E. W. MIX.

AUTOMATIC REGULATION OF MIXED PRESSURE TURBINES.

APPLICATION FILED DEC. 14, 1910.

1,021,257. Patented Mar. 26, 1912.

2 SHEETS—SHEET 1.

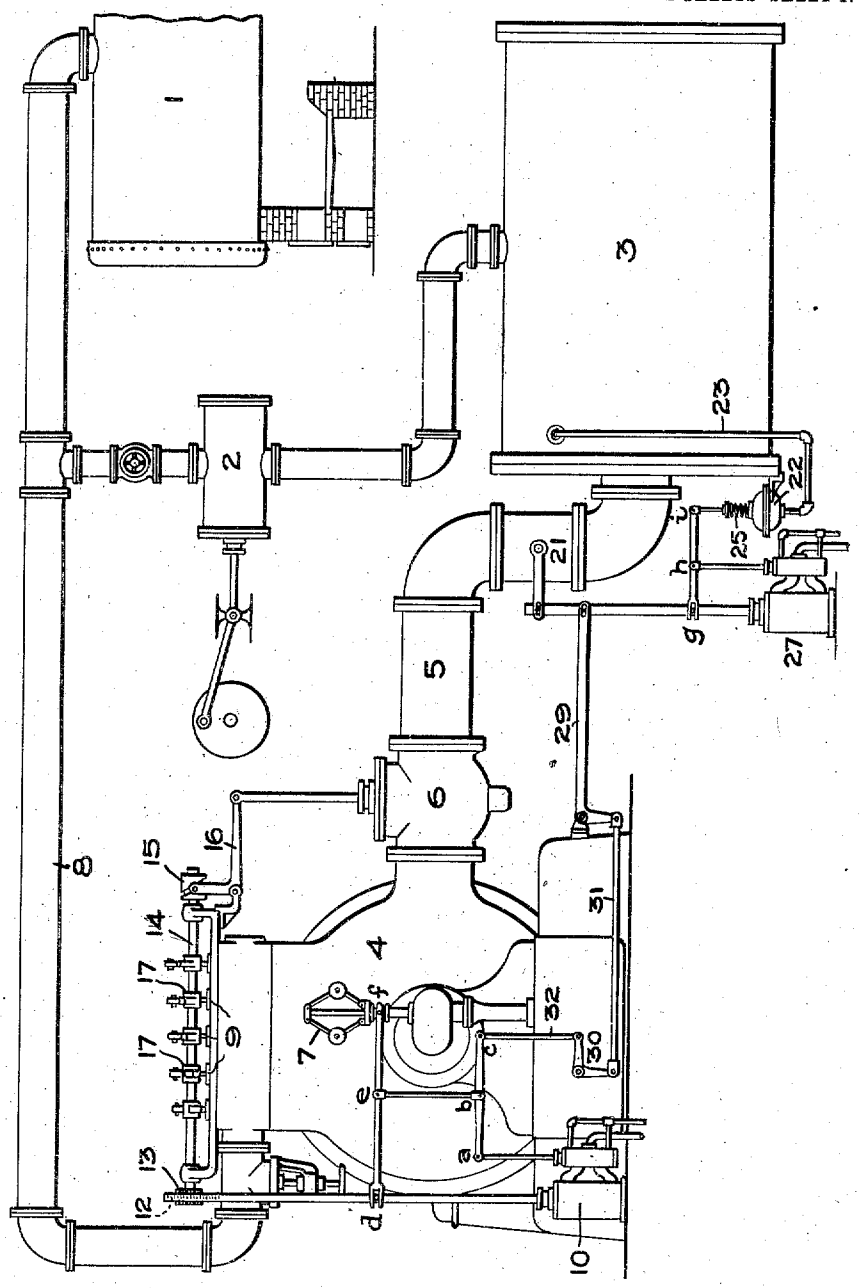

Fig. 1.

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2 SHEETS—SHEET 2.

Fig. 2.

