No. 669,069. Patented Mar. 5, 1901.

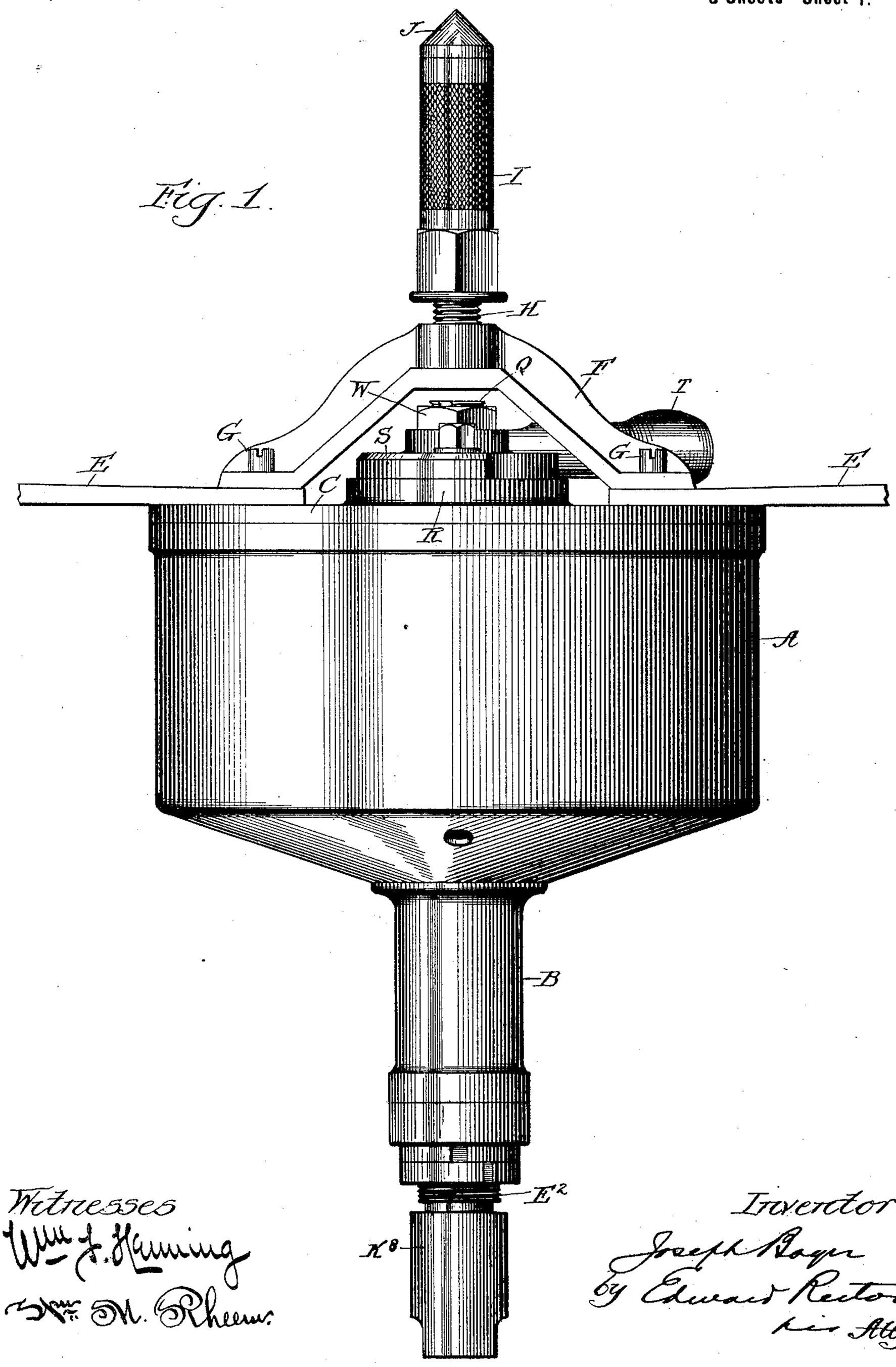
J. BOYER.

ENGINE.

(Application filed May 4, 1898.)

(No Model.) 5 Sheets—Sheet 1.

Fig. 1.



Witnesses
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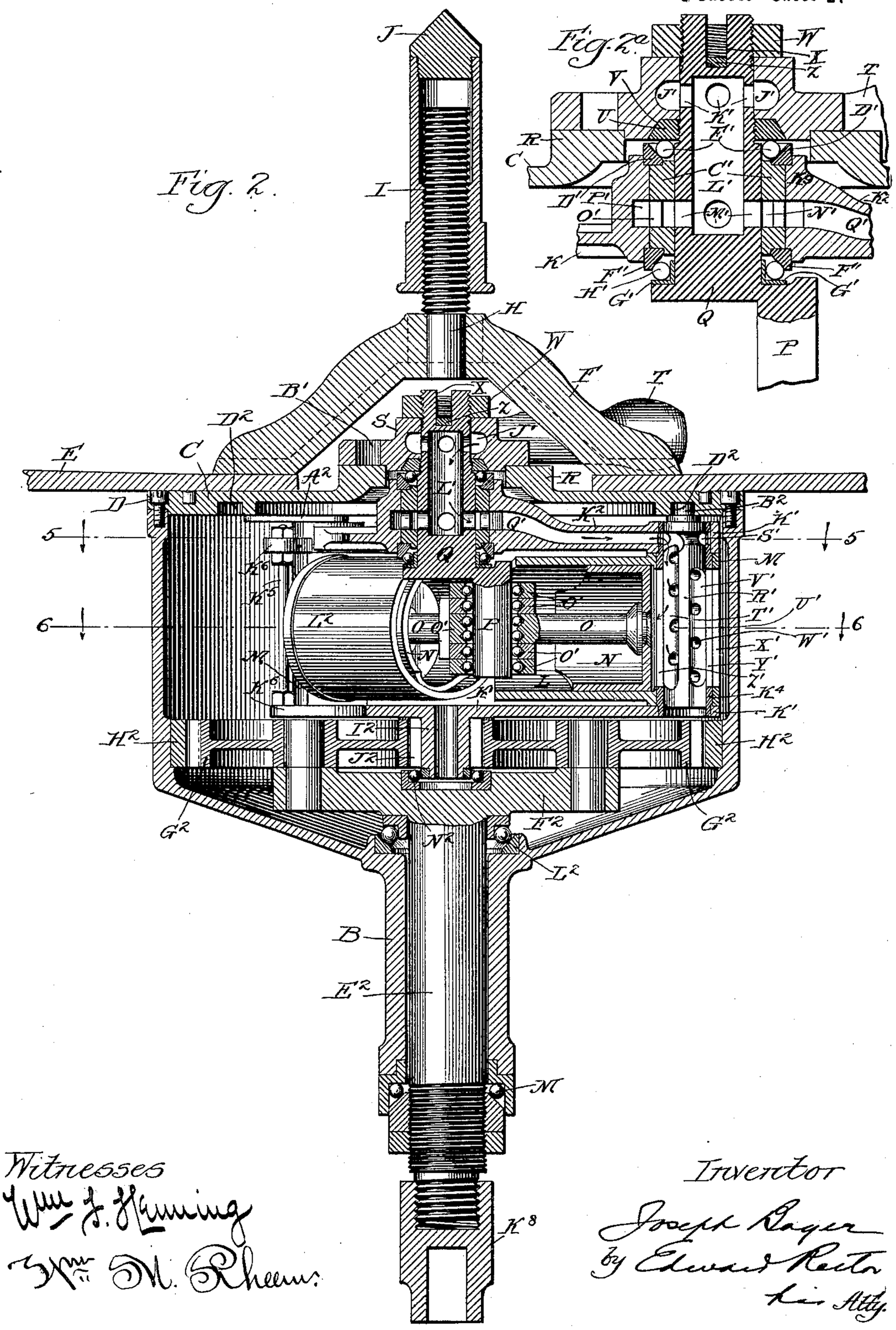
(No Model.) 5 Sheets—Sheet 2.

