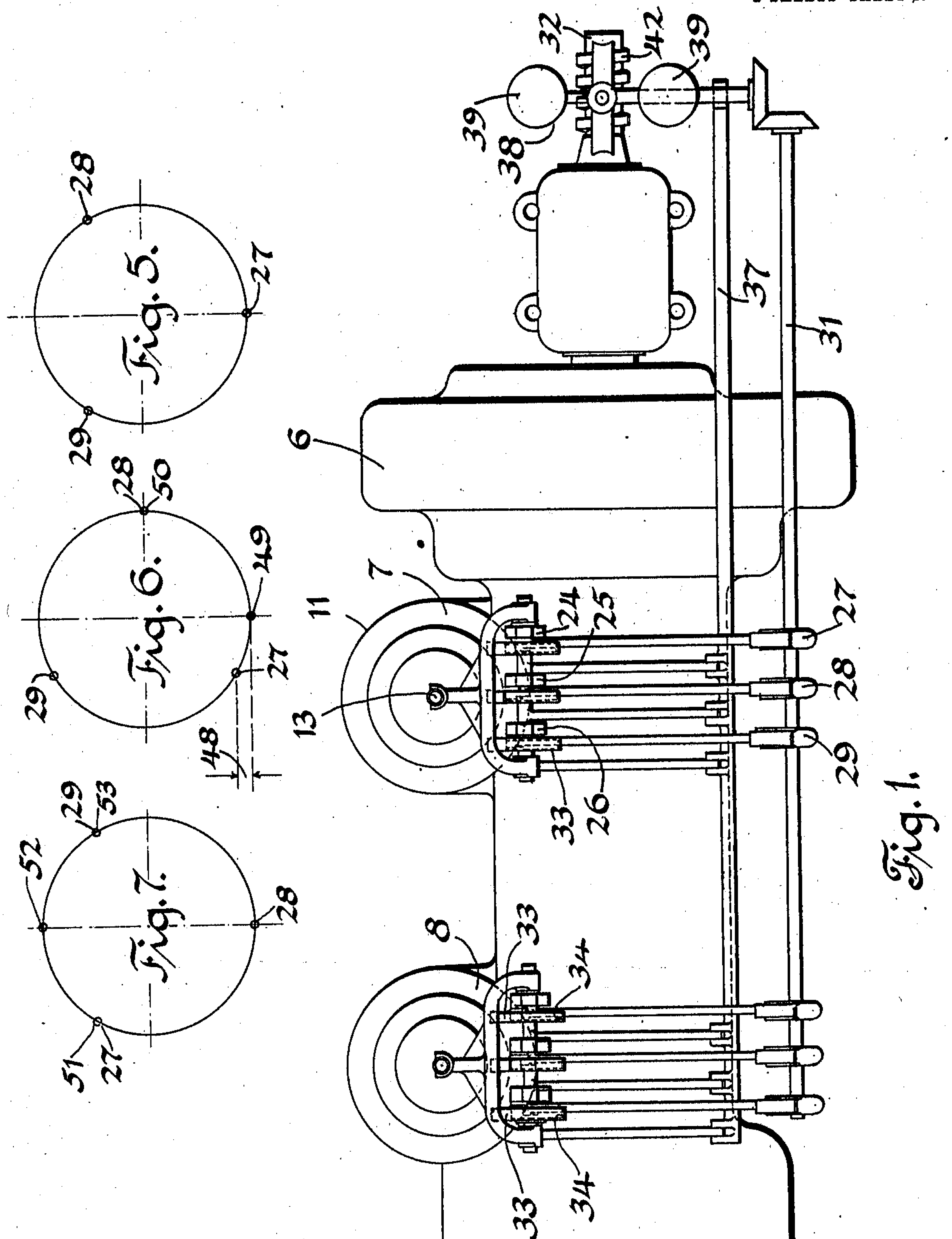
F. HODGKINSON.

TURBINE GOVERNING MECHANISM.

APPLICATION FILED JUNE 16, 1906.

