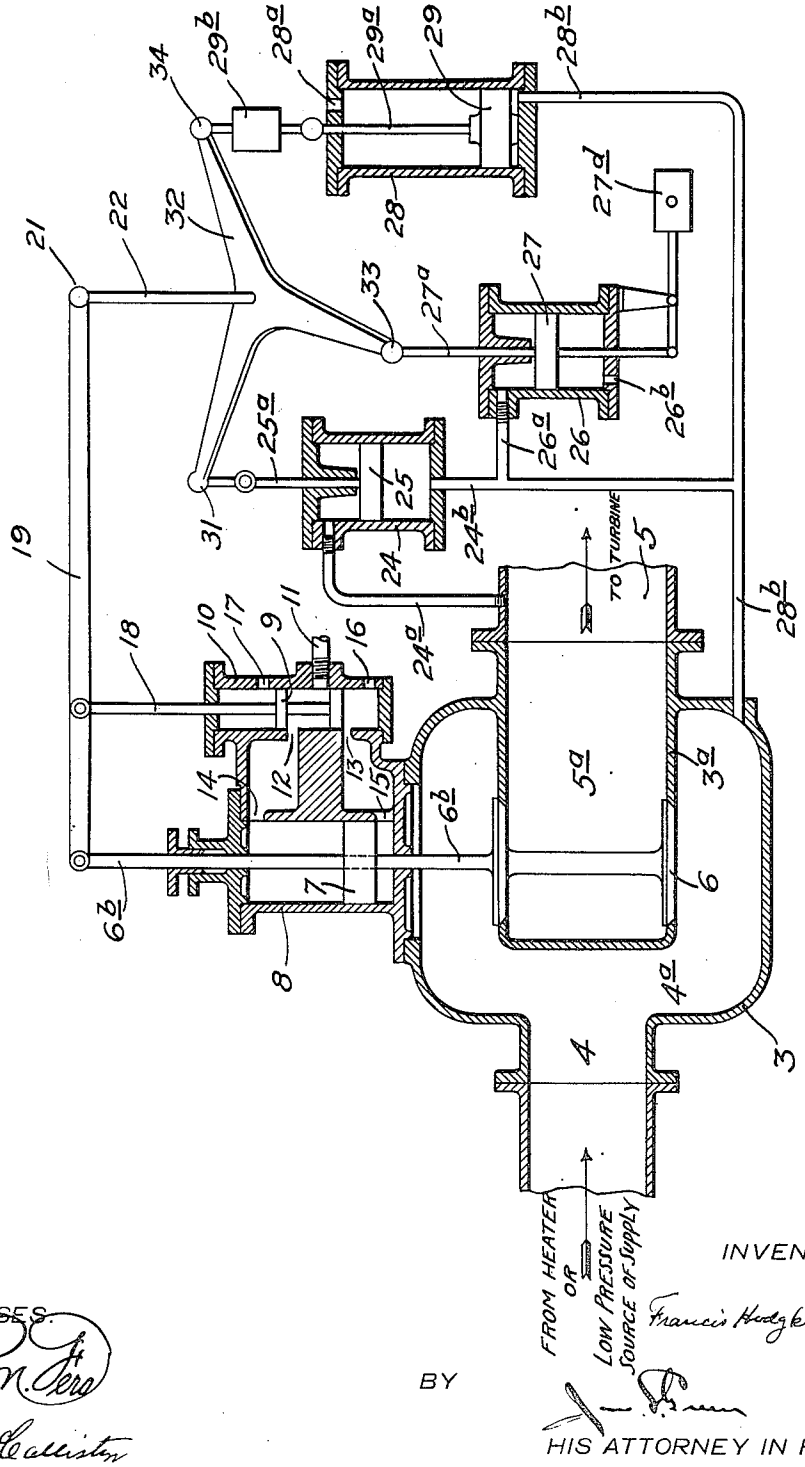
F. HODGKINSON.

RELAY CONTROLLED HEAT BALANCE VALVE.

APPLICATION FILED MAY 18, 1915. RENEWED MAR. 11, 1916.

1,199,036. Patented Sept. 19, 1916.



WITNESSES.

E. M. Callister

INVENTOR.

Francis Hodgkinson

BY

HIS ATTORNEY IN FACT

UNITED STATES PATENT OFFICE.

FRANCIS HODGKINSON, OF PITTSBURGH, PENNSYLVANIA, ASSIGNOR TO THE WESTINGHOUSE MACHINE COMPANY, A CORPORATION OF PENNSYLVANIA.

RELAY-CONTROLLED HEAT BALANCE-VALVE.

