

F. HODGKINSON.

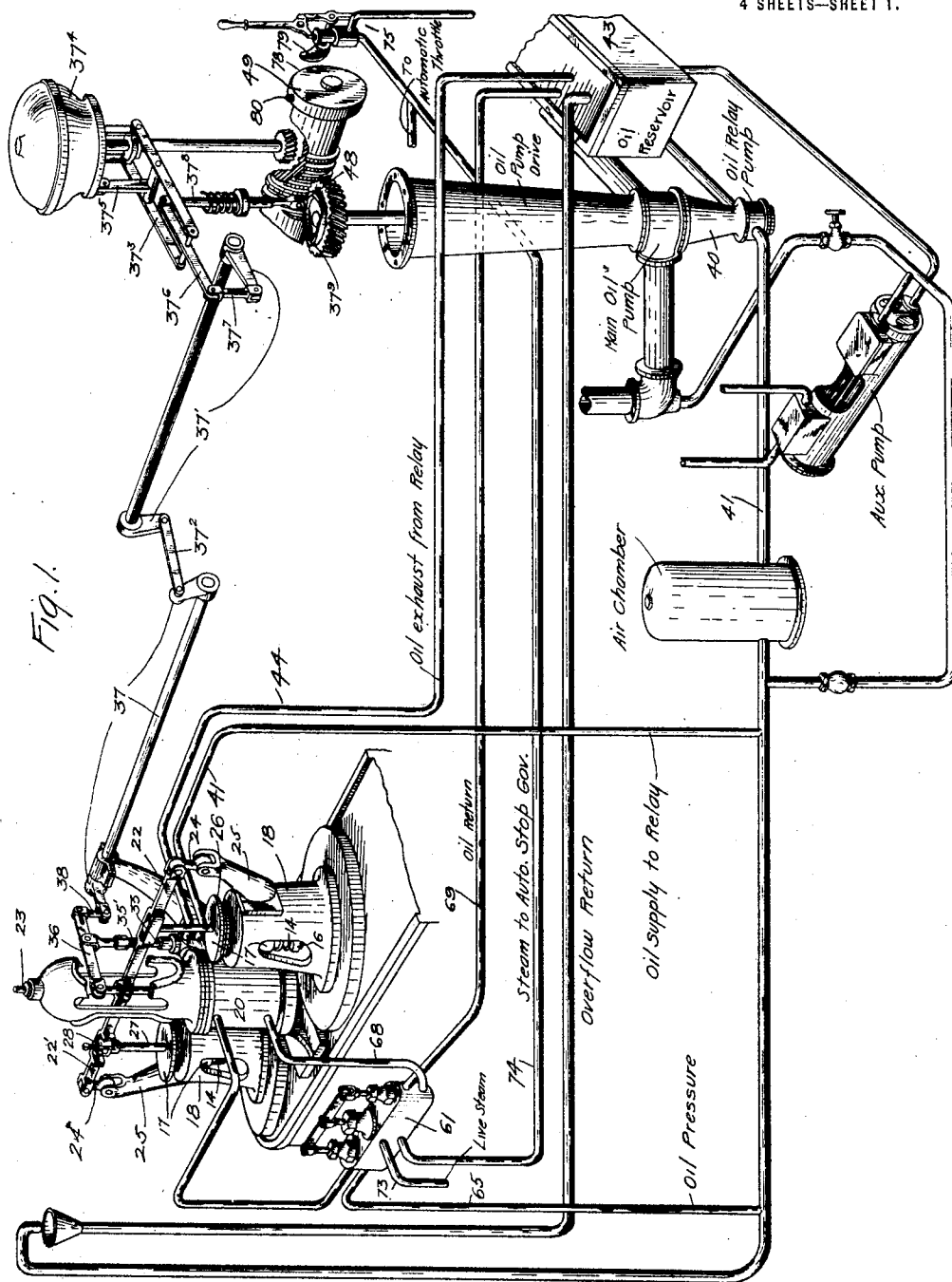
OIL ACTUATED VALVE MECHANISM FOR STEAM TURBINES.

APPLICATION FILED FEB. 10, 1910.

