No. 826,985. PATENTED JULY 24, 1906.

D. APPEL.

ROTARY MACHINE.

APPLICATION FILED MAY 16, 1905.

5 SHEETS—SHEET 1.

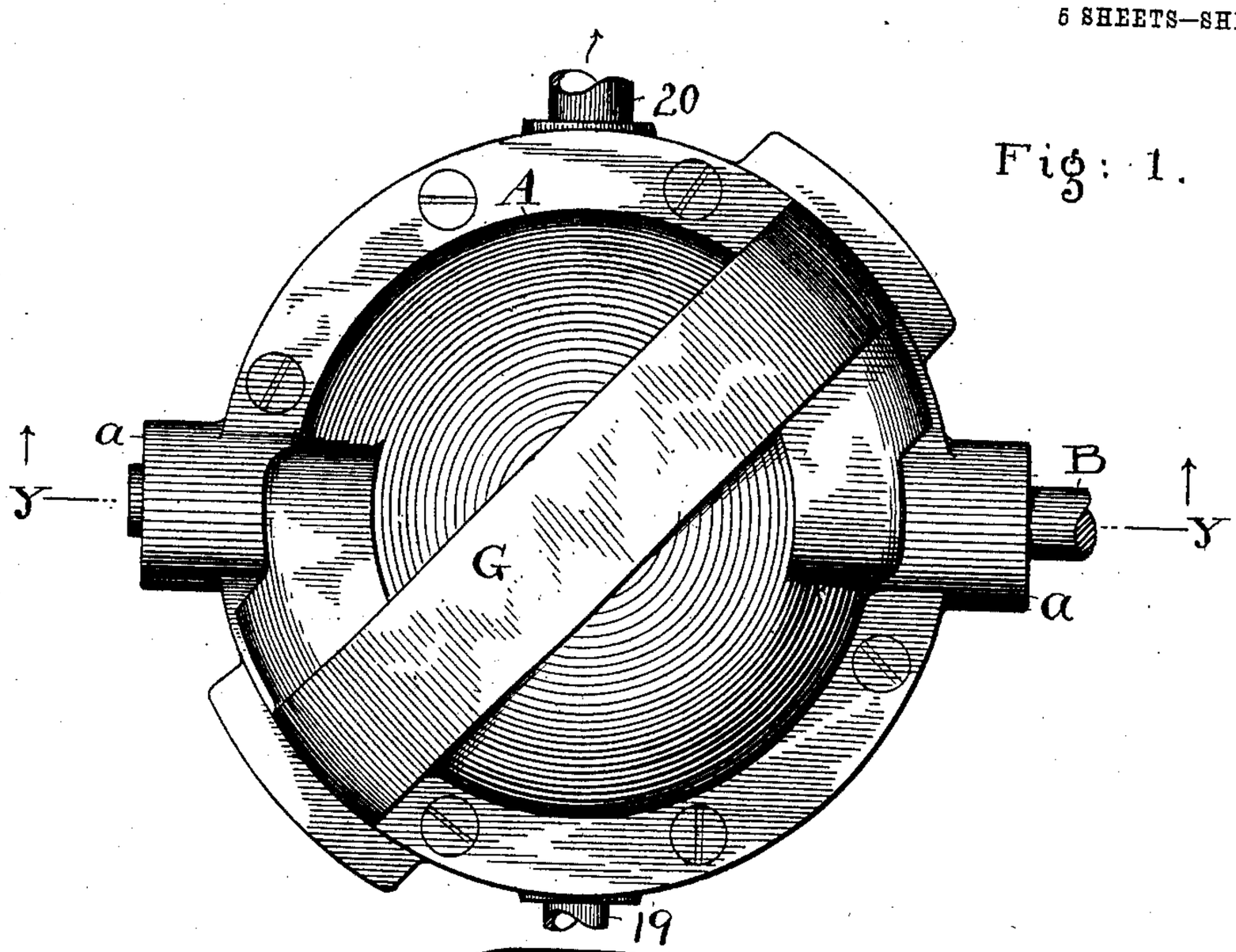

Fig: 1.

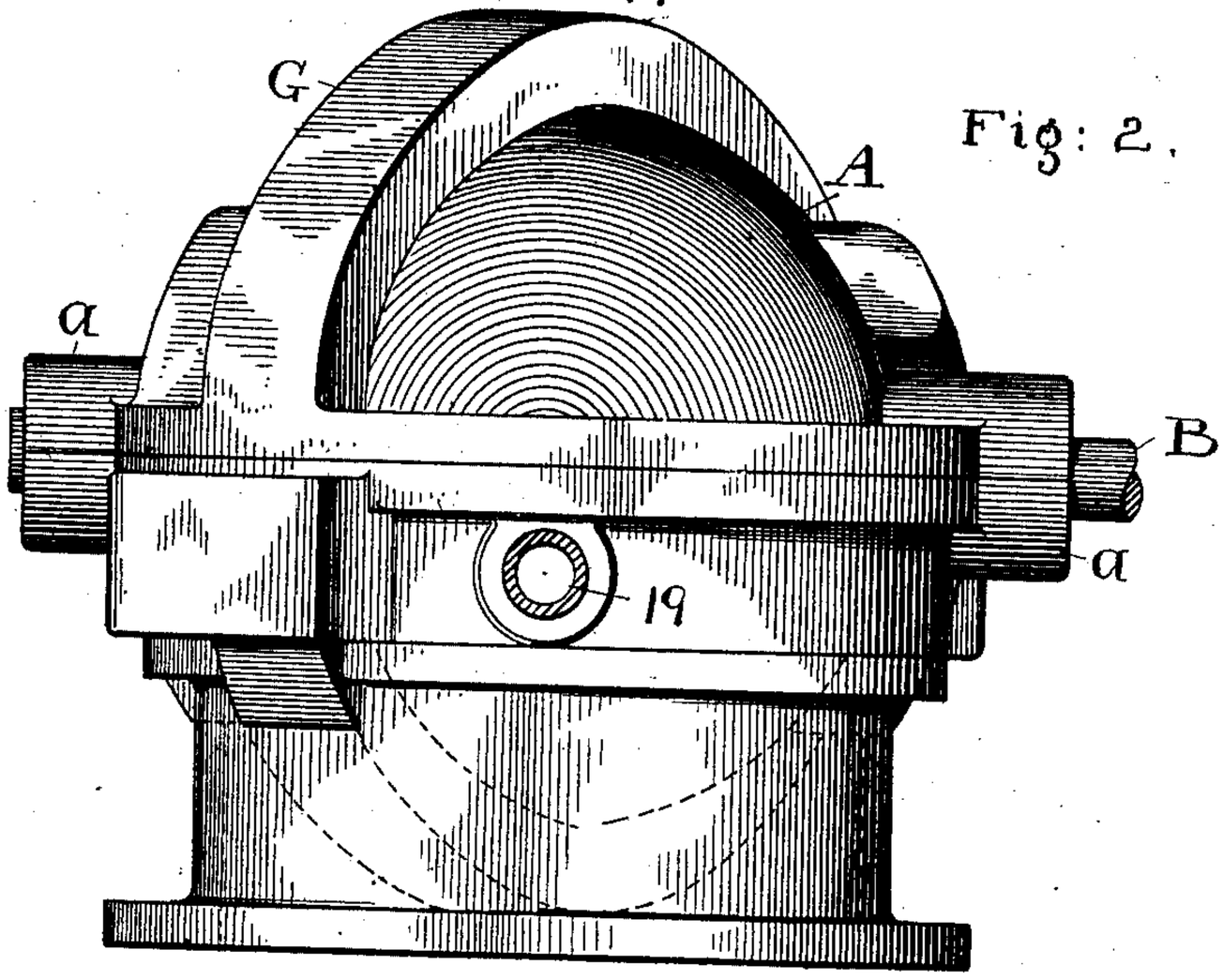

Fig: 2.

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5 SHEETS—SHEET 2.