Fig. 2.



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(No Model.) 5 Sheets—Sheet 3.

Fig. 3.

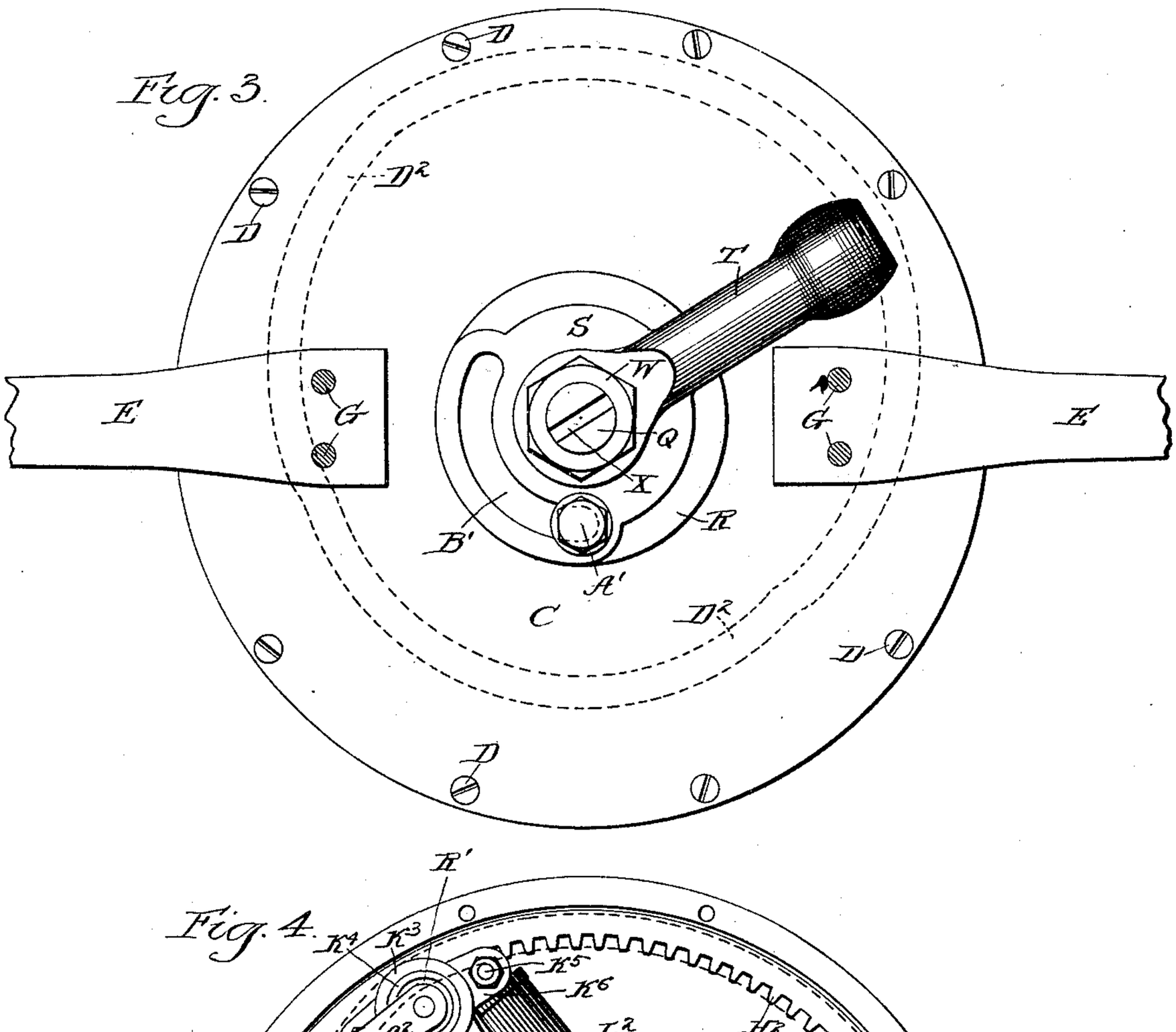

Fig. 4.

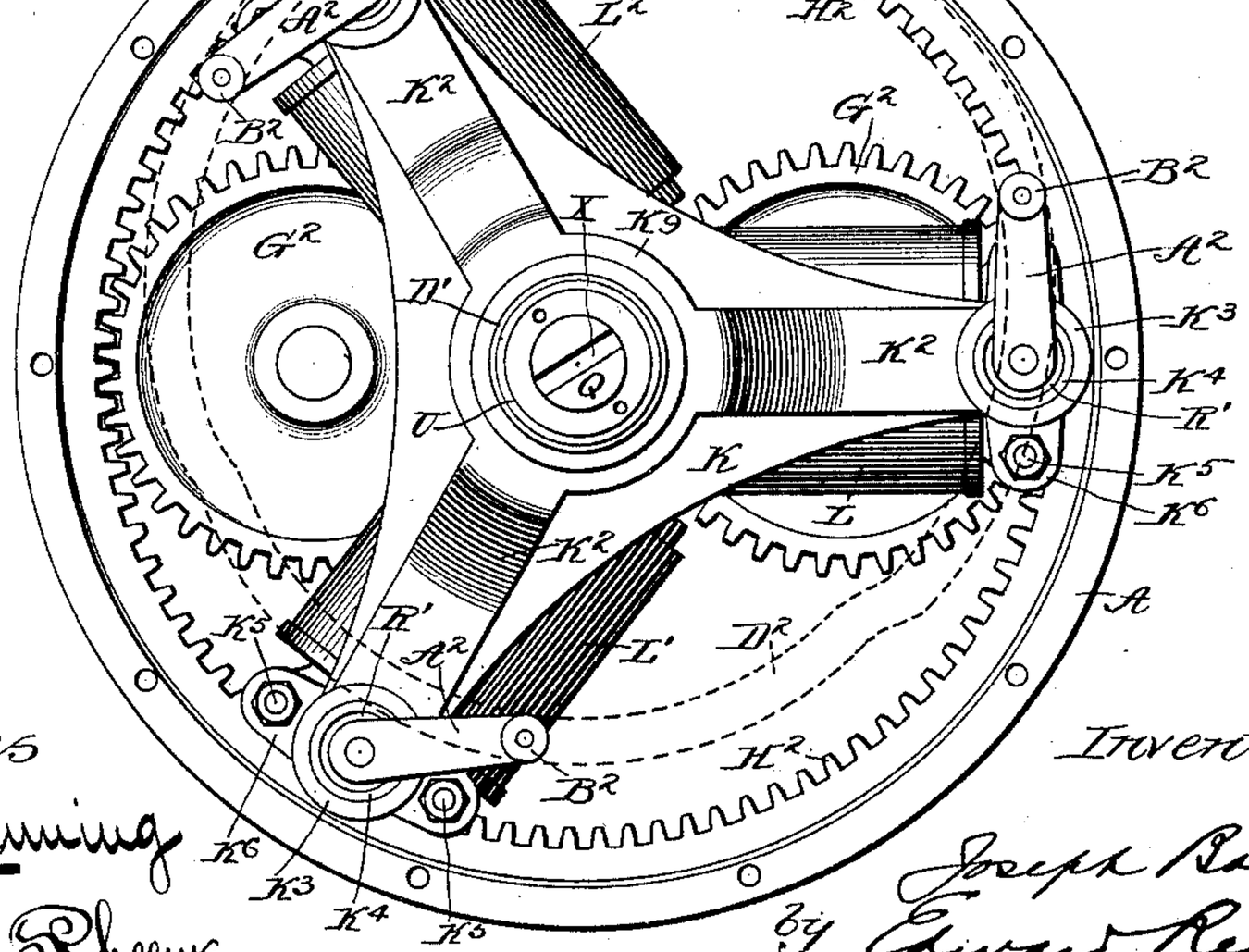

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Fig. 5.

