

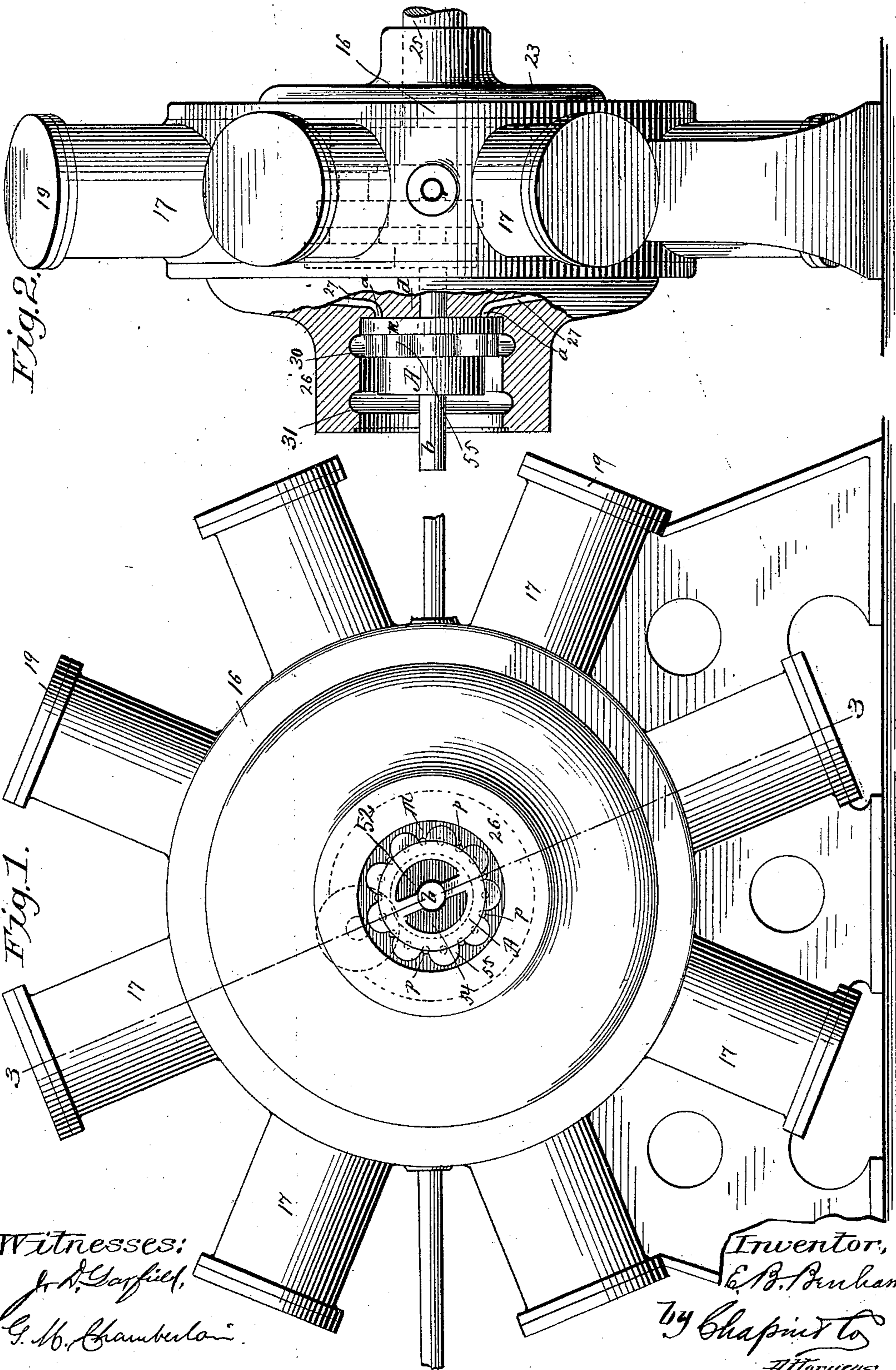
(No Model.)

4 Sheets—Sheet 1.

E. B. BENHAM.
MULTIPLE CYLINDER MOTOR.

No. 459,736.

Patented Sept. 22, 1891.



Witnesses:
J. N. Gayfield,
G. W. Chamberlain.

Inventor,
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Attorneys.

