No. 861,054.

PATENTED JULY 23, 1907.

F. SAMUELSON.

GOVERNING MECHANISM FOR TURBINES.

APPLICATION FILED DEC. 19, 1905.

2 SHEETS—SHEET 1.

Fig. 1.

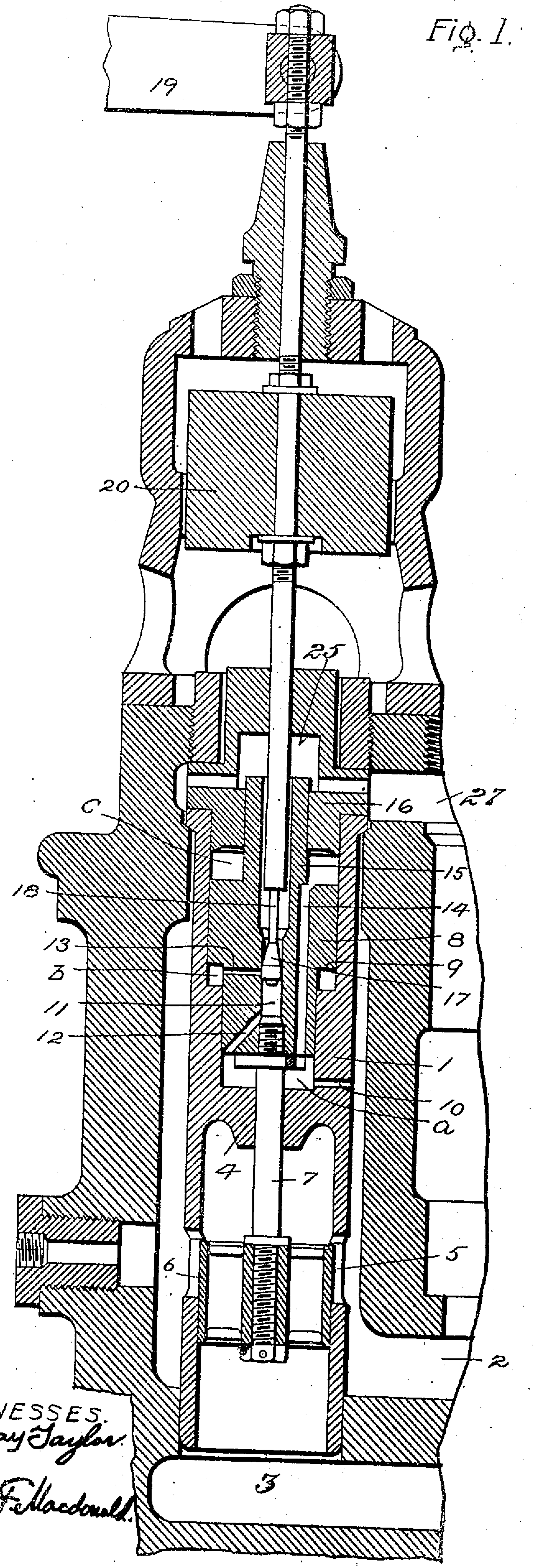

Fig. 3.