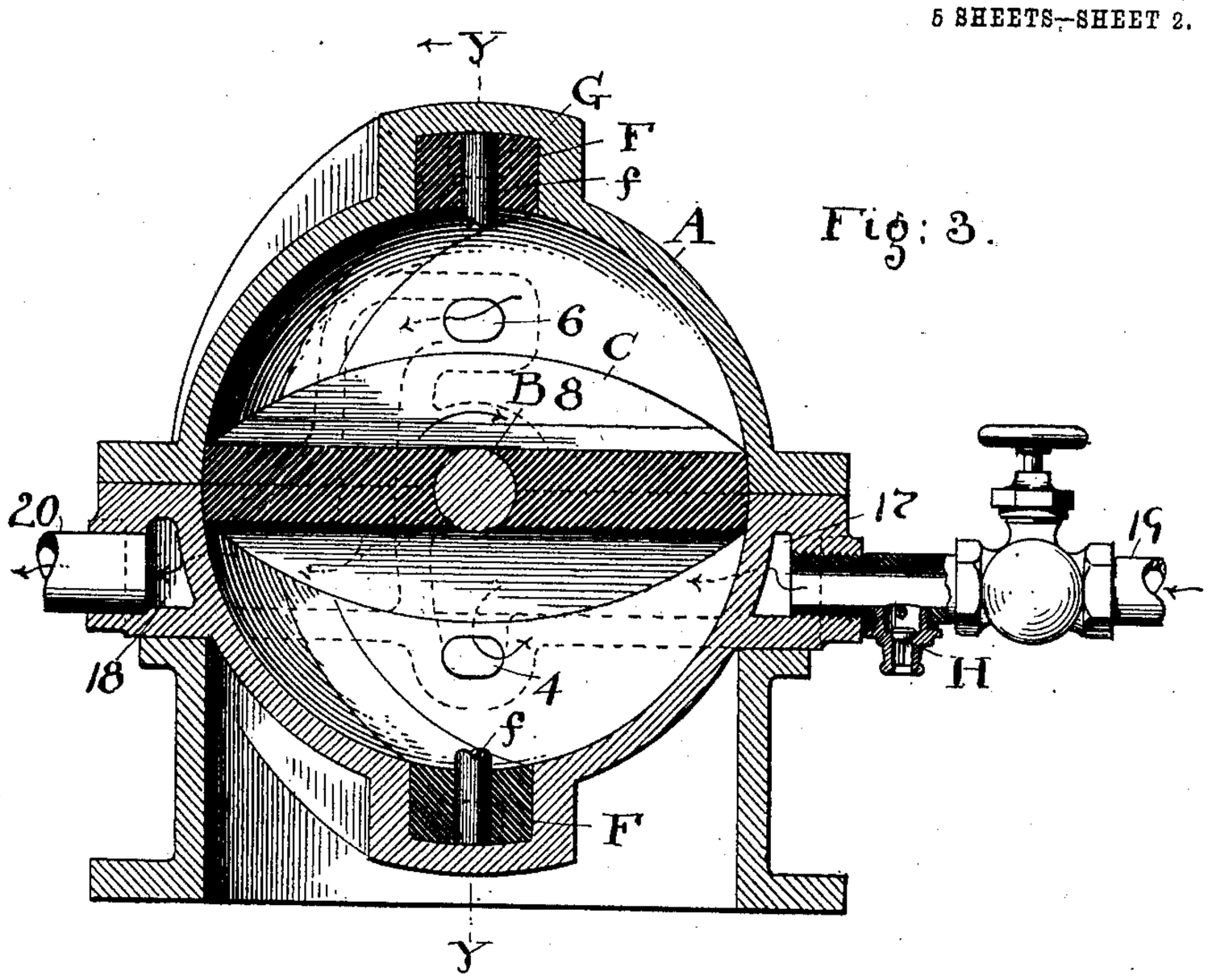

Fig: 3.

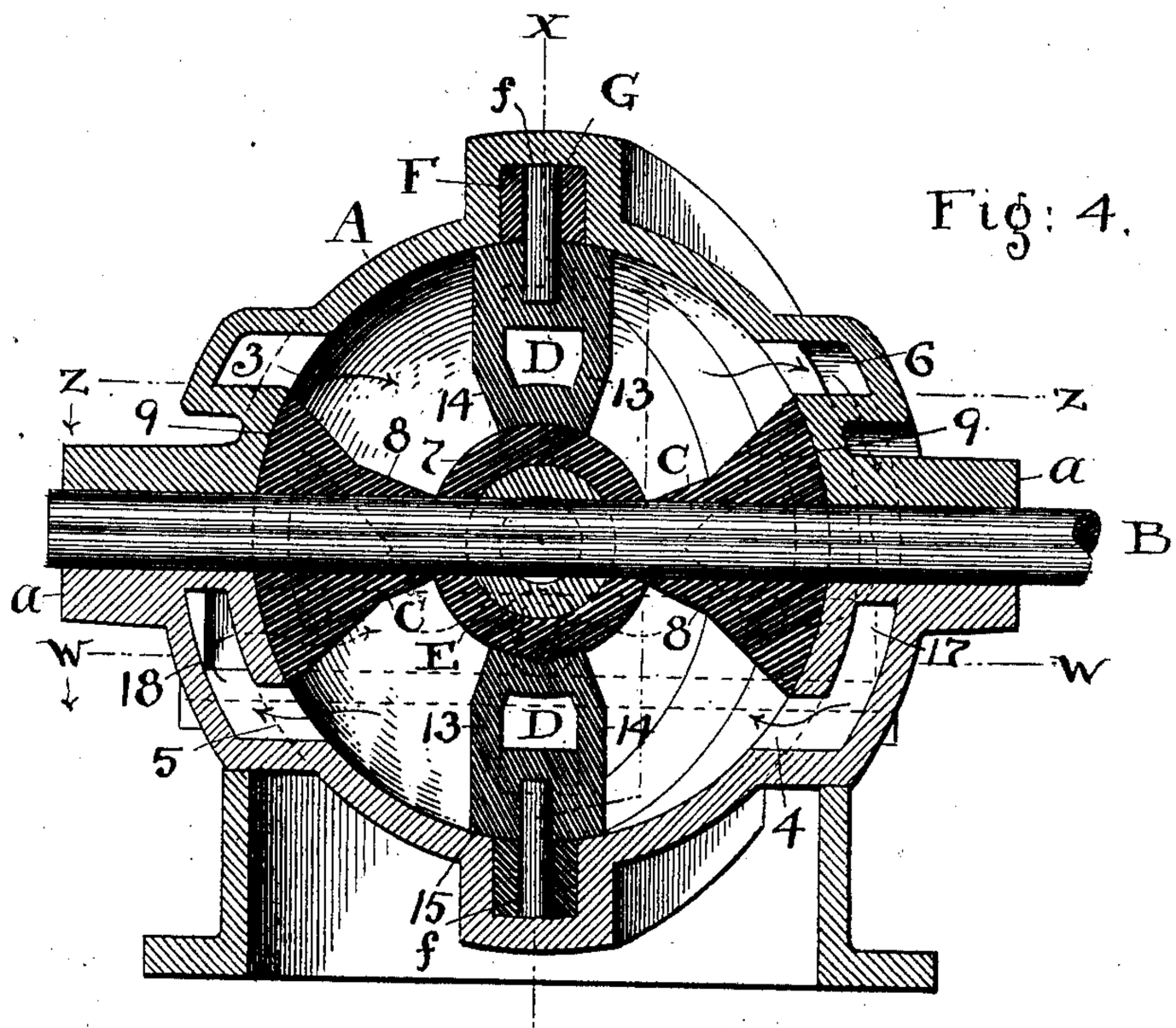

Fig: 4.

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5 SHEETS—SHEET 3.

Fig: 5.

