No. 751,587. PATENTED FEB. 9, 1904.

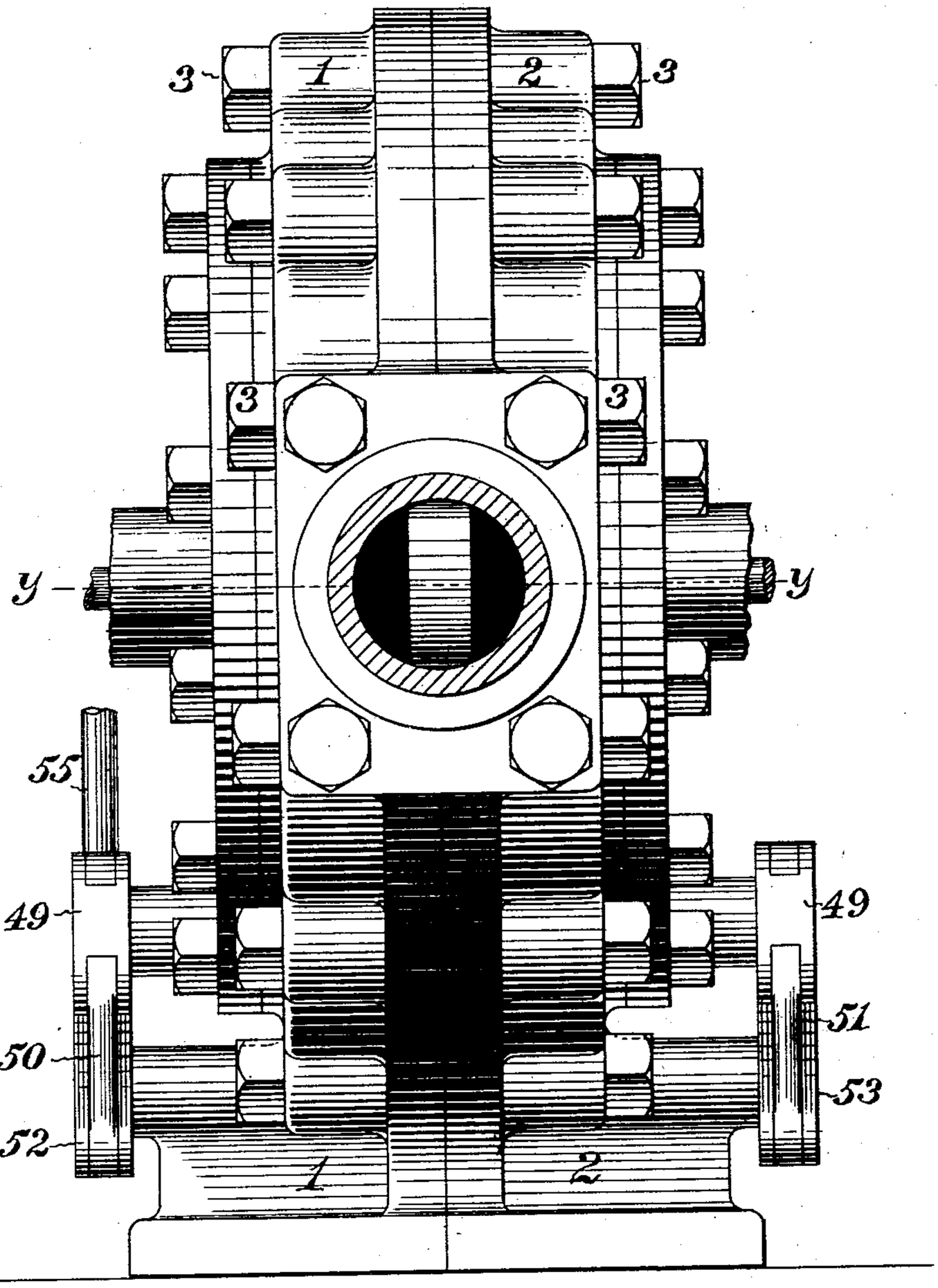
G. WESTINGHOUSE, Jr.

ROTARY FLUID MOTOR.

APPLICATION FILED FEB. 20, 1894.

NO MODEL. 7 SHEETS—SHEET 1.

FIG. 1.



WITNESSES:

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F. E. Gaither.

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by Howard Bell,

Att'y.

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NO MODEL. 7 SHEETS—SHEET 2.

