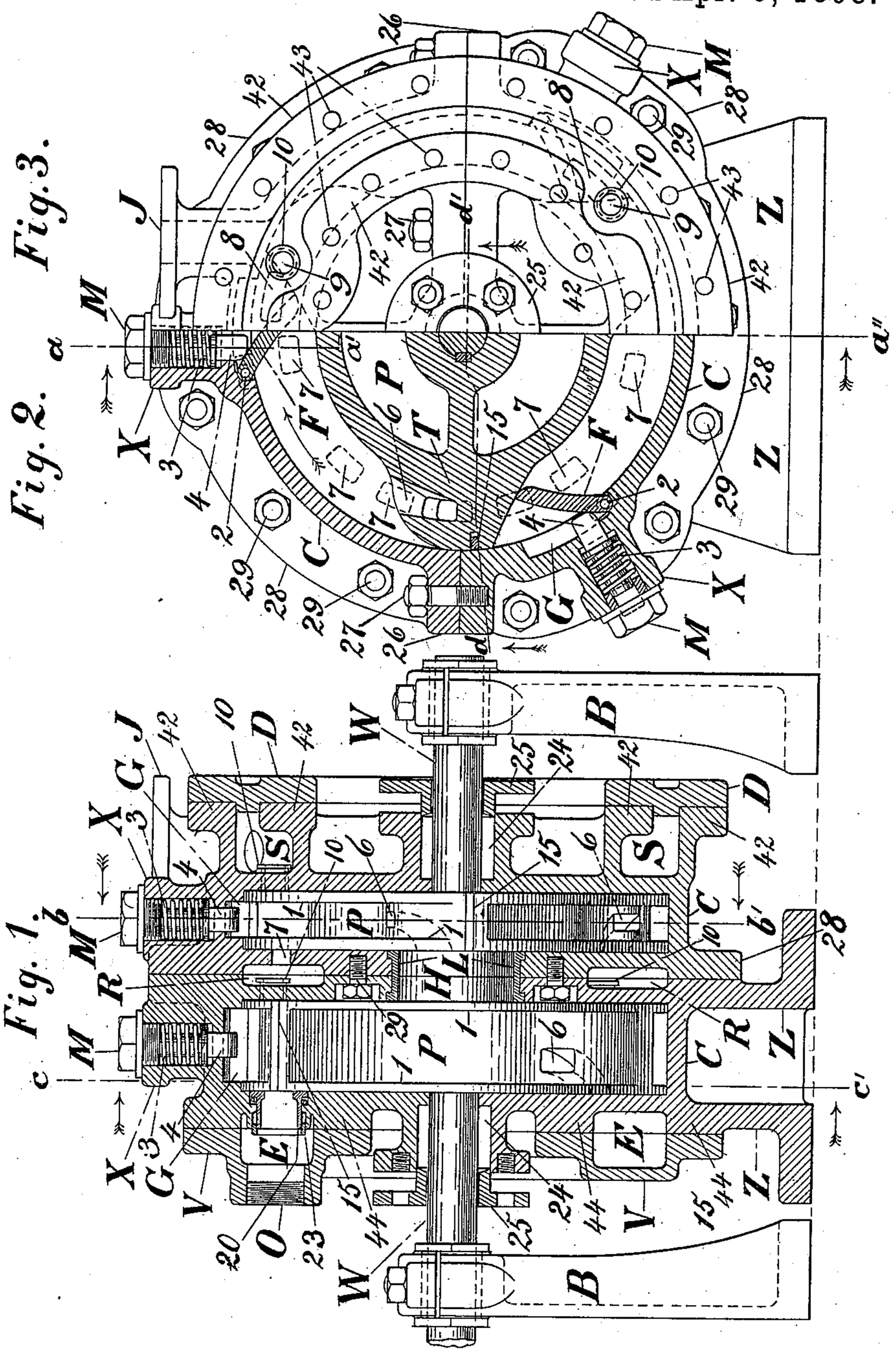
(No Model.)

4 Sheets—Sheet 1.

J. H. MEYER.

ROTARY ENGINE.

No. 601,854. Patented Apr. 5, 1898.



WITNESSES

Mm. Lord

Sam'l Kirkpatrick

INVENTOR.

John H. Meyer

BY

Thos. D. Mowdy

ATTORNEY

(No Model.)

4 Sheets—Sheet 2.

J. H. MEYER.

ROTARY ENGINE.

No. 601,854. Patented Apr. 5, 1898.

Fig. 4.

