No. 855,148. PATENTED MAY 28, 1907.

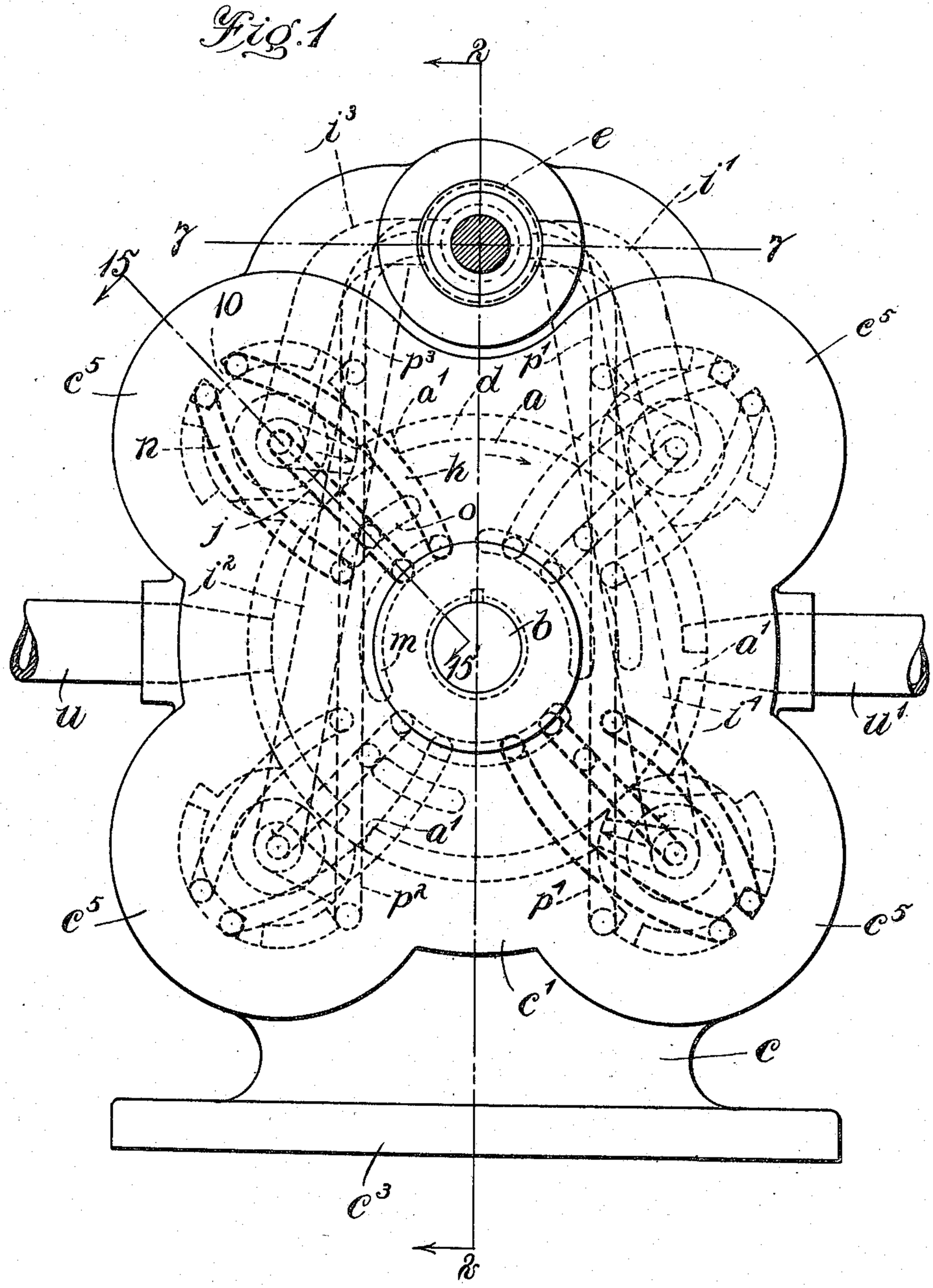
F. VAN CHOATE.

ROTARY ENGINE.

APPLICATION FILED OCT. 4, 1904.

6 SHEETS—SHEET 1.

Fig. 1



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No. 855,148. PATENTED MAY 28, 1907.

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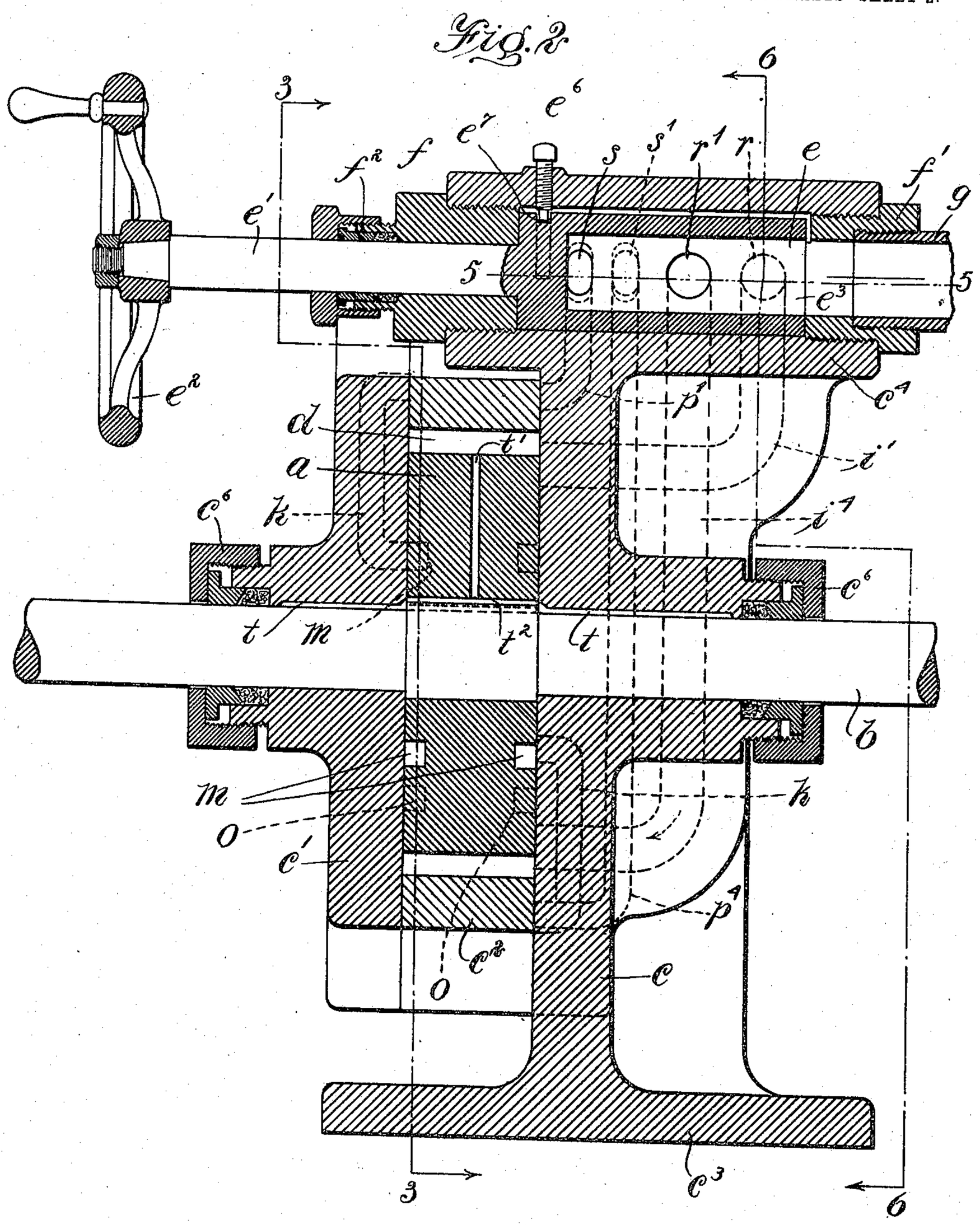
6 SHEETS—SHEET 2.

Fig. 2.



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6 SHEETS—SHEET 3.