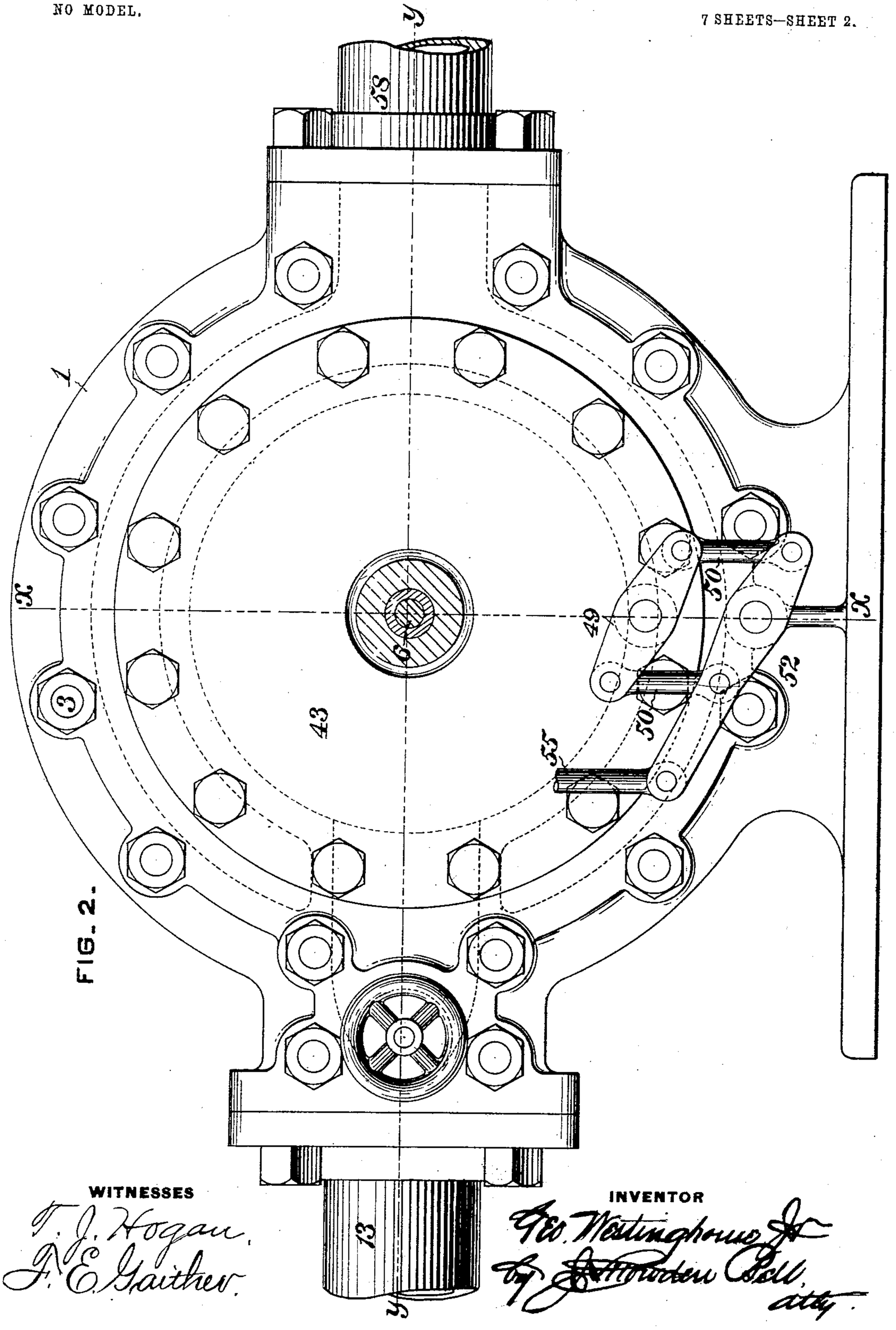

FIG. 2.

WITNESSES

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ROTARY FLUID MOTOR.

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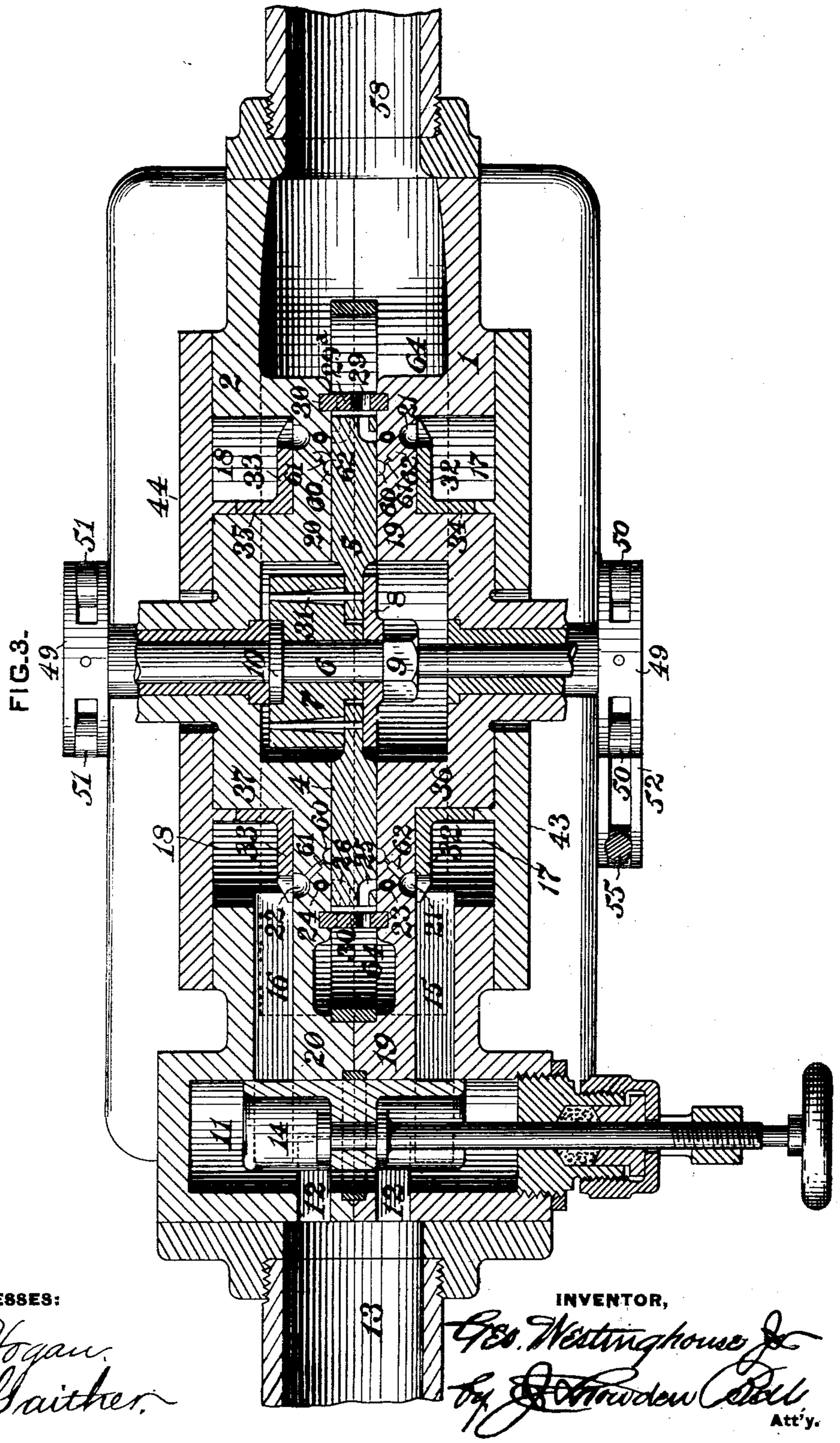
NO MODEL. 7 SHEETS—SHEET 3.

FIG. 3.



