Sept. 1, 1925. 1,551,569

J. F. JOHNSON

BLEEDER TURBINE

Filed June 3, 1921

Fig. 1.

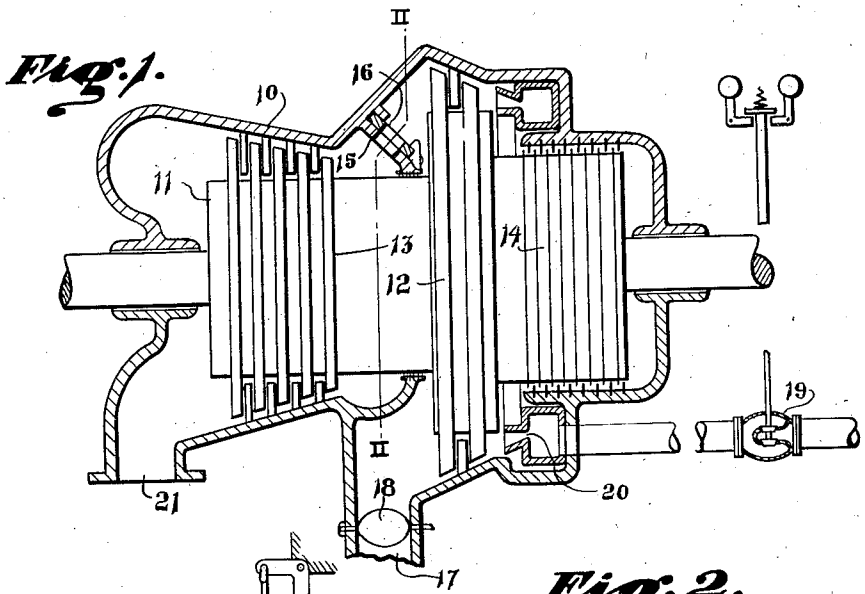
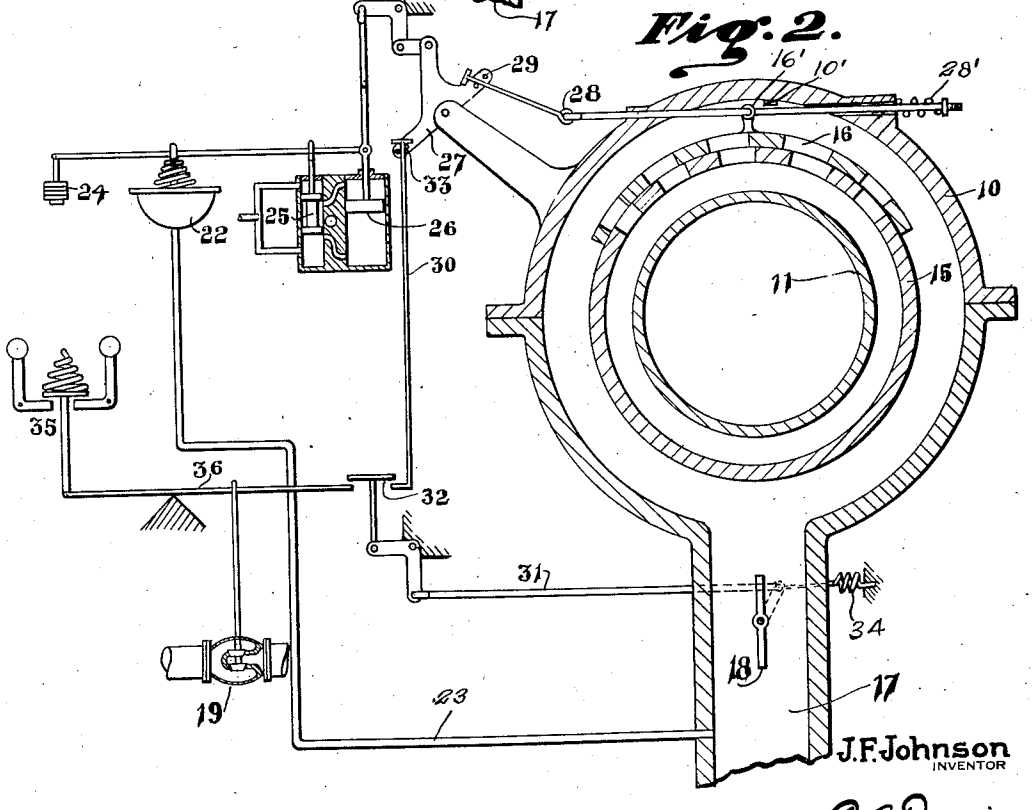


Fig. 2.



