No. 706,116. Patented Aug. 5, 1902.

R. C. SAYER.

ROTARY MOTOR.

(Application filed Sept. 30, 1901.)

(No Model.) 4 Sheets—Sheet 1.

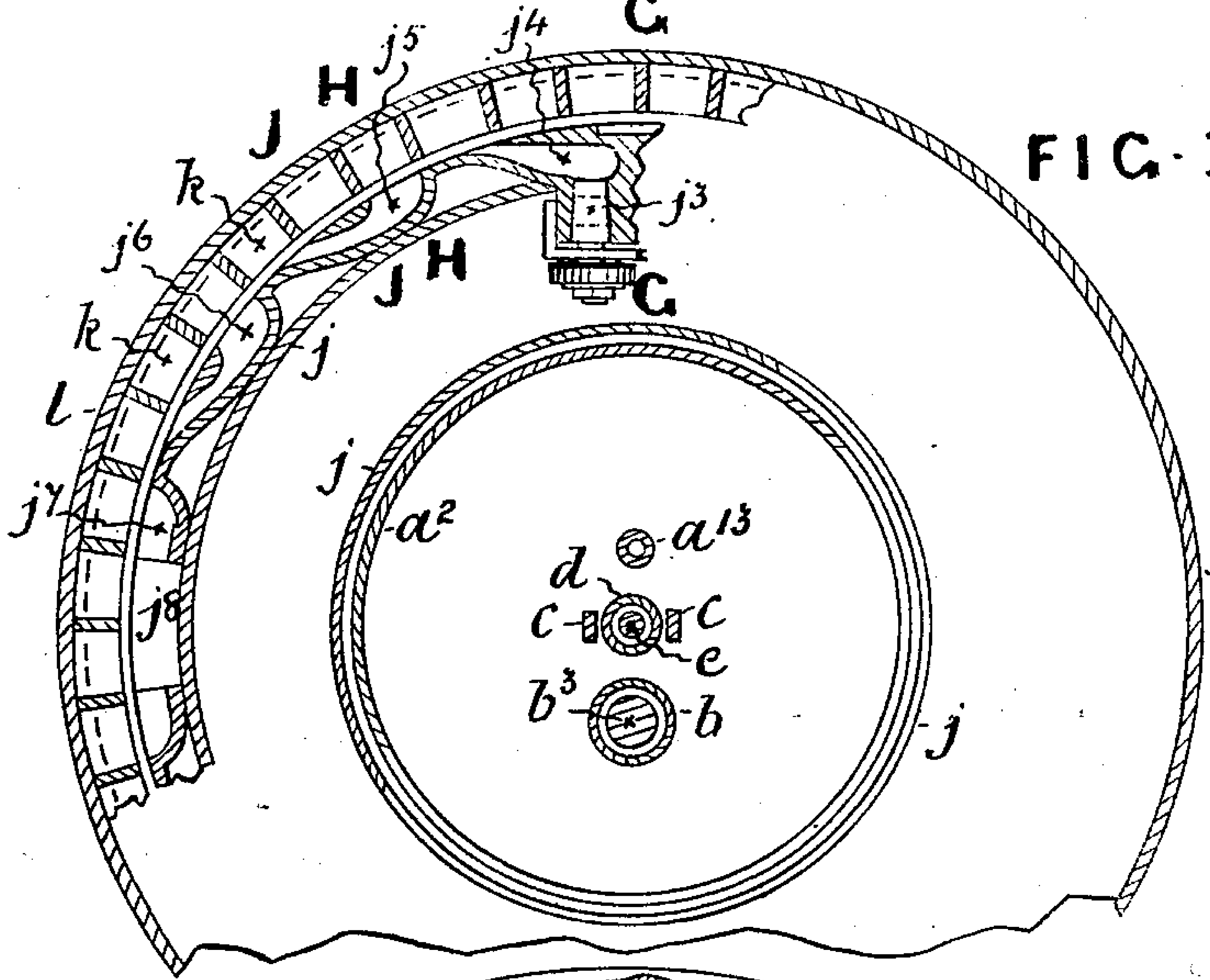

FIG. 3.