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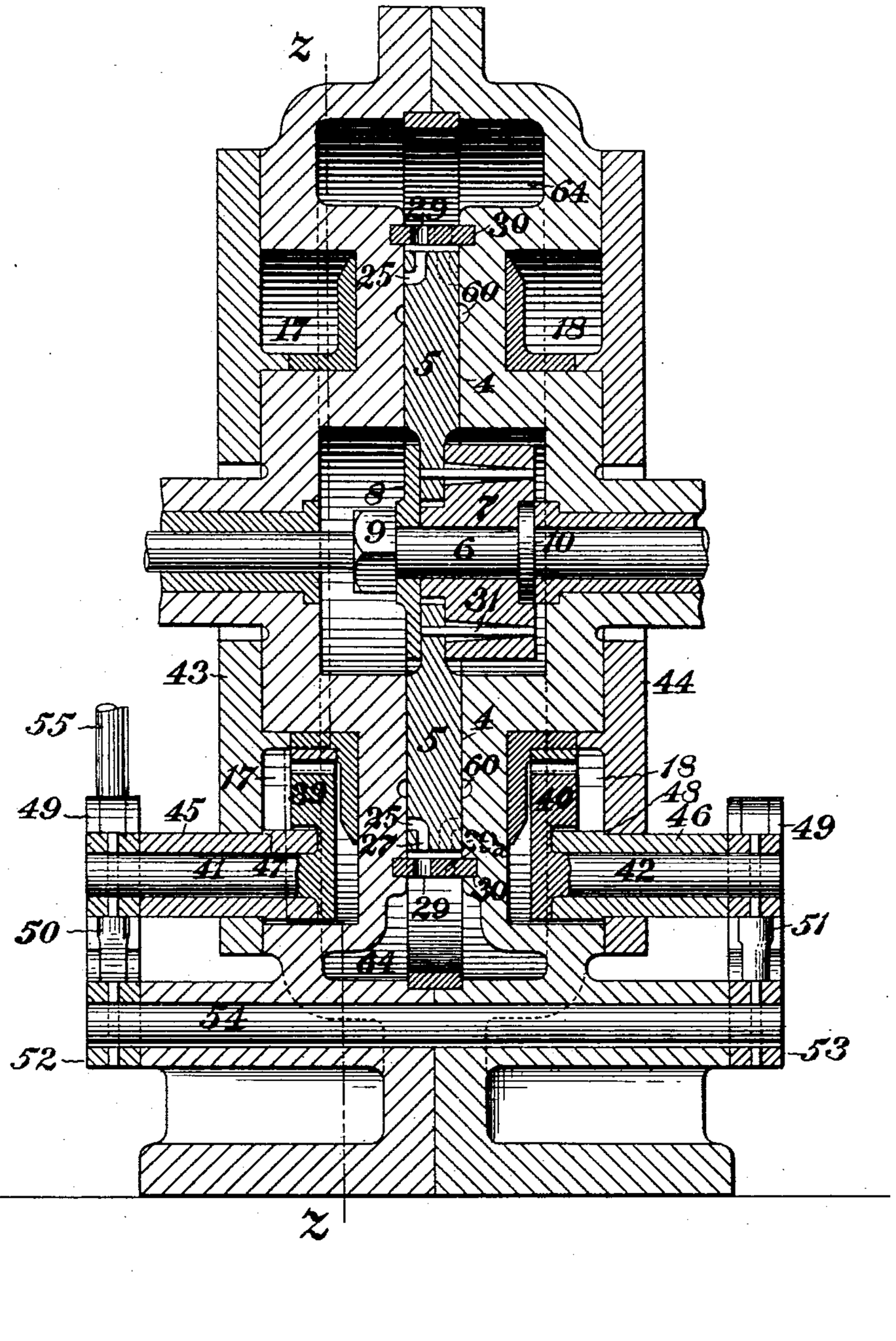
NO MODEL. 7 SHEETS—SHEET 4.

FIG. 4.



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ROTARY FLUID MOTOR.

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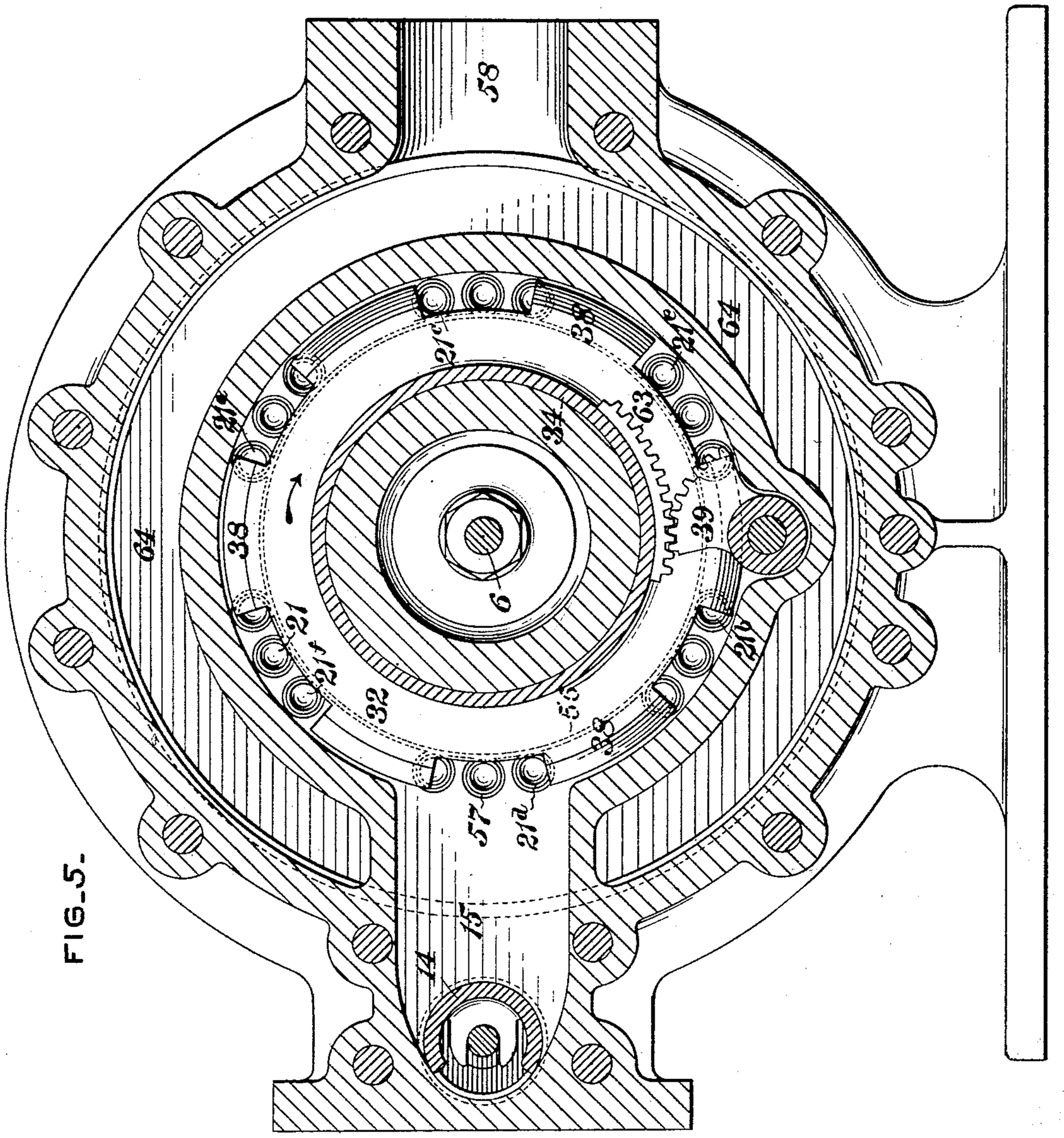
NO MODEL. 7 SHEETS—SHEET 5.



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ROTARY FLUID MOTOR.

APPLICATION FILED FEB. 20, 1894.

NO MODEL. 7 SHEETS—SHEET 6.

FIG. 6.