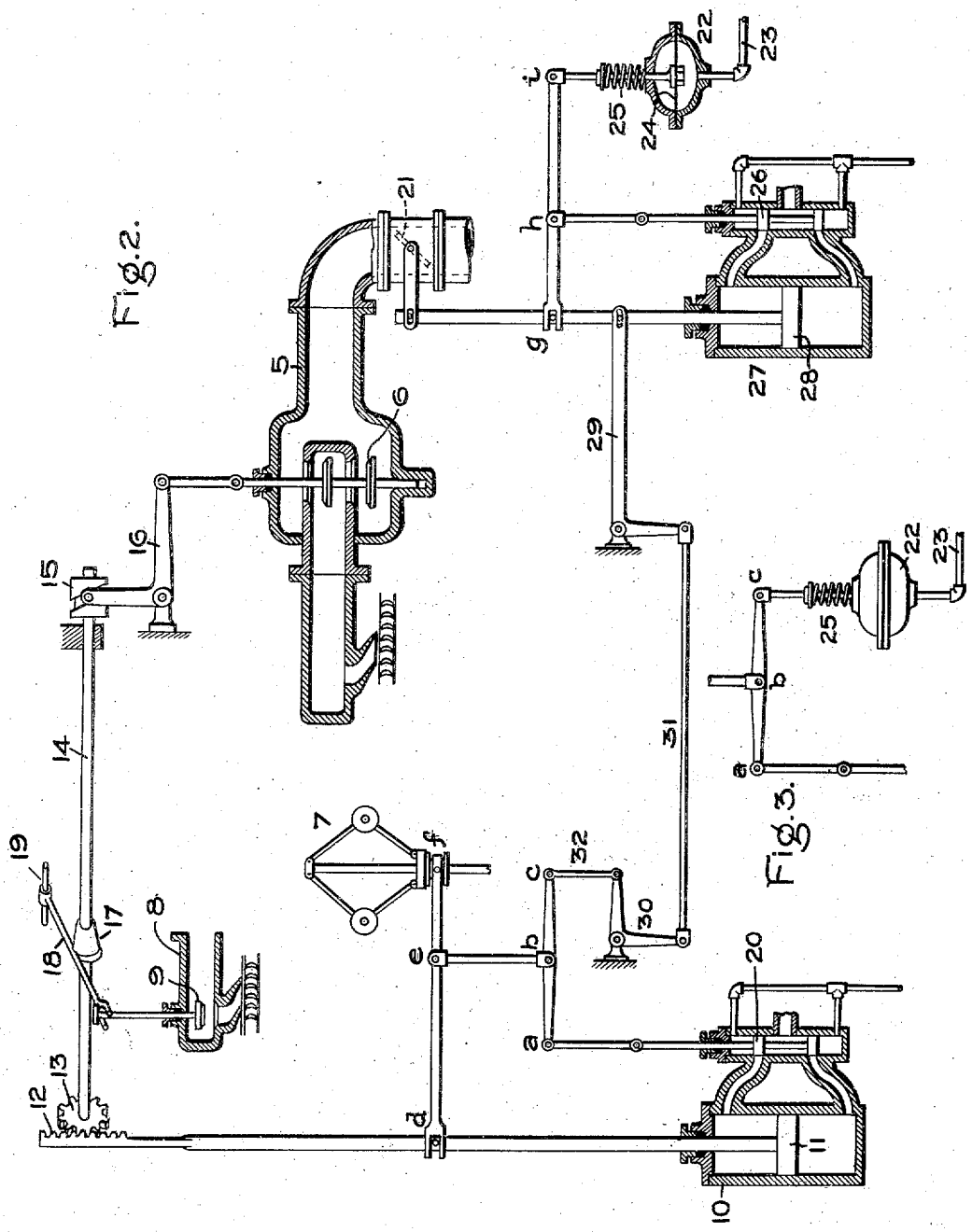

Fig. 3.

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UNITED STATES PATENT OFFICE.

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AUTOMATIC REGULATION OF MIXED-PRESSURE TURBINES.

1,021,257. Specification of Letters Patent. Patented Mar. 26, 1912.

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To all whom it may concern:

Be it known that I, EDGAR W. MIX, a citizen of the United States, residing at Paris, France, have invented certain new and useful Improvements in Automatic Regulation of Mixed-Pressure Turbines, of which the following is a specification.

This invention relates to systems of feeding a turbine, or other similar prime mover, with elastic fluid at different pressures and from different sources. Such systems are commonly employed in what are known as mixed pressure turbines, that is to say, a turbine which is normally supplied with low pressure steam from the exhaust of a reciprocating engine or other source, but is also arranged to take steam at boiler pressure whenever there is a failure of the low pressure supply, or in case greater power is demanded from the turbine than it can produce with low pressure steam. Consequently, with an increasing load on the turbine, the regulating device should at first progressively open the low pressure steam valve or valves to substantially full flow capacity, and when necessary it should then progressively open the high pressure valve or valves. Moreover, if the load remains constant, but the pressure or supply of the low pressure steam decreases, it is necessary that the regulating device produce an increase in the admission of high pressure steam, and furthermore that it shall if necessary produce a throttling of the low pressure steam in order to moderate the lowering of its pressure, and possibly to maintain it at or above a predetermined minimum pressure, especially if a steam accumulator is employed between the high pressure engine and the low pressure turbine. It is very evident that the same regulating device should be capable of producing the reverse operation in case of diminution of the load, or of augmentation of the pressure of the low pressure steam or of the available quantity of this fluid. In short, the regulating device for controlling the admission of low pressure and high pressure steam will comprise two pieces of apparatus: (1) Apparatus to maintain the speed constant notwithstanding the variations of load, including a speed or load responsive device which shall suitably modify the total amount of the two fluids admitted, acting in the same manner on the admission of both, whatever may be the part performed by each fluid in furnishing energy to the turbine. (2) Apparatus dependent upon the pressure or the amount of low-pressure steam which, under the action of the variations of these physical quantities, will produce upon the members controlling the admission of the two fluids the same actions as those produced by the speed-responsive device under the action of variations of speed, in such a manner as to avoid, for example, at constant load, the occurrence of a reduction of speed after a reduction of the low-pressure steam supply. At the same time this last apparatus will cause the throttling of the low pressure steam mentioned above.