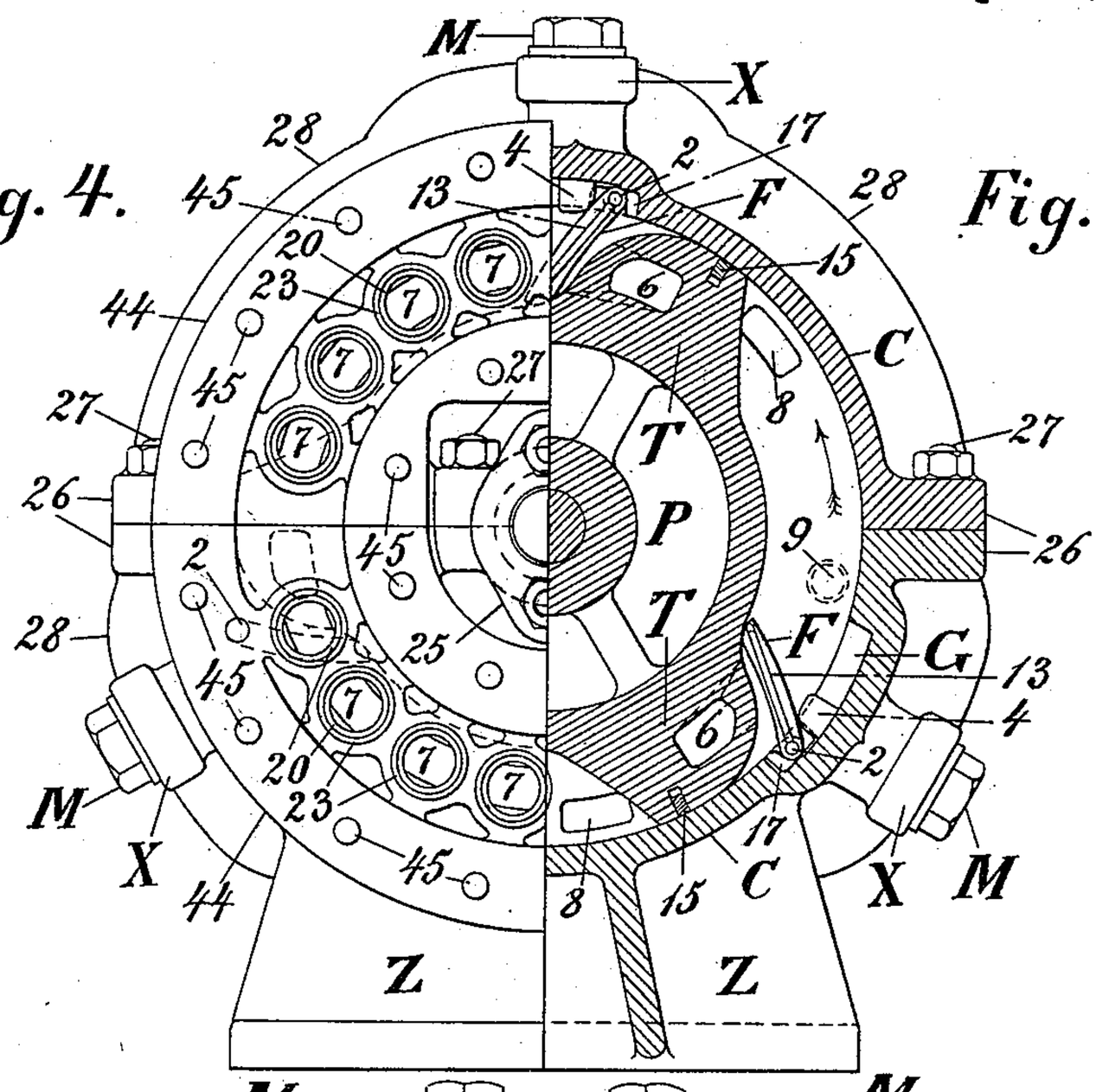


Fig. 5.

Fig. 6.

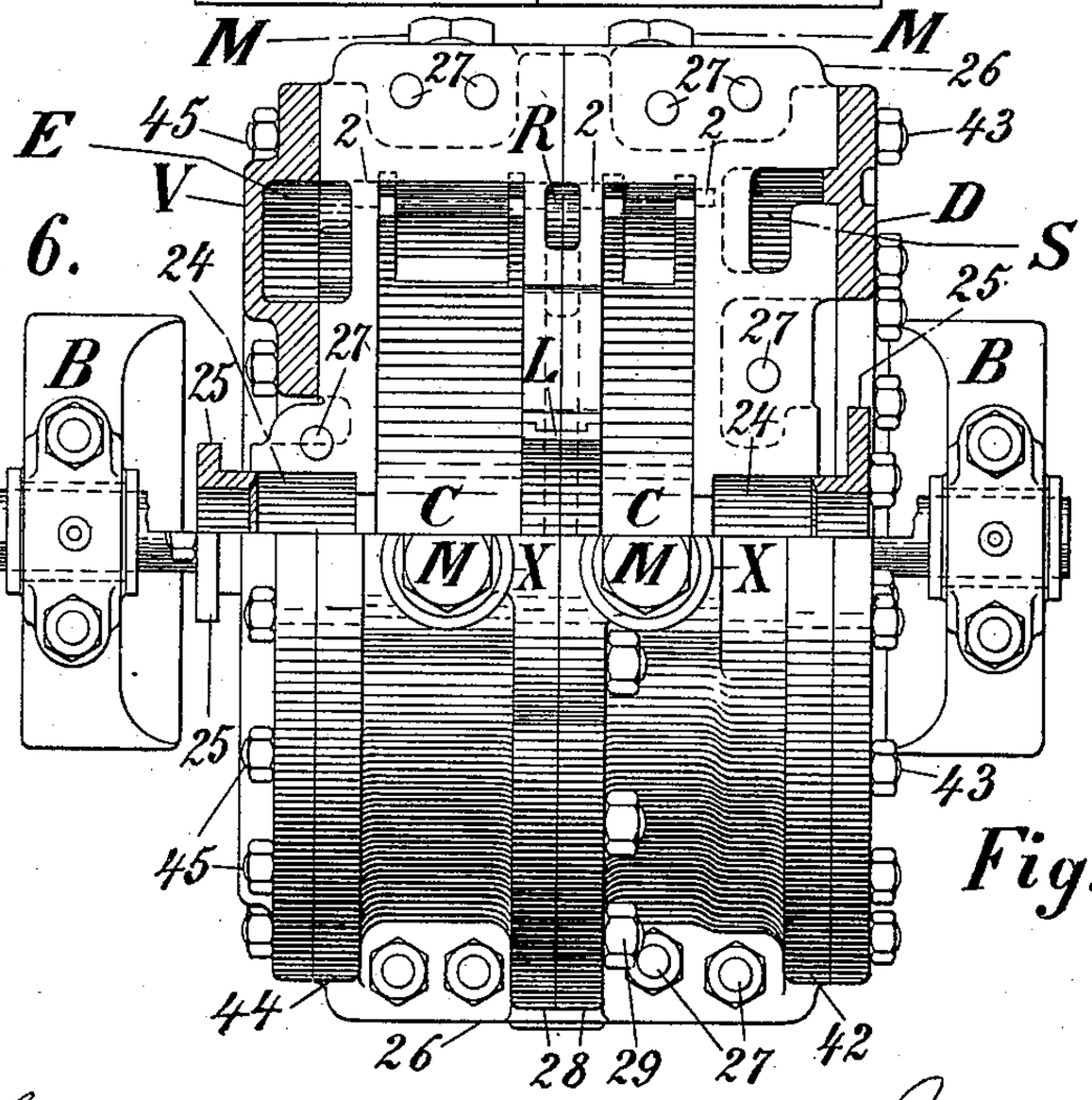


Fig. 7.

