O. BANNER.

GOVERNING MECHANISM FOR STEAM TURBINES.

APPLICATION FILED APR. 10, 1914.

1,117,306. Patented Nov. 17, 1914.

2 SHEETS—SHEET 1.

Fig. 2

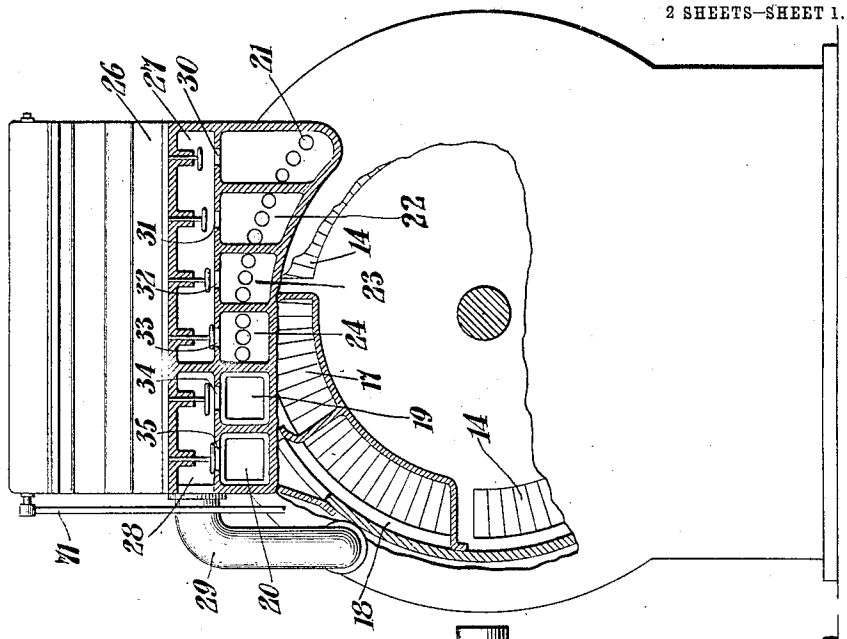
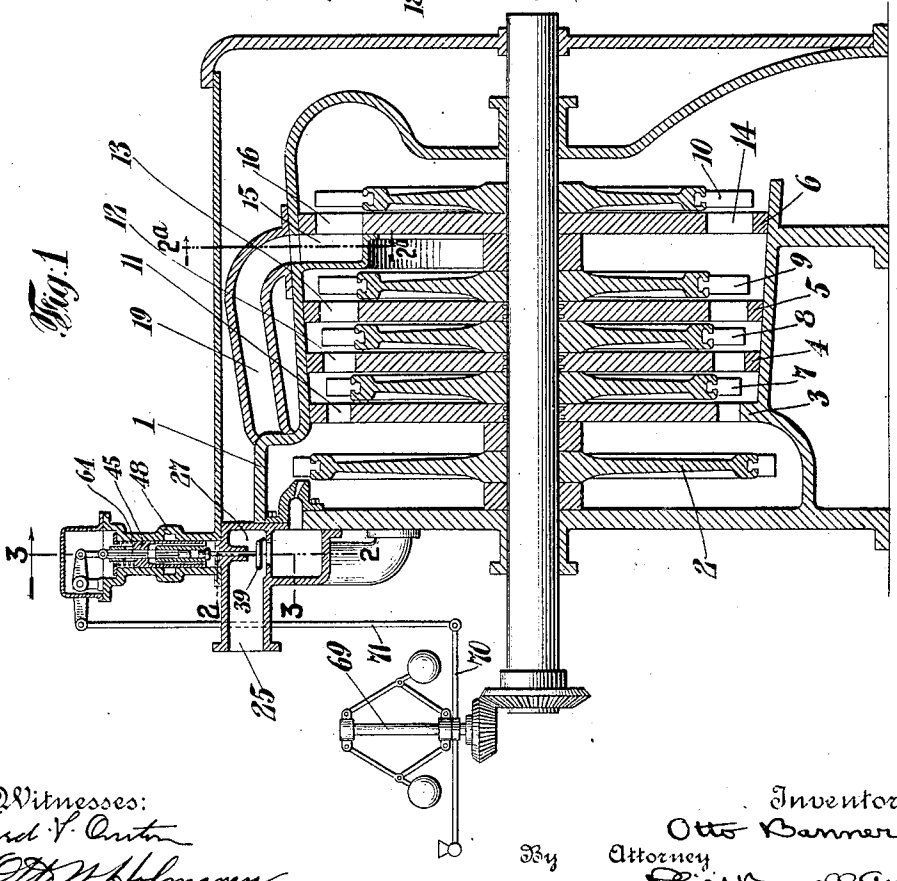


Fig. 1



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2 SHEETS—SHEET 2.