982,819. **Patented Jan. 31, 1911.**

2 SHEETS—SHEET 1.



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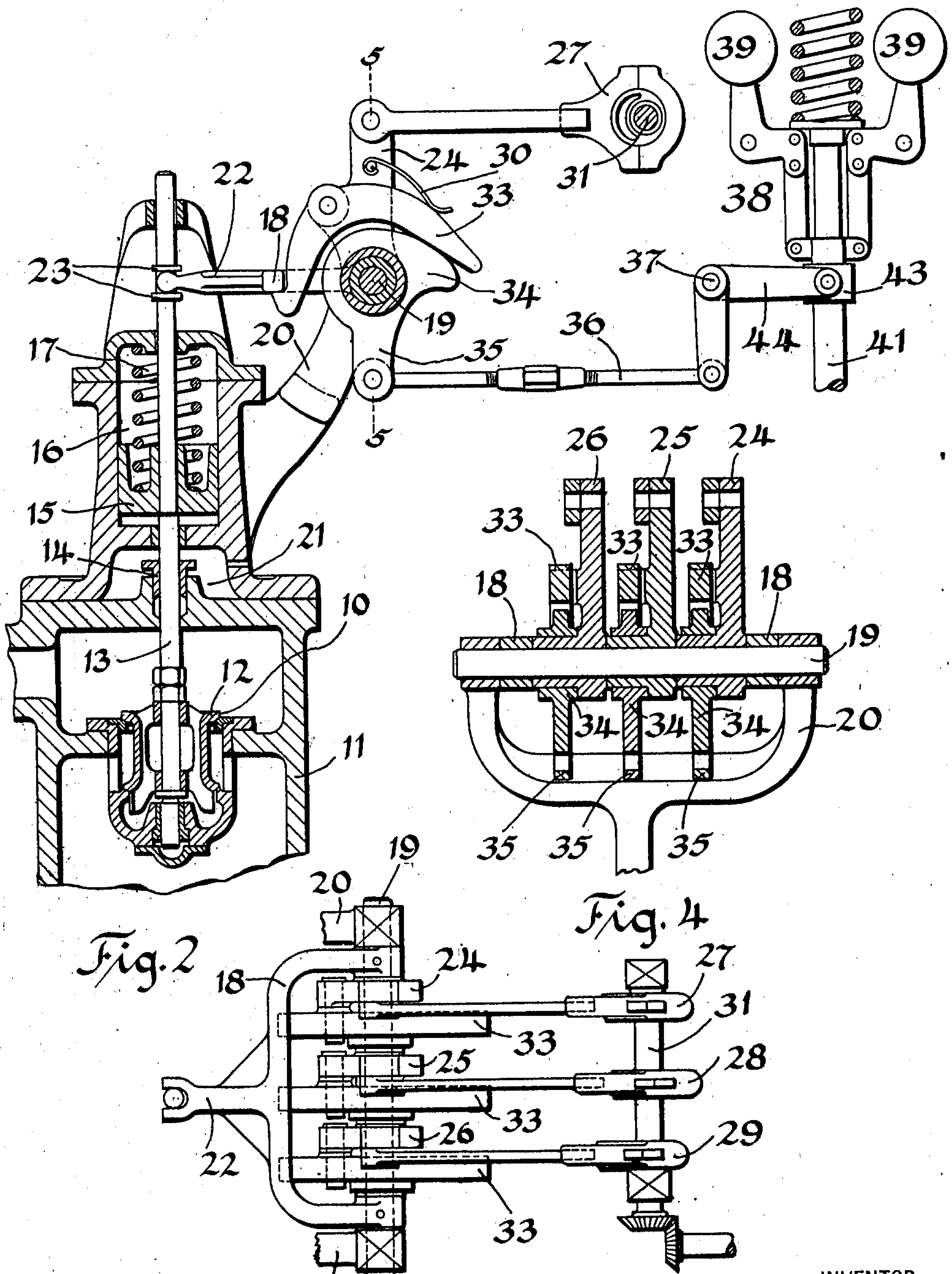

Fig. 2

Fig. 4

Fig. 3.

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TURBINE-GOVERNING MECHANISM.

982,819. Specification of Letters Patent. **Patented Jan. 31, 1911.**

Application filed June 16, 1906. Serial No. 322,028.

To all whom it may concern:

Be it known that I, FRANCIS HODGKINSON, a subject of the King of Great Britain and Ireland, residing at Edgewood Park, in the county of Allegheny and State of Pennsylvania, have made a new and useful Invention in Turbine-Governing Mechanism, of which the following is a specification.

This invention relates to elastic fluid turbines and more particularly to governing means for turbines.

Elastic fluid turbines are ordinarily provided with extremely sensitive speed governors, or controlling devices, which operate in conjunction with more or less complicated valve-operating mechanisms and proportion the amount of motive fluid supplied to the turbine in accordance with the load demand. The valve-actuating mechanism is usually controlled by the governor through a fluid or electrically actuated relay device and while it is ordinarily reliable and accurate in operation, it is expensive to build and difficult to adjust.

The object of this invention is, therefore, the production of a governing mechanism for turbines which is of simple construction and extremely sensitive and effective in operation.