1,199,036. Specification of Letters Patent. **Patented Sept. 19, 1916.**

Application filed May 18, 1915, Serial No. 29,004. Renewed March 11, 1916. Serial No. 83,692.

To all whom it may concern:

Be it known that I, FRANCIS HODGKINSON, a subject of the King of Great Britain and Ireland, and a resident of Pittsburgh, in the county of Allegheny and State of Pennsylvania, have made a new and useful Invention in Relay-Controlled Heat Balance-Valves, of which the following is a specification.

This invention broadly relates to the conservation of motive fluid in connection with installations including an engine or fluid actuated motor, to which high pressure motive fluid is delivered, and a heating system to which low pressure fluid is delivered and in which it is necessary or desirable to maintain a substantially constant pressure.

As an example of an installation or organized apparatus with which apparatus embodying my invention may be employed, reference may be made to the modern power plant, in which the main power units receive high pressure motive fluid, (hereinafter called steam or live steam) and the low pressure fluid, (hereinafter called steam or exhaust steam) exhausted from auxiliary units, such as engines for driving pumps, etc., is employed in heating the feed water delivered to the steam generators supplying live steam to the main power units and to the auxiliary units. The amount of steam exhausted from the auxiliaries is substantially constant, regardless of variations in load on the main power units, whereas variations in load on the main power units necessitate variations in the amount of steam generated and consequently in the amount of feed water supplied to the generators. For this reason, it is difficult to so proportion the power or the number of auxiliary units, delivering exhaust steam to the feed water heater, that the amount of steam delivered to the heater will always correspond to the heater's requirements. There is generally an excess of steam available for feed water heating during periods of light load on the main power units and consequently the surplus exhaust steam is wasted unless some means is employed for utilizing it. On the other hand, there is usually an insufficient amount of exhaust steam, available from the auxiliaries during periods of heavy loads on the main power units and, as a result, the feed water is not heated to the desired temperature.

Automatic means have been employed for augmenting the exhaust steam delivered to the feed water heaters during periods of heavy loads on the power units by bleeding steam from a working passage of a power unit and delivering it to the heater. Automatic means have also been employed for conserving the excess exhaust steam delivered to the heater during periods of light load on the main units by delivering it to a working passage of a power unit. This is usually accomplished by providing a bleeder port at such a point in the working passage of a main power unit that the pressure at the port approximates as nearly as possible the pressure it is desired to maintain within the heater. The excess steam from the heater is fed into the power units through this bleeder port, during periods of light load on the power unit, and an augmenting supply of steam is delivering from the working passage of the power unit through the bleeder port to the heater when the exhaust steam delivered to the heater from the auxiliaries is insufficient to maintain the feed water at the desired temperature. The objection to such an arrangement of apparatus is that the auxiliaries must exhaust against the pressure obtaining at the bleeder port which, under certain load conditions of the main power unit, may be many pounds above atmosphere or the pressure which it is desired to maintain in the heater. If this difficulty is avoided by so locating the bleeder port with relation to the working passage of the power unit that the pressure at the port will never exceed a desired exhaust pressure for the auxiliaries, the ratio of expansion of the steam exhausted from the auxiliaries would be lower than desirable and objectionable, in that it could not be economically employed in the main power unit during periods of normal and light loads.

Apparatus has also been employed for automatically closing communication between the exhaust of the auxiliary units and the power unit when the pressure at the bleeder port of the power unit exceeds a desired or determined pressure, or a pressure above which it is undesirable to exhaust the

auxiliary units. Such apparatus does not fulfil requirements, since at periods, during which the pressure at the bleeder port of the power unit is such as to close the valve controlling that port, the exhaust steam delivered by the auxiliaries to the heater might be, and in general would be, insufficient to heat the feed water to the desired temperature.

An object of this invention is to produce an improved valve mechanism for bleeding steam from a steam actuated engine or power developing unit and for delivering the steam to a heater, a heating system or to apparatus employing low pressure steam, in which means are employed for conserving the steam delivered to the heater or apparatus and for maintaining the pressure in the heater or apparatus at approximately a determined pressure independently of fluctuations in pressure within the engine or power developing unit above that which it is desired to maintain within the heater or apparatus.

A further object is to produce a single motor actuated valve and a pressure responsive relay for controlling the operation of the valve such that the valve will operate to deliver excess steam from an apparatus with which the valve communicates to a working passage of a power developing unit and will bleed steam from the unit to maintain the pressure within the apparatus substantially constant independently of variations in pressure within the unit above that which it is desired to be maintained within the apparatus.

