No. 743,727.

PATENTED NOV. 10, 1903.

O. JUNGGREN.

GOVERNOR FOR ELASTIC FLUID TURBINES.

APPLICATION FILED DEC. 26, 1902.

NO MODEL.

4 SHEETS—SHEET 1

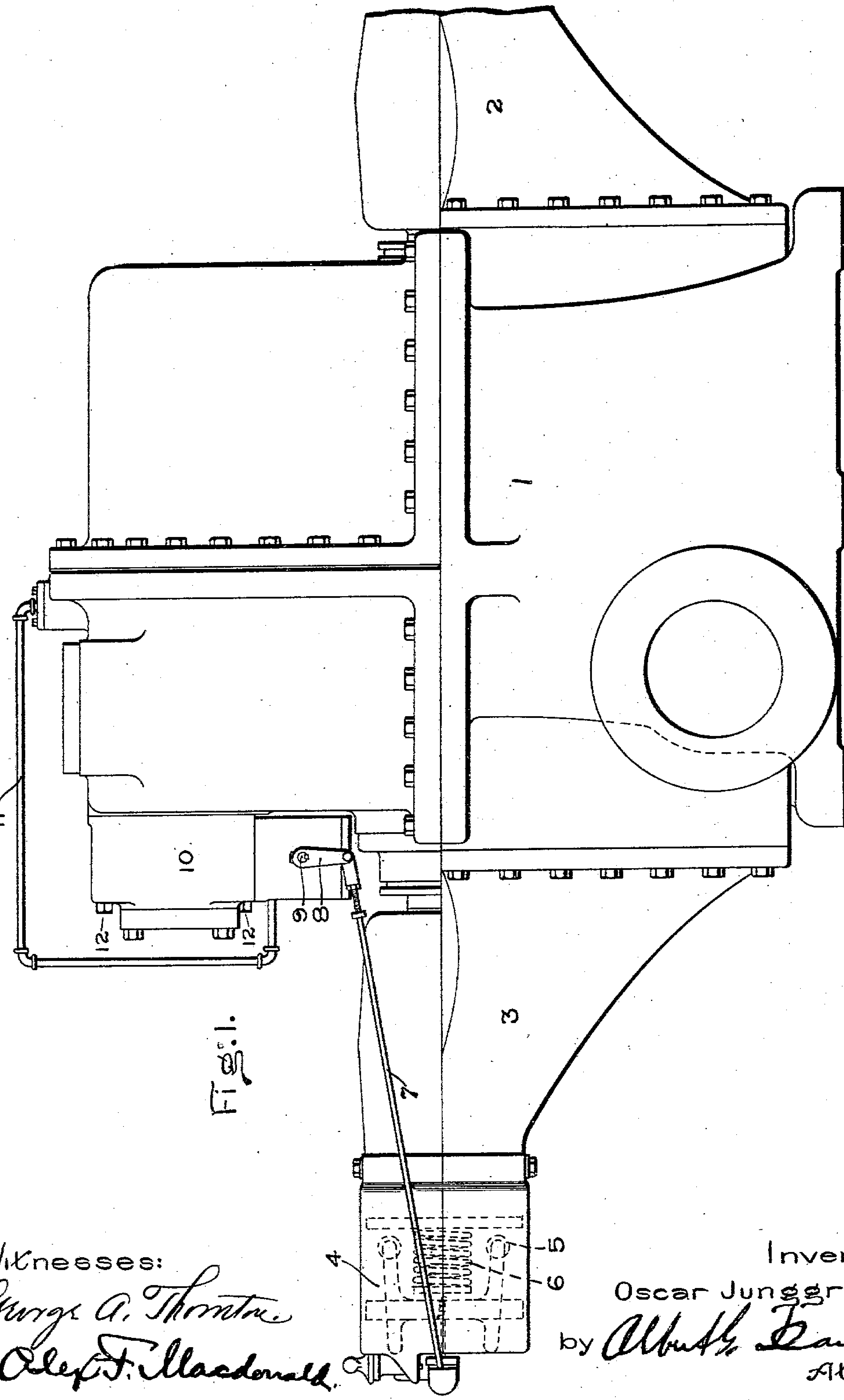

Fig. 1.

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Alex. F. Macdonald

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NO MODEL. 4 SHEETS—SHEET 2.