The drawings accompanying the present description show by way of example a device which may be employed for the regulation of a mixed pressure turbine. It permits the maintaining of constant speed (within the limits of the variation admissible between speed at no load and speed under load) regardless of the part performed by each of the two fluids in furnishing energy; and it insures at the same time the maintenance of a sufficient minimum pressure of the low-pressure supply.

In the drawings, Figure 1 is a diagrammatic view of a high pressure reciprocating engine, an accumulator receiving the exhaust steam, a low pressure turbine taking steam from said accumulator, and governing mechanism embodying my invention; Fig. 2 is a diagram of the governing mechanism showing it in detail; and Fig. 3 shows a modification.

High pressure steam is supplied by the boiler 1 to the reciprocating or other high pressure engine 2 from which it exhausts into the accumulator 3. The low-pressure steam from the accumulator is furnished to the turbine 4 through the conduit 5. In this conduit is located a regulating member, for example, a balanced valve 6, the action of which is made dependent upon that of the speed governor 7, and permits the latter to maintain constant speed at variable load. When the amount of energy required of the turbine exceeds that which can be furnished by the low-pressure steam with the valve 6 fully open, the speed governor admits, in order to give a supplementary amount of energy, an additional supply of

high-pressure steam through the conduit 8. An impulse-turbine having an admission pipe provided with a valve 9, has been shown here, by way of example. The turbine may be furnished with several valves 9 which the speed governor opens in succession after the complete opening of the valve 6.

The speed governor may control the valves 6 and 9 by any desired means. It has been assumed here that a centrifugal speed governor is used, acting upon the valves through a servo-motor 10 which may be, for example, a servo-motor employing oil under pressure. The servo-motor 10 is furnished with a piston 11 which, by the use of a rack 12 and a gear 13, gives to a shaft 14 a limited movement of rotation. The shaft 14 carries on one end a helicoidal cam 15 which actuates the valve 6 through an elbow lever 16, and also carries cams such as that shown at 17, Fig. 2, which lift the valves 9 by the assistance of levers 18 fulcrumed at 19. The cams are disposed in such a manner that in its ascending movement the piston 11 causes first the opening of the valve 6 and then that of the valves 9 in succession. The valves are closed in the reverse order. The servo-motor is controlled by a piston-valve 20 placed so as to be controlled by the speed governor 7 through the levers *a b c*, *d e f* connected by the link *b e*.

It will be seen that a retardation of the turbine speed causes the lowering of the sleeve *f* of the speed governor 7 and, consequently, causes the points *e b a* to be lowered since the points *c* and *d* are, temporarily at least, immovable and the lowering of *a* causes the admission of oil under pressure beneath the lower end of the piston 11. The latter then rises producing, due to the movement of the point *d* about the point *f*, the return of the valve 20 to the position of rest and prevents further movement of the piston 11. This action is repeated until the displacement of 11 is sufficient to open enough valves to cause the speed to become normal. It will be seen that these actions depend solely upon the speed, if once for all the cams 15 and 17 have been fixed in such a relation that the high-pressure steam begins to be admitted starting from a certain opening for admitting low-pressure steam through the valve 6.

In advance of the valve 6 is placed a throttling device, for example, a throttle valve 21 which is dependent upon the pressure of the low-pressure steam, in order to reduce the delivery of this steam when its pressure falls. Different methods may be employed to control this throttling arrangement. For example, observing that the steam in the accumulator is always saturated, that is to say, that its temperature depends solely upon its pressure, it is possible to control the throttle valve 21 by a metallic thermometer or an expansible liquid or volatile liquid or gas thermometer. It is also possible to make use of a manometer and a servo-motor, and this is what has been shown here. The manometer 22, of any desired type, may consist, for example, of a vessel of variable capacity connected by the pipe 23 to the accumulator 3 and closed by a deformable wall 24 whose movement in one direction is opposed if necessary by a spring 25 and which controls through the lever *g h i* the valve 26 of the servo-motor 27.