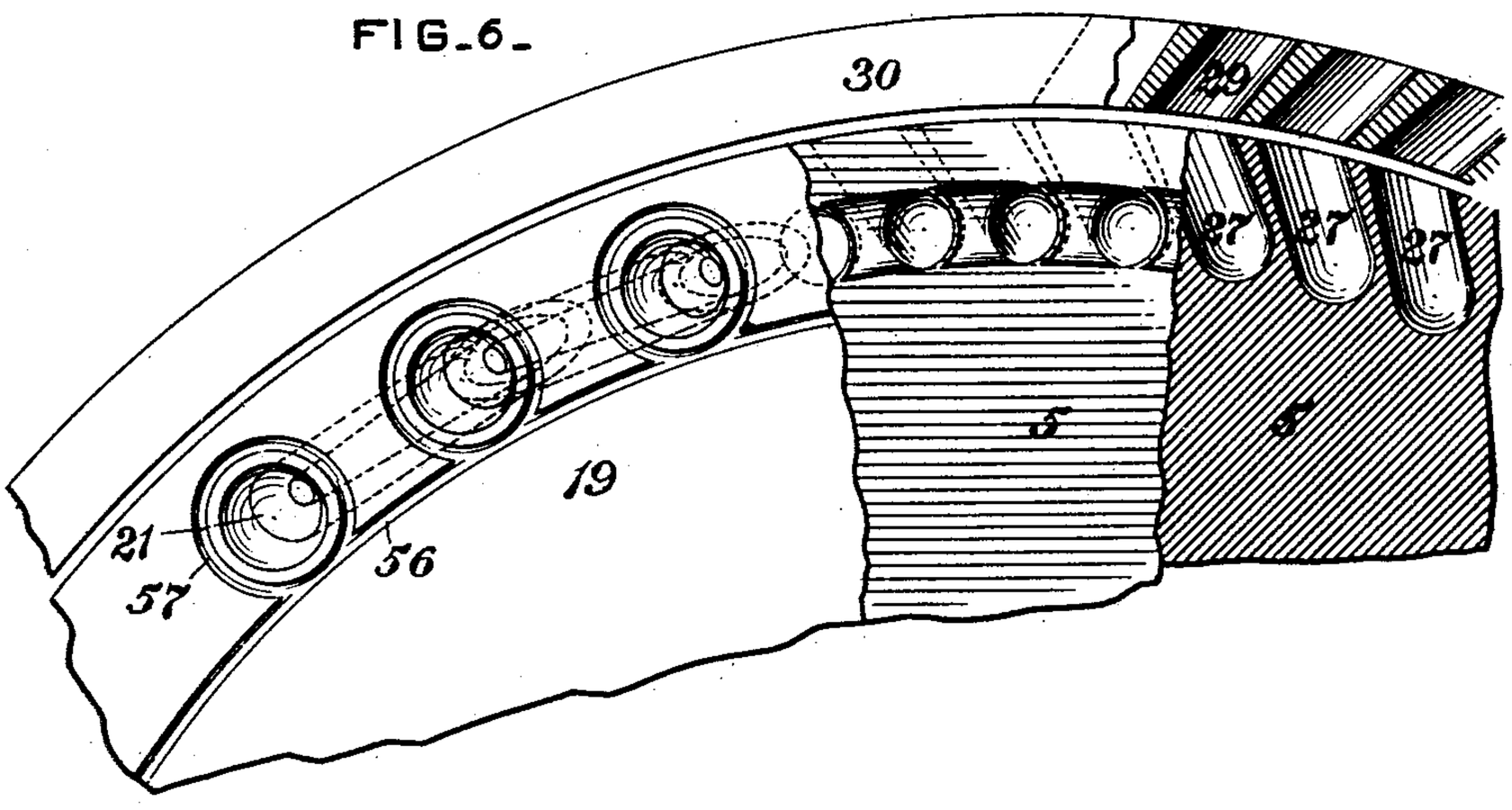


FIG. 8.

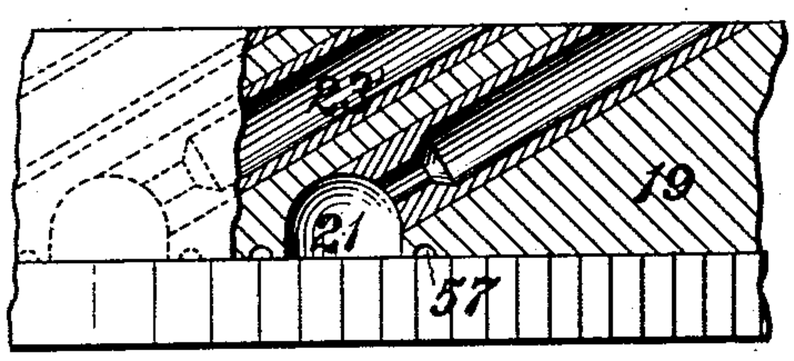
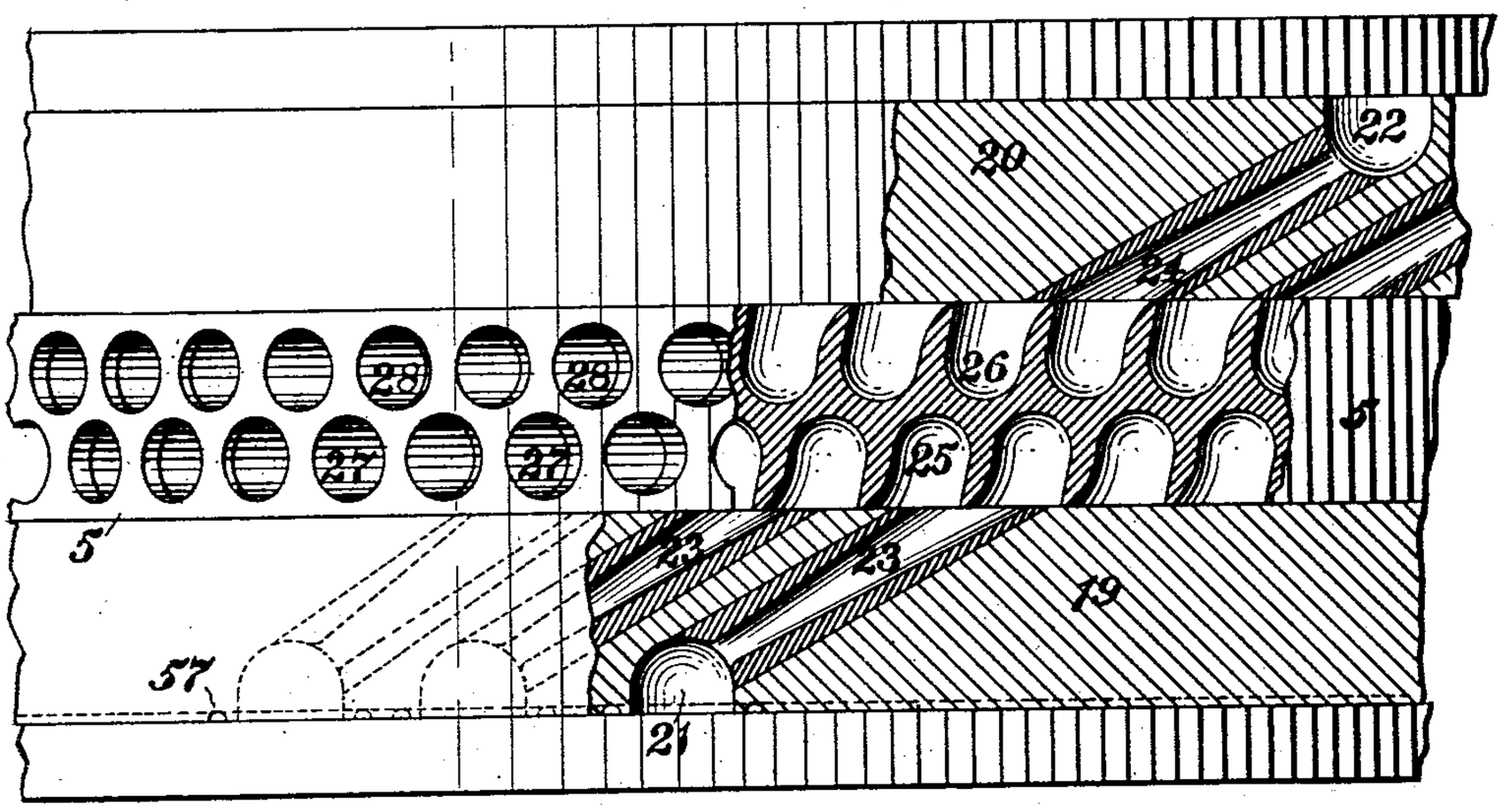