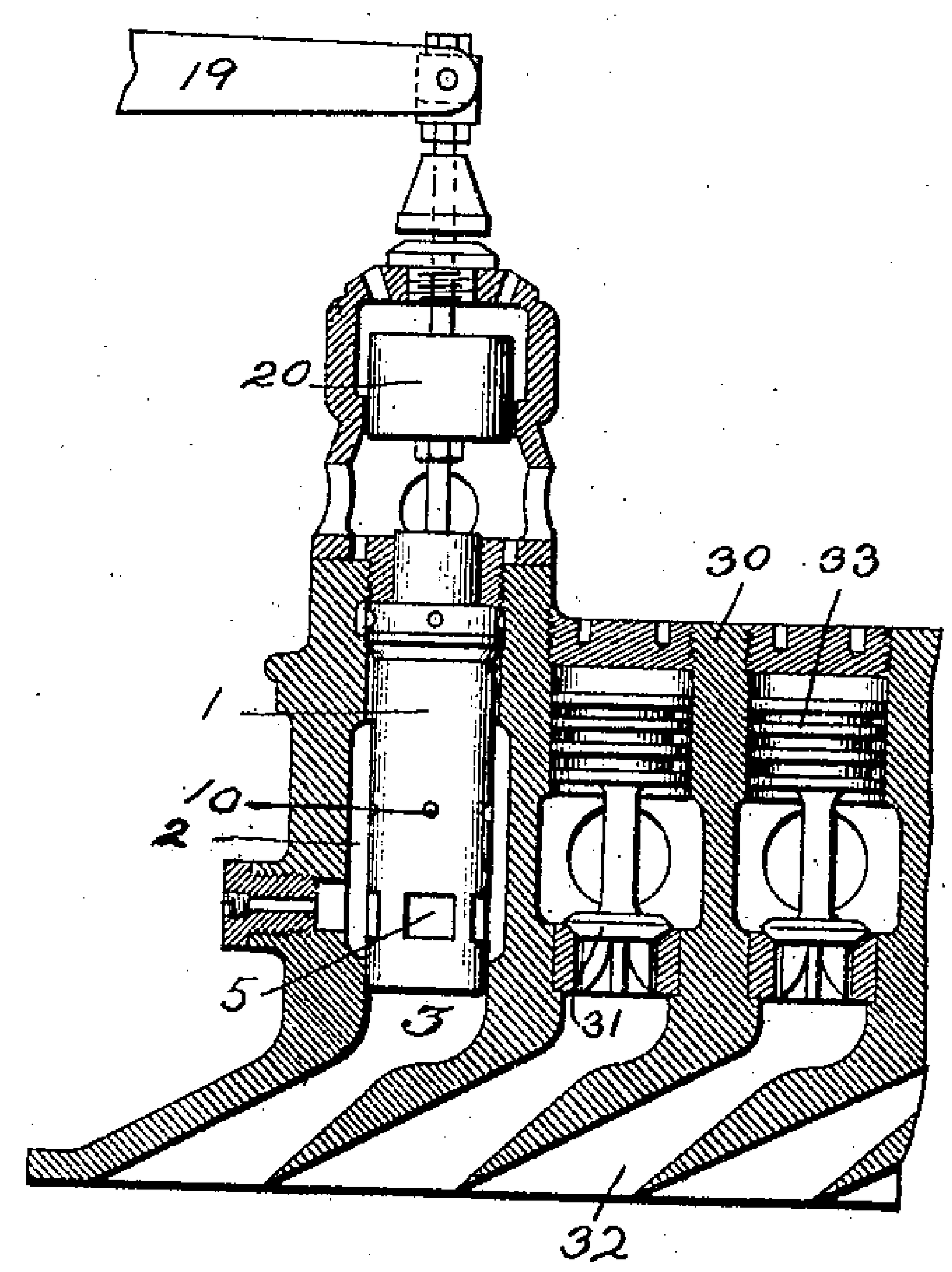

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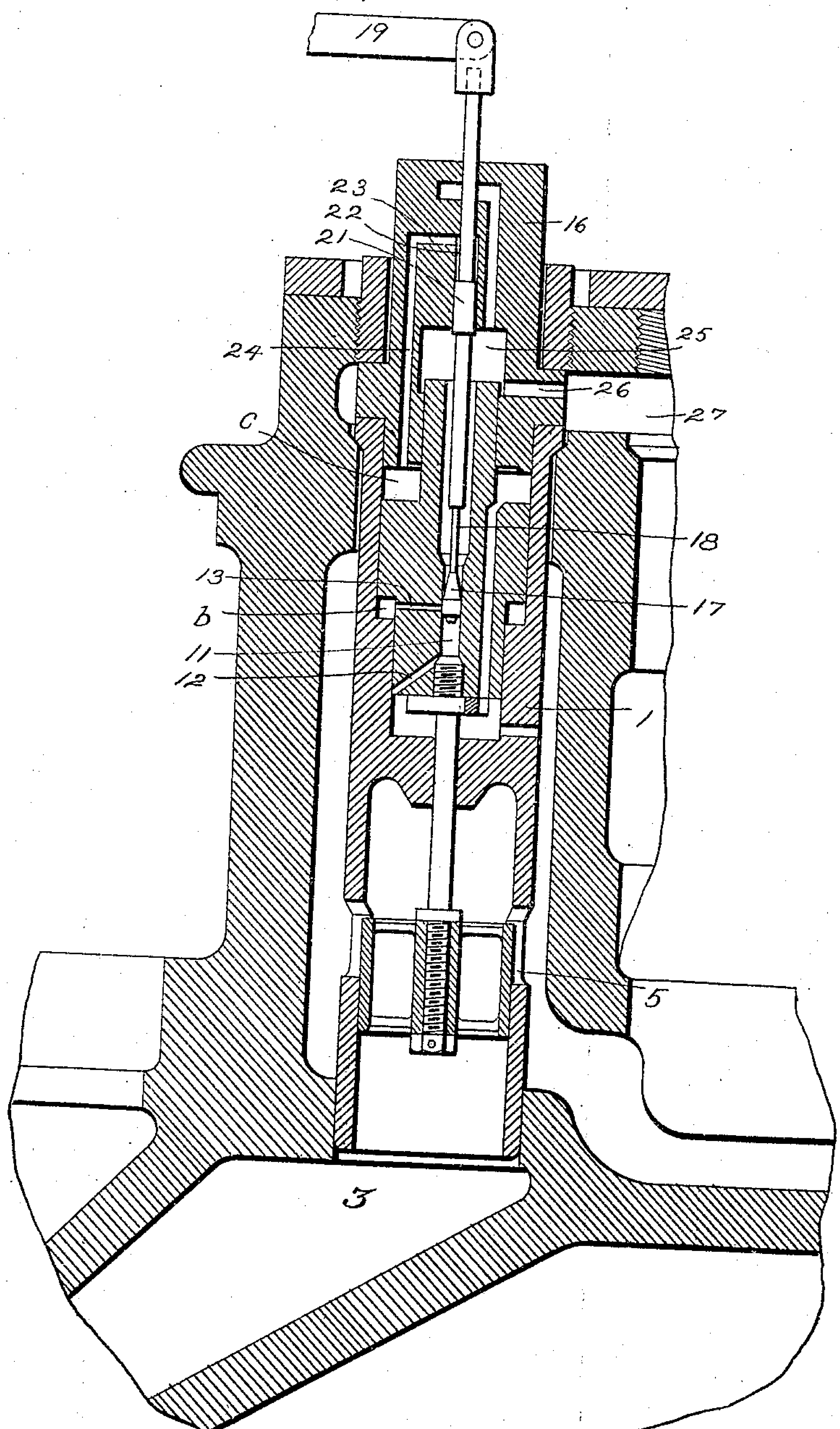
Fig. 2.



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UNITED STATES PATENT OFFICE.

FREDERICK SAMUELSON, OF RUGBY, ENGLAND, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

GOVERNING MECHANISM FOR TURBINES.

No. 861,054. **Specification of Letters Patent.** **Patented July 23, 1907.**

Application filed December 19, 1905. Serial No. 292,406.

To all whom it may concern:

Be it known that I, Frederick Samuelson, a subject of the King of Sweden, residing at Rugby, England, have invented certain new and useful Improvements in Governing Mechanism for Turbines, of which the following is a specification.

This invention relates to throttle valves and more especially to valves working in conjunction with elastic fluid turbine governing mechanism, in which the supply of working fluid to the turbine wheel is roughly regulated by varying the number of inlet nozzles which are open, the finer regulation being attained by means of a throttle valve operating upon an inlet nozzle the full capacity of which is approximately the same as one of the inlet nozzles.

I have found that the throttle valve is not so sensitive to slight variations in speed as may sometimes be desired, and the object of my present invention is to provide a valve which will operate to admit or cut off more or less of the working fluid on any slight alteration in the speed or load of the turbine taking place.