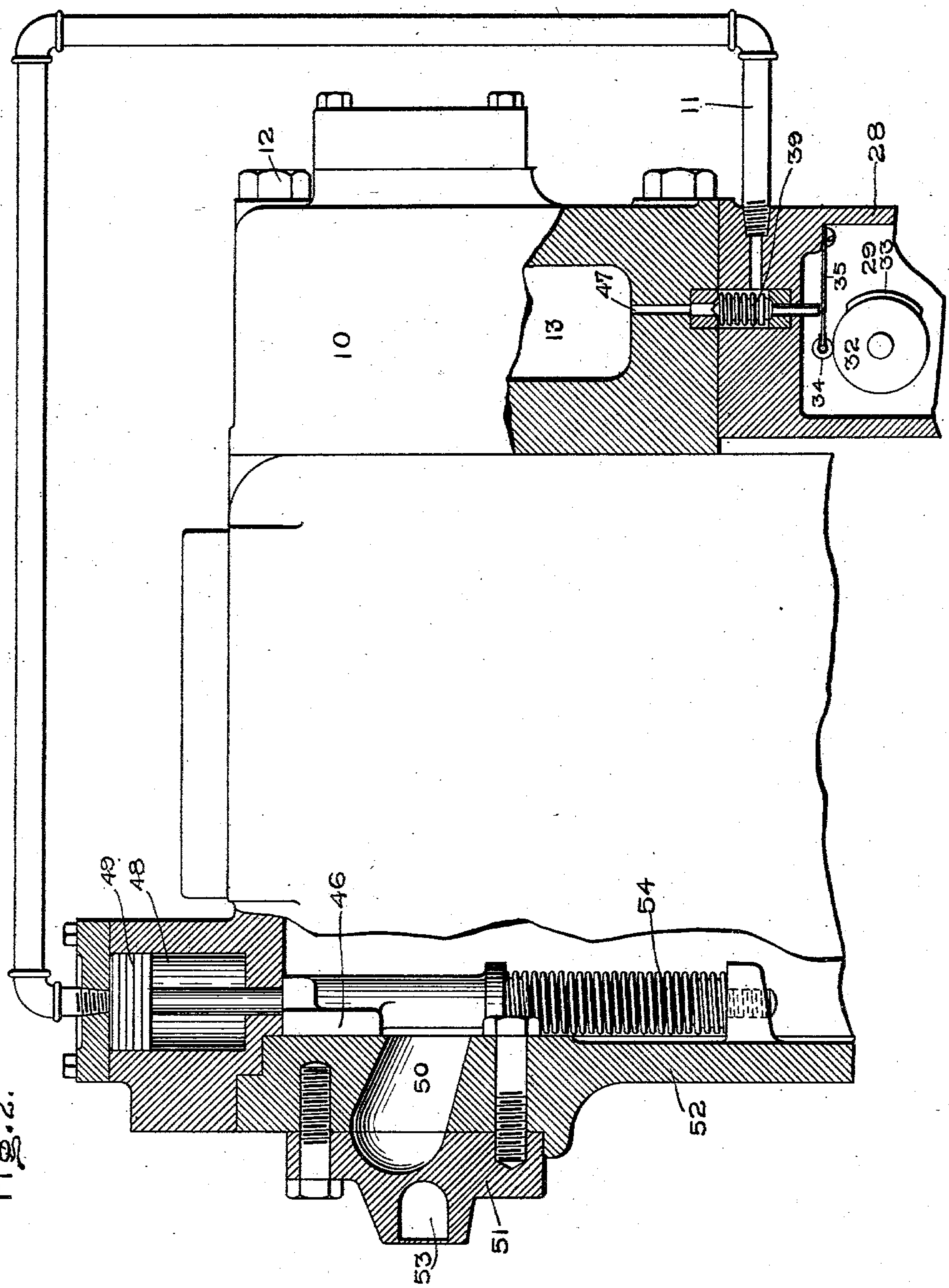

Fig. 2.

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NO MODEL. 4 SHEETS—SHEET 3.

Fig. 3.

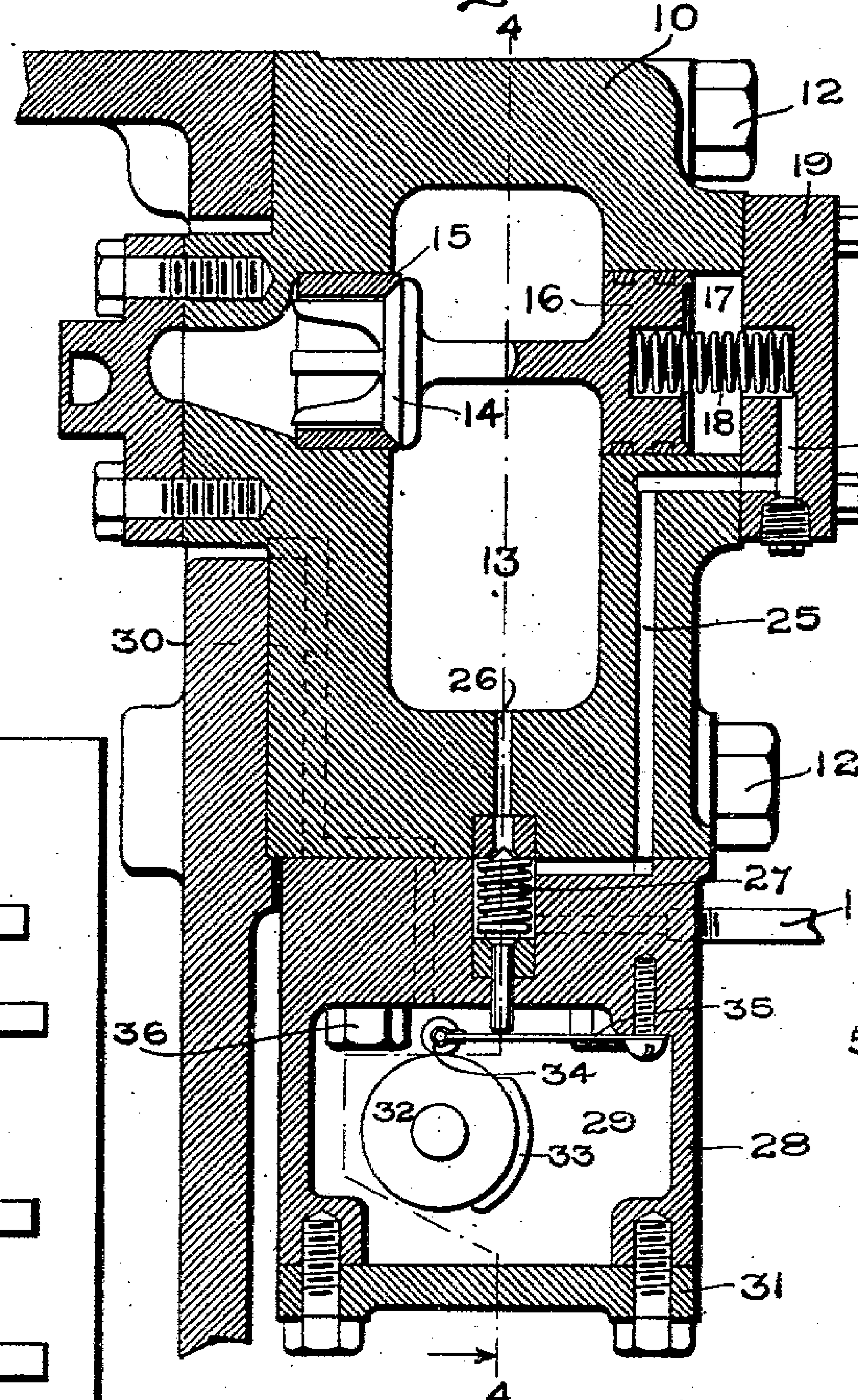


Fig. 8.