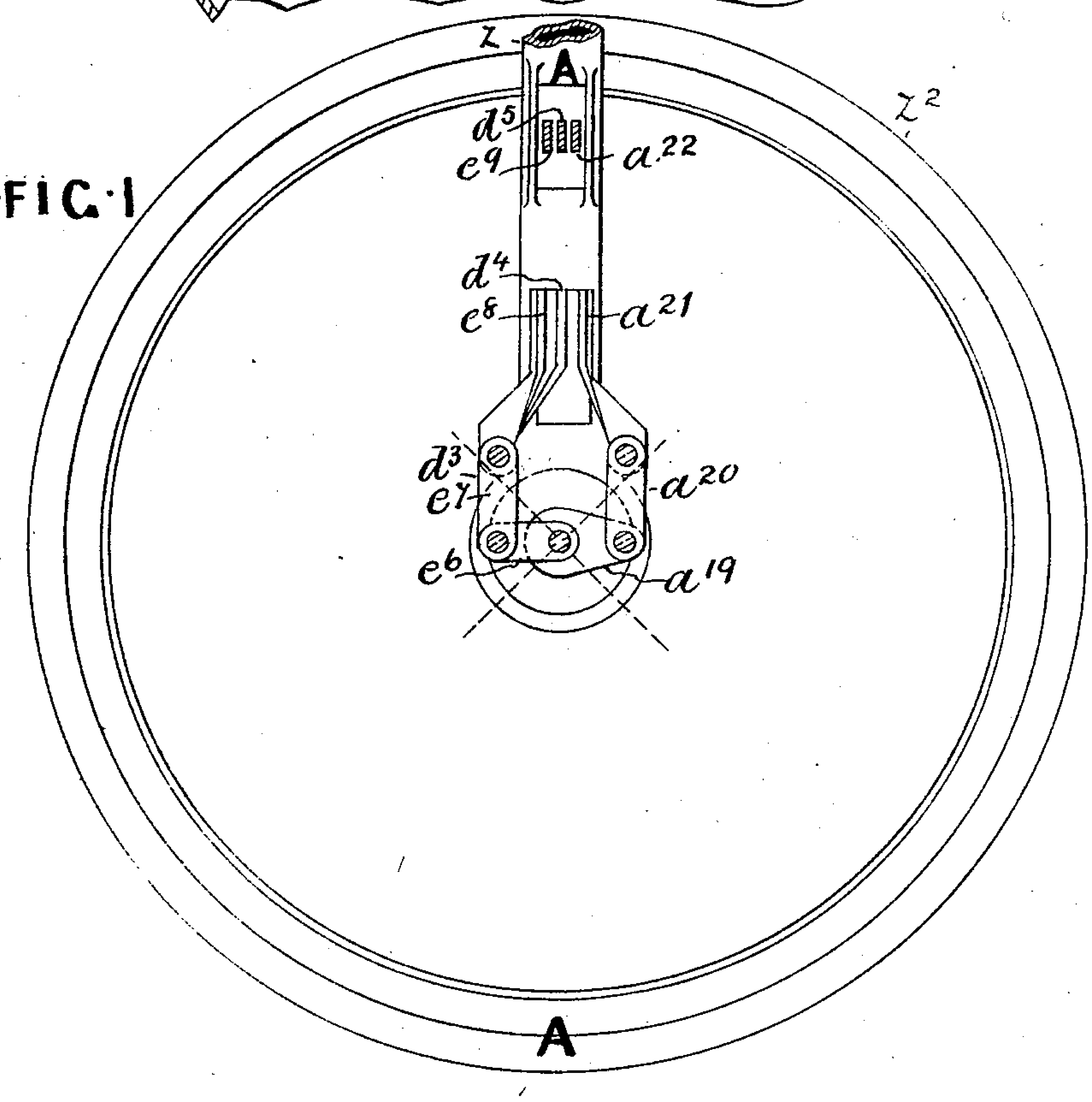

FIG. 1

D D

Witnesses:-
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(No Model.) 4 Sheets—Sheet 2.

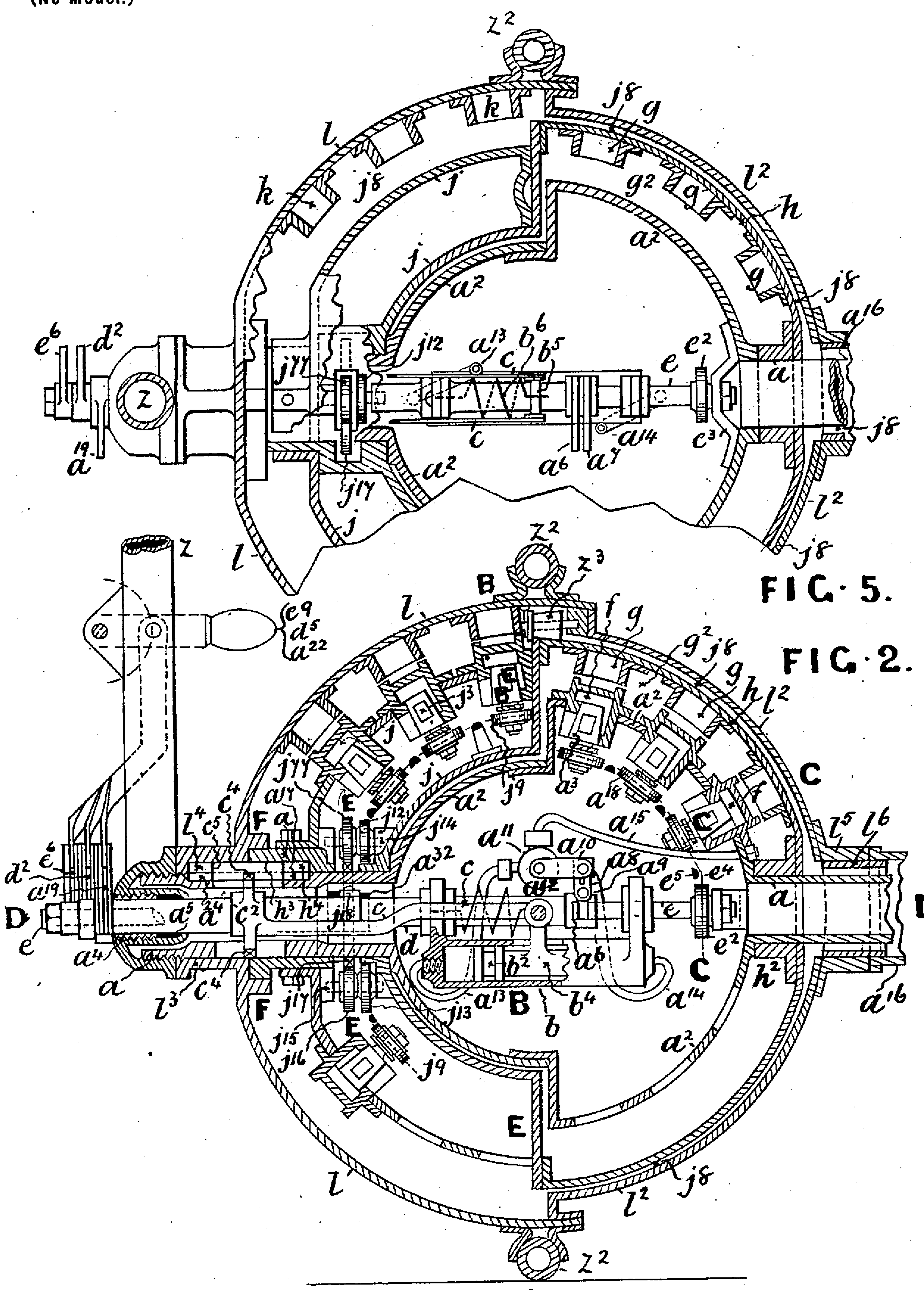

FIG. 5.

FIG. 2.

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(No Model.) 4 Sheets—Sheet 3.

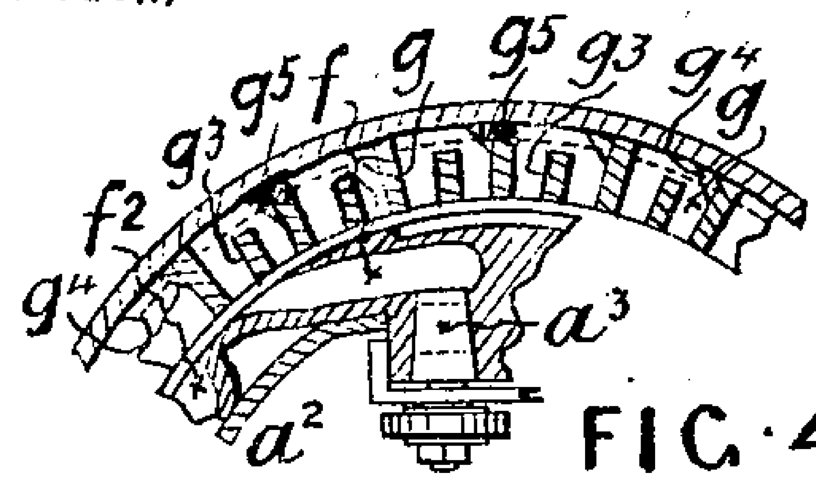

FIG. 4.

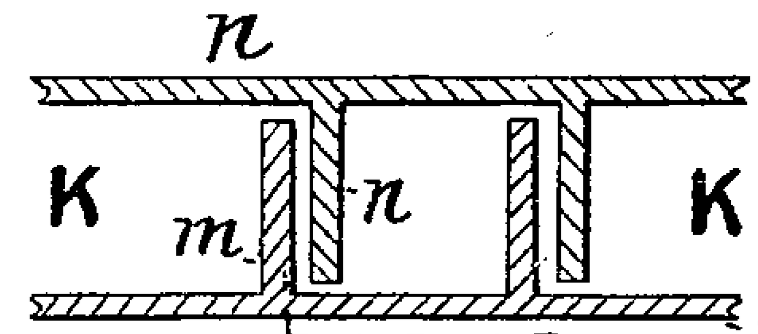

FIG. 12.