FIG. 7.



WITNESSES

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No. 751,587. PATENTED FEB. 9, 1904.

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ROTARY FLUID MOTOR.

APPLICATION FILED FEB. 20, 1894.

NO MODEL. 7 SHEETS—SHEET 7.

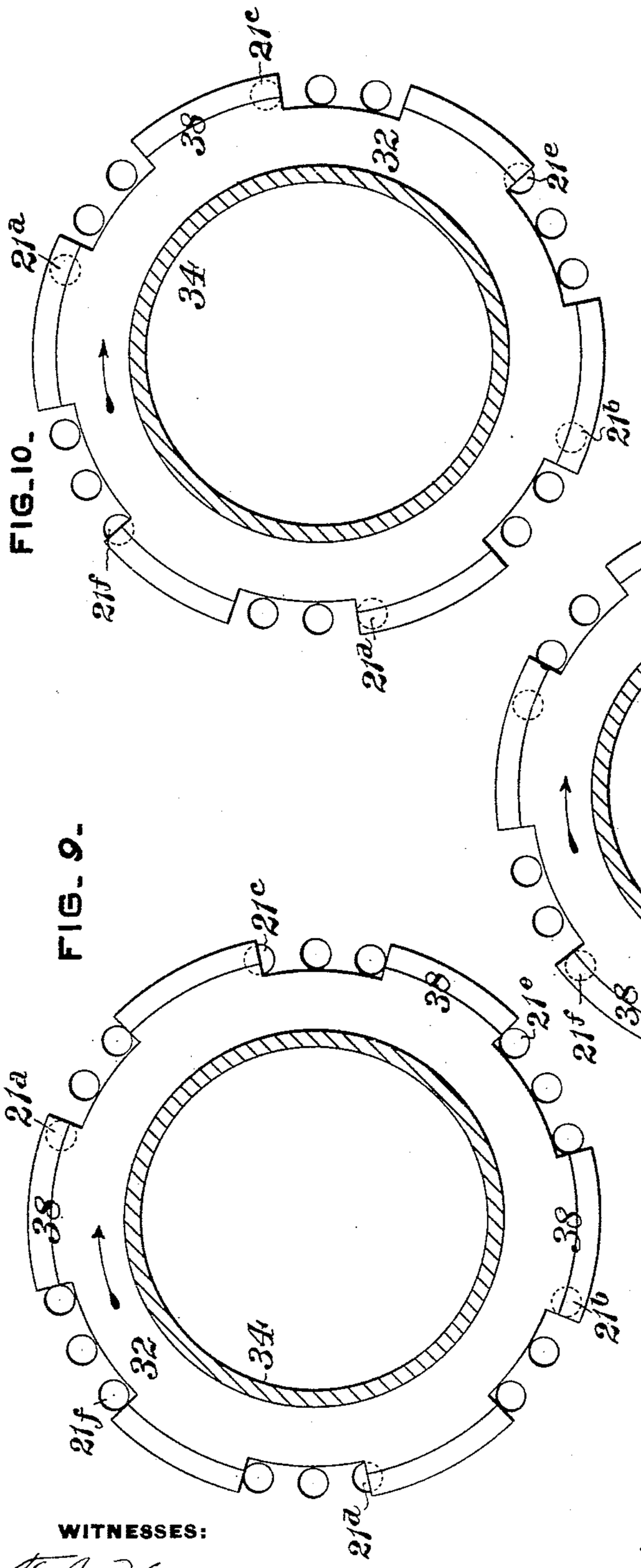

FIG. 10.

