No. 720,818. PATENTED FEB. 17, 1903.

M. E. KNIGHT.

ROTARY ENGINE.

APPLICATION FILED JUNE 16, 1902.

NO MODEL. 5 SHEETS—SHEET 1.

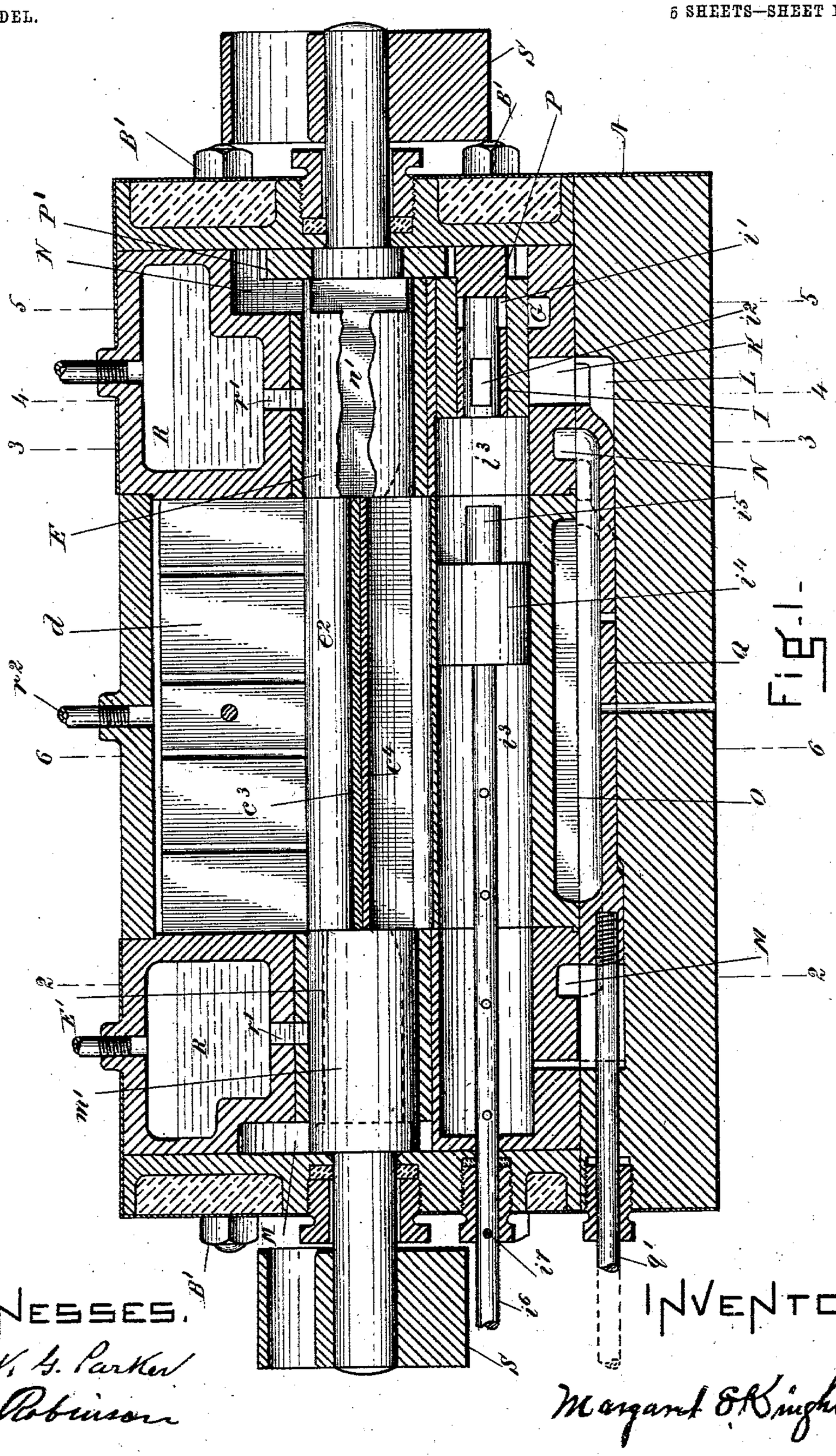

Fig. 1.

WITNESSES.

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NO MODEL. 5 SHEETS—SHEET 2.

