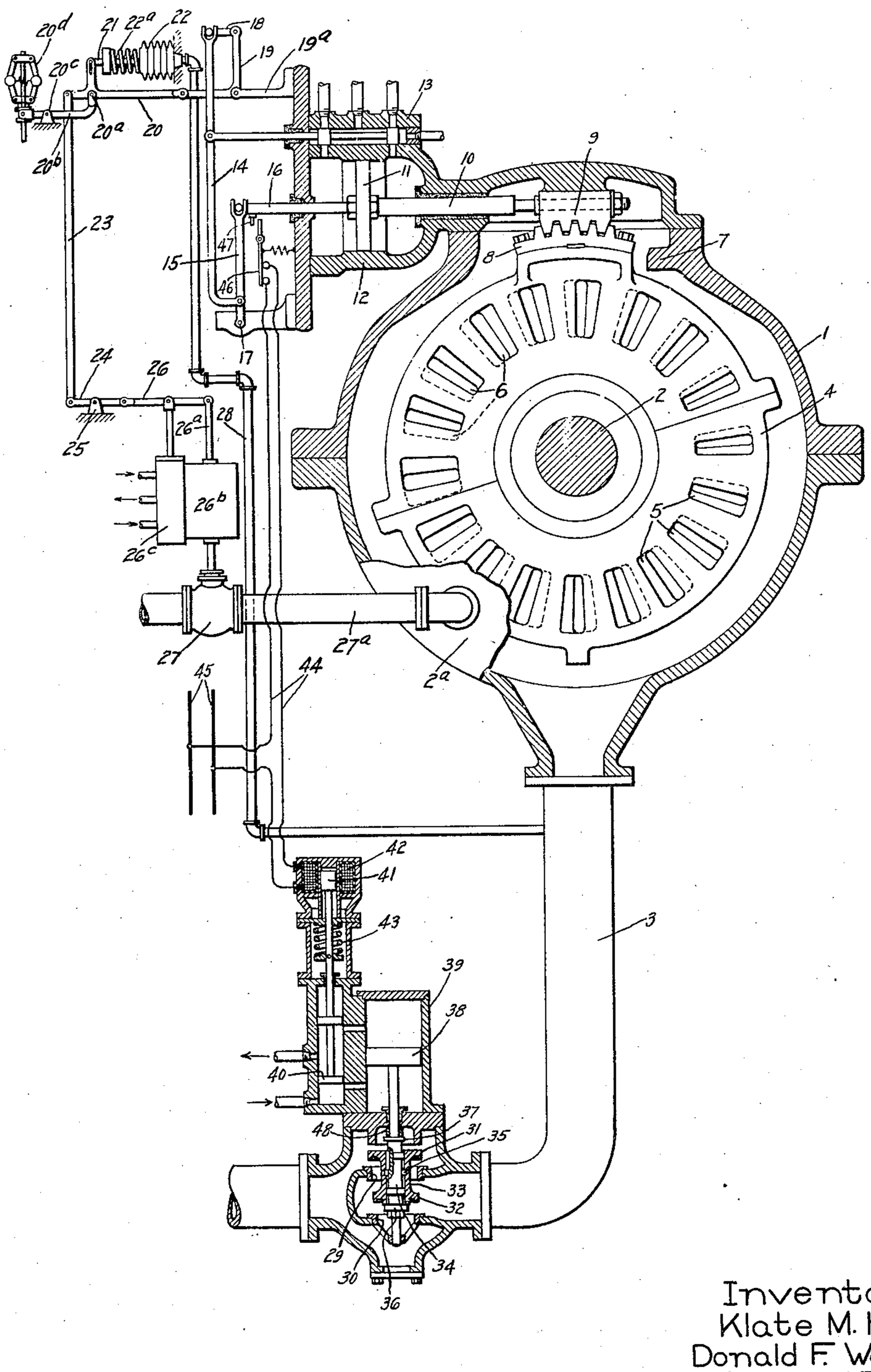
July 16, 1929. K. M. HOLT ET AL 1,721,394

ELASTIC FLUID TURBINE

Filed April 23, 1928



Inventor:
Klate M. Holt,
Donald F. Warner,
Edward V. Pollard,
by Charles E. Tullar
Their Attorney.