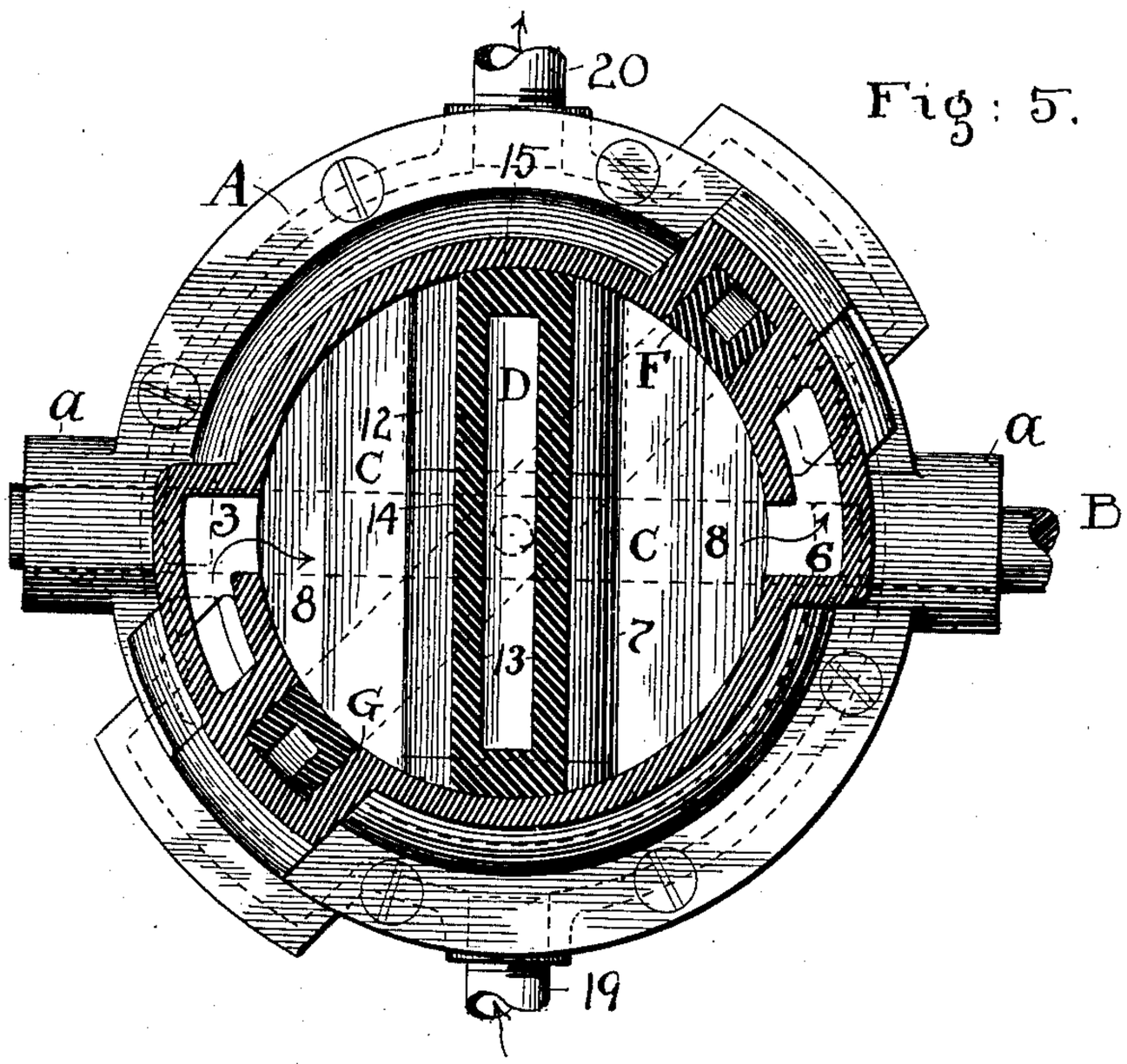
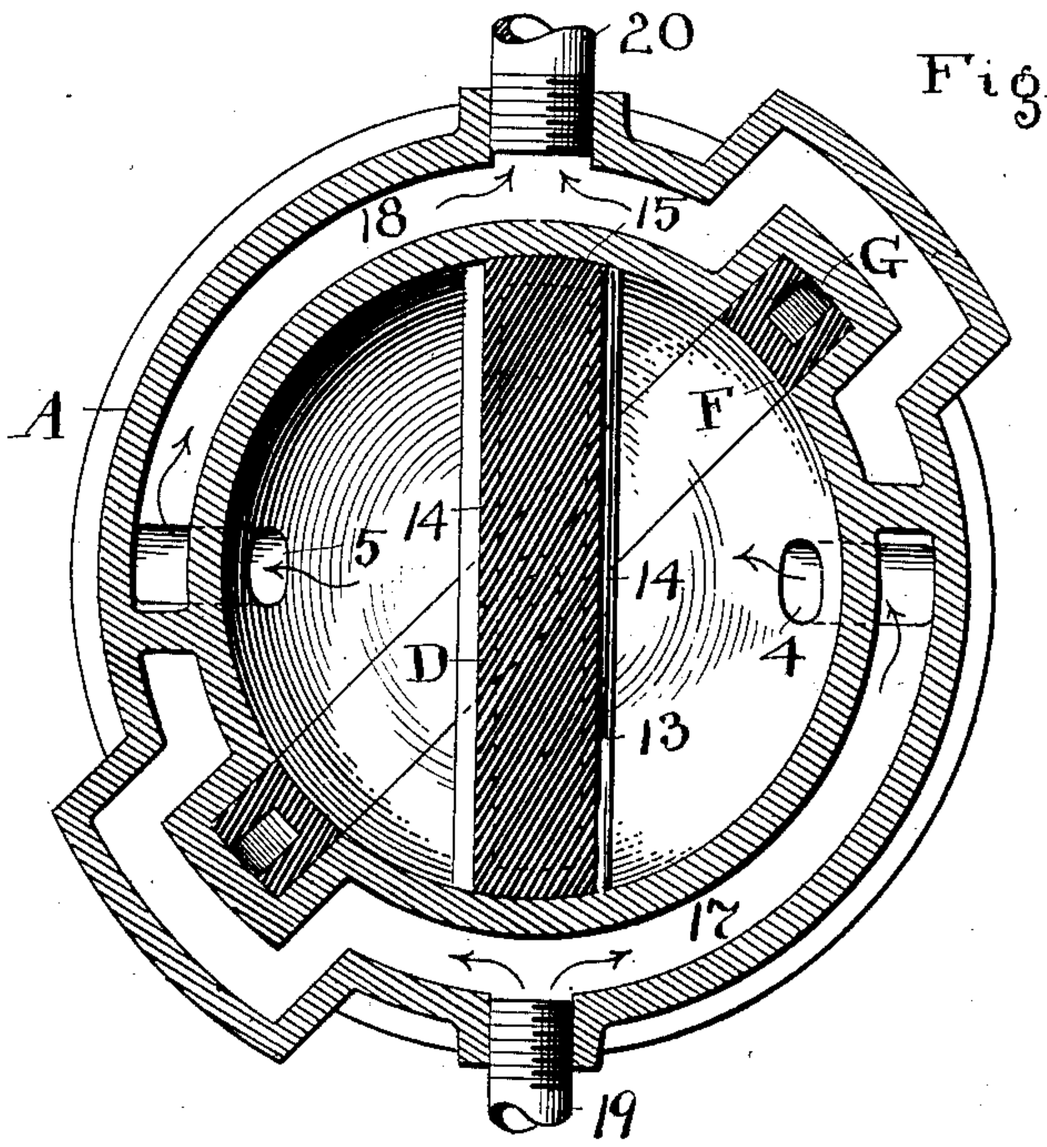


Fig: 6



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5 SHEETS—SHEET 4.

Fig: 7.