Fig. 4

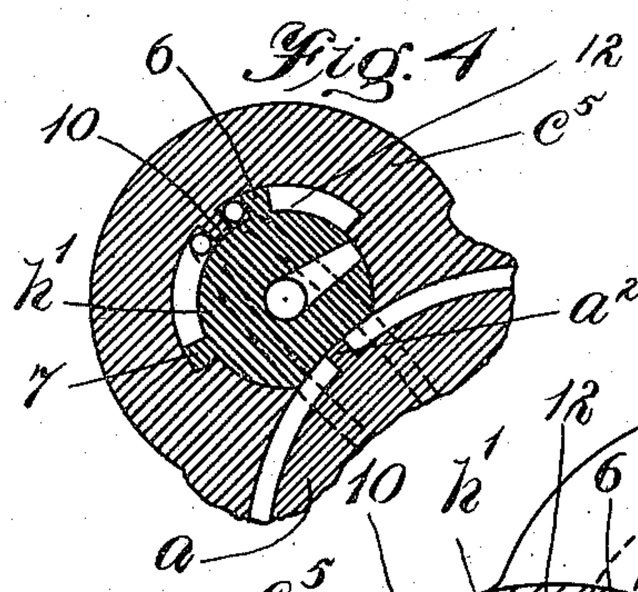

Fig. 5

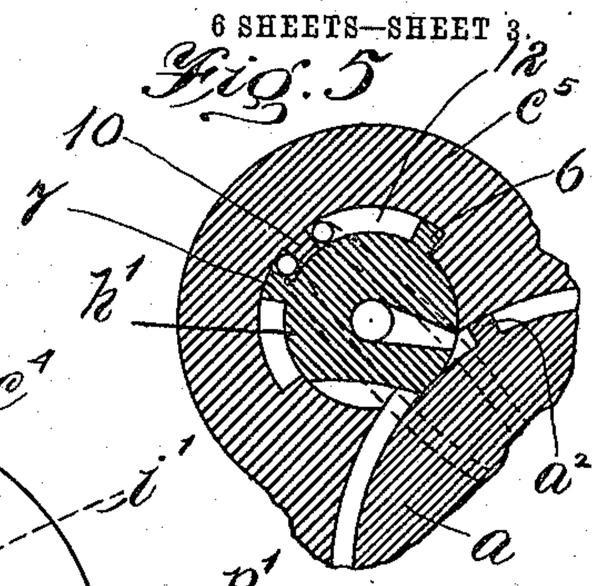

Fig. 3

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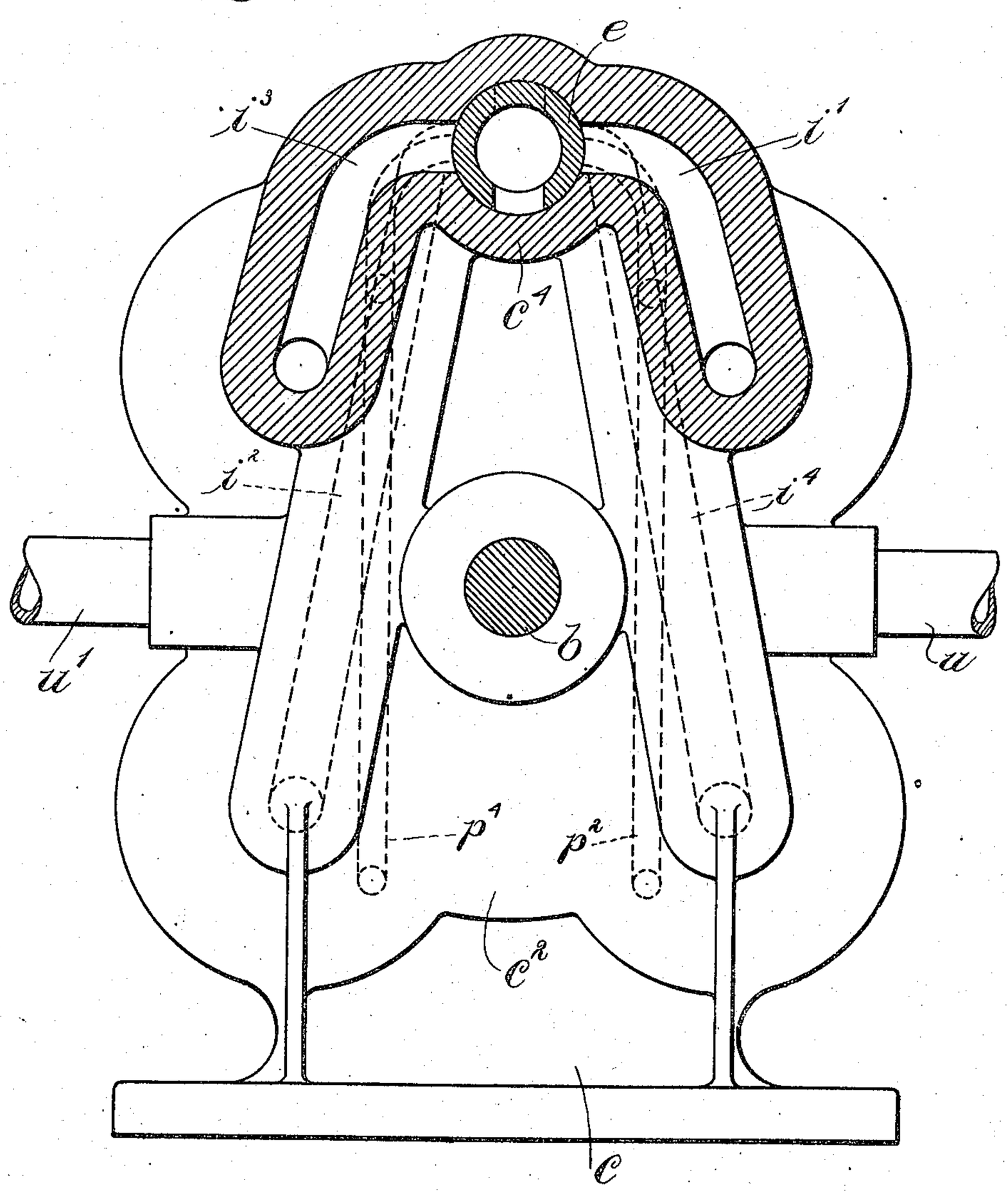
6 SHEETS—SHEET 4.

Fig. 6



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6 SHEETS—SHEET 5.