In the accompanying drawings, Figure 1 is a sectional elevation of a throttle valve constructed according to one modification of my invention; Fig. 2 is a similar view of a second modification; and Fig. 3 is a detail sectional view of valve chest showing separately-actuated admission valves and a throttle valve coöperating therewith.

In carrying my invention into effect according to the modification illustrated in Fig. 1, I provide a cylindrical valve casing 1 situated in a passage 2 leading to one of the inlet nozzles 3 of the turbine, preferably the nozzle next to the last inlet nozzle operated on by the governor so as to preserve the continuity of the stream of fluid supplied to the wheel. The exterior of the valve casing which is hollow is in contact for the greater part of its length with fluid from the source of supply, and is provided at about its mid point with a partition 4 which divides it into two internal cylindrical chambers. The lower of these two chambers is provided with a number of apertures 5 communicating with its interior which form passages for the fluid from the source of supply to the inlet nozzle 3. The passage of fluid through these apertures is controlled by a piston valve 6 which is adapted to move up or down in the lower chamber of the casing 1 to cover or uncover more or less of the apertures 5 according to the amount of fluid required to keep the speed of the turbine normal. The piston valve is connected by a rod 7 passing through the dividing partition 4 to a piston 8 situated in the upper internal chamber, and is operated by said piston in a manner hereinafter described.

The upper chamber in the valve casing is of two different internal diameters and the cylindrical body of the piston 8 is made in two portions of different diameters corresponding to the diameters of the two portions of the chamber as illustrated. The total length of the piston body is less than the length of the casing in which it operates, thereby forming three separate chambers which will be referred to as the upper or chamber *c* the lower or chamber *a*, the intermediate or chamber *b*, the intermediate chamber *b* being the annular space between the shoulders 9 on the piston and on the inside of the casing; the upper chamber *c* being the space above the piston and the lower chamber *a* being the space below the piston. The lower chamber, which is also the smallest, is in direct communication with the fluid from the source of supply through a small aperture or apertures 10 in the walls of the valve casing 1 at its lower end, so that the lower side of the piston is always subjected to fluid at the same pressure as is supplied to the turbine. The piston is provided with a central aperture 11 extending throughout its length but closed at its lower end, conveniently by the rod 7 connecting the piston 8 to the piston valve 6. An angularly disposed passage 12 passing from the lower end of the piston 8 communicates with this central passage or aperture 11 which in turn communicates with the intermediate chamber *b* through an aperture 13 passing at right angles through the piston body and terminating at the top of the portion of smaller diameter immediately under the shoulder 9 formed by the difference in diameter between the upper and lower portions of the piston. The upper chamber *c* is kept in constant communication with the lower chamber *a* by means of a small passage 14 passing vertically through the piston body. A boss or extension 15 fomed on the upper side of the larger portion of the piston 8 passes through a cap 16 which closes the upper end of the valve casing 1.

The area of the upper surface of the larger portion and the areas of the lower surface of the larger portion and that of the lower surface of the small portion of piston 8 are so proportioned that when the pressure in the intermediate chamber *b* is above that of the exhaust but below that of the source the piston is balanced in any position under the influence of the pressure of the fluid on these surfaces, and movement of the throttle valve 6 operated by the piston 8 is effected by reducing and increasing the pressure on the lower surface of the larger portion of the cylindrical piston, or in other words by altering the pressure in the intermediate chamber *b*. This is accomplished by means of a governor operated pilot valve 17 which causes fluid pressure to be admitted or exhausted from the intermediate chamber *b*. This pilot valve is situated in the central aperture 11 of the piston and controls the passage of fluid to the intermediate chamber. This valve is provided with a head which fits the aperture, and has a reduced stem 18, so that fluid may pass out between the stem and the walls of the aperture when the passage 13 leading to the intermediate chamber *b* is uncovered. The stem is preferably only reduced for a short distance and the aperture is enlarged so as to provide a passage for the fluid as shown. The valve stem 18 passes out through the turbine casing and is connected to one end of a rod or lever 19 operated on by the governor, to the other end of which lever, mechanism, such as a controller drum, for obtaining the rough regulation of the supply of fluid is attached. The stem 18 of the pilot valve 17 is preferably acted upon by a weight such as 20 or by steam pressure as hereinafter described with reference to Fig. 2 operating against the fluid pressure on its lower end so as to balance it and make it sensitive to slight variations in speed.