Fig. 4

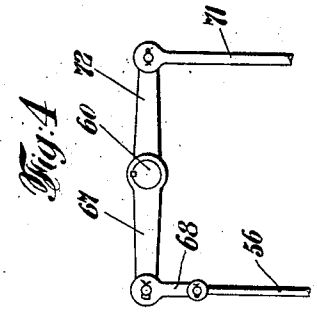
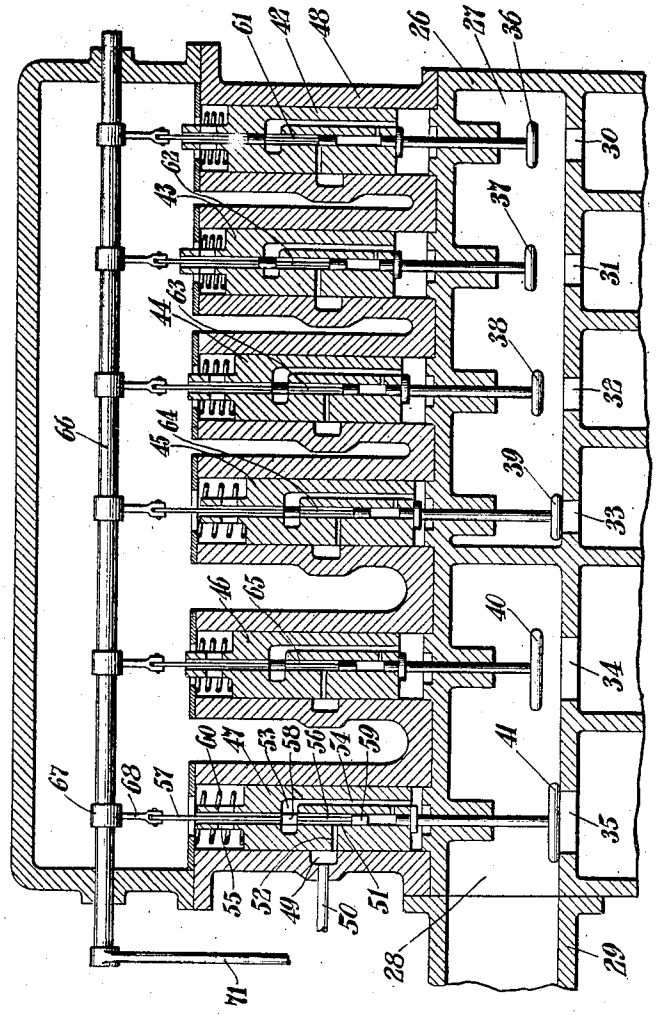


Fig. 3



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GOVERNING MECHANISM FOR STEAM-TURBINES.

1,117,306. Specification of Letters Patent. Patented Nov. 17, 1914

Application filed April 10, 1914. Serial No. 830,843.

To all whom it may concern:

Be it known that I, OTTO BANNER, a subject of the German Emperor, residing at Easton, in the county of Northampton and State of Pennsylvania, have invented a certain new and useful Improvement in Governing Mechanism for Steam-Turbines, (Case A,) of which the following is a specification.

This invention relates to fluid operated turbines and more particularly to turbines and regulating mechanism therefor adapted to operate efficiently under load conditions above or below the normal.

The object of this invention is to provide a turbine which will be simple in construction and which will operate efficiently through a large range of loads.

A further object is to provide a regulating mechanism for turbines of this class which will be positive and powerful in its operation without undue complication, such regulating mechanism being suitable for any turbine wherein it is desired to admit the operating fluid successively to separate nozzles or groups of nozzles.