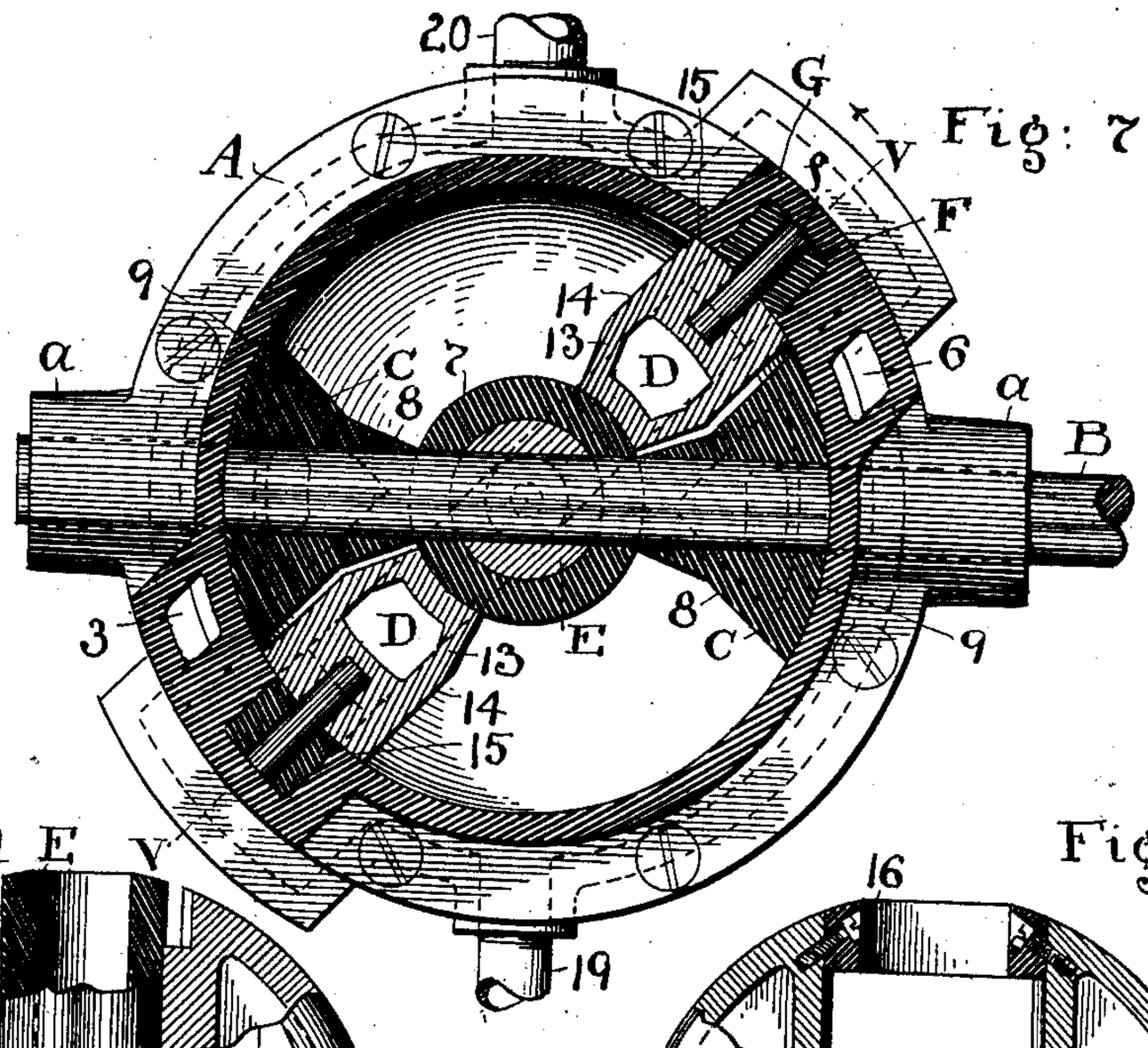


Fig: 9

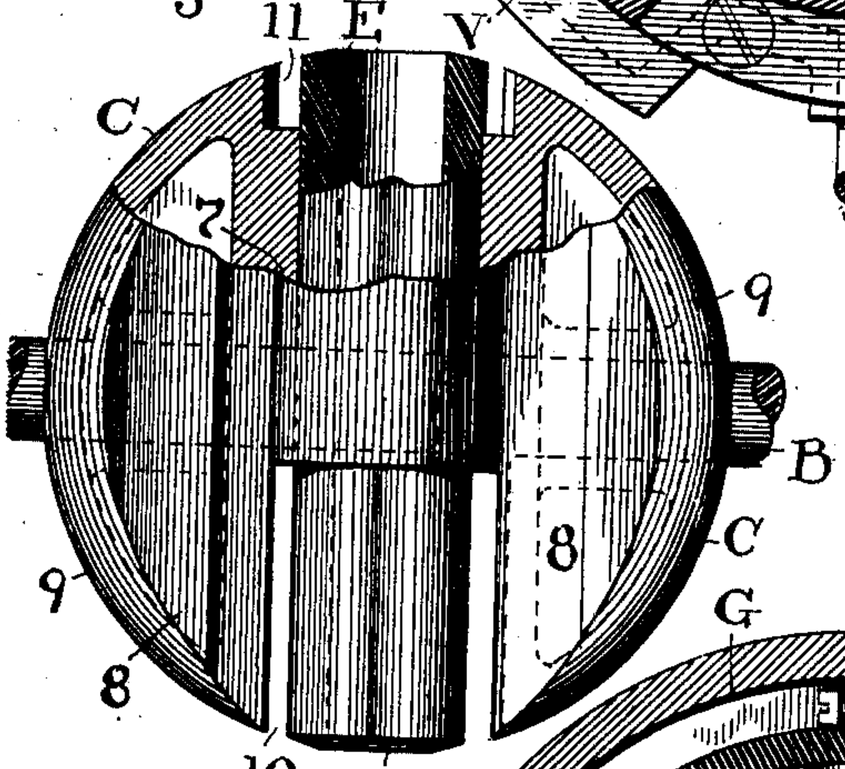


Fig: 10.

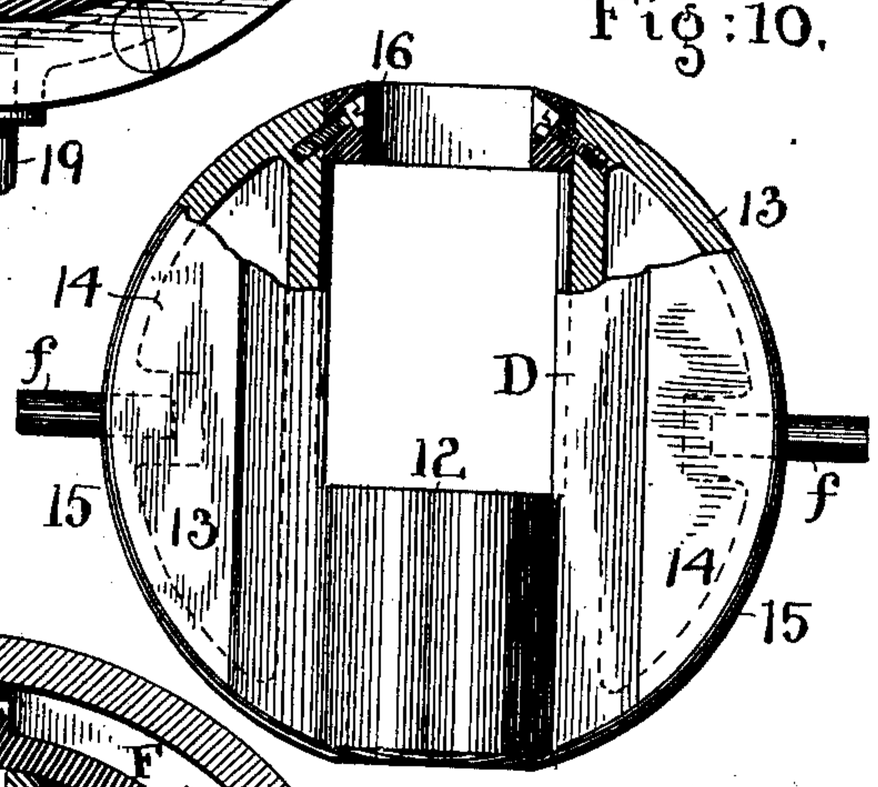
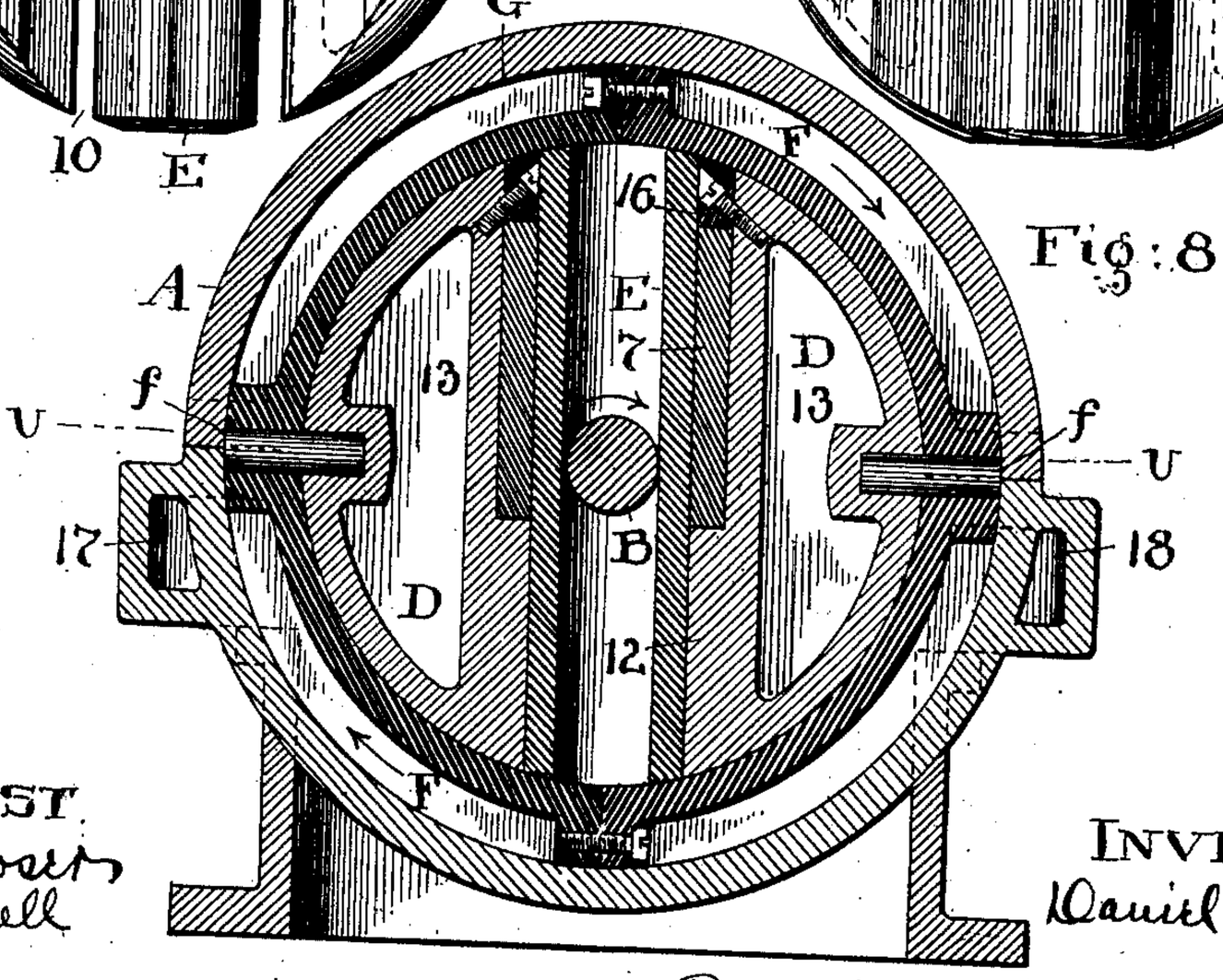