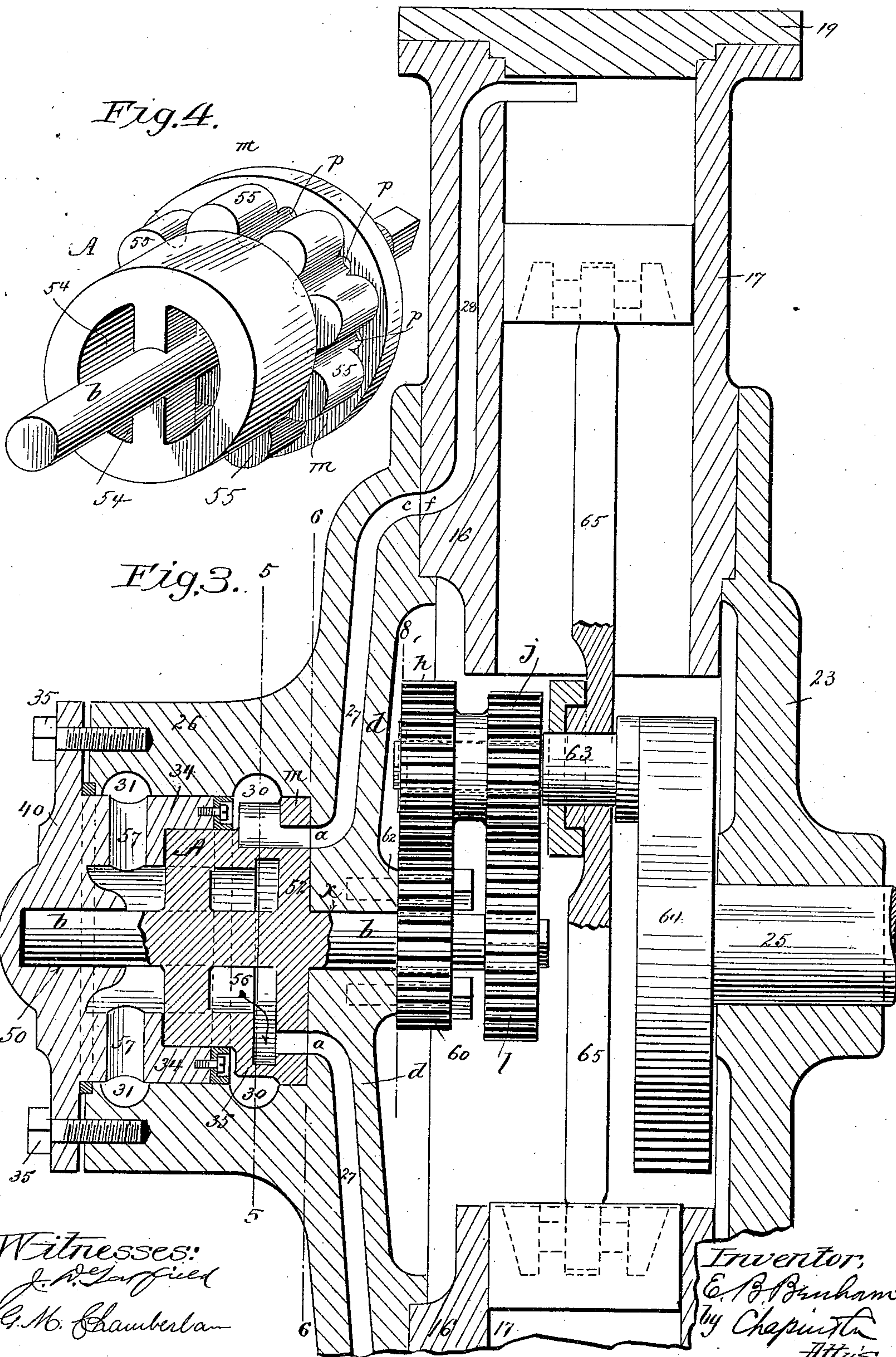
(No Model.)

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No. 459,736.

Patented Sept. 22, 1891.



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(No Model.)

4 Sheets—Sheet 3.

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Fig. 5.