Fig. 7

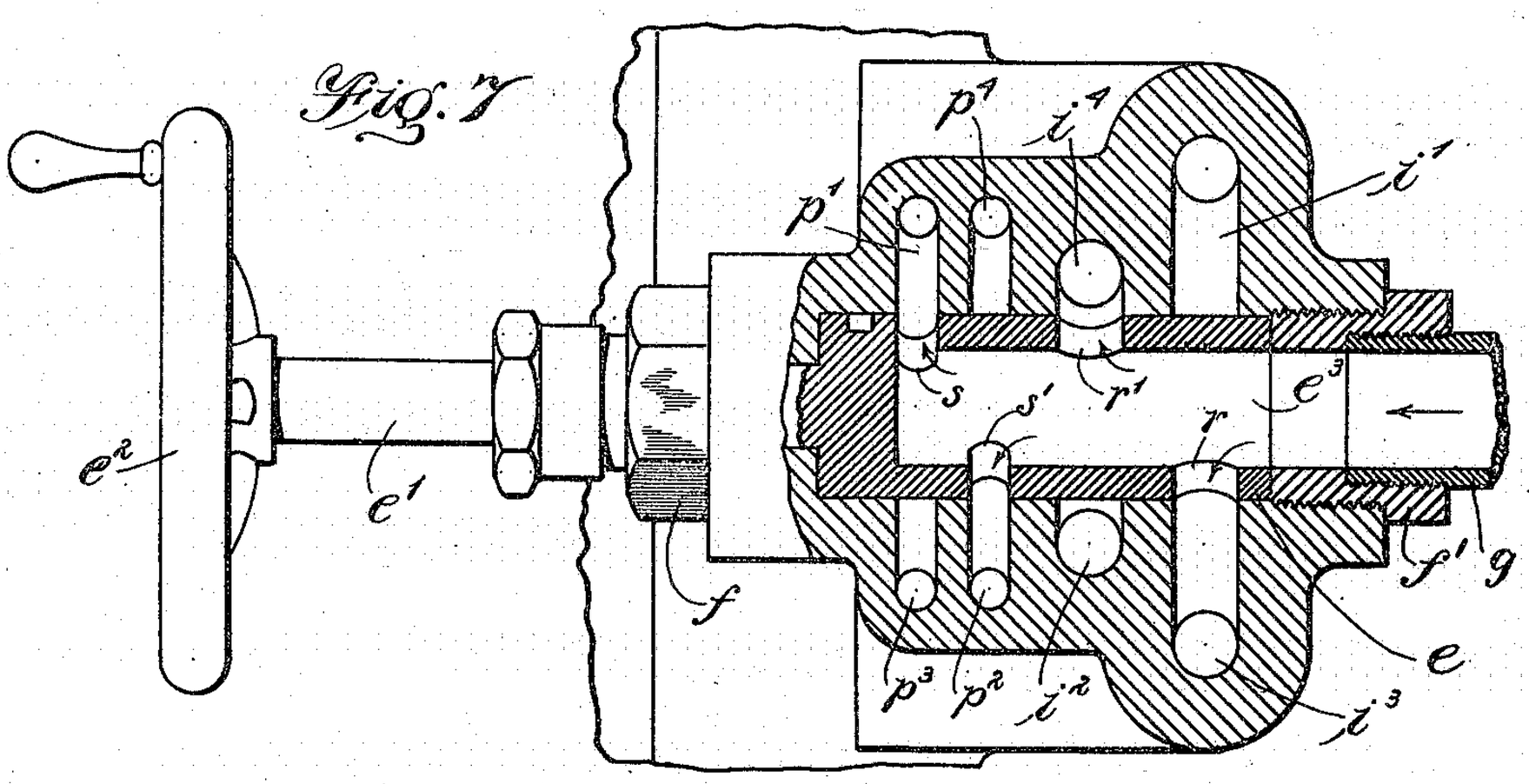


Fig. 8

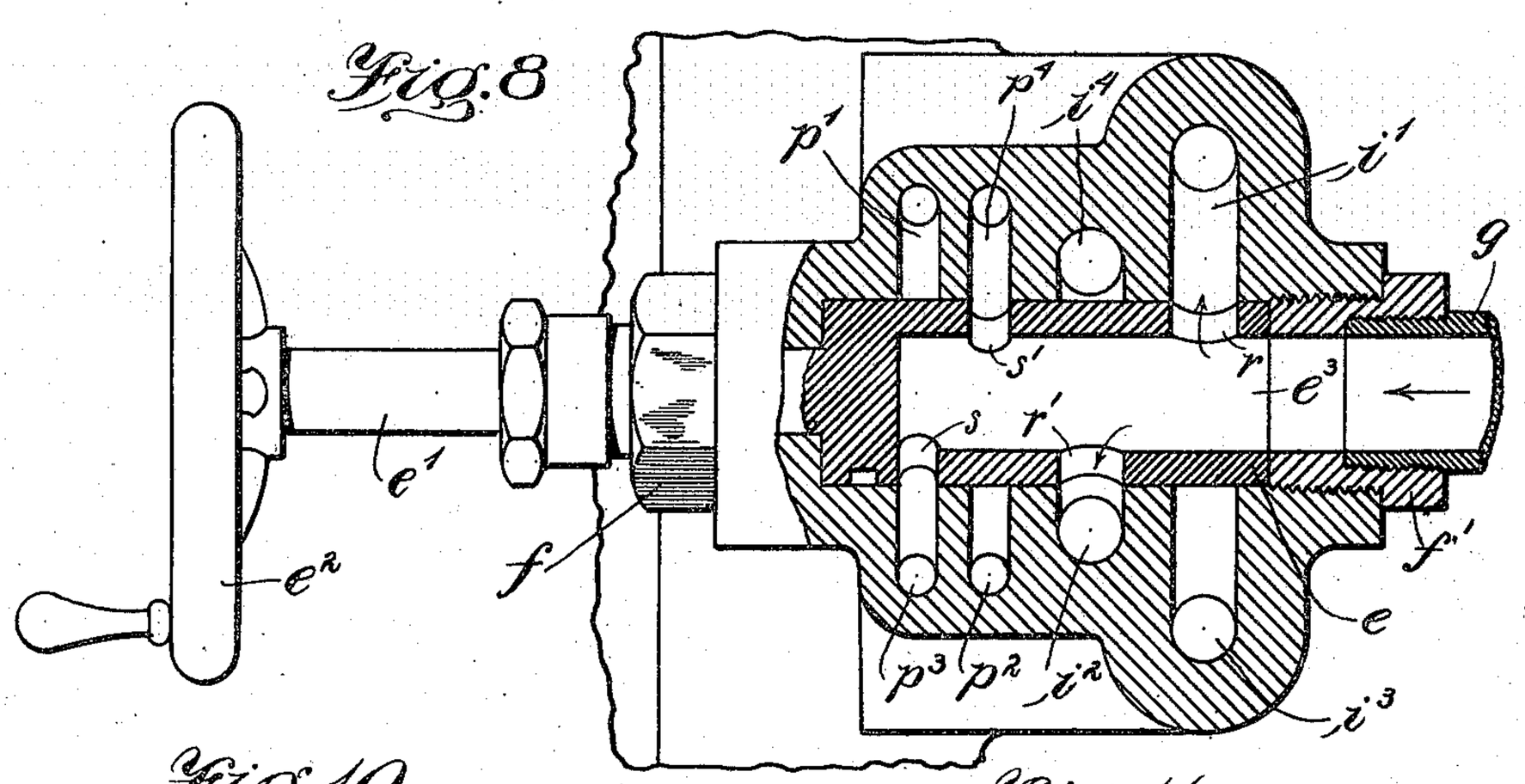


Fig. 10

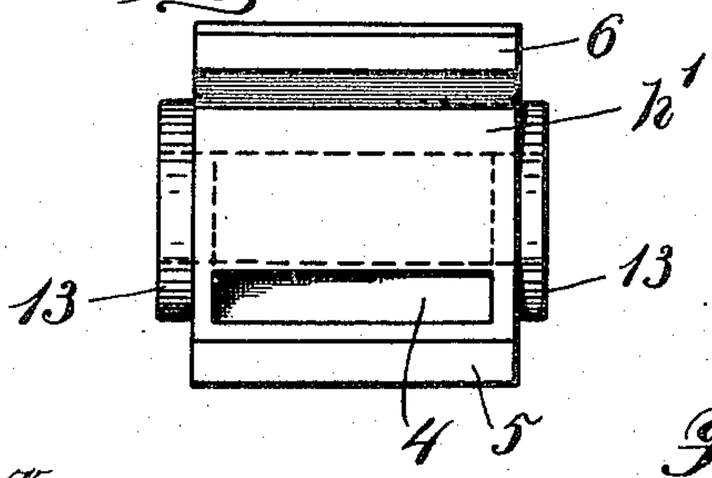


Fig. 11

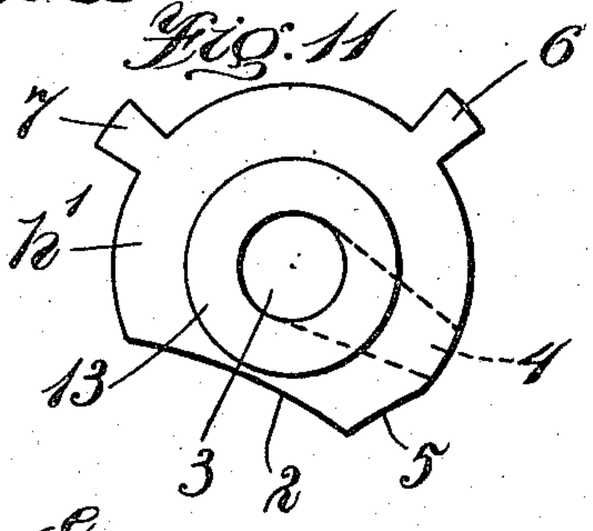
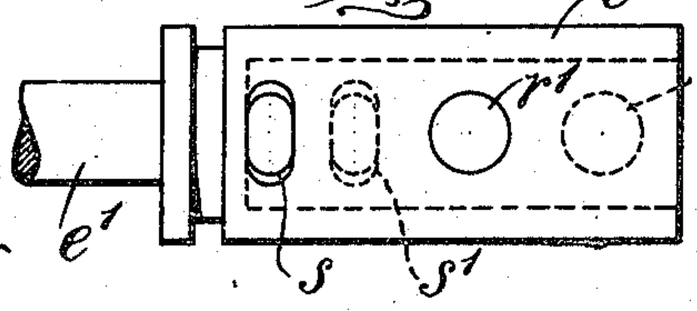


Fig. 9



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No. 855,148. PATENTED MAY 28, 1907.

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ROTARY ENGINE.

APPLICATION FILED OCT. 4, 1904.