A further object is the production of a mechanically-actuated governor-controlled valve-operating mechanism for turbines.

The invention, broadly, consists of a mechanically-actuated governing mechanism which operates in conjunction with the primary and secondary valves of a turbine and is adapted to admit motive fluid to the turbine periodically or in puffs; the amounts of fluid admitted, or the duration of the puffs, being proportioned in accordance with the load demand. The governing and valve-operating mechanisms are so arranged that the primary valve will admit motive fluid in regulable amounts to the initial or primary stage of the turbine while the turbine is operating under normal loads and the secondary valve will operate in conjunction with the primary valve and admit motive fluid to a secondary stage of the turbine while the turbine is operating under excessive loads.

In the drawings accompanying this application and forming a part thereof, Figure 1 is a plan view of a turbine equipped with a governing mechanism embodying my invention; Fig. 2 is a somewhat diagrammatic view of a valve-operating mechanism in conjunction with a controlling governor; Fig. 3 is a partial plan view of the apparatus shown in Fig. 2; Fig. 4 is a section along the line 5—5 of Fig. 2; and Figs. 5, 6 and 7 illustrate diagrammatically the operation of the valve-operating mechanism.

A turbine 6 is provided with a primary admission port 7, which communicates with an initial stage of the turbine, and a secondary admission port 8, which communicates with a secondary stage of the turbine. The primary and secondary admission ports are provided with automatically-actuated valves which are operated by a system of eccentrics, links and levers and are adapted to admit motive fluid to the turbine in accordance with the load demand.

The primary admission port 7 is provided with a valve 10 and a valve casing 11, formed integrally with the casing of the turbine, the interior passages of which communicate with a source of motive fluid supply. A piston 15, rigidly mounted on the stem 13, operates in a cylinder 16, located above the valve casing 11, and performing the function of an air dash-pot. A helical spring 17 mounted between the piston 15 and the end wall of the cylinder surrounds the stem 13 and is adapted to force the valve 10 against its seat and close the primary admission port. A chamber 21 is interposed between the valve casing 11 and the cylinder 16 and is provided with an exhaust port 21′ which is adapted to discharge into the atmosphere the motive fluid leaking through the gland 14 and thereby prevent fluid pressure from piling up under the piston 15 and raising the valve 10.

A bifurcated lever 18 is provided with an extending arm 22, which is forked at the end, and is fulcrumed on a shaft 19, which is mounted on a suitable bracket 20, formed integrally with the walls of the cylinder 16. The valve stem 13 is provided with integrally-formed collars 23 which operate in conjunction with, and are located at either side of the forked end of the arm 22.

Three levers 24, 25 and 26 are fulcrumed on the shaft 19 and are respectively oscillated by eccentrics 27, 28 and 29, which are mounted on a rotatable shaft 31 journaled on the casing of the turbine and driven by the turbine shaft 32 through suitable gears.

Each of the levers 24, 25 and 26 is provided with a pivotally-mounted hook 33 which is provided with a controlling spring 30 and which, for certain positions of its supporting lever, is adapted to seize the bifurcated lever 18 and raise the valve 10, through the agency of the forked arm 22 and the valve stem 13, and admit motive fluid to the initial stage of the turbine.

The operating eccentrics 27, 28 and 29 are 120° apart on the shaft 31 and the hooks 33 are adapted to successively seize the lever 18 and open the valve 10; the amount of port opening being proportioned by the speed of the turbine.

A governor-actuated cam 34 is mounted on the hub portion of each of the levers 24, 25 and 26 and each cam is provided with an arm 35, to which an adjustable rod 36 is pivotally connected. The rods 36 are connected by suitable levers to a shaft 37 which is actuated by a speed-responsive governor 38 through suitable links and levers.

The governor 38 consists of fly-balls 39, pivotally mounted on brackets, (not shown) which are rigidly mounted on a rotatable standard 41. The standard 41 is provided with suitable gears, (not shown), which mesh with a worm 42, formed on the shaft 32 of the turbine. A reciprocating sleeve 43 surrounding the standard 41 is actuated by the fly-balls 39 and is adapted to occupy different positions along the shaft corresponding to different speeds of the turbine.

The shaft 37 is operated by the reciprocating sleeve 43 through suitable links and levers, diagrammatically illustrated in Fig. 2 by the lever 44, and is adapted to vary the positions of the cams 34 relative to their corresponding supporting levers.