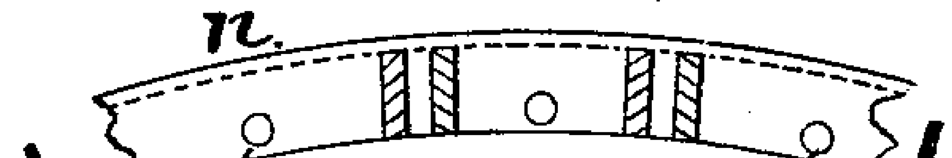

FIG. 11.

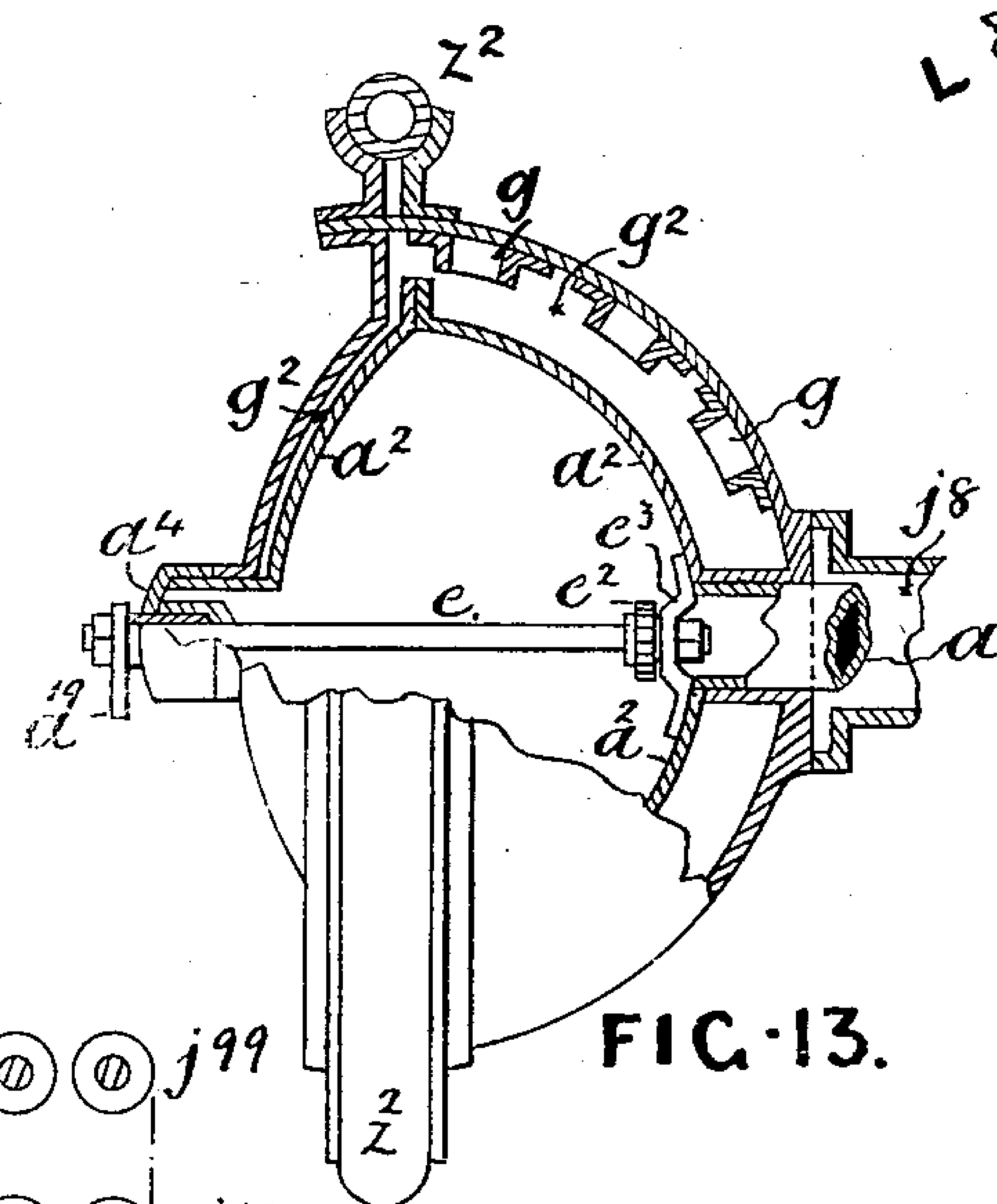

FIG. 13.

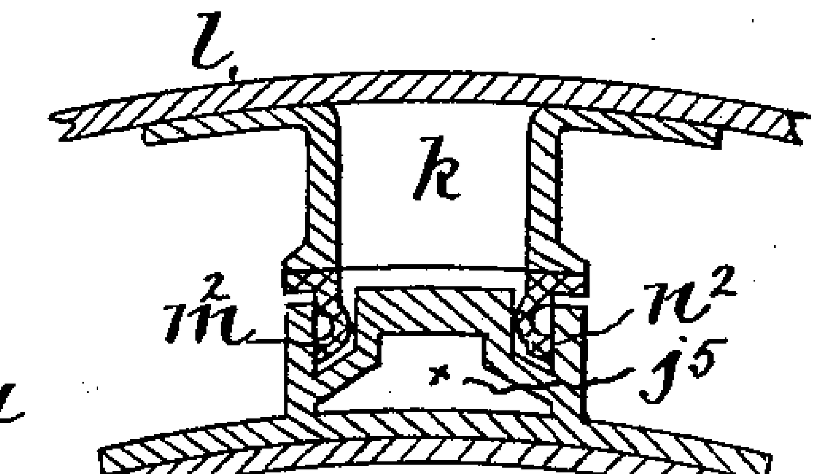

FIG. 10.

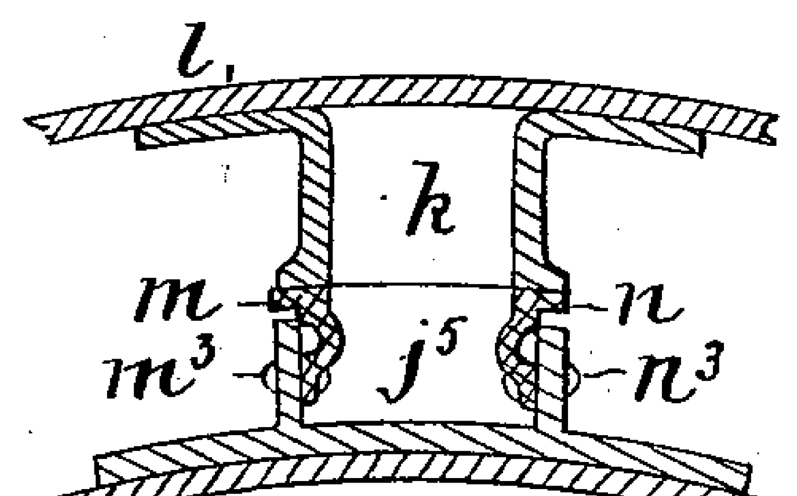

FIG. 9.