With these objects in view, a turbine and regulating mechanism has been devised, a practical embodiment of which is shown in the accompanying drawings, in which,

Figure 1 shows a longitudinal section of the machine, Fig. 2 shows an end elevation, partly broken away to show partial sections on the lines 2—2 and 2^a—2^a of Fig. 1, Fig. 3 shows a transverse section on the line 3—3 through the regulating means on a larger scale, and Fig. 4 is a detail showing the construction of the pilot valve operating levers.

The turbine, as shown, comprises a casing 1 in one end of which is placed a high pressure wheel 2 the discharge of which passes through a series of low pressure stages comprising diaphragms 3, 4, 5 and 6 and low pressure wheels 7, 8, 9 and 10. The discharge of the high pressure wheel 2 passes through the low pressure stages in series, the diaphragms 3, 4 and 5 being provided with nozzle passages 11, 12, and 13 which extend preferably around the whole periphery of the diaphragms giving full injection to the low pressure wheels 7, 8 and 9. In the diaphragm 6 the nozzles 14, which receive the discharge from the preceding stage, only extend partly around the periphery of the diaphragm, the remaining portion of the diaphragm on its inlet side being covered by a steam chamber 15 from which a separate set of nozzles 16 which may or may not be of the same angle and expansion as the nozzles 14, lead through the diaphragm 6 and discharge against the blades of the wheel 10. This steam chamber 15 may be in one or more divisions and is here shown as divided into two parts 17 and 18, to which steam is furnished from the discharge of the high pressure wheel 2 through conduits 19 and 20 by means of valve mechanism, further to be described.

Steam is admitted to the high pressure wheel through one or more groups of expansion nozzles, here shown as consisting of four groups 21, 22, 23 and 24, which receive high pressure steam from a boiler or other source of supply, (not shown), by means of the inlet pipe 25. The admission of steam to the various groups of high pressure nozzles and the sections of the low pressure steam chamber feeding the nozzles 16, is effected in the following manner: Mounted on the end of the turbine casing is a valve chest 26 which is divided into a high pressure steam chest 27 into which the high pressure inlet pipe 25 opens and a low pressure steam chest 28 which is supplied with low pressure steam from the discharge of the high pressure wheel by means of a conduit 29 leading from the casing of the turbine. In the lower wall of the steam chest 27 are inlet openings 30, 31, 32 and 33 for admitting steam separately and respectively to the nozzle groups 21, 22, 23 and 24, while in the lower wall of the low pressure steam chest 28 are inlet openings 34 and 35 for admitting low pressure steam separately to by-pass conduits 19 and 20. These inlet passages are controlled independently by valves 36, 37, 38, 39, 40 and 41 which have stems attached to motor pistons 42, 43, 44, 45, 46 and 47 which are of similar construction and adapted to have a limited movement in a series of cylinders formed in a cylinder casing 48 on top of the valve chest 26. These pistons are operated by the pressure of fluid such as oil, the admission and discharge of which is controlled in the following manner, it being necessary to describe only, in detail, piston 47 as the others are entirely similar. Oil or other fluid under pressure is admitted to a port 49 in the side of the cylinder by means of a pipe 50

from a source, not shown. The port 49 is in communication with a bore 51 which extends axially from one end of the piston to the other, by means of a passage 52 which is always in communication with the port 49 no matter what position the piston is in. Above the passage 52 is an annular chamber 53 of larger diameter than the bore 51 from which a passage 54 leads to the bottom of the cylinder. The upper end of the bore 51 is in communication with the open upper end of the cylinder by means of ports 55. Sliding in the bore 51 is a pilot valve 56 which has an operating stem 57 which projects from the upper end of the cylinder and two heads or controlling portions, an upper head 58 which controls the admission and discharge of the oil from the lower part of the cylinder and a lower head 59 which serves as a guide and also to prevent oil from passing through the open lower end of the bore 51 to the lower end of the cylinder. Movement of the pilot valve upwardly admits oil through the passage 52 to the lower end of the cylinder through the passage 54 forcing the piston upwardly while downward movement of the pilot valve allows the passage 54 to be put into communication with the upper end of the bore 51 and permits the oil in the lower part of the cylinder to escape into the upper casing permitting a spring 60, which presses against the top of the piston 47, to move it downwardly. The oil escaping from the top of the cylinders flows to the bottom of the casing and escapes by an outlet tube, (not shown). The pilot valve 56 and the inlet and exhaust ports of the piston 47 are so arranged however that the pilot valve can move considerably farther either up or down, than the piston 47 without having any further effect on the movement of the piston, this being limited by the length of the cylinder.