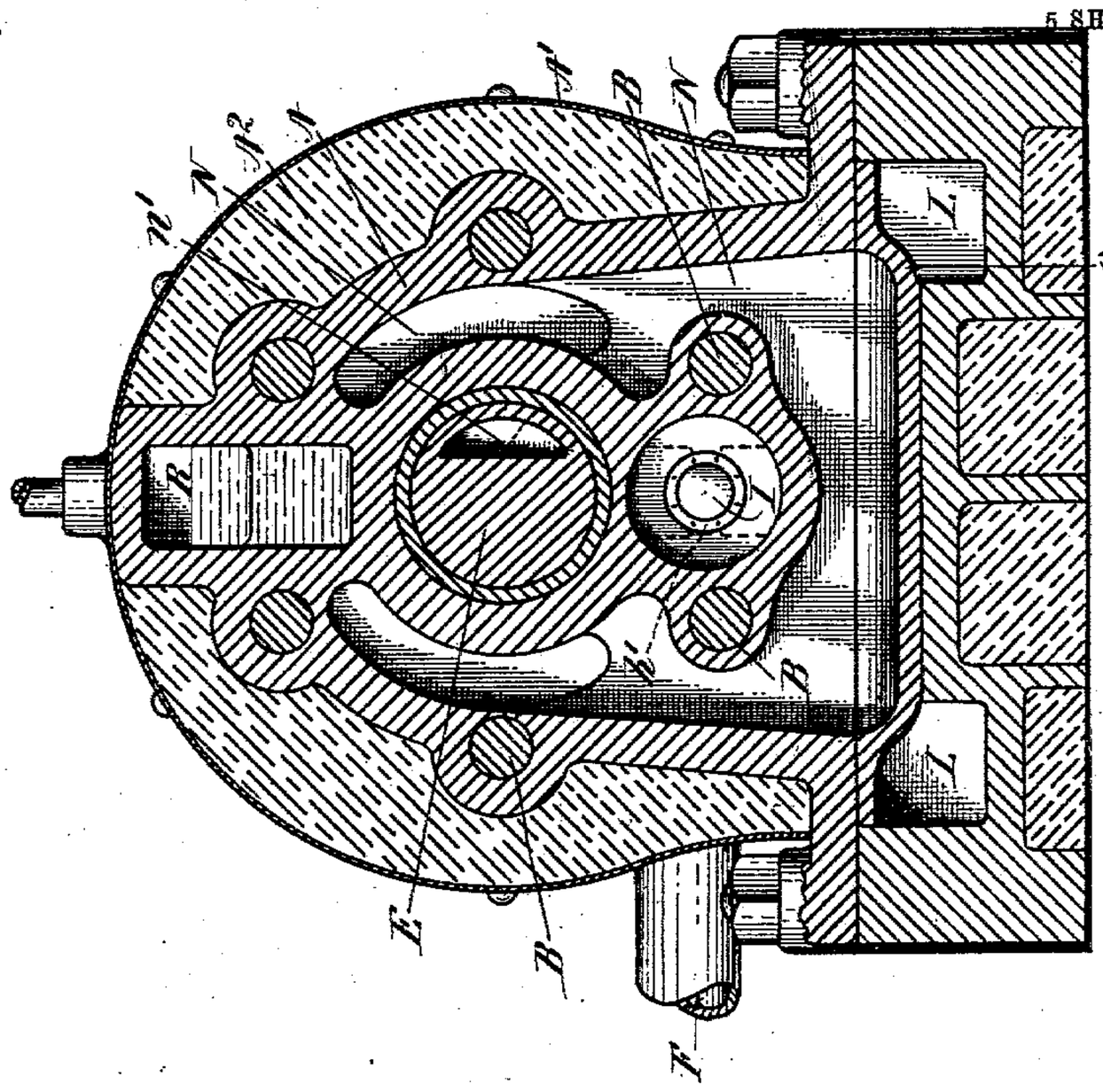

Fig. 3.

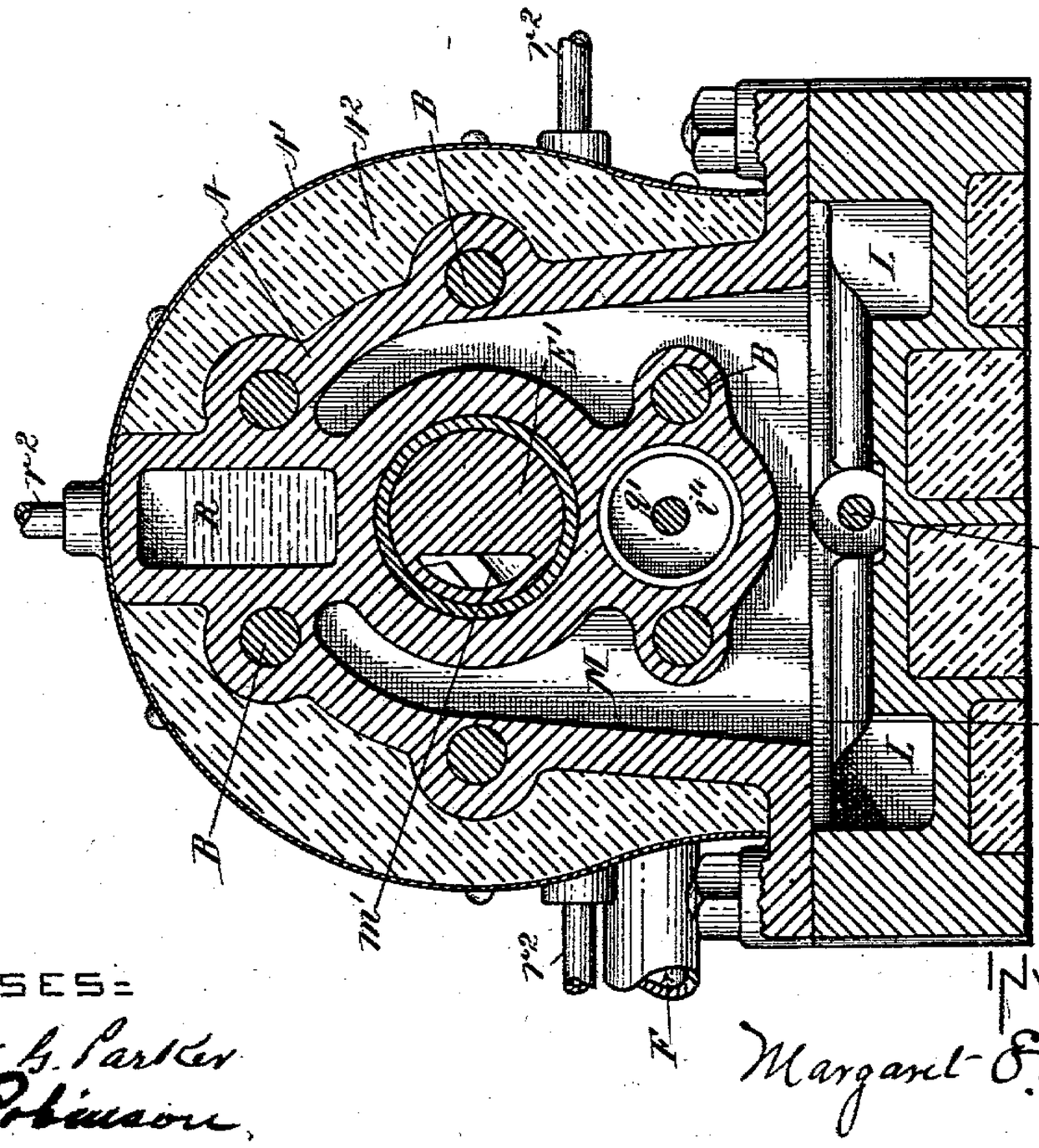

Fig. 2.

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NO MODEL. 5 SHEETS—SHEET 3.

