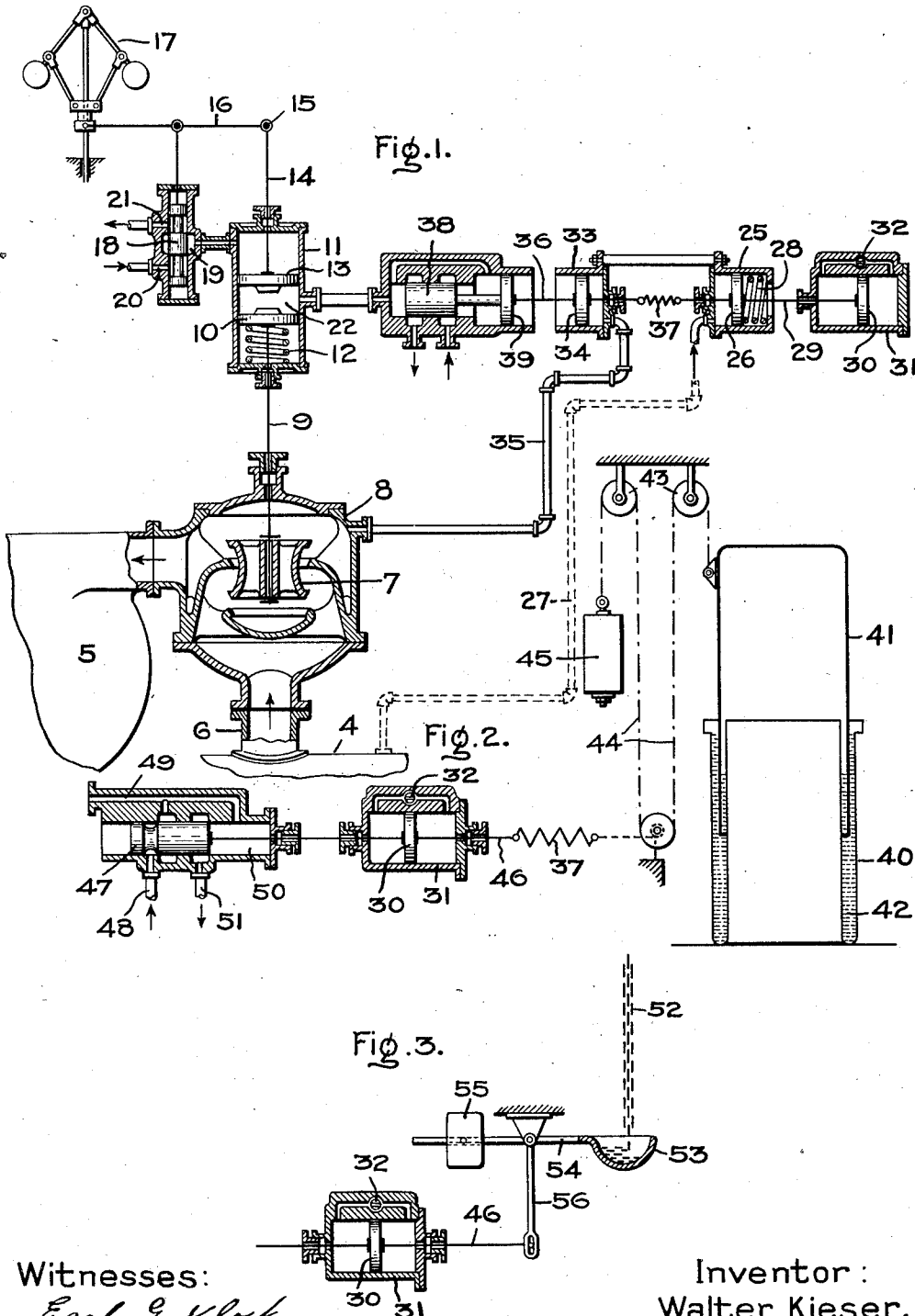


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REGULATING MECHANISM FOR STEAM TURBINES.
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UNITED STATES PATENT OFFICE.

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REGULATING MECHANISM FOR STEAM-TURBINES.

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Specification of Letters Patent.

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To all whom it may concern:

Be it known that I, WALTER KIESER, a citizen of Switzerland, residing at Charlottenburg, Germany, have invented certain new and useful Improvements in Regulating Mechanism for Steam-Turbines, of which the following is a specification.