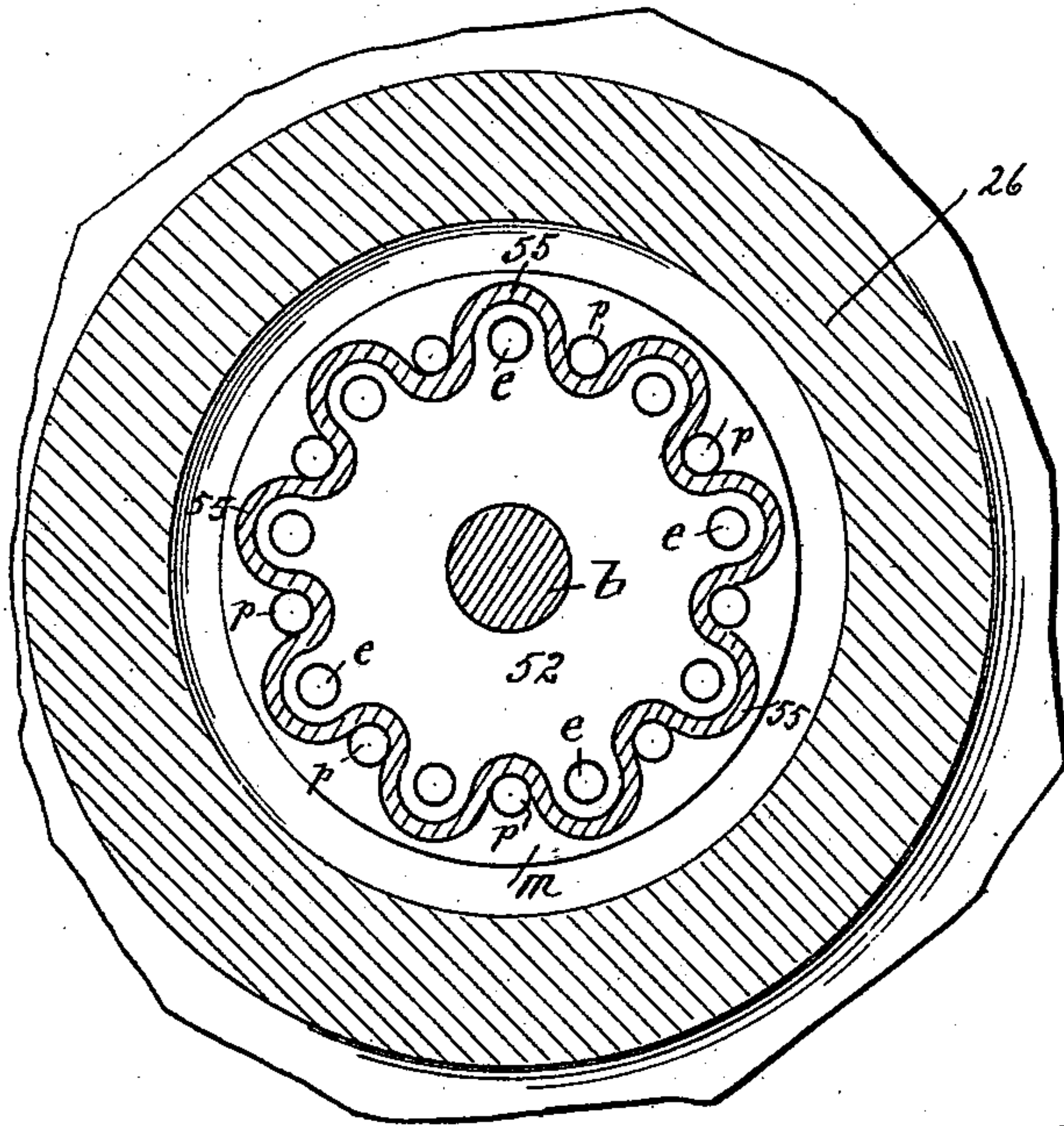


Fig. 6.