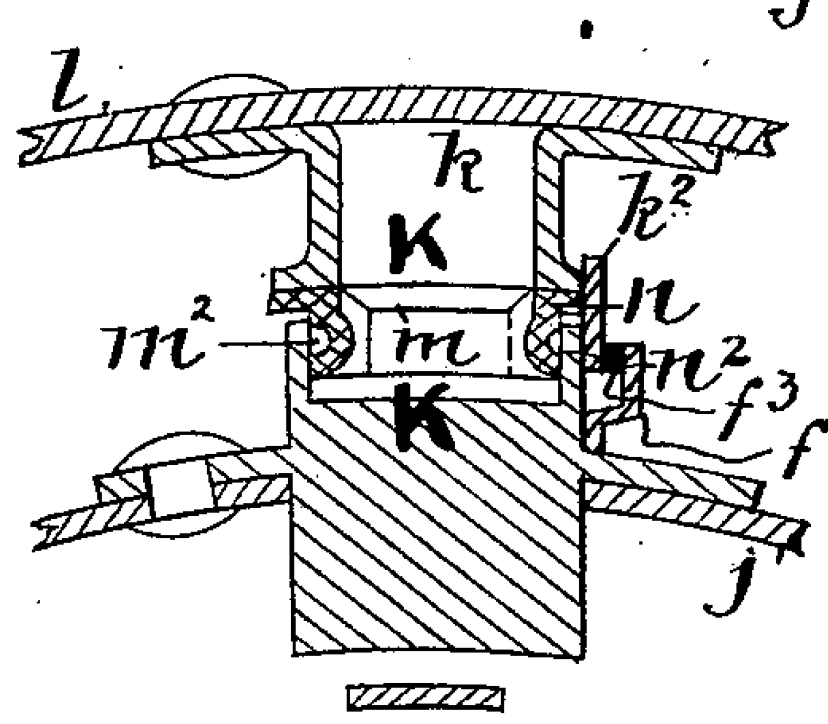

FIG. 8.

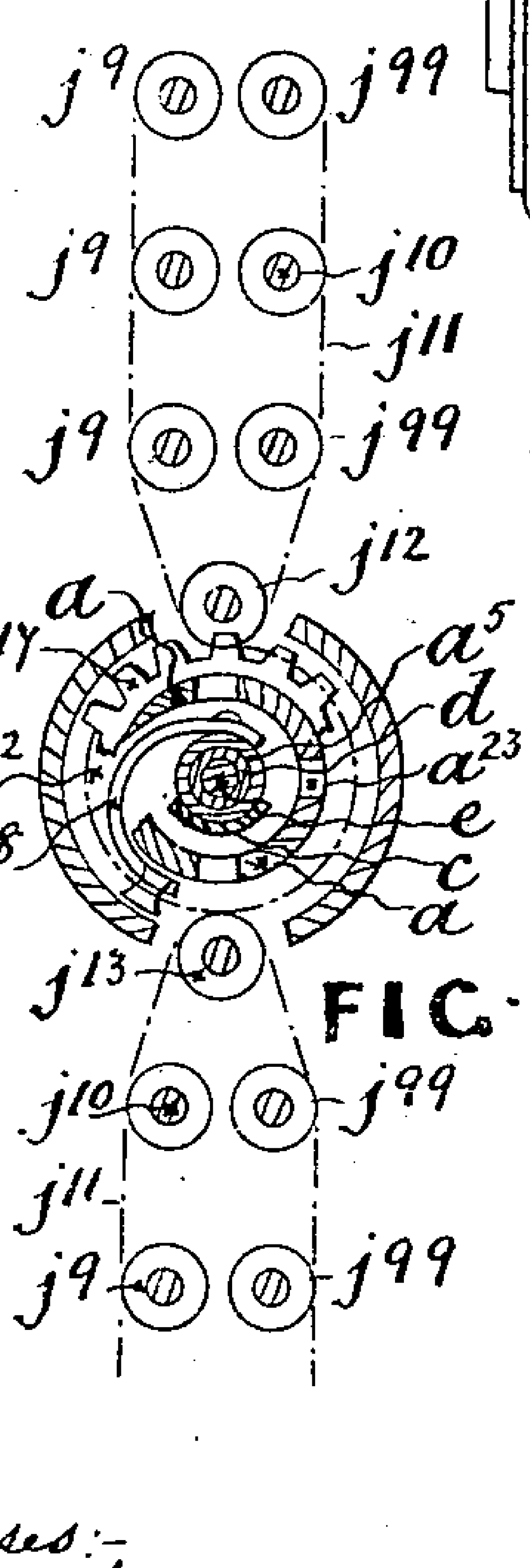

FIG. 6.

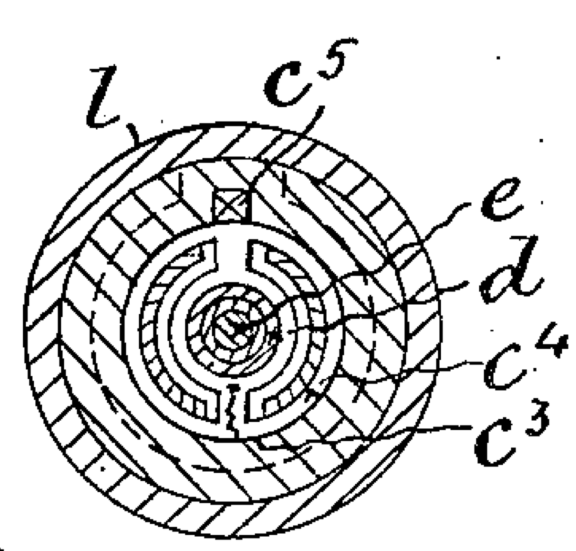

FIG. 7.

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ROTARY MOTOR.

(Application filed Sept. 30, 1901.)

(No Model.) 4 Sheets—Sheet 4.