1,151,522.

Patented Aug. 24, 1915.

4 SHEETS—SHEET 1.



WITNESSES:

Wm. J. Fox
B. J. Hunt

INVENTOR

BY

Francis Hodgkinson
Jno. S. Green
HIS ATTORNEY IN FACT.

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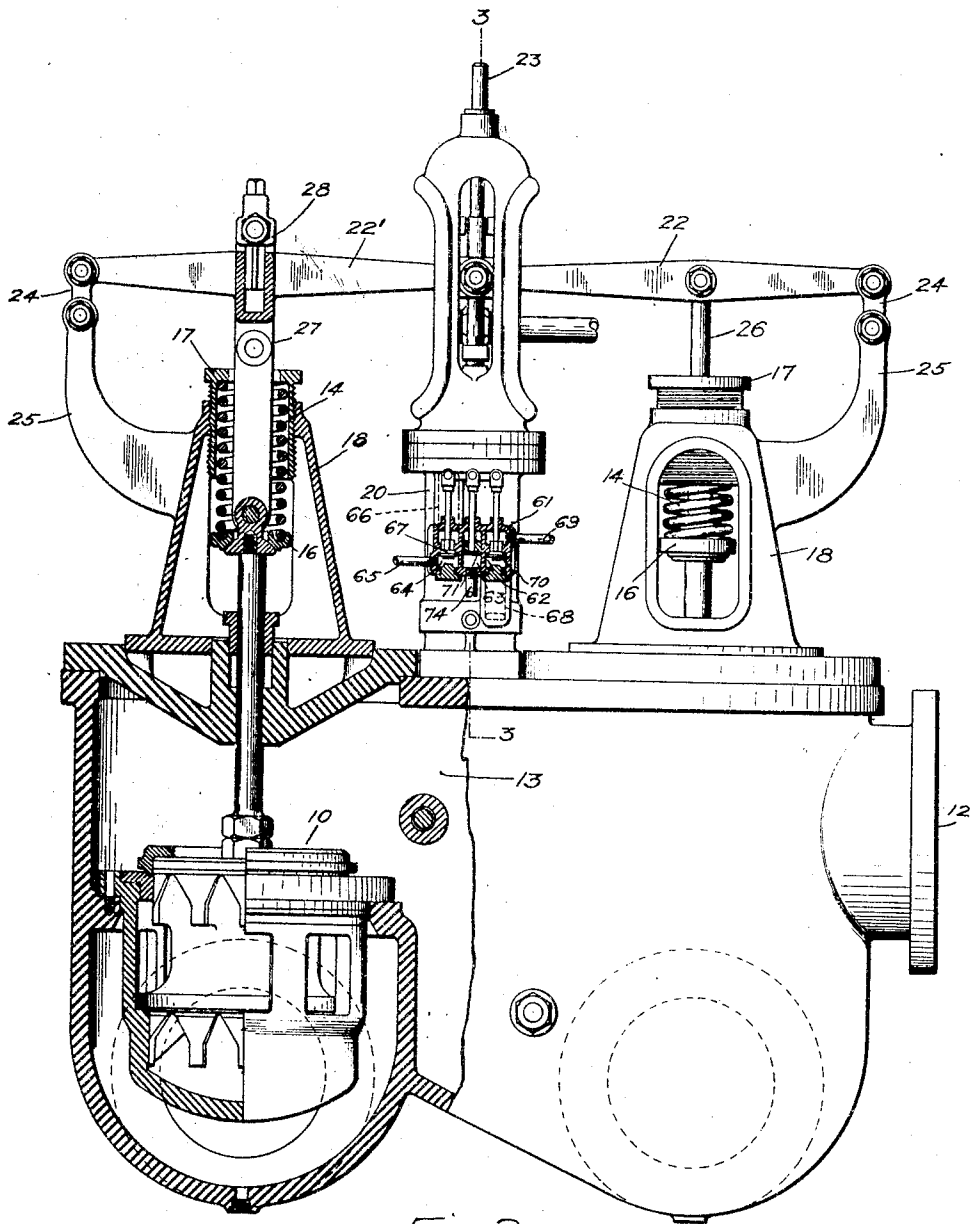


Fig. 2.