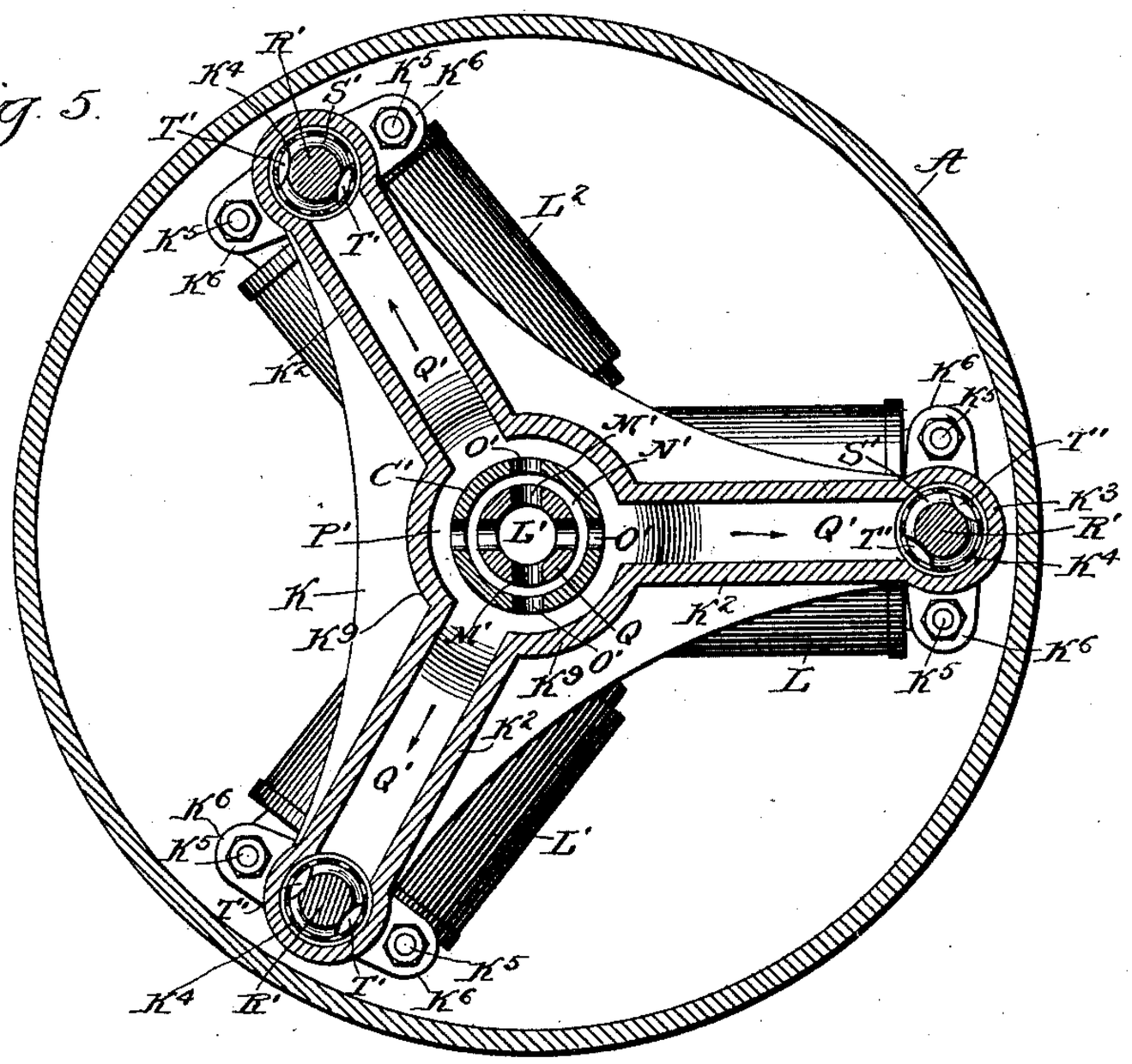
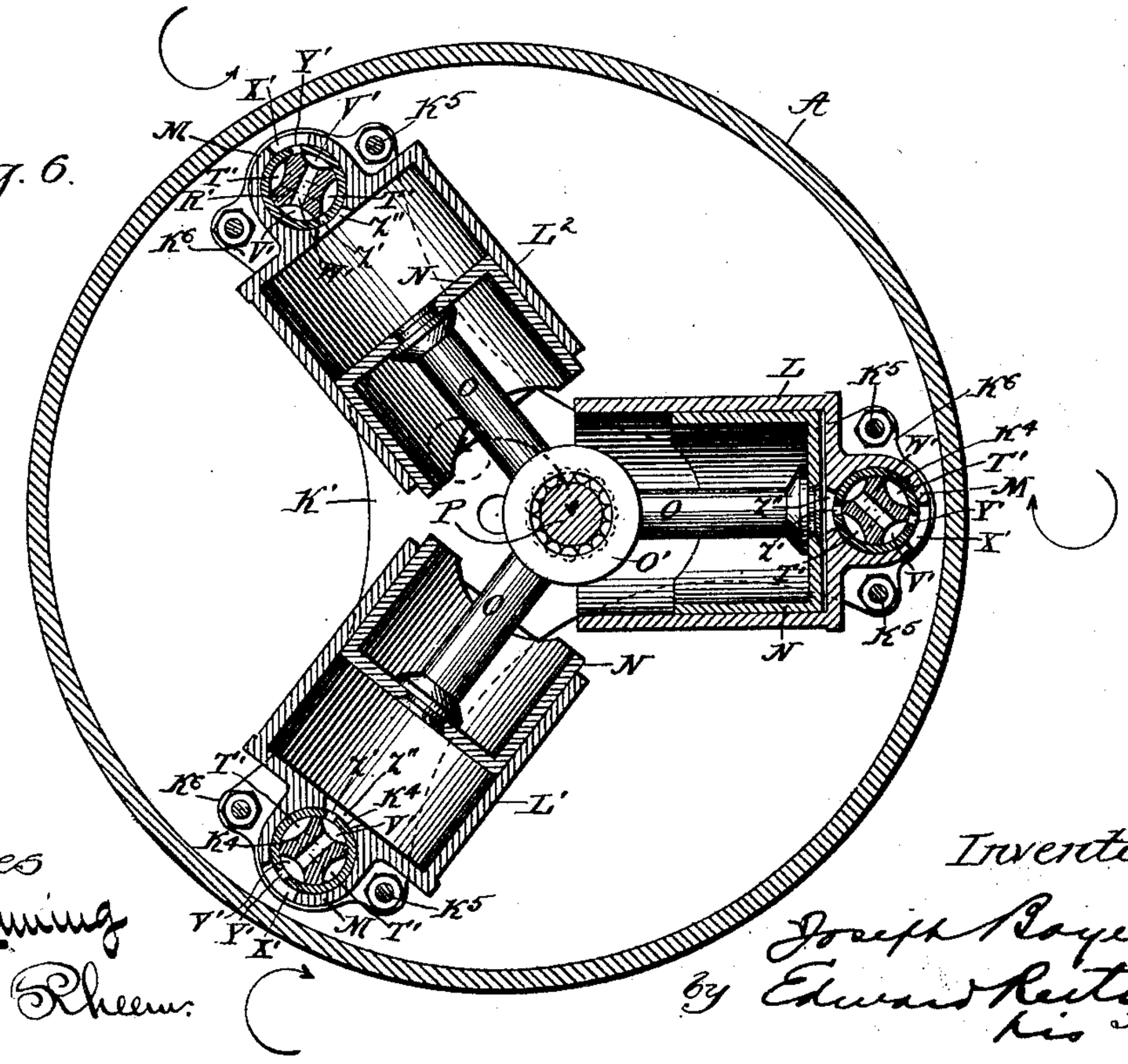


Fig. 6.