Referring now to the modification illustrated in Fig. 2. In this case instead of opposing the fluid pressure acting upon the under side of the pilot valve 17 by a weight secured to the valve stem as described above, the valve stem has a cylindrical enlargement or piston 21 formed integral with or secured to it. This piston operates in a cylindrical aperture or chamber 22 formed in the cap 16 closing the upper end of the valve casing 1. The chamber 22 is in direct communication through ports 23 and 24 formed in the cap 16, with the upper piston chamber *c* and consequently receives fluid at the same pressure at which it is supplied to the turbine. This fluid acts upon the upper side of the piston 21 the area of which is such that the downward pressure produced balances the upward thrust on the rod caused by the fluid acting upon the lower side of the pilot valve 17. The valve stem 18 is continued upward beyond the piston through the cap 16 and is connected to the governor operated lever 19 as above described with reference to Fig. 1.

In both the modifications illustrated the cap 16 is provided with an internal chamber 25 into which the fluid from chamber *b* is exhausted and which is in communication through a port or ports 26 with a passage 27 leading to atmosphere, exhaust or a lower pressure stage.

The operation of both modifications of the valve described above is as follows:—During normal working the piston is balanced and the pilot valve is in such a position that it cuts off communication between the central aperture 11 and the intermediate chamber *b*. If, however, the speed of the machine varies, the pilot valve is forced up or down by the governor thereby causing it to uncover the passage 13 leading to the intermediate chamber. If it has been forced downwards, for example, it establishes communication between said chamber and the passage 27 which is at a considerably lower pressure than the supply, or if it has been lifted it puts the intermediate chamber in communication with the source of supply through the central aperture and the angularly disposed passage 12 above referred to. In either case the effective pressures on the various surfaces of the piston are immediately unbalanced and the piston is moved up or down until the passage 13 leading to the intermediate chamber *b* is again covered by the pilot valve. As soon as the chamber *b* is cut off from the supply of steam or other elastic fluid, a drop in pressure occurs therein owing to condensation etc., and the throttle valve remains in a given position until there is a further movement up or down of the pilot valve 17. It will be seen from the above that the piston 8 is only balanced when the pressure in chamber *b* is slightly below that of the supply, and that movement of the valve is caused either by increasing this pressure by connecting the chamber to the supply, or by decreasing it by connecting the chamber to the exhaust.

It is to be noted that the piston follows the movement of the pilot valve, that is to say, if the valve moves upward the piston does likewise until it overtakes the valve, when the balanced condition of the piston is reëstablished. The reverse operation takes place when the pilot valve moves downward. It is this action which enables the piston to assume positions intermediate the extreme upper and lower. It is to be understood, of course, that the pilot valve is usually moving more or less in one direction or the other in response to load changes. As the piston moves up or down the throttle valve moves with it, thereby restricting or increasing the area of the apertures 5 through which the fluid passes to the nozzle to which the valve is fitted.

Where the turbine is supplied with motive fluid at a practically constant pressure either of the above modifications may be employed but where the pressure from the source fluctuates the modification illustrated in Fig. 2 is preferable. This arises from the fact that the weight used for balancing the pressure acting on the lower end of the pilot valve should be varied as the pressure of the fluid supply varies. This, however, is impracticable with a fixed weight whereas with the modification illustrated in Fig. 2 any variation in pressure of the supply fluid acting upwardly on the lower side of the pilot valve is immediately compensated for by a similar variation in the pressure acting downwardly on the upper side of the piston 21.

In Fig. 3 is shown a valve chest 30 containing one, two or more admission valves 31 controlling the passage of motive fluid to the nozzles or other discharging devices 32. Where nozzles are employed they may be expanding or non-expanding in character. Each of these valves is separately actuated, as for example, by a piston 33. The movements of the pistons are controlled by pilot valves—not shown—which are under the control of a shaft governor, preferably, but not necessarily, the one that controls the pilot valve 17 of the motor which opens and closes the throttle valve 6.