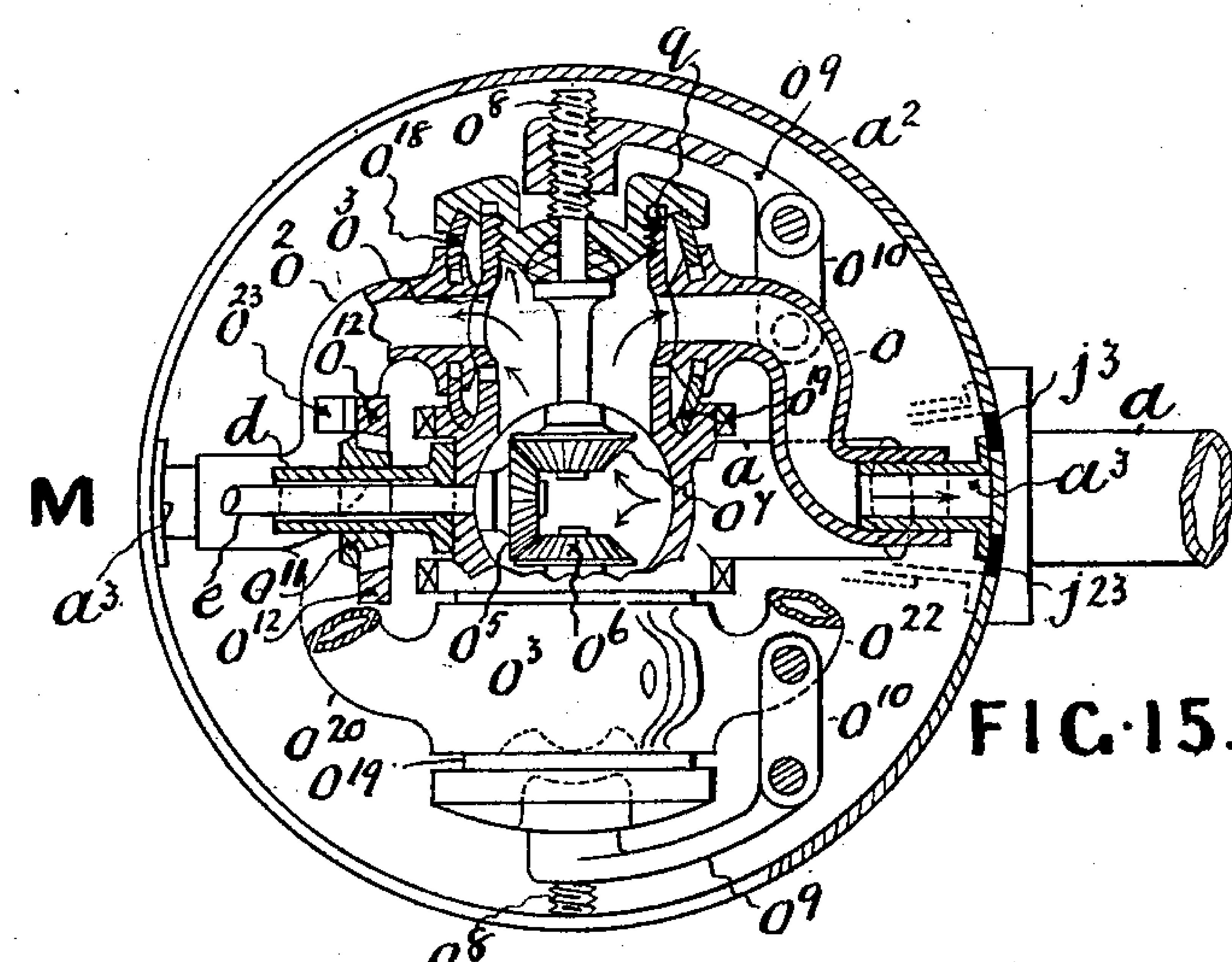


FIG. 15.

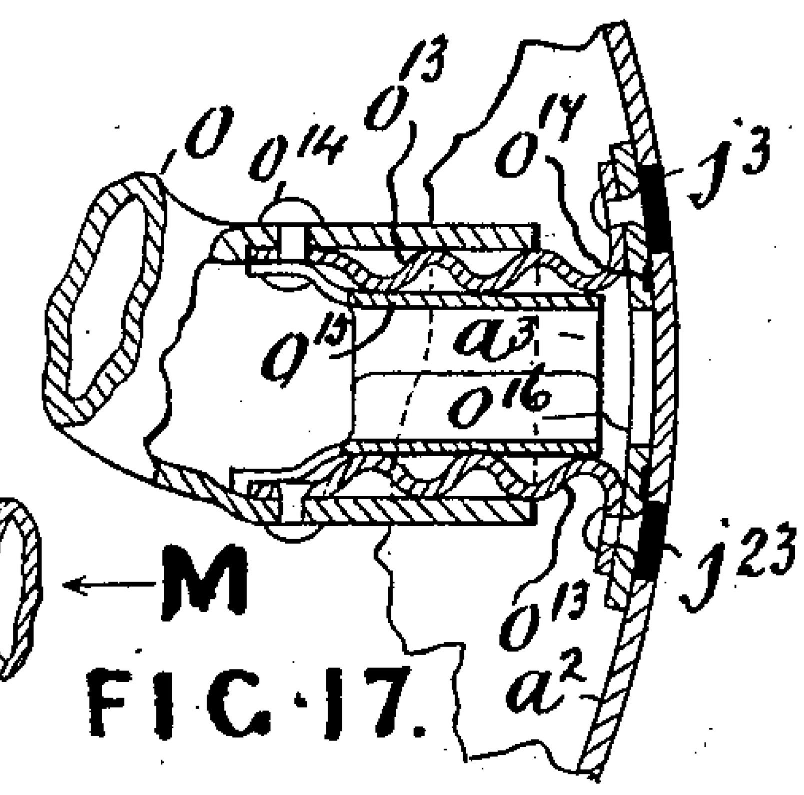


FIG. 17.