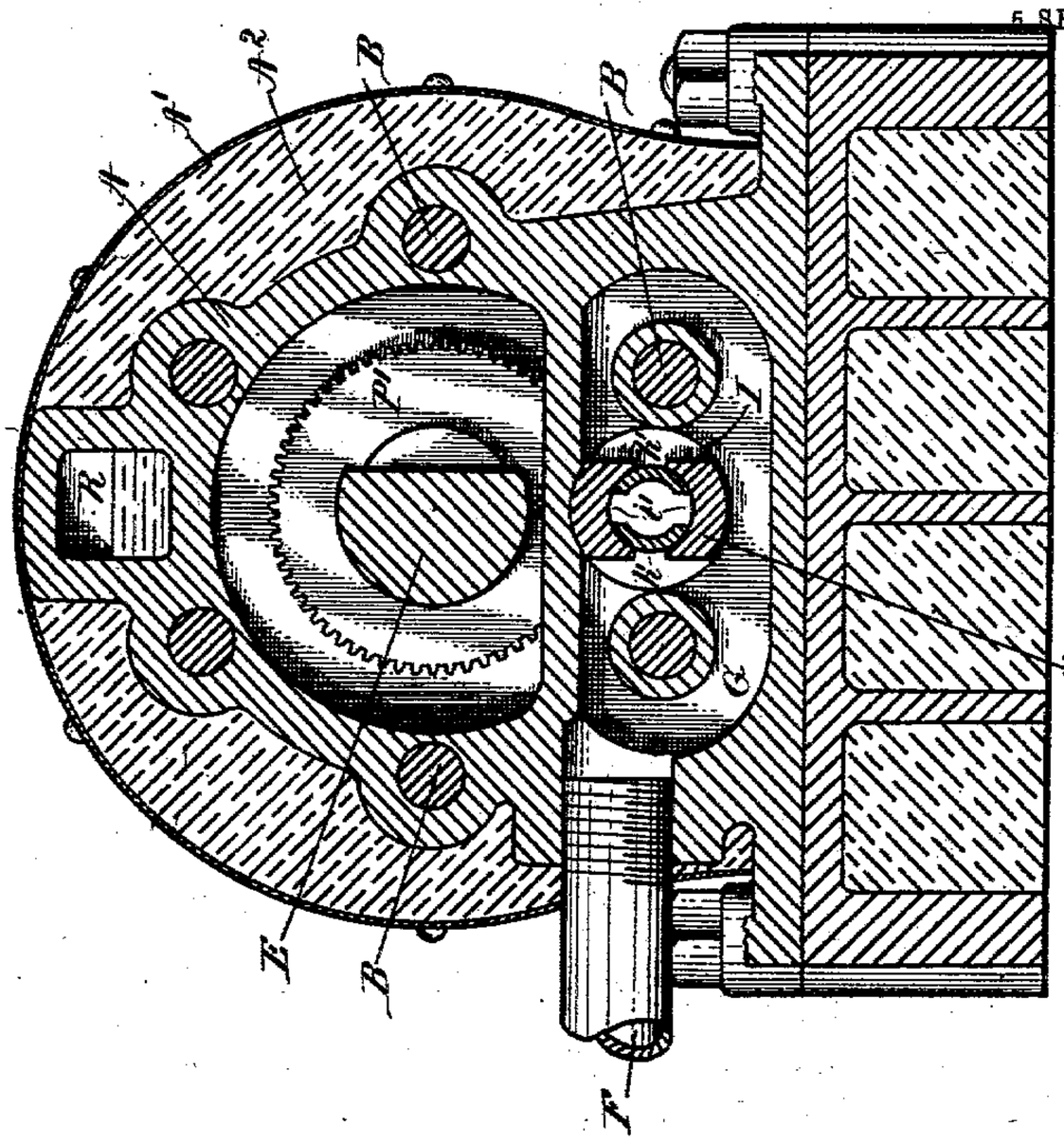

FIG. 5.