It will be obvious that various alterations in the construction may be made without departing from the spirit of my invention.

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. In a governing mechanism, the combination of a piston which is normally balanced and is arranged to assume intermediate positions in its cylinder, a valve directly connected to the piston for throttling the passage of motive fluid by an amount determined by the position of the piston, a casing for the valve, a governor responsive

to load changes, and a pilot valve located within the piston for creating a balanced pressure condition on the piston to hold it stationary and an unbalanced condition for moving it, which valve progressively assumes different closed positions for each balanced position of the piston.

2. In a governing mechanism, the combination of a throttle valve, a floating piston having upper and lower surfaces which differ in area and an intermediate surface subjected to inlet and exhaust pressures, and a pilot valve operated by a load-responsive device for controlling the action of the motive fluid on the intermediate surface.

3. In a governing mechanism, the combination of a throttle valve, a hollow cylindrical casing therefor containing chambers of different area, a piston rigidly connected to the valve and located in said casing, the piston being of less length than the casing, conduits for connecting the end chambers in the casing with a source of high-pressure fluid, and a pilot valve that connects the intermediate chamber alternately with the high-pressure source and the exhaust to unbalance the piston and move the throttle valve.

4. In a governing mechanism, the combination of a throttle valve, a piston for operating it which is capable of assuming intermediate positions, a casing for the valve and piston containing end and intermediate chambers, and a balanced pilot valve which is capable of assuming intermediate positions for supplying fluid to the chamber and controlling the exhaust therefrom.

5. In a governing mechanism, the combination of a nozzle, a valve for throttling the supply of fluid thereto to compensate for minor load changes, a piston for moving the valve that is capable of assuming intermediate positions, a pilot valve for regulating the piston and having a closed position where the piston is balanced and open positions on opposite sides thereof, where the piston is unbalanced, the position of the valve when closed progressively shifting from point to point depending upon the position of the piston, and a governor-actuated means for moving the pilot valve over its range of movement.

6. In a governing mechanism the combination of a fluid-discharging device, a valve which throttles the supply of fluid thereto, a floating piston connected thereto which is normally balanced and assumes intermediate positions for different degrees of throttling, ports in the piston, and a pilot valve located within the piston for regulating it and having a closed position where the piston is balanced and open positions where the piston is unbalanced, the said positions of the pilot valve progressively shifting from point to point depending upon the position of the piston.

7. In a governing mechanism, the combination of a discharge port, a throttle valve for controlling the passage of fluid through the port, a balanced piston for operating the valve which is capable of assuming intermediate positions, and a pilot valve for admitting fluid to and cutting it off from the piston, which is also capable of assuming intermediate positions, the piston being arranged to follow the direction of movement of the pilot valve and restore the balanced condition as to pressure.

8. In a governing mechanism, the combination of a plurality of ports arranged to discharge motive fluid in the form of an unbroken column, controlling valves therefor, a throttle valve controlling a port at one end of the column, a piston for moving the throttle valve to and fro to compensate for intermediate load changes, which is capable of assuming intermediate positions, and a pilot valve controlling the piston which is also capable of assuming intermediate positions.

9. In an elastic-fluid turbine, the combination of a discharging device, a valve for controlling the passage of fluid thereto, a piston for actuating the valve, and a pilot valve that starts the piston into motion and stops it, the piston and pilot valve being so arranged that a movement of the pilot valve is followed by a movement in the same direction of the piston.

10. In an elastic-fluid turbine, the combination of a plurality of fluid-discharging devices, separately-actuated admission valves therefor, an additional fluid-discharging device, a throttle valve for controlling the passage of fluid therethrough, means for actuating the admission valves, a piston for actuating the throttle valve, and a pilot valve for unbalancing the piston when it is desired to move the valve in either direction, and for balancing the piston when it is desired to hold the valve stationary.

In witness whereof, I have hereunto set my hand this seventh day of December, 1905.

FREDERICK SAMUELSON.

Witnesses:
ERNEST HARKER,
ETHEL M. WEBB.