No. 877,977. PATENTED FEB. 4, 1908.

F. C. AXTELL.

MOTOR.

APPLICATION FILED MAR. 19, 1907. 4 SHEETS—SHEET 1.

Fig. 1.

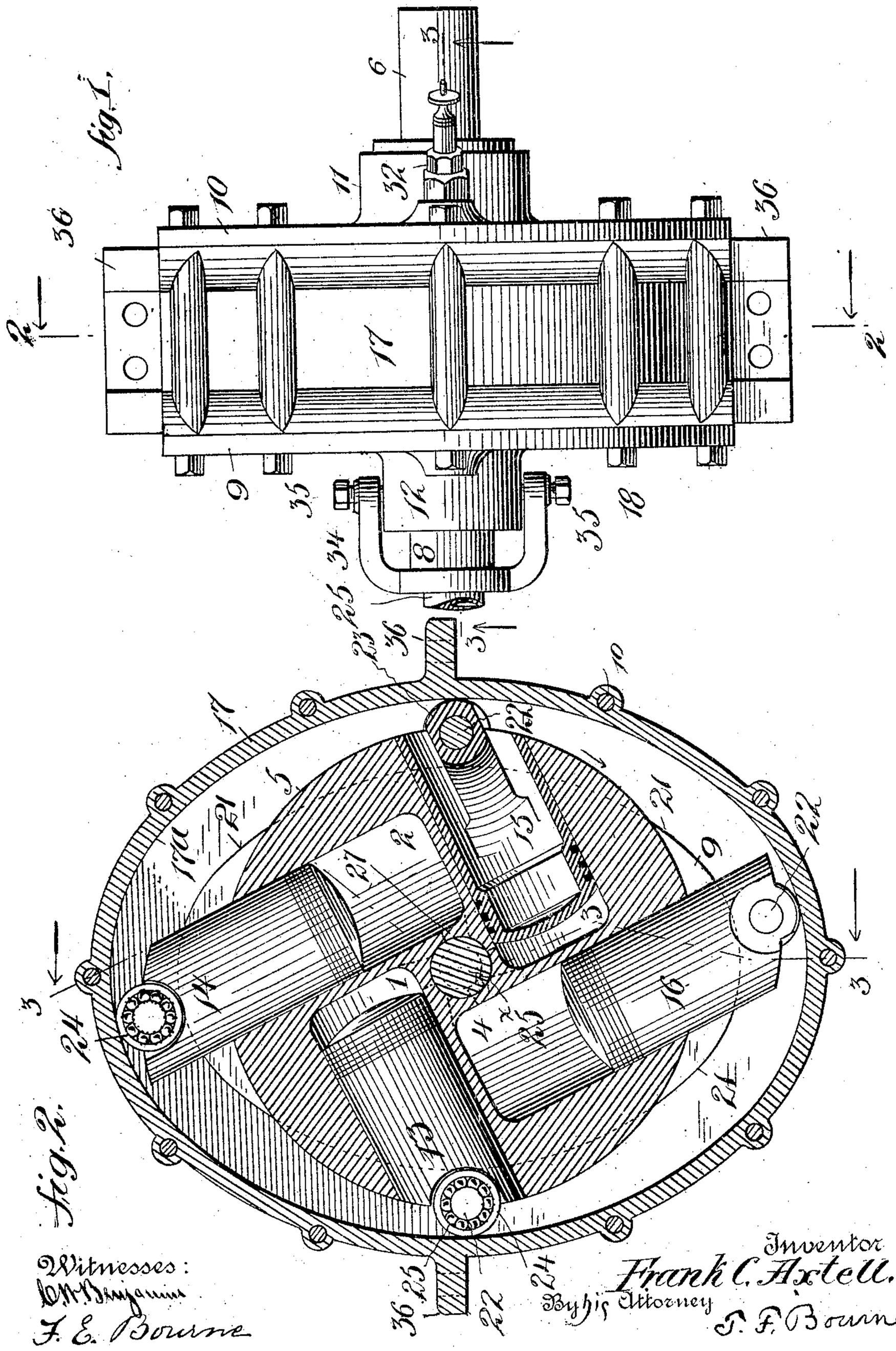

Fig. 2.

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Fig. 4.