WITNESSES:

Wm. S. Green
B. J. Frank

INVENTOR.

BY *Francis Hodgkinson*
Jos. S. Green
HIS ATTORNEY IN FACT.

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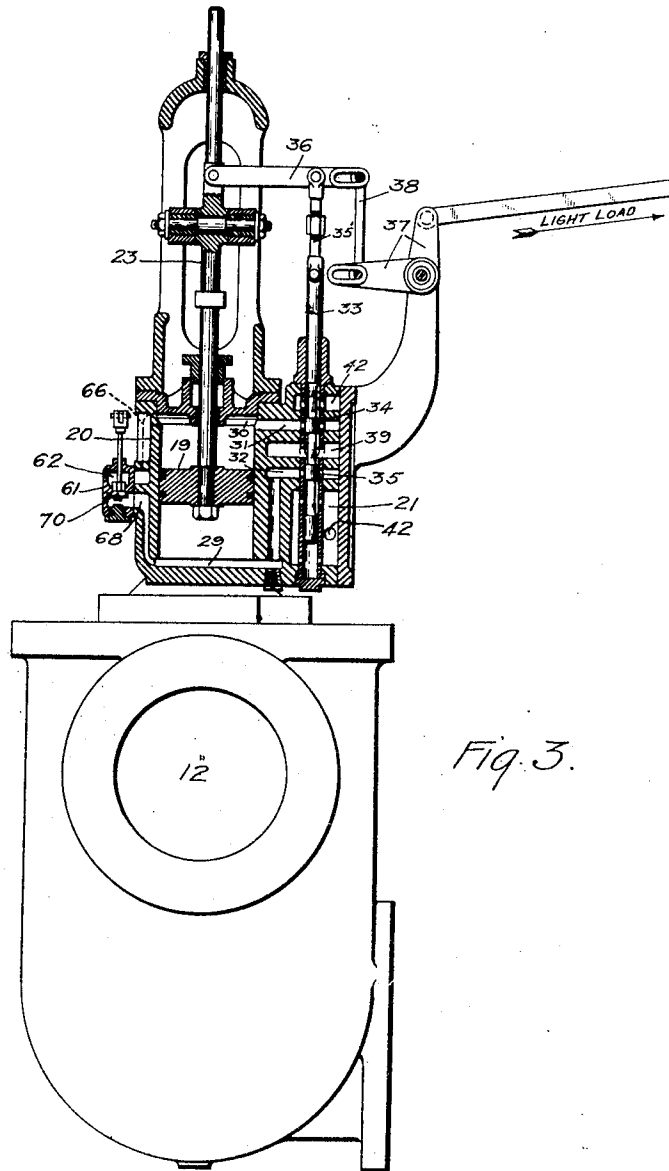


Fig. 3.

WITNESSES:

Wm. J. Peto.
B. J. Peto.

INVENTOR.

BY

Francis Hodgkinson
Jos. S. Green
HIS ATTORNEY IN FACT.

1,151,522.

Fig. 4.

Wm. H. P.
B. H. P.

BY

Francis Hodgkinson
Jno. S. Green
HIS ATTORNEY IN FACT.

UNITED STATES PATENT OFFICE.

FRANCIS HODGKINSON, OF EDGEWOOD PARK, PENNSYLVANIA, ASSIGNOR, BY MESNE ASSIGNMENTS, TO THE COLONIAL TRUST COMPANY, TRUSTEE, OF PITTSBURGH, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA.

OIL-ACTUATED VALVE MECHANISM FOR STEAM-TURBINES.

1,151,522.

Specification of Letters Patent.

Patented Aug. 24, 1915.

Application filed February 10, 1910. Serial No. 543,110.

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 Edgewood Park, in the county of Allegheny and State of Pennsylvania, have made a new and useful Invention in Oil-Actuated Valve Mechanism for Steam-Turbines, of which the following is a specification.

10 This invention relates to governing means for fluid pressure engines and has for an object, to produce a valve controlling mechanism which will readily respond to variations of speed and will proportion the delivery of fluid to the engine in accordance with the load demand.