WITNESSES

Mm. Lore

Sam'l Kirkpatrick

INVENTOR.

John H. Meyer

BY Thos. S. Moulds

ATTORNEY.

(No Model.)

4 Sheets—Sheet 3.

J. H. MEYER.
ROTARY ENGINE.

No. 601,854. Patented Apr. 5, 1898.

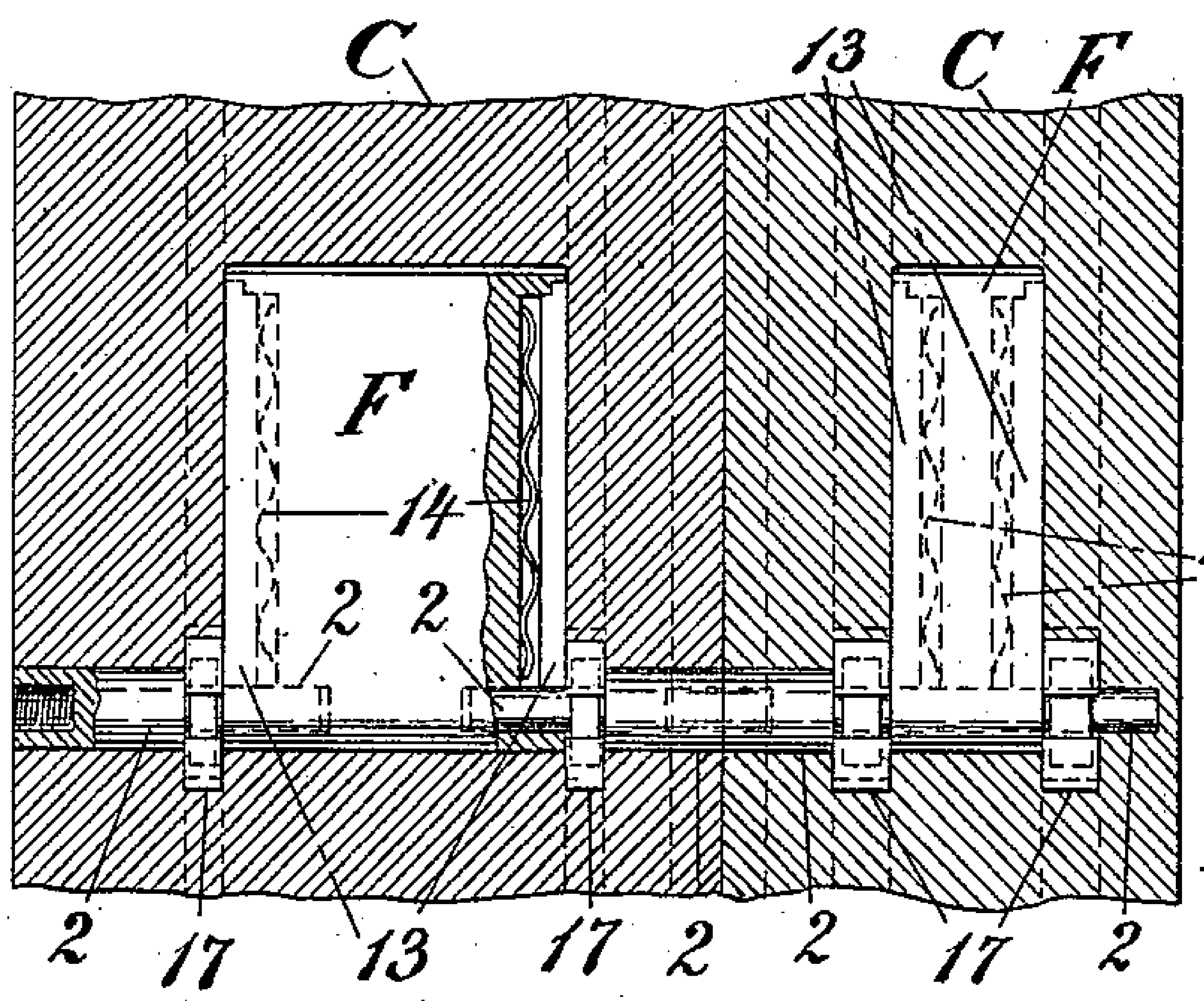


Fig. 9.