As stated before, the pistons 42, 43, 44, 45 and 46 are precisely similar in construction and operation to the piston 47, as are also the pilot valves 61, 62, 63, 64 and 65 which control them. In order that these pistons and their valves may not operate simultaneously however, the pilot valves are connected each in a different manner to the operating mechanism as will now be described.

Running longitudinally above the cylinders is a rock shaft 66 to which are secured a series of levers 67 one for each pilot valve, which are identical in construction and project in the same direction from the rock shaft. Pivoted to the end of each of these levers is a connecting rod 68, which, in turn, is pivotally connected with the stem of its respective pilot valve. A rocking motion in accordance with the load on the turbine is given to the shaft 66 by means of a speed governor 69, here shown as geared to the turbine shaft, through the agency of lever 70, connecting rod 71 and lever 72 secured to the outer end of the rock shaft. In order that the various pistons and the valves attached thereto, may operate successively in accordance with the load, the stems of the pilot valves 61, 62, 63 and 64 are given a successively greater length so that the controlling portions of these valves come into effective positions in relation to the controlling ports of the pistons at successive points in the movement of the rock shaft 66. This operation is made possible by the construction described above, which allows these pilot valves to have a considerable travel in either direction after its piston has stopped moving without affecting the position of the piston so that pilot valve 64, for instance, can move a considerable distance upward, as shown in Fig. 3, without having any effect on the movement of its piston. It is evident that the same result could be accomplished by having the pilot valve stems of the same length and the levers 67 set at different angles on the rock shaft.

As shown in Fig. 3, the four high pressure pistons have their pilot valve stems of such a length that they open successively under varying conditions of load, while pilot valves 55 and 56 have their stems of the same length as pilot valves 63 and 64 so the low pressure valves 40 and 41 are operated simultaneously and to the same extent as the last two high pressure valves 38 and 39. Under normal conditions of operation, therefore, live steam will be admitted in accordance with the load through high pressure inlet openings 30 and 31 only. Under overload conditions, high pressure valves 38 and 39 will be opened admitting steam to high pressure nozzle groups 23 and 24, while at the same time, low pressure valves 40 and 41 will be opened allowing low pressure steam to enter the by-pass conduits 19 and 20, thus successively relieving the excess pressure due to the large excess of high pressure steam admitted to the high pressure wheel, progressively in accordance with the excess of high pressure steam admitted. In this way the steam passing to the low pressure wheels through the nozzles 11 is maintained at a pressure at which the low pressure wheels will work efficiently while the excess steam is by-passed to the chambers 17 and 18 and utilized for effective work by passing through the nozzles 16 to the last low pressure wheel 10.

The operation of the turbine and its regulating mechanism will be evident from the above description. Assuming that the turbine is operating under no load and hence at its maximum speed, all the levers 67 and hence the pilot valve 61 will be substantially

in the position shown for the pilot valve 63 with the inlet opening 30 partly closed and all the other inlet openings completely closed. As the load on the turbine increases, the levers 67 will move upwardly, the pilot valve 61 first opening the valve 30 to its fullest extent and the other pilot valves successively opening their inlet valves as their operating heads 58 successively come into operative relation with the passages 54.

The turbine here shown is constructed to operate efficiently both above and below the normal load, that is, the load at which the turbine is designed to give its maximum efficiency. In the present case, for instance, the turbine would probably be designed to have its greatest efficiency when the valves 36 and 37 are open as far as they can be, without valve 38 being open.

As shown in Fig. 3, the regulating mechanism is in a position to cover a partial overload, the valves 36 and 37 being raised to their fullest extent while the valves 38 and 40 are partially raised admitting a certain amount of steam to the nozzles 23, and to the by-pass conduit 19 and part of nozzles 16.