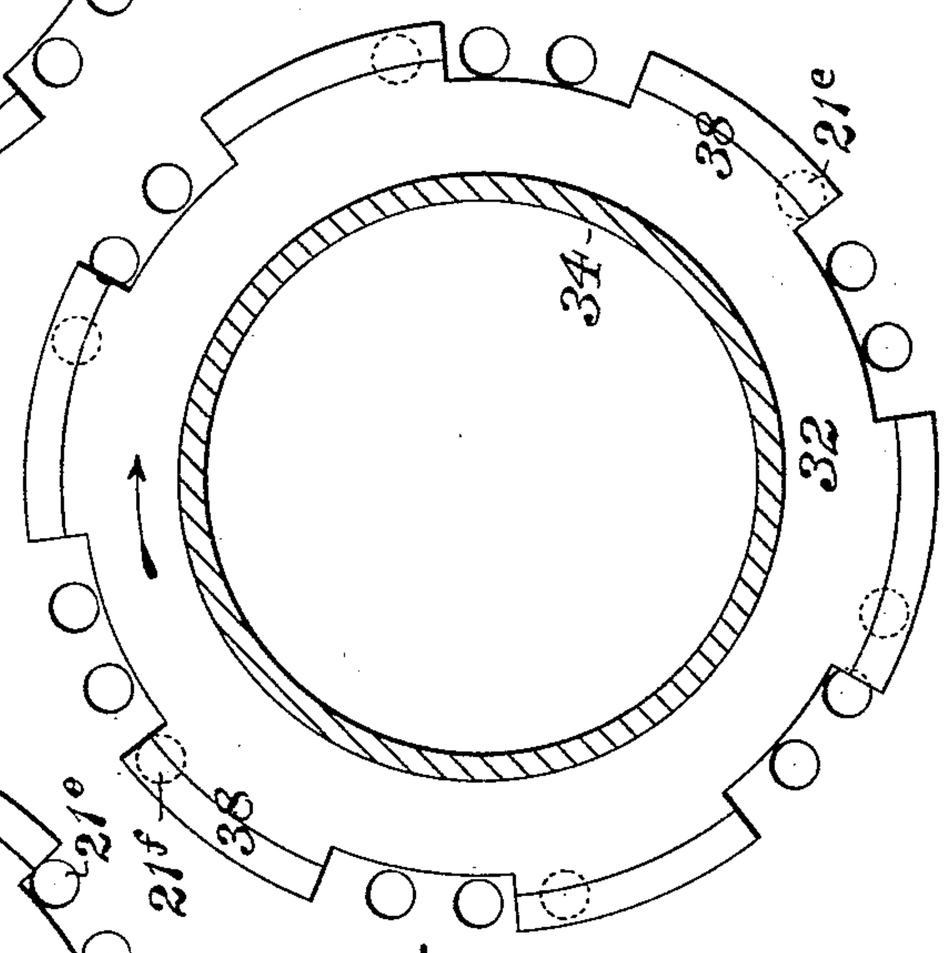

FIG. 11.

FIG. 9.

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Att'y.

No. 751,587. Patented February 9, 1904.

UNITED STATES PATENT OFFICE.

GEORGE WESTINGHOUSE, JR., OF PITTSBURG, PENNSYLVANIA.

ROTARY FLUID-MOTOR.

SPECIFICATION forming part of Letters Patent No. 751,587, dated February 9, 1904.

Application filed February 20, 1894. Serial No. 500,844. (No model.)

To all whom it may concern:

Be it known that I, GEORGE WESTINGHOUSE, Jr., a citizen of the United States, residing at Pittsburg, in the county of Allegheny and State of Pennsylvania, have invented or discovered certain new and useful Improvements in Rotary Fluid-Motors, of which improvements the following is a specification.

My invention relates to that class of fluid-motors in which the fluid is caused to act by impact upon a suitably-constructed rotary member or members, and has for its object the improvement of the efficiency of such motors in the utilization and control of the motive fluid.

To this end my invention, generally stated, consists of means whereby the delivery of the steam to and its action upon a rotary abutment, disk, wheel, or similar member is effected in such manner as to cause such member to revolve at an exceedingly high velocity or at such a velocity that the energy of the steam is utilized at its maximum efficiency; of means for regulating the supply and distribution of the motive fluid for the purpose of regulating and controlling the speed and direction of motion of the motor, and of improvements in certain details of construction, all as hereinafter more fully set forth.

In the accompanying drawings, which illustrate an embodiment of my invention, Figure 1 is a side elevation, and Fig. 2 an end elevation, of my improved motor; Fig. 3, a horizontal section on the line $y\ y$ of Figs. 1 and 2; Fig. 4, a vertical section on the line $x\ x$ of Fig. 2; Fig. 5, a vertical section on the line $z\ z$ of Fig. 4; Figs. 6 and 7, detail views, on an enlarged scale, partly in section and partly in elevation, showing the openings in the disk and in the ring surrounding it and the arrangement of the ports and passages or nozzles for delivering the steam to the disk, Fig. 6 being a side view and Fig. 7 a plan view; Fig. 8, a detail view, on the same scale as Figs. 6 and 7, of a modified form of delivery passage or nozzle; and Figs. 9, 10, and 11, views showing the cut-off valve in different positions.

The casing of the motor is formed in two sections 1 and 2, which are secured together by means of bolts 3 and which inclose between them a central space which may be divided into two concentric chambers or compartments by means of a ring 30, which fits into circular grooves formed in the opposite sections of the casing, or, if preferred, the ring 30 may be omitted.

In the chamber or space 4 within the ring 30, when the ring is employed, is fitted a disk 5, of steel, bronze, or other suitable material, mounted on a shaft 6 between two collars 7 and 8, which are clamped between a fixed collar 10 and a screw-nut 9. The disk is reduced in thickness near its central portion and is provided with a central opening which fits loosely over a hub formed on the end of the collar 7. The length of this hub is slightly greater than the thickness of the reduced central portion of the disk, so that when the collar 8 is clamped in place by the screw-nut 9 the disk will be free to move in the recess or groove between the collar 8 and the shoulder on the collar 7. The collar 7 may be forced into place against the collar 10 and secured in any ordinary manner, or, if preferred, it may be formed integral with the shaft.

A number of holes are bored in the collar 7 in a circle concentric with the shaft and disk and are reamed out, so as to be conical or tapered in form, with the large ends next to the disk. A series of holes corresponding in number and position to those formed in the collar 7 is formed in the disk, and steel pins 31 are tightly fitted therein and project from the disk into the holes formed in the collar 7. The pins 31 are fitted at their outer ends into the small ends of the tapered or conical holes in the collar 7 and are adjusted to central positions in the holes and tend to hold the disk concentric with the shaft 6, but are capable of yielding sufficiently to permit the disk to adjust itself to a slightly different position when the velocity of rotation is great enough to move the disk transversely to the shaft. The pins 31 may be fitted tightly in the disk only or in the the collar 7 or in both the collar and disk.

If the center of gravity of the disk coincides perfectly with the axis of the shaft, there will be no tendency to transverse movement of the disk relatively to the shaft even at the

highest velocity; but as it is practically impossible to obtain such a perfect coincidence the disk tends when rotating at exceedingly high velocities to move relatively to the axis of the shaft and to adjust itself to a position in which its center of gravity coincides with the center of motion. It is for the purpose of permitting such adjustment that the disk is mounted on the shaft with a yielding connection in the manner herein described, and shown in the drawings, and my invention is not limited to the specific construction shown and described, as the adjustability of the disk relative to the shaft may be secured by other forms of yielding connection.

The disk 5 is fitted within the ring 30 when the ring is employed, so as to leave but a small annular space between the periphery of the disk and the inner surface of the ring, and the disk is so constructed near its periphery as to adapt it to receive the impact of the steam or other motive fluid, which is directed against it in the form of jets and causes it to rotate. The jets of steam are delivered to the pressure surfaces or vanes of the disk from the sides by means of passages or nozzles located alongside of the disk near its periphery. When the steam has acted on the disk, it escapes at the periphery through holes or openings in the peripheral surface and then passes through openings in the ring 30 into the annular exhaust-chamber 64, which surrounds the ring 30, or directly into said exhaust-chamber when the ring is not used.

The steam may be delivered to one side only or to both sides of the disk and in such direction that the jets of steam acting on the opposite sides of the disk will tend to drive the disk in one direction only, or the jets may be directed in opposite directions on the two sides, so that the jets on one side tend to drive the disk in one direction and those on the opposite side tend to drive it in the reverse direction.