6 SHEETS—SHEET 6.

Fig. 12

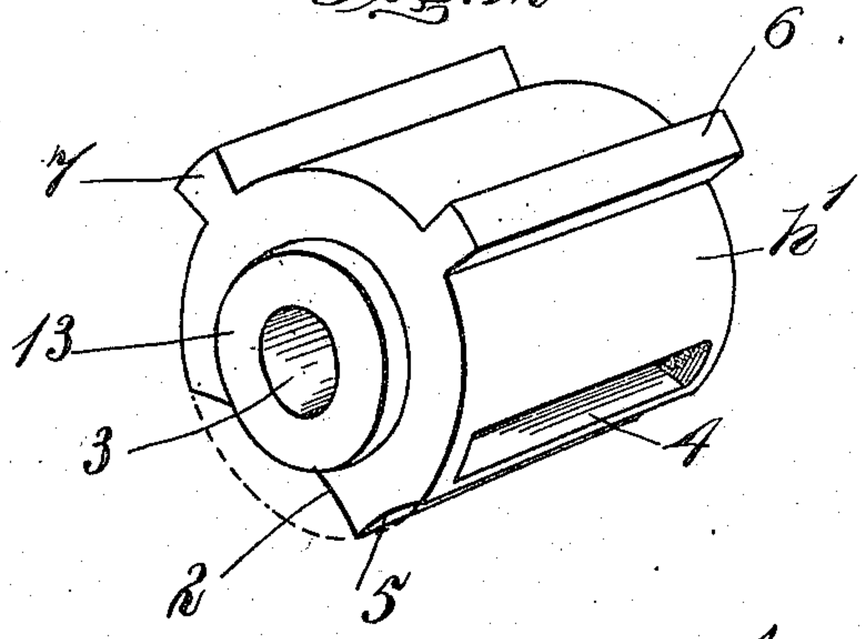


Fig. 13

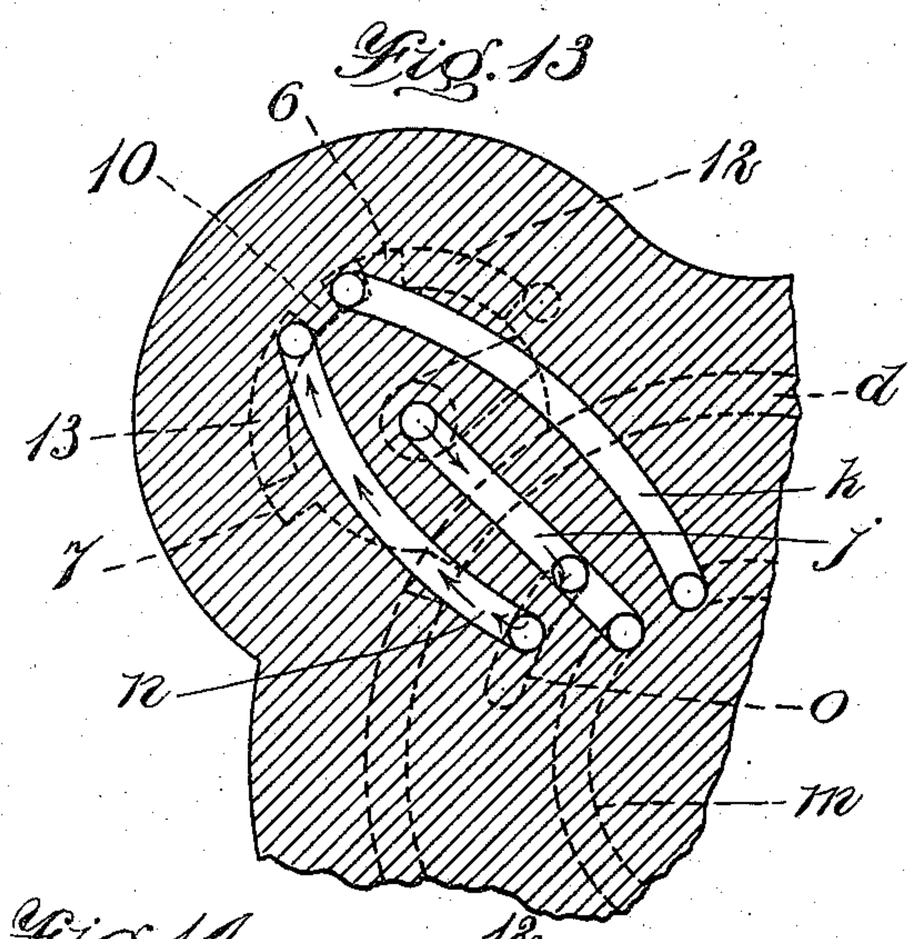


Fig. 15

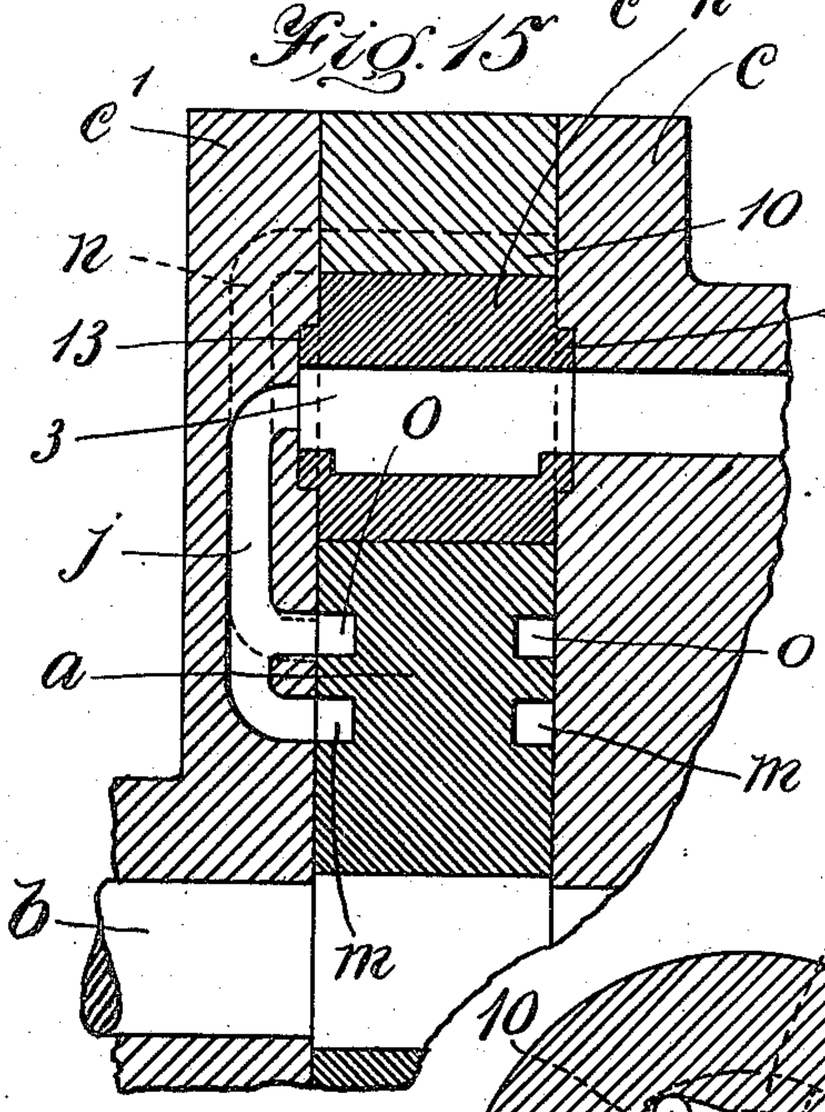


Fig. 14

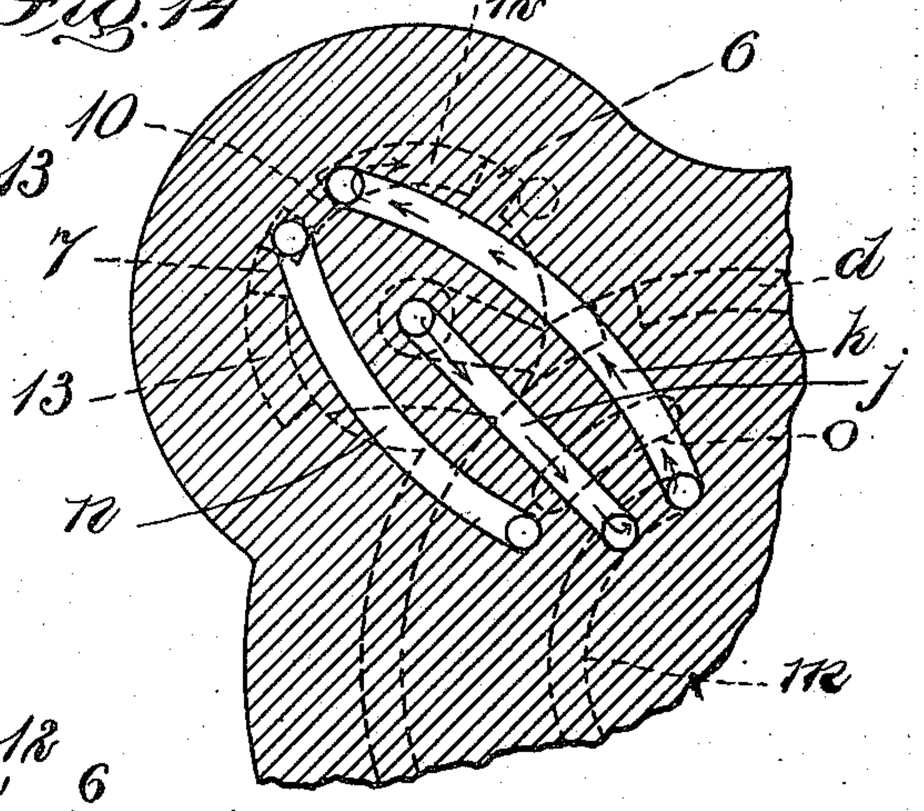


Fig. 17

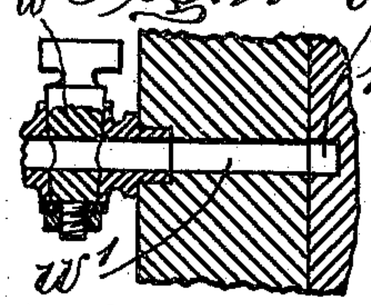
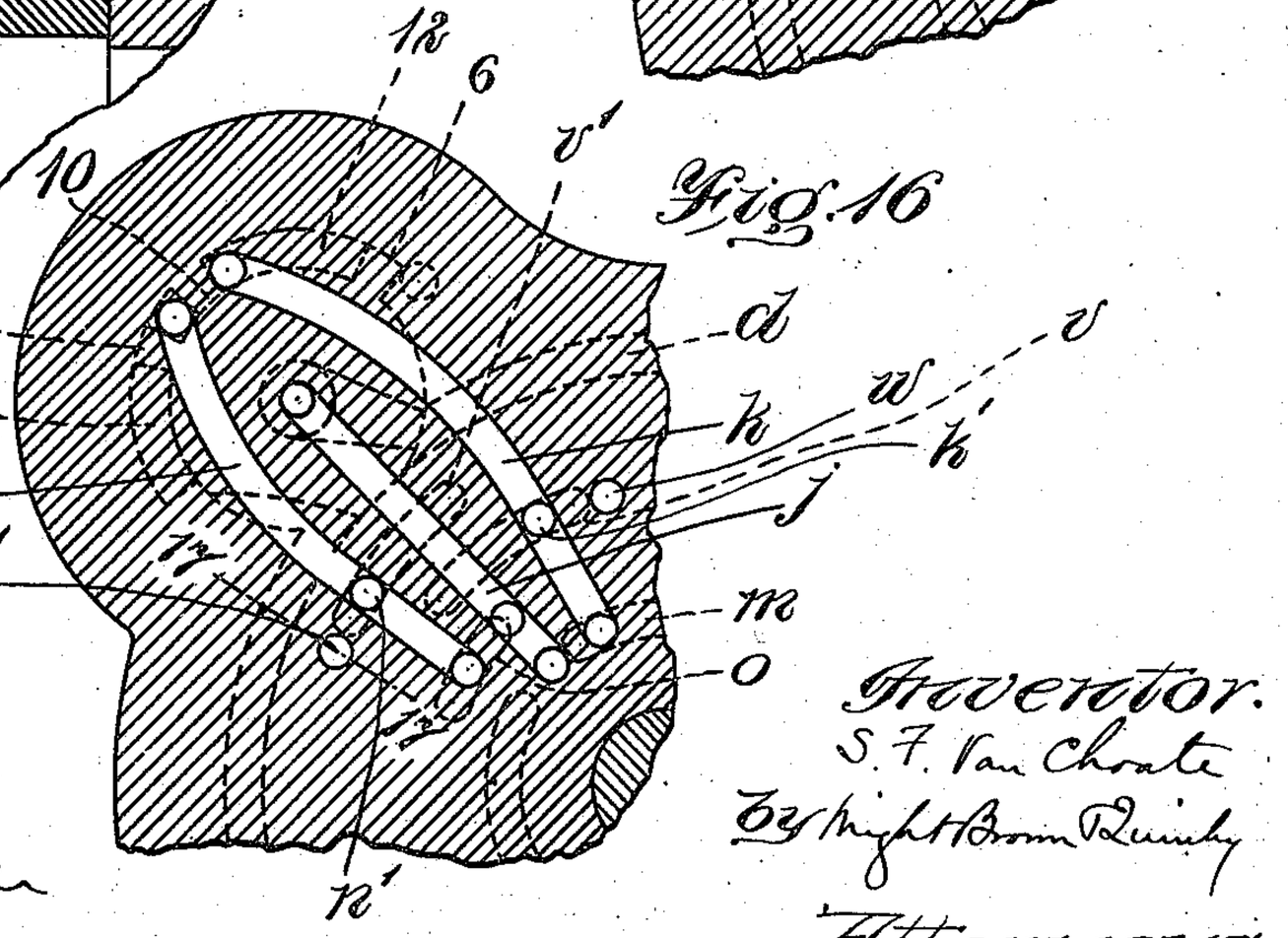


Fig. 16



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UNITED STATES PATENT OFFICE.

SILVANUS F. VAN CHOATE, OF BOSTON, MASSACHUSETTS.

ROTARY ENGINE.

No. 855,148. Specification of Letters Patent. Patented May 28, 1907.

Application filed October 4, 1904. Serial No. 227,110.

To all whom it may concern:

Be it known that I, SILVANUS F. VAN CHOATE, of Boston, in the county of Suffolk and State of Massachusetts, have invented certain new and useful Improvements in Rotary Engines or Motors, of which the following is a specification.

My invention relates to an engine or power motor to be operated by steam, air, or any suitable impelling force, and its objects are to provide an engine or motor having important advantages and improvements as to efficiency, economy, and simplicity.

Of the accompanying drawings, forming a part of this specification,—Figure 1 represents an end elevation of an engine or motor embodying my invention. Fig. 2 represents a section on line 2—2 of Fig. 1. Fig. 3 represents a section on line 3—3 of Fig. 2. Figs. 4 and 5 represent fragmentary sectional views hereinafter referred to. Fig. 6 represents a section on line 6—6 of Fig. 2, and an elevation of parts at the left of said line. Figs. 7 and 8 represent sections on line 7—7 of Fig. 1. Fig. 9 represents a side view of the throttle-valve. Figs. 10 and 11 represent side and end views of one of the abutment valves. Fig. 12 represents a perspective view of the abutment valve. Figs. 13 and 14 represent sections on a plane extending through one of the series of passages shown by dotted lines in Fig. 1. Fig. 15 represents a section on line 15—15 of Fig. 1. Fig. 16 represents a view similar to Figs. 13 and 14, showing certain additional features hereinafter referred to. Fig. 17 represents a section on line 17—17 of Fig. 16.

The same reference characters indicate the same parts in all the figures.

In the drawings,—*a* represents a rotary piston and distributing valve, which is a disk of substantial thickness. From its periphery project radial abutments *a'* extending across the said periphery and spaced equally apart, the preferred number of said abutments being three. The piston abutments may be integral with the body of the piston, or made in separate pieces, rigidly affixed in any suitable way to said body. The said rotary piston is keyed or otherwise rigidly affixed to a shaft *b*, which is rotated by the piston. The shaft is journaled in bearings in a casing, preferably constructed as shown in Fig. 2, said casing being composed of side members *c c'* at opposite sides of the piston, said side members having hubs forming elongated bearings for the shaft, and stuffing-boxes c^6 at the outer ends of said hubs. The casing also comprises an intermediate member c^2, having a circular inner surface surrounding the piston and concentric with its periphery, and forming the outer wall of an annular steam or vapor space *d*, the inner wall of which is formed by the periphery of the piston. The abutments *a'* of the piston project across the said annular space *d* and interrupt its continuity, the outer edges of the abutments being in close proximity to the outer wall of the annular steam space *d*, while their ends are in close proximity to the inner faces of the side members *c c'* of the casing. The working agent, which may be steam, compressed air, an expansive vapor, or any suitable impelling force,—and for convenience is hereinafter denominated steam, is admitted to the annular space *d*, as hereinafter described, and acts on the said abutments to rotate the piston. The said casing is supported by a base c^3, which may be bolted or otherwise secured to a suitable support, and is preferably formed integral with the side member *c*, the other side member *c'* and the intermediate member c^2 being bolted or otherwise secured to the side member *c*, although, if desired, the intermediate member *c* may be integral with either the inner or the outer side member. To avoid confusion in the drawings, I have omitted any representation of the bolts which connect the members of the casing.

e represents a throttle or controlling valve, which is adapted to turn or partially rotate in a throttle-valve casing or hub c^4 formed on the main casing, the said throttle-valve casing having a cylindrical inner surface, internally threaded at its ends to engage annular screw-threaded sleeves *f f'* (Fig. 2), which bear against and confine against longitudinal movement of the cylindrical throttle-valve. The sleeve *f'* is provided with means such as an internal screw-thread for engaging a supply-pipe *g* to supply steam to the engine, and the sleeve *f* is provided with a stuffing-box f^2, which surrounds the stem *e'* of the throttle-valve. Said stem is provided with a hand-wheel or crank e^2 or other means, whereby said stem may be rotated to change the position of the throttle-valve. In this embodiment of my invention, the throttle-valve casing is integral with the member *c* of the main piston casing, and its axis is parallel with the shaft *b*.