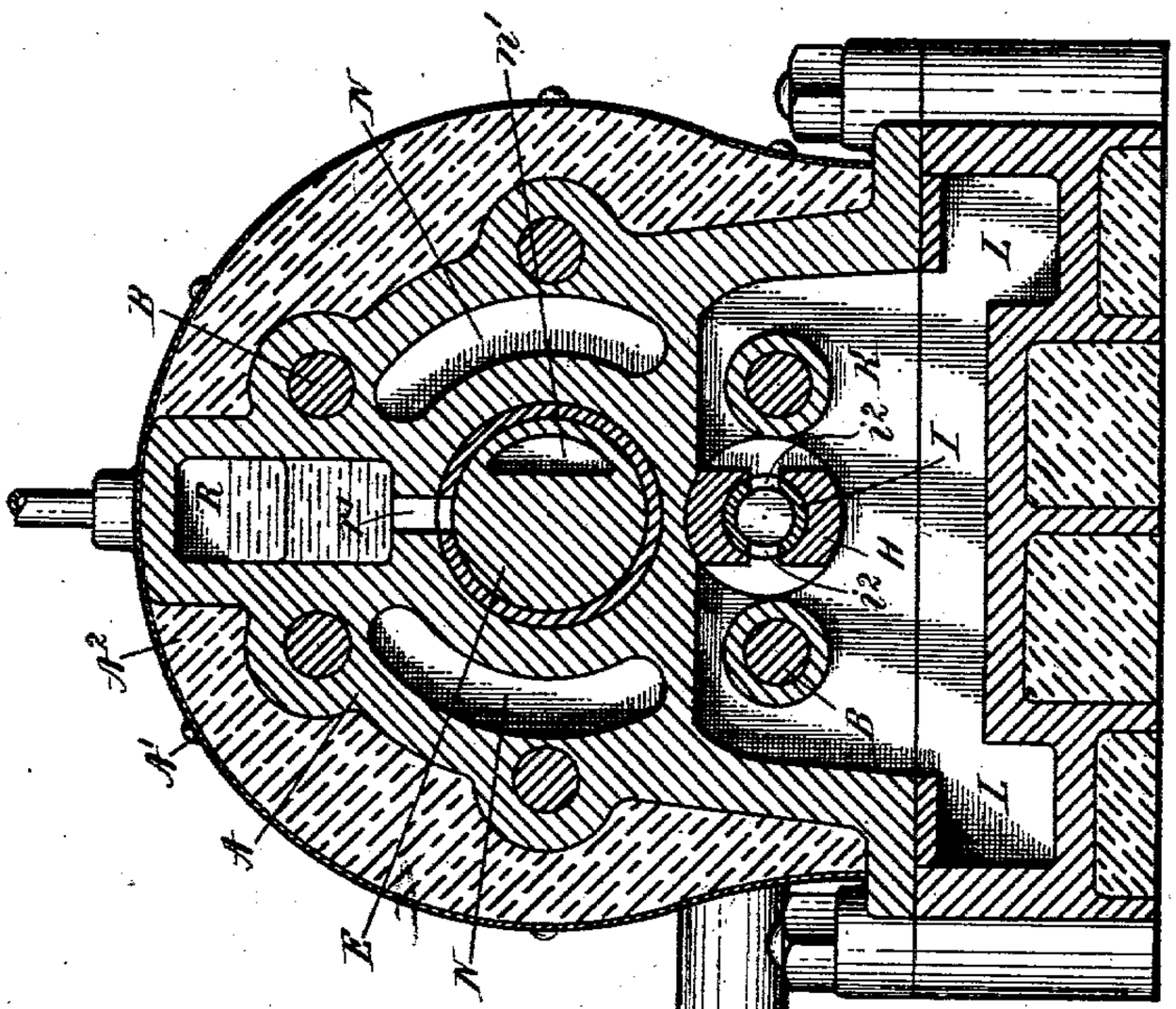

FIG. 4.

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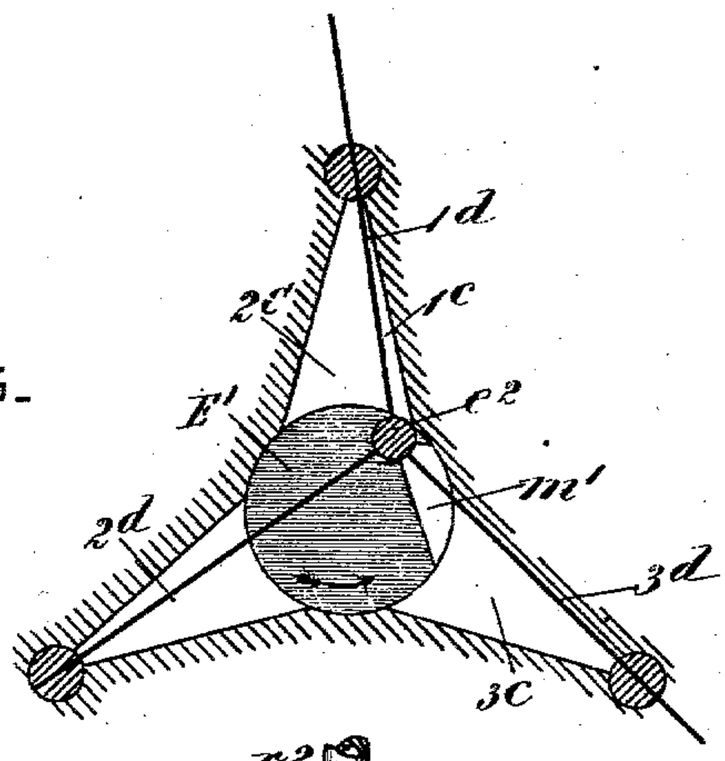
NO MODEL. 5 SHEETS—SHEET 4.

Fig. 13.



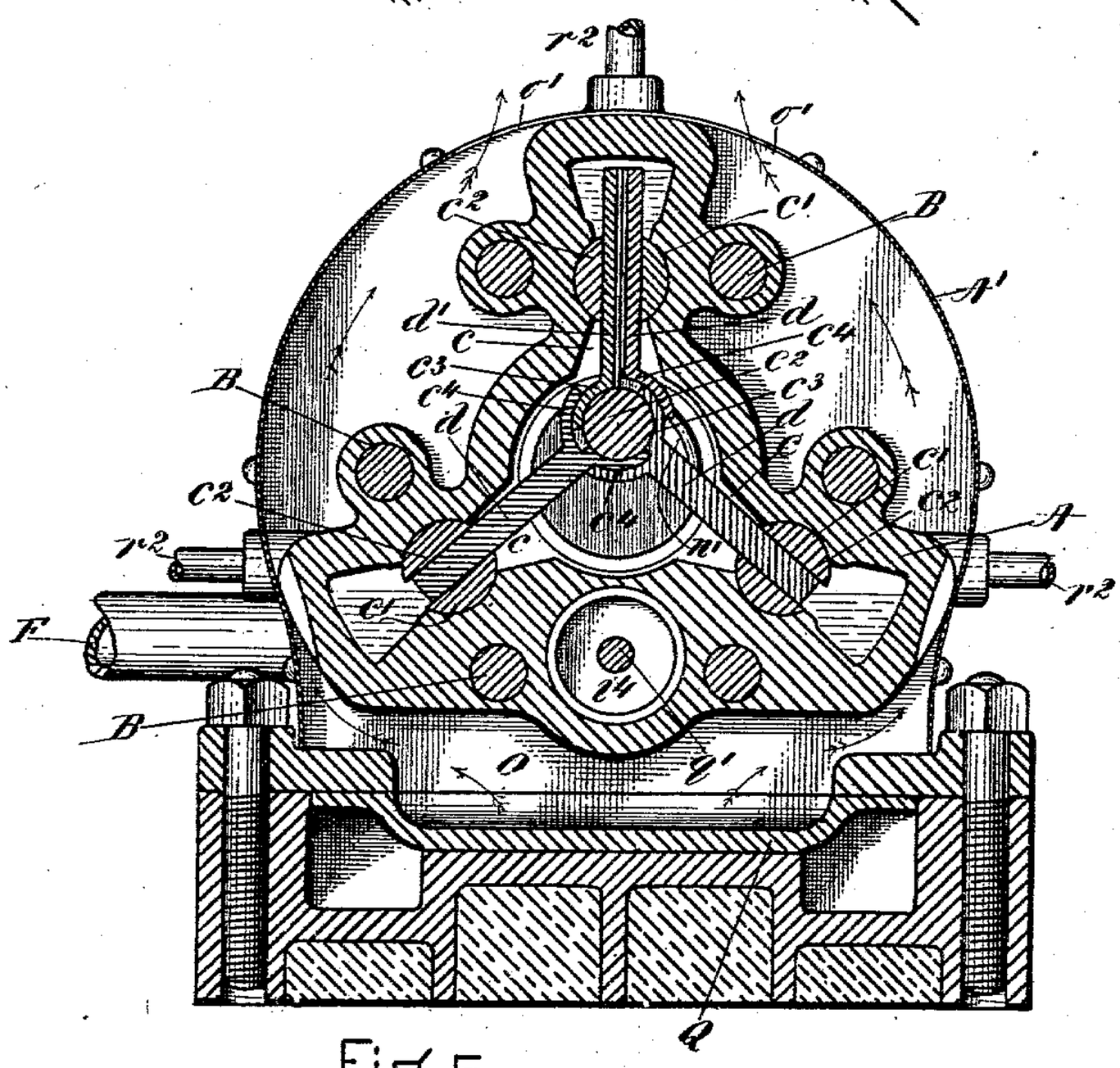


Fig. 6.