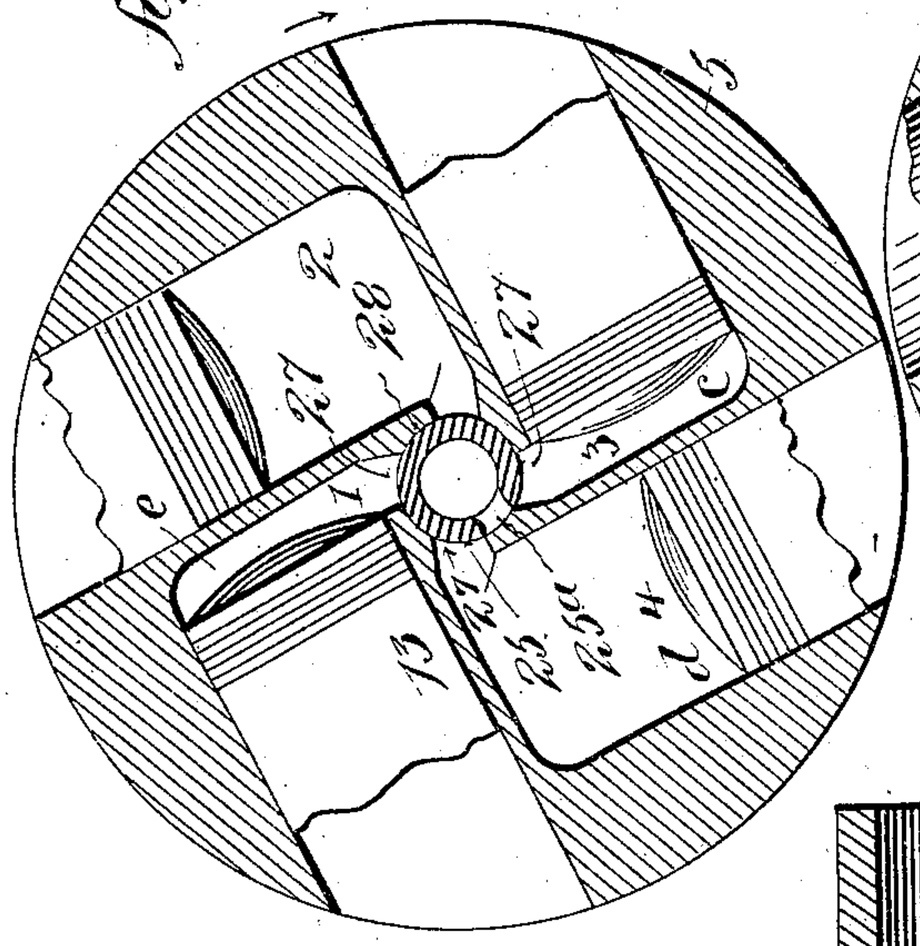
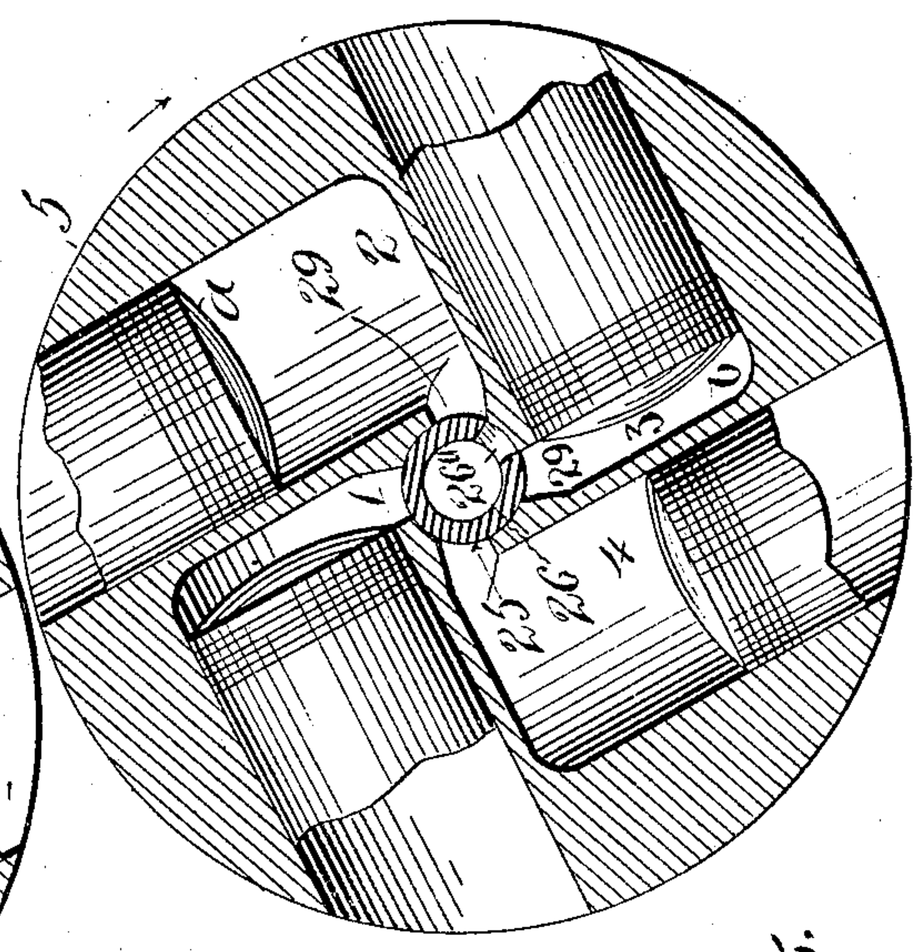
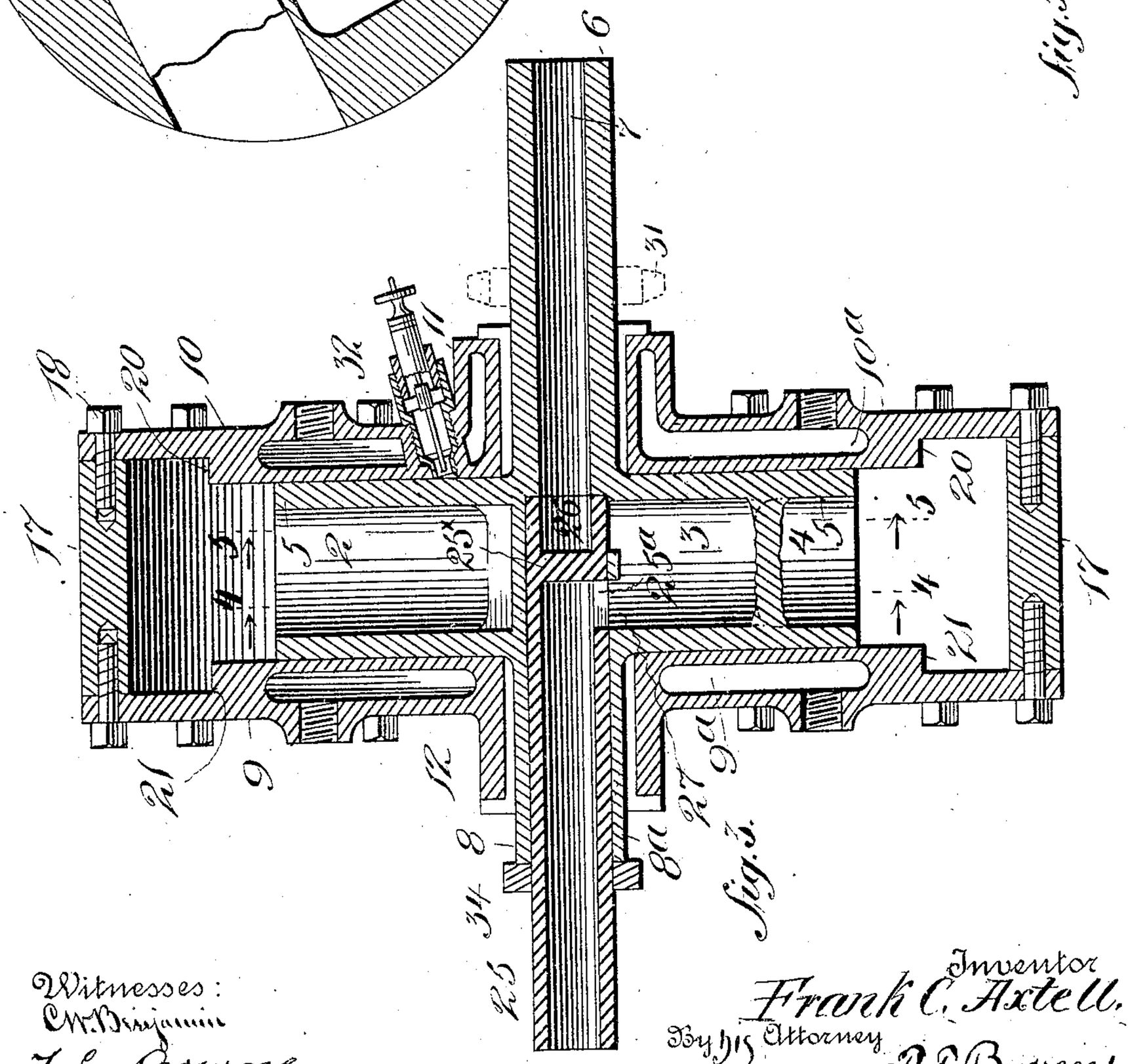