A further object is to produce a motor actuated valve having a controlling relay which is responsive to variations in several different pressures in controlling the operation of the valve.

These and other objects, which will be made apparent throughout the further description of the invention, are accomplished by means of a valve mechanism embodying the features herein described and illustrated in the single sheet drawing accompanying and forming a part hereof.

In the drawing I have illustrated, more or less diagrammatically, a sectional view of a valve equipped with an actuating motor, a relay for controlling the motor and pressure responsive devices for controlling the operation of the relay.

The valve mechanism illustrated includes a casing 3, provided with a port 4, adapted to communicate with a low pressure source of supply, and a port 5, adapted to communicate with a working passage of a power developing unit, such for example as a turbine, through a bleeder port with which the unit is provided. The casing 3 incloses a valve 6, which may be a single seat valve, but is illustrated as a balanced valve, and which controls communication between the ports 4 and 5. The seats for the valve are located upon a substantially rectangular diaphragm 3^a, which divides the interior of the casing into a compartment 4^a, communicating with the port 4, and a compartment 5^a, communicating with the port 5. The valve stem 6^b projects through the casing 3 and is provided with an operating plunger or piston 7, which is located within a cylinder 8, shown mounted on the exterior of the casing. The delivery of actuating fluid to the cylinder 8 is controlled by a relay valve 9, which is located within a cylindrical casing 10 to which actuating fluid, such as steam or oil under pressure, is delivered through a port 11. The casing 10 is also provided with ports 12 and 13, which respectively communicate with ports 14 and 15, formed in opposite ends of the cylinder 8, or as illustrated, above and below the piston 7. When the valve 9 is moved to place the port 12 in communication with the delivery port 11, fluid under pressure is delivered to the cylinder 8, through the port 14, above the piston and fluid is discharged from the cylinder 8 through the port 15, the port 13 and a discharge port 16, with which the casing 10 is provided, and consequently the valve 6 is closed. When the relay valve 9 is moved to establish communication between the port 11 and the port 13, communication between the ports 15 and 16 is shut off and communication is established between the port 14 and a discharge port 17, with which the casing 10 is provided. With the valve 9 in this position, fluid under pressure is delivered to the cylinder 8 below the piston, while fluid is discharged from the cylinder 8 through the port 14 and the valve 6 is opened.

The valve 9 is provided with a stem 18 which, as illustrated, is pivotally connected to a floating lever 19, one end of which is positively connected to the stem 6^b, while the other end is connected by suitable means, such as a ball and socket joint 21, to a link 22, which forms a part of a pressure actuating mechanism for the valve 9.

The pressure actuating mechanism includes a cylinder 24, with its coöperating piston 25; a cylinder 26, with its coöperating piston 27 and a cylinder 28 with its cooperating piston 29. One end of the cylinder 24 communicates, through piping 24^a with the compartment 5^a of the valve casing, and the other end communicates, through piping 24^b and 28^b, with the compartment 4^a of the casing. The piston 25 is provided with a rod 25^a, which is connected by means of a pivotal connection, such for example as a ball and socket joint 31, with one arm of a three armed lever 32, to which the link 32 is operatively connected. One end of the cylinder 26 communicates with the compartment 4^a of the valve casing

through piping 26[a], the piping 24[b] and the piping 28[b]. The other end communicates with the atmosphere through a port 26[b]. The piston 27 of this cylinder is provided with a rod 27[a] which, like the rod 25a, is connected to one arm of the member 32 by means of a ball and socket joint 33. One end of the cylinder 28 communicates with the atmosphere through a port 28[a], while the other end communicates with the compartment 4[a] of the casing through the piping 28[b]. The piston 29 is provided with a rod 29[a], which is connected by means of a ball and socket joint 34 with the member 32.

For the purposes of description, but with no idea of limiting the application of my invention, I will throughout the further description of the illustrated embodiment of the same, consider it as applied to, or operating in connection with an installation including a feed water heater, receiving steam from any more or less constant source of supply, such as the exhausts of the auxiliaries, and a turbine operating as a power developing unit and having a bleeder port communicating with a stage in which the pressure under normal full load conditions approximates atmospheric pressure. I will also assume that under maximum overload conditions the pressure within the working passage or stage of the turbine, communicating with the bleeder port, rises to approximately 10 or 15 pounds above atmosphere and that it is desirable to have the auxiliaries, which supply steam to the heater, subjected to a maximum back pressure of not over 5 pounds above atmosphere. I will also assume that the steam pressure within the heater is to be maintained at approximately atmospheric pressure under periods of normal loads on the turbine. As previously stated, the port 4 of the valve casing 3 is in communication with the heater, and the port 5 is in communication with the bleeder port of the turbine.