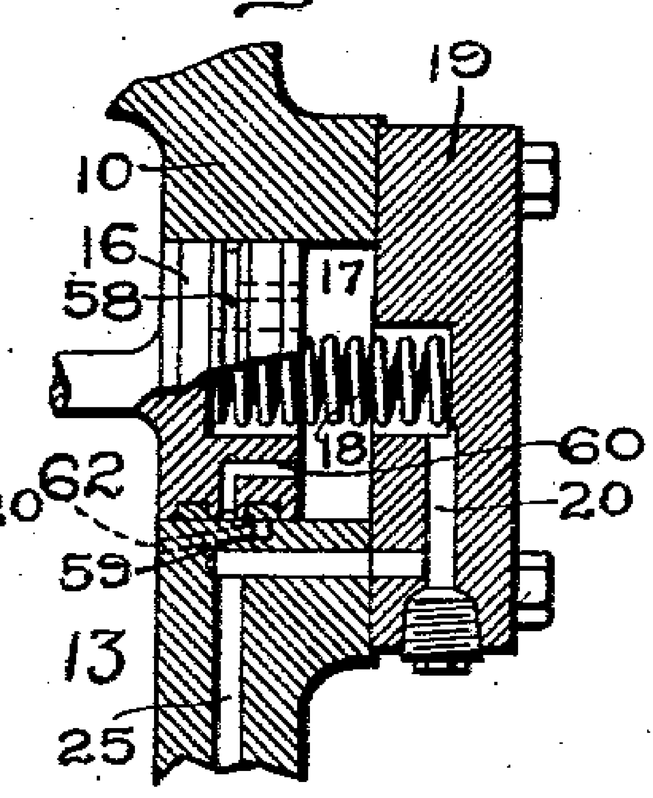


Fig. 6.

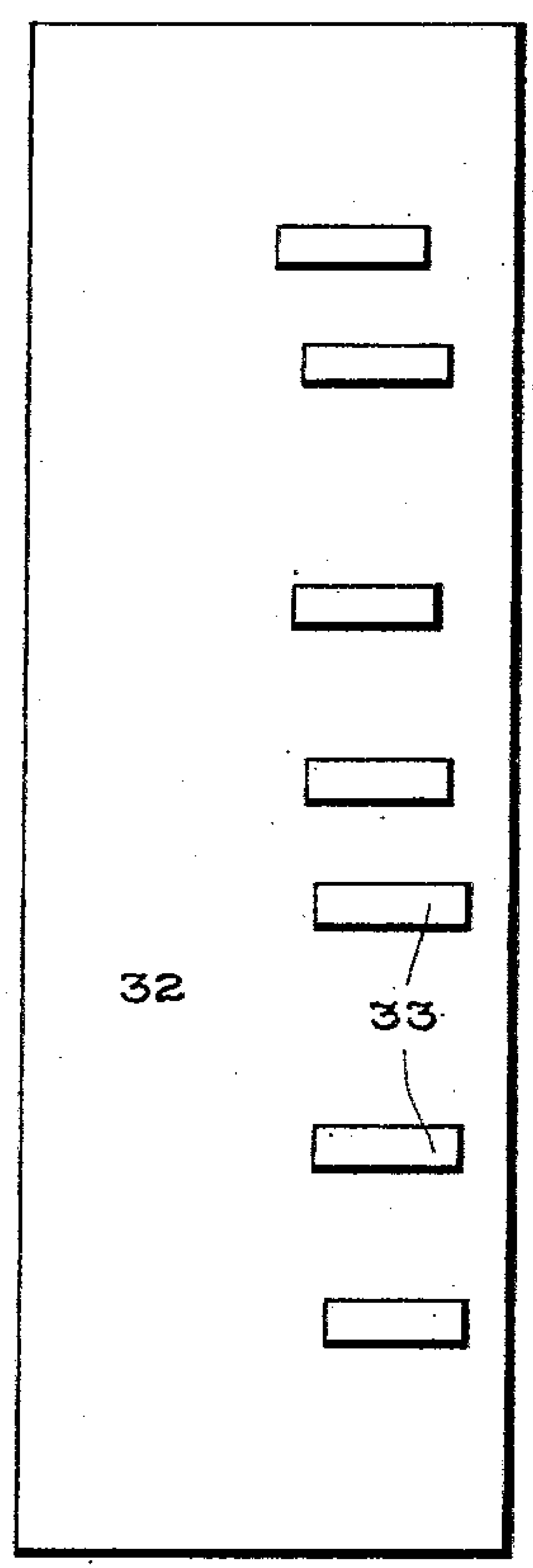


Fig. 5.