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NO MODEL. 6 SHEETS—SHEET 5.

Fig. 7.

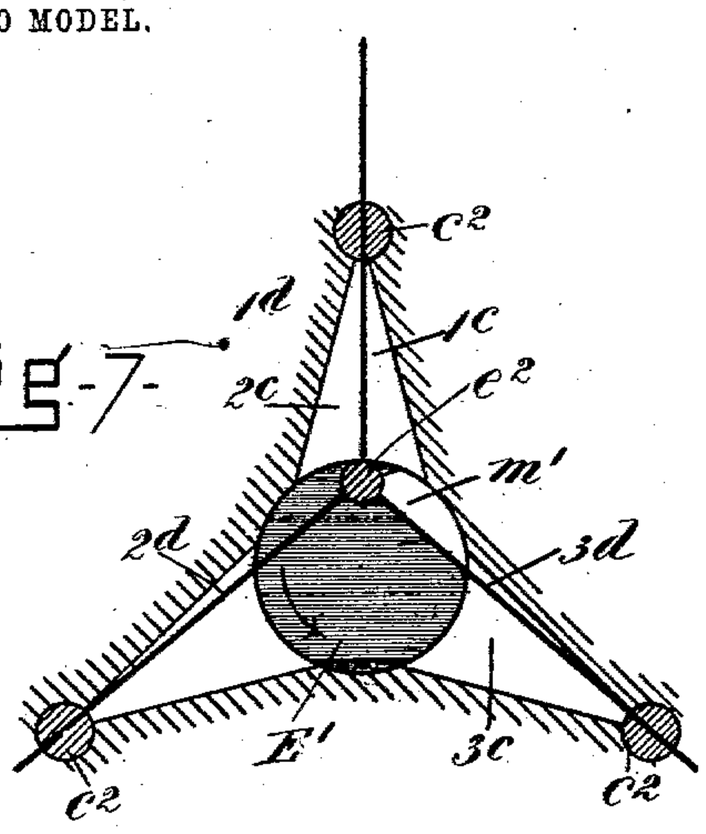


Fig. 8.

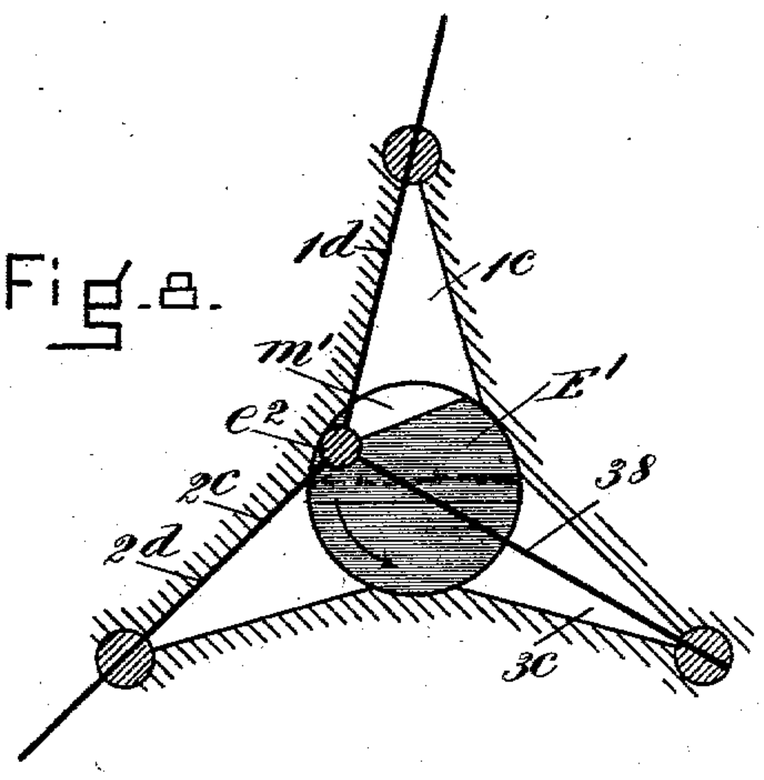


Fig. 9.

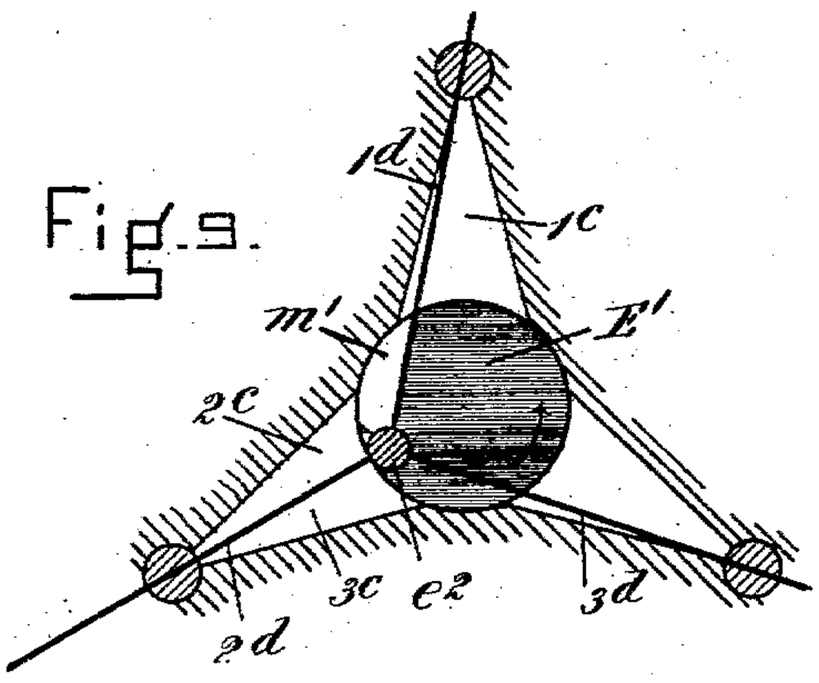


Fig. 10.