Each hook 33 is adapted, when in its lowest position, to seize the lever 18, and the levers 24, 25 and 26 are arranged to move their corresponding hooks sufficiently to open the initial valve 10 a maximum amount. Each cam 34 is moved by the governor, during light or normal loads on the turbine, to such positions that it will contact with its corresponding hook 33 at some point during the forward travel of the hook, release the lever 18 and permit the closing of the valve 10, thereby proportioning the periodic port opening of the valve in accordance with the load demand. At excessive speeds of the turbine the cams 34 are moved by the governor to such positions that the hooks 33, during their reciprocations, are rendered ineffective and the valves remain closed.

The operation of the valve is diagrammatically illustrated in Figs. 5, 6 and 7, in which the different positions of the eccentrics are shown. In Fig. 5 the eccentric 27 is shown in the position at which its corresponding hook 33 seizes the lever 18 and starts to open the valve 10. At exceedingly light loads, the cam 34, corresponding to the lever 24, which is actuated by the eccentric 27, will knock off its corresponding hook 33 and releases the lever 18 at some position of the eccentric's travel, as illustrated in Fig. 2, and the valve 10 will drop the distance 48, through which it has traveled, and close the port 7. The port 7 will remain closed until the eccentric 28 has moved through the arc 49—50, or until the lever 25, which is actuated by the eccentric 28, moves to such a position that its hook 33 will seize the lever 18 and open the valve. As the load on the turbine increases, the periodic port opening of the valve increases and the time the valve remains seated is decreased until at some predetermined load on the turbine the governor-actuated cams 34 are moved to such positions that the lever 18 is released by one hook 33 at an eccentric position corresponding to the positions of the eccentric 27, as illustrated in Fig. 7, and the valve 10 on reaching its seat is immediately raised by the hook 33 of the eccentric 28. As the load continues to increase, the valve 10 is raised greater amounts by the valve-operating mechanism and when released by the governor-actuated cams does not reach its seat but is caught by the next hook 33 and again raised a predetermined amount. The governor-actuated cams are moved by the governor during increasing loads to such positions that the time of releasing the lever 18 during the eccentric stroke is retarded until at some load on the turbine, (about full load) the cams are moved to such positions that they do not contact with the hooks 33 or release the valve 10 and the valve 10, as illustrated in Fig. 7, is raised by each hook, while its corresponding eccentric moves from 51 to 52, and then lowered, while the eccentric travels from 52 to 53, at which point the descending lever 18 is seized by the hook 33 of the next eccentric which then occupies the position 51 and the valve will be again raised and will continue to oscillate between three-fourths and maximum cut-off until the load decreases. At about full load, or when the primary valve is oscillating between maximum and three-fourths port opening, the secondary valve begins to admit motive fluid to a secondary stage of the turbine through the port 8. The valve-operating mechanism of the secondary valve is similar to the operating mechanism of the primary valve, except that the cams 34 are adapted to hold the hooks 33 in an inoperative position so that they do not open the secondary valve until the primary valve is admitting a maximum amount of motive fluid to the turbine. As the load on the turbine continues to increase past full load, the cams 34 of the secondary valve mechanism move to such a position that the periodic port openings of the valve increase in accordance with the load demand. At a predetermined and excessive load on the turbine, the secondary valve, like the primary valve, will be continuously open, but will oscillate between three-fourths and maximum port opening.

The position of the controlling cams 34 may be readily adjusted by lengthening or shortening the connecting rods 36 and the throw of the valve disk 12 varied accordingly, and various means may be utilized in connection with the valve stem to close the valve after the lever 18 is released by the hooks 33.

It is apparent that the amount of motive fluid admitted to the turbine is proportioned by the governor 38 in accordance with the speed of the turbine, and that practically unlimited power is available for operating the valves and consequently they will operate effectively with no danger of sticking or becoming inoperative.

What I claim is:

1. In combination with the primary and secondary valve of a steam turbine, a valve-operating mechanism comprising a primary and secondary valve-actuating lever, a system of oscillating levers provided with hooks for seizing said actuating levers and opening said valves, a governor-controlled means for contacting with said hooks and releasing said actuating levers to close said valves, thereby proportioning the port opening of the valves in accordance with the load demand.

2. In combination with the primary and secondary valve of a steam turbine, a valve-operating mechanism comprising a system of oscillating levers, an actuating lever for each of said valves, hooks carried by said oscillating levers for seizing said actuating levers and opening said valves, and governor-controlled means whereby one or both of said valves is rendered operative or inoperative.

3. In combination with the primary and secondary valves of a turbine, means positively actuated by the turbine rotor for opening each valve and mechanisms responsive to variations of speed of the turbine for disengaging said means and thereby proportioning the delivery of fluid to the turbine in accordance with the speed of the turbine.