J.F.Johnson
INVENTOR

BY D.C.Davis
ATTORNEY

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JOSIAH F. JOHNSON, OF SWARTHMORE, PENNSYLVANIA, ASSIGNOR TO WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA.

BLEEDER TURBINE.

Application filed June 3, 1921. Serial No. 474,827.

To all whom it may concern:

Be it known that I, JOSIAH F. JOHNSON, a citizen of the United States, and a resident of Swarthmore, in the county of Delaware and State of Pennsylvania, have invented a new and useful Improvement in Bleeder Turbines, of which the following is a specification.

My invention relates to bleeder turbines and it has for its object to provide apparatus of the character designated and a method of control therefor, whereby substantially a constant predetermined bleeder pressure may be maintained with a wide range of variation in the amount of motive fluid passing through the turbine and a consequent tendency to alter the pressure within the turbine at the bleeding point.

Referring to the accompanying drawing, Figure 1 is a side view, partially in section and partially in elevation, embodying a preferred form of my invention and Figure 2 is an end view, partially in section, partially in elevation and partially diagrammatic of the apparatus shown in Figure 1, together with other elements of the controlling system.

Bleeder turbines are well known in the art wherein motive fluid such, for example, as steam, is tapped at an intermediate point in the turbine for supplying fluid to a heating system or for use in various mechanical and chemical processes.

It is well known that in a turbine of the multi-stage type, there is a tendency, at lights loads, to expand the steam largely in the initial stages, vacuum or atmosphere, as the case may be, backing up through the low pressure stages. Thus it follows that if a bleeder connection is applied at one of the latter stages of a turbine, there is a tendency for pressure variation at the bleeding point with consequent variation in the bleeder pressure.

It has been proposed in the past to overcome this action in two different ways. In the first place, it has been proposed to place throttling means within the turbine and beyond the bleeding point, this throttling means being closed to a greater or less degree when the pressure at the bleeding point tends to fall below the desired bleeder pressure, thus retarding the flow of motive fluid through the turbine and building up the pressure at the bleeding point to the desired bleeder pressure. Obviously means of this character are ineffective to control the bleeder pressure when the pressure at the bleeding point tends to rise above the desired bleeder pressure and thus it has been necessary to so select the bleeding point that the maximum pressure thereat is substantially equal to the desired bleeder pressure.

In the second place, it has been proposed to install throttling means in the bleeder connection and to close this throttling means to a greater or less extent when the pressure at the bleeding point tends to rise above the desired bleeder pressure. Obviously, apparatus of this character is unable to maintain the desired bleeder pressure when the pressure at the bleeding point falls therebelow and thus it has been necessary to select the bleeding point so that the minimum pressure thereat is substantially equal to the desired bleeder pressure.

In accordance with the present invention, I install both of the above described throttling means, that is to say, I may throttle the flow of motive fluid through the turbine at a point beyond the bleeding point in order to raise the pressure at the bleeding point and increase the flow of motive fluid through the bleeder connection; or I may use throttling means in the bleeder connection for reducing the pressure of motive fluid supplied thereto. In this way I am enabled to substantially double the permissible range of pressure variation at the bleeding point within the turbine with the maintenance of substantially constant bleeder pressure and therewith the maintenance of desired operating characteristics within the turbine.

In addition to the foregoing, I may, if desired, further subject the throttling means within the bleeder connection to the control of the turbine governor, whereby if the speed of the turbine falls below a predetermined amount due, for example, to low boiler pressure or to excessive load, said throttling means is partially or wholly closed, thus re-

ducing or cutting off the steam supplied to the bleeder system and thus increasing the amount of steam passed through the low-pressure stages to the extent necessary to develop the required power.