With the apparatus illustrated, variations in pressure on opposite sides of the valve 6 will occasion variations in the position of the relay valve 9, and consequently will control the operation of the valve 6. For example, a rise in pressure in the heating system slightly above atmospheric pressure will cause the piston 27 within the cylinder 26 to move downwardly, since the pressure within the compartments 4[a] is imparted to the upper end of this cylinder, as above described, and the lower end of the cylinder is open to atmosphere. The piston 27 is shown provided with a counterbalancing weight 27[d], so that a slight preponderance of the pressure in the heater above atmospheric pressure will move the piston 27 to the lower end of its stroke. It will of course be understood that the weight 27[d] slightly overbalances the piston, so that the piston occupies a position within the upper end of the cylinder when the pressure within the heater is approximately atmospheric pressure, and it will also be apparent that the weight may be replaced by a spring.

The downward movement of the piston 27 will cause a tilting of the three armed member 32 about the ball and socket joints 31 and 34 and will thereby actuate the lever 19, which in turn will move the valve 9 to such a position that fluid pressure is delivered to the cylinder 8 below the piston and is exhausted from above the piston. This will open the valve 6 and permit the excess steam from the heater to be delivered into the turbine through the bleeder port. If, now, the pressure in the turbine at the bleeder port rises above 5 pounds above atmosphere, or an amount in excess of that against which it is desirable to exhaust the auxiliaries supplying steam to the heater, the piston 27 will be rendered inoperative as a controlling agent of the valve 6 and will be closed through the operation of the piston 29. This piston is restrained or weighted, as for example by being provided with a weight 28[b] corresponding to 5 pounds fluid pressure on the piston. The piston will therefore remain at the lower end of its cylinder until the pressure in the compartment 4[a] of the valve casing exceeds 5 pounds pressure, at which time it will be raised by the fluid pressure introduced into the cylinder 28 through the piping 28[b] and will tilt the member 32 about the ball and socket joints 31 and 33, thereby raising the link 22 and shifting the valve 9 so as to cause a closing movement of the valve 6. The throw of the piston 29 is such that it will shift the valve 9 to close the valve 6 irrespective of the positions occupied by the pistons 27 and 25, and will therefore render both these pistons ineffective as controlling agents of the valve 6.

As soon as the pressure within the compartment 4[a] of the valve has decreased below 5 pounds the piston 29 will move downwardly in response to the unbalanced pressure of the weight 29[b], and will shift the position of the valve 9 to open the valve 6, provided one or the other of the pistons 25 or 27 occupy valve opening positions. For example, if the pressure in the compartment 5[a] exceeds 5 pounds above atmosphere, the descending piston 29 will establish communication between the compartments 5[a] and 4[a] by opening the valve 6 and this will again raise the pressure within the compartment 4[a] and cause the piston 29 to move downwardly to close the valve 6. If the pressure in the compartment 4[a] falls below five pounds above atmosphere, but is in excess of the pressure existing in the compartment 5[a], the piston 29 in descending in response to the unbalance pressure of the weight 29[b],

will shift the valve 9 to open the valve 6 and to again establish communication between the compartments 4^a and 5^a. This is due to the fact that the piston 27 will, under such conditions, occupy a valve opening position. It will therefore be apparent that as the piston 29 moves upwardly in response to an excess in pressure in the compartment 4^a, it assumes control of the valve 6 independently of the pistons 25 and 27, and as it moves downwardly in response to the unbalanced force of the weight 29^b, it again shifts the control of the valve 6 to the pistons 25 and 27.

If the pressure in the compartment 4^a is below atmospheric pressure it is desirable to bleed steam from the turbine to augment the normal supply to the heater. Under such conditions the piston 25 within the cylinder 24 will be exposed on its upper face to pressure within the compartment 5^a and on its lower face to the pressure within the compartment 4^a. Consequently, the piston 25 will move downwardly and will shift the valve 9 so that the valve 6 will be opened. The piston 25 will remain in this position until the pressure within the compartment 4^a exceeds that within the compartment 5^a, at which time it will close. When the pressure at the bleeder port of the turbine exceeds 5 pounds, the pressure in the heater will be maintained at 5 pounds, but will not exceed that amount, since the difference in pressure on opposite sides of the piston 25 will move it to the valve-opening position or to the lower end of its stroke, thereby opening the valve 6 which will remain open until the pressure in the compartment 4^a attains 5 pounds, at which time the piston 29 will shift its position and close the valve 6, by rendering the piston 25 ineffective as the controlling agent of the valve 9.