Fig: 8



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5 SHEETS—SHEET 5.

Fig: 11.

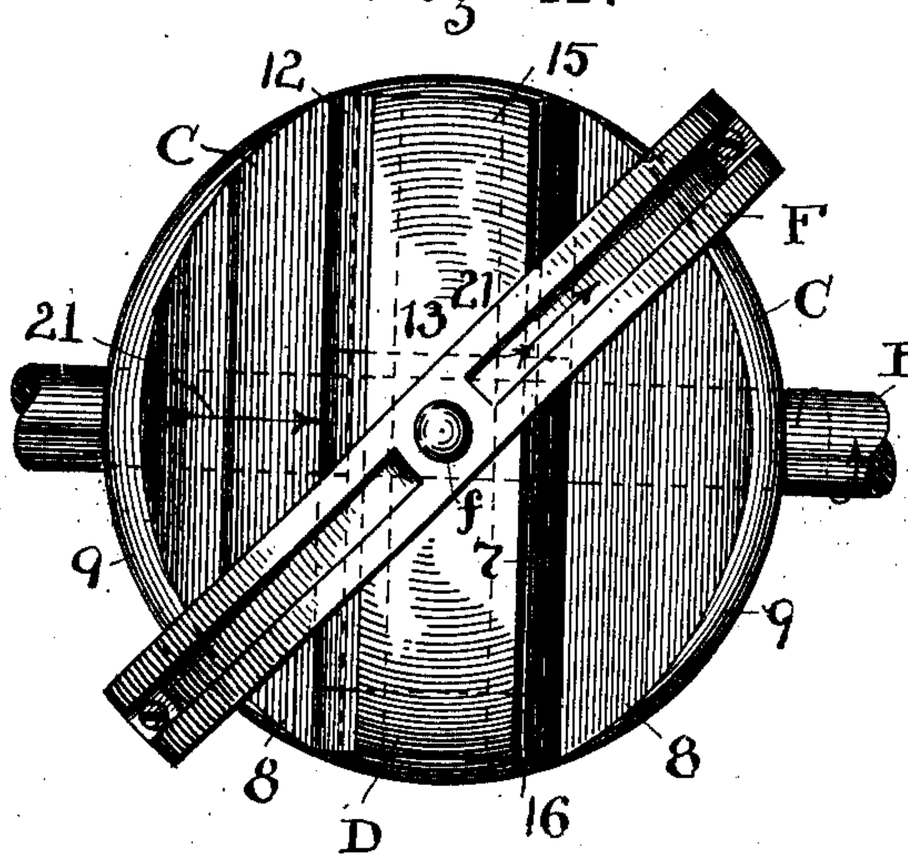


Fig: 12.

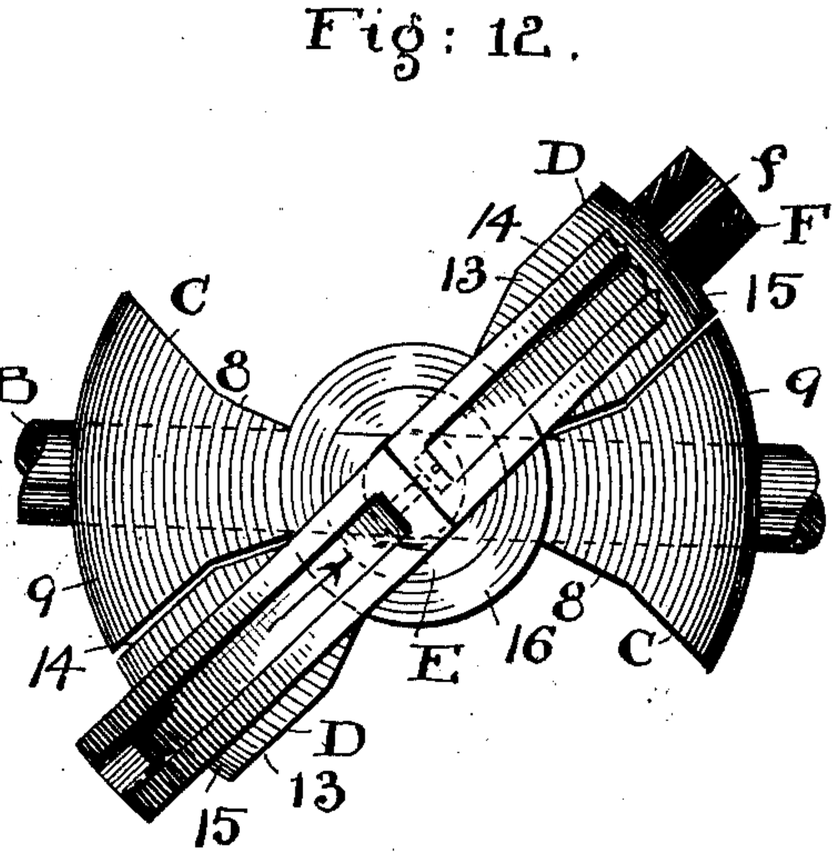


Fig: 13.