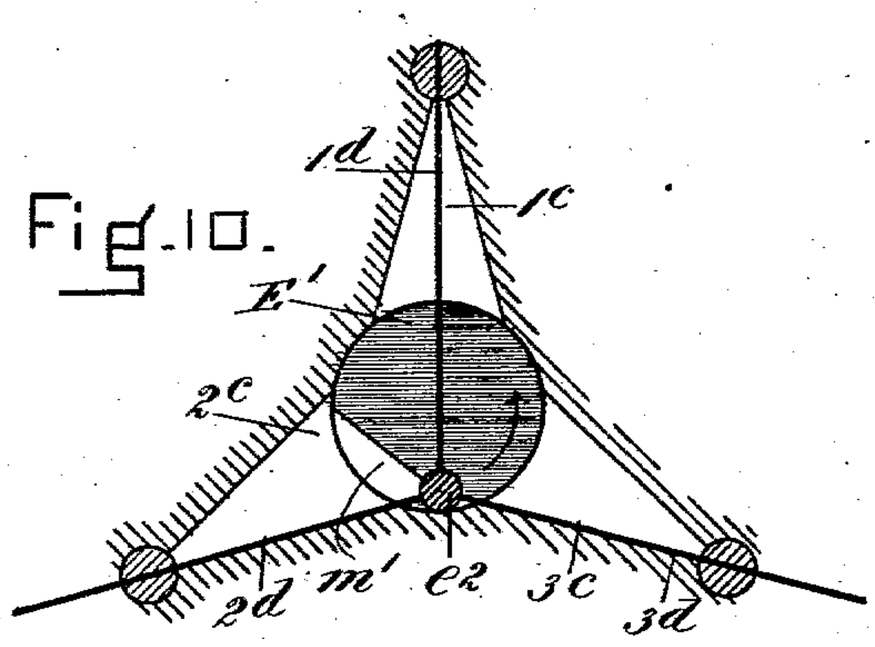


Fig. 11.

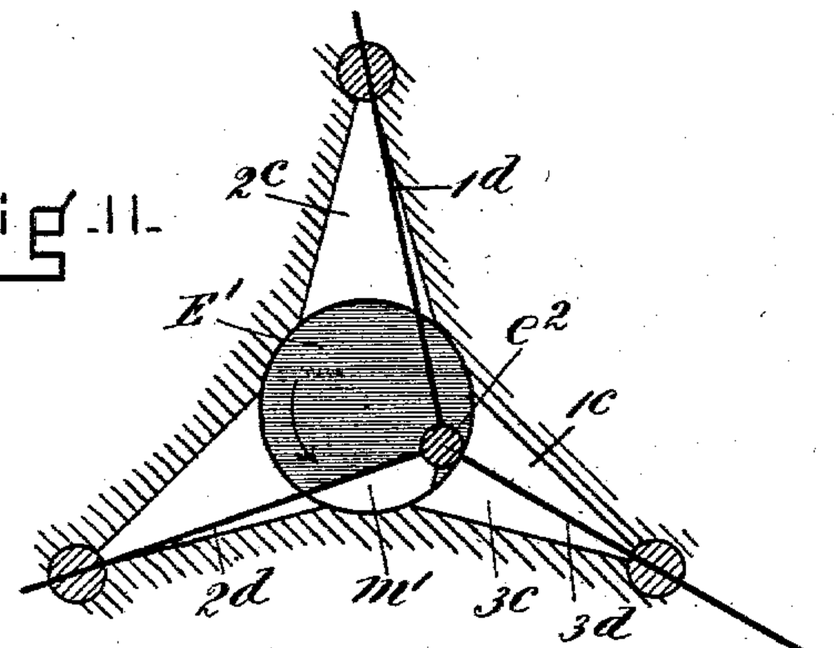
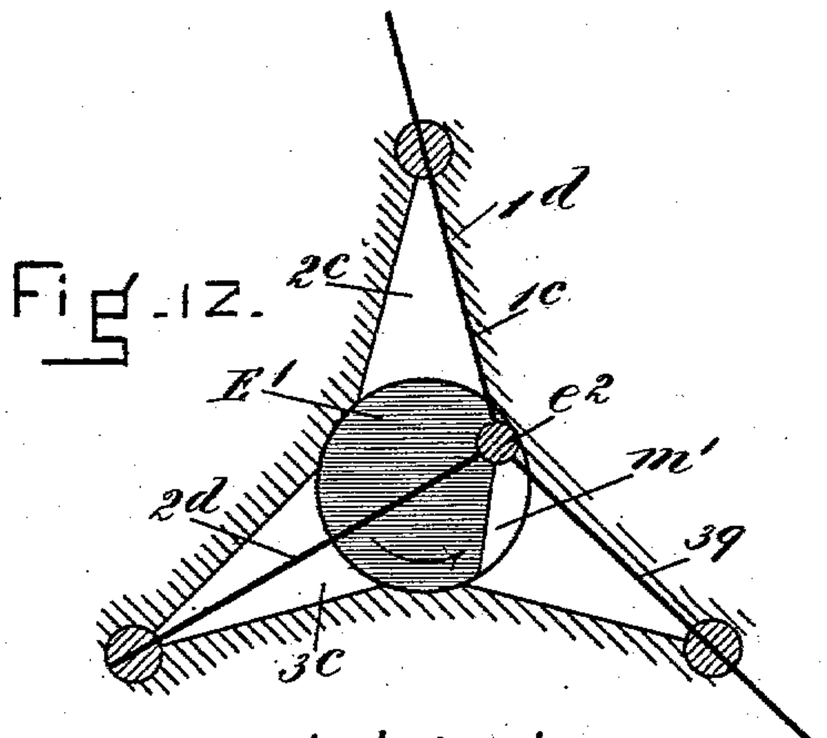


Fig. 12.



WITNESSES.

Frank G. Parker.

A. L. Robinson

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UNITED STATES PATENT OFFICE.