In operating steam turbines driven by the exhaust of other turbine engines or machines, it is common practice to insert a heat storage device or accumulator between the engine and turbine, or to insert a header or other conduit containing a relatively large storage space, to equalize as fully as possible the current of steam flowing to the turbine although the steam is received intermittently and in greatly varying quantities from the engine. These devices only imperfectly fulfil their purpose, however, since their size is necessarily restricted. Great variations in the pressure or quantity of steam occur, with corresponding variations in the steam flowing to the turbine that result in an irregular delivery of power by said turbine. It is true that the delivery of power by the turbine may be kept constant by means of its regulator or by other parallel connected engines but variations in the speed of the turbine rotor will take place which are highly objectionable for many classes of work, notably where the turbine is driving an alternating current generator connected in parallel with one or more similar generators.

My invention has for its object to overcome the objections above noted and to provide an improved regulating mechanism which will insure a uniform supply of low pressure steam to the turbine, said supply corresponding to the average steam conditions prevailing.

Briefly stated, my invention comprises a mechanism which compensates for variations in pressure or amount of steam in the equalizing vessel, so that these variations are only transmitted to the regulating device proper to an average extent.

For a fuller description of my invention, attention is directed to the accompanying description and the claims appended thereto.

In the drawings which are illustrative of my invention, Figure 1 is a more or less diagrammatic view showing my improved

regulating mechanism adapted for conditions where the pressure variations of the exhaust steam supply are great; Fig. 2 is a modification adapted for use where the steam storage device between the engine and its exhaust turbine has a variable capacity; and Fig. 3 is a modification of the damping means.

Referring to Fig. 1, the equalizing vessel or accumulator 4 has a space or chamber of invariable size to receive the exhaust steam from one or more reciprocating engines or other machines. It is connected to the low pressure turbine 5 by a conduit 6 that contains the main regulating valve 7 and its inclosing casing 8. The valve is attached to a rod 9 that is connected to a piston 10. Between the piston and the lower head of the cylinder 11 is a compression spring 12 that tends at all times to open the valve. A second piston 13 is also mounted in the cylinder which is attached to a rod 14, the latter carrying a pivot 15 for the governor lever 16. The cylinder 11 and its contained pistons 10 and 13 and the compression spring 12 form a motor mechanism for actuating the main regulating valve in response to speed variations of the turbine, the left hand end of the lever 16 being attached to a sliding collar that is moved by the speed governor 17, the latter being driven by the turbine. Located in a suitable casing is a pilot valve 18 that controls the port 19 leading to the upper end of the cylinder 11, also an inlet port 20 and an exhaust port 21. Some fluid, such as oil under pressure, is admitted to the cylinder 11 above the piston 13 for actuating both pistons. When the pressure above the piston exceeds that below, the piston moves downward until an equilibrium is reestablished. When the pilot valve uncovers the exhaust port 21, fluid above the piston 11 can escape, and the amount thereof will depend upon the pressure under said piston, due either to the spring 12 or the pressure within the chamber 22 between said pistons, which will be referred to later. When the opposed projections on the pistons 10 and 13 contact they both move up and down in unison. They also move up and down in unison when there is a column of fluid trapped between them, the fluid in this case forming in effect

a part of the pistons. The mechanism thus far described is not specifically new with me. My invention is directed to a mechanism that coöperates with the parts described whereby they are caused to act more effectively than heretofore.