Another object is to produce a valve controlling mechanism in which means are employed for eliminating, to a great extent, the friction of rest between the governor controlled parts and, for overcoming the tendency of the valve and the valve operating parts to stick.

Another object of the invention is to provide an oil relay actuated by speed responsive device and one which will not be subjected to static friction but which will be extremely sensitive so as to respond quickly to variations in the position of the movable member of the speed responsive device.

30 A further object is to produce a governor controlled valve and means for closing the valve and for rendering the governor controlled operating mechanism incapable of opening the valve when the turbine has exceeded a predetermined speed.

A further object is to produce a hydraulically actuated governor controlled valve operating mechanism for fluid pressure engine, in which new and effective means are employed for automatically delivering the initial pressure motive fluid to a section or portion of the engine, normally exposed to, and operating under low pressure motive fluid.

45 These and other objects I attain by means of the apparatus illustrated in the accompanying drawings which form a part of this application.

50 In the drawings accompanying this ap-

plication, Figure 1 diagrammatically illustrates, by means of perspective views of the principal elements, an embodiment of my invention as applied to a steam turbine. Fig. 2 is a partial side elevation and sectional view of the steam chest of the turbine, equipped with a valve operating mechanism, embodying my invention. Fig. 3 is a side elevation of a steam chest shown in connection with a sectional elevation taken along the line 3—3 of Fig. 2, of the valve operating mechanism and Fig. 4 is a fragmental sectional view of the turbine, provided with a valve operating mechanism embodying my invention.

I have illustrated an embodiment of my invention in connection with a steam turbine of the multi-stage type, in which a primary valve admits steam to the initial stage or section of the turbine and a secondary or overload valve by-passes a portion of this steam, admitted through the primary valve, around one or more stages or sections of the turbine and admits it to a stage or section normally operating under lower pressure.

75 The valve operating mechanism is shown as controlled by the turbine governor and is so arranged that the primary valve will open, and proportion the amount of steam delivered to the turbine in accordance with the load demand until a certain load or overload is encountered, at which time the secondary valve will open, the primary valve being wide open, and the function of governing the turbine will then be shifted to the secondary valve. The secondary valve will then proportion the amount of steam by-passed around the high pressure section and delivered to a low pressure stage or section of the turbine.

90 The valve operating mechanism shown, consists of a reciprocating piston mounted in a cylinder to which oil, under pressure, is delivered by a governor controlled relay valve. The relay valve controls the delivery of oil to the cylinder and consequently the piston moves up and down in response to variations in the speed of the turbine. A supplemental relay device is provided, and is adapted to control the delivery of oil to, 100

and the discharge of oil from the cylinder so that the piston will move to close both the primary and secondary valves, irrespective of the operation of the governor controlled valve mechanism. This supplemental relay is shown as controlled by an emergency governor, which comes into action when the speed of the turbine has exceeded a predetermined safe speed. The oil for actuating the reciprocating piston is under pressure and may be delivered from the lubricating system of the turbine.

Referring to the drawings by means of the numerals which designate the separate parts, the turbine consists of a rotor element 5 and an inclosing casing 6, which is provided with a main fluid inlet port 7 and a secondary inlet port 8. These ports are respectively controlled by valves 9 and 10, mounted in a steam chest 11, which is secured to the turbine casing and through which steam is delivered to the turbine. A main admission port 12 is provided in the steam chest and communicates with some source of high pressure steam, such as a steam generator. The valve 9 is the primary valve of the turbine and controls the delivery of steam through the inlet port 12 to the turbine. The valve 10 may be termed the secondary or overload valve and controls the delivery of steam through a by-pass 13 to the secondary inlet port 8. The passage 13 receives steam delivered by the valve 9, prior to its delivery to the port 8, and consequently steam delivered to the turbine through the secondary inlet port 8 is bypassed around the primary or high pressure sections or stages of the turbine and is delivered to a section or stage which normally receives steam at a lower pressure.