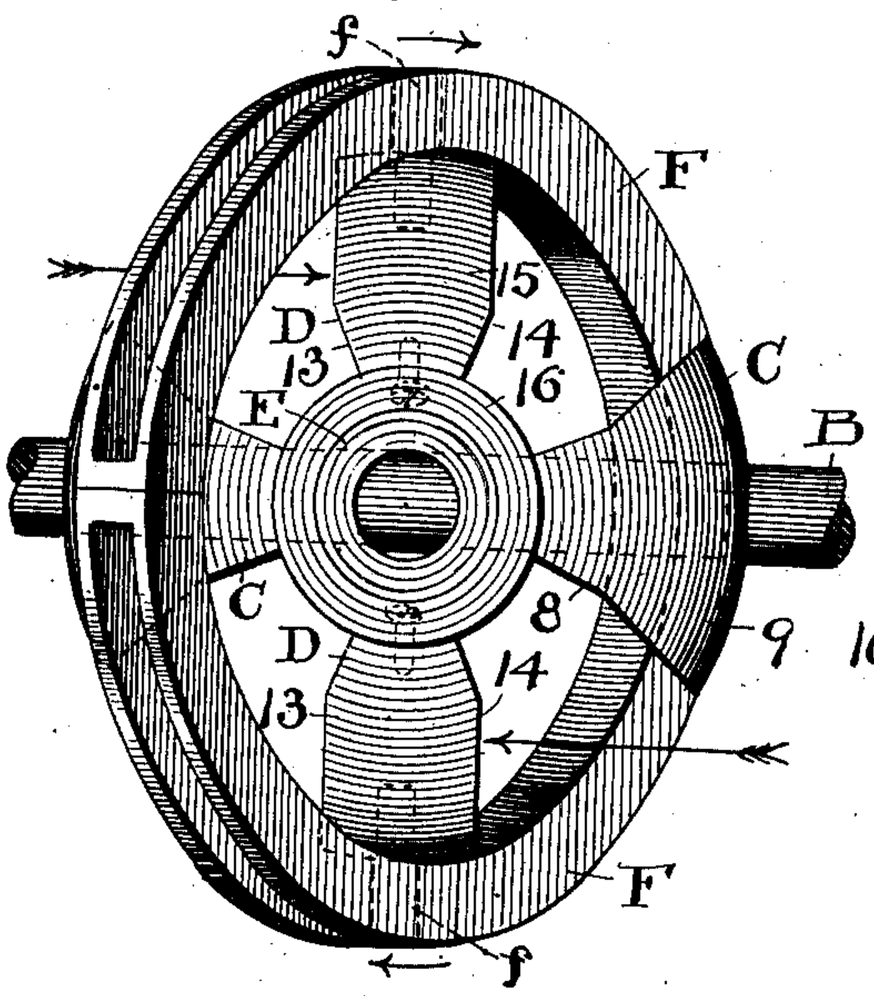
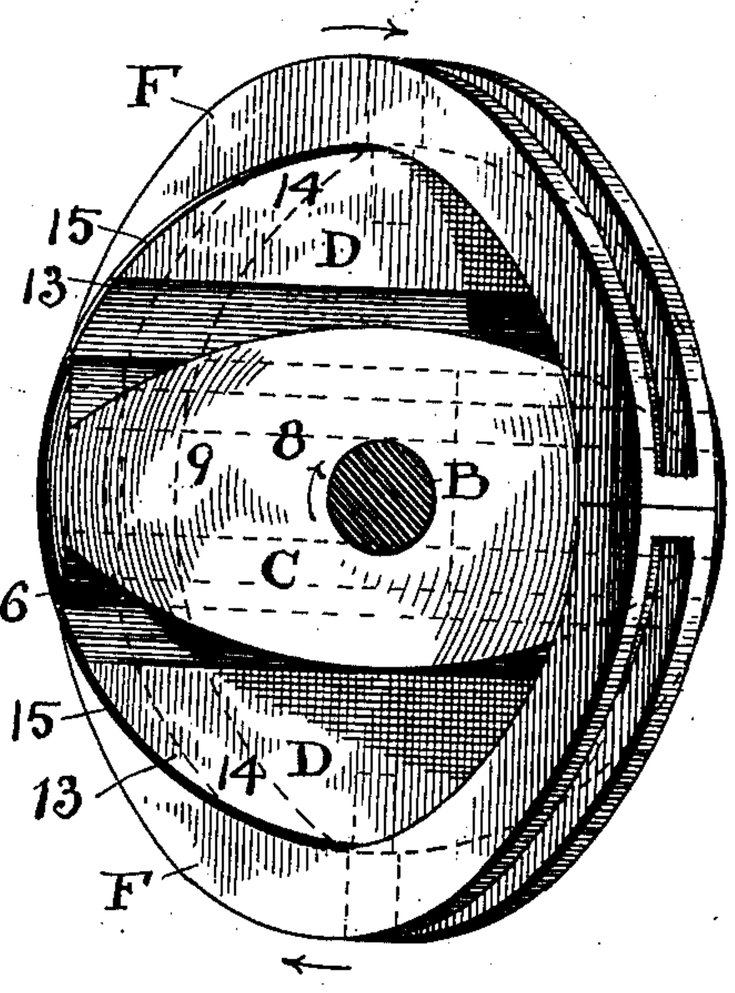


Fig: 14.



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UNITED STATES PATENT OFFICE.

DANIEL APPEL, OF CLEVELAND, OHIO.

ROTARY MACHINE.

No. 826,985. Specification of Letters Patent. Patented July 24, 1906.

Application filed May 15, 1905. Serial No. 260,366.

To all whom it may concern:

Be it known that I, DANIEL APPEL, a citizen of the United States, residing at Cleveland, in the county of Cuyahoga and State of Ohio, have invented certain new and useful Improvements in Rotary Machines; and I do declare that the following is a full, clear, and exact description of the invention, which will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to a rotary machine which it adapted to be used either as a motor to communicate power or as a pump or compressor adapted to have power applied thereto; and the object of the invention is to provide a machine which is simple in construction and efficient and economical in use and which by reason of its construction and manner of operation has exceptional possibilities as to speed and the development of power.

In my improved rotary machine the driving fluid acts upon constant surfaces of maximum area of piston and abutment during the entire stroke of the piston, so that the expansion of the fluid may be fully utilized in contradistinction to the principle embodied in most rotary engines having a crescent-shaped working chamber wherein the piston and abutment-surfaces are reduced to zero at each end with a changeable low average surface for power between. The design of this machine also permits the compounding of several engines when using steam, so that the exhaust from one motor may be directed to actuate another motor which necessarily is provided with working chambers of greater area, whereby the expansion of the exhaust fluid may be fully utilized. I may also place two or more motors on the same shaft, and they can be reversibly arranged by providing a reversing-valve which will exchange the inlet and exhaust ports with each other.

In its preferred form my improved rotary machine is double-acting and consists of a spherical casing within which two disks or segments of a sphere are rotatably fitted and so arranged that one serves as an abutment while the other serves as a piston, as hereinafter fully described.

In the accompanying drawings, Figure 1 is a plan view, and Fig. 2 is a side elevation, of my improved rotary machine as it appears mounted upon a cylindrical base. Fig. 3 is a vertical cross-section on line *x x*, Fig. 4, of the machine, showing an inlet and an exhaust port and a section of the main fluid-channel for the main admission and exhaust pipes. Fig. 4 is a vertical cross-section on line *y y*, Fig. 3, showing the piston in middle position to the abutment and with arrows showing the direction of the driving fluid to and from the inlet and exhaust ports. Figs. 5 and 6 are horizontal cross-sections of Fig. 4 on lines *z z* and *w w*, respectively, and showing by arrows the flow of the driving fluid in the main channel from the admission-pipe to and from the upper and lower ports to the main exhaust-pipe. Fig. 7 is a horizontal cross-section slightly above the shaft on line *u u*, Fig. 8, showing the piston one-quarter of a revolution in advance as compared with the foregoing described figures. Fig. 8 is a cross-section on line *v v*, Fig. 7, showing the hinge construction of piston and abutment disks with the guide-ring in its guide-groove, the arrows showing the direction of motion of the ring and shaft. Fig. 9 shows a side view of the abutment-disk with power-shaft and the hinge-pivot partly in section. Fig. 10 shows the piston-disk separately with thrust-collar at the top of the central hinge-slot and with the pivot-pins at each side, which connect said disk with the guide-ring. Fig. 11 is a plan view of the working parts with the piston and guide-ring in edge elevation, and Fig. 12 is a plan view of the same parts except that the parts are a quarter-turn advanced. Fig. 13 is a side view of Fig. 11, showing the working parts with the piston in middle position, and also showing end view of hinge and hollow pivot for the piston-disk, the arrows showing direction of motion of all the parts. Fig. 14 is an elevation of the parts in the relation as shown in Fig. 13, direction of motion of guide-ring and abutment with power-shaft indicated by arrows.

Referring to the several parts of the invention, A represents the casing, which is preferably made in two halves or sections meeting on the center line of the shaft B and fashioned to constitute a spherical chamber in which the actuating members of the invention are contained and adapted to rotate. These members consist, first, of a so-called "abutment-disk" C, fixed rigidly upon shaft B by spline or otherwise, and a so-called "piston-disk" D, supported across its center or middle part on a so-called "hinge" or tubular cross-shaft E, upon which it is adapted to oscillate or vibrate under the action of steam or other motive fluid within fixed limits in any case, but which limits may be

varied according to the angle at which the said disk or piston is set in respect to the abutment or abutment-disk C. In the present instance a forty-five-degree angle is used as compared with the central plane of the abutment, and the piston has a maximum movement of ninety degrees from one side of the abutment to the other. Piston-disk D is hinged to the abutment-disk C centrally between its ends at its greatest diameter and at right angles to power-shaft B, thus forming diametrically-opposed double chambers serving like purposes at opposite sides of said shaft.