The main casing is provided with a series of subsidiary casings or abutment-valve chambers c^5 (Fig. 3), opening into the annular steam space d surrounding the rotary piston and formed to contain and co-operate with a series of oscillatory abutment-valves h' h^2 h^3 h^4. In this embodiment of my invention, I show four of said casings c^5, and four abutment valves, equally spaced apart, this number being preferred in an engine which is adapted to be reversed and to rotate the shaft b in either direction, although as hereinafter set forth, my invention may be embodied in an engine adapted to be driven in one direction only, and having two or more subsidiary casings and abutment-valves. Each of the said abutment-valves is formed as shown in Figs. 8, 9, and 10, and comprises a cylindrical body having a concave face 2 at one side, which forms a part of the outer wall of the annular steam or fluid space d when the abutment-valve is in position to cut off the communication between the throttle-valve and the said steam space d, as shown in Fig. 4. The hub portion of the abutment-valve has a central longitudinal passage or steam chamber 3 occupying its axis of oscillation, and a port 4 extending radially from said conduit to the perimeter of the valve, said port directing the steam into the annular space d. The passage 3 and port 4 constitute movable or adjustable parts of a conduit which supplies steam to the piston chamber to rotate the piston, said conduit also comprising a fixed passage, hereinafter described, formed in the casing and connecting the throttle-valve casing with the passage 3 of the abutment-valve. Between the said port 4 and the recess 2 is a narrower cancave face or jaw 5, which conforms to and has a bearing on the periphery of the rotary piston, as shown in Fig. 5. The abutment-valve is thus adapted to serve as an abutment to confine the steam in the space d between the port 4 and the adjacent abutment a' of the rotary piston, and prevent the steam from passing backwardly, or away from the said adjacent piston abutment.

The abutment-valve has two radially projecting abutments or projections 6, 7, the outer edges or ends of which are in close proximity to the segmental inner wall of an enlargement of the abutment-valve chamber. The ends of said enlargement are formed by two shoulders or abutments 8, 9, between which is an inwardly projecting fixed abutment 10 formed on the casing. Said shoulders and the ends of the abutment 10 form the ends of two segmental steam spaces 12, 13, partially surrounding the abutment-valve, the abutments 6, 7, of the abutment-valve being movable in said segmental chambers, as hereinafter described.

The central or hub portion of the abutment-valve has annular end projections or trunnions 13, which are adapted to turn in counter-sunk or other bearings formed for their reception in the side members of the main casing, as shown in Fig. 15. All the abutment-valves are of the same form and construction, each being preferably an exact duplicate of all the others, so that the valves of the series may be used interchangeably by turning the ends of one pair in one direction, and the similar ends of the other pair in the other direction.

The throttle or controlling valve e has a cylindrical periphery closely fitting the interior of the casing, and an internal steam chamber or conduit e^3, which is open at one end, as shown in Fig. 2, to receive and hold steam from the supply-pipe g, said open end bearing against the confining sleeve f'. The other end of the throttle-valve is closed, and shouldered to bear against the sleeve f. A steam-passage extends from the throttle-valve casing to the hub of each abutment-valve, to conduct steam to the abutment-valve for the purpose of moving the valve to its open position (Fig. 5) and of propelling the piston, said passages being designated i' i^2 i^3 i^4. Each passage constitutes the fixed part of the conduit above referred to for supplying steam to the piston chamber. One of the said passages is provided for each abutment-valve, as shown by dotted lines in Figs. 1, 2, and 3. The throttle-valve is provided with a series of ports coöperating, as hereinafter described, with the said passages.

In Figs. 2, 13, and 14, I show means for establishing an abutment-valve opening connection and an abutment-valve closing connection between the hub of each abutment-valve and the segmental steam spaces 12 and 13 of the abutment-valve casing. Fig. 14 shows a connection established between the hub of an abutment-valve and the segmental steam-space 12, so that steam admitted to said hub will exert pressure on the abutment 6 of the abutment-valve in the direction required to move the valve from the closed position shown in Fig. 13 to the open position shown in Fig. 14. The said means include two outer passages j k formed in the main casing, the inner ends of said passages opening side by side into the piston-containing space or chamber. The outer end of the passage j opens into one of the bearings of the abutment-valve, and the outer end of the passage k opens into the inner end of the segmental chamber 12. In the rotary piston is formed a series of inner segmental supply passages, grooves, or ports m, which are concentric with the shaft b and are arranged to act as tubes to connect the inner ends of the passages j k at predetermined intervals, thus completing the connection between the hub of the abutment-valve and the segmental steam-space 12, and permitting the steam to

act on the abutment 6 as indicated by the arrows in Fig. 14, in opening the abutment-valve.

The passage *j* constitutes a part of the means provided for momentarily moving the abutment-valve to its closed position, as shown ir Fig. 13, to remove the abutment jaws 5 of the valve from the path of an approaching abutment of the rotary piston. Said means also include a central pasage *n*, which opens at its inner end into the piston-chamber and at its outer end into the inner portion of the segmental steam-space 13, and a series of concentrically arranged segmental supply passages, grooves, or ports *o* formed in the side of the rotary piston and adapted to connect the inner end of the passage *n* with a branch *j'* (Fig. 14) of the passage *j*, thus completing a connection between the hub of the abutment-valve and the segmental space 13, and permitting the steam to act on the valve-abutment 7, as indicated by the arrows in Fig. 13, in moving the abutment-valve to its closed position. The outer and inner segmental ports *o* and *m* correspond in number and position with the abutments *a'* of the piston. The relative arrangement of the ports or grooves *m o* and the passages *j k n* is such that when the passages *j k* are connected by a port or groove *m*, the passages *j n* are disconnected, as shown in Fig. 14; and when the passages *j n* are connected by a port *o*, the passages *j k* are disconnected as shown in Fig. 13. The outer ports or grooves *o* are shorter than the inner ports or grooves, so that the valve-closing connection shown in Fig. 13 is much briefer than the valve-opening connection shown in Fig. 14. The said valve-closing connection is broken as soon as the piston-abutment has passed the abutment-jaw 5 of the abutment-valve, and the valve-opening connection is at the same time restored and continues until the next piston-abutment *a'* nearly reaches the said abutment-jaw.

It will be seen from the foregoing that the rotary piston besides acting as a main power piston or disk, constitutes and acts also as a distributing valve, and enables the steam or force that impels the piston to also cause the abutment-valve to jump the piston-abutments, the impelling steam or force holding the abutment-valve open and in operative relation to the periphery of the piston, then briefly raising the abutment-valve jaw 5 while the piston-abutment is passing it, and finally returning the abutment-valve to its open position and the jaw 5 to its operative relation to the periphery of the piston. It will also be seen that the piston or revolving disk, acts as intermediate tubes or connecting communications between the throttle-valve or source of power and a set or sets of tubes or openings through which the said piston or disk supplies steam or other force to the abutment-valve chambers 12 and 13, (Figs. 13, 14, 15 and 16) and to the abutments of the abutment-valves, and that said piston, by means of its movement and its segmental grooves in its sides, not only supplies steam or other force through connecting means, by bridging or jumping the steam or force, by said means, over the space between the moving piston or disk and the fixed abutment-valve chambers to operate the abutment-valves, but also, by the same means, bridges or jumps the steam or impelling force back again, through the said openings, to the grooves of said piston or disk, thus distributing said steam or force to and from said abutment-valve chambers, and finally conveying it to the desired exhausts. The steam pressure is constant in the hub or chamber of the abutment-valve while the passage remains open, so that the valve responds quickly to each of the described changes of connection caused by the ports of the rotating piston.

In a reversible engine embodying my invention, a series of relatively small steam-passages p' p^2 p^3 p^4 extend from the throttle-valve casing to the outer ends of the segmental steam-spaces 12 of the abutment-valve casings, to conduct steam to said spaces for the purpose of closing the abutment-valves, the steam acting on the abutments 6 of each abutment-valve, and firmly setting and holding said valves in their closed position. In the reversible engine here shown, the ports of two of the abutment-valves are arranged to cause the steam to impel the piston in one direction, while the ports of the other two valves are arranged to cause the steam to impel the piston in the opposite direction, as shown in Fig. 3, the valves which cause the movement of the piston in one direction alternating with the other valves which cause the movement of the piston in the opposite direction. The throttle-valve is provided with two larger ports or openings *r r'* formed in opposite sides of the valve and out of alinement, or diagonally opposite each other, the said ports being arranged to register simultaneously with the passages i^1 i^2 when the throttle-valve is at one extreme of its movement, as shown in Fig. 8, and with the passages i^3 i^4 when the throttle-valve is at the other extreme of its movement, as shown in Fig. 7. The throttle-valve is also provided with two smaller ports or openings *s s'* formed in opposite sides of the valve and diagonally opposite each other, the said ports *s s'* being arranged to register with the smaller passages p^3 p^4 when the throttle-valve is in the position shown in Fig. 8, and with the smaller passages p' p^2 when the throttle-valve is in the position shown in Fig. 7. The larger ports *r r'* are circular, while the ports *s s'* are elongated, as shown in Fig. 9, their width being equal to the diam-

eter of the smaller passages which they control, while their length is considerably greater than said diameter, the arrangement of the ports being such that when the throttle-valve is turned to start or reverse the engine, the ports s and s' will be opened to admit setting and holding pressure to the casings of two of the abutment-valves before pressure is admitted to the hub of the other two respective abutment-valves. The larger valve-supplying passages i' i^2 i^3 i^4 and the smaller passages p' p^2 p^3 p^4 which supply steam to close the valves are therefore so arranged relatively to the ports of the throttle-valve that when the larger passage supplying steam to either abutment-valve is open, the smaller passage supplying steam to the casing of that valve is closed, to exclude the valve-setting and holding pressure from that casing; and when the smaller passage supplying steam to the casing of either abutment-valve is open, the larger passage supplying steam to that abutment-valve is closed, so that no pressure is admitted to the hub and port of that valve.