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(No Model.) 5 Sheets—Sheet 5.

Fig. 7

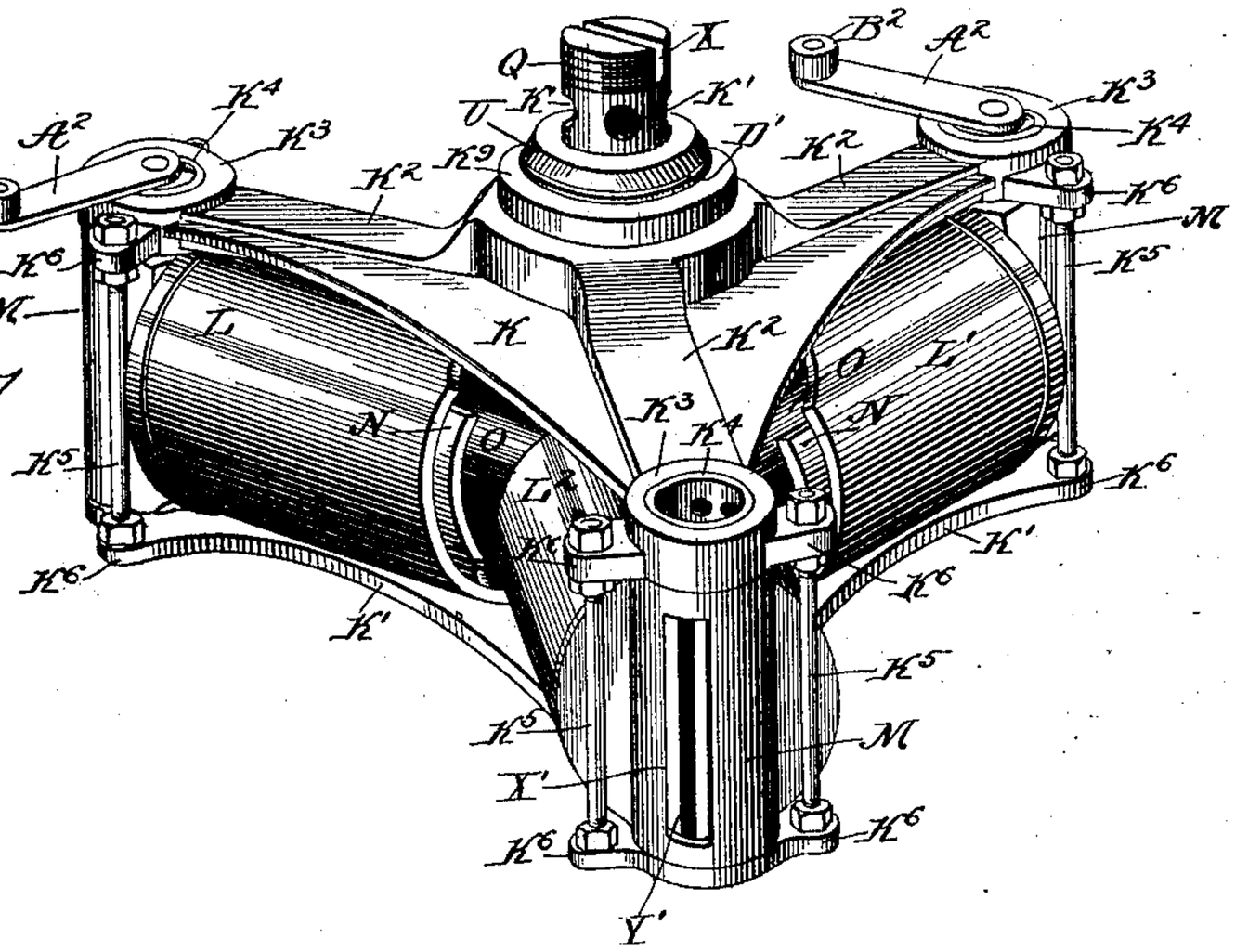


Fig. 8.

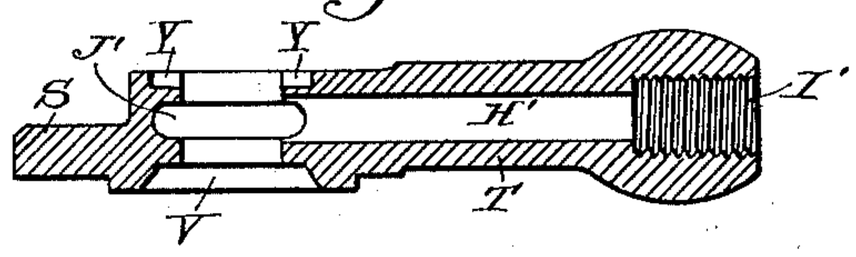


Fig. 9.

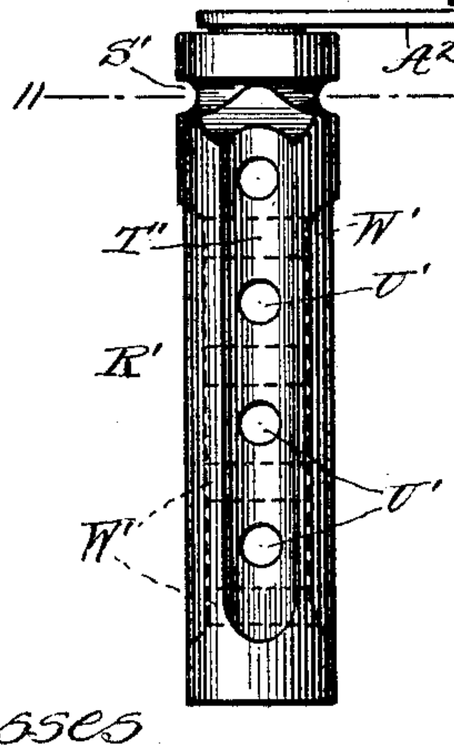


Fig. 11.

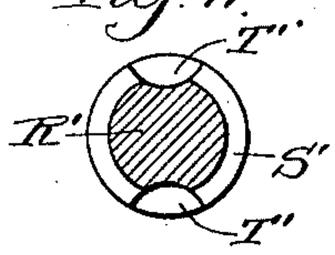


Fig. 12.