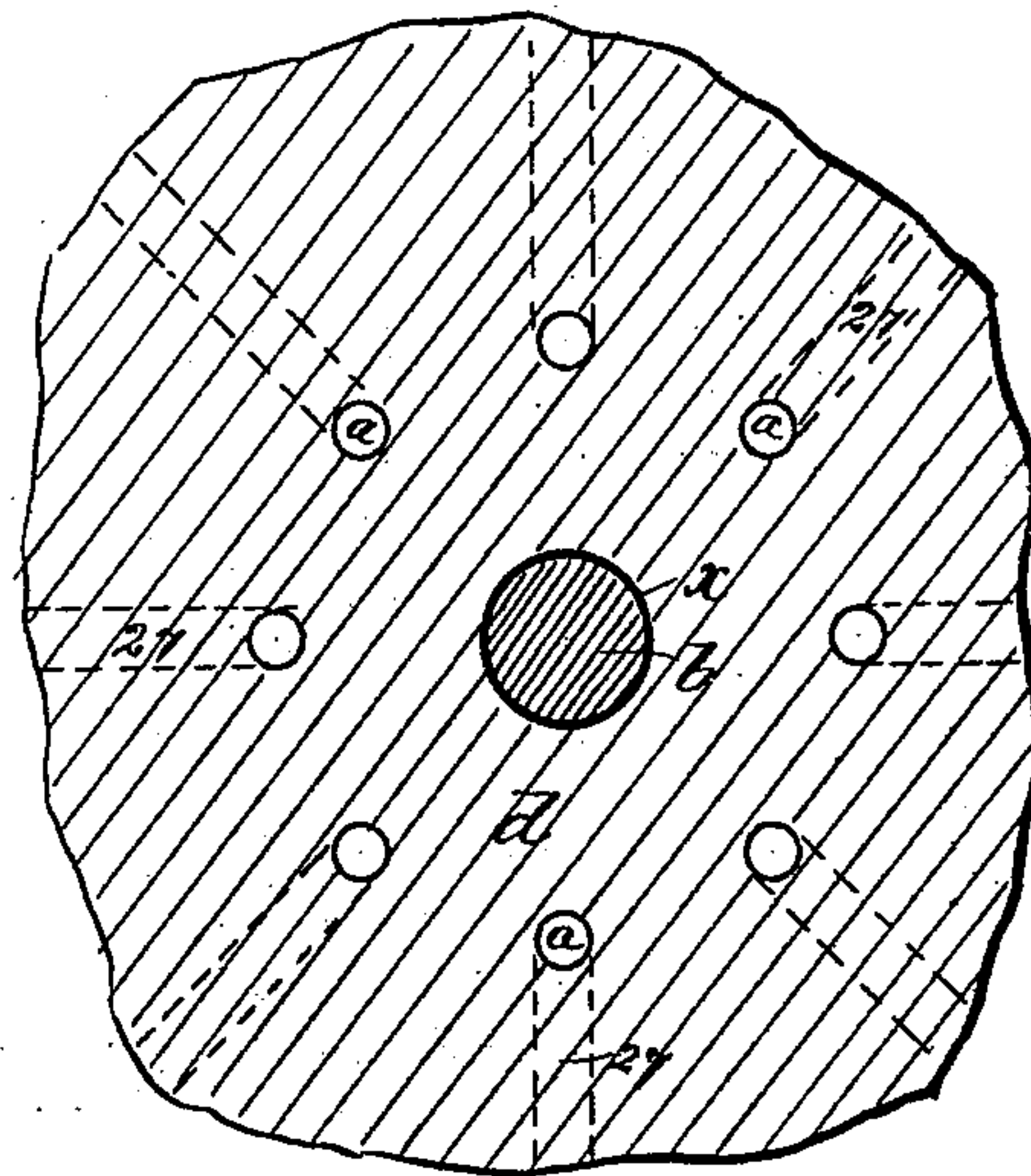
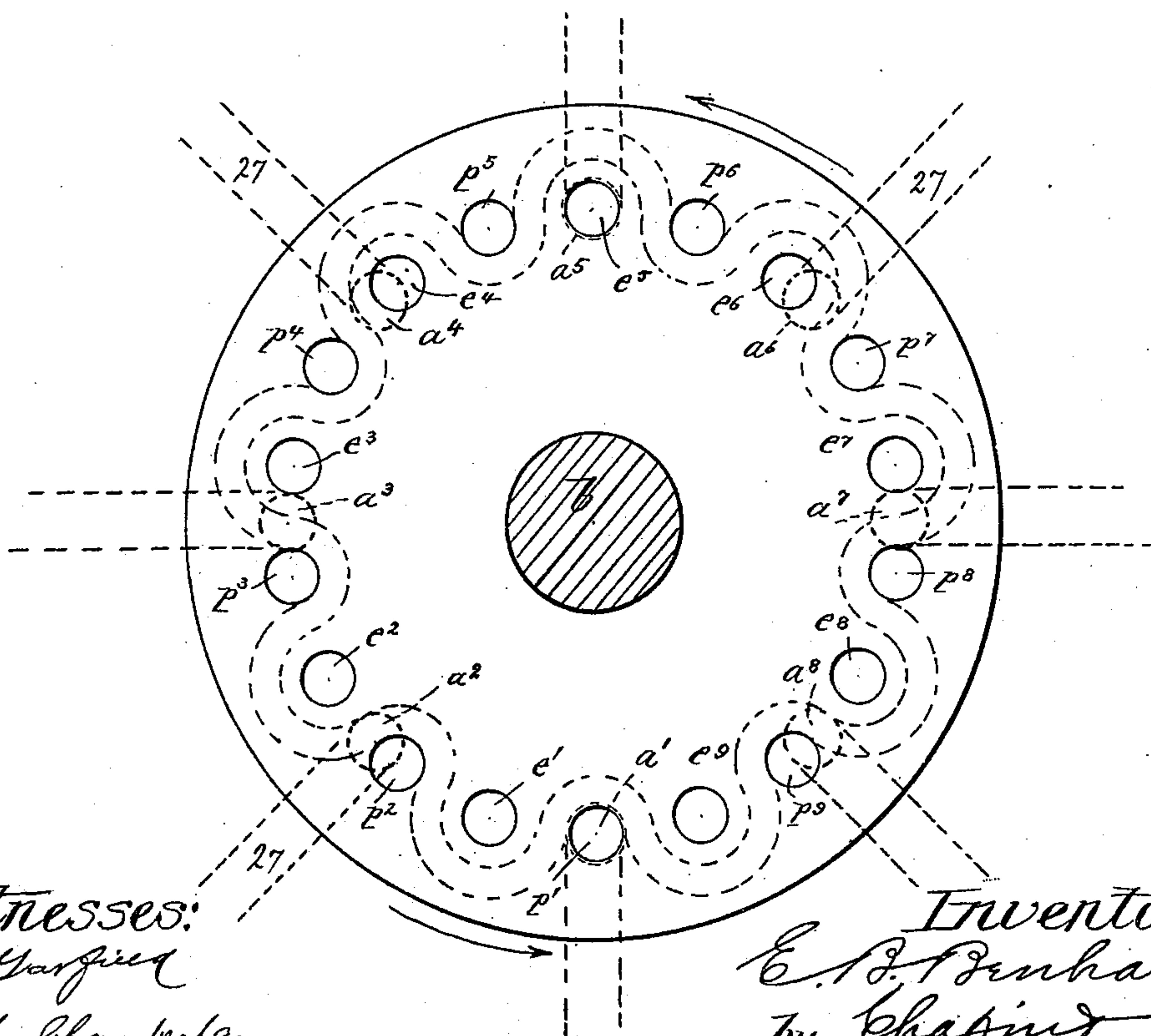


Fig. 7.