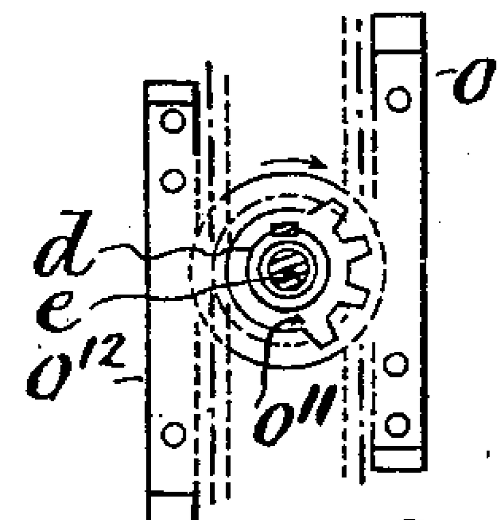
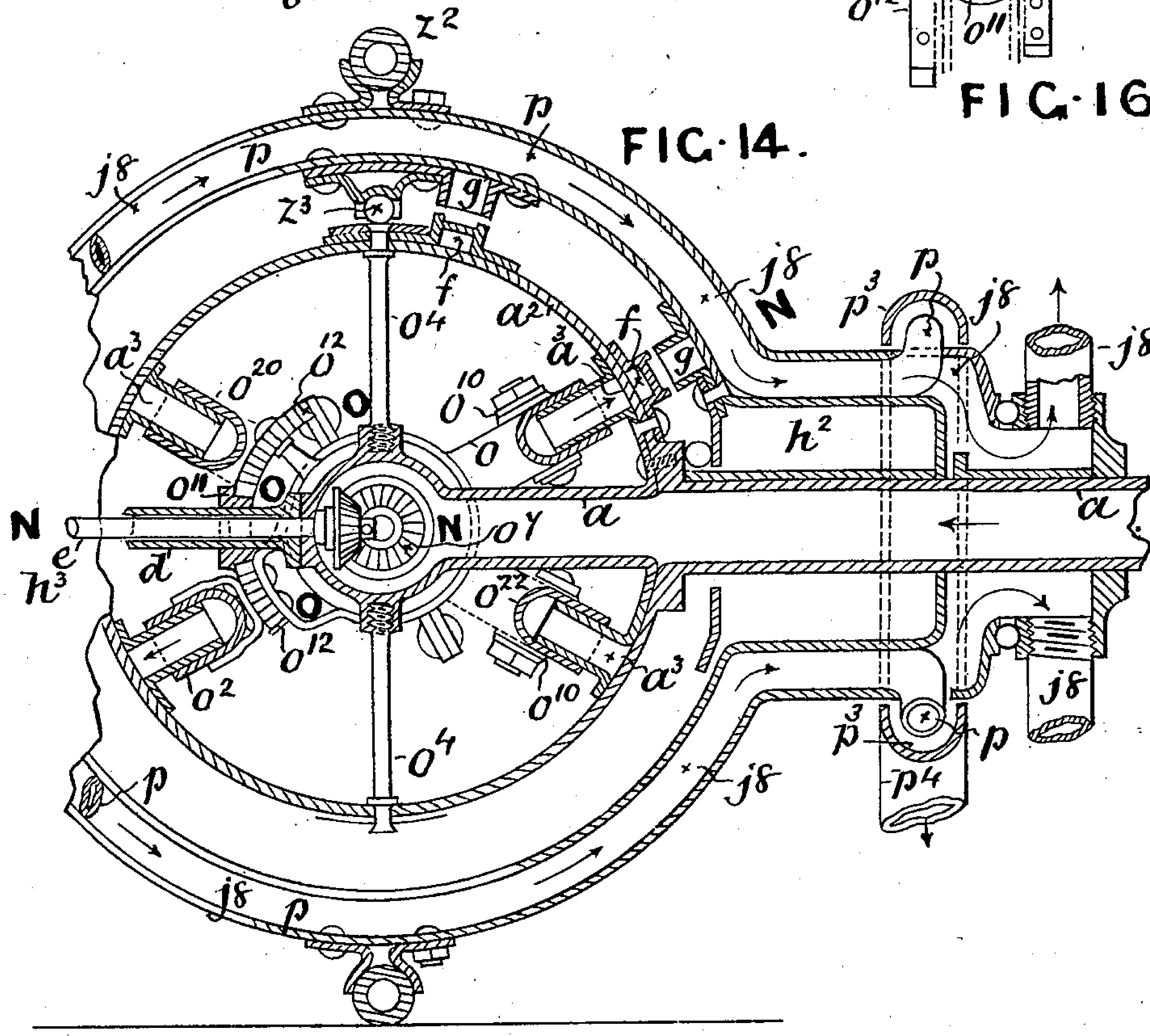


FIG. 16.

FIG. 14.



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UNITED STATES PATENT OFFICE.

ROBERT COOKE SAYER, OF BRISTOL, ENGLAND.

ROTARY MOTOR.

SPECIFICATION forming part of Letters Patent No. 706,116, dated August 5, 1902.

Application filed September 30, 1901. Serial No. 77,112. (No model.)

To all whom it may concern:

Be it known that I, ROBERT COOKE SAYER, a subject of the King of Great Britain and Ireland, residing at 11 Clyde road, Redland, Bristol, England, have invented certain new and useful Improvements in Rotary Motors; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention for improvements in rotary motors relates to an impact-motor adapted to be driven by steam or other fluid, and has for its object to provide a motor in which variations in the power or speed can be readily effected without employing intermediate mechanism, so that the loss of power due to friction is avoided and the efficiency of the motor unimpaired; and it consists in forming the rotary elements of spheroidal, cylindrical, or similar shape and in causing the motive fluid to act on the rotary elements at various distances from their axes, pivots, or centers around which they rotate.

In one form of the invention as applied to a wheel adapted to run on roadways the motor comprises a hollow fixed axle, a fixed pressure-chamber formed by an enlargement of the axle, a series of nozzles carried on the outer surfaces of the pressure-chamber wall, valves in the pressure-chamber communicating with the nozzles, a rotary element mounted on the fixed axle, a series of vanes or buckets fixed to the interior of the rotary element and against which the jets from the nozzles are directed, and a means for actuating the valves through the fixed axle for controlling the supply of fluid to the nozzles. The nozzles and their corresponding vanes or buckets are arranged in series at different vertical distances from the center line of the axle, so that the jets act with varying leverage, each nozzle being followed by a number of sinuous passages arranged to successively redirect the jet of fluid after its first action on the vanes or buckets to cause it to act on other vanes in the series until the point of exhaust is reached.

The invention is hereinafter more fully described with reference to the accompanying drawings, in which—

Figure 1 is an elevation of two concentric motors upon a fixed axle adapted as a wheel to run on roadways. Fig. 2 is in part a section through the valves at A A, Fig. 1. Fig. 3 is in part a section through the valves at B B, Fig. 2. Fig. 4 is in part a section through the valves at C C C, Fig. 2; Fig. 5, a sectional elevation at D D, Figs. 1 and 2; Fig. 6, a sectional development showing means for working the valves at E E E, Fig. 2; Fig. 7, a section of the key at F F, Fig. 2; Fig. 8, a section of the key at G G, Fig. 3; Fig. 9, a section of the key at H H, Fig. 3; Fig. 10, a a section of the key at J J, Fig. 3; Fig. 11, a sectional elevation at K K, Figs. 8 and 12; Fig. 12, a sectional plan at L L, Fig. 11; Fig. 13, a section at D D, Fig. 1, for a single motor. Fig. 14 is a similar section to Fig. 2 at M M, Fig. 15, of a single motor by which the object of the invention is attained by arms. Fig. 15 is a sectional elevation at N N N, Fig. 14. Fig. 16 is a sectional elevation at O O O, Fig. 14. Fig. 17 is in part the same as Fig. 15 of the exit enlarged.