Referring now to the mechanism that is responsive to pressure and which modifies the action of the main regulating valve 7, 25 indicates a cylinder containing a piston 26, one side of which is exposed to the pressure in the accumulator, receiver or other vessel 4. This pressure is communicated by the pipe 27, shown in dotted lines for simplicity. The other side of the piston is acted upon by the compression spring 28 and also by atmospheric pressure. To the piston is attached a rod 29 having a dash-pot piston 30 on it forming a part of a damping device. The piston is located in a cylinder 31 filled with fluid such as oil. A by-pass connects opposite ends of the cylinder and contains a throttle valve 32 by means of which the effective action of the piston can be controlled. In other words, the piston 30 forms a controllable brake or damper for the piston 26 and parts associated therewith and any desired ratio of the force acting on the pistons 30 and 26 can be obtained by suitable adjustment of the valve 32. Situated at the left of the cylinder 25 and in axial alinement therewith is a cylinder 33 containing a piston 34, one side of which is exposed to steam on the turbine side of the throttle, *i. e.*, to the pressure of the steam admitted to the nozzles or other fluid discharging devices of the low pressure turbine 5. Steam is conveyed from the valve casing to the cylinder by the pipe 35. The left hand side of the piston is exposed to some constant pressure, such as atmospheric pressure, for example. The piston is mounted on a rod 36 which is connected on its right hand end by an extension spring 37 with the piston rod 29. The function of this spring is to absorb the small and constantly occurring pressure variations that take place in the vessel 4. The left hand end of the piston rod 36 is connected to the regulating or controlling valve 38 that is of the sliding type and controls the passage of oil under pressure into and from the chamber 22 between the pistons 10 and 13 before referred to. On the rod 36 and associated with the controlling valve 38 is a piston 39 that is exposed on one side to a constant pressure such as that of the atmosphere, and on the other side to the pressure of the fluid in the chamber 22 between the pistons 10 and 13. The relative positions of the several cylinders and damping devices can obviously be changed from that shown and described while they continue to function in the manner herein set forth.

It will be seen that the piston 10 is in-

fluenced by the spring 12 and the oil pressure and the piston 13 by the oil pressure under the control of the valves 18 and 38. From this it follows that the position of the main valve 7 will be dependent on the speed governor 17 on the one hand and the difference between the steam pressure prevailing in the storage vessel 4 and that on the delivery side of the valve 7 or in front of the nozzles, on the other hand.

The operation of the mechanism is as follows: The great variations of pressure in the storage vessel 4 after being much lessened by the effect of the spring 37 and the retarding effect of the piston 30 are transmitted to the controlling valve 38. The spring 37 absorbs the frequently occurring smaller pressure variations so that under an average rising pressure the controlling valve 38 is gradually moved to the right. Under these conditions, oil will escape from the chamber 22 in the motor cylinder 11 thereby relieving the pressure above the lower piston 10 and permitting the spring 12 to raise it and open the main valve wider. The net result of this is to supply the turbine with steam under the average steam conditions. In order to make the regulation dependent also upon the pressure on the turbine side of the admission valve, the piston 34 by virtue of this pressure is displaced in the opposite direction from piston 26 that is affected by the accumulator or reservoir pressure so that if the pressure at the nozzles is too great, (due to a right hand movement of controlling valve 38), the main valve is prevented from opening further and in some cases is even moved toward its seat. The operation of the main valve in consequence of too great a pressure at the turbine or too small a pressure in the accumulator is effected by means of oil under pressure passing into the chamber 22 under the control of the slide valve 38. This fluid pressure also acts upon the return piston 39 associated with the valve. If the main valve 7 has sufficiently closed, that is, if the back pressure on the piston 39 has so increased that it preponderates over the steam- and spring-pressures acting on the pistons 34 and 26, then the controlling valve 38 will be moved to the right to cover its ports and further transfer of oil is temporarily prevented. Under these conditions the speed governor 17 will be directly in control of the main valve 7, the oil in the chamber 22 constituting in effect a part of the piston.

In Fig. 2 is shown an arrangement of parts suitable for installations where the chamber of the accumulator, vessel or steam-holding device is capable of enlarging and contracting as the quantity of the fluid supply from the engine increases or decreases. Such a vessel has the advantage of keeping

the outflowing steam under constant pressure and because of this fact the governing mechanism can be somewhat simplified. In this embodiment of the invention, the position of the main regulating valve of the turbine is made dependent upon the quantity of steam in said vessel. In this figure a device similar to a gasometer is provided wherein 40 is the fixed element and 41 the bell that moves up and down to accommodate the changes in the quantity of exhaust steam. 42 indicates a suitable liquid seal. The movements of the bell are transmitted to the spring 37 by means of a system of pulleys 43, cord 44 and weight 45. 30 indicates the piston of the fluid brake, 31 its cylinder and 46 its piston rod which is connected to the spring and also to the controlling valve 47 that controls the passage of oil to the chamber 22 between the pistons 10 and 13 in the motor cylinder 11.

By reason of the parts above specified, movements of the bell are transmitted to the controlling valve, and due to the interpolation of said spring 37 and brake only small oscillations of the valve about its central position are caused by large or sudden variations in the quantity of steam in the accumulator caused by the periodic supply. Small movements of the bell are taken up by the fluid brake and by the spring 37. A movement of the controlling valve to the right admits oil by the pipe 48 to the passage 49 leading to the chamber 22, see Fig. 1, and also to the chamber 50 to the right of the piston. The exhaust is carried off by the pipe 51. As the operation of the other parts of the system is the same as previously described, further description is unnecessary.