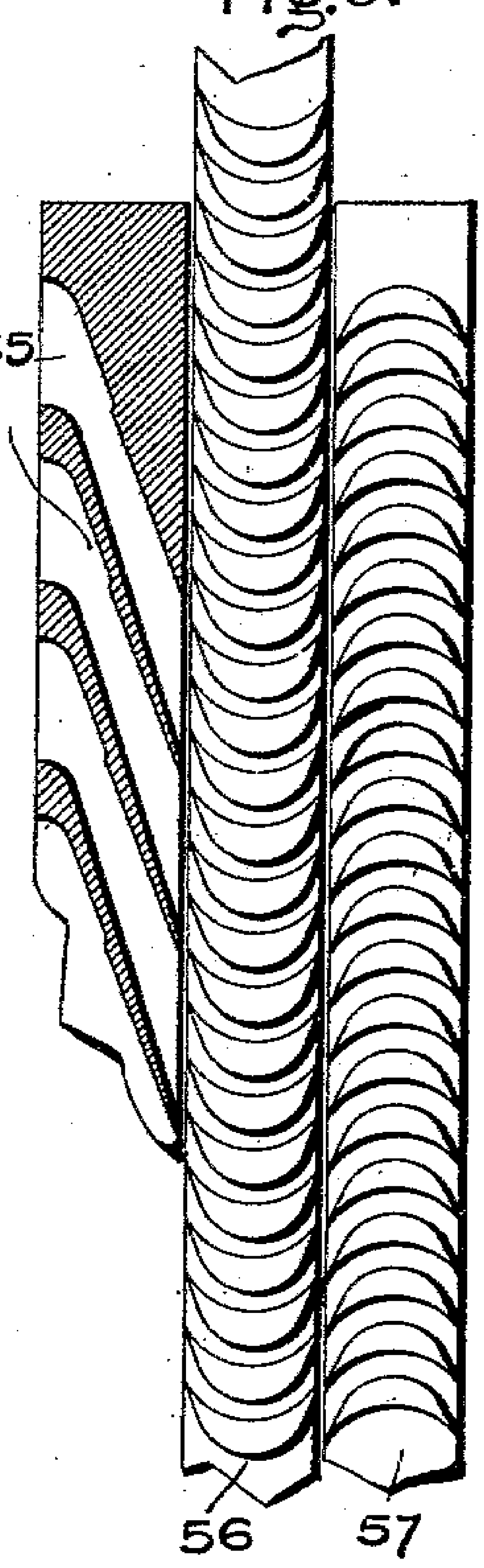


Fig. 7.

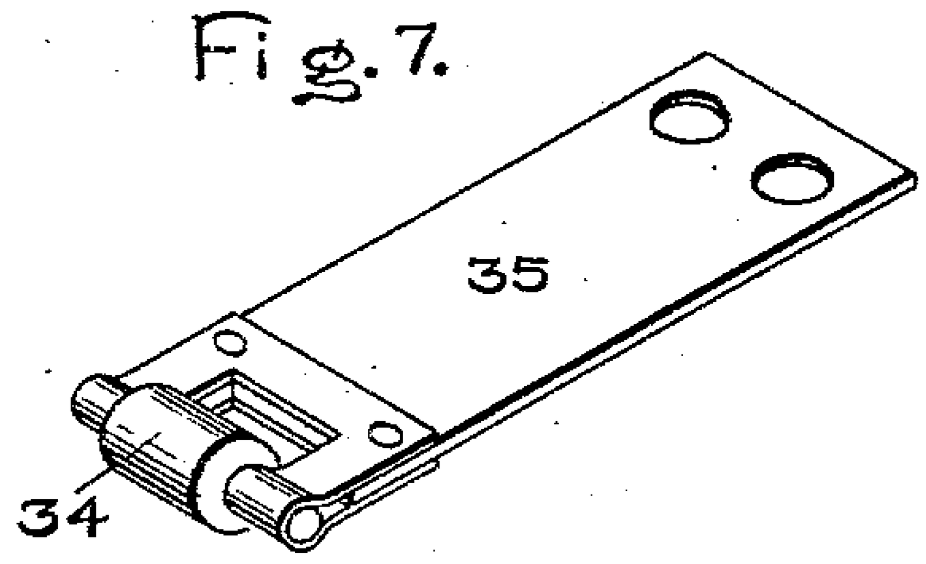
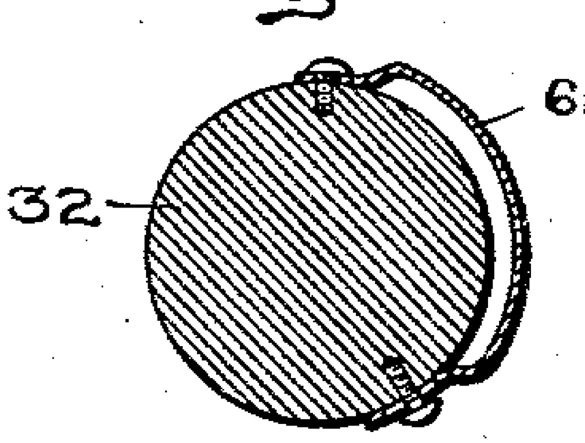


Fig. 9.



Witnesses:

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GOVERNOR FOR ELASTIC FLUID TURBINES.

APPLICATION FILED DEC. 26, 1902.

NO MODEL. 4 SHEETS—SHEET 4.