Fig. 5.





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APPLICATION FILED MAR. 19, 1907. 4 SHEETS—SHEET 3.

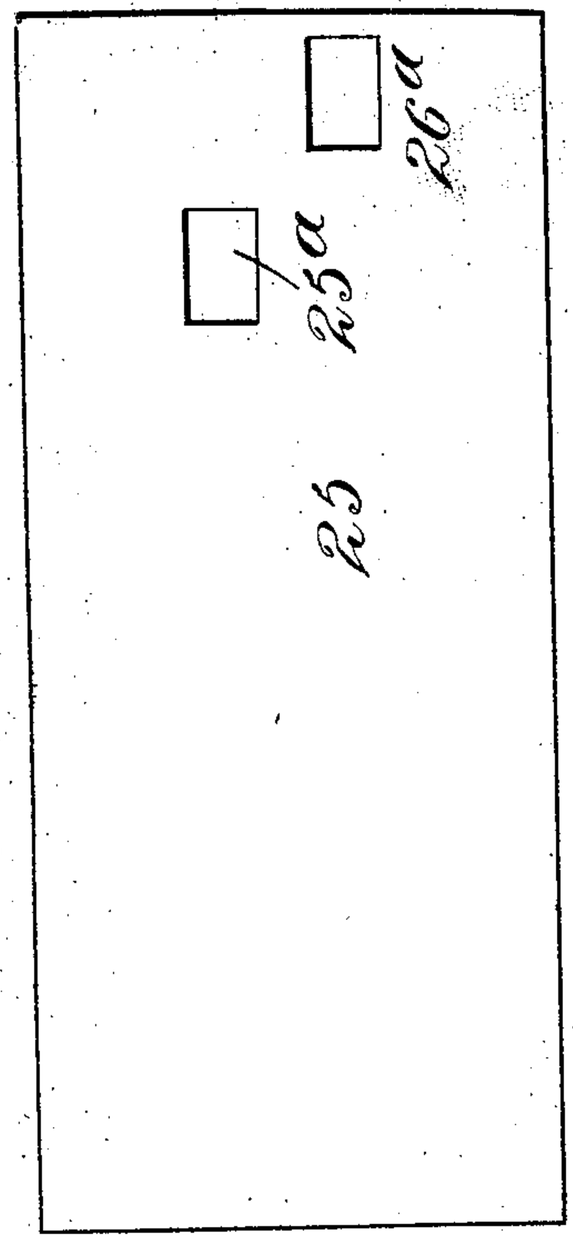

Fig. 10.