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(No Model.)

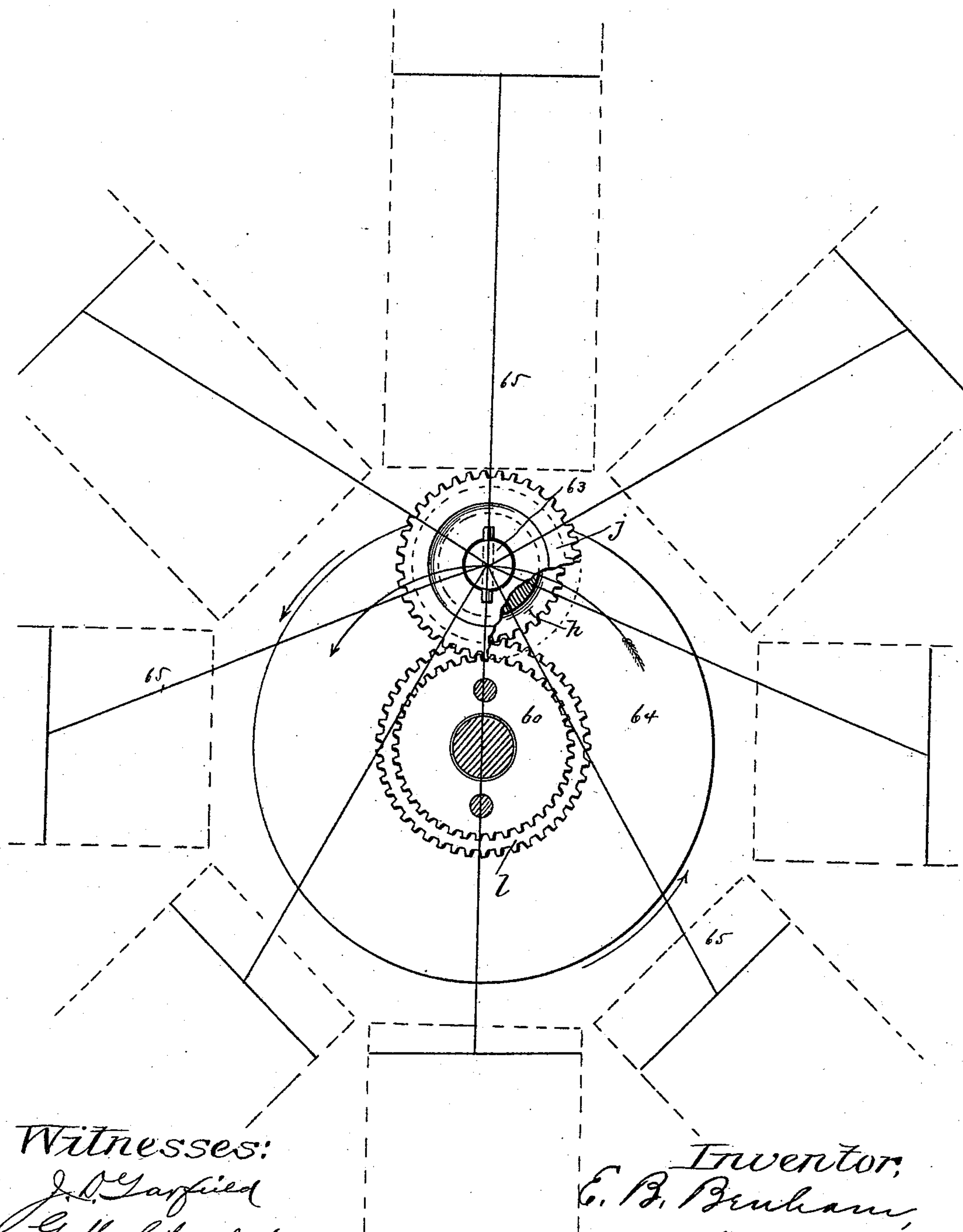
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Fig. 8.



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UNITED STATES PATENT OFFICE.

ELIJAH B. BENHAM, OF PROVIDENCE, RHODE ISLAND.

MULTIPLE-CYLINDER MOTOR.

SPECIFICATION forming part of Letters Patent No. 459,736, dated September 22, 1891.

Application filed January 19, 1891. Serial No. 378,236. (No model.)