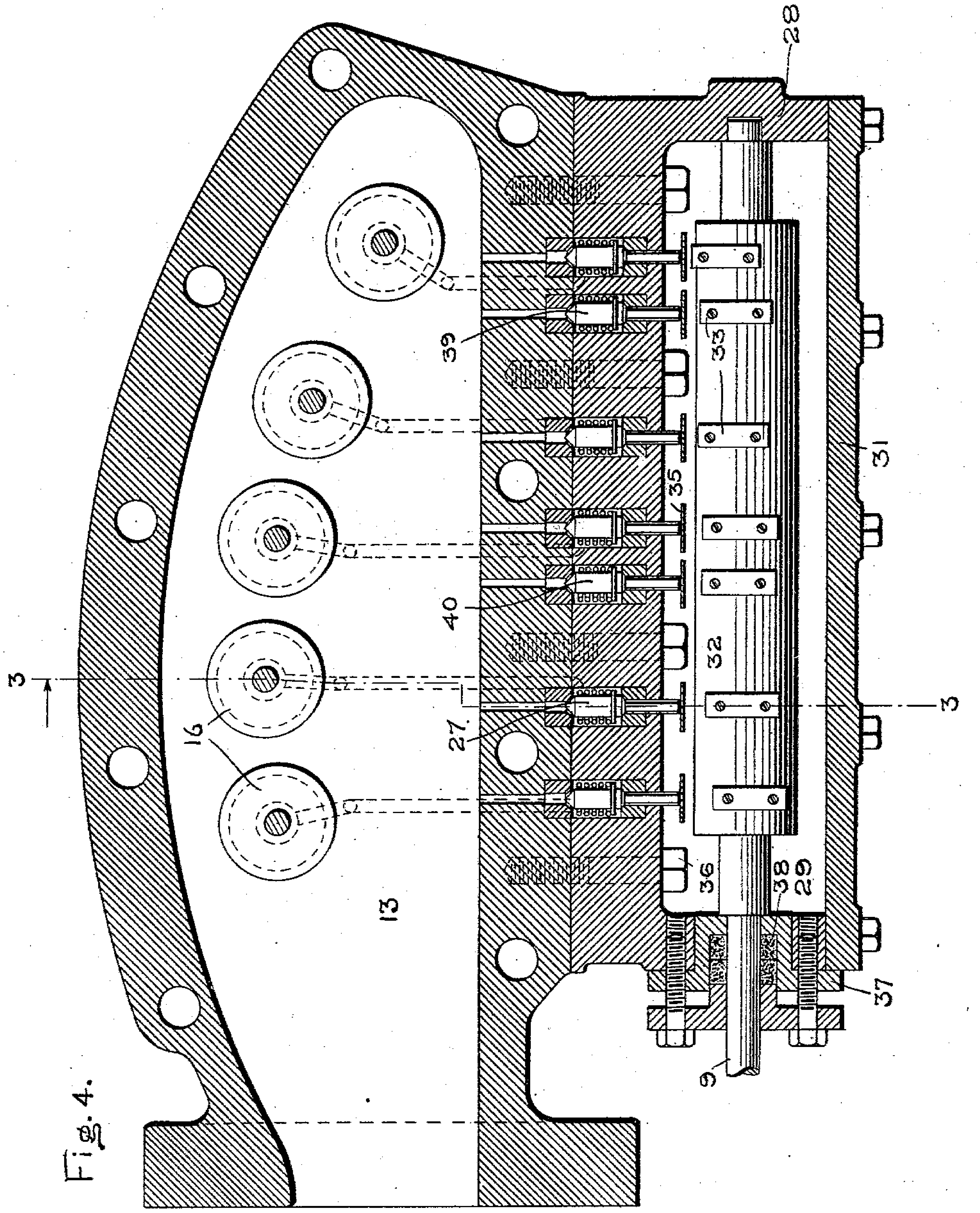

Fig. 4.

Witnesses
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Inventor:
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No. 743,727. Patented November 10, 1903.

UNITED STATES PATENT OFFICE.

OSCAR JUNGGREN, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

GOVERNOR FOR ELASTIC-FLUID TURBINES.

SPECIFICATION forming part of Letters Patent No. 743,727, dated November 10, 1903.

Application filed December 26, 1902. Serial No. 136,531. (No model.)

To all whom it may concern:

Be it known that I, OSCAR JUNGGREN, a citizen of the United States, residing at Schenectady, in the county of Schenectady, State of New York, have invented certain new and useful Improvements in Governors for Elastic-Fluid Turbines, of which the following is a specification.

In order to efficiently govern elastic-fluid turbines of the jet type, wherein the steam flow is radial or axial, or a combination of both, and especially where the pressure of the vapor is largely or wholly converted into *vis viva* before being delivered to the buckets, it is preferable to vary the volume of the vapor delivered without varying its velocity. A reduction in the velocity of the fluid means a reduction in efficiency, and since the machines are designed for a certain definite fluid velocity it is impractical to increase it beyond that point.

In a prior application of mine I have described a governor for elastic-fluid turbines wherein a plurality of separately-actuated valves are arranged to control the supply of fluid to the nozzles or sections of nozzles, each of said valves being under the control of an electromagnet, and the magnets themselves are under the control of a device that is responsive to speed variations.

The present invention follows along the general lines of the one referred to above; but it has this difference that all of the parts are mechanical. It sometimes happens that turbines are used for purposes other than driving electrical apparatus, and in such cases it is inconvenient to provide a separate source of electricity for energizing the magnets. In systems where the voltage fluctuates greatly for any cause it adds to the difficulty of making suitable magnets, because the latter have to have a greater working range. It is also necessary to carry a large stock of magnets, because different ones have to be supplied with machines working at different voltages. If the magnets are made large enough to work at ordinary high voltages, then they consume too much energy when used with low-voltage machines.

In its broadest sense my invention has for its object to provide a governor which will efficiently regulate an elastic-fluid turbine and in a more limited sense to provide a governor which will vary the volume of fluid supplied to a turbine without changing its velocity, and this in a simple and effective manner by mechanical means.

For a consideration of what I consider to be novel and my invention attention is called to the accompanying description and claims appended thereto.

In the accompanying drawings, which represent embodiments of my invention, Figure 1 is a side elevation of a turbine. Fig. 2 is a partial view in elevation of the turbine as viewed from the opposite side, certain of the parts being in section. Fig. 3 is a cross-section of the first-stage valve-chest, taken on the line 3 3 of Fig. 4 and looking in the direction of the arrow. Fig. 4 is a longitudinal section of said valve-chest, taken on the line 4 4 of Fig. 3 and looking in the direction of the arrow. Fig. 5 is a partial view in development, showing the relation of the nozzles or nozzle-sections and the buckets. Fig. 6 is a developed view showing the cams for actuating the auxiliary valves that control the nozzle-valves. Fig. 7 is a perspective detail view of one of the spring-pressed rollers that act on the auxiliary valves. Fig. 8 illustrates a means for cushioning the movements of the nozzle-valves, and Fig. 9 represents a modified form of cam for actuating the auxiliary valves.

Referring to Fig. 1, 1 represents the casing of an elastic-fluid turbine, having outboard-bearings 2 and 3, supporting the driving-shaft. The casing is divided into parts, and mounted on the part nearer the governor are the first and second stage valves. This arrangement facilitates the assembling or taking down of the machine and is also advantageous in alining the parts. The bearing 3 is provided with a cylindrical extension 4, in which is mounted a governor that is responsive to speed variations. As the speed increases the weights 5 tend to fly outward, and as the speed decreases the spring 6 tends to bring them nearer to the shaft. The movements of the spring and weight are transmitted to the rod 7 by means of suitable connections whereby the necessary longitudinal movement of the rod is obtained. The outer end of the rod is adjustably connected to the arm 8, that is secured to the rock-shaft 9, which actuates the controlling-cam and will be hereinafter described. 10 represents the valve-chest, which is bolted to the end face or wall of the turbine-shell. This chest contains the valves which control the supply of motive fluid to the buckets of the first stage and also contains the auxiliary valves, which control the action of the regulating-valves of the second stage. The motive fluid for actuating the second-stage valves is conveyed by the conduits 11.