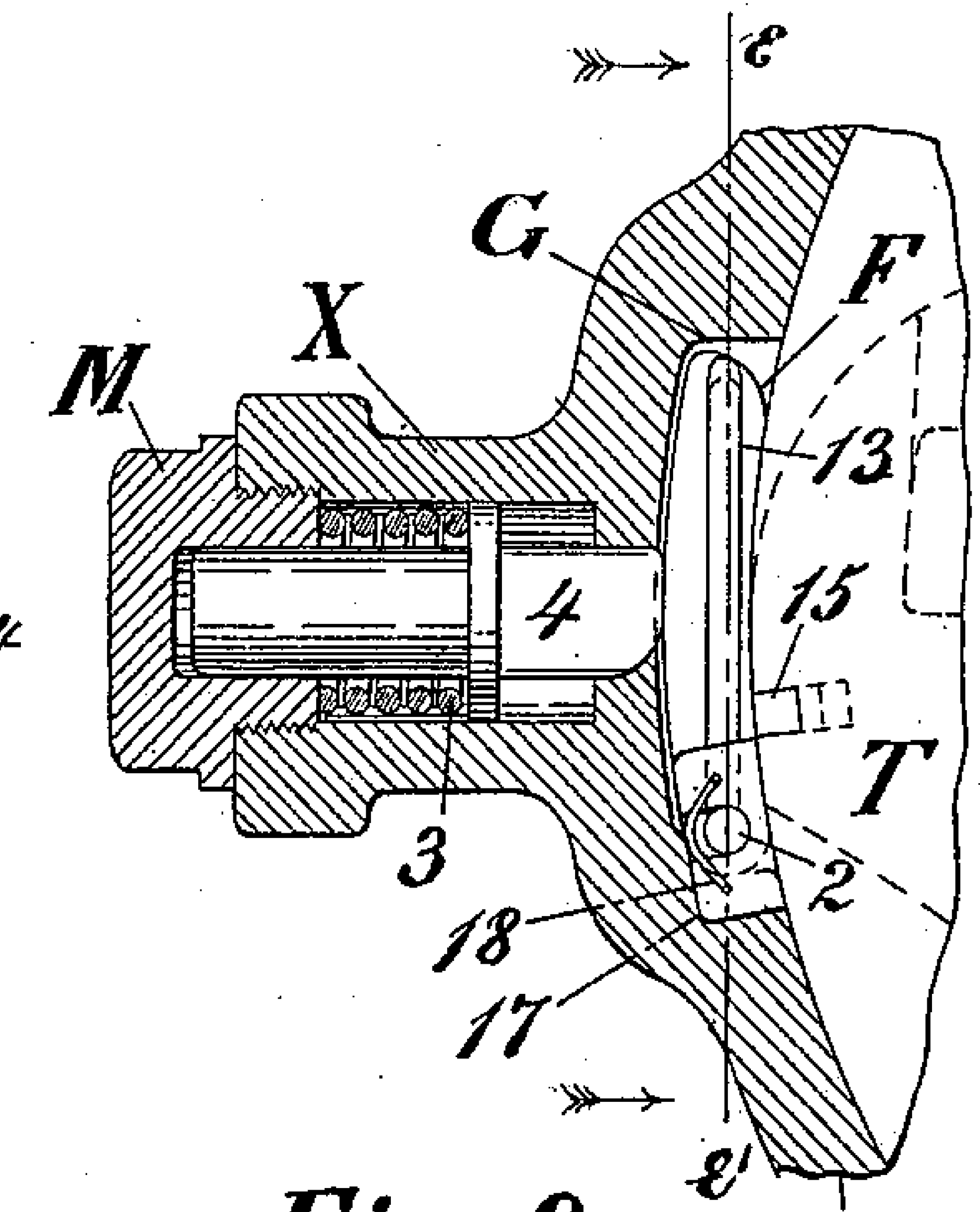
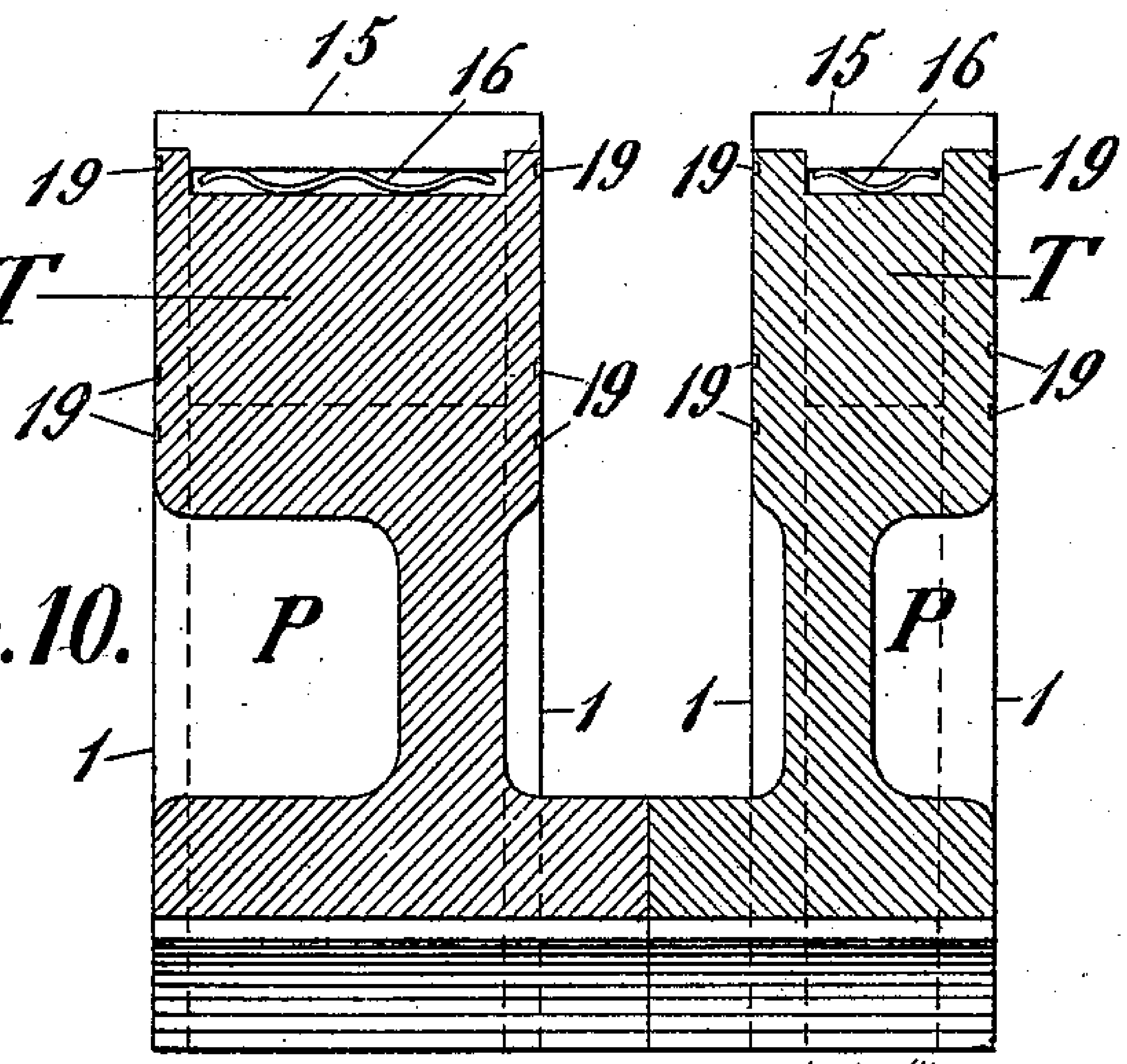