In the working relations between the piston-disk D and the abutment-disk C the abutment may be regarded as being the same as if it were stationary, though it rotates with the shaft, and the equivalent of a crank action upon the shaft is obtained through and by reason of the angle thereto at which the piston-disk D is set and adapted to travel subject to the guide-ring F, which defines the orbit of the said disk. The said guide-ring is rotatably confined in a walled channel G, formed in spherical casing A and which circumscribes the power-shaft in an oblique direction at an angle of about forty-five degrees when viewed from the top, and the piston is pivotally and operatively connected with said ring by means of pivot-pins *f* or their equivalent. The said ring F is caused to travel or run in said channel or groove under pressure against piston-disk D and serves as a guide for the disk as it travels around the shaft and inclines first in one direction thereto and then in the opposite direction according to its position in the orbit of its travel. Suitable inlet and exhaust ports are provided, one of each within approximately forty-five degrees of the power-shaft on each side of the spherical casing A and in a vertical line with the shaft. The motor may be operated by any fluid under pressure. To this end I provide two inlet-ports 3 and 4 for the motive fluid and two exhaust-ports 5 and 6; but I might use only one port of each kind, if preferred This affords pressure on corresponding sides of both wings or blades of piston-disk D at the same time with a double-acting effect, and the exhaust is shown as above at one side and below at the other, according as the inlets are above and below, respectively, and both sets of inlet and exhaust ports are controlled by the enlarged outer portions of the abutment, and both sets are closed when the piston is at dead-center position. In this position the piston stands in a plane with ring F and as shown in Figs. 1 and 10. Now assuming that the abutment-disk is in a position to cover all the ports, as it is designed to do at dead-center, and then by turning the power-shaft a few degrees to clear or free the ports from the abutment, and thereby permitting steam to enter between the abutment and the piston-disk, the piston-disk will be pushed away from the abutment in a direction parallel to the power-shaft, and being pivotally connected to guide-ring F it is also compelled to follow guide-groove G, which carries the piston-disk diagonally over an arc of one hundred and eighty degrees to the opposite side of the sphere and to the other side of the abutment, and as the abutment is hinged to the piston-disk it also makes a half-revolution and again covers all the ports; but as the new cycle begins fluid will enter the adjacent chambers while the former chambers are opened to exhaust.

I have so far, to avoid complication, only referred to a single unit, although the machine is double-acting, and my object in arranging this motor to be double-acting is due to the difficulty experienced in a single-acting motor working on the same principle. With a double motor action I not only obtain a perfect balance of all the rotating parts, but also eliminate all frictional resistance by admitting and exhausting the driving fluid at diametrically opposite points, thereby equalizing the effect of the forces on all bearings.

As will be noticed from the foregoing description, there are but three working parts, all of which rotate continuously with the power-shaft, and all are contained in a dust-proof chamber, permitting of the simplest form of lubrication, and as the abutment-disk covers and uncovers the inlet and exhaust ports successively at the face of the working chamber there is no inactive or waste fluid, thereby effecting steadiness of motion and economy in fuel.

The working parts of the motor may be inspected by removing the upper half of the centrically-dividing casing A, which is free from admission and exhaust pipe connections and which is possible because the upper and lower half of the shaft-bearings *a* form a part of each half of the casing. The contact-friction of the moving parts is practically taken up by packing-rings and other means of usual design, which for clearness of illustration I have omitted from the drawings.

In detail the abutment C comprises a central hub 7 with integral oppositely-extending disk portions 8, having a substantially semicircular outlined face 9 upon opposite sides of power-shaft B, which passes centrally through said hub 7 and portions 8, and the outer face 9 of disk portions 8 conforms to the spherical shape of the interior of casing A. Tubular cross-shaft E has a cross-passage centrally between its ends, through which power-shaft B passes and extends at either side and at right angles thereto. Hub 7 is greatly shortened in respect to cross-shaft E to provide recesses or pockets 10 and 11, respectively, within which certain parts of piston D are adapted to fit and rotate. Thus piston

D in detail also comprises a central hollow hub 12 of a length and diameter to fit upon cross-shaft E within recess or pocket 10, and a pair of disk wings or blades 13, integral with hub 12, extend at opposite sides thereof and have oppositely-disposed semicircular outlined faces 14 and an edge face 15, conforming in contour with the spherical interior of casing A. A collar 16, detachably secured to opposite ends of disk-wings 13 and arranged at one side and in axial line with hub 12, is adapted to sleeve over one end of tubular shaft E and fit within recess or pocket 11 within abutment C, and said collar serves as a thrust-bearing for piston D and holds the parts in working relation as against centrifugal action. Otherwise piston D would bear against casing A and cause wear and undue friction.

Guide-ring F is preferably made in two halves or sections screwed together at their meeting ends, as seen most clearly in Fig. 8.

The lower half of casing A has a steam-inlet channel 17 and a steam-exhaust channel 18 about its circumference, and which connect with intake-pipe 19 and exhaust-pipe 20, respectively. Inlet-ports 3 and 4 have open connections with channel 17, and exhaust-ports 5 and 6 open to channel 18. I further provide intake-pipe 19 with a relief-valve H, which is normally closed or held to its seat by the fluid-pressure when the machine is running, but which will automatically open when the supply is cut off to prevent a vacuum forming within the working chambers, and thereby avoid sudden stoppage and undue strain upon the machine as a whole or in part.

In a steam-driven machine the operation is as follows: The steam from ports 3 and 4 enters the working chambers behind both piston-wings 13 and acts thereon to move them to the opposite side, the upper and lower wings 13 moving, of course, in opposite directions. When the wings reach the exact half-way position between the opposite abutment-disk portions 8 and the piston stands exactly at right angles thereto, all the inlet and exhaust ports are wide open. Following the movement of the parts from this position onward it will be seen that as the steam under full head forces the wings over power-shaft B is compelled to rotate, because guide-ring F through its pivot-pin connection with piston-wings 13 is rotated within its groove G. Thus in Fig. 11 it will be seen that as force is applied to the left side of wing 13, as shown by arrow 21, the movement of ring F is also in that direction, but at an angle thereto, as shown by arrow 22. Ring F must rotate with this pressure exerted upon pivot-pin 2, and it follows that piston D also rotates in the same direction and carries all the connected parts and shaft B with it. A quarter-rotation of the parts from the half-way position (seen in Fig. 11) carries the wings 13 into the relation with abutment C, as seen in Fig. 12, and when these relations are present abutment portions 8 are at right angles to what they were before and all the ports are closed. When this dead-center point is passed, communication between the ports and the chambers is again effected by the consequent uncovering of the ports by portions 8; but now the steam enters the chambers between the face of the wings which lie in closest relations to the face of the abutment, and which chambers were just previously open to the exhaust-ports. The chambers at the other side of wings 8 are now open to the exhaust, and each chamber is successively brought into open communication with an inlet-port and an exhaust-port during one revolution of the shaft.

The machine, as thus shown and described, is valveless and is designed to be used on automobiles and other vehicles, and therefore may be made as light and portable as such service will require. Furthermore, as above indicated, the machine may be used as a pump without any alteration mechanically and by simply driving the same instead of developing power thereby, and it may also be used as a blower, only on a larger scale and for motive or pumping purposes.

Among the distinguishing features of this machine the following may be especially noted in this connection:

First. That the full area of each wing of the piston is exposed to the power from intake to exhaust.

Second. That the active surfaces or area of both piston and abutment or abutment-wall are equal and that they remain equal from intake to exhaust.

Third. That the entire surface of each piston-wing from hinge to edge is an invariable constant surface from intake to exhaust and that the vibration of said piston as to its axis is always at right angles to the abutment-wall.

Fourth. That abutment-wall and piston rotate together about the fixed axis of said wall and remain at right angles to each other at their intersection throughout their operations.

Fifth. That by reason of the oblique edge pivots of the piston in respect to the axis of the abutment-wall the equivalent of a crank action is obtained to rotate the said wall and transmit the power from the piston.

Sixth. That the driving fluid rotates with the working members for a radius of one hundred and eighty degrees.

Seventh. That the driving fluid is active on the full area of the exposed wing of the piston during the whole of a single cycle of one hundred and eighty degrees.

Eighth. That one-half of both sides or wings of the piston are simultaneously active during the whole cycle of one hundred and eighty degrees

Ninth. That the driving fluid is confined by and rotates with the working members while exerting power thereon.

Tenth. That the expansive power of the driving fluid is exerted on both working members oppositely from naught to one hundred and eighty degrees during a travel of one hundred and eighty degrees.

Eleventh. That the piston is pivotally engaged with an independent or separate guide therefor, which travels in its orbit in the casing, and the piston is free to vibrate across said orbit.