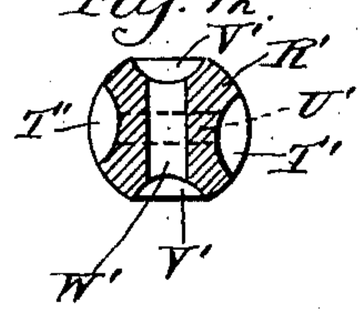
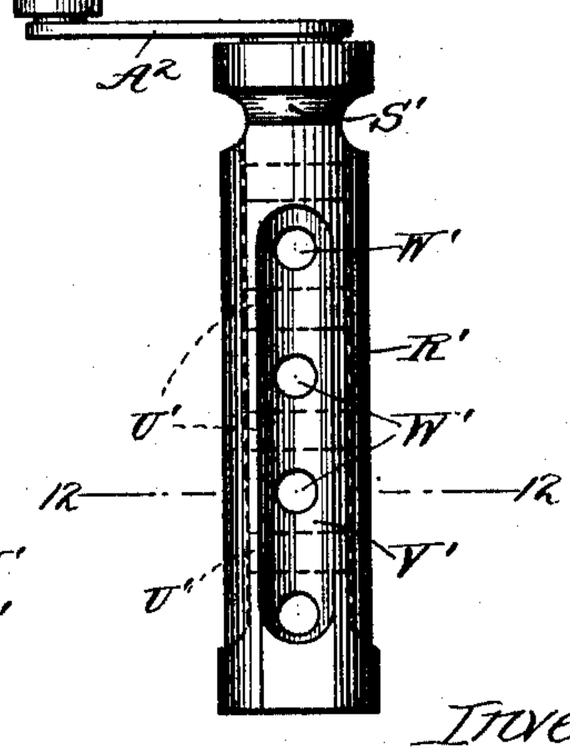


Fig. 10



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UNITED STATES PATENT OFFICE.

JOSEPH BOYER, OF ST. LOUIS, MISSOURI.

ENGINE.

SPECIFICATION forming part of Letters Patent No. 669,069, dated March 5, 1901.

Application filed May 4, 1898. Serial No. 679,696. (No model.)

To all whom it may concern:

Be it known that I, JOSEPH BOYER, a citizen of the United States, residing at the city of St. Louis, in the State of Missouri, have invented a certain new and useful Improvement in Engines, of which the following is a description, reference being had to the accompanying drawings, forming part of this specification.

My novel engine belongs to that class in which a rotary frame carries a plurality of cylinders whose piston-rods are connected to a fixed pivot or crank pin eccentric to the axis of the rotary frame, whereby the action of the motive fluid upon the cylinders and pistons causes the rotation of the frame carrying the cylinders. It has been designed, primarily, for use as the motor part of a rotary drill to be operated by compressed air and has been illustrated in the accompanying drawings as part of such a machine. It is applicable, however, to many other uses of an engine and embodies essential features of novelty as an engine, *per se*, so that my present invention relates both to the engine itself, for whatever use it may be applicable, and also to its combination with the other elements making up a rotary pneumatic drill.

It is the object of my invention to produce a small and compact light-running high-speed engine of maximum power in proportion to its size and weight and which shall be perfectly balanced and especially suitable for use as the motor of a light portable manually-handled rotary drill or for other purposes for which a small powerful high-speed engine is desirable. These results I accomplish in the manner and by the means to be now described by reference to the accompanying drawings, which illustrate one form and embodiment of the several features of my invention, and in which—

Figure 1 is an elevation of a rotary pneumatic drill embodying my invention with the outer ends of the handles broken away; Fig. 2, a transverse vertical section of the same; Fig. 2ª, an enlarged sectional detail from Fig. 2; Fig. 3, a top plan view with the yoke supporting the force-feeding device removed and the cam-groove upon the under side of the top plate of the casing shown in dotted lines; Fig. 4, a top plan view with the top plate of the casing and the parts carried by it removed, the cam-groove being shown in dotted lines, as in Fig. 3; Figs. 5 and 6, horizontal sections approximately on the lines 5 5 and 6 6 of Fig. 2, omitting from the view some of the parts below the cylinders; Fig. 7, a perspective view of the rotary frame and parts carried by it; Fig. 8, a sectional detail of the reversing-lever and inlet-tube; Fig. 9, an enlarged detail elevation of one of the valves, showing its inlet-ports; Fig. 10, a similar view showing its exhaust-ports; Fig. 11, a sectional detail on the line 11 11 of Fig. 9, and Fig. 12 a sectional detail on the line 12 12 of Fig. 10.

The same letters of reference are used to indicate corresponding parts in the several views.

In some respects the machine shown in the accompanying drawings resembles that heretofore patented to me by Letters Patent No. 590,511, dated September 21, 1897. One of the principal differences between the engine of my present invention and that shown and described in said patent relates to the inlet-passages for supplying the motive fluid to the cylinders and to the manner of operating the valves for controlling the admission of the motive fluid to and its exhaust from the cylinders, as will be apparent from the explanation hereinafter given.

The inclosing casing of the machine is shown in the present instance as consisting of a cylindrical body A, having an integral tubular extension B depending from the center of its under side and closed at its top by a removable circular plate or head C, suitably secured in place by screws D. Secured to the top plate C are the inner ends of laterally-projecting handles E E, whose outer grasping portions are broken away in the view shown in the drawings, and also a yoke F, whose opposite extremities rest upon the upper sides of the inner ends of the handles E E, the yoke and handles being secured to the top plate C by the screws G, Figs. 1, 2, and 3. The yoke F carries the force-feeding device, consisting of a spindle H, firmly secured at its lower end in the yoke F at the middle of the latter and exteriorly threaded to receive

a nut I, provided at its upper end with the usual centering-point J.

As in the machine of my patent above referred to the three oscillating cylinders of my present machine are mounted in a rotary frame having its support and bearing upon a fixed crank-shaft, to whose crank-pin or eccentric the rods of the several pistons are connected and about which as a center the rods and pistons revolve, while the center of rotation of the cylinders and rotary frame is the central axis of the machine. As shown more particularly in Figs. 4 to 7, the rotary frame carrying the cylinders consists of two three-armed plates or spiders K and K′, the upper one, K, of which has formed upon it radial ribs K^2, extending from its central hub or cap K^9 to the extremities of its several arms, within which ribs are formed ducts for the passage of the motive fluid to the valve-chambers at the outer ends of the arms. Each of the arms of the two frame-plates K K′ is provided at its outer end with a circular enlargement K^3, adapted to receive one end of a tubular valve casing K^4, Figs. 2, 5, 6, and 7. As seen in Fig. 2, the opposite ends of the tubular valve-casings K^4, which fit in the circular openings in the extremities of the arms of the frame-plates K and K′, are slightly reduced in diameter, forming shoulders, against which the faces of the frame-plates abut. These tubular valve-casings K^4 form rigid connecting-posts between the upper and lower plates K and K′ of the rotary frame, said plates being securely tied together upon the interposed tubular casings K^4 by bolts K^5 passing through ears K^6, projecting laterally from the extremities of the arms of the plates K and K′, Fig. 7, and provided with suitable nuts, as shown. The tubular valve-casings K^4 are provided with suitable inlet and exhaust ports controlled by valves located within the casings, as hereinafter described. They also constitute the fixed pivots upon which the three cylinders L, L′, and L^2 oscillate, the cylinder-head at the outer end of each of said cylinders being provided with an integral cylindrical sleeve M, surrounding and snugly fitting the corresponding valve-casing K^4, as shown more particularly in Figs. 2, 6, and 7.

Each of the three cylinders has fitted in it a cup-shaped piston N, having a rigid piston-rod O, provided at its inner end with a circular strap O′, surrounding the fixed crank-pin P, Figs. 2 and 6. Two of the three piston-rods are forked at their inner ends and provided with two straps O′, the straps of the several rods fitting between one another, as shown in Fig. 2 and as described in my former patent. The inner surfaces of the straps O′ are suitably grooved to receive antifriction-balls, which are interposed between them and the fixed crank-pin P to relieve the friction.

The fixed crank-pin P is formed integral with and eccentric to the lower end of a central shaft Q, which extends vertically through and is rigidly secured to the top plate C of the casing in the manner and by the means to be described.