A hollow fixed axle a carries a fixed spherical chamber a^2 with any number of valves, taps, or ports a^3, three being shown. Fluid-pressure enters a and a^2 at one side, the other side being closed by glands a^4. Within a, a^2, and a^4 passes a tube a^5 to work the valves j^3 of a second motor as follows and a tube d to carry a lever a^6 to work by trunnion-nuts a^7 and a^8, link a^9, and lever a^{10}, a tap a^{11} to admit pressure from a^2 through a port a^{12}, pipes a^{13} and a^{14} to either or both ends of a cylinder b or to exhaust either end through the pipe a^{15} and jacket a^{16} outside a. The cylinder b is carried by arms on the tube d and shaft e. It has two pistons b^2 and b^3, (not shown,) connected by a rod b^4, arms b^5 passing through a slot in the cylinder b and connected to a spring b^6, which tends to bring b^5 from either side to a central position. Links c are attached to a sleeve c^2, mounted to slide on the tube a^5, and by its arms c^3 and ring c^4, Fig. 7, that enters a notch in a key c^5 to actuate c^5 from its center position, as shown in Fig. 2, to either side within the keyway a^{17}, formed in the axle a. The shaft e passes through and beyond the tube d. It has a support e^3 and carries a pinion e^2 to work the valves or ports a^3 by their pinions a^{18}, which are connected to e^2

by the pitch chain or cord e^4, that slides on guides e^5. The shaft e and tubes d and a^5 are actuated, respectively, by the levers e^6, d^2, and a^{19} through the links e^7, d^3, and a^{20}, rods e^8, d^4, and a^{21}, and levers e^9, d^5, and a^{22}, carried by the standard z, as shown.

Exterior to the chamber a^2 a series of passages or nozzles f and f^2, Fig. 4, are carried to receive the pressure from the valves $a^3 f^2$, being formed as shown at j^5 and j^6, Fig. 3, when the rotor acts in one direction only; but when it is required to act in both directions and the pressure to act on the buckets at the whole periphery of the stator a^2, f^2, j^5, and j^6 have their entrances and exits formed alike and direct the pressure against a series of vanes or buckets g and exhaust through the passages g^2 and j^8. The vanes g are fixed upon the semisphere h and are formed, as shown, with a center-dividing tongue g^3, that does not reach the far side or back of the buckets, and a partly-inclined side g^4, and one, two, or more alternate buckets are connected by apertures g^5 when the rotor h acts in one direction only. When the rotor h acts in both directions, g^4 is formed as a tongue and is hinged centrally to give the inclination in either direction at will, so that the pressure acting on the straight vane g clears g^3, then takes against it. Thus the pressure is divided into two jets, one each side of g^3, the latter of which is directed by the incline g^4 to meet the former at the forward angle of the bucket, against which the resultant force of the pressure of both jets acts favorably to turn the rotor. The velocity of the flow of the jets acts on the buckets of the rotor first, and its pressure not being able to escape, as explained hereinafter, acts upon them also and passes through the apertures g^5 (where provided) to help the pressure in the previous bucket to give rotary motion to the semisphere, which rotates in bearings h^2 and h^3. The semisphere h has a keyway h^4, corresponding to the keyway a^{17}.

A concentric superimposed semisphere j, formed as a pressure-tight chamber supplied with pressure from the chamber a^2 through the axle a and its ports a^{32} and a^{23}, Figs. 2 and 6, carries the valves j^3 in duplicate with a^3 and their parts and is formed to rotate with the semisphere h. On the exterior of and secured to the chamber j are a series of passages or nozzles $j^4 j^5 j^6 j^7$, Fig. 3, to receive the pressure from the valves j^3, direct it against the series of vanes k, carried by the semisphere l, until it exhausts through passage j^8, Figs. 2 and 5. The outer rotary element is formed by connecting the semispheres l and l^2, which rotate on bearings at l^3, with a keyway l^4 and at l^5 upon a part l^6, through which the exhaust passes. It has a tire z^2 and friction-rollers z^3 to run upon the semisphere h.

To prevent escape of the pressure between the vanes g or k and passages $f f^2$ or $j^4 j^5 j^6 j^7$, they have packings m and n, Figs. 8 to 12, corrugated at m^2 and n^2, and are secured by rivets m^3 and n^3. When the pressure enters the passages and then alone, m and n are thrust by it against the intrados of the sides of the vanes, and in addition to or in substitution of m and n the bucket k, Fig. 8, carries each side a spring-plate k^2 for the pressure to thrust it against a suitable annular packing f^3, carried on a chamber f^4 at the sides of the passages f and j^5 to effect a like object. The key c^5, Fig. 2, is able to be sent by the ring c^4 to the right into the keyways h^4 and a^{17} to connect the fixed axle a to the rotor h and j and its vanes g, to which the valves j^3 and their chambers j^4 are attached, or to the left to leave the keyways h^4 and a^{17} pass along the annular space a^{24} into the keyway l^4. The key c^5 then rotates with l^4 around the ring c^4, which is able at all times to return it to the central position, as shown, to connect the semispheres l and l^2 with h and j by their keyways l^4 and h^4 and rotate with them in the space a^{24}. The valves are in pairs, Fig. 6, the valves j^3 being arranged to admit the pressure for driving the motors forward and j^{23} (not shown) for driving them backward. Each valve has a pinion j^9 for forward and j^{99} for backward motion on their spindles j^{10}, connected by the pitch chain or cord j^{11}, that passes around the two driving-pinions j^{12} and j^{13}, or j^9 and j^{99} are mitered toothed pinions actuated as usual. The ports of the valves are set so that when j^3 are open j^{23} are kept closed or the reverse, and each set of any number from all closed are successively opened and closed. The pinions j^{12} and j^{13} as representative of any number to suit the number of series of valves are carried on the same spindles j^{14} and j^{15} as the pinions j^{16} and j^{77}, that gear with the toothed wheel j^{17}, carried on the fixed axle a. The toothed wheel j^{17} has attached a spring j^{18}, that passes through the port a^{32} of the fixed axle and is also attached to the tube a^5, so that by turning a^5 with the lever a^{22} whatever the position of the pinions j^{16} and j^{77} in their rotation with the semisphere j around j^{17} the spring j^{18}, actuates j^{17} and with it j^{16} j^{77} j^{12} and j^{13} more or less to open one or all the valves j^3 for the desired direction. When the motor is to go forward only, the valves j^3 alone are used and the space required for backward driving and braking is available for more forward valves j^3 and parts.

When desired, the superimposed concentric motors are omitted and the single motor (shown by Figs. 13 or 15) is used, the valves a^3 being actuated by the pinion e^2 on the shaft e by the lever a^{19}, as before, the other parts being omitted, or single or concentric motors are formed spherically or spherically with flattened parts at the axle or cylindrically and all fitted with more or less of the ports and connections on the curved or flat parts.