Each abutment-valve when its position is changed is cushioned by steam in the spaces 12 and 13 acting on the abutments 6 and 7 to prevent hammering by the abutments in the movements of the valves, the steam in said spaces 12, 13 being allowed to gradually disperse, but is renewed by the movements of the valve. If desired, the steam may be exhausted from the spaces 12, 13, as hereinafter described. When the throttle-valve is at one position of its movement, it supplies steam to the two abutment-valves which cause the rotation of the piston in one direction, and shuts off all the steam from the other two valves except the steam required to set and hold the latter valves in a fixed position. When the throttle-valve is at the other position of its movement, it supplies steam to the valves which cause the rotation of the piston in the opposite direction, and shuts off all the steam from the two first-named valves, except the steam required to set and hold the other two valves.

The movements of the throttle-valve are limited by a stop-pin or screw-bolt e^6 (Fig. 2) fixed in the valve-casing, the lower end of said bolt traveling in a segmental slot e^7 in the periphery of the valve, the ends of the slot abutting against the stop-pin when the valve reaches the extremes of its movement. When the throttle-valve is in a position half way between the extremes of its movement, it closes all the passages, and stops the engine. The valve may be held in said intermediate position, or any other position, by a suitable movable detent. The valve may be turned to various intermediate positions to permit a restricted passage of steam for driving the engine at variable speeds and the speed may be controlled by any desirable governor.

The passages j k n in Fig. 2 which communicate with the abutment-valves h' and h^2 in Fig. 3 and their casings are formed in one of the side members of the casing, while the passages j k n, which communicate with the abutment-valves h^3 h^4 and their casings are formed in the opposite side member of the casing as partially indicated in Fig. 2. Each side of the rotary piston-disk or body is provided with the segmental ports m and o, the ports in one side being duplicates of the ports in the opposite side, as indicated also in Fig. 2.

t t' t^2 (Fig. 2) represent channels in the solid body of the rotary disk (Fig. 2) also formed in the shaft-bearings and in the inner faces of the side members of the casing (Fig. 2) to conduct oil, steam, or vapor to the shaft-bearings, for purposes of lubrication. Similar channels t^3 t^4 are formed in the throttle-valve casing.

The casing is externally ribbed or reinforced, to provide walls of suitable thickness for the steam passages.

In a motor the shaft of which is required to rotate in one direction only with no provisions for reversal, one pair of the abutment-valves, for example the valves h' and h^2, will be sufficient, the other valves h^3 h^4 and their connections with the throttle-valve being omitted.

The exhaust-steam passes from the annular steam-space d, through exhaust passages u u' extending from opposite sides of the casing, as shown in Fig. 3. The exhaust steam may be conducted to noise-mufflers or to condensing apparatus, or it may be utilized for any desired purpose, by being supplied to another motor, adapted to be operated by the expansion of the exhaust, or to a heating apparatus or system.

In Fig. 16, I show means for exhausting steam from the segmental spaces 12, 13, of the abutment-valve casings, said means comprising segmental grooves or ports v v' formed in the sides of the piston body, and exhaust passages w w' formed in the side members of the piston-casing. The ports v are arranged to communicate with branches k' of the passages k, and to connect said branches with the exhaust passage w. The ports or grooves v' are arranged to communicate with branches n' of the passages n, and to connect said branches with the exhaust-passage w'. When a port v is caused by the rotation of the piston to coincide both with the branch k' and exhaust-passage w, it completes an outlet for steam from the segmental space 12 to the exhaust-passage w; and when a port or groove v' is caused by the rotation of the piston to coincide both with the exhaust-passage w' and branch n', an outlet for steam is completed from the segmental space 13 to the exhaust-passage w'. The ports v and v' are formed to complete said outlets alternately. The exhaust-passages w w' are or

may be provided with regulating valves or taps w^3 (Fig. 17), adapted to regulate the amount of exhaust to be held back as a cushioning agent to prevent hammering of the abutments of the abutment-valves against their respective stop abutments. Each regulating valve or tap may comprise a simple plug crossing and fully stopping the exhaust-passage or conduit; the said plug having a transverse bore or opening through its body to register and correspond with the exhaust-passage. The said plug is constructed to turn to the right or left by the thumb and fingers, so as to turn on or shut off more or less of the exhaust as may be desired. It will be noticed that this regulation of the exhausts from the abutment-valve chambers does not create back pressure on the steam that operates the piston and does not interfere in any way with the conduits that furnish steam to said piston.

When the motor is at rest, the throttle-valve is at a full cut-off position, all the passages leading therefrom being closed by imperforate portions of the periphery of the valve. To start the motor-shaft in either direction, it is only necessary to give the throttle-valve a turn either to the right or to the left, the shaft being caused to rotate in the direction in which the throttle-valve is turned; hence, there is no liability of starting the shaft in the wrong direction, the operator realizing that a movement of the throttle-valve in a given direction causes the rotation of the shaft in the same direction.

Referring to Fig. 3, it will be seen that steam from the two open valves h' h^2 is acting simultaneously on the two piston-abutments a' a^3, and moves the piston to the right, or in the direction of the hands of a watch, the second abutment a^2 being in one of the exhaust portions of the steam-space d. The piston-abutments are so arranged that no two of said abutments simultaneously cross the abutment jaws of the two open valve h h^2, and the grooves or ports m and o in the sides of the piston-body are correspondingly arranged, so that the valves h' h^2 are moved successively in jumping the piston abutments, one valve being open during the momentary closure of the other while the latter is jumping a piston-abutment. The steam-pressure on the piston is therefore practically continuous or uninterrupted throughout the entire cycle of movement of the piston, and a continuous and unvarying rotation of the latter is insured. In some positions of the piston two of its abutments are under pressure, while in other positions all the abutments are under pressure, so that after each piston-abutment completes its cycle, it and the others are in action or under pressure until the third one completes its cycle.

The continuous application of pressure to a series of piston-abutments revolving about a common center and each having a leverage corresponding to its distance from the shaft, gives a far higher efficiency in proportion to the pressure employed, than can be obtained from a reciprocating engine, in which the loss by friction and the reversal of motion of the piston, is much greater than in my improved engine or motor. The various moving parts of my motor are continuously enveloped in the steam or other motive agent, and therefore are continuously lubricated. Stop-cocks or outlets may be arranged at suitable points, to carry off the condensation. It will be seen that the rotary body or disk a, besides serving, with its abutments, as a rotary piston, is enabled by the segmental grooves or ports formed in its sides, to serve as an automatic distributing valve, which causes the abutment-valves to jump the piston-abutments, the said valves meanwhile continuously supplying pressure to rotate the piston. The throttle-valve coöperates with the series of passages extending therefrom to the abutment-valves in controlling both the direction and the rapidity of movement of the piston, the working or operative abutment-valves not only supplying steam to the rotary piston, but also forming steam abutments or back-stops which are held by the steam-pressure in operative position. The throttle-valve also coöperates with the series of passages leading to the casings of the abutment-valves in closing and holding the abutment-valves which are out of action and which exclude steam from the piston. The steam or impelling force is applied squarely and in a straightforward direction, to the piston-abutments and utilizes the full leverage of one-half of the diameter of the piston. All these useful results are accomplished without the employment of cranks, cams, cam movements, connecting-rods, piston-rods, fly-wheels, or any kind of moving external mechanism, and without change of leverage at the points where the power or force is applied.

The shape, size, and capacity of motors to be constructed in accordance with my invention, may be determined by competent mechanical engineers and draftsmen. The larger the motor, the more easy and facile are the proportions and mathematical calculations and formulæ determined.

My invention is not limited to an engine or motor in which the valves which admit steam to the abutments of the rotary piston carry or constitute abutments or abutment-jaws to prevent the backward escape of steam. The abutments or abutment-jaws may be independent of the means for admitting steam to the piston-chamber, in which case the valves controlling the admission of steam to the piston-chamber may be termed working valves, and may be opened

and closed by means similar to those hereinbefore shown and described for opening and closing the abutment-valves, although when working valves without abutment-jaws are employed no provision will be required for oscillating the valves to cause them to jump the piston-abutments. The abutments or abutment-jaws when constructed only to prevent the backward escape of steam, may be distinguished from the abutment-valves above described, only by the absence of the ports 4 for the admission of steam to the piston-chamber.

Having thus explained the nature of my invention and described a way of constructing and using the same, although without having attempted to set forth all the forms in which it may be embodied or all the modes of its use, I declare that what I claim is:—

1. An engine or motor comprising a casing having a piston-chamber, a fixed passage forming a portion of a conduit extending from a source of supply to said chamber, an oscillatory abutment-valve forming a movable part of said conduit, and a rotary piston having abutments upon its periphery, said piston moving in said piston-chamber and impelled by steam, or other impelling force, passing through said conduit, the said casing, piston, and valve having coöperating means for causing the impelling force to oscillate the abutment-valve.

2. An engine or motor comprising a casing having a piston-chamber, a fixed passage forming a portion of a conduit extending from a source of supply to said chamber, an oscillatory valve having, first, a hollow hub or chamber and a delivery port extending therefrom, said hub and port forming movable parts of said conduit, and secondly, an abutment face or jaw at one side of said port, and a rotary piston having an abutment on its periphery, said piston being movable in said chamber and impelled by steam, or other impelling force, passing through said conduit, the said casing, piston, and valve having coöperating means for causing the impelling force to move the said abutment face alternately toward and from the periphery of the piston.

3. An engine or motor comprising a casing having a piston-chamber and a subsidiary valve-chamber communicating therewith, and having segmental enlargements or steam-spaces, a fixed passage extending from a source of supply to the valve-chamber, an oscillatory valve in said subsidiary chamber, having first, a hollow hub, and a delivery port extending therefrom, said hub and port forming movable parts of said conduit, secondly, a concave abutment face at one side of said port, and thirdly, two abutments projecting into said segmental chambers, and a rotary piston having abutments upon its periphery said piston moving in said piston-chamber and impelled by steam, or other impelling force, passing through said conduit, the said casing and piston having coöperating means for causing the impelling force to enter the said segmental spaces alternately, and act on said valve abutments to oscillate the abutment-valve.

4. An engine or motor, comprising a casing having a piston-chamber, a fixed passage forming a portion of a conduit extending from a souce of supply to said chamber, an oscillatory abutment-valve having, first, a hollow hub or chamber, and a delivery port extending therefrom, said hub and port forming movable parts of said conduit, secondly, a concave piston-abutment clearing face at one side of the delivery port, and thirdly, an abutment face between said abutment-clearing face and port, and a rotary piston having abutments on its periphery, said piston moving in said piston-chamber and impelled by steam, or other impelling force, passing through said conduit, the said casing, piston, and valve having coöperating means for causing the impelling force to hold the abutment-valve alternately in its abutment position and in its piston-clearing position.