Twelfth. That the piston oscillates parallel to the power-shaft and vertical to the abutment-wall and at an angle across its guide.

Thirteenth. The piston edge of this motor has uniform surface contact during each cycle and each revolution. The abutment edge has uniform and unvariable surface contact during entire revolution.

Fourteenth. The piston-disk has uniform and unvariable contact with the wall of the main chamber and with hinge and pivot of abutment, while abutment-disk has uniform and unvariable contact with the wall of the main chamber and with hinge of piston.

Fifteenth. The main chamber is perfectly spherical and serves equally as a working chamber for the piston and for the abutment, and every fraction of the working surface is engaged at every revolution by both.

Sixteenth. A single port charges each working chamber, and a single port exhausts each working chamber, and a single main supply and a single main exhaust communicate with the several ports.

Seventeenth. The piston-disk and the abutment-disk are constantly in contact with the guide or bridge ring, and the piston and abutment successively traverse the guide-groove at every revolution.

What I claim is—

1. In a rotary machine, a casing having inlet and exhaust ports and a rotatable power-transmitting abutment-wall subdividing said casing, a piston extending centrally through the said wall to opposite sides thereof and adapted to oscillate and thereby impart a rotary motion to said wall, said piston having its entire active surface exposed to the power fluid from inlet to exhaust.

2. In a rotary machine, a spherical casing, a power-transmitting wall rotatably mounted in said casing, and an oscillating power-piston hinged across the center of said wall and equally exposed on opposite sides thereof, said piston and wall having uniform and unchanging active surfaces and rotatable together.

3. In a rotary machine, a casing having inlet and exhaust ports and a rotatable wall centrally thereof adapted to transmit power, in combination with a piston intersecting said wall at right angles across its center, and means to cause said piston to oscillate obliquely to the axis of said wall and thereby impart a rotary motion to said wall and piston.

4. In a rotary machine, a chamber and a rotatable power-transmitting wall subdividing said chamber, a piston pivoted across the center of said wall at right angles to its axis and adapted to swing from side to side in respect to said wall, and means to cause said piston to assume an oblique angle to the plane of said wall and thereby convert the power into a rotary motion for said piston and wall together.

5. A rotary machine having a rotatable shaft and an abutment-wall fixed on said shaft and in the same plane, and a piston-disk hinged at its center and adapted to oscillate on said hinge in respect to said abutment-wall.

6. In a rotary machine, a spherical casing, a rotatable abutment-wall therein and a piston-disk centrally across the same and in hinged relation therewith, a guide having an orbit in said casing at an oblique angle to the axis of said abutment-wall and provided with pivots on which the said piston-disk is adapted to oscillate across the plane of the orbit of said guide.

7. In rotary machines, a casing and a rotatable subdividing-wall therein, and a piston hinged at its middle in said wall and having a portion of its edge pivotally confined to an orbit at an angle to the axis of said wall.

8. In rotary machines, a spherical chamber a rotatable abutment-wall therein having fixed bearings, a piston-disk having its axis centrally across said wall, and means engaged with the edge of said disk to cause the disk to oscillate obliquely as it rotates.

9. In rotary machines, a spherical chamber, a rotatable abutment-wall therein having fixed bearings, a piston hinged centrally at right angles to said wall and rotatable therewith, and rotatable means in the wall of said chamber adapted to travel at an angle of inclination to the axis of said abutment-wall and having said piston pivotally engaged therewith, whereby said disk is caused to oscillate as it rotates.

10. In a rotary machine, a rotatable abutment-disk and a piston-disk extending through said abutment-disk, and a traveling pivot-point for said piston-disk at its edge on which it is adapted to oscillate.

11. A rotary machine having an abutment-disk rotatable about a fixed axis and a piston-disk hinged at its middle midway across said abutment-disk and rotatable therewith, and a rotatable guide outside both said disks with which the piston-disk has pivoted connection.

12. In a rotary machine, a rotatable abutment-wall having a fixed axis and a piston-disk hinged at right angles to the said axis

across the middle of said abutment-wall, and a guide provided with pivots for said piston-disk and adapted to travel in a fixed orbit at an inclined angle to the plane of said abutment-wall.

13. In rotary machines, a spherical casing comprising base and cover sections dividing at the center of the power-shaft and supply and exhaust connections on the said base-section, thereby leaving the cover-section free to be detached without disturbing said connections, in combination with an abutment and a piston rotatable with said abutment adapted to traverse the said supply and exhaust connection.

14. A spherical casing having its line of division central and lengthwise to the power-shaft and provided with a guide-channel centrally at right angles to said division-line, and supply and exhaust connections on said base-section, whereby the working parts may be readily inspected and removed by taking off the cover-section and without disturbing the permanent supply and exhaust connections.

15. In a rotatable machine having a power-shaft, a rotatable abutment-disk having said shaft extending diametrically through its center and provided with port-controlling enlargements on opposite sides of said shaft, and a casing having ports located in the path of said enlargements.

16. In a spherical rotary machine, a casing comprising a base-section and a power-shaft on which said sections divide, supply and exhaust connections secured to the said base-section and an endless guide-channel across both said sections at an inclination to the axis of said shaft, whereby the cover-section may be conveniently taken off and the working members inspected or removed from the casing without disturbing any permanent connections.

17. In a rotary machine, an abutment-disk, a piston-disk engaged at its center across the center of the abutment-disk and at right angles to the axis thereof, and a traveling circular guide with which said piston-disk is pivotally engaged at its periphery.

18. In a rotary machine, a rotatable abutment-disk an oscillating piston-disk hinged centrally across the middle of said abutment-disk, and a guide-ring operatively connected with said piston-disk and encompassing both said disks.

19. In a rotary machine, a suitable casing, a rotatable abutment-disk therein having fixed bearings, a piston-disk hinged across the center of said abutment-disk, a ring adapted to travel rotarily in said casing and opposite pivot connections between said ring and the said piston-disk.

20. In a rotary machine, a casing having a spherical chamber provided with a channel extending around the wall thereof, a guide-ring slidably mounted in said channel, a piston-disk pivotally engaged with said ring at its edge and an abutment-disk traversed by said piston-disk.

21. In a rotary machine, a casing having a spherical chamber and a ring-shaped channel extending around the same, a guide-ring mounted in said channel, an abutment-disk rotatably supported in said chamber and having its axis extending centrally through the same at an angle to the said ring, and a piston-disk hinged at its center and engaged at opposite points at its edge with the said guide-ring.

22. The casing having a chamber with a channel about the same, an abutment-disk rotatably mounted in said chamber at an angle to said channel, a guide-ring rotatably mounted in said channel and a piston-disk hinged at its center across the center of said abutment-disk and having opposite pivot connections with said guide-ring.

23. The casing having a spherical chamber and a guide-channel about the same, a main shaft and an abutment-disk mounted thereon at an angle to said channel, a piston-disk hinged at an angle across said abutment-disk, and a guide-ring in said channel operatively engaged with the edge of said abutment-disk and flush with the wall of said chamber.

24. The casing having a spherical chamber and a ring-shaped guide-channel about said chamber, a guide-ring occupying said channel and having its inner surface flush with the surface of the said chamber, a piston-disk and pivots connecting the edge thereof with said ring, an abutment-disk in said chamber at an angle to the said ring and a shaft on which said abutment-disk is fixed.

25. The casing having inlet and exhaust ports, an abutment-disk constructed to control said ports, a piston-disk mounted at an angle across said abutment-disk, and a rotatable guide with which the said piston-disk is operatively engaged at its edge.

26. The casing having a spherical chamber and inlet and exhaust ports, a shaft centrally through said chamber and an abutment-disk fixed thereon and constructed to control said ports, a piston-disk hinged across said abutment-disk and means to cause said disk to oscillate to and fro in respect to the said abutment-disk.

27. A rotary machine having an inlet and an outlet for fluid-pressure and comprising rotating and oscillating members in combination with an automatic relief-valve for the fluid-inlet of said machine.

28. In a rotary machine, a set of rotatable power members having opposed working surfaces of a fixed area during an entire cycle of rotation and one of said members adapted to oscillate obliquely in respect to the axis of rotation of both members.

29. In a rotary machine, a set of power members comprising a rotatable abutment and an oscillating piston adapted to rotate with said abutment, said abutment and said piston having opposed working surfaces of a given area adapted to operate with an unvarying exposure during their entire travel.

In testimony whereof I sign this specification in the presence of two witnesses.

DANIEL APPEL.

Witnesses:
R. B. MOSER,
C. A. SELL.