MARGARET E. KNIGHT, OF SOUTH FRAMINGHAM, MASSACHUSETTS.

ROTARY ENGINE.

SPECIFICATION forming part of Letters Patent No. 720,818, dated February 17, 1903.

Application filed June 16, 1902. Serial No. 111,831. (No model.)

To all whom it may concern:

Be it known that I, MARGARET E. KNIGHT, a citizen of the United States of America, residing at South Framingham, in the county of Middlesex and Commonwealth of Massachusetts, have invented certain Improvements in Rotary Engines, of which the following is a specification.

The invention relates to improvements in rotary engines; and it consists chiefly in the novel construction of the pistons of the engines, and, further, in the construction of the steam-chest and the operation of the valve, all of which will be understood from the detailed description hereinafter contained and specified in the claims when taken in connection with the drawings, which form a part of the specification, and wherein—

Figure 1 is a central longitudinal section through the entire engine. Fig. 2 is a vertical cross-section on line 2 2, Fig. 1. Fig. 3 is a vertical cross-section on line 3 3, Fig. 1. Fig. 4 is a vertical cross-section on line 4 4, Fig. 1. Fig. 5 is a vertical cross-section on line 5 5, Fig. 1. Fig. 6 is a vertical cross-section on line 6 6, Fig. 1. All of the cross-sections, Figs. 2 to 6, are viewed from the left of Fig. 1. Figs. 7 to 13 are diagrammatic views showing the pistons in seven different positions during one revolution of the shaft. The steam-chambers about the pistons are somewhat exaggerated.

Referring to the drawings, A designates the engine-casting, which may be encompassed by an outer casing A′ with some non-conductor of heat A^2 in the intervening spaces. The head and end portions of the engine and the middle portion, which contains the steam-chambers and pistons, are secured together by bolt-rods B and nuts B′.

In the drawings three sliding pistons are shown; but more than three, or even two such pistons, may be employed, the requisite being that the steam-ports shall be so arranged that in whichever direction the engine is running the pressure of live steam, whether upon one or more pistons, shall tend to move the crank-rod in the same direction.

As illustrated, the middle portion of the engine-casting, which contains the steam-chambers and pistons, is constructed with three wing-chambers *c c c* to accommodate the three sliding plate-pistons or steam-abutments *d d d*, which severally have a hinged or pivotal connection at their inner ends with the eccentric crank-rod e^2 between the two end portions E E′ of the main shaft. (See Figs. 1 and 6.) At about midway of the depth of the wing-chambers *c* semicylindrical grooves *c′* are formed upon opposite sides thereof throughout the length of each, and in these grooves cylindrical segments c^2 are placed, which support the outer ends of the pistons *d* and serve as bearings through which the pistons slide and tilt in the operation of the engine.

The construction by which the pistons or abutments *d* are hinged to the crank-rod e^2 consists of projecting cylindrical sections c^3 c^4 upon either side of the inner ends of each piston. The curve of one of these sections c^3 has the same radius as the periphery of the crank-rod e^2 and fits it accurately, and the curve of the opposite section c^4 has a radius equal to that of the crank-rod plus the thickness of the projecting section e^3, which fits the periphery of the crank-rod, so that when the several pistons are assembled in proper position about the crank-rod e^2 the projecting cylindrical section of each piston which has the curve of longer radius overlaps and bears upon the cylindrical section which has the curve of shorter radius upon an adjoining piston, and by this overlapping and interlocking of alternate portions of the projecting sections the several pistons are held in contact with the crank-rod e^2. In order to easily accomplish this interlocking of the several pistons, one of them—for instance, the upper or perpendicular one, as shown in Fig. 6—is made in two parts *d d′*, and after all the pistons are assembled these two parts are bolted together, thereby locking them all together and about the crank-rod.

Steam is supplied and conducted to the steam-chambers of the engine in the manner and by the means as follows: Steam from the boiler enters through the pipe F into the chamber G, Fig. 5, which is at the right-hand end of the engine, as illustrated in Fig. 1, and extends across the end of the engine-casting. Within a cylindrical seat H, which is provided with diametrically opposite longitudinal ports *h′ h′*, is a cylindrical tube-

valve I, provided with diametrically opposite ports i' i', which are in the same vertical plane with the chamber G and intermittently open into that chamber through ports h' h', and two other diametrically opposite ports i^2 i^2, which are in the same vertical plane with another steam-chamber K and intermittently open thereto through the ports h' h'. The diametrical planes of the two pairs of ports i' i^2 are at right angles to each other. The chamber K is connected with two steam-passages L, which extend substantially across the length of the engine upon each side, near the lower part thereof, and connect with another steam-chamber M at the left-hand end of the engine. A portion of this chamber M is open to the end E' of the shaft, and from this chamber steam is supplied to the engine or exhausted from it through a port m' in that shaft. Whether the chamber serves as a supply or exhaust chamber depends upon the direction or rotation of the engine. At the end of the engine opposite to the chamber M is a similar chamber N, a portion of which is open to the end E of the shaft, and through a port n' in this end steam is supplied to or exhausted from the engine; also, by branches from the chamber N it may be connected with the steam-supply chamber K or with the exhaust-chamber O near the bottom of the engine. (See Figs. 1, 3, and 4.) The ports m' and n' are made somewhat smaller at the ends next to the steam-chamber c, as shown in dotted lines, to regulate the flow of steam to those chambers.

The valve I has a pinion P upon its outer end which meshes with a gear P' upon the shaft E. These gears are so proportioned that one rotation of the gear P' causes the gear P to rotate three times. Beyond the inner end of the valve I is a chamber i^3, within which is a movable partition in the form of a piston or plunger i^4, which closely fits that chamber. Projecting from the end of the plunger i^4 toward the valve I is a smaller plunger i^5, which accurately fits the interior of the valve I, and the length of the plunger i^5 is sufficient to cover and close the ports i^2 when that plunger is entered its full length and may be employed to stop the engine. The piston i^4 may be operated by means of a rod i^6, attached thereto and which extends through a stuffing-box to the outside of the engine. This rod may be provided with a series of holes i^7, so that the piston i^4 may be secured in a number of different positions by means of a pin inserted through a hole in the end of the stuffing-box gland and into one of the holes in the rod i^6.