Patented July 16, 1929. 1,721,394

UNITED STATES PATENT OFFICE.

KLATE M. HOLT, DONALD F. WARNER, AND EDWARD V. POLLARD, OF LYNN, MASSACHUSETTS, ASSIGNORS TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

ELASTIC-FLUID TURBINE.

Application filed April 23, 1928. Serial No. 272,243.

The present invention relates to elastic fluid turbines and especially to elastic fluid turbines wherein a conduit is provided at an intermediate stage through which elastic fluid may be supplied to or withdrawn from the turbine. In connection with such turbines, it is the practice to provide a valve means for controlling the flow of elastic fluid from such intermediate stage to the next lower stage, the valve means being actuated to maintain constant or substantially constant pressure in the intermediate stage. When, in a turbine of this type, the conduit is connected to a stage of fairly high pressure, it becomes desirable to arrange the valve means controlling the flow of elastic fluid from such stage to the next lower stage in a manner such that it cannot be closed beyond a predetermined amount for otherwise the turbine diaphragm at the intermediate stage might be subjected to pressures of too high a value. In other words, it is desirable that the arrangement be such that the valve means cannot be closed to an extent such that the drop in pressure across the intermediate stage diaphragm will become excessive. However, with an arrangement of this character, the difficulty is met with that when the turbine is operating as a mixed pressure machine, elastic fluid being supplied to the turbine through the intermediate stage conduit, the intermediate stage valve means, since it cannot be closed completely, is not capable of diminishing the supply of elastic fluid beyond a predetermined amount so that in case of light load the turbine may be overspeeded and its emergency governor tripped. In other words, after the stage valve means has reached the limit of its travel toward closed position, it is still open far enough that sufficient elastic fluid could flow past it to overspeed the turbine in case of light load or no load.

The object of the present invention is to provide an improved construction and arrangement in a turbine of the above referred to type whereby this difficulty is overcome, and for a consideration of what we believe to be novel and our invention, attention is directed to the accompanying description and the claims appended thereto.

In the drawing, the figure is a diagrammatic view, partly in section, of an elastic fluid turbine embodying the invention.

Referring to the drawing, 1 indicates the casing of an elastic fluid turbine and 2 the shaft on which the bucket wheels are arranged. The turbine is shown in transverse section except at one point where 2^a indicates the high pressure end of the casing. The section is taken through the intermediate stage to which the conduit through which elastic fluid may be supplied to or withdrawn from the turbine is connected, such conduit being indicated at 3. 4 indicates the valve means which controls the flow of elastic fluid from the stage to which conduit 3 is connected to the next lower stage. A known type of valve means termed usually a ring valve is shown. It comprises a plate having openings 5 therein which are moved into and out of alignment with openings 6 in the turbine diaphragm. 7 indicates a stop which limits the extent to which valve means 4 can be moved toward closed position and hence the extent to which openings 6 can be closed.

On its upper portion valve means 4 is provided with a gear segment 8 which meshes with a rack 9 connected by a rod 10 to a piston 11 which moves in a cylinder 12. 13 indicates a pilot valve for regulating the supply of actuating fluid to cylinder 12. The stem of pilot valve 13 is connected to a lever 14 which at its lower end is connected through a link 15 to a stem 16 connected to piston 11, link 15 being pivoted at 17 on a stationary support. Stem 16 forms, in substance, an extension of rod 10. The upper end of lever 14 is connected to a link 18 which in turn is connected to one arm of a bell crank lever 19 pivoted at its elbow on a bracket 19^a. The other arm of bell crank lever 19 is connected to one arm of a three-arm lever 20 pivoted as indicated at 20^a on the end of a governor lever 20^b. Governor lever 20^b is pivoted at 20^c and has connected to it a suitable speed governor 20^d. The illustration of the speed governor is diagrammatic. It will be understood that it may be a usual type of speed governor driven from the turbine shaft. The vertical arm of three-arm lever 20 is connected through a pin and slot connection to the stem or rod 21 to a pressure responsive device 22 here shown as being in the form of a collapsible bellows loaded with a spring 22^a which may be arranged to be adjusted in any suitable manner. The third arm of three-arm lever 20 is connected by a link 23 to one end of a lever 24 pivoted on a fulcrum 25. The other end of