When the pressure in the accumulator falls the point *i* is lowered as well as the point *h*, since the point *g* is, temporarily at least, immovable; consequently, the valve 26 causes the admission of oil below the piston 28 which rises producing the closure, more or less complete, of the throttle valve 21. The manometer and its controlling lever *g h i* cause the arrest of the movement of the throttle valve 21 as soon as the pressure ceases to diminish in the accumulator. The lowering of the pressure of the low-pressure steam carries with it a diminution of the energy furnished by it to the turbine. If, moreover, the reduced low-pressure steam is throttled, we lessen still further the amount of energy furnished to the turbine. It is necessary therefore, in order to prevent a retardation of the turbine speed, to furnish a certain amount of high-pressure steam, that is to say, that the high-pressure admission valve (or valves) be opened as it would be opened under the control of the speed governor in case of retardation. A simple means of obtaining this result is to substitute the action of the manometer for that of the speed governor on the admission controlling mechanism. To obtain this result, it is only necessary to arrange between the speed governor and the valve 20 a connection which may be actuated either by the speed governor or by the manometer (or by a member the movements of which reproduce those of the manometer). This is what is indicated in the drawings.

The lever *a b c* is controlled by its connection to the speed governor at the point *b*, and by its connection at the point *c* to a member controlled by the manometer. In the present case it will be assumed by way of example that the point *c* is controlled only by the displacements of the piston of the servo-motor 27, which correspond to those of the diaphragm of the manometer 22. It will be seen that through the levers 29, 30 and the links 31, 32, a diminution of pressure at constant speed would produce on the valve 20 the same downward displacement by moving up the end *c* of the lever *a b c* as would be produced by the speed governor acting on the point *b* when

there is a reduction of speed. Since it is sufficient to transmit to the valve 20 the displacements of the speed governor and the manometer, while preserving the independence of these devices, it is clear that the manometer may be made to act directly upon the lever *a c*, as shown in Fig. 3, and then to control directly the servo-motor 27, or even to employ for this control a second manometer (or thermometer).

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. Means for regulating a mixed pressure turbine, comprising a valve admitting low-pressure steam, a valve admitting high-pressure steam, means including a device responsive to the speed of the turbine for opening said valves in successive order, a throttle valve for the low-pressure steam, and means for actuating said throttle valve responsive to variations in the pressure of the low-pressure steam.

2. Means for regulating a mixed pressure turbine, comprising a valve admitting low-pressure steam, a valve admitting high-pressure steam, a throttle valve for the low-pressure steam, means for actuating said throttle valve responsive to variations in the pressure of the low-pressure steam, and means whereby said low-pressure responsive means also controls both admission valves.

3. Means for regulating a mixed pressure turbine, comprising a valve admitting high-pressure steam, a valve admitting low-pressure steam, a speed responsive device controlling both of said valves, a throttle valve for the low-pressure steam, means for actuating said throttle valve responsive to a drop in pressure of the low-pressure steam, and means whereby said low-pressure responsive means also controls both admission valves independently of the speed-responsive device.

4. Means for regulating a mixed pressure turbine, consisting of a valve admitting low-pressure steam, a valve admitting high-pressure steam, a motor for operating both valves in succession, a speed-responsive device controlling said motor, a valve for controlling the communication between the first valve and its source of supply, and a device responsive to variations in the low-pressure steam for controlling the last valve and also exerting a control of said motor independently of the speed-responsive device.

5. Means for governing a mixed pressure turbine, comprising a valve for regulating the admission of high-pressure steam, a valve for regulating the admission of low-pressure steam, a speed responsive device that controls both valves, a valve for controlling the communication between the low-pressure valve and its source of supply, a device responsive to the pressure of the low-pressure steam from said source for controlling the last valve, and means whereby said pressure responsive device also controls the two admission valves.

6. Means for governing a mixed pressure turbine, comprising a valve for regulating the admission of high-pressure steam, a valve for regulating the admission of low-pressure steam, means including a speed responsive device that opens the low-pressure valve first and then opens the high-pressure valve to supplement the low-pressure supply when necessary, a valve controlling the communication between the low-pressure valve and its source of supply, and a device responsive to the pressure of the low-pressure steam that controls all three valves.

7. Means for governing a mixed pressure turbine, comprising a valve for regulating the admission of high-pressure steam, a valve for regulating the admission of low-pressure steam, a motor for actuating the valves, a controller for the motor, a speed governor that acts on the controller, a valve for controlling the communication between the low pressure valve and its source of supply, a device responsive to the pressure of the low-pressure steam from said source for controlling the last valve, and means whereby said pressure responsive device also acts on the controller.

In witness whereof, I have hereunto set my hand.

EDGAR W. MIX.

Witnesses:
WERNER HILDEBRAND,
H. C. COXE.