The top plate C of the casing is provided with a large central circular opening, which is surrounded by a raised circular boss R, formed upon the upper surface of the plate C, Figs. 1, 2, and 3. Resting upon the upper surface of this boss is an approximately circular plate S, formed integral with the reversing-lever T and constituting the enlarged inner end of the latter, Figs. 1, 2, 3, and 8. The plate S is provided upon its under side with a circular boss, snugly fitting within the central circular opening in the plate C of the casing upon which the plate S rests, Figs. 2 and 2^a, thus forming a rigid bearing for the lever T and permitting it to be moved only axially about the center of the machine. The plate S is provided with a central vertical opening, through which extends the reduced upper end of the shaft Q. The shaft Q is exteriorly threaded immediately below the plate S and has screwed upon it a collar U, whose upper surface is suitably shaped to snugly fit within a recess V, formed in the under side of the plate S, Fig. 8. The extreme upper end of the shaft Q is also exteriorly threaded and has secured upon it a nut W, by means of which the plate S and lever T are secured to the shaft Q between the collar U and nut W. The upper end of the shaft Q is provided with a transverse slot or nick X, coincident with a like slot or recess Y, formed upon the upper surface of the inner end of the lever T, Fig. 8, and the lever and shaft are locked together by a key Z, fitting in these coincident slots and held in place by the nut W, Fig. 2. The lever T and plate S are rigidly and firmly, but adjustably, secured to the top plate C of the casing (upon the upper surface of its central boss R) by means of a clamping-screw A′, which passes through a curved slot B′ in the plate S and screws into a hole in the boss R. By slightly loosening this screw the lever T may be shifted until the opposite end of the slot B′ contacts with the screw A′, whereupon the tightening of the screw will again firmly clamp the plate S and lever T in fixed position. Inasmuch as the shaft Q is rigidly secured in and locked to the plate S of the lever T it follows that this shifting of the lever T from one position to the other will partially rotate the shaft Q, swinging its crank P a corresponding distance in the arc of a circle concentric to the axis of the shaft Q, as indicated by the dotted lines in Fig. 6, and thereby so oscillating the several cylinders upon their pivots (the valve-casings K^4) as will serve to reverse the direction of motion of the engine when the motive fluid is again admitted to it.

The upper plate K of the rotary frame is mounted upon the fixed shaft Q beneath the

plate S and collar U in the following manner: The shaft Q is surrounded by a sleeve C′, which snugly fits within the central circular opening in the plate K. Formed conjointly in the upper surface of the sleeve C′ and the surrounding central portion or hub of the plate K is an annular seat in which is fitted a ring D′, having its upper surface inwardly beveled to receive a circle of anti-friction-balls E′, which are confined between the ring D′, shaft Q, and under surface of the collar U. A similar annular seat is likewise formed conjointly in the lower surface of the sleeve C′ and surrounding central portion of the plate K, and in this lower seat is fitted a similar ring F′, between which and an L-shaped ring G′, surrounding the shaft Q and resting upon its enlarged lower end, are interposed a second series of balls H′. In this manner and by these means the plate K of the rotary frame is given a rigid bearing and support upon the fixed shaft Q and friction between the parts relieved by the interposed balls.

The supply of motive fluid is admitted to the machine through the reversing-lever T, whence it passes through a chamber formed in the fixed shaft Q, and thence to the radial ducts formed within the ribs K^2 upon the arms of the plate K and leading to the valve-chambers at the outer ends of said arms. To this end the lever T is provided with a longitudinal passage H^3, Fig. 8, whose outer end terminates in an interiorly-threaded opening I′ in the end of the lever T, adapted to receive the exteriorly-threaded nipple of a suitable hose-coupling and whose inner end communicates with an annular groove or recess J′, formed in the plate S of the lever around the shaft Q, Figs. 2 and 2^a. The latter is provided with a series of ports K′, coincident with the annular recess J′ and opening from the latter into the vertical chamber L′, formed in the shaft Q. The lower end of said chamber L′ communicates by a series of ports M′ with a coincident annular recess or chamber N′, formed in the sleeve C′, surrounding the shaft Q, Figs. 2, 2^a, and 5, and the annular chamber N′ communicates by ports O′ with an annular recess or chamber P′, formed in the hub or central portion K^9 of the plate K, from which chamber P′ the radial passages Q′, formed in the ribs K^2 on the frame K, lead to the valve-chambers at the outer ends of the cylinders, Fig. 5.

Under the above-described construction and arrangement of the parts it will be seen that the motive fluid admitted to the machine through the lever T has free passage at all times to the valve-chambers at the outer ends of the cylinders, and it will be next in order to describe the means by which the admission of the motive fluid to the cylinders and its exhaust therefrom are controlled. As shown in Figs. 2, 5, and 6, and more particularly in Figs. 9 and 10, the valves R′, fitting within the valve-casings K^4, consist of solid cylindrical members provided with certain exterior grooves and certain diametrical ports and passages. In the first place each valve is provided near its upper end with a circumferential groove S′, which groove forms an annular chamber surrounding the valve within its casing K^4. These circumferential grooves S′ are in the same horizontal plane as the radial motive-fluid passages Q′ in the top plate K of the rotary frame, and the valve-casing K^4 is provided with an exterior circumferential groove and a series of holes opening from its interior to said groove, so that the motive fluid from the supply-passage Q′ passes freely through the valve-casing into the annular chamber S′ around the valve, the chambers S′ being thus constantly filled with motive fluid whenever the latter is admitted to the machine. The cylindrical portion of the valve above the groove S′ snugly fits the interior of the valve-casing K^4, Fig. 2, and prevents escape of the motive fluid in an upward direction. Each valve is provided upon diametrically opposite sides with two longitudinal grooves T′, connected with each other by holes U′ through the valve. These grooves T′ open at their upper ends into the circumferential groove S′ at the upper end of the valve, but do not extend entirely to the lower end of the valve, so that their lower ends are closed by the cylindrical portion of the lower end of the valve, which fits snugly against the inner surface of the valve-casing. Owing to their communication with the circumferential groove S′ at their upper ends, these longitudinal grooves T′ of the valve are constantly filled with motive fluid while the latter is being admitted to the machine. Intermediate the two longitudinal grooves T′ and on diametrically opposite sides of the valve from each other are two longitudinal grooves V′, Figs. 2, 6, 10, and 12, connected by holes W′ through the valve. These grooves do not communicate at their upper ends with the circumferential groove S′ of the valve, but in the present instance (though not necessarily) extend entirely to the lower end of the valve or communicate with flattened portions of the valve at its lower end, so that the lower ends of these grooves are always open to the atmosphere or the space in the lower part of the casing of the machine beneath the lower plate K′ of the rotary frame. They also communicate with exhaust-ports in the valve-casings K^4, hereinafter described. The grooves T′ may be termed the "inlet" or "admission" chambers of the valves and the grooves V′ the "exhaust-chambers" thereof.

As seen in Figs. 6 and 7, the sleeves M of the cylinder-heads are provided upon their outer sides with wide vertical slots X′, which coincide and constantly communicate with narrower vertical slots Y′, formed in the outer sides of the valve-casings K^4. These slots constitute exhaust-ports. At its opposite sides each of the valve-casings is provided with a like vertical slot Z′, which coincides

with and is in constant communication with a wider vertical slot Z″, formed in the cylinder-head. These two slots Z′ Z″ constitute both inlet and exhaust ports controlled by the valve and through which the motive fluid is admitted to and exhausted from the outer ends of the cylinders behind the pistons N.