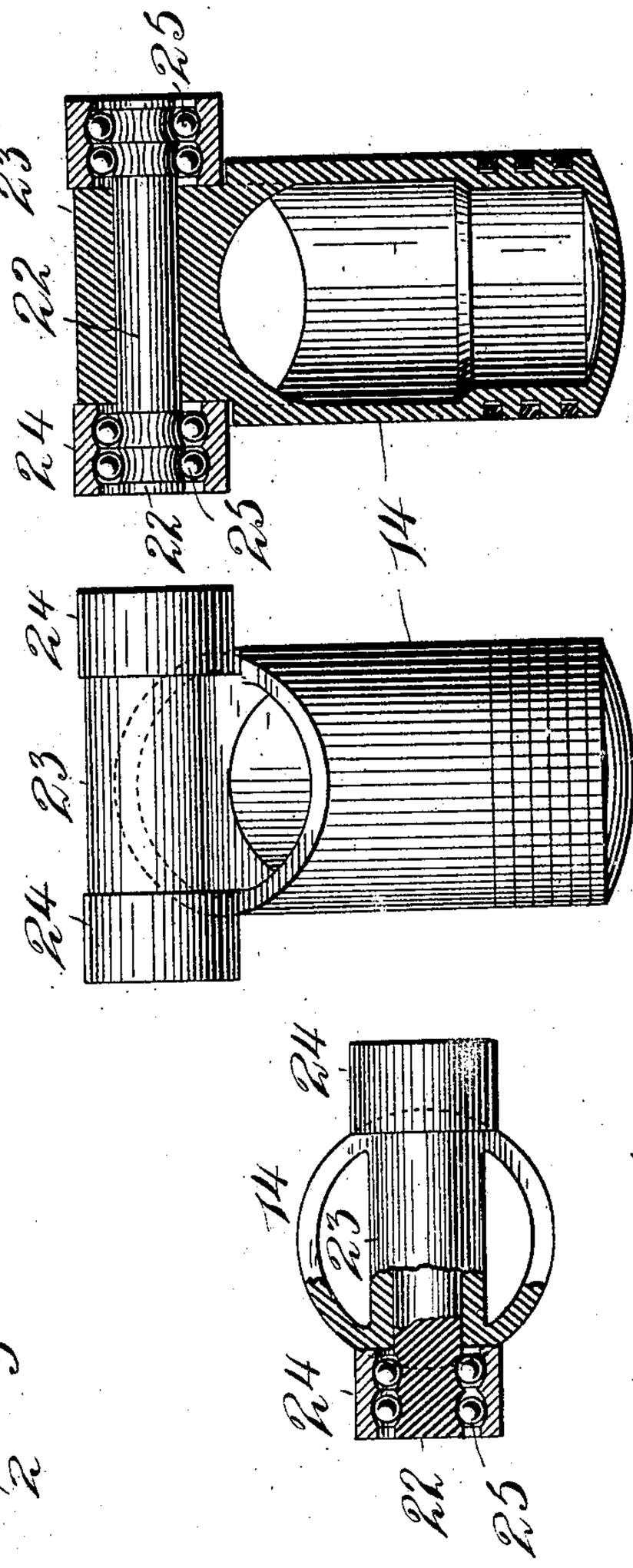

Fig. 9. Fig. 8.

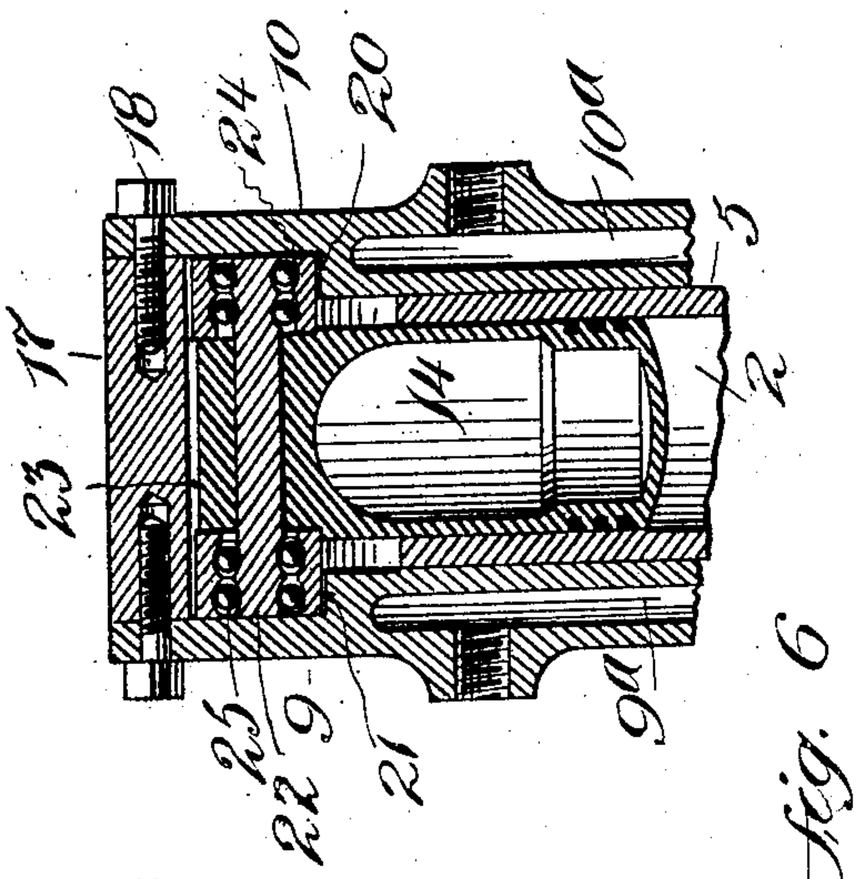

Fig. 6

Fig. 7

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APPLICATION FILED MAR. 19, 1907.

4 SHEETS—SHEET 4.

Fig. 13.

Fig. 14.

