an extension of the link 15. Assuming now that the load on the turbine remains constant, and the pressure of the low pressure steam drops. The pressure-regulator will therefore proceed to close the low pressure valve 1, in the manner previously described. During this procedure, the sleeve 34 is lifted a certain amount, and the point of connection 7^a of the link 15 with the lever 7 has been depressed, so that, if the number of revolutions remains unchanged the pilot valve 29 remains at rest. Corresponding to the smaller supply of steam, however, upon the closure of the low pressure steam valve 1, the number of revolutions will drop off. The governor sleeve 4 therefore falls and moves the pilot valve 29 downward. Thus a rush of oil under pressure enters under the piston 25 and flows also to the under side of the piston 32. The latter lifts the sleeve 31 and the slide valve 33 until the latter has shut off the flow of oil to the piston 32. By the lifting of the sleeve 31, the ports in it are further opened without the aid of the governor. The upward movement of the piston 25 opens the high pressure steam valve 2 to such a point that by means of the levers 21 and link 23 the pilot valve 29 will again close the ports in the sleeve 31. The pressure-regulator, therefore, by shifting the sleeve 34 establishes only the extent of the movement of the high pressure steam valve 2, while the governor 3 must cause the movement. The transmission between the governor and the pilot valve 29 is so chosen that a difference of only one half of one per cent. in revolutions is necessary in order to

cause the shifting of the high pressure steam valve. According to the degree of movement of the low pressure steam valve by the pressure-regulator, a temporarily different ratio of transmission is introduced between the governor and the live steam valve, since for a variation of only one half of one per cent. in the revolutions there is always an opening movement of the high pressure steam valve which corresponds to the movement of the low pressure steam valve. I have shown throttle valves for controlling both the high and low pressure sources of steam supply but it is evident that other forms of valves may be utilized.

In accordance with the provisions of the patent statutes, I have described the principle of operation of my invention, together with the apparatus which I now consider to represent the best embodiment thereof; but I desire to have it understood that the apparatus shown is only illustrative, and that the invention can be carried out by other means.

What I claim as new and desire to secure by Letters Patent of the United States, is:—

1. In a mixed pressure turbine, the combination with the low pressure steam valve and the high pressure steam valve, of a speed governor, a pressure regulator, and

means whereby each of said devices can control the low-pressure steam valve independently, and each must cooperate with the other in controlling the high pressure steam valve.

2. In a mixed pressure turbine, the combination with the low pressure steam valve and the high pressure steam valve, of a speed governor, a pressure regulator, and means so arranged that said pressure regulator can vary the rate of transmission between the governor and the high pressure steam valve.

3. In a mixed pressure turbine, the combination with the low pressure steam valve and the high pressure steam valve, of a speed governor, a pressure regulator, motors for operating said valves, a system of levers and rods connecting said motors with said governor and pressure regulator, an auxiliary motor for controlling the flow of the actuating medium to the motor of the high pressure steam valve, and means controlled by the pressure regulator for governing the flow of such medium to the auxiliary motor.

In witness whereof, I have hereunto set my hand this 20th day of May, 1913.

WILHELM PAPE.

Witnesses:

WOLDEMAR HAUPT,
HENRY HASPER.