4. In combination with the primary and secondary valves of a steam turbine, means positively actuated by the turbine rotor for controlling the operation of said valves by periodically engaging therewith and mechanisms actuated by the turbine governor for disengaging said means and thereby timing the operation of said valves.

5. In combination with the primary and secondary valves of a steam turbine, means positively actuated by the turbine rotor for engaging with and periodically opening each of said valves and mechanisms actuated by the turbine governor for timing the operation of said means whereby one or both of said valves are rendered inoperative.

6. In combination with the primary and secondary valves of a steam turbine, means positively actuated by the turbine rotor for periodically engaging with and actuating each of said valves and a timing device actuated by the turbine governor for controlling the operation of said means whereby the delivery of motive fluid is controlled in accordance with the load demand and the secondary valve is rendered inoperative until the primary valve is delivering a maximum amount of fluid to said turbine.

7. In combination with the primary and secondary valves of a turbine, a valve operating mechanism comprising a valve operating lever for each of said valves, a system of oscillating hooks engaging each of said valves and governor controlled means for timing the operation of each of said hooks and thereby controlling the operation of said valves.

8. In combination with the primary and secondary valves of a turbine, means positively actuated by the turbine rotor for periodically opening each of said valves and mechanisms controlled by the turbine governor for controlling the operation of said means and thereby proportioning the delivery of motive fluid to the turbine in accordance with the load demand.

9. In a governing mechanism for an elastic fluid turbine, a valve and a valve operating mechanism comprising a valve operating lever, a series of hooks adapted to successively engage said lever and open said valve, a governor controlled timing device for disengaging said hooks and thereby proportioning the port opening of said valve in accordance with the speed of the turbine.

10. In combination with the primary and secondary valves of a steam turbine, a valve operating mechanism comprising a valve operating lever for each of said valves, a system of oscillating hooks adapted to successively engage said lever and open said valve and a governor controlled timing device for disengaging each of said hooks and thereby timing the operation of said valves.

11. In a governing mechanism for an elastice fluid turbine, a valve and a valve operating mechanism comprising a valve operating lever, a series of hooks adapted to successively engage said lever whereby said valve is periodically opened and a governor controlled timing device for disengaging said hooks and thereby controlling the operation of said valves.

12. In an elastic fluid turbine, in combination with the primary and secondary

valves thereof, a mechanically actuated valve operating mechanism for each valve, and means dependent on the speed of the turbine for controlling the operation of each valve operating mechanism.

13. In an elastic fluid turbine, in combination with the primary and secondary valves of the turbine, a valve operating mechanism for each valve, rotatable means for actuating said mechanisms to pulsate said valves, and means dependent on the speed of the turbine for controlling the operation of said valve operating mechanisms.

14. In an elastic fluid turbine, a primary and a secondary valve, an actuating hook for each valve, an eccentric for actuating each hook and speed responsive means for controlling the operations of said hooks.

15. In an elastic fluid turbine, primary and secondary valves, valve operating mechanism for each valve, eccentrically operated mechanisms for said valve operating mechanisms, and means dependent on the speed of the turbine for controlling the operation of said valve operating mechanisms.

16. In combination with the primary and secondary valves of a turbine, separate valve operating mechanism positively actuated by the turbine rotor for periodically opening each valve and means actuated by the turbine governor for timing the operation of said mechanisms whereby one mechanism is rendered ineffective for opening its corresponding valve until the other valve is delivering a maximum amount of motive fluid to the turbine.

17. In combination with the primary and secondary valves of a turbine, valve operating mechanisms positively actuated by the turbine rotor for opening said valves and means actuated by the turbine governor for timing the operation of said valves, operating mechanism whereby one valve is held closed until the other valve is delivering a maximum amount of motive fluid to the turbine.

18. In combination with the primary and secondary valves of a turbine, a valve operating mechanism comprising a system of oscillating hooks and a governor controlled timing device for each valve for controlling the operation of said hooks and thereby controlling the operation of said valves.

19. In combination with the primary and secondary valves of a turbine, a valve operating mechanism for each valve comprising oscillating hooks and a governor controlled timing device for timing the operation of said hooks whereby one valve operating mechanism is rendered ineffective for opening its corresponding valve until the other valve is delivering a maximum amount of steam to the turbine.

20. In a turbine, a valve and a valve operating mechanism comprising a series of oscillating hooks for successively opening said valve, the opening movement of one hook overlapping the opening movement of another hook of said series.

In testimony whereof, I have hereunto subscribed my name this 14th day of June, 1906.

FRANCIS HODGKINSON.

Witnesses:

CHARLES W. McGHEE,

E. W. McCALLISTER.