Referring to Fig. 3, which represents a section of the valve-chest as viewed from a point opposite that of Fig. 1, 10 represents the casting that forms the valve-chest, which is secured to the casing or shell of the turbine by bolts 12. The valve-chest is provided with a large central chamber 13, from which open a plurality of passages, each having a separately-actuated nozzle-valve 14. These valves are similar in construction and operation, so that a description of one of them will be sufficient. The left-hand side of the valve-chest is provided with a projection that extends into an opening formed in the wall of the turbine-shell, and to this is detachably secured the nozzle or nozzle-sections. By reason of this construction the valve-chest and nozzle can be removed as the single unit. This greatly facilitates shipment and the assembling and taking down of the machines. The parts are readily alined, and even a workman having little or no knowledge of turbines can assemble them. The wall of the shell is faced off true and is provided with a projection on which the lower end of the valve-chest rests and is supported thereby.

Formed in the left-hand wall of the steam-chest is a plurality of openings, each of which has a cylindrical sleeve 15, that acts as a seat for the valve. The valve is also provided with a guide that works on the inside of the sleeve. On the opposite end of the valve-stem is a piston 16, which opens and closes the valve and also acts as a guide. The piston is fitted into the cylinder 17, and its inward movement is assisted by the compression-spring 18. Secured to the right-hand wall of the steam-chest by suitable bolts is a plate 19, that forms the rear head of all of the cylinders 17 and acts as an abutment for the compression-springs 18. By mounting the nozzle-valves within the steam-chest, as shown, I do away with all packings, and any leakage from said valves goes into the second stage. In addition to this the plate is provided with fluid-carrying passages 20, that communicate with the passages 25, formed in the valve-chest. In the lower part of the valve-chest are passages 26, that convey fluid under pressure to the passages 25. Included in each of these passages is a double-seat valve 27, which in the position shown permits the fluid to flow from the interior of the valve chest to the rear side of the piston. When the auxiliary valve is in the position shown, the nozzle-valve 14 is closed, because the pressures on the front and rear faces of the piston 16 are balanced. In closing the nozzle-valve a spring 18 is employed to overcome the starting-friction and give the necessary impetus. The lower end of the auxiliary valve 27 is provided with a conical surface that engages with a seat carried by the cam-inclosing box or casing 28. The upper seat for the auxiliary valve is carried by the valve-chest, while the lower seat is carried by the box, the line of division being such as will permit the parts to be readily separated. The valve 27 is normally held against its lower seat by the compression-spring, which surrounds it. The lower end of the valve is provided with an extension or stem that enters the chamber in the box, and when the chest and box are separated for any reason the valve can be removed without trouble. The interior of the box is provided with a chamber 29, which is connected with the low-pressure side of the turbine, or it may be connected to the atmosphere, as desired. In the present instance the exhaust admitted to the chamber is conveyed to the second stage by the passage 30. (Shown in dotted lines.) The lower end of the box or casing is provided with a detachable plate 31, that is secured in place by bolts. When for any reason it is desired to inspect the operating parts within the box, the cover or plate is removed. Situated within the box and mounted on the shaft 9 is a cam-carrying support 32, that controls the operation of the auxiliary valves. As the shaft 9 is oscillated back and forth by the governor-rod 7 the cam faces or projections 33 are brought into successive engagement with the antifriction-rollers 34, that are carried by the spring-plates 35. The rollers are secured to the spring-plates by a U-shaped holder, that is riveted in place. These plates are secured to the interior of the valve-box and are in engagement with the stems of the auxiliary valves. The object in using these springs is to compensate for any slight differences which may exist in the valves and cams, and thereby insure their closing and opening. When the cam-faces 33 are out of engagement with the rollers 34, the valves are permitted to drop under the action of their springs and gravity and close the space back of the valve-piston 16 to the exhaust. This same movement connects the cylinder-space back of the valve-piston with the source of fluid-supply under pressure, and the valve closes.

It has been pointed out that the auxiliary valves are sometimes in engagement with the cam and at other times not, and since the cam is actuated by the governor it follows that there is a lost-motion connection between the auxiliary or secondary valve and the governor, because after the cam has raised a particular valve further motion thereof does not affect it. This arrangement enables the governor to actuate said valve with a minimum expenditure of energy, which obviously improves the regulation. To state the matter in a different way, after the governor has caused the secondary valve to open or close it is, so to speak, "disengaged" therefrom and progresses to the next valve in the series.

The box or casing 28 is secured to the valve-chest by the bolts 36, so that it can readily be removed for the purpose of inspection or repair.

Referring to Fig. 4, which shows a longitudinal section of a steam-chest, 13 represents the chamber formed therein, and 16 represents the pistons of the separately-actuated valves that control the admission of motive fluid to the nozzles or nozzle-sections. The shaft 9 for the cams is supported at its rear end in a bearing formed in the end of the box 28, and the opposite end is supported in a detachable bearing 37, that also carries a packing 38 to prevent the escape of steam at this point. In the present instance I have shown five valves controlling as many nozzles or nozzle-sections of the first stage. It is obvious that the number can be increased or diminished, as desired. It will be noted that whereas five nozzle-valve pistons are provided seven auxiliary valves are shown. Five of these valves control the operation of the nozzle-valves of the first stage, and the remaining valves 39 and 40 are arranged to control the two valves of the second or low-pressure stage. This feature of my invention will be referred to later in connection with Fig. 2.

The projections 33 on the cam are so arranged that they engage with the springs 35 for actuating the auxiliary valves at different times, the object of this being to cut in or out one section of the nozzle after the other, and it is to be noted that each of the nozzle-valves has an open and a closed position, but no intermediate, the object of this particular arrangement being to vary the volume of the motive fluid without changing its velocity, each nozzle being arranged to impart to the fluid stream a certain definite velocity. The projection on the right-hand end of the cam is the first one to actuate an auxiliary valve. This is followed by the third projection, which controls the second of the first-stage nozzle-valves. The second projection is the next to engage with a spring 35, and thus act on the valve 39, that regulates a second-stage valve. The fourth and fifth cam projections, considered from the right-hand end of the cam, simultaneously engage with the springs 35, which means that another nozzle or section of a nozzle of the first stage is cut in and also that another nozzle or section of a nozzle of the second stage is cut in. When the cam is rotated in the opposite direction, these projections disengage themselves from the auxiliary valve mechanism one after the other and permit one nozzle-valve after the other to close.