Although the turbine and regulating mechanism are here shown as having four groups of high pressure nozzles and two groups of low pressure nozzles, it is evident that the number of nozzle groups or the number of nozzles in each group may be varied without departing from the invention, as also may the number of blades or blade rows in each stage and the amount of injection of each, and furthermore, although the regulation of the steam is effected by a certain definite regulating mechanism, any sort of device for regulating the amount of steam admitted to the turbine in accordance with the load thereon may be substituted without invention for the present device. Furthermore, instead of regulating the flow of steam to the by-pass conduits directly by the load, the steam may be admitted to these by valves opening when the pressure in the steam chest 28 reaches a predetermined quantity, and it is to be understood that the present showing and description discloses only one specified modification of my invention and other forms and modifications are included in the spirit and scope of the invention as expressed in the claims.

What I claim is:—

1. In a steam turbine, a high pressure stage, a series of low pressure stages each having stage nozzles receiving the discharge from the preceding stage, a steam chamber covering part of the stage nozzles of one of said low pressure stages and a by pass conduit connecting said steam chamber with the exhaust of said high pressure stage.

2. In a steam turbine, a high pressure stage, a series of low pressure stages each having stage nozzles receiving the discharge from the preceding stage, a steam chamber covering part of the stage nozzles of one of said low pressure stages, a by pass conduit connecting said steam chamber with the exhaust of said high pressure stage and governing means controlled by the load to open said by pass conduit under overload conditions.

3. In a steam turbine, a high pressure wheel, a series of low pressure wheels, one of said low pressure wheels having a set of nozzles receiving the discharge of the preceding wheel and a second set of nozzles adapted to receive fluid from a by pass conduit leading from the discharge of said high pressure wheel, and means depending on the load for regulating the admission of steam to said high pressure wheel and to said by pass conduit.

4. In a steam turbine, a high pressure stage, a series of low pressure stages, one of said low pressure stages having a set of nozzles receiving the discharge from the preceding stage and a second set of nozzles receiving fluid from a by pass conduit leading from the discharge of said high pressure wheel, a series of valves for admitting fluid to said high pressure stage, a valve for admitting fluid to said by pass conduit, and regulating mechanism governed by the load for successively opening said high pressure valves and for opening said by pass valve simultaneously with a late opening high pressure valve.

5. In a steam turbine, a high pressure stage, a series of low pressure stages, a by pass conduit leading from the discharge of said high pressure stage to one of the low pressure stages, a valve controlling the admission to said high pressure stage, a valve controlling the admission to said by pass conduit, and means controlled by the load for controlling said high pressure valve and for opening said by pass valve under overload conditions.

6. In a steam turbine, a high pressure stage, a series of low pressure stages, a by pass conduit leading from the discharge of said high pressure stage to one of the low pressure stages, a valve controlling the admission to said high pressure stage, a valve controlling the admission to said by pass conduit, and means for controlling said high pressure valve and for opening said by pass valve under high load conditions.

7. In a steam turbine, a high pressure stage, a series of low pressure stages, a by pass conduit leading from the discharge of said high pressure stage to one of the low pressure stages, a series of valves controlling the admission of fluid to said high pressure stage, a valve for controlling admission to said by pass conduit, and means controlled by the load for successively opening

said high pressure valves and for opening said by pass valve simultaneously with one of said later opened high pressure valves.

8. In a steam turbine, a series of inlet valves, motors for opening said valves having limited movement, inlet and discharge ports for said motors, pilot valves moving to control said inlet and discharge ports, said pilot valves having further movement than said motors in either direction, without affecting the position of said motors, an element moving with the load on the turbine, and connection between said moving element and said pilot valves to successively operate said valve motors.

9. In a steam turbine, a series of inlet valves, motors for operating said valves, said motors having limited movement, and similarly arranged controlling ports, pilot valves for controlling said ports said pilot valves being capable of movement past said ports in either direction without affecting the positions of said motors, an element movable with the load on the turbine and means connecting said pilot valves with said movable element in different positions with respect to said motor ports.

In testimony whereof, I have hereunto set my hand.

OTTO BANNER.

Witnesses:
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F. A. POPE.