The openings or cavities in the outer portion of the disk into which the steam is delivered and from which it escapes are so formed that their surfaces upon which the steam acts are of the most efficient form for utilizing the energy of the steam as delivered by the jets or nozzles and constitute, in effect, curved vanes for receiving the impact of the steam and converting the energy due to the momentum of the steam into energy of rotation of the disk.

The steam-supply pipe 13 is connected to the casing in position to deliver steam through the passages 12 to the chamber 11, in which the valve 14 is located. The valve 14 may act as a throttle-valve to control the supply of steam to the motor, and when the motor is arranged to run in either direction the valve 14 may also act as a reversing-valve. The construction shown in the drawings is such that the motor is adapted to run in either direction, and the direction of its motion is controlled by the valve 14. When the valve 14 is in the central position, as shown in Fig. 2, steam is cut off from both sides of the disk, and in order to start the motor the valve is moved in either direction, so as to uncover one of the passages 15 or 16, which lead from the chamber 11 to chambers 17 and 18, respectively, on opposite sides of the disk.

The nozzles or passages 23 and 24, through which the steam is delivered to the disk 5, are formed in the walls 19 and 20 between the disk-chamber 4 and the valve-chambers 17 and 18. The number and position or arrangement of these nozzles or passages may be varied; but I prefer to arrange them in diametrically opposite sets and to space the sets at equal distances apart around a circle corresponding to the circle on which the openings in the side of the disk are formed.

As shown in Figs. 5, 6, and 7 of the drawings, there are three nozzles, passages, or openings in each set; but, if preferred, single nozzles may be arranged at intervals around the circle, or they may be arranged in groups or sets of two, four, or more.

Circular openings 21 and 22 in the surface of the walls 19 and 20 form admission-ports, through which the steam is admitted from the chambers 17 and 18 to the small ends of the nozzles 23 and 24.

As shown in Figs. 6 and 7 of the drawings, the nozzles are in the form of tapered or conical passages, which extend from the ports 21 and 22 in a direction which is suitably inclined to the surface of the disk 5 and register at their large ends with openings 25 and 26 in the sides of the disk in position to deliver the steam to the disk in the most efficient manner. If preferred, however, the nozzles may be of the form shown in Fig. 8 of the drawings, in which they are formed with a contracted opening or passage at one end and a larger passage of uniform area throughout the remainder of their length.

The supply of steam to the ports 21 and 22 is controlled and regulated by means of flat annular valves 32 and 33, which are fitted against the outer surface of the walls 19 and 20, and are provided with cylindrical flanges 34 and 35, which extend outwardly and fit around the central cylindrical portions 36 and 37 of the sections 1 and 2 of the casing.

The valves 32 and 33 have their edges cut away, so as to form alternate projections and spaces, as shown in Fig. 5, and are capable of being rotated so that the projections 38 may occupy positions between the sets or groups of ports 21 and 22 to admit the maximum quantity of steam to the disk or may be rotated so as to partially or wholly close the ports 21 and 22, and thereby diminish or wholly cut off the supply of steam to the disk.

In order to rotate the valves 32 and 33, gear-teeth 63 are formed on or secured to the flanges

34 and 35 and engage or mesh with teeth on pinions or segment-gears 39 and 40, which are mounted on shafts 41 and 42, extending through the bonnets 43 and 44. The bearings 45 and 46 of the shafts 41 and 42 are provided with flanges or shoulders 47 and 48 adjacent to their inner ends, which flanges bear against the inner sides of the bonnets 43 and 44 and are held in place by the pressure of the steam in the chambers 17 and 18. Each of the pinion-shafts 41 and 42 has a lever 49 secured to its outer end, and the levers 49 are connected by links 50 and 51 with the opposite ends of levers 52 and 53, secured to the ends of a shaft 54, which is journaled in the lower part of the casing. The lever 52 on one end of the shaft 54 is connected at one end to a rod 55, by means of which the shaft 54, and through it the shafts 41 and 42 and the segment-gears 39 and 40, may be rotated.

The movement of the rod 55 may be effected by means of a governor of any suitable form, which is connected to the motor and operates automatically in accordance with the speed of the motor. When so connected, the rotation of the segment-gears 39 and 40 effects the rotation of the cut-off valves 32 and 33 and the successive closure or opening of the ports 21 and 22 as the speed of the motor increases or decreases, respectively.

The projections 38 on the valves 32 and 33, which operate to close the ports 21 and 22, are arranged so as to close or partially close but a single pair of ports at a time or one port in each of two diametrically opposite sets, thereby diminishing the supply of steam to the disk without at the same time affecting the admission to all of the nozzles. This is an important feature of my invention, as the nozzles 23 and 24 and ports 21 and 22 are so constructed and arranged that the steam will operate with the greatest efficiency when admitted to the ports and nozzles without throttling, and my improved construction by affecting but a single port in each set at a time affects the efficiency of that port only, and both during and after the closing of a port the remaining ports and nozzles in a set operate with their maximum efficiency.

The operation of the valves 32 and 33 will be clearly understood by reference to Fig. 5, in which the valve 32 and ports 21 are shown in elevation, the valve being shown in position to admit a full supply of steam to all of the nozzles. In Fig. 5 the projections 38 are shown partially covering some of the ports 21, but the flow through the nozzles is not affected thereby, because the uncovered portions of the ports 21 have a greater capacity than the small ends of the nozzles, which open into the ports 21, as shown in Fig. 7. When the valve 32, which is in all respects like the valve 33, is operated to cut off steam, it moves in the direction shown by the arrow in Figs. 5, 9, 10, and 11, and in the first part of the movement one of the projections 38 moves over the port 21^a in one set, and a diametrically opposite projection moves over a port 21^b in another set, as shown in Fig. 9. If the movement is great enough, the ports 21^a and 21^b will be closed and the steam entirely cut off from them. If not, they will be only partially closed and the flow through them diminished, but all of the other ports will be open to receive a full supply of steam. As the valve moves further ports 21^c and 21^d of two other opposite sets will be covered, as shown in Fig. 10, and a still further movement will cover the ports 21^e and 21^f, as shown in Fig. 11, and after this has been done, with the effect of reducing the power of the motor, if the valve moves no further, the remaining two ports and nozzles in each set are still wide open and operating with their greatest efficiency. If the movement of the valve continues, the second port in each of the sets will be covered in the same order and later the third port in each set, and this principle of operation may be applied to other numbers and arrangements of ports and sets of ports without departure from the spirit of my invention.

In order to balance or partially balance the valves 32 and 33, and thereby diminish the friction between the valve and its seat, a circular groove 56 is formed in the valve-seat inside of the line of ports, with branches 57 extending around the ports 21 and a little beyond the outer edge of the valve, so that the groove is always filled with live steam.