5. An engine or motor comprising a casing having a piston-chamber and a subsidiary valve-chamber communicating therewith, said chamber having recesses or countersinks forming valve-bearings, a fixed passage extending from a source of supply through one of said bearings to the valve-chamber, an oscillatory valve in said chamber, having, first, end trunnions journaled in said bearings, secondly, a hollow hub or central chamber communicating through one of said trunnions with said passage, and a delivery port extending from the hub, said hub and port forming movable parts of said conduit, and thirdly, an abutment face or jaw at one side of said port, and a rotary piston movable in the piston-chamber, and having abutments on its periphery, said piston being impelled by steam, or other impelling force, passing through said conduit, the said casing, piston, and valve having coöperating means for causing the impelling force to rock the abutment-valve and move the said abutment jaw alternately toward and from the periphery of the piston.

6. An engine or motor comprising a casing having, first, a piston-chamber, secondly, a fixed passage forming a portion of a valve-supplying conduit extending to said chamber, thirdly, a subsidiary valve-chamber communicating with the piston-chamber and having two segmental enlargements or spaces, and fourthly, two outer passages which communicate at their outer ends with said segmental spaces and a central passage which communicates with the central portion of the valve-chamber, an oscillatory abutment-valve, forming a movable part of said con-

duit and having a hollow hub or central chamber communicating at one end with said central passage and at the other end with the said valve-supplying conduit, said valve having a delivery port communicating with the hub, and radial abutments, said valve movable in said segmental spaces, and a rotary piston having abutments upon its periphery movable in said piston-chamber and impelled by steam or other force, passing through said conduit, the body of said piston having segmental ports adapted to connect the said outer passages with the said central passage alternately.

7. An engine or motor comprising a casing having, first, a piston-chamber, secondly, a fixed passage forming a portion of a valve-supplying conduit extending to said chamber, thirdly, a subsidiary valve-chamber communicating with the piston-chamber and having segmental enlargements or spaces, fourthly, a plurality of passages comprising outer passages which communicate at their outer ends with said segmental spaces and a central passage which communicates with the central portions of the valve-chambers, and fifthly, escape or exhaust passages, an oscillatory abutment-valve forming a movable part of said conduit, and having a hollow hub or chamber communicating at one end with said central passage and at the other end with the said valve-supplying conduit, said valve having delivery ports communicating with the hub or central chambers and radial abutments movable in said segmental spaces, and a rotary piston having abutments upon its periphery, said piston being movable in said piston-chamber and impelled by steam, or other impelling force, passing through said conduit, the body of said piston having segmental supply-ports or grooves and a series of exhaust-ports, the said supply-ports being adapted to connect the said outer passages with the central passage alternately, while the exhaust-ports are adapted to connect said outer passages with exhaust passages.

8. An engine or motor comprising a casing having a piston-chamber, and a throttle-valve chamber, a fixed passage forming a portion of a conduit extending from the throttle-valve chamber to the piston-chamber, a hollow throttle-valve acting as a steam chamber and adapted to turn in said throttle-valve chamber and having a port adapted to register with said fixed passage, an oscillatory abutment-valve forming a movable part of said conduit, and a rotary piston having abutments upon its periphery, said piston being movable in said piston-chamber and impelled by steam, or other impelling force, passing through said conduit, the said casing, piston, and valve having coöperating means for causing the impelling force to oscillate the abutment-valve.

9. An engine or motor comprising a casing having a piston-chamber, and a throttle-valve chamber, a plurality of abutment-valve chambers communicating with the piston-chamber, a plurality of fixed passages extending from the throttle-valve chamber to the abutment-valve chambers and forming parts of piston-supplying conduits, the said passages being arranged in pairs and the throttle-valve being provided with ports adapted to communicate first with the passages of one pair and then with the passages of another pair, abutment-valves movable in said abutment-valve chambers and forming movable parts of said conduits, said abutment-valves being arranged in oppositely and alternately acting pairs, and a rotary piston having a plurality of abutments upon its periphery, and moving in said piston-chamber, the said casing, piston, and valves having coöperating means for causing the impelling fluid to oscillate the acting abutment-valves.

10. An engine or motor comprising a casing having a piston-chamber and a throttle-valve chamber, a plurality of abutment-valve casings communicating with the piston-chamber and having segmental enlargements, a plurality of fixed larger passages extending from the throttle-valve chamber to the central portions of the abutment-valve casings and forming parts of piston-impelling conduits, a plurality of smaller passages extending from the throttle-valve chamber to the enlarged outer portions of the abutment-valve casings, the said larger and smaller passages being arranged in pairs and the throttle-valve being provided with ports adapted to connect and close said passages in pairs, abutment-valves movable in said abutment-valve casings and forming movable parts of said conduits, said abutment-valves being arranged in oppositely and alternately acting pairs and having abutments moving in said segmental spaces, and a rotary piston having a plurality of abutments upon its periphery, said piston moving in the piston-chamber, the said piston-casing and piston having coöperating passages and ports which admit steam alternately to the segmental enlargements of the abutment-valve casings.

11. An engine or motor comprising a casing having a piston-chamber, a subsidiary valve-chamber communicating therewith and having segmental enlargements or steam spaces, an oscillatory valve in said subsidiary chamber, having abutments movable in said segmental spaces, said casing having exhaust passages communicating with the segmental spaces, and adjustable cocks controlling the said exhaust passages, and adapted to regulate the cushioning effect of steam on the abutments in the said spaces.

12. An engine or motor having a rotary

piston or disk provided with means for causing steam or other impelling force to pass from a throttle-valve or source of power to the bodies of valves which communicate with the chamber in which the piston rotates.

13. An engine or motor having a rotary piston or disk provided with a passage forming an intermediate part of one or more conduits which serve to carry steam, or other impelling force, between the boiler or generator and the bodies of one or more abutment-valves and to bridge the steam over the space or opening between the piston and the said valves.

14. An engine or motor having a rotary piston provided with a conduit whereby it acts as an automatic valve to distribute steam, or other impelling force, from one passage or set of passages to another passage or set of passages, the said passages including a working valve or valves, all co-operating to cause and regulate the movement of the piston.

15. An engine or motor having a rotary piston or disk provided with a passage which alternately or intermittently forms a part of a conduit or passage between a generator or source of power and a piston-chamber, and while in motion alternately or intermittently brings into unison or incident connection a series of ports or passages carried by it with fixed passages or sets or systems of such passages, and at the same time automatically bridges the impelling force over the openings between the said piston and the bodies of adjacent abutment-valves.

16. An engine or motor having a rotary piston which contains or is constructed with ports or grooves in its sides, adapted to receive and convey steam, or other impelling force, and to automatically distribute the same intermittently from one set or system of passages to another set or system of passages, to alternately or intermittently and automatically operate abutment-valves and cause the latter to control the passage of the steam to and from the chamber in which said piston rotates.

17. An engine or motor having a rotary piston or disk which serves as a distributing-valve, and, when in motion, by means of ports formed in its sides distributes steam, or other impelling force, from one fixed passage or set of passages to another fixed passage or set of passages, thereby causing a series of abutment-valves to clear the abutments upon said rotary piston.

18. An engine or motor having a rotary piston or disk which acts as an automatic valve to distribute steam, or other impelling force, between various fixed passages and the bodies of abutment-valves, to cause and regulate the movement of said piston.

19. An engine or motor having a rotary piston or disk which is provided with ports in its sides, said ports being arranged in series occupying different positions relatively to the center of the piston, one series serving to move a series of abutment-valves in one direction, while another series serves to move the said valves in another or opposite direction.

20. An engine or motor provided with a hub or bearing for a throttle-valve, and said hub or bearing being provided at each of its sides with two sets of differently sized passages, there being two larger and two smaller passages at each side, said sets being arranged in pairs each including two smaller and two larger passages, said larger passages extending laterally from each side of said hub or bearing, to and connecting with the working valves of the engine or motor, and coöperating with other intermediate tubes or openings to rotate a piston or disk, while the smaller tubes or openings extend laterally from each side of the hub or bearing to the casings of the working valves and supply steam to set and hold the said valves in a closed position.

21. An engine or motor whose throttle-valve contains or is provided with two sets of ports or openings in its sides, there being one smaller and one larger opening on each side, the arrangement being such that when said valve is moved in one direction from its cut-off position, one of its smaller openings and one of its larger openings on each side is caused to match or correspond, in a diagonal direction across to the other side, with two respective and alternate fixed passages on each side of the hub or bearing of said valve, while a similar movement of the valve in the other direction from a full cut-off position brings a larger and a smaller opening on each side of the valve in a diagonal relation or position and in unison or in the desired position to connect diagonally with the other and alternate set of larger and smaller openings on the two sides of the said hub or bearing.

22. An engine or motor having a throttle-valve provided with a longitudinal bore or chamber and with two openings of different sizes on each side for the exit of steam, the said valve being seated in or connected with a hub or bearing, and said hub or bearing being provided with eight openings of different dimensions, four smaller and four larger, two smaller and two larger on each side, said valve and said hub or bearing being constructed and arranged relatively to each other so that when the valve is moved or turned in one direction, steam is allowed to pass out of said valve-chamber to move and operate two working valves and a revolving piston or rotary disk in one direction, and to hold two other working valves in a fixed position, and when said throttle-valve is moved or turned in the opposite direction, to move and operate the two latter working valves and move

and operate said piston or disk in the other direction, and to hold in a fixed position the two former working valves.

23. An engine or motor having a throttle-valve provided with openings of different dimensions, one smaller and one larger on each side, said valve being seated in a hub or bearing provided with eight openings, two of smaller and two of larger dimensions, on each side, the said openings in the valve and in the bearing being constructed and related so that when the valve is turned or moved in one direction, the first small and the first large openings on one side of the valve are made to come into unison with and to match the first small and the first large openings in the hub or bearing on the same side, and at the same time, bring into unison the small and the large openings on the other side of the valve with the second small and second large openings in the bearing on that side, and on turning or moving the valve in an opposite direction, the second small and second large openings on the side of the valve are brought into unison with the second small and the second large openings in the first side of the bearing, and the small and the large openings of the valve and the bearing on the other side are brought into unison with the first small and the first large openings in the bearing on the other side, and thus allow the steam to pass out of both the small and the large openings on either side of the system and in a diagonal direction as to the position of the openings, and to move and operate the working valves and the piston or disk of the engine or motor.