Referring now more particularly to Fig. 6, and assuming that (by means hereinafter described) the respective valves are turning in the directions indicated by the arrows, their operation in admitting and exhausting the motive fluid may be explained as follows: Bearing in mind the fact that the grooves T′ of the valves are constantly filled with motive fluid from the source of supply while the grooves V′ open to the exhaust, it will be seen that the valve of the right-hand cylinder L in Fig. 6 is just about to open the inlet-port Z′ of the valve-casing K^4, and thereby place the groove T′ in communication through said port and the coincident port Z″ in the cylinder-head with the interior of the cylinder to thereby admit motive fluid behind the piston N. The valve of the cylinder L^2 in said view is closing the inlet-port Z′ and cutting off the motive fluid from the cylinder, while the valve of the cylinder L′ in said view has entirely cut off such supply and opened the exhaust from the cylinder through the ports Z″ Z′, grooves V′, holes W′, and slots Y′ X′, so that the cylinder L′ is free to move inward upon its piston N. As shown in Fig. 6, therefore, the rotary frame and cylinders are turning in the direction of the arrow from right to left, the cylinders begin to receive the motive fluid behind their pistons as they reach the position of the cylinder L in said view, and it acts upon them with its full force as they pass to the position of the cylinder L^2 in said view. As they pass onward to the position of the cylinder L′ the motive fluid is cut off and the exhaust opened, and as they pass onward from the position of the cylinder L′ to the position of the cylinder L again the exhaust is closed and the inlet-port opened. If the machine be stopped and the reversing-lever shifted to its opposite position, the crank-pin P will be shifted to the position indicated by the dotted lines, and upon then admitting motive fluid to the machine again the direction of motion will be reversed.

It will be understood that the principal reason for providing each valve with duplicate grooves T′, connected by the ports U′, is to balance them as nearly as possible within the valve-casings and that the operation of the valves would remain substantially the same if the valves were provided with but a single set of grooves T′. The provision of the duplicate sets of grooves also facilitates the admission of the motive fluid.

The means for turning the valves in their casings to control the inlet and exhaust of the motive fluid consists of crank-arms A^2, rigidly secured to the upper ends of the valves R′, Figs. 4, 7, 9, and 10, and provided at their extremities with studs surrounded by anti-friction-rollers B^2, which fit and travel in a cam-groove D^2, formed upon the under side of the top plate C of the casing. The shape of this groove is such, as indicated by the dotted lines in Figs. 3 and 4, as to properly oscillate the valves to control the admission and exhaust of the motive fluid.

The foregoing completes the description of the engine of my machine, and it remains now to describe the means by which the power of the engine is employed to drive the rotary drill of the machine shown in the drawings. Extending vertically through the depending tubular extension B of the casing is a spindle E^2, which has formed integral with its upper end a cross-head F^2, upon whose opposite ends are mounted two gear-wheels G^2, which mesh with the teeth of a fixed internal gear or rack H^2, secured in the casing A, Figs. 2 and 4. The bottom plate K′ of the rotary frame is provided with a central depending spindle I^2, upon which is formed or secured a pinion J^2, Fig. 2, which is located immediately between and meshes with both of the gears G^2, carried by the cross-head F^2 of the spindle E^2. The movement of the rotary frame is thus transmitted, through the medium of the pinion J^2, gears G^2, and fixed rack H^2, to the cross-head F^2 and spindle E^2 at a reduced rate of speed and with increased power, and the spindle E^2 carries at its lower end the chuck K^8, which receives the working tool. To relieve the friction, ball-bearings are interposed between the spindle E^2 and the casing of the machine at the points L^2 and M^2, Fig. 2, which will be understood without further explanation. These bearings support the spindle E^2 in the casing A, and the end thrust of the machine, under the action of the force-feeding device at its upper end, is borne by the lower bearings at M^2.

For the purpose of forming a supplemental guide and lateral support for the rotary frame the extreme lower end of the spindle I^2, which carries the pinion J^2, is given a bearing at N^2 in the rotary cross-head F^2, the arrangement of the bearing and the balls employed to relieve the friction being clearly shown in Fig. 2 and requiring no description.

Having thus fully described my invention, I claim—

1. In an engine, the combination of a rotary frame, a plurality of cylinders carried thereby and having their piston-rods connected to a fixed pivot eccentric to the axis of the frame, and cam-operated valves at the outer ends of said cylinders for controlling the admission and exhaust of the motive fluid to and from the outer ends of the cylinders behind their pistons.

2. In an engine, the combination of a rotary frame, a plurality of cylinders pivotally mounted thereon and having their piston-rods connected to a fixed pivot eccentric to the axis of the frame, and cam-operated valves coincident with the pivotal axes of the

cylinders for controlling the admission and exhaust of the motive fluid to and from the cylinders through their pivotal supports.

3. In an engine, the combination of a rotary frame, a plurality of tubular valve-casings fixed therein, a plurality of cylinders mounted upon said valve-casings as pivots and having their piston-rods connected to a fixed pivot eccentric to the axis of the frame, and valves located in the valve-casings and movable therein to control inlet and exhaust ports communicating with the cylinders and with the atmosphere.

4. In an engine, the combination of a rotary frame, a plurality of tubular valve-casings fixed therein, a plurality of cylinders mounted at their outer ends upon said valve-casings as pivots and having their piston-rods connected to a fixed eccentric or crank-pin, and a plurality of valves located in the respective valve-casings and operated by a cam to control inlet and exhaust ports communicating with the cylinders and with the atmosphere.

5. In an engine, the combination of a rotary frame, a plurality of tubular valve-casings fixed in said frame, a plurality of cylinders having heads at their outer ends provided with sleeves surrounding and fitting said valve-casings and having their piston-rods connected to a fixed eccentric or crank-pin, inlet and exhaust ports in said valve-casings and sleeves, and valves in said valve-casings for controlling said ports.

6. In an engine, the combination of a rotary frame, a plurality of tubular valve-casings fixed in said frame, a plurality of cylinders having heads at their outer ends provided with sleeves surrounding and fitting said valve-casings and having their piston-rods connected to a fixed eccentric or crank-pin, inlet and exhaust ports in said valve-casings and sleeves, and valves in said valve-casings operated by a cam to control said ports.

7. In an engine, the combination of a rotary frame, a plurality of tubular valve-casings fixed therein, a plurality of cylinders mounted thereon as pivots and having their piston-rods connected to a fixed eccentric or crank-pin, and valves located in the respective valve-casings and provided with crank-arms coöperating with a cam-groove in the casing to operate said valves and control the inlet and exhaust of the motive fluid to and from the cylinders.

8. In an engine, the combination of a rotary frame, a plurality of tubular valve-casings fixed in said frame, a plurality of cylinders having heads at their outer ends provided with sleeves surrounding and fitting said valve-casings and having their piston-rods connected to a fixed eccentric or crank-pin, and valves located in the respective valve-casings and provided with crank-arms coöperating with a cam-groove in the casing to operate said valves and control the inlet and exhaust of the motive fluid to and from the cylinders.

9. In an engine, the combination of the rotary frame K K′, the tubular valve-casings K^4 fixed at their opposite ends in the rotary frame and provided with the longitudinal ports Y′ Z′, the cylinders having heads provided with the sleeves M surrounding the valve-casings K^4 and provided with the longitudinal ports X′ Z″ coöperating respectively with the ports Y′ and Z′ in the valve-casings K^4, the valves R′ located in the valve-casings K^4 and having the inlet grooves or passages T′ and the exhaust grooves or passages V′, and means for turning the valves R′ in their casings K^4 to control the respective ports.

10. In an engine, the combination of the rotary frame K K′, the tubular valve-casings K^4 fixed at their opposite ends in the rotary frame and provided with the longitudinal ports Y′ Z′, the cylinders having heads provided with the sleeves M surrounding the valve-casings K^4 and provided with the longitudinal ports X′ and Z″ coöperating respectively with the ports Y′ and Z′ in the valve-casings K^4, the valves R′ located in the valve-casings K^4 and each having the two diametrically opposite inlet grooves or passages T′ connected by the ports U′, and the two diametrically opposite exhaust grooves or passages V′ connected by the ports W′, and means for turning the valves in their casings to control the respective inlet and exhaust ports.