Referring to Fig. 2, 39 represents the valve which controls the operation of the second-stage nozzle-valve 46. 13 represents the chamber in the valve-chest, and this is in communication with the pipe 11 through the passage 47. The valve 39 being in its lower position, the exhaust-chamber 29 of the box 28 is cut off, and the motive fluid under pressure passes from the chamber 13 through the passage 47, thence by the pipe 11 into the cylinder 48, which is secured to or forms a part of the casing of the first stage. Under these conditions the second-stage valve 46 would be in the act of closing. Mounted for movement within the cylinder is a piston 49, which is connected to the second-stage valve 46, that is arranged to slide to and fro and by its movements cover and uncover the passage 50, leading to the bowl of the second-stage nozzle 51. This nozzle is detachably secured to the wall or diaphragm 52, that divides the stages one from the other. Fluid is discharged against the wheel of the second stage by the passage 53, which may or may not expand, as desired; but in any event it imparts to the fluid stream the necessary velocity. When the cam 32 moves to a point where the spring 35 is moved upward, the supply of high-pressure fluid to the upper end of the piston 49 is cut off and the steam contained in the cylinder and pipe 11 is discharged into the exhaust-chamber 29 in the box. The spring 54, which is supported by suitable means formed on the wall 52, raises the valve 46 to the position shown and uncovers the passage 50, leading to the second-stage nozzle and permits vapor from the first stage to freely enter the second stage at this point.

The operation of the second-stage valve 40 (shown in Fig. 4) is the same as that of the valve 39 and for that reason will not be described. It should be noted, however, that the cam projection for operating this valve is so arranged that the valve is actuated after the valve 39. In other words, the second-stage valves are successively operated, as are also the first-stage valves.

Referring to Fig. 5, I have shown three closely-associated nozzle-sections 55; but as many of these sections can be employed as desired, and I can so arrange the nozzle-valves that some or all of the nozzle-sections are capable of being cut out one after the other, or two or more of the valves may be simultaneously actuated either in the first stage or in the second, or I may simultaneously operate a valve of the first stage and one of the second, as described in connection with Fig. 4. The timing of the auxiliary valves is regulated by the position of the cam projections 33 on the support 32.

The nozzles 55 are so designed that they will give to the fluid stream the necessary velocity, and they may be of the expanding or non-expanding type. The velocity given to the stream or streams may be anything that is desired. I have found that a velocity of two thousand two hundred feet per second will give satisfactory results, but do not limit myself to this or any other particular velocity. The vapor discharged from the nozzles strikes the buckets on the wheel 56 and in flowing through the passages formed between the buckets imparts movement thereto. The vapor discharged from the bucket-wheels is received by the intermediates 57, which in turn discharge it against an adjacent bucket-wheel, and so on. It is to be noted that when one section of a nozzle is cut out the working passages between the buckets situated directly in front thereof are also cut out. The same is true of the passages between the stationary buckets on the intermediate. In so far as the present invention is concerned the intermediate buckets 57 can be stationary or movable, as desired.

I have found by actual test that there is a tendency for the nozzle-valve piston 16 to strike the head 19 with a decided blow when the valve opens, and to avoid this a cushioning device is provided, as shown in Fig. 8. 16 represents the piston as before, and turned in the periphery is a groove 58, which in the movements of the piston momentarily registers with the inlet-port 59, that communicates with the chamber 13 of the steam-chest by means of the passage 62. (Shown in dotted lines.) Formed in the piston and communicating with the groove 58 at one end and the rear of the piston at the other are one or more passages 60. In the present instance four of these passages are provided, but the number can be varied to suit the conditions of operation. When the piston moves to the right, or in a direction to open the valve, the cylindrical space back of it is connected to the exhaust, and the instant the groove 58 registers with the port 59 there will be a momentary rush of high-pressure steam through the passages 60 into the cylindrical space back of the piston, and although this space is in communication with the exhaust through passage 25 the passage of steam is relatively restricted, so that a cushioning effect is obtained. The continued movement of the piston closes the groove 58 to the supply of steam, so as to prevent leakage. The amount of steam that is momentarily trapped behind the piston permits the piston to seat itself without undue shock, and the steam escapes by way of the exhaust-chamber 29.

In Fig. 9 is shown a slightly-modified form of cam for operating the auxiliary valves. Owing to the number of valves and their seats being made of separate pieces and mounted in separate supports—such, for example, as the steam-chest and cam-containing box—there is a chance of the parts not alining exactly or having exactly the same movement. To compensate for this, a spring 35, Fig. 3, is placed between the cam projections 33 and the valve-stems. In the modification referred to the cam is made out of a piece of spring metal 61, that is firmly secured at one end to the support 32, while the opposite end is free to slide to a certain extent. Any undue pressure on the spring will cause it to approach the support more closely, and thus compensate for any inaccuracy in the valve mechanism. This arrangement has the advantage of decreasing the number of parts.

The number of stages can be varied as desired and such valves as 39 and 40 used to control the admission of fluid thereto. Where the number of valves to be controlled is large, the steam-chest and cam can be duplicated, if desired.

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 combination, a main valve which has an open and a closed position but no intermediate, buckets receiving motive fluid from the main valve, an auxiliary valve for controlling the main valve, a governor and a lost-motion connection between the governor and valve for actuating the latter.

2. In combination, a plurality of main valves each of which has an open and a closed position but no intermediate, wheel and intermediate buckets receiving motive fluid from the main valves, an auxiliary valve for controlling each of the main valves, a lost-motion connection for actuating each of the auxiliary valves, and a speed-governor for imparting movement to the valves through said connection.

3. In combination, a nozzle, a main valve for controlling the nozzle, an auxiliary valve for controlling the main valve, a cam for controlling the movements of the valves, and a governor for regulating the movements of the cam.

4. In combination, a plurality of independent fluid-actuated main valves, auxiliary valves for controlling the main valves, and a cam which acts on a plurality of the auxiliary valves.