24. An engine or motor having a throttle-valve, four working valves, and a revolving piston or rotary disk, said valve being provided with openings on its two sides for the emission of steam to move and operate said working valves and said piston or disk and said throttle-valve being constructed and arranged so that on moving it in one direction two of said working valves are made to move and operate said piston or disk, while the other two working valves are set and continuously held in position to clear the passing abutments on the periphery of the disk while the engine or motor is running in one direction, and when the said throttle-valve is moved or turned in an opposite direction, the other or latter two working valves are brought into action to move and operate the piston or disk, while the other or first two working valves are set and continuously held in position to clear the passing abutments.

25. An engine or motor having a throttle-valve provided with a central or longitudinal opening to hold or convey steam, and with different sizes of openings in its sides, and seated in a hub or bearing having double the number of similar openings in its sides, the valve and bearing so constructed and arranged that on moving or turning the valve in one direction two openings on each side of the valve will come or be brought into unison with the same number of similar openings in the two sides of the hub or bearing, so that steam or vapor from the openings in the valve can pass out on each side through the diagonally corresponding openings in the bearing, and by means of intermediate tubes or openings, move and operate the working valves and the revolving piston or rotary disk.

26. An engine or motor having a throttle-valve provided with a central bore or chamber, and main admission and valve-controlling openings of different sizes in its sides, and held in position by a hollow screw sleeve or abutment at each end, said valve being provided with a hand crank wheel or handle and other means or fixture to operate said valve and to lock it in position.

27. An engine or motor having working valves, each of which is provided with projections or trunnions at its ends, serving as pivots or centers for said valve to turn upon, the projections and the valve having a central bore or opening extending from end to end of the valve, for the passage of steam and a lateral mouth or port opening on one side for the emission or discharge of steam into a piston-chamber.

28. An engine or motor having a throttle-valve and working valves arranged in pairs and each pair on lines at right angles to each of the other, each of said valves being provided with projections or trunnions at its ends, a center bore or opening extending entirely through the valve, and a lateral mouth or port on one side constructed and adapted to emit or discharge steam into a piston-chamber.

29. An engine or motor having working valves, each of which is provided with projections or trunnions on its ends and a central bore or opening, each valve having on its periphery one or more abutments or lugs extending lengthwise of the valve and parallel with the central openings, said central bore or opening and said lateral slot or mouth being for the purpose of carrying and emitting or injecting steam into a piston or disk-chamber to move and operate a rotary piston therein.

30. An engine or motor having a casing and working valves, each of which is provided with hubs or projections at its ends, a central bore entirely through the valve, and a lateral mouth or port opening on one side, each valve having also a concave recess in one side adapted to conform to or constitute a continuation of the inside circular wall of a piston or disk chamber in said casing.

31. An engine or motor having a casing and working valves, each of which is provided with hubs or projections at its ends, abut-

ments on its periphery, a central bore or opening, a lateral mouth or port in one side, and a concave recess near the said mouth or port, the said recess forming the face of a jaw or abutment to prevent the steam or vapor issuing from the said port from escaping backwardly, said jaw being carefully turned or ground to closely conform to the periphery of a piston or disk in said casing.

32. An engine or motor having a casing and working valves arranged diametrically opposite to each other in said casing and in pairs of two, and each pair being on lines at right angles with the other pair, the said casing being provided with circular cavities or chambers accurately formed to closely fit the peripheral bodies of said valves, and each chamber provided at one side with a segmental enlargement and with a fixed central abutment which occupies the central portion of said enlargement and subdivides the latter into segmental spaces which terminate at their outer ends in solid abutments or shoulders, openings being provided at each side of said central abutment and at one end of one of said segmental spaces, which openings are connected with various intermediate tubings or openings to carry and admit steam into said segmental spaces on each side of said central abutment to oscillate the valve, by impingement or pressure against projecting abutments on the peripheral body of the valve, and to one of said segmental spaces for the admission of steam or vapor to move, set, and hold one set or pair of valves in a non-active position, while the other pair or set are being operated to move and revolve the piston or disk.

33. An engine or motor having a casing and working valves oscillating or moving on their trunnions or projecting ends in countersinks or bearings formed in the sides of the casing, and said valves being provided with central openings or steam-chambers extending entirely through the axial lengths of the valves, and said openings being connected centrally with tubes or openings constructed for and capable of furnishing steam from a boiler or generator through a throttle-valve and said connecting and intermediate tubes or openings to the central openings or chambers in the working valves, and thence through the lateral mouths or openings in the valves into the piston or disk chamber to move and operate said piston or disk.

34. The combination with a casing and a rotatable piston therein each having a passage, of an abutment valve provided with a supply passage extending between its opposite ends said supply passage being connected with the piston passage by that in the casing.

35. The combination with a casing and a rotatable piston therein, of an abutment valve provided with a supply passage extending between its opposite ends, the casing having separated passages registering with the valve passage, and means carried by the piston for controlling the flow through the supply passage.

36. The combination with a casing and a rotatable piston therein, of an abutment valve provided with a supply passage extending between its opposite ends and a branch passage opening from the supply passage and through the side of the valve, the valve delivering fluid through both the ends of the supply passage and through the branch passage.

37. The combination with a casing and a rotatable piston therein, of an abutment valve provided with a supply passage extending between its opposite ends, there being an exhaust passage in the casing controlled by the piston.

38. The combination with a casing and a rotatable piston therein, of an abutment valve provided with a supply passage, the piston having recesses and the casing having passages connecting said recesses with the supply passage of the valve.

39. The combination with a casing and a rotatable piston therein, of an abutment valve provided with a supply passage, the piston having inner and outer recesses and the casing having passages connecting said recesses with the supply passage of the valve.

40. The combination with a casing and a rotatable piston therein, of an abutment valve provided with a supply passage, the piston having inner and outer recesses of different length and the casing having passages connecting said recesses with the supply passage of the valve.

41. The combination with a casing and a rotatable piston therein, of a throttle valve, and a rotatable abutment valve provided with a supply passage, there being a plurality of connecting passages between the throttle valve and abutment valve, one leading to the supply passage of said valve and another to its periphery.

42. A rotary engine comprising a casing having a main chamber and a secondary chamber having an enlargement, a piston rotatable in the main chamber, a valve rotatable in the secondary chamber and having a projection extending into its enlargement, said valve being provided with a recess which may co-operate with the piston and a recess forming a portion of the main chamber and means for supplying pressure to the chamber enlargement to rotate the valve.

43. A rotary engine comprising a casing having a main chamber and a secondary chamber having an enlargement, a piston rotatable in the main chamber, a valve rotatable in the secondary chamber and having separated projection extending into its en-

largement and means controlled by the piston for alternately applying pressure to the projections.

44. A rotary engine comprising a casing having a main chamber and a secondary chamber having an enlargement into which a projection from the casing extends, said casing having supply passages leading to opposite sides of the projection, a piston rotatable in the main chamber and controlling the flow through the passages, and a valve rotatable in the secondary chamber and having separated projections lying in the enlargement at opposite sides of the casing projection.

45. The combination with a casing and a rotatable piston therein, of a throttle valve having ports of different length and an abutment valve provided with a supply passage, there being a plurality of connecting passages between the throttle valve and abutment valve.

46. The combination with a casing and a rotatable piston therein, of a throttle valve having ports of different length, an abutment valve provided with a supply passage, there being a plurality of connecting passages between the throttle valve and abutment valve, and an exhaust passage controlled by the piston.

47. An engine or motor comprising a casing, a rotary piston having segmental conduits on its outside faces arranged in series, and a piston-chamber centrally located in the casing, and four abutment valves arranged diametrically to each other around the outer periphery of the piston-chamber and operating together in sets or pairs of two, each pair located at right angles to a direct line between the other pair, each valve being adapted to furnish steam to operate the piston, one set acting to move the piston in one direction, and the other set to move it in the other direction, and said piston controlling the movements of said valves by its movement and steam passing through the center bore of the valves and segmental conduits in the two sides of the piston, the conduits in one side of the piston serving to operate one pair of valves and move the piston in one direction, and the conduits in the other side of the piston serving to operate the other pair of valves and to move the piston in the other or opposite direction.

48. An engine or motor comprising a casing, a piston chamber and a piston rotating therein, a series of abutment valve chambers surrounding said piston-chamber and oscillatory hollow center abutment valves therein, said hollow center forming a part of a main steam conduit, and the casing being provided with sets of intermediate and smaller conduits, each set consisting of three conduits practically parallel to each other, one end of each conduit leading to an abutment valve chamber, the center conduit of the three terminating at the end of the hollow center of an abutment valve, and the other two conduits in each set, and the conduits in the sides of the piston serving to take steam from the central conduit and alternately delivering it to an abutment chamber to operate the valve; and said piston having formed in each side of its outside faces three sets and three series of segmental grooves or connecting conduits of various lengths, one of said grooves or conduits of each set being adapted or fitted to take steam from the central or middle conduit of the set of three formed in the casing, and to discharge it into one of the two outside conduits in a set formed in the casing to operate the valve in one direction, and another conduit of the series in the face of the piston being adapted to take steam from said central conduit and to discharge it into the other outside conduit of the set formed in the side of the casing and to operate the valve in the other direction, while other segmental conduits in the face of the piston act to exhaust the steam from said conduits, the piston by its movement and the conduits on its sides completing the continuity between the various conduits in the sides of the casing and the hollow center abutment valves.

49. An engine or motor comprising a casing, a central piston-chamber, a rotary piston having sets and series of segmental grooves or conduits in both of its outside faces and rotating in said chamber, four abutment valve chambers formed in the sides of said casing and located at equal distances around the outer periphery of said piston-chamber and partly opening out into the same, abutment valves in said abutment-chambers oscillating upon hubs with hollow centers, and each valve having a lateral outlet for emission of steam into said piston-chamber, the said hollow centers forming an extension part or continuation of a main steam conduit from the steam source to and through a throttle-valve and to and through the hollow centers of said abutment-valves, and a plurality of smaller conduits adapted to furnish steam to said abutment-valves and formed in sets of three for each valve, and three of the series of the segmental grooves or conduits in the side of the piston being adapted to connect with the central conduits of the sets in the sides of the casing and adapted to take steam from the main conduit at each side of the central bore in the abutment-valve and convey it to one of the two outside conduits in a set in the casing to move a valve in one direction, and another segmental conduit of the set in the side of the piston being adapted to take and deliver steam from said central conduit and deliver it to the other outside conduit in the set to operate the valve in the other direction, and the

other series of segmental conduits in the sides of the piston being adapted to exhaust the steam from said smaller conduits and said abutment-valves on motion of the piston, and the piston being operated by means of steam passing through the conduits in its sides and through the hollow centers of the abutment-valves.

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

SILVANUS F. VAN CHOATE.

Witnesses:
C. F. BROWN,
E. BATCHELDER.