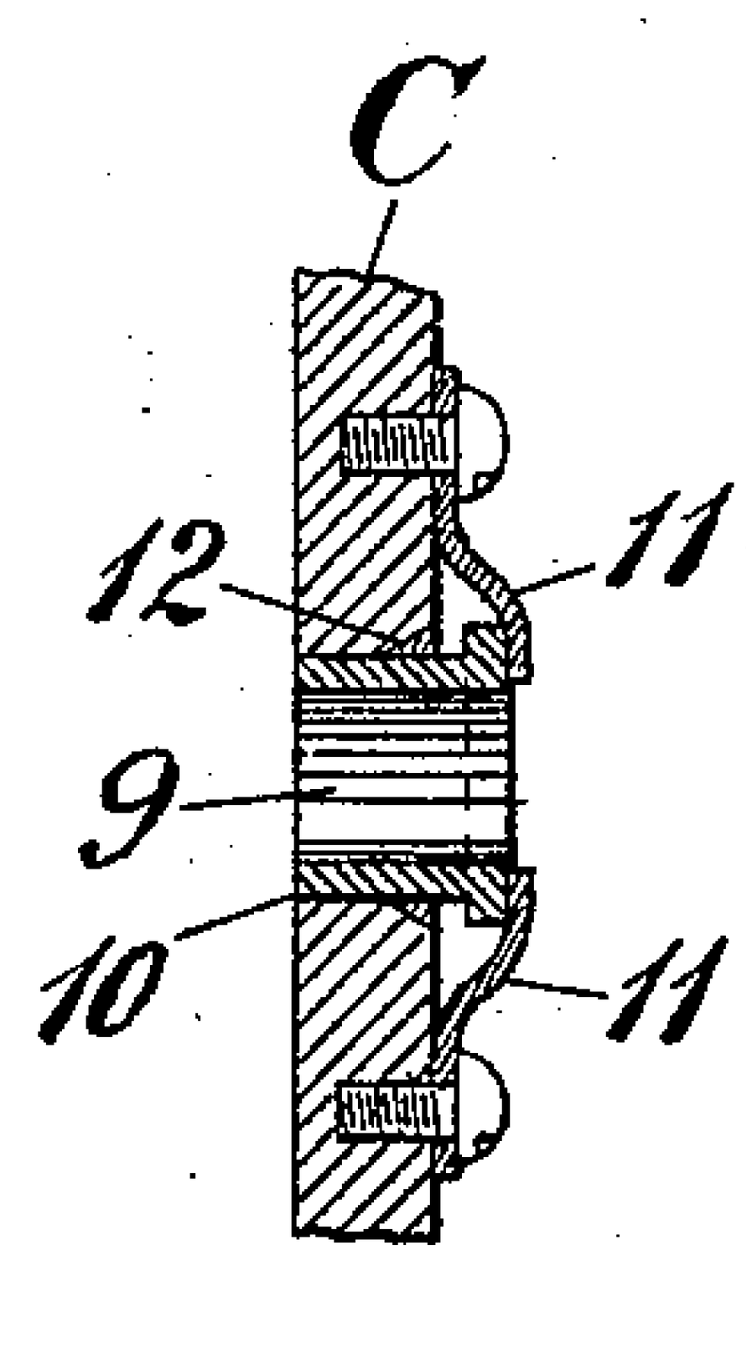