By means of a slide-valve Q in the lower part of the engine, which may be operated by a rod q', extending without the casing, the direction of the flow of live steam to the piston-chambers and the exhaust therefrom may be reversed.

Oil-reservoirs R are provided at the top of the engine-casting, from which the lubricant is conducted to the interior of the engine by small passages r'. Also lubricant is supplied to the wings of the steam-chambers c through small pipes r^2, Figs. 2 and 6.

The driving-wheels S on the ends of the engine-shaft may be eccentrically weighted sufficiently to counterbalance the crank-rod e^2 and the pistons d, which are secured thereto.

When operating the engine, steam from the boiler is admitted through the pipe F to the chamber G, and by turning the engine until the ports i' of the valve I coincide with the ports h' of the valve-seat H steam will be admitted to the chamber i^3. By a further turn of the engine sufficient to give the valve I a quarter-turn the ports i' will be closed and the ports i^2 thereof will be brought opposite to the ports h', and steam will issue from the chamber i^3 to the chamber K. From thence it will pass to the passages L along the bottom of the engine to the chamber M and thence through the port m' in the shaft E' to the steam-chambers c in succession, as that shaft is rotated by the action of the steam-pressure upon the pistons d. From the chambers c the steam is exhausted through the port n' in the shaft E into the chamber N and from there to the chamber O and thence up through the space between the engine-casting A and the outer casing A' and out into the atmosphere through ports o' o'. (See Fig. 6.) This is the course of the steam when the slide-valve Q is in the position shown in full-line section, Fig. 1, and the engine will turn from left to right, as illustrated in Fig. 6. In order to reverse the rotation of the engine, the valve Q is pulled to the left by means of the rod q' to the position shown in dotted lines in Fig. 1. Then when the valve I is in the position shown therein steam will pass from the chamber i^3 through the ports i^2 to the chamber K, thence through the chamber N and port n' in the shaft E to the steam-chambers c, and be exhausted through the port m', chamber M, and passage O to the outlet-ports o'. The position of the piston i^4 in the chamber i^3 determines the size of the portion of that chamber which receives steam at boiler-pressure through the ports i' at each half-turn of the valve I, and hence the volume of steam admitted through the ports i^2 to the chamber K and thence to the piston-chambers of the engine at each half-turn of the valve I. It will be understood that the eduction of steam from the chamber i^3 through the ports i^2 alternates with the induction of steam to the chamber i^3 through the ports i'.

The steam-chambers c, each of which is comprised between the sides of two plates d and the walls of the engine-casting A, are continually enlarging and then contracting in the operation of the engine, and for the purpose of illustrating the operation reference may be made to the diagrams, Figs. 7 to 13, wherein it may be assumed that the parts are viewed from a direction opposite to that shown in Fig. 6, that the port m' is the inlet

for live steam, and that the crank-rod e^2 is revolving around the axis of the shaft E from right to left, as indicated by the arrows.

Starting with Fig. 7, live steam is entering at m' and expanding in the chamber 1^c, thus pressing the plate 1^d to the left. At this time the port n' at the opposite end of the engine-shaft is open to the chamber 2^c and exhausting steam therefrom. Immediately after the crank-rod e^2 has passed the point where the steam-chambers 1^c and 2^c are equal on the two sides of plate 1^d the port at the opposite end of the engine begins to pass the plate 2^d and open to the chamber 3^c and exhaust steam therefrom. When the port m' has reached the position shown in Fig. 8, steam has been entirely exhausted from chamber 2^c, and that chamber is practically closed. As soon as the crank-rod e^2 moves downward from the position shown in Fig. 8 the chamber 2^c begins to open again, and a portion of the port m' at the same time having passed the plate 1^d admits steam to the chamber 2^c, and the plate 2^d, with the crank-rod e^2, is forced downward. The port at the opposite end of the engine meantime exhausts the steam from the chamber 3^c, and so it proceeds. The steam continually expanding in the chambers and pressing against the plates causes the crank-rod e^2 to revolve around the axis of the shaft, and thus rotate it. In positions of the crank intermediate of those shown in Figs. 8 and 9, 10 and 11, 12 and 7 the port m' is open to two of the chambers c, as illustrated in Fig. 13, which is a position intermediate of those in Figs. 12 and 7. In this instance the steam is acting upon plates 1^d and 3^d to push the crank-rod e^2 around to the left.

The great advantage of this improved construction over those heretofore employed is the minimum amount of wearing-surfaces. There is no grinding between the ends of the pistons and the interior of a steam-cylinder. The plates d easily slide in and out through their oscillating bearings c^2, and the crank-rod e^2 presents a small friction-surface to the inner curved ends of the plate-abutments, and, besides, the means for internal lubrication are adequate and effective.

I claim—

1. In a rotary engine, the combination of a plurality of radiating steam-abutments hinged at one edge upon a crank-rod which connects two portions of the engine-shaft; and compartments radiating from the steam-chamber into which the abutments respectively project, and cause the crank-rod to revolve by the pressure of steam upon the sides of the abutments successively, as described.

2. In a rotary engine, the combination of a plurality of radiating plate-abutments, one end of each of which is hinged upon a crank-rod which connects two portions of the driving-shaft, radial chambers into which the opposite ends of the plates respectively project, and a longitudinal steam-port in the shaft portion at each end of the engine, which two ports are respectively located upon opposite sides of a plane which passes through the axes of the shaft and the crank-rod.

3. In a rotary engine, a plurality of radiating plate-abutments, the inner end of each of which is provided with a projecting cylindrical section upon each side and with the curve of the section upon the corresponding side of each piston constructed to overlap and fit the exterior curved surface of the opposite cylindrical section of the next adjoining piston, for the purpose described.

4. In a rotary engine, a crank-rod between two portions of the driving-shaft, a plurality of radiating plate-abutments, each provided at its inner end with a projecting cylindrical section upon one side which fits upon the crank-rod, and upon the other side a projecting cylindrical section, each of which overlaps the first-mentioned section of an adjoining piston, substantially as described.

5. In a rotary engine, a cylindrical rotary valve open to the steam-chest, ports in the cylindrical valve located at different positions of its length and in diametrical planes at right angles to each other, which differently-located ports communicate alternately with the boiler and the engine when the valve is rotated, and mechanism which connects the engine-shaft and the valve to give motion to the latter.

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Witnesses:
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A. L. ROBINSON.