In Fig. 3 is shown a modification wherein the spring 37 is done away with and a variable weight substituted. The chain 52 is attached at its upper end to the bell and as the latter rises and falls the weight of the chain in the cup 53 varies. This cup is mounted on a lever 54 whose opposite end has an adjustable counterweight 55. Depending from the lever is a slotted arm 56 through which the effect of the chain weight is transmitted to the piston rod 46 of the fluid brake piston 30. In this construction as before the small oscillations or variations in pressure are taken up by intermediate mechanism so that only a change in the average steam conditions will affect the position of the main admission valve of the turbine.

In accordance with the provisions of the patent statutes, I have described the principle of operation of my invention, together with the apparatus which I now consider to represent the best embodiment thereof; but I desire to have it understood that the apparatus shown is only illustrative, and that the invention can be carried out by other means.

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

1. A governing mechanism comprising a main valve, means for actuating it, and a speed responsive device for controlling the means, in combination with a device sensitive to pressure changes in the source of supply, and a device sensitive to the pressure of the fluid on the discharge side of the valve, both of said devices modifying the position of the valve as determined by the speed responsive device.

2. A governing mechanism comprising a main valve, means for actuating it, and a speed responsive device for controlling the means, in combination with a device sensitive to pressure changes in the source of supply, a device sensitive to the pressure of the fluid on the discharge side of the valve, both of said devices modifying the position of the valve as determined by the speed responsive device, and a means for neutralizing the effects of fluctuation in pressure.

3. A governing mechanism comprising a main valve, means for actuating it, and a speed responsive device for controlling the means, in combination with a device sensitive to pressure changes in the source of supply, a device sensitive to the pressure of the fluid on the discharge side of the valve, both of said devices modifying the position of the valve as determined by the speed responsive device, and a damping device to retard the action of said pressure responsive devices.

4. A governing mechanism comprising a main valve, means for actuating it, and a speed responsive device for controlling the means, in combination with a device sensitive to pressure changes in the source of supply, a device sensitive to the pressure of the fluid on the discharge side of the valve, both of said devices modifying the position of the valve as determined by the speed responsive device, means for neutralizing the effects of pressure fluctuations, and a damping device which coöperates with said means.

5. In a governing mechanism for low pressure turbines, the combination of a main valve, means for actuating it comprising a pair of pistons located in the same cylinder and separated by a chamber, a pilot valve for controlling their simultaneous movement in the same direction, a governor for the pilot valve, a valve controlling the passage of fluid to said chamber, and means responsive to pressure for moving the last named valve.

6. In a governing mechanism, the combination of a main valve for regulating the flow of motive fluid from one region to another, mechanism for actuating the valve, said mechanism having a plurality of movable members, and means responsive to the pressure difference existing between the regions on the opposite sides of the valve that

acts to move one of said members relatively to another to modify the action of the actuating mechanism on the valve.

7. In a governing mechanism, the combination of a main valve, a motor mechanism for actuating it, a device responsive to the pressure existing on one side of the valve, a second device responsive to the pressure existing on the other side of the valve, and a means for modifying the action of the motor mechanism on the valve, said devices acting differentially on the means.

8. In a governing mechanism, the combination of a main valve for controlling the flow of motive fluid from one region to another, mechanism for actuating it, means responsive to the pressure difference existing between the regions on the opposite sides of the valve for controlling the action of said mechanism, and means for reducing the effects of periodic pressure variations on the said mechanism.

9. In a governing mechanism, the combination of a main valve, a motor mechanism for actuating it, a speed governor therefor, a pressure responsive means for modifying the action of the governor on the motor mechanism which includes a pair of pressure responsive devices acting in opposition to each other, and a means that interposes a variable resistance to the action of said devices.

10. In a governing mechanism, the combination of a main valve, a motor mechanism for actuating it comprising a divided piston having a chamber between its parts, one of said parts being connected to the valve, a cylinder, and a pilot valve, a governor for actuating the pilot valve, a valve controlling the admission of fluid under pressure to the chamber between the parts of the piston, and a pressure responsive means for actuating the last named valve.