Fig. 8.

Fig. 10.





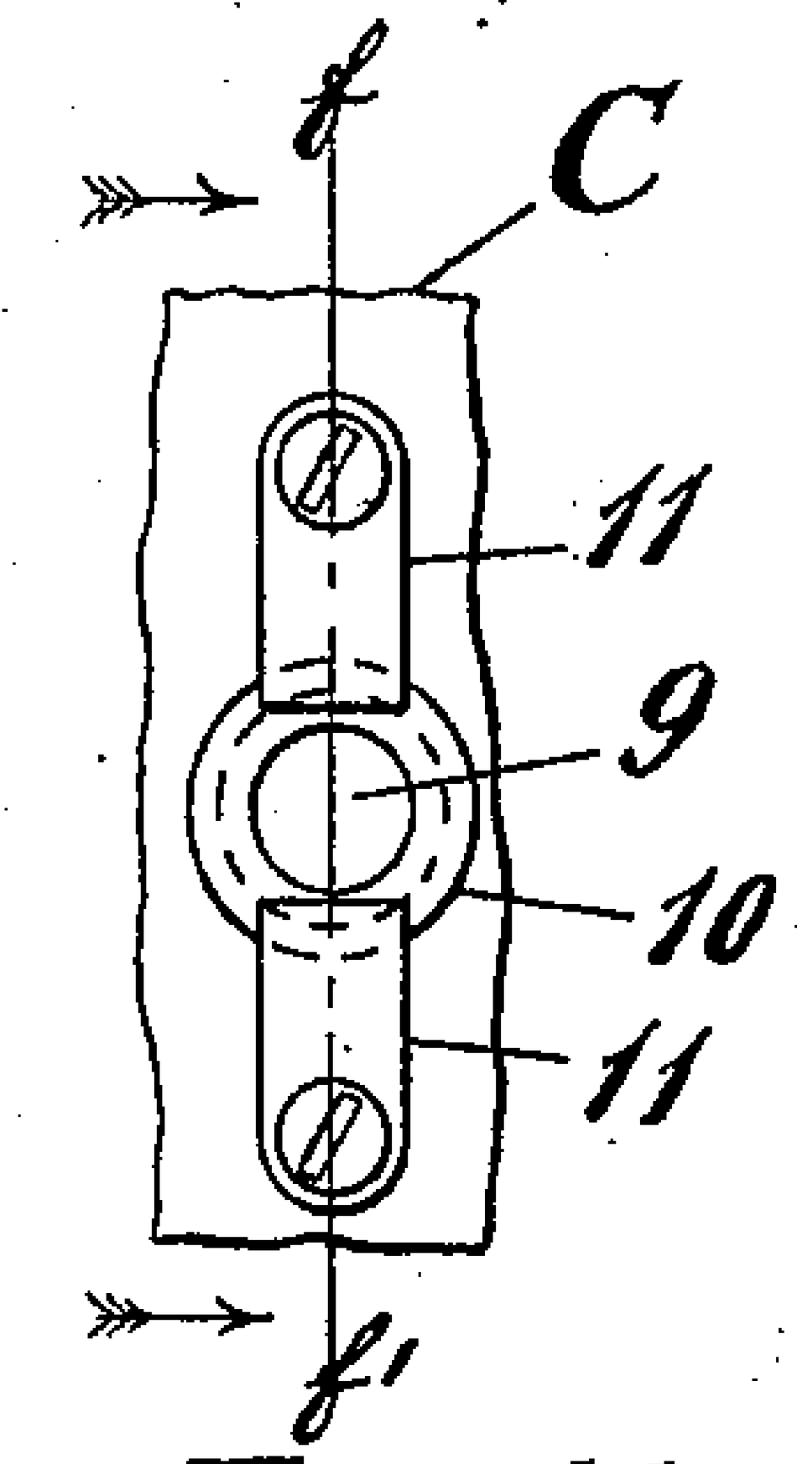


Fig. 12. Fig. 11.