In the walls of the chamber 4, on opposite sides of the disk 5, I form circular grooves 60, concentric with the shaft and disk, and connect these grooves with any preferred number of the ports 21 by means of passages 61 and 62, through which steam may pass from the ports 21 to the grooves. A bearing or cushion of steam is thus formed on opposite sides of the disk, which serves to balance it laterally and to prevent friction between the sides of the disk and the walls of the casing. The passages through which steam is supplied from the ports 21 to the grooves 60 have contracted portions 61, which are large enough to furnish the necessary supply to the grooves 60, but which, on account of their small cross-sectional area, prevent the sudden return flow in any great quantity of the fluid from the grooves 60. The object of this construction is to so confine the fluid in the groove 60 that on any sudden lateral movement or vibration of the disk the steam in the groove will undergo a certain amount of compression and offer a spring-like resistance to the lateral movement of the disk, and by forcing out the steam between the wall of the casing and the disk to form a film of steam which operates as an antifriction device to prevent friction of the sides of the disk on those of the casing.

The valve 14 may be operated either by hand or automatically by means of a governor, and in case the disk is to be driven in one direction only the ports or passages 15 and 16 may be opened and closed simultaneously by a suitably-modified form of the valve to permit the steam to act on both sides of the disk at the same time, or when less power is needed the steam may be admitted through one only of the ports 15 16.

The ports 21 and 22 are so proportioned relatively to the small ends of the nozzles 23 and 24 that the steam passes through the ports 21 and 22 rather slowly relatively to its velocity through the nozzles, the object being to deliver the steam to the small ends of the nozzles at its full initial pressure, or as nearly so as possible and in such quantity as will exceed the capacity of the nozzle. The velocity of the steam on entering the small end of the nozzle will then be that due to the practically unvarying high pressure maintained at the entrance to the nozzles, and the enlargement of the nozzles between the small openings and the disk permits an increase in the velocity of the steam.

As shown in the drawings, the delivery passages or nozzles are formed in cylindrical tubes or bushings, which are inserted in cylindrical holes in the walls of the casing; but, if preferred, the passages may be formed directly in the wall of the casing and the bushings omitted.

When the steam flows through the nozzles, it impinges on the sides of the openings 25 and 26, and when acting with the greatest efficiency its momentum will be almost completely absorbed and its velocity so reduced that the exhaust-steam will tend under the influence of centrifugal force to escape in the direction of the periphery, and in order to permit this I form passages 27 and 28, which extend from the openings 25 and 26 through the peripheral surface of the disk, the direction of the passages 27 and 28 being inclined to the radii of the disk at a suitable angle.

As the steam escapes from the passages or openings 27 and 28 in the disk it impinges against the walls or sides of the openings 29 and 29^a, which are formed in the ring 30 in case the ring 30 is employed, and these openings 29 and 29^a are so inclined that if the steam escapes with any considerable velocity the reactive effect of the steam may be utilized. If preferred, the ring 30 may be formed integral with one side of the casing instead of separately, as shown.

After the steam passes into the annular chamber 64 it is allowed to escape through the passage 58 to the atmosphere or to a condenser.

I claim as my invention and desire to secure by Letters Patent—

1. In a fluid-pressure motor, the combination with a casing, of a rotary disk having a side bearing against a wall of the casing and having buckets for receiving and discharging the propelling fluid, each of said buckets consisting of two cups, one of which projects inwardly and forwardly from the periphery of the disk and the other of which projects outwardly and rearwardly from the inner end of the first cup, and delivery-nozzles located in the wall of the casing and inclined to the side of the disk.

2. In a fluid-pressure motor, the combination with a casing having two side walls, of a rotary disk fitting closely between said walls, a series of buckets formed in the disk, each of which consists of two cups, one of which projects inwardly and forwardly from the periphery of the disk and the other of which projects outwardly and rearwardly from the inner end of the first cup, and inclined nozzles located in the walls of the casing and adapted to communicate with the buckets in the disk.

3. In a fluid-pressure motor, the combination, with a rotary disk having buckets near its periphery which open at its side and at its periphery, delivery nozzles or passages for delivering fluid to the buckets in the disk, and a ring which receives the impact of the fluid discharged from the disk, and having openings through which the discharged fluid may escape, substantially as set forth.

4. The combination, with a casing, of a rotary disk in the casing the outer portion of which is adapted to receive the impact of a fluid, a ring or annular wall, surrounding the disk and having openings through it for the passage of fluid from the disk, and an exhaust-chamber surrounding the ring and disk, substantially as set forth.

5. In a fluid-pressure motor, the combination, with a rotary disk, of a casing inclosing the disk, a ring or annular wall surrounding the disk and having passages through it for the escape of fluid from the disk, an exhaust-chamber outside of the ring or annular wall, and nozzles or passages formed in the wall of the casing and inclined to the plane of the disk, substantially as set forth.

6. A fluid-pressure-operated wheel having buckets formed in the body thereof and severally comprising two substantially cylindrical cups which respectively terminate at the side and at the periphery of the wheel.

7. A fluid-pressure-operated wheel having buckets cut therein which severally consist of two angularly-disposed cups that respectively terminate at the side or sides and at the periphery of the wheel.

8. In a fluid-pressure motor, the combination with a casing having a central chamber, a rotary disk in said chamber, a ring, or annular wall, surrounding the disk and having passages through the same, an annular exhaust-chamber outside of the ring, and inclined passages or nozzles in position to deliver fluid to the side of the disk near its periphery, substantially as set forth.

9. In a fluid-pressure motor, the combination, with a rotary fluid-actuated disk having buckets severally comprising two angularly-disposed parts which respectively terminate at the side and at the periphery, of a casing having supply and discharge nozzles or passages, and a valve device for controlling the flow of fluid to said supply nozzles or passages, substantially as set forth.

10. In a rotary motor, the combination, with a rotary disk, which is liable to be given a sudden slight movement in a direction lateral to the plane of its rotation, of restricted passages opening into passages in the lateral wall of the disk-chamber through which steam may be delivered to the opposite sides of the disk, to form a cushion and antifriction device and to laterally balance the disk, substantially as set forth.

11. In a rotary motor, the combination, with a rotary disk, subject to sudden slight lateral movement, of grooves formed in the opposite side walls of the disk-chamber and separated by the rotary disk, and restricted passages opening into passages in the lateral wall of the disk-chamber through which steam is supplied to the opposite grooves and to the sides of the disk, substantially as set forth.

12. In a fluid-pressure motor, the combination, with a disk, wheel, or other rotatable member having buckets which severally consist of two substantially cylindrical cups that respectively terminate at the side and at the periphery of the disk, of a casing having supply-passages and a member against which the fluid may react to assist in the rotation of the disk, substantially as set forth.

13. In a fluid-pressure motor, the combination with a wheel, disk, or other rotatable member having a series of buckets severally consisting of two passages which respectively extend inwardly from the side and the periphery of the disk and meet at their inner ends, of means for supplying fluid to said buckets and means for exhausting the same therefrom.

In testimony whereof I have hereunto set my hand.

GEO. WESTINGHOUSE, JR.

Witnesses:

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J. SNOWDEN BELL.