Each valve 9 and 10 is normally held closed by a yielding agent, such for example, as a coil spring 14, which surrounds the valve stem and operates between a disk 16 carried by the stem and an adjustable spring block 17 mounted on a guide frame, shown as a bonnet 18, which is secured to the steam chest 11. Both the valves 9 and 10 are controlled by a hydraulically operated piston 19, which is mounted in a cylinder 20, to which the delivery of oil or other liquid under pressure is controlled by a governor controlled relay 21.

The piston 19, in reciprocating, opens and closes the valves 9 and 10 through the agency of levers 22 and 22', each of which is pivotally connected to the piston rod 23 of the piston 19 and is fulcrumed on a separate link 24 secured to a separate stationary bracket 25 formed integrally with the guide frame 18.

The stem of the valve 9 is connected to the operating lever 22 by means of a link 26 and the stem of the valve 10 is connected to its operating lever 22' by means of link 27

and an adjustable lost motion connection 28. The lost motion connection 28 may be so arranged that the valve 9 will be fully open and delivering a maximum amount of steam to the turbine before the valve 10 starts to open.

The operating cylinder 20 is provided with ports 29 and 30, located at the opposite ends of the cylinder and which respectively communicate with ports 31 and 32 of the relay 21. A plunger 33 is provided with collars 34 and 35 which form valves and control the respective ports 31 and 32. The plunger 33 is pivotally connected, by means of an adjustable link 35', with a lever 36, which is fulcrumed on the piston rod 23 and is connected to a bell-crank lever 37 by means of a link 38. The valves 34 and 35 are provided with sufficient lap to permit of a slight vibratory motion which may be communicative to them by an actuating device through the same linkage which connects them to the speed responsive device. The actuating device is so arranged that the valves will, on account of their constant movements, become extremely sensitive, and by admitting a small amount of oil to the cylinder 20 at each pulsation, cause the piston 19 to slightly pulsate and be ready to respond quickly to the will of the speed responsive device and at the same time obviate static friction which would be present if the valves 34 and 35 were at any time in a position of rest. The bell-crank 37 is connected to a similar bell-crank 37' through the medium of a link 37². A lever 37³ is connected to a speed responsive device 37⁴ and is pivotally supported by bracket 37⁵. Fulcrumed on the lever 37³ is a lever 37⁶ connected to a bell-crank 37⁷ by a link 37⁸ and to a reciprocatory rod 37⁹, the roller 48 of which bears upon a cam surface on a worm wheel 37¹⁰ on a shaft of the pump 40. The weight of the rod 37⁹ may keep the roller in contact with the cam surface but if desired a spring may be employed for this purpose.

A port 39 is provided in the casing of the relay 21 and is adapted to communicate with a source of oil supply, such as the rotary pump 40, through a supply pipe 41. Exhaust ports 42 are located on each side of the admission port 39 and are adapted to communicate with an oil reservoir 43, through suitable piping 44. The valves 34 and 35 are so located on the plunger 33 and with reference to the ports 31 and 32, that when one of the ports 31 or 32 is closed both are closed and when the one is open to the port 39 for the purpose of supplying oil pressure to the cylinder 20 the other is opened to one or the other of the exhaust ports 42 for the purpose of discharging oil from the cylinder 20. With this arrangement, oil is delivered to one end of the cylinder 20 and is discharged from the other end and the pis-

ton 19 moves up or down in response to variations in speed of the turbine.

During light loads on the turbine the valves 34 and 35 will move to such positions that the ports 31 and 32 will respectively communicate with the ports 39 and 42. This will deliver oil to the cylinder 20 above the piston 19 and discharge oil from the cylinder below the piston 19 and the piston will move downwardly in response to the oil pressure to close one or both of the valves 10 and 9. As the piston 19 moves downward in response to the oil pressure, it carries with it the fulcrum of the lever 36 and consequently moves the plunger 33 down and eventually closes the ports of the relay valve and, by confining the oil in the cylinder, temporarily holds the piston 19 in a set position.