It will be apparent from this description of the illustrated embodiment of my invention that the pressure within the heater will always be maintained at the desired pressure, within close limits, independently of the fluctuations in pressure within the turbine above the maximum pressure which it is desirable to maintain within the heater. It will also be apparent that a valve mechanism embodying my invention may be employed for bleeding steam from the power-developing unit for industrial purposes or supplying steam to a heater or heating system whether the steam supplied from the turbine is the only steam supplied or is utilized to augment a low pressure source of supply.

While I have described but one embodiment of my invention, I desire it to be understood that various changes, modifications, additions, omissions, and substitutions may be made in the apparatus illustrated without departing from the spirit and scope of the invention as set forth by the appended claims.

What I claim is:

1. In combination with a valve for bleeding motive fluid from a working passage of a power developing unit and for delivering fluid from a low pressure source of supply to a working passage of the power unit, a fluid actuated motor for controlling the operation of the valve, a relay for controlling the delivery of actuating fluid to said motor, and means responsive to a preponderance in the pressure within the working passage of the unit over the pressure of the fluid at the low pressure source for actuating said relay to open the valve.

2. In combination with a valve for bleeding motive fluid from a working passage of power developing unit and for delivering fluid from a low pressure source of supply to a working passage of the power unit, a fluid actuated motor for controlling the operation of the valve, a relay for controlling the delivering of actuating fluid to said motor, means responsive to a preponderance in the pressure within the working passage of the unit over the pressure of the fluid at the low pressure source for actuating said relay to open the valve, and means responsive to the pressure of the fluid at the source for closing the valve independently of the first mentioned means, when the pressure at the source exceeds a determined pressure.

3. In combination with a valve for bleeding motive fluid from a working passage of a power developing unit and for delivering fluid from a low pressure source of supply to a working passage of the power unit, a fluid actuated motor for controlling the operation of said valve, a relay for controlling the delivery of actuating fluid to said motor, means responsive to the pressure of the fluid at the source for controlling the operation of said relay to open the valve when the pressure at the source attains an established pressure, and pressure responsive means for actuating the relay to close the valve independently of said first mentioned means when the pressure at the source exceeds a determined pressure.

4. In combination with a valve for bleeding motive fluid from a working passage of a power developing unit and for delivering fluid from a low pressure source of supply to a working passage of the power unit, a fluid actuated motor for controlling the operation of said valve, a relay for controlling the operation of the motor, means responsive to the pressure of the fluid at the source for controlling the operation of the relay, independent means responsive to a preponderance in the pressure of the fluid within the working passage of the unit over the pressure of the fluid at the source for controlling the operation, and independent

means responsive to the pressure of the fluid at the source for closing the valve independently of both of said mentioned means when the pressure at the source exceeds a determined pressure.

5. In combination with a valve, a valve casing provided with a port adapted to communicate with a source of low pressure fluid and a second port adapted to communicate with an augmenting fluid supply for said source, a valve located within said casing for controlling communication between said ports, a pressure actuated motor for controlling the operation of said valve, means responsive to fluid pressure at the first mentioned port for controlling the motor to open the valve when the pressure at said port reaches an established pressure, and means responsive to the pressure at said first mentioned port for controlling said motor to close the valve independently of the operation of the first mentioned means when the pressure at the first mentioned port exceeds a determined pressure.

6. In combination with a valve, a valve casing provided with a port adapted to communicate with a source of low pressure fluid, and a second port adapted to communicate with an augmenting fluid supply for said source, a valve located within said casing for controlling communication between said ports, a pressure actuated motor for controlling the operation of said valve, means responsive to fluid pressure at the first mentioned port for controlling the motor to open the valve when the pressure at said port reaches an established pressure, means responsive to a preponderance of fluid pressure at the second port over that at the first port for controlling the motor to open said valve, and independent means responsive to fluid pressure at the first port for controlling the motor to close the valve independently of both of said first mentioned means.

7. In combination with a valve, a valve operating motor, a plurality of independent pressure responsive devices for independently controlling the operation of said motor, and a pressure responsive device for rendering said first mentioned devices incapable of controlling the motor.

8. In combination with a valve, a valve operating motor, a relay for controlling the operation of the motor, independent pressure responsive means for controlling the operating of said relay, a pressure responsive device for actuating said relay to close said valve, independently of the operation of said pressure responsive means.

In testimony whereof, I have hereunto subscribed my name this 15th day of May, 1915.

FRANCIS HODGKINSON.

Witnesses:
C. W. McGHEE,
E. W. McCALLISTER.