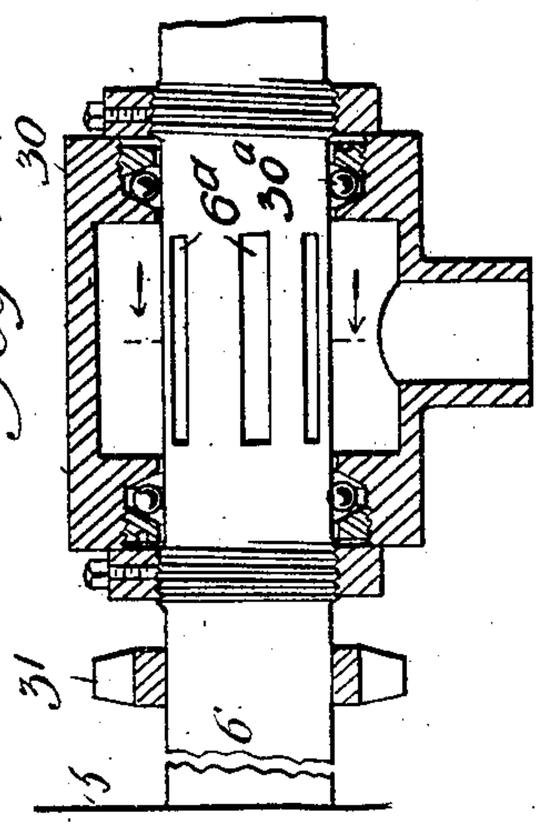


Fig. 13

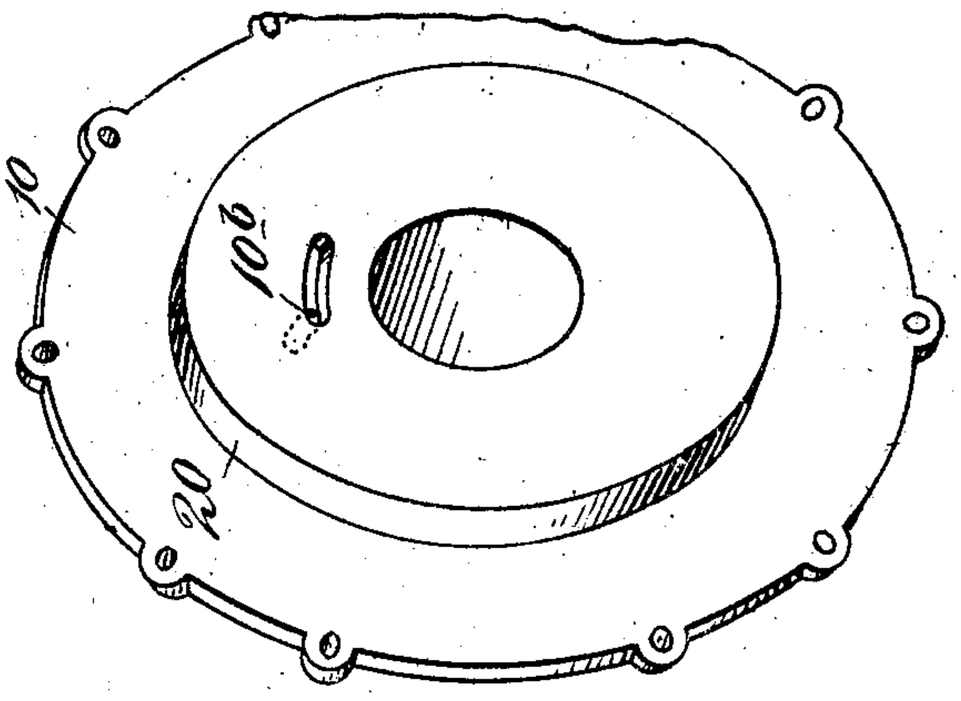


Fig. 12

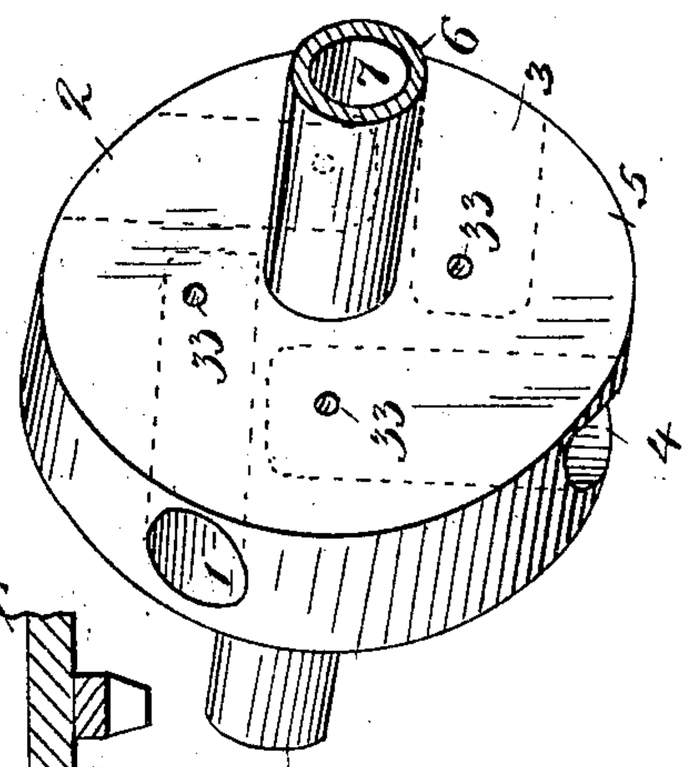
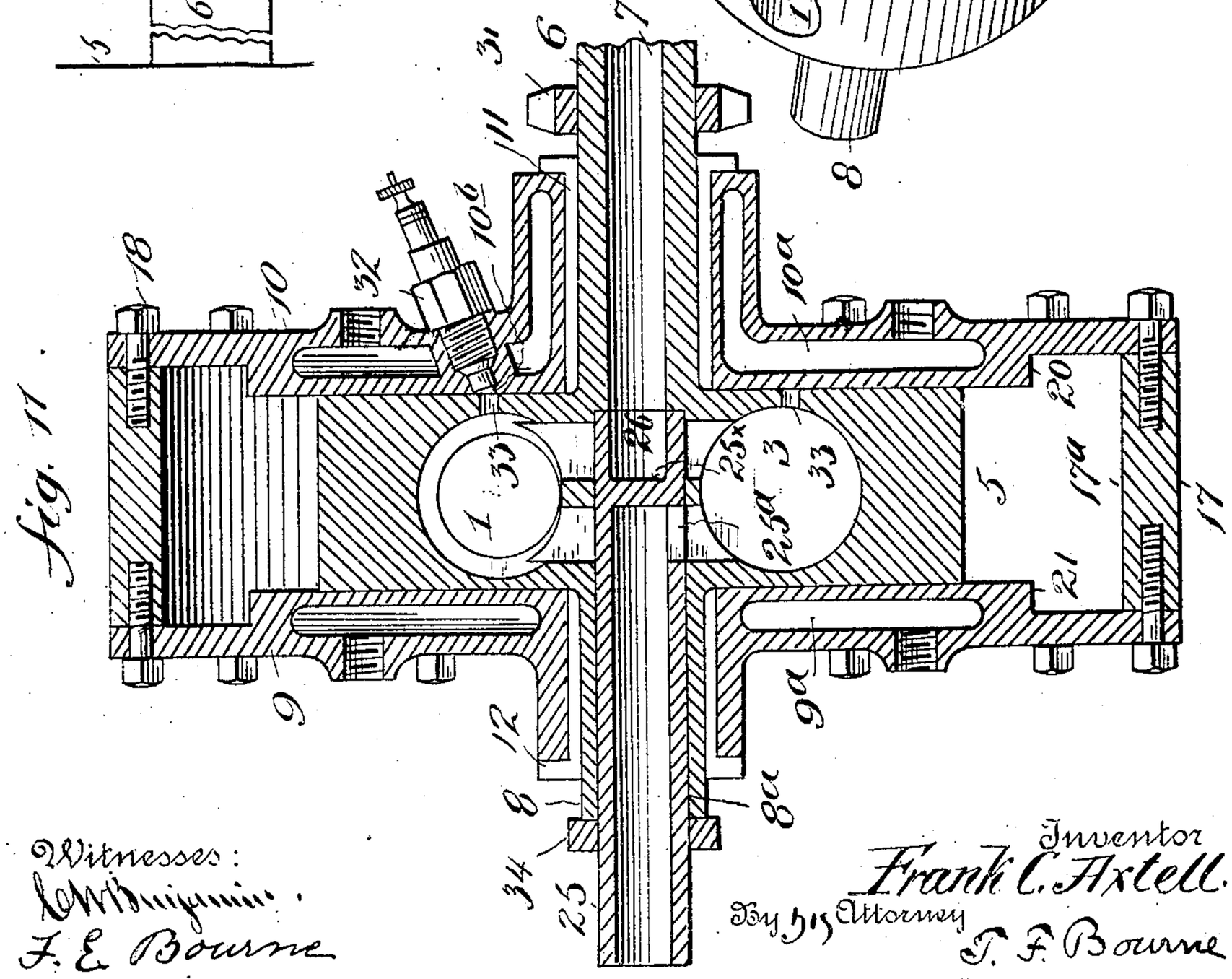