When the load on the turbine increases, the plunger 33 will be moved by the speed responsive device 37⁴ through the communicating links, to such a position that the valves 34 and 35 will place the ports 31 and 32 in communication with the respective ports 42 and 39. This will admit oil to the cylinder 20 below the piston 19 and will exhaust oil from above the piston and the piston will rise, in response to the oil pressure, to open the valve 9 a greater or less amount, or to fully open valve 9 and then open or partially open valve 10. The continual reciprocations of the plunger 33, in response to the reciprocations of the rod 37⁸ causes the oil pressure of the cylinder 20 to pulsate slightly at all times. This causes sufficient motion in the valve operating mechanism to overcome a tendency of the valves and the valve operating mechanism to stick, but it may not be sufficient to cause substantial pulsations in the steam delivered to the turbine.

During light and normal loads on the turbine, the piston 19 in reciprocating, varies the position of the valve 9 only. As the load increases and the turbine slows down a corresponding amount, the piston 19 is raised to such a position that the lost motion connection 28 becomes effective and lifts the valve 10.

The supplemental relay 61 is provided for the purpose of closing the valves 9 and 10 when the turbine exceeds a certain determined speed. The relay valve 61 is adapted to exhaust oil from the cylinder 20 below the piston 19 and to admit oil to the cylinder above the piston, and its ports are so proportioned that the piston 19 will move down to close both of the valves 9 and 10, irrespective of the position of the relay valves 34 and 35. The casing of the valve 61 is divided into three chambers 62, 63 and 64, and the chamber 64 communicates with a source of oil supply, such as the pump 40, through a pipe 65 and with the upper por-

tion of the cylinder 20 through a pipe or passage 66. In Fig. 1, the relay valve 61 is shown as a separate valve for illustrative purposes and is connected to the cylinder 20 by means of pipes. The other drawings illustrate a preferable arrangement in which the valve casing is secured to the cylinder 20 and communicating passages are formed in the cylinder walls. A valve 67 is located in the chamber 64 and is adapted to control the communication between the oil supply pipe 65 and the cylinder 20.

The chamber 62 communicates with the lower end of the cylinder 20 through a passage or pipe 68 and with an exhaust pipe 69, which leads to the reservoir 43. The chamber 62 incloses a valve 70 which controls the communication between the passage 68 and the exhaust pipe 69 when seated. Both of the valves 67 and 70 are coupled together and their operation is controlled by means of the piston 71, which is located within the cylinder 63.

Live steam is admitted to the cylinder 63 above the piston 71 through a pipe 73. An exhaust pipe 74 communicates with the lower end of the chamber 63 below the piston 71 and is closed by means of a valve 75. The piston 71 is so constructed that it permits steam to leak around it and consequently it is balanced when the valve 75, in the exhaust pipe 74, is closed. Each of the valves 67 and 70 are so arranged that that are held to their seats by oil pressure, when closed. In seating the relay valve 61 the valve 75 is first closed so that steam pressure equalizes on each side of the piston 71, then the piston 71 and the valves 67 and 70 are raised so as to close communication between the respective pipes or passages 65 and 66 and pipes or passages 68 and 69.

An emergency governor 78 is diagrammatically shown on one end of the turbine shaft 49 and consists of a spring restrained weight 80 which is adapted to move outwardly, under the influence of centrifugal force, to engage a trip lever 79 and to thereby open the valve 75 and exhaust the steam from the chamber 63 below the piston 71. When this is accomplished, the steam pressure above the piston 71 preponderates and moves the piston down thereby opening both the valves 67 and 70 and admitting oil pressure to the cylinder 20 above the piston 19 and discharging it from out the cylinder below the piston. The ports of the relay valve 61, as has been said, are of such size that the piston 19 will move to what is shown as the lower end of the cylinder 20 and close both of the valves 9 and 10 irrespective of the position of the relay plunger 33. In reseating the relay 61 it is necessary to close the valve 75 in the exhaust pipe 74, set the trip lever 79 and also raise the valves 67 and 70 and the piston 71 to an upper

position. This closes the ports in the relay 61 and renders the relay 21 again effective in controlling the operation of the piston 19. The emergency governor contacts with the trip lever only when the speed of the turbine exceeds a safe determined speed.