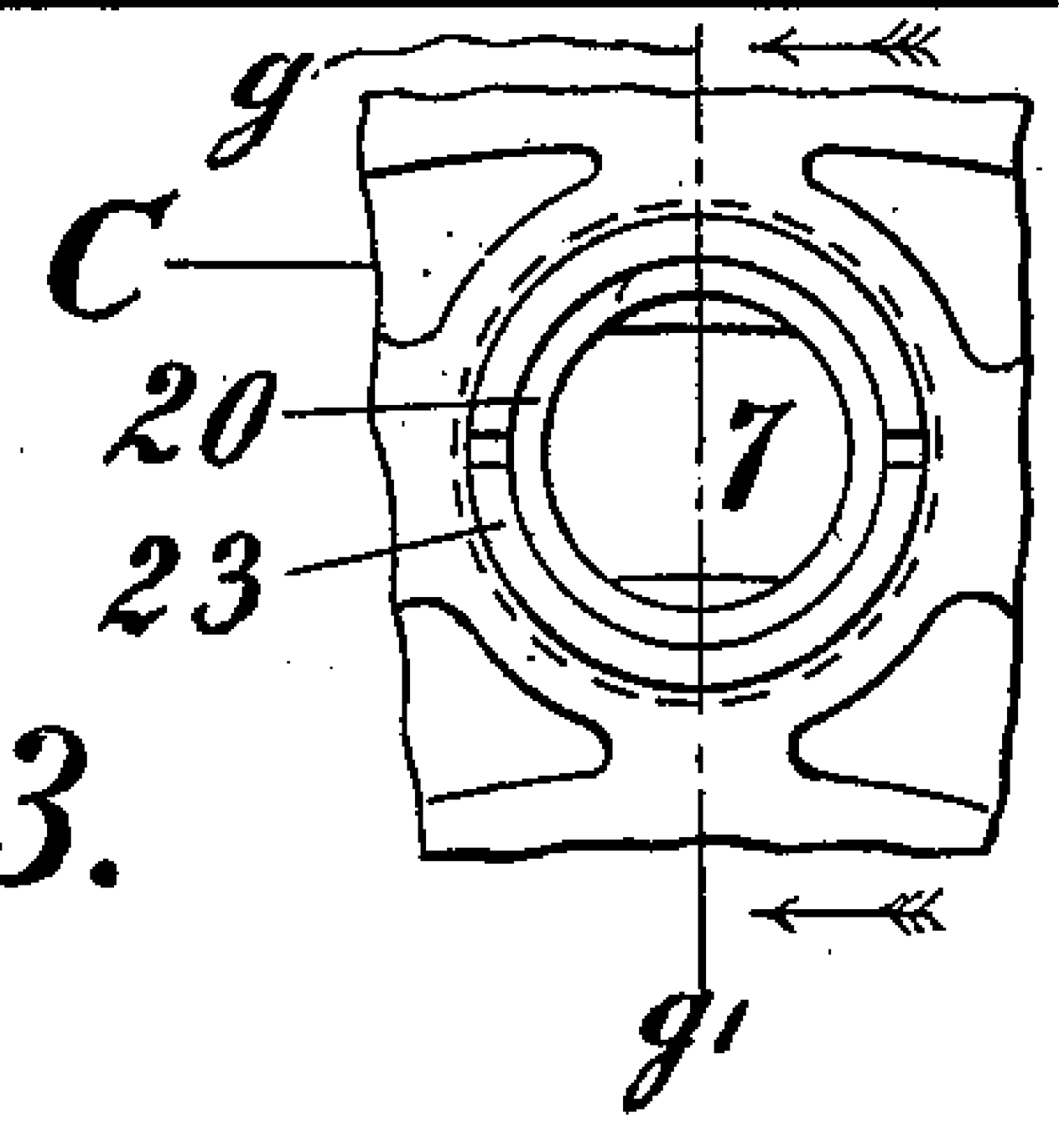


Fig. 13.

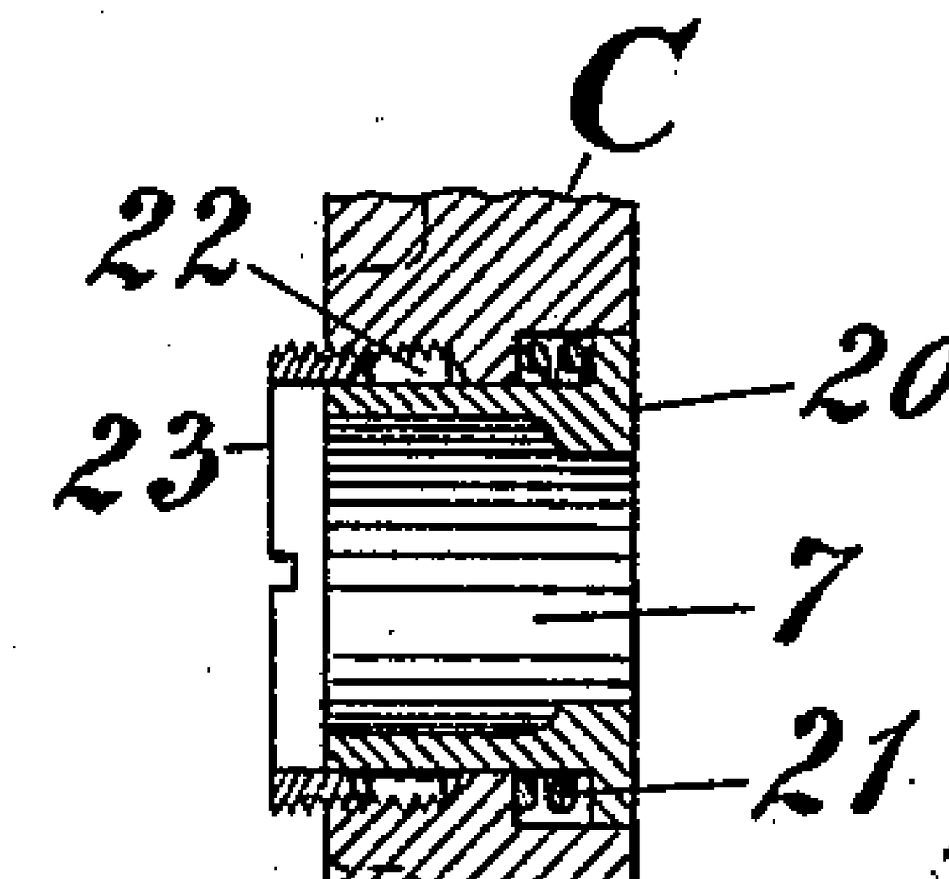


Fig. 14.

WITNESSES:
Wm. Lord
Saml. H. Kirkpatrick

INVENTOR.
John H. Meyer
BY
Thos. S. Moulds
ATTORNEY.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

(No Model.) 4 Sheets—Sheet 4.

J. H. MEYER.

ROTARY ENGINE.

No. 601,854. Patented Apr. 5, 1898.

Fig. 16.

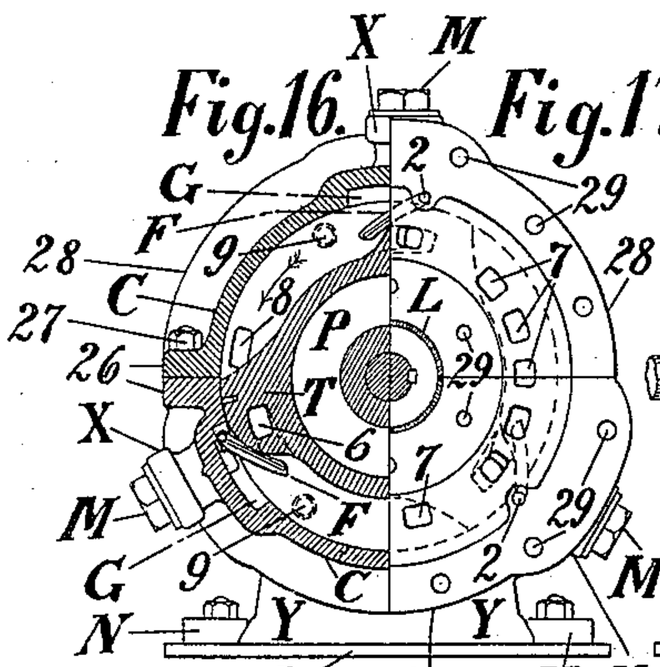


Fig. 17.