Fig. 11.



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UNITED STATES PATENT OFFICE.

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MOTOR.

No. 877,977. Specification of Letters Patent. Patented Feb. 4, 1908.

Application filed March 19, 1907. Serial No. 363,259.

To all whom it may concern:

Be it known that I, FRANK C. AXTELL, a citizen of the United States, and resident of Short Hills, Essex county, New Jersey, have invented certain new and useful Improvements in Motors, of which the following is a specification.

The object of my invention is to produce a motor, simple in construction, relatively light in weight, and which is applicable for use as an internal combustion heat motor or engine, and whereby substantially continuous rotative force or torque may be obtained.

In carrying out my invention I provide a plurality of cylinders arranged substantially tangentially with respect to an axis around which they rotate, pistons for said cylinders and means for causing said pistons to reciprocate back and forth at least twice for each complete revolution of the corresponding cylinder, or in other words, to cause any given point of each piston to describe an approximately elliptical path or curve during each revolution of the cylinders or four strokes of the pistons. To cause the pistons to perform four strokes during each revolution of the corresponding cylinder, I have shown an elliptical guide disposed without the cylinder, and means connected with the pistons for coaction with such guide for causing each piston, during each revolution of its cylinder, to move inwardly, then outwardly, again inwardly, and again outwardly. To cause the motor to operate on the principles of the four-cycle gas-engine, so that the well known four stroke cycle will be performed during each revolution of each cylinder, I have shown valvular means for permitting the entrance of fuel into each cylinder, its compression therein, its explosion or expansion therein for the power stroke, and the exhaust of the spent gases therefrom.

My invention also comprises the novel details of improvement and combination of parts that will be hereinafter more fully set forth and then pointed out in the claims.

Reference is to be had to the accompanying drawings forming part hereof, wherein Figure 1 is an edge view of a motor embodying my invention; Fig. 2 is a vertical cross-section, substantially on the line 2, 2, in Fig. 1; Fig. 3 is a cross section, substantially on the irregular line 3, 3, in Fig. 2, the pistons being omitted; Fig. 4 is a diagrammatic section on the line 4, 4, in Fig. 3; Fig. 5 is a diagrammatic section on the line 5, 5, in Fig. 3; Fig. 6 is a detail section through one cylinder and piston, showing also the casing and piston-controlling guide; Fig. 7 is an end view of a piston partly in section; Fig. 8 is a face view of a piston; Fig. 9 is a central section of a piston; Fig. 10 is a developed plan of the tubular valve, shown in the drawings, for controlling the fuel and exhaust gases; Fig. 11 is a sectional view of the motor showing disk 5 in a different position from Fig. 3; Fig. 12 is a perspective view of disk 5; Fig. 13 is a perspective view of casing member 10; Fig. 14 is a detail section of a modification; and Fig. 15 is a cross section thereof.

In the accompanying drawings the numerals 1, 2, 3 and 4, indicate cylinders which may be of any suitable construction, being shown formed in a disk 5, which is adapted to rotate upon a central axis. I have shown the cylinder support or disk 5, provided with a power transmitting shaft 6, having a bore 7, located on one side of disk 5, and a corresponding tubular shaft or gudgeon 8 extending from the opposite side of disk 5, whereby said disk is mounted to rotate in suitable bearings. I have shown the cylinder support or disk 5 as mounted to rotate within a suitable casing or frame, comprising side members or plates 9, 10, provided with bearings 11, 12, of any suitable construction for the shafts 6, 8. If said frame or casing be made of plates they may be provided with suitable passages 9^a, 10^a, for the circulation of fluid for cooling purposes, while if said frame be made in skeleton form the cylinders may be air-cooled. Said frame or casing is provided with a guide for causing reciprocation of the pistons 13, 14, 15, 16, of the corresponding cylinders. The guide I have shown comprises an outer band 17, secured to or between the casing members 9, 10, as by screws 18, having a working face 17^a, and ways 20, 21, within said band, which are shown formed on the casing members 9, 10. This, piston controlling guide 17, 20, 21 is shown of substantially elliptical form on the working surfaces (see Fig. 2) and the axis of revolution of the cylinders (the shafts 6, 8) is journaled within and at the center of said elliptical piston guide. The pistons are provided with means for co-acting with said elliptical guide, whereby for each revolution of each cylinder and its piston the corresponding piston has four strokes

(two outward and two inward strokes.) As a convenient means for this purpose, I have shown each piston provided with a pin or shaft 22, providing gudgeons extending from opposite sides of the piston, being shown as secured in a cross member 23 at the outer end of the piston. Upon said gudgeons the rollers 24, are mounted to rotate, being shown supported by suitable antifriction ball or roller bearings 25. Said rollers 24, are adapted to travel on the inner elliptical working face 17ª, of the guide 17 and also upon the ways 20, 21 of the elliptical piston guide causing reciprocations of the pistons during their revolution. The diameters of the rollers 24, are preferably very slightly less than the distance between the elliptical working surface 17ª and the ways 20, 21 of the piston guide, so that when rollers 24, bear upon the elliptical guide 17, they will be out of contact with the ways 20, 21, and vice versa.