Having now described my invention, what I claim is:

1. An engine, a valve for admitting motive fluid to said engine, a pressure actuated motor for actuating said valve, a governor controlled relay for controlling the operation of said motor and an auxiliary relay for rendering said governor controlled relay ineffective and for causing said motor to close valve.

2. An engine, a valve for admitting motive fluid to said engine, means for actuating said valve, a governor controlled relay device for controlling the operation of said means, an emergency governor, and an auxiliary relay controlled by said emergency governor for rendering said governor controlled relay ineffective and for causing said means to close said valve.

3. An engine, a valve for admitting motive fluid to said engine, hydraulically actuated means for controlling the operation of said valve, a governor controlled relay device for controlling the operation of said means, an emergency governor, and an auxiliary relay controlled by said governor for rendering said relay device ineffective and for causing said means to close said valves.

4. In combination in a turbine, a valve for delivering motive fluid to the turbine, a pressure actuated mechanism for opening and closing said valve, a relay valve for controlling the operation of said mechanism, a governor for controlling the operation of said relay valve, a connection between said relay valve and said mechanism whereby movements of said mechanism cause motion of said relay valve, and means for imparting a vibrating motion to said relay valve.

5. In an oil relay, a piston and its cylinder, ports leading to said cylinder, a valve for uncovering said ports, means for imparting a positive opening movement to said valve, and means for imparting a constant vibratory motion to said valve.

6. In an engine, a valve for admitting motive fluid to said engine, a pressure-actuated motor for actuating said valve, a governor-controlled relay for controlling the operation of said motor, an auxiliary relay for rendering said governor-controlled relay ineffective and for causing said motor to close said valve, and means for preventing operation of said auxiliary relay until the engine has accelerated beyond a determined speed.

7. An engine, a valve for admitting motive fluid to said engine, a pressure-actuated motor for actuating said valve, a governor-controlled relay for controlling the operation of said motor, means for connecting the movable parts of the motor and the relay together, and an auxiliary relay for rendering said governor-controlled relay ineffective and for causing said motor to close said valve.

8. In a relay, a piston and its cylinder, ports leading to the cylinder, a valve for controlling the ports, a connection between the valve and the piston whereby movements of the piston cause movements of the valve, and means for imparting a constant vibratory motion to the valve.

9. In an oil relay, a piston and its cylinder, pressure delivery ports leading to the cylinder, a valve having lap and controlling said ports, a connection between the piston and the valve whereby movements of the piston cause movements of the valve, and means for imparting a vibratory motion to the valve without fully uncovering said ports.

10. In an oil relay, a cylinder having pressure delivery ports formed therein, a piston located within the cylinder and movable in response to variations in pressure within the cylinder, a vibratory valve for controlling the cylinder ports, said valve being mechanically connected to the piston whereby movements of the piston cause movements of the valve.

11. In combination in an engine, an inlet valve for delivering motive fluid to the engine, a pressure actuating motor for opening and closing said inlet valve, a governor-controlled valve for controlling the delivery of actuating pressure to said motor, an emergency valve for delivering actuating pressure to said motor to close said inlet valve independently of the operation of the governor-controlled valve, and an emergency governor for controlling the operation of said emergency valve.

12. In combination in a turbine, a main inlet valve for delivering motive fluid to the high pressure section of the turbine, a secondary inlet valve for delivering motive fluid to a section of the turbine normally receiving low pressure fluid, a motor for actuating both of said valves, a governor driven by the turbine for controlling the operation of said motor, and emergency means for controlling the motor to close said valves independently of the operation of the governor.

13. In combination in a turbine, a valve for admitting motive fluid to a high pressure section thereof and for governing the turbine through a determined range of speeds, a by-pass valve for delivering high

pressure fluid to a section of the turbine normally receiving fluid at a lower pressure and on which the function of governing the turbine is imposed when the first valve is fully opened, mechanisms for controlling both of said valves and for opening the by-pass valve after the first mentioned valve is fully opened, a relay device for controlling the operation of said mechanisms, and a device for rendering said relay device ineffective and for causing said mechanisms to close both of said valves.