To all whom it may concern:

Be it known that I, ELIJAH B. BENHAM, a citizen of the United States, residing at Providence, in the county of Providence and State of Rhode Island, have invented new and useful Improvements in Multiple-Cylinder Motors, of which the following is a specification.

This invention relates to motors, whether to be operated through the agency of steam, hydraulics, compressed air, or other motor-fluid, which are of the multiple-cylinder class.

The object of the invention is to provide a motor of the class mentioned which is of very simple construction and effective in operation; and the invention consists in the construction and combination of parts, all substantially as will hereinafter more fully appear and be set forth in the claims.

Reference is to be had to the accompanying drawings, forming part of this specification, in which similar characters of reference indicate corresponding parts in all the views.

Figure 1 is a front elevation of the improved multiple-cylinder motor with the valve-case removed from the valve-box, showing the valve in end view. Fig. 2 is a side elevation of as much of the motor as is comprised in Fig. 1, with a portion of the valve-box in vertical section, showing the valve therein in side view. Fig. 3 is a central vertical section of the motor from front to rear on a much enlarged scale. Fig. 4 is a perspective view of the valve. Fig. 5 is a vertical section across the valve and valve-box on the line 5 5, Fig. 3. Fig. 6 is a vertical section on the motor-head, as indicated by the line 6 6, Fig. 3. Fig. 7 is a view in the nature of a diagram to indicate the disposition of valve-ports in relation to cylinder-ports to illustrate the entrance of effective pressure to certain of the ports and the exhaust from other of the ports. Fig. 8 is a view in the nature of a diagram, showing geared parts as seen on the plane indicated by the line 8 8, Fig. 3, and the arrangement of the multiple-cylinder pistons and their pitmen at one instant in the running of the motor.

In an application for patent filed by me under date of September 19, 1888, Serial No. 285,774, I have illustrated a multiple-cylinder motor in which many parts are constructed substantially as I have constructed

parts of the present motor, and as in the motor described in the specification forming part of said application the cylinder comprises an annular body 16, cast with the cylinders 17, extending radially from said body. The outer ends of the cylinders are flanged or otherwise formed to receive the closing plates or heads 19. Suitable supporting-feet are also cast on said head. On the rear side of the motor-head an inclosing disk 23 is bolted, having a hub or bearing for the support of the main driving and crank shaft 25, and the valve-box 26 is similarly secured on the front side of the motor-head. The valve-box is of cylindrical form, having at its inner end an integrally-cast disk or web wall d entirely closing such end, except so far as the axial opening x and radial passages 27 form openings therefrom, which radial passages at their inner ends, or ends toward the axis of the cylinder-head, terminate in ports a , opening to the front side of said disk-wall d , said ports being arranged in a circle concentric with the axial line of the motor-head and box, and the said radial passages at their outer ends terminate in ports c , (see Fig. 3,) concentrically disposed, opening to the rear side of said disk-wall, and when the valve-box is in place they register with the inner end openings or ports f at the front side of the cylinder-head of radial passages 28 in said head at the front side of the cylinders thereof, said passages 28 at their outer ends opening inwardly to the interior of the cylinders at or near the outer ends of the cylinder-chambers, and when the motor parts are assembled the said passages 27 and 28 form continuous radial passages from the pressure-chamber in the valve-box to the ends of the cylinder-chambers, said pressure-chamber being indicated by the enlarged annular space 30 at the inner end of the valve-box.

Another similar enlarged annular space is shown near the outer end of the valve-box, which is the exhaust-chamber, and suitable passages (not shown in the present drawings, but which may be such as those clearly illustrated in the drawings of the aforementioned specification and drawings) are provided to lead, respectively, to the pressure-chamber 30 and from the exhaust-chamber 31 and constitute the inlet or pressure passage and the

exhaust-passage. The valve-case 34 is in the form of a cylindrical shell and is fitted within the extended cylindrical portion of the valve-box, its inner end being extended to or nearly
 5 to the pressure-chamber 30 and suitably packed, and at its outer end it is provided with a closing head and is also flanged to overlie the end of the valve-box, bolts 35 passing through said flange into the end of said
 10 box, maintaining the said valve-case immovably in place.