5. In combination, a plurality of fluid-actuated main valves that have an open and a closed position but no intermediate, a support on which the valves are mounted, auxiliary valves, one for each of the main valves, a cam, and devices between the cams and the auxiliary valves whereby motion is imparted from one to the other.

6. In a turbine, the combination of a plurality of nozzles or nozzle-sections, a fluid-actuated valve for controlling the action of each nozzle or nozzle-section, buckets situated in front of the nozzles and acted upon by fluid discharged therefrom, cams corre-

sponding to each of the nozzle-sections for controlling the valves, a governor, and a mechanical connection between the governor and the cams for moving the latter in response to speed variations.

7. In an elastic-fluid turbine, the combination of a shell, a valve-chest detachably secured to the shell, a plurality of valves mounted in the chest, a number of nozzle-openings which register with the valve-openings and are controlled by said valves, and cams which separately actuate the valves.

8. In an elastic-fluid turbine, the combination of a shell, a valve-chest detachably secured to the shell, a plurality of valves mounted in the chest, a nozzle that is provided with a plurality of fluid-passages, and means for detachably securing the nozzle to the valve-chest.

9. In an elastic-fluid turbine, the combination of a valve-chest, a fluid-actuated valve mounted therein, a box situated in operative relation to the chest, a cam mounted in the box, and an auxiliary valve that controls the fluid-actuated valve and is itself actuated by the cam.

10. In combination, a valve-chest, a plurality of fluid-actuated valves mounted therein, a box detachably secured to the valve-chest, a cam mounted therein, auxiliary valves which are mounted in the wall of the box and are controlled as to their action by the cam, and a means for rocking the cam.

11. In combination, a valve-chest, a box detachably secured thereto, a plurality of fluid-actuated valves mounted within the chest, a piston for each valve, a passage leading from the valve-chest to the back of each of the pistons, an auxiliary valve for controlling each of the passages, and two seats for each of the valves, one of said seats being carried by the valve-chest, the other by the box.

12. In an elastic-fluid turbine, the combination of a plurality of controlling-valves which have a normal tendency to close as soon as fluid is admitted to the turbine, a piston for each of the valves, a plurality of separately-actuated auxiliary valves for creating a balanced or unbalanced condition as to pressure on the piston, a cam for each of the auxiliary valves, and a means for imparting simultaneous movement to all of the cams.

13. In an elastic-fluid turbine, the combination of a plurality of valves, a spring for each valve tending to move it in one direction, a cam for moving each valve against its spring, a support common to all of the cams, and a governor for rocking the support.

14. In an elastic-fluid turbine, the combination of a shell, a valve-chest detachably secured to an end wall of the shell, a box carried by the chest, a cam mounted in the box, a governor mounted in line with the main shaft, and a rod for transmitting motion from the governor to the cam.

15. In an elastic-fluid turbine, the combination of a nozzle, a valve for controlling its action, a spring tending to hold said valve open, a piston and cylinder for closing the valve against the spring, a secondary means for regulating the admission of fluid to the cylinder, a speed-responsive device, and a lost-motion connection between the means and said device.

16. In combination, a plurality of separate fluid-actuated valves, a piston for moving each valve, a second set of separate fluid-actuated valves, springs opposing movement in one direction of the second set of valves, a plurality of independent auxiliary valves for regulating the first and second sets of valves, and a means common to all of the auxiliary valves for actuating them.

17. In an elastic-fluid turbine, the combination of a divided casing, means for dividing it into stages, and valves for controlling the first and second stages, which are mounted on that portion of the casing which incloses the first wheel.

18. In an elastic-fluid turbine, which is divided into stages, the combination of separate fluid-actuated valves for the stages, which have an open and a closed position but no intermediate, auxiliary valves for controlling the fluid used to actuate the valves, and a cam which successively operates the auxiliary valves.

19. In an elastic-fluid turbine, the combination of a valve-chest, a valve mounted therein, a box detachably secured thereto, containing an exhaust-chamber, and a cam mounted in the box for actuating the valve.

20. In an elastic-fluid turbine, the combination of a valve-chest, fluid-actuated valves therein, auxiliary valves controlling the first-named valves, cams for actuating the valves and spring-plates between the cams and the auxiliary-valve stems.

21. In an elastic-fluid turbine, the combination of a plurality of nozzles or nozzle-sections, a separately-actuated valve for controlling each nozzle or nozzle-section, which has an open and a closed position but no intermediate, a device responsive to speed variations for controlling the action of the valves, a fluid-pressure means for cushioning the movements of the valves, a row of wheel-buckets situated adjacent to the nozzles, and sectionalized intermediate buckets situated adjacent to the wheel-buckets.

22. In an elastic-fluid turbine, the combination of a plurality of discharge-openings, separate valves for the openings, which have an open and a closed position but no intermediate, a piston for each valve, a cushioning device for each piston, auxiliary valves for regulating the movements of the pistons, and a governor for regulating the auxiliary valves.

23. In a turbine, the combination of bucket-wheels, separate inclosures for the wheels working at different pressures, a plurality of nozzles for discharging motive fluid thereto,

a plurality of nozzle-valves, pistons for actuating the valves, secondary valves controlling the pistons, and a passage for conveying fluid from the exhaust side of the pistons to a low-pressure stage.

24. In an elastic-fluid turbine, the combination of a bucket-wheel, a nozzle comprising a plurality of closely-associated sections for discharging motive fluid to the wheel, independent nozzle-valves for cutting the sections into and out of service, pistons for actuating the nozzle-valves, secondary valves for controlling the movements of the pistons by creating a balanced or unbalanced condition as to pressures, a speed-responsive device, and a lost-motion connection between the said device and the secondary valves, whereby the latter may be successively cut into and out of action.

25. In combination, a bucket-wheel, a casing therefor, a nozzle mounted on the casing, a valve arranged to control the nozzle which has an open and a closed position but no intermediate, a piston for actuating the valve, a secondary valve for controlling the nozzle-valve, and a fluid-pressure means for cushioning the action of the nozzle-valve.

In witness whereof I have hereunto set my hand this 24th day of December, 1902.

OSCAR JUNGGREN.

Witnesses:
BENJAMIN B. HULL,
HELEN ORFORD.