Referring to the drawing for a more detailed understanding of my invention, I show a turbine casing 10 which incloses a rotor 11, the casing and the rotor carrying impulse blading 12, defining a high-pressure turbine portion, reaction blading 13, defining a low-pressure turbine portion, and a dummy 14, all as is well-known and understood in the art.

A diaphragm 15 sub-divides the space between the impulse blading, or high-pressure portion, and the reaction blading, or low-pressure portion, and it is provided with a throttling valve of the sliding or damper type at 16, this valve being shown more clearly in Figure 2. Steam for the operation of the turbine is admitted through a suitable throttle valve 19 and steam nozzles 20 directed at the impulse blading 12, and is exhausted through a suitable passage 21.

A bleeder connection 17 is attached to the turbine casing on the high-pressure side of the diaphragm 15 and at the exhaust side of the high-pressure portion and it is provided with throttling means 18, indicated as a valve of the ordinary butterfly type.

For the control of the throttling means thus disclosed, a pressure responsive device 22 is provided subject to the pressure within the bleeder passage beyond the valve 18 as by a conduit 23. The pressure responsive device 22 may be loaded to varying amounts as by a weight 24 for the maintenance of different predetermined bleeder pressures within the bleeder conduit and controls a small oil relay device 25, which in turn controls the movements of a piston 26 connected through suitable linkage to a rocking member 27 indicated in substantially a 45° position. The upper end of the lever 27 is connected to the valve 16 through a link 28 and a lost-motion connection 29, and in like manner, the lower end of the rocking lever 27 is connected to the butterfly valve 18 through a linkage 30—31 including lost-motion connections 32 and 33. The valve 18 tends to be maintained in an open position as by a spring 34. Tension means 28′ cooperates with the valve 16 for the purpose of normally bringing the latter to open position when permitted by the linkage, a stop 10′, carried by the casing 10, cooperating with a stop 16′, on the valve member 16, to limit movement of the latter toward the right, as viewed in Fig. 2.

The turbine governor is indicated diagrammatically at 35 controlling, through a suitable linkage 36, the throttle valve 19 and controlling the link 31 and the butterfly valve 18 through the lost motion connection 32, independently of the link 30, in the event that the turbine speed falls below the predetermined amount.

Having thus described the arrangement of a system embodying my invention, the operation thereof is as follows: Let it be assumed that the desired bleeder pressure is two pounds above atmospheric, with a permissible variation between an upper limit of 2½ pounds and a lower limit of 1½ pounds. If the turbine is operating under heavy load, there is a tendency for the pressure at the bleeding point to exceed the desired bleeder pressure and under these conditions, the pressure responsive device 22 operates through the relay mechanism to swing the lever 27 in a clockwise direction, partially closing the butterfly valve 18 but not materially affecting the valve 16. Thus the pressure at the bleeding point within the turbine which may exceed the predetermined upper limit of 2½ pounds atmospheric, is throttled down to the desired amount by the valve 18. A limited bleeder demand produces a like action.

Let it further be assumed that the load upon the turbine falls to a pronounced degree so that the pressure at the bleeding point falls below the lower limit of 1½ pounds, tending to lower the bleeder pressure in like amount or that excessive bleeder demand produces a like result. The pressure responsive device 22 operates in the opposite direction and rotates the lever 27 in a counter-clockwise direction, partially closing the valve 16 but leaving the butterfly valve 18 approximately wide open. Under these conditions, the motive fluid within the turbine backs up, so to speak, creating sufficient pressure at the bleeding point to maintain the desired bleeder pressure.

From the structure illustrated, it will be apparent that the valves 16 and 18 operate successively in order to secure the maintenance of a substantially constant bleeder pressure over a wide range of loads and bleeder demands, the valve 18 being moved in its range of movement for the higher range of loads or lower range of bleeder demands and the valve 16 being moved to control the flow of steam from the high-pressure blading 12 to the low-pressure blading 13, with the valve 18 wide open, in order to back up the steam in the turbine more or less for the purpose of maintaining a substantially constant bleeder pressure over the lower range of turbine loads or an excessive range of bleeder demands.