By means of the arrangements described, it will be understood that during revolutions of the cylinders when pressure or resistance is within a cylinder (such as explosion, exhausting or compression pressure) the rollers 24, of the corresponding piston will press against the guide 17, and that when a piston is moving outwardly on the suction or intake stroke the rollers 24 will bear upon the ways 20, 21.

The means I have shown for admitting charges of fuel to the cylinders, igniting the charges, and exhausting the spent products of combustion from the cylinders are as follows:— Within the bore 8ª of the shaft or gudgeon 8 is located a tube 25, shown provided near its inner end with a partition 25ˣ providing a chamber 26 communicating with bore 7 of shaft 6. The tube 25 has a port 25ª, adapted to communicate with corresponding intake ports 27 (see Figs. 2 and 4) at or near the inner ends of the cylinders and correspondingly arranged in position, the tube 25 fitting snugly, adjacent to said ports, in a bore in the cylinder support or disk 5, indicated at 28 in Fig. 4. At or near their inner ends the cylinders also have exhaust ports, indicated at 29 in Fig. 5, and correspondingly arranged in the cylinders, adapted to successively register with exhaust port 26ª of chamber 28, to permit the escape of products of combustion through the bore of shaft 6. Instead of permitting the exhaust gases to escape through the open end of bore 7 of shaft 6, the gases may be permitted to escape through holes or slots 6ª in said shaft communicating with said bore and inclosed within suitable hood or chamber 30, mounted upon said shaft, as by anti-friction bearings 30ª, and having an outlet indicated at 29ª, which, when connected with an ordinary muffler, will prevent rotation of said hood, see Figs. 14 and 15. The engine may be started by any suitable means, as by a chain passing over a sprocket 31 secured to shaft 6, see Figs. 3, 11 and 14.

Ignition of the compressed fuel charges in the cylinders may be effected in any suitable manner. For this purpose I have shown an igniter or spark plug 32, suitably attached to the member 10 of the casing, and communicating with opening 10ᵇ in the wall thereof, the cylinders being provided in their walls with suitably shaped apertures 33 (see Figs. 11 and 12) adapted to register with the spark plug or igniter opening 10ᵇ of member 10. The igniter opening 10ᵇ may be elongated in the direction of a circle described around the axis of rotation of the cylinders, (see Fig. 11) which may extend for nearly 90° in the direction in which the cylinders rotate, whereby the spark may be maintained in the presence of the compressed and burning gases from openings 33 during a considerable portion of the explosion stroke.

The fuel inlet tube or valve 25 may be held from rotation by any suitable means. For this purpose I have shown a yoke 34 secured to tubular valve 25 and provided with set screws 35 adapted to engage hub 12 for holding tubular valve 25 in positions of adjustment, and by this means also the ports of said tube may be adjusted angularly with respect to the ports of the cylinders for regulating the inlet and exhaust of the gases with reference to the cylinders. Said yoke, however, may be fastened to any other suitable stationary part associated with the motor.

The frame of the motor is shown provided with lugs 36 which may be fastened to any suitable support, although said frame may be supported in any suitable manner, or said lugs may be placed in any other suitable position upon the casing.

The operation of my improvements as a four stroke cycle gas engine producing an explosion stroke for each revolution of a cylinder, may be described as follows:—A suitable carbureter or the like being connected with tubular valve 25, and the igniter or spark plug being connected with an electric circuit arranged and controlled in any well known or suitable manner, and the cylinders then being rotated, as to the right in Figs. 4 and 5, it may be assumed that the charge back of piston 13 of cylinder 1 is compressed and just at the point of explosion. The following will be the action respecting said piston: Upon this explosion occurring, the pressure acting tangentially with respect to the disk 5, drives the latter in the direction shown by the arrow, and the rollers 24, carried by said piston, follow the increasing radii of the elliptical guide face 17ª, as the piston advances on the explosion stroke, until the piston reaches the position represented at *a* in Fig. 5. At this point, the exhaust port 29, of the cylinder, reaches a po-

sition with respect to exhaust port 26ª so that communication next begins to be established between said ports, and as disk 5 continues to revolve, the rollers 24 of the aforesaid cylinder still bearing against the elliptical guide face 17ª (said rollers now traveling on the decreasing radii of said guide face) force the piston back into the cylinder until it reaches the position indicated at *b* in Fig. 5 (indicated also by the position of piston 15 in Fig. 2) by which time the spent gases have been exhausted or expelled from the corresponding cylinder, and then the inlet port 27 of said cylinder begins, during further revolution, to register with the inlet port 25ª, as indicated by the position of the piston and ports at *c* in Fig. 4. At this point the rollers 24, in place of bearing against the inner face 17ª of the piston guide, find a seat or seats upon the elliptical ways 20, 21, and during the continued revolution through the next quarter portion of the elliptical guide (at its increasing radii) the piston is drawn outward, and as the ports 27, 25ª (Fig. 4) register, the suction created in the cylinder by the piston causes a charge of fuel to enter the cylinder, and when the piston reaches the position shown at *d* in said figure (indicated also by the position of piston 16 in Fig. 2) the ports 25ª and 27 will have closed. As the disk 5 continues to rotate, the rollers 24 of its piston again engage the fourth quarter of the elliptical surface (traveling along the next decreasing radii) thus forcing the piston back into the cylinder and compressing the charge therein, and when such piston again reaches its first named position, indicated at *e* in Fig. 4, explosion again occurs. From the description given above of the revolution of one cylinder it will be understood that an explosion occurs once in each revolution of such cylinder. By having four cylinders and pistons fitted to the support 5, it will be obvious that there will be four explosion strokes for each complete revolution of support 5, the explosions in the cylinders following successively in order. It will also be understood that any desired number of cylinders may be fitted to a rotating support (limited only by the dimensions of the support and cylinders) all the pistons of such cylinders working in corresponding order with the elliptical guide to produce an explosion stroke in each cylinder for every revolution thereof.