11. In an engine, the combination of the rotary frame K K′, the tubular valve-casings K^4 fixed therein, the cylinders having the sleeves M surrounding and fitting the casings K^4, and the valves R′ located in the casings K^4 and having fast to their ends the crank-arms A^2 carrying the antifriction-rollers B^2 traveling in the cam-groove D^2 in the plate C of the casing.

12. In an engine, the combination of a fixed crank-shaft provided with an inlet-passage for the motive fluid, a rotary frame mounted upon said shaft, radial passages in said frame communicating at their inner ends with the passages in the crank-shaft, valve-casings fixed in the rotary frame at the outer ends of said radial passages, cylinders mounted at their outer ends upon said valve-casings and having their piston-rods connected to the fixed eccentric of the crank-shaft, valves located in the valve-casings for controlling the admission of the motive fluid from the radial passages in the rotary frame to the outer ends of the cylinders and its exhaust therefrom, and means for turning the valves in their valve-casings to effect such control.

13. In an engine, the combination of a fixed crank-shaft provided with an inlet-passage for the motive fluid, a rotary frame mounted upon said shaft, radial passages in said frame communicating at their inner ends with the passage in the crank-shaft, valve-casings fixed in the rotary frame at the outer ends of said radial passages, cylinders mounted at their outer ends upon said valve-casings and

having their piston-rods connected to the fixed eccentric of the crank-shaft, and valves located in the valve-casings and operated by a cam for controlling the admission of the motive fluid from the radial passages in the rotary frame to the outer ends of the cylinders and its exhaust therefrom.

14. In an engine, the combination of a fixed crank-shaft provided with an inlet-passage for the motive fluid, a rotary frame mounted upon said shaft, radial passages in said frame communicating at their inner ends with the passage in the crank-shaft, valve-casings fixed in the rotary frame at the outer ends of said radial passages, cylinders mounted at their outer ends upon said valve-casings and having the inner ends of their piston-rods connected to the fixed eccentric of the crank-shaft, valves located in the valve-casings for controlling the admission of the motive fluid from the radial passages in the rotary frame to the outer ends of the cylinders and its exhaust therefrom, and crank-arms projecting from the ends of said valves and carrying antifriction-rollers traveling in a cam-groove in the casing.

15. In an engine, the combination of the fixed crank-shaft Q having an inlet-passage through it, the rotary frame K K′ mounted upon said shaft and provided with radial passages Q′ communicating at their inner ends with the inlet-passage in the shaft Q, the valve-casings K^4 fixed in the rotary frame at the outer ends of the passages Q′, the cylinders having the heads at their outer ends provided with the sleeves M surrounding and fitting the valve-casings K^4, and having the inner ends of their piston-rods O connected to the fixed eccentric P of the crank-shaft Q, the valves R′ located in the valve-casings K^4 and controlling the communication between the radial passages Q′ and the interior of the cylinders, and between the latter and the exhaust, and means for oscillating the valves in their casings.

16. In an engine, the combination of the fixed crank-shaft Q having the inlet-passage through it, the rotary frame K K′ mounted upon said shaft and provided with the radial passages Q′ communicating at their inner ends with the passage in the shaft Q, the ball-bearings E′ H′ interposed between the rotary frame and the shaft Q, the valve-casings K^4 fixed in the rotary frame at the outer ends of the passages Q′, the cylinders provided at their outer ends with the sleeves M surrounding and fitting the valve-casings K^4, and having the inner ends of their piston-rods O provided with the straps O′ surrounding the eccentric P of the crank-shaft Q, the ball-bearings interposed between said straps and eccentric, and the cam-operated valves R′ located in the valve-casings K^4 and controlling communication between the passages Q′ and interior of the cylinders and between the latter and the exhaust.

17. In an engine such as described, the combination of the fixed crank-shaft Q provided with an inlet-passage for the motive fluid, the rotary frame-plate K mounted upon said shaft and provided with the radial passages Q′, the sleeve C′ interposed between the hub of the plate K and the shaft Q, the beveled rings D′ F′ seated partly in the opposite ends of the sleeve C′ and partly in the hub of the frame-plate K, the rings or collars U and G′ surrounding the shaft Q, the circles of balls E′ H′ interposed between the rings D′ and U, and F′ and G′, respectively, and suitable ports in the shaft Q and sleeve C′ for connecting the inlet-passage of the shaft with the radial passages Q′ in the frame-plate K.

18. In an engine of the character described, the combination, with the plate C of the casing having the central opening, of the reversing-lever T having at its inner end the plate S seated upon the plate C above the central opening in the latter and capable of being turned upon the same, the crank-shaft Q fixed in and depending from the plate S, the rotary frame mounted upon the shaft Q, the cylinders mounted in said frame and having their piston-rods connected to the eccentric P of the shaft Q, and means for securing the plate S in different positions upon the plate C when the same is shifted by the reversing-lever T.

19. In an engine of the character described, the combination, with the plate C of the casing having a central opening, the reversing-lever T provided at its inner end with the plate S seated upon the plate C above its central opening and provided with the curved slot B′, the clamping-screw A′ passed through the slot B′ and screwed into the plate C, the crank-shaft Q fixed in and depending from the plate S, the rotary frame mounted on said shaft, and the cylinders mounted in said frame and having their piston-rods connected to the eccentric P of the shaft Q.

20. In an engine such as described, the combination, with the plate C of the casing having the central opening, of the reversing-lever T provided at its inner end with the plate S seated upon the plate C above the central opening in the latter and having the curved slot B′, the clamping-screw A′ passing through the slot B′ and screwed into the plate C, the crank-shaft Q extending vertically through the central opening in the plate C and through a central opening in the plate S, the key Z seated in a transverse slot in the upper end of the shaft Q and in coincident recesses in the upper surface of the plate S, the nut W screwed upon the upper end of the shaft Q, the rotary

frame-plate K mounted upon the shaft Q beneath the plate C, the sleeve C′ surrounding the shaft Q within the hub of the plate K, the beveled ring D′ seated partly in the upper end of the sleeve C′ and partly in the upper end of the hub of the plate K, the ring U screwed upon the shaft Q and seated in a recess in the under side of the plate S, the circle of balls E′ interposed between the rings U and D′, the ring F′ seated partly in the lower end of the sleeve C′ and partly in the lower end of the hub of the plate K, the L-shaped ring G′ seated on the shaft Q below the ring F′, and the circle of balls H′ interposed between the rings F′ and G′, the reversing-lever T being provided with an inlet-passage H′ communicating with the radial passages Q′ in the plate K through the annular chamber J′ in the plate S, ports K′ M′ and chamber L′ in the shaft Q, and ports O′ in the sleeve C′.

21. In an engine such as described, the combination of the rotary frame composed of the plates K K′, the former having the radial passages Q′, the tubular valve-casings K⁴ fixed at their opposite ends in the plates K K′ and having the longitudinal ports Y′ Z′, the valves R′ located in the casings K⁴ and provided at their outer ends with the annular grooves S′ communicating with the radial passages Q′, and with the longitudinal grooves T′ communicating at their upper ends with the annular grooves S′, and with the longitudinal grooves V′ not communicating with the annular grooves S′, and means for turning the valves R′ to bring their grooves T′ V′ alternately into register with the ports Z′ in the valve-casings K⁴.

22. In an engine, the combination of a frame, a plurality of tubular valve-casings therein, a plurality of cylinders, mounted upon said valve-casings as pivots, valves located in said valve-casings, and means for moving said valves to control inlet and exhaust ports communicating with the cylinders and with the atmosphere.

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Witnesses:
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