When the power required is less, Figs. 14 to 17, the mechanical advantage described is attained by, instead of fixed valves a^3, a stirrup radial arm o, shown attached to its fellow o^2 and their duplicates o^{20} and o^{22}, which center on socket hinged joints o^3, made tight by split spring-plates o^{18} and o^{19}, and carried by the arms q on the axle a and by rods o^4, within and concentric to the chamber a^2. The arm o carries a valve or port a^3, which by the shaft e, pinions o^5 o^6, screw-shaft o^8, arm o^9, and links o^{10} is brought laterally from its center position, as shown, to either side in part as dotted and coincident to the ports or apertures j^3 or j^{23}. The center of the hinges o^3 not being the center of the sphere a^2 laterally the difference required in the length of the arm o is obtained by making the exit a^3, Fig. 17, of a corrugated elastic sleeve o^{13}, secured to o by rivets o^{14} and has within a spring split sleeve-ring o^{15} and a friction-plate o^{16} with packing o^{17} to take against the inner surface of the sphere a^2, so that the pressure acting against o^{16}, o^{15}, and o^{13} shall maintain a tight joint. The arm o is traversed from any one pair of ports j^3 and j^{23} to another pair by turning the tube d and pinion o^{11} to actuate the curved ratchet-tooth bars o^{12} and with them the arms o^2 o and o^{20} and o^{32} by means of the slide-guides o^{23}, the fluid-pressure normally retained within the arm o by its exit-port a^3, acting against the sphere a^2, passes from the axle a direct to the hinge o^3, the arm o, exit a^3, port j^3 to send the tire z^2 forward or j^{23} to send it backward after passing through the chambers f and f^2 to act on the vanes g, as before described. When required for condensing steam-exhaust in the passage j^8, spiral tubes p subdivide j^8 and pick up the cold feed-water or air at or near the center of rotation p^2, passes to the trough p^3, the pipe p^4, and supply-reservoir. (Not shown.) The condensed steam passes off to the same through the pipes j^8.

The working is as follows: Fluid-pressure is admitted to the axle a, chamber a^2, and by the ports a^{32} and a^{23} to the chamber j. The key c^5, as shown, connects the rotors j and l and h, so that pressure through the valves a^3 only can drive the tire z^2 when admitted to the passages f and f^2 and vanes g by the pinions a^{18}, cord e^4, pinion e^2, and shaft e being actuated by the lever e^9. The leverage with which the pressure acts on the vanes g depends on the distance of the valve a^3 in action from the axle. The full pressure is given from the nozzle f against the vane g, which moving on allows it to escape into the passage f^2 and be redirected to act on a vane g and similarly any number of times until it exhausts. To increase the driving effect on the tire z^2, the lever a^{22} is actuated to rotate through its connections the tube d and tap a^{11} to open the pipe a^{14} and its end of the cylinder b to exhaust through the pipe a^{15} and retain pressure in the pipe a^{13} and its end of the cylinder b, which, acting on the piston b^2, sends the piston and arms b^5 against the spring b^6 to draw along the links c, sleeve c^2, ring c^4, and key c^5; but should the keyway h^4 of the rotor h not coincide with the keyway a^{17} of the axle a the pressure on b^2 acts against it and slips it rapidly home when opposite. The rotor h is thus fixed to the axle a. The valves a^3 are closed by the lever e^9. The lever d^5 is then actuated to rotate the tube a^5, spring j^{18}, Fig. 6, toothed wheel j^{17}, pinions j^{16} and j^{77}, cord j^{11}, pinions j^{99} and j^9, their spindles j^{10}, and the valves j^3 for the pressure to rotate the rotor l and l^2 and tire z^2. To further increase the power, the tap a^{11} is returned to its former central position to close exhaust from and open pressure to both ends of the cylinder b and let the spring b^6 return the pistons b^2 and b^3 and the key c^5 to their central position. The tap a^{11} is then sent to the right to exhaust the cylinder b through pipe a^{13} and retain pressure against the piston b^3, and so actuate the key c^5 into the keyway l^4 and rotate with it. The two motors are then separate, so that when the valves a^3 are opened to actuate the rotor h and j and the valves j^3 open to actuate the rotor l and l^2 the maximum power and speed are attained, which may be varied by reversing the direction of either rotor or closing some of the valves.

What I claim, and desire to secure by Letters Patent, is—

1. In fluid-pressure motors a semispherical pressure-chamber formed by an enlargement of the fixed axle, a series of nozzles or passages carried on and exterior to the pressure-chamber, a valve carried by and in the pressure-chamber, a means for actuating the valve through the fixed axle from outside it for the valve to admit the pressure to the nozzles, a rotary element outside the pressure-chamber carried on proper bearings on the fixed axle, a series of vanes or buckets inside the rotary element and formed to receive jets of fluid from the nozzles or passages and be rotated by it; corrugated packings to prevent the pressure from escaping until the point of exhaust, a passage for the exhaust-pressure to pass between the rotary element, the pressure-chamber, and fixed axle, spiral pipe-coils to subdivide the exhaust-passage and a means for supplying the spiral pipe-coils with water or air, substantially as described.

2. A fluid-pressure motor comprising a fixed axle, a pressure-chamber formed by an enlargement of the fixed axle at an intermediate part of its length, a series of nozzles or passages carried on and exterior to the pressure-chamber, valves arranged in pairs in the pressure-chamber, a means for operating either valve of a pair to open while the other is closed to admit the fluid under pressure to either of a series of oppositely-directed nozzles to rotate the motor in either the forward or backward direction, a rotary element mounted outside the pressure-chamber on bearings on the fixed axle, and a series of

vanes or buckets fixed inside the rotary element and adapted to receive the jets of fluid from the nozzles or passages, the valves, nozzles, and vanes or buckets, being arranged in series at different vertical distances from the center line of the axle, substantially as described.

3. In fluid-pressure motors the combination with a semispherical pressure-chamber and an outer rotary element adapted to be driven therefrom, of a semispherical auxiliary fluid-pressure chamber attached to the rotary element of the said motor, ports or openings through which the pressure in the axle pressure-chamber of the said motor can pass to the auxiliary pressure-chamber of the rotary element, valves in the said pressure-chamber disposed like those of the said motor, a means through and outside the fixed axle for actuating the valves, series of nozzles or passages outside the auxiliary pressure-chamber adapted to admit the pressure to and act and react against vanes or buckets fixed upon and within the concentric superimposed outer rotary element able to rotate on proper bearings directly or indirectly upon the fixed axle of the said motor, packing to prevent escape of the pressure and a passage in communication with the atmosphere to carry off the exhaust-pressure with dividing-pipes substantially as described.

4. In fluid-pressure motors having two or more concentrically-mounted rotors able to rotate on a fixed axle, keyways in the two rotors, and the fixed axle, and an annular passage in the axle in which a key may rotate with the one rotor or both so that in a center position the key connects the rotors and rotates in a side position the key frees the rotors and rotates; and the other side position it connects the fixed axle and its adjacent rotor; means for traversing the key by a ring on arms and a sleeve; means for traversing the sleeve on a tube against a spring secured to an arm on a rod having a piston each end within an elastic fluid-pressure cylinder in the axle pressure-chamber; a tap and pipes to send pressure to both ends of the cylinder, or retain it at either end and exhaust the other end, and a means for actuating the tap through and from outside the axle, substantially as described.

In testimony whereof I have affixed my signature in presence of two witnesses.

ROBERT COOKE SAYER.

Witnesses:

LORIN A. LATHROP,

GEO. E. COLLS.