lever 24 is connected to one end of a floating lever 26, the other end of the floating lever being connected to the stem 26[a] of a fluid-actuated motor 26[b]. 26[c] indicates the pilot valve of the fluid-actuated motor, the stem of the pilot valve being connected to lever 26 at a point intermediate between its ends. The piston rod of fluid-actuated motor 26[b] is connected to a valve means 27 which controls the flow of high pressure elastic fluid to the turbine, being located in the admission conduit 27[a] of the turbine. Valve means 27 is shown only diagrammatically and by way of example and is to be taken as typical of any suitable valve structure for controlling the admission of elastic fluid to the turbine. Bellows 22 is connected to conduit 3 by a pipe 28 whereby the bellows is subjected to the pressure which obtains in conduit 3. When the pressure in the conduit 3 increases bellows 22 is distended while when the pressure therein decreases, spring 22[a] serves to collapse the bellows.

The construction so far described is a known arrangement of regulation for an extraction and/or mixed pressure turbines, the operation being well-understood by those familiar with this type of apparatus. Such an arrangement is disclosed in the patent to Moss, No. 1,154,533, patented September 21, 1915. The operation may be described briefly as follows:

Assume that the turbine is running, that the high pressure valve means 27 and ring valve means 4 are each open a predetermined amount, and that the system is in equilibrium. If now the speed tends to increase, the speed governor 20[d] will turn governor lever 20[b] in a clockwise direction, thereby lowering the fulcrum of three-arm lever 20 and hence the lever itself. This serves to effect a closing movement of the high pressure valve means 27 through the intermediary of the fluid-actuated motor 26[b] and a closing movement of the ring valve means 4 through the intermediary of the fluid-actuated motor comprising piston 11 and pilot valve 13. As will be noted, the connections for the fluid-actuated motors include the usual arrangement of follow-up mechanism. On the other hand, if the speed of the turbine decreases, then governor lever 20[b] is turned on its pivot to lift the three-arm lever 20 thereby effecting opening movement of the two-valve means 27 and 4. It will thus be seen that when the speed varies the two valve means 27 and 4 are adjusted in the same sense. If the pressure in conduit 3 increases bellows 22 is distended thereby turning the three-arm lever 20 on its pivot 20[a] and through the two fluid-actuated motors effecting a closing movement of valve means 27 and an opening movement of valve means 4. On the other hand, if the pressure in conduit 3 decreases bellows 22 is collapsed somewhat thereby turning three-arm lever 20 in the opposite direction to effect an opening movement of valve means 27 and a closing movement of valve means 4. It will thus be seen that when the pressure in conduit 3 changes the valve means 27 and 5 are both operated but in the opposite sense.

With the above-described arrangement elastic fluid may be extracted through conduit 3 from the stage of the turbine to which the conduit is connected, the turbine then operating as what is known as an extraction turbine, or low pressure elastic fluid may be supplied through conduit 3 to a stage of the turbine, the turbine then operating as what is known as a mixed pressure turbine.

The construction so far described is, as stated above, a known one, and is to be taken as typical of any suitable extraction and mixed pressure turbine arrangement.

According to our invention, we provide in conduit 3, a valve mechanism which when open permits flow of elastic fluid through conduit 3 in either direction but which when closed acts as a non-return valve in that it permits flow of elastic fluid from the turbine out through conduit 3 but prevents flow of elastic fluid through conduit 3 to the turbine. In other words, when the valve mechanism is open it permits the turbine to operate either as an extraction machine or as a mixed pressure machine while when the valve is closed, the turbine can operate only as an extraction machine and is prevented from operating as a mixed pressure machine.

The valve mechanism comprising a valve casing in which are arranged upper and lower seats 29 and 30 adapted to be engaged by valve heads 31 and 32 carried by a spool 33. Valve head 31 is of greater diameter than valve head 32 which serves to render the valve unbalanced. Spool 33 is connected to a valve stem 34 by means of splines 35 in a manner such that it may move axially on the stem between stops 36 and 37. Valve stem 34 is connected to a piston 38 which moves in a cylinder 39. This forms a fluid-actuated motor for operating the valve. The supply of actuating fluid to the fluid-actuated motor is controlled by a usual form of pilot valve 40. On the stem of pilot valve 40 is the armature 41 of an electromagnet 42. 43 is a spring which tends normally to move the pilot valve downward. Electromagnet 42 is connected into an electric circuit 44 which comprises a suitable source of potential 45 and an electric switch 46. Switch 46 is arranged to be actuated by a moving part associated with valve means 4, it being shown in the present instance as being arranged to be opened by a finger 47 on stem 16. The arrangement is such that when valve means 4 has been moved a predetermined distance toward closed position, finger 47 will engage switch 46 to open it.