14. In a turbine, a main inlet valve for delivering motive fluid to a high pressure section of the turbine, a secondary inlet valve for delivering high pressure motive fluid to a section of the turbine normally receiving motive fluid of a lower pressure, means for actuating said valves so that the main inlet valve is opened first and operates to govern the speed of the turbine until the secondary valve is open, governor-controlled mechanisms for controlling the operation of same means, a device for rendering said governor-controlled mechanisms ineffective and for causing said means to close both of said valves, and an emergency governor for controlling the operation of said device.

15. In combination in a turbine, a valve for delivering motive fluid to the turbine, a pressure actuated mechanism for actuating said valve, a relay valve for controlling the delivery of actuating fluid to said mechanism, a governor for actuating said relay valve, means for imparting a vibratory motion to said relay valve, and means for moving said relay valve in response to movements of said admission valve.

16. In combination with an engine, an admission valve, a pressure actuated motor for actuating said valve, a governor actuated relay valve for controlling the operation of said motor, means for moving said relay valve in response to movements of said valve actuating motor, and means for imparting a constant vibratory motion to said relay valve.

17. In combination with an engine, an admission valve, a valve actuating motor for controlling the operation of said valve, a relay valve for controlling the operation of said motor, a governor responsive to the speed of the engine for actuating said relay valve, means for moving said relay valve in response to motion imparted to said admission valve by said motor, and means actuated by said engine for imparting a vibratory motion to said relay valve.

18. In combination with an engine, an admission valve, a valve actuating motor for controlling the operation of said valve, a governor relay valve for controlling the operation of said motor, means for moving said relay valve in response to movements

of said motor, an emergency valve for controlling the operation of said motor independently of said relay valve, and an emergency governor for actuating said emergency valve.

19. In combination in a turbine, a valve for admitting motive fluid to a high pressure section thereof and for governing the turbine through a determined range of speeds, a by-pass valve for delivering high pressure motive fluid to a section of the turbine normally receiving fluid at a lower pressure and on which the function of governing the turbine is imposed when the first valve is substantially wide open, pressure actuated mechanisms for controlling both valves and for opening the by-pass valve after the admission valve is substantially fully open, governor controlled means responsive to movements of said pressure actuated mechanisms for controlling the operation of said mechanisms, and means for imparting a vibratory motion to the governor controlled means during the operation of the turbine.

20. In combination in a turbine, a valve for admitting high pressure motive fluid to a high pressure section of said turbine, a second valve for delivering motive fluid to a section of the turbine normally receiving motive fluid at a pressure less than that delivered by the admission valve, a pressure actuated motor for controlling the operation of both valves, a governor, a relay valve actuated by said governor for controlling the operation of said motor, means for moving said relay valve in response to movements of said motor, and means for imparting a vibratory motion to the relay valve during the operation of the turbine.

21. In combination in a turbine, an admission valve for delivering motive fluid to the turbine, a second valve for delivering motive fluid to the turbine, a pressure actuated motor for actuating both of said valves, a separate actuating lever between said motor and each valve, a governor actuated relay for controlling the operation of said motor, means for imparting a vibratory motion to said relay during the operation of the turbine, and a lever actuated by said motor for moving said relay.

22. In combination in a turbine, an admission valve for delivering motive fluid to the turbine, a second valve for delivering motive fluid to the turbine, a pressure actuated motor, connections between said motor and said valves whereby one of said valves is opened prior to the opening of the other and closed subsequent to the closing of the other, a relay for controlling the operation of the motor, a connection between the motor and the relay whereby motion is imparted to the relay by a move-

ment of the motor, and means for imparting a vibratory motion to the relay during the operation of the turbine.

23. In a relay mechanism, a piston, a cylinder therefor having a port formed therein, a valve having lap controlling the passage of fluid through said port, a connection between the piston and the valve whereby movements of the piston cause movements of the valve,

and means for eliminating the effect of the lap with which said valve is provided.

In testimony whereof, I have hereunto subscribed my name this 8th day of February, 1910.

FRANCIS HODGKINSON.

Witnesses:

B. F. FUNK,

C. W. MCGHEE.