The parts which have now been described as above are those mentioned which in this motor are substantially the same as in the
 15 one embodied in the said specification. And now with respect to the features of novelty in the present motor, A represents the valve, which is of a general cylindrical form and hollow and having a central longitudinal or axial
 20 shaft or spindle *b* extending forwardly and rearwardly of the valve-body and having a bearing by its forward extension through the opening *x* in the closing disk-wall *d* of the valve-box and projecting into the annular
 25 space in the motor-head within the inner ends of the radial cylinders, said spindle by its rear extension having a support in the bearing 50, formed in the head 40 of the valve-case. Said valve at its forward end has a
 30 closing wall 52, which is projected in or by the surrounding flange *m* outwardly beyond the periphery of the valve-body, and when applied in the motor said end wall is adapted to bear upon the said disk-wall *d* of the valve-
 35 box. The valve-body at its rear end is open, as shown at 54. There are a number of ports in the valve through the said flange-wall at the front end thereof, which ports are arranged in a circle corresponding as to di-
 40 ameter and circumference to the circle in which the cylinder-ports are arranged, and a half of said ports are pressure-ports, while the other half are exhaust-ports. The alternate
 45 ports *p*, which are pressure-ports, are merely openings extending through from front to rear of the flange-wall, while the relatively intermediate ports *e* are exhaust-ports, and at the
 50 forward side of said flange-wall, through which wall said ports *e* are also continued, the said ports *e* are "housed in" by the inclosing walls
 55 55, whereby said ports are shut out from communication with the pressure-chamber 30, (with which pressure-chamber the pressure-ports *p* freely communicate,) and yet said in-
 60 closed exhaust-ports each have communication, as shown at 56, Fig. 3, and in Figs. 5 and 7, with the annular chamber in the valve, which chamber, as already stated, is in free communication with the exhaust-chamber
 65 31 in the valve-box, intermediate openings 57 being provided through the valve-case. There is to be such a number of pressure-ports in the valve in relation to the number of cylinder-ports *a* that when one or more of
 said pressure-ports, either as to the whole or a portion of the area thereof, are opposite or register with ports *a*, which are at one side of

the circle in which such ports are arranged, the valve-pressure ports at the other side of the valve will be intermediately of the cylin-
 70 der-ports at the other side of the circle, and one or more of the exhaust-ports at this latter or "other" side of the valve will register with cylinder-ports, while the exhaust-ports
 75 at the side of the valve first mentioned (as having its pressure-ports registering with cylinder-ports) lie between cylinder-ports *a*. In the motor here illustrated are shown eight
 80 cylinder-ports regularly distanced in circular arrangement, and in the valve (in a circle corresponding to the one in which the cylinder-ports are arranged) are nine pressure-ports, and alternately or intermediately thereof are
 the exhaust-ports, also nine in number.

Reference is to be had to Fig. 7. The dotted circles, particularly indicated in this view
 85 by *a'* *a*², &c., to *a*⁸, represent the cylinder-ports, while the circles particularly indicated by *p'* *p*², &c., to *p*⁹ represent the pressure-ports in the valve, and the circles here particularly indicated by *e'* *e*², &c., to *e*⁹ represent the exhaust-ports. The valve is assumed
 90 to have a regular rotation in the direction of the arrows, and it will be seen that cylinder-port *a*⁸ is taking pressure through port *p*⁹ in an increasing extent, *a'* is receiving its maximum of effective pressure through valve-port
 95 *p'*, and the port *a*² is taking pressure through the valve-port *p*² in a decreasing extent. The pistons in the cylinders to which the ports *a*⁸ *a'* *a*² lead are at this time being operated
 100 by the effective pressure admitted thereagainst. Pressure has been admitted to port *a*³ and has just been cut off, the piston corresponding to *a*³ having done its work and its cylinder is just about to exhaust and cylin-
 105 der-port *a*⁷ is just about to take pressure, its piston at such time being in its outermost disposition and ready to be driven inwardly. It will also be seen that port *a*⁴, having had
 110 its pressure through *p*⁴, is now beginning to exhaust through *e*⁴ *p*⁵, has passed sufficiently far past *a*⁵, so that the full area of exhaust-port *e*⁵ is over *a*⁵ and the pressure received
 115 through *e*⁶ from *p*⁶, which has passed by and "cut off," has nearly exhausted through *e*⁶. Of course as the cylinders at one side of the motor receive effective pressure the pistons
 120 therein are inwardly driven to exert its effect on the crank, as usual in this class of motors, while the effective pressure in cylinders at the other side of the motor-head, which pressure is exhausting, permits, through the con-
 125 nection of the crank with the pistons in said exhausting-cylinders, the said pistons to be moved outwardly to assume proper positions
 130 to again receive driving movements under pressure; and of course it will be understood that in the rotation of the valve constantly-varying combinations are made by pressure and exhaust valve ports registering with cylin-
 der-ports of the motor-head at relatively opposite sides thereof, all whereby sets of the multiple pistons will properly and success-

ively act against the crank to secure its rotation, and while the valve is being moved around so that, say, the pressure-port p' moves so far from cylinder-port a' as to bring it opposite a^8 , there will have been such a number of registering-port combinations formed and cut out for pressure and exhaust that all the pistons will have made their one back-and-forth stroke and secured one rotation of the crank and the shaft 25. Of course the valve must have a comparatively slow rotational movement, and while a variety of means may be provided to insure a proper rotation of the valve, whether connected to and actuated by the crank-shaft or otherwise, in the drawings is illustrated an arrangement of valve-operating gears which is simple and effective, and 60 represents a gear-wheel which is affixed, as by bolts, on a boss 62 on the inner side of the disk-wall d , inwardly through and beyond which gear the valve-spindle loosely passes.