11. In a governing mechanism, the combination of a main valve, a motor mechanism for actuating it comprising a divided piston having a chamber between its parts, one of said parts being connected to the valve, a cylinder, and a pilot valve, a governor for actuating the pilot valve, a valve controlling the admission of fluid under pressure to the chamber between the parts of the piston, and means responsive to the difference in pressure existing on opposite sides of the main valve for actuating the valve controlling the admission of fluid to said chamber.

12. In a governing mechanism, the combination of a regulating valve, mechanism for operating it, a speed governor which primarily controls the mechanism, and means responsive to the pressures on the opposite sides of the valve for controlling movements of the mechanism that are independent of the control of the speed governor.

13. In a governing mechanism, the combination of a regulating valve, a fluid motor for operating it, a speed governor for controlling the motor under certain conditions, a valve controlling the passage of fluid under pressure to the motor for actuating it independently of the governor, and means dependent upon the pressures existing on the supply and discharge sides of the regulating valve for controlling the action of said controlling valve.

14. In combination, a turbine, a vessel supplying steam thereto, a regulating valve for the turbine, means for actuating it, a controller for the means, and a device movable in response to variations in the pressure within the vessel and the pressure within the turbine for actuating the controller, said pressures acting on the device in opposition to each other.

15. In combination, a turbine, a vessel supplying steam thereto, a regulating valve for the turbine, means for actuating it, a controller for the means, and a device movable in response to variations in pressure of the fluid within the turbine for actuating the controller.

16. In combination, a turbine, a vessel supplying steam thereto, a regulating valve for the turbine, means for actuating it, a controller for the means, and means that are responsive to the pressure difference existing on opposite sides of the regulating valve for actuating the controller.

17. A governing mechanism having a regulating valve and mechanism for operating it, in combination with means for modifying the action of the mechanism on the valve, and comprising a cylinder, a piston therein that is responsive to pressure changes, a second cylinder, a piston therein that is also responsive to pressure changes, a yielding means that connects the pistons, and a controller for said mechanism that is actuated by the pistons.

18. A governing mechanism having a regulating valve and mechanism for operating it, in combination with means for controlling the action of the mechanism which are responsive to variations in the pressure of the steam supply on the inlet and outlet sides of the valve, and a damping device so arranged that only the average of said variations are transmitted to the means.

19. A governing mechanism having a regulating valve and mechanism for operating it, in combination with means for modifying the action of the mechanism which are responsive to variations in the steam supply, and a damping device comprising a fluid brake and a spring so arranged that only the average of said variations are transmitted to the means.

20. A governing mechanism comprising a regulating valve, a fluid motor for actuat-

ing it, a controller for the motor, a governor for actuating the controller, a second controller for the motor, and a pressure sensitive device for actuating the second controller.

21. A governing mechanism comprising a regulating valve, a fluid motor for actuating it, a controller for the motor, a governor for actuating the controller, a second controller for the motor, a pressure sensitive device for actuating the controller, and a damper acting on said device.

22. In a governing mechanism for low pressure turbines, the combination of a main valve, means for actuating the valve comprising a hydraulic cylinder, a pair of pistons arranged in the cylinder and separated by a chamber formed between their adjacent faces, a piston rod for each piston, one of said rods being connected to the main valve, a pilot valve for controlling the supply of liquid to and its exhaust from the region between the piston that is not connected to the valve and the adjacent end of the cylinder, a speed governor for actuating the pilot valve, a valve controlling the supply of liquid to and its exhaust from said chamber, means responsive to variations in the supply of low pressure steam for actuating the last mentioned valve, and

a damping device which coöperates with said means.

23. In combination, a turbine, a vessel supplying steam thereto, a valve for regulating the admission of steam to the turbine, means for operating the valve, a controller for the operating means, a speed responsive device for actuating the controller, a second controller for said means, a device responsive to variations in the steam supply for actuating the second controller, and means for preventing over operation of said means by either controller.

24. In combination, a turbine, a vessel supplying steam thereto, a valve for regulating the admission of steam to the turbine, a fluid motor for operating the valve, a valve for regulating supply of fluid to the motor, a casing for the valve, a device responsive to variations in the steam supply for actuating the valve, and means acting independently of the movement of the motor that coöperates with the valve to prevent overtravel of said motor.

In witness whereof, I have hereunto set my hand.

WALTER KIESER.

Witnesses:

HERMANN HILLS,
BERNNHARD KUHNOW.