During normal operation the circuit for

electromagnet 42 is closed so that the electromagnet holds plunger 41 in its uppermost position against the action of spring 43. When in this position, pilot valve 40 admits actuating fluid to the underside of piston 38 and permits it to escape from the upper side thereof. Under these circumstances stop 36 lifts valve heads 31 and 32 off their seats so that the valve is held open, permitting elastic fluid to flow through conduit 3 in either direction. The upward movement of valve stem 34 is limited by a sleeve 48 with which stop 37 engages.

If now, due to operating conditions, valve means 4 moves a predetermined distance toward closed position, for example until it reaches stop 7 which limits the extent to which it can move toward closed position, finger 47 opens electric switch 46 thereby de-energizing electromagnet 42 whereupon spring 43 forces pilot valve 40 downward, reversing its position. Actuating fluid now will be admitted by pilot valve 40 to the upper side of piston 38 and permitted to escape from beneath it whereupon piston 38 will move downward permitting valve heads 31 and 32 to engage their seats.

The valve now functions as a non-return valve because of the fact that valve head 31 is larger than valve head 32. Elastic fluid cannot flow past the valve to the turbine since the predominating pressure is on the upper surface of valve head 31 thereby holding the valve closed. On the other hand, however, if elastic fluid tends to flow out through conduit 3, the predominating pressure is on the underside of valve head 31 which means that the valve will be opened due to the pressure, the same being moved into engagement with stop 37. It will thus be seen that while elastic fluid can flow through conduit 3 away from the turbine it cannot flow through the conduit 3 toward the turbine.

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

1. The combination with an elastic fluid turbine having a conduit connected to an intermediate stage through which elastic fluid may be supplied to such stage, valve means controlling the flow of elastic fluid from such stage to a lower stage, and means preventing the complete closure of said valve means, of a valve in said conduit, means for holding said valve open, and means for effecting closing of said valve when said valve means has moved a predetermined distance toward closed position.

2. The combination with an elastic fluid turbine having a conduit connected to an intermediate stage through which elastic fluid may be supplied to such stage, valve means controlling the flow of elastic fluid from such stage to a lower stage, and means preventing the complete closure of said valve means, of a valve in said conduit, means for holding said valve open, and means for effecting closing of said valve when said valve means has reached the limit of its travel toward closed position.

3. The combination with an elastic fluid turbine having a conduit connected to an intermediate stage through which elastic fluid may be supplied to or withdrawn from such stage, and valve means controlling the flow of elastic fluid from said stage to a lower stage, of a valve in said conduit which when closed permits flow of elastic fluid from said stage but prevents flow toward said stage, means for normally holding said valve open, and means for effecting closing of said valve when said valve means has moved a predetermined distance toward closed position.

4. The combination with an elastic fluid turbine having a conduit connected to an intermediate stage through which elastic fluid may be supplied to or withdrawn from such stage, and valve means controlling the flow of elastic fluid from said stage to a lower stage, of a non-return valve in said conduit, means comprising an electromagnet for holding said non-return valve open, an electric circuit for said electromagnet, and means operating through the intermediary of said electromagnet for effecting closing of said non-return valve when said valve means has moved a predetermined distance towards closed position.

5. The combination with an elastic fluid turbine having a conduit connected to an intermediate stage through which elastic fluid may be supplied to or withdrawn from such stage, and valve means controlling the flow of elastic fluid from said stage to a lower stage, of a non-return valve in said conduit, a fluid actuated motor for opening said non-return valve, a pilot valve for said motor, an electromagnet for moving said pilot valve, an electric circuit for said electromagnet, and means actuated when said valve means has moved a predetermined distance toward closed position for modifying said electric circuit to effect closing of said non-return valve.

In witness whereof we have hereunto set our hands this 20th day of April, 1928.

KLATE M. HOLT.
DONALD F. WARNER.
EDWARD V. POLLARD.