It will be noticed that the crank-pin 63 of the crank arm or disk 64 (to which pin the feet of the pitman-rods 65 for the cylinder-pistons are attached) is extended forwardly beyond the place of engagement therewith of the said pitman-rods and carries loosely thereon a sleeve which comprises as a single part the two gears h and j , the one h meshing with the said fixed gear 60. The pitch-line of the said gear h is such in relation to the axis of revolution of the crank-pin that as said gear h is carried around on the crank-pin there is always a meshing between its teeth and those of the said fixed gear 60, and of course as the crank-pin revolves the double gear h j , carried thereon, is also rotated as it revolves, and if the diameters of said engaging gear-wheels h 60 are equal as the crank-pin makes one revolution the gear h , and also the other gear j , makes one rotation. On the inner extremity of the valve-spindle is fixed a gear l of slightly larger diameter than the gear j or those h and 60, and to mesh therewith the gear j of the sleeve must be smaller even than the said gears h or 60. Were the loose gear j on the crank-pin of the same diameter as the one l on the valve it might rotate around said gear l , the same being, as it were, a fixture; but as the loose crank-gear j is of a somewhat smaller diameter than the gear l , in making a revolution around said gear it necessitates the turning of said gear a fraction of a rotation, such fraction being as to the whole of a rotation as the difference between the diameter of the gears is to the whole of the diameter of one of the gears, and therefore under the running of the motor several revolutions of the crank shaft and pin only insure but one rotation of the valve.

The entrance of the motor-fluid to the pressure-chamber of the motor may be controlled in any way desired, one way being to provide a suitable valve in the pipe which conveys the said fluid to the pressure-chamber and to

merely open and close the valve when desired to start and stop the engine.

What I claim as my invention is—

1. In a multiple-cylinder motor, the combination, with a motor-head having a series of cylinder-ports in circular arrangement, of a valve mounted for rotation and to lie against the part of the motor-head comprising said cylinder-ports provided with a series of pressure and exhaust ports arranged in a circle corresponding to that comprising the cylinder-ports, the ports of the pressure and exhaust series alternating with each other and the ports of each series being in number unequal to the number of cylinder-ports, all so arranged that at any instant that pressure is admitted to some of the cylinder-ports through a portion of the pressure-ports of the valve, which are at one side of the port-circle, a portion of the exhaust-ports are over cylinder-ports at the opposite side of said circle, for the purpose set forth.

2. A valve for a multiple-cylinder motor, consisting of a body of general cylindrical form having a closing end wall provided with a series of ports circularly arranged in said end wall and extending through same and opening to the exterior of said body at the rear of said end wall, and another series of ports arranged in the same circle as said first-mentioned series of ports, but relatively intermediate thereof, and extending through said end wall and communicating with the interior of said valve-body, substantially as described.

3. In a multiple-cylinder motor, the combination, with a motor-head comprising a valve-box having a closed end wall, in which is provided a series of cylinder-ports in circular arrangement, and a pressure and exhaust chamber 30 and 31, substantially as shown, of a valve mounted for rotation in said valve-box and having a closing end wall extended in the outlying and surrounding flange, adapted to lie in advance of the said pressure-chamber, said flanged portion of the wall being provided with a series of pressure-ports circularly arranged and extending through same and communicating with said pressure-chamber, and a series of exhaust-ports arranged in the same circle as said pressure-ports, but relatively intermediate thereof, and extending to the interior of said valve-body, which in turn communicates with the exhaust-chamber, substantially as described.

4. In a multiple-cylinder motor, the combination, with a motor-head comprising a series of radial cylinders having pistons therein, of a passage leading from the interior of each cylinder to the side of the motor-head, the said passages terminating in the circularly-arranged series of cylinder-ports and a pressure-chamber, a driving-shaft having the crank thereon and connections between the pistons and said crank, the rotatable valve mounted to lie against the part of the motor-head comprising said cylinder-ports and provided with

a series of pressure and exhaust ports arranged in a circle corresponding to that of the cylinder-ports, the ports of the pressure and exhaust series alternating with each other
5 and the ports in each series being in number unequal to the number of the cylinder-ports, for the purpose set forth, and a motion-reducing mechanism connecting said crank-shaft and said valve, whereby on a given rotation
10 of said shaft a much slower rotation will be imparted to the valve, substantially as described.

5. In a multiple-cylinder motor comprising the circularly-arranged cylinder-ports, the
15 crank-shaft, and crank-pin, and the valve having pressure and exhaust ports in number

and arrangement substantially as and for the purpose described and provided with the spindle extended into proximity to said crank-pin and having fixed thereon a gear l , a two-part
20 gear $h j$, rotatable on the revoluble crank-pin, the gear part j meshing with the valve-gear l and having a diameter unequal thereto, and a gear fixed on the motor-head, with which
25 the other gear part h on its revolution with the crank-pin has an engagement, whereby the two-part gear is rotated, for the purpose set forth.

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