Some of the advantages of my improvements may be enumerated as follows:—Expansion takes place behind a piston which is practically free and the moment of rotation or torque is always tangent to a circle of revolution of the cylinders, such force being practically the same whether the explosion occurs near the beginning of the stroke of the piston or toward the end thereof—due allowance being made, of course, for the loss of power, in the latter case, through a reduction in the compression of the exploding charge—as distinguished from the ordinary explosion motor having a crank connected with the piston, wherein explosions occur, normally, about as the piston is on the point of beginning its working stroke, when the crank is least in a position to convert the power of the explosion into useful torque. It will thus be seen that with my improvements full leverage, equal to the distance from the axis of rotation of the cylinder to its longitudinal axis, is constantly in position to act with the explosion and expansion forces of the gases (as well as for exhausting, taking in, and compressing the gases) as distinguished from the varying leverage of a motor utilizing a crank, and by reason of the elliptical piston guide such full and constant leverage is exerted four times during each revolution of each cylinder. The motor is simple and durable in construction, contains no small or delicate parts and, for the power developed, compared with motors having cranks and cylinders of similar bore and stroke, is relatively light in weight.

It will be evident that practically any number of disk and cylinder units may be arranged on or connected with a single shaft, such as side by side, the disposal of the several cylinders around the axis of rotation being so arranged that power strokes or explosions may follow each other at relatively short intervals thereby permitting substantially constant torque upon said shaft.

Lubrication may be effected in any suitable manner as by well known oil holes in the bearings communicating with a helical or other groove cut in the concave bearing surface and communicating with the interior of the casing adjacent the sides of disk 5, so that the rotation of the shafts 6 and 8 carries the oil inwardly, and when it reaches the surface of the disk centrifugal force causes the oil to travel toward the periphery of the disk, and it is finally deposited within the elliptical chamber where it serves to lubricate the parts by "splash". Suitable passages may also be provided through the walls of the cylinders for lubrication of the pistons and cylinders. By having the sides of the disk 5 and the parts of the casing that come in contact therewith properly ground and fitted. there will be a film of oil between the sides of the disk and said plates, providing an efficient lubrication and preventing the leakage of gases from the cylinders into the elliptical case, should there be a tendency to such escape from the holes 33 for ignition.

Any desired number of cylinders may be provided on a disk or support 5, by properly proportioning the dimensions thereof to the dimensions of the cylinders.

While I have illustrated and described an embodiment of my invention, it will be understood that the arrangements shown and

set forth may be varied within the scope of the appended claims, without departing from the spirit thereof.

Having now described my invention, what I claim is:—

1. A motor comprising a cylinder disposed substantially tangentially with respect to its axis of rotation, means for rotatively supporting said cylinder, a piston for said cylinder, means for causing a given point of said piston to describe an approximately elliptical path or curve around its axis of rotation during one revolution of the cylinder to cause the piston to make four strokes during such revolution, and means to admit fluid to and discharge it from said cylinder.

2. A motor comprising a cylinder disposed substantially tangentially with respect to its axis of rotation, a support for said cylinder, a piston for said cylinder, an elliptical guide having its center substantially coincident with the axis of said support, means connecting said piston with said elliptical guide for causing said piston to reciprocate four times in its cylinder during one revolution thereof, and means to admit fluid to and discharge it from said cylinder.

3. A motor comprising a cylinder disposed substantially tangentially with respect to its axis of rotation, a support for said cylinder, a piston for said cylinder, an elliptical guide having its center substantially coincident with the axis of said support, means connecting said piston with said elliptical guide for causing said piston to reciprocate four times in its cylinder during one revolution thereof, said cylinder having inlet and exhaust ports near its inner end, separate inlet and exhaust ports to communicate therewith, and means to ignite compressed charges in said cylinder.

4. A motor comprising a plurality of cylinders disposed substantially tangentially with respect to their axis of rotation, a rotative support for said cylinders, pistons for said cylinders, an elliptical guide having its axis substantially concentric with the axis of rotation of said cylinder support, means operatively connecting said pistons with said elliptical guide to cause each of said pistons to reciprocate four times during each complete revolution of each cylinder, and means to admit fluid to and discharge fluid from said cylinders successively.

5. A motor comprising a plurality of cylinders disposed substantially tangentially with respect to their axis of rotation, a rotative support for said cylinders, pistons for said cylinders, an elliptical guide having its axis substantially concentric with the axis of rotation of said cylinder support, means operatively connecting said pistons with said elliptical guide to cause each of said pistons to reciprocate four times during each complete revolution of each cylinder, means to admit fluid to and discharge fluid from said cylinders successively, said cylinders having ports, and an igniter located in position to communicate with said ports of said cylinders.

6. A motor comprising a rotative support provided with a plurality of cylinders substantially tangentially disposed with respect to the axis of rotation of said support, pistons in said cylinders, said support having hollow shafts, a casing containing said support and cylinders, and provided with hubs receiving said shafts, said cylinders having inlet and exhaust ports, means to control the flow of gases through said ports and hollow shafts said cylinders having ignition ports in their side walls, a spark plug supported by said casing independently of said cylinder support and having an elongated opening to co-act with the cylinder ignition ports to ignite gases in said cylinders through said ignition ports, and an elliptical guide to cause said pistons each to reciprocate four times during each revolution of each cylinder.

7. A motor comprising a rotative support provided with a plurality of cylinders substantially tangentially disposed with respect to the axis of rotation of said support, pistons in said cylinders, said support having hollow shafts, a casing containing said support and cylinders, and provided with hubs receiving said shafts, said cylinders having inlet and exhaust ports, means to control the flow of gases through said ports and hollow shafts, said cylinders having ignition ports, means to ignite gases in said cylinders through said ignition ports, an elliptical guide disposed without said cylinders, and means connected with said pistons to co-act with said guide to cause four reciprocations of said pistons during each revolution thereof.

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