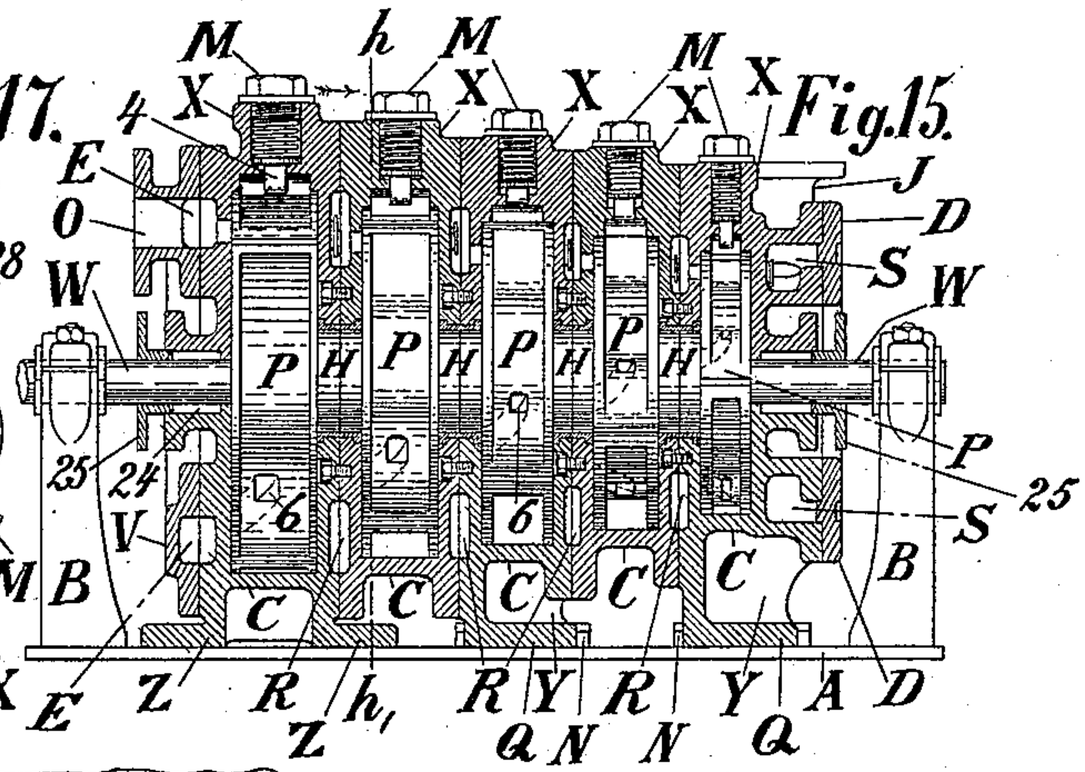


Fig. 15.

Fig. 18.

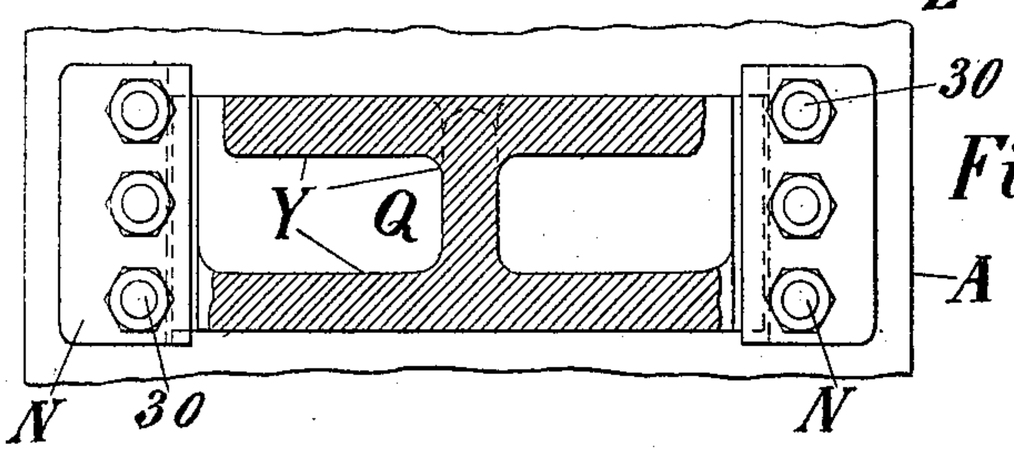


Fig. 19.

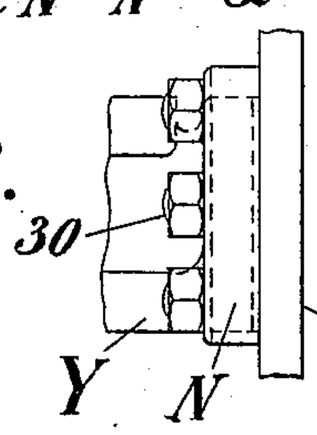


Fig. 20.

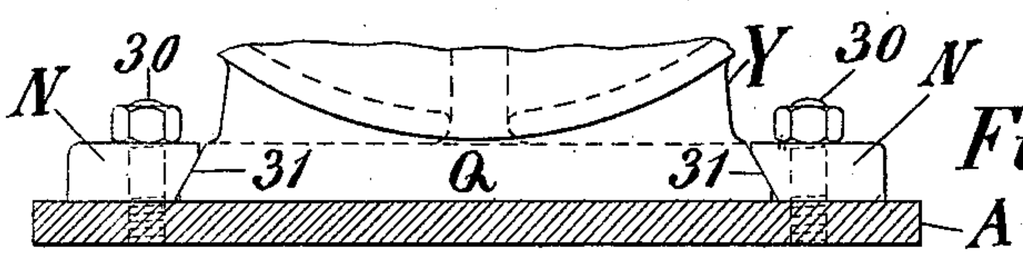


Fig. 21.