If the turbine is operating under very heavy load, the butter-fly valve 18 will be nearly closed and the valve 16 will be maintained open due to the tension device 28′, movement of the valve 16 in a clockwise direction being limited by the abutments

16′ and 10′. As the load on the turbine diminishes, or if the bleeder demand should increase, this would result in a tendency to a lower pressure in the bleeder conduit 17, and, therefore, the pressure responsive device 22 would be acted upon to secure upward movement of the operating piston 26, resulting in downward movement of the link 30 and the opening of the valve 18 to the extent permissible by such downward movement. This operation continues as the load diminishes or as the bleeder demand increases until the butter-fly valve 18 occupies a position such as indicated in Fig. 2. Thereafter, if the load should diminish or the bleeder demand should increase, the valve 16 will be moved in a counter-clockwise direction to restrict the flow of steam to the low-pressure blading 13. The restriction of flow of steam to the low-pressure blading tends to build up or back up pressure in the casing at the exhaust side of the high-pressure blading 12, thereby tending to maintain the pressure at a point suitable for the bleeder connection.

With exceedingly light loads, or excessive bleeder demand, the valve 16 is entirely closed. Assuming that the turbine is operating under conditions of extremely light load with the valve 16 closed and the valve 18 wide open, then upon an increase in load the valve 16 is opened, this opening movement continuing as the load increases; and, when the valve 16 is fully open increases in the bleeder pressure are avoided by moving the butter-fly valve in a counter-clockwise direction so as to restrict flow to the bleeder connection.

Upon a reduction of the speed in the turbine below a predetermined amount caused by excessive load or by low boiler pressure, the governor 35 takes over the control of the link 31 from the link 30 at the lost motion connection 32 and partially or wholly closes the butterfly valve 18, irrespective of the pressure at the bleeding point within the turbine, thus limiting the steam supplied to the bleeder system and rendering available more of the fluid for use in the turbine in order to maintain the speed thereof at as high a value as possible.

While I have described the adjustment of the two valves as non-contemporaneous in that one is fully opened before the closing of the other is initiated, and vice versa, I may, if desired, so adjust the mechanism that the operation of these valves overlaps to a greater or less extent.

While I have described my invention in connection with a steam turbine, it is obvious that it is readily applicable in connection with multiple-expansion reciprocating engines where it is desired to withdraw steam at intermediate pressure and it may be applied otherwise under suitable operating conditions. I desire, therefore, that in the following claims the word "turbine" shall be construed to cover any form of fluid expanding devices from which it is desired to derive fluid at intermediate pressure.

From all of the foregoing it will be obvious that I may permit an extremely wide variation in the pressure within the turbine at the bleeding point with the maintenance of substantially constant bleeder pressure. Furthermore, it should be noted that the system thus disclosed is highly efficient in that the throttling action, if any, is usually exercised upon a relatively small amount of fluid, it being borne in mind that throttling is necessarily an inefficient operation. Thus, in the event that the pressure within the turbine at the bleeding point tends to fall below the predetermined amount, the major portion of the fluid is passing out through the bleeder connection and inefficient throttling of the valve 16 is exercised only on the relatively small residue.

In like manner, when the pressure within the turbine at the bleeding point tends to exceed the predetermined bleeder pressure, the major portion of the motive fluid is passing on through the turbine and thus the throttling action of the valve 18 is exercised only on a minor portion of the fluid.

While I have shown my invention in but one form, it will be obvious to those skilled in the art that it is not so limited but is susceptible of various other changes and modifications without departing from the spirit thereof; and I desire, therefore, that only such limitations shall be placed thereupon as are imposed by the prior art or as are specifically set forth in the appended claims.

What I claim is:

1. A turbine of the extraction type comprising a high pressure portion, a low pressure portion, an extraction or bleeder connection communicating with the turbine at the exhaust side of the high pressure portion, an admission valve for controlling the supply of motive fluid to the turbine, a valve for controlling the passage of motive fluid from the high pressure portion to the low pressure portion, a second valve for throttling the supply of motive fluid from the turbine to the bleeder connection, means responsive to pressure within the bleeder connection for effecting a gradual opening or closing of both of said valves, speed responsive means for controlling the admission valve, and means actuated by said speed responsive means for controlling said second valve independently of the means responsive to pressure within the bleeder connection.

2. The combination with a turbine pro-

vided with a bleeder connection at an intermediate point therein, the desired bleeder pressure being substantially the mean pressure within the turbine at the bleeding point, of throttling means for retarding the flow of motive fluid through said turbine beyond the bleeding point, throttling means in said bleeder connection, a pressure responsive device subject to the pressure in said bleeder connection beyond said last named throttling means, and a lost-motion connection between said pressure responsive device and both of said throttling means, whereby when the pressure within said turbine at the bleeding point tends to fall below the desired bleeder pressure, said turbine throttling means is closed to a greater or less extent and whereby, as the pressure within the turbine at the bleeding point rises, said turbine throttling means is first opened and said bleeder throttling means closed to a greater or less degree.

3. The combination with a turbine provided with a bleeder connection at an intermediate point therein, of means for retarding the flow of motive fluid through said turbine beyond said bleeder connection when the pressure at the bleeding point tends to fall below the predetermined bleeder pressure, means for retarding the flow of motive fluid through said bleeder connection when the pressure at the bleeding point tends to exceed the predetermined bleeder pressure, means responsive to the speed of the turbine, and means whereby, when the speed of said turbine falls below a predetermined amount, the afore-mentioned control of said bleeder retarding means is assumed by the means responsive to the speed of the turbine and said bleeder flow is retarded.

4. The combination with a turbine provided with a bleeder connection at an intermediate point therein, of means for retarding the flow of motive fluid through said turbine beyond said bleeder connection when the pressure at the bleeding point tends to fall below the predetermined bleeder pressure, means for retarding the flow of motive fluid through said bleeder connection when the pressure at the bleeding point tends to exceed the predetermined bleeder pressure, means for subjecting both of said retarding means to the pressure within the bleeder connection, and means whereby when the speed of said turbine falls below a predetermined amount, the said bleeder-pressure control of said bleeder connection retarding means is operated upon to retard the flow of motive fluid through said bleeder connection.

5. The combination with a turbine provided with a bleeder connection at an intermediate point therein, the desired bleeder pressure being substantially the mean pressure within the turbine at the bleeding point, of throttling means for retarding the flow of motive fluid through said turbine beyond the bleeding point, throttling means in said bleeder connection, a pressure responsive device subject to the pressure in said bleeder connection beyond said last-named throttling means, a lost-motion connection between said pressure responsive device and both of said throttling means, whereby when the pressure within said turbine at the bleeding point tends to fall below the desired bleeder pressure, said turbine throttling means is closed to a greater or less extent and whereby, as the pressure within the turbine at the bleeding point rises, said turbine throttling means is first opened and said bleeder throttling means closed to a greater or less degree, means responsive to the speed of the turbine, and means whereby, when the speed of said turbine falls below a predetermined amount, the control of said bleeder throttling means is assumed by the means responsive to the speed of the turbine and said bleeder throttling means is closed to a greater or less degree.

6. The method of supplying fluid at substantially constant pressure at an intermediate point in a fluid pressure turbine to a bleeder system which comprises retarding the flow of motive fluid through said turbine beyond the bleeding point when the pressure at the bleeding point tends to fall below a predetermined bleeder pressure, retarding the flow of motive fluid through said bleeder connection when the fluid pressure within the turbine at the bleeding point tends to exceed the predetermined bleeder pressure, and closing said bleeder retarding means, irrespective of pressures, when the speed of said turbine falls below a predetermined amount.

In testimony whereof, I have hereunto subscribed my name this 27th day of May, 1921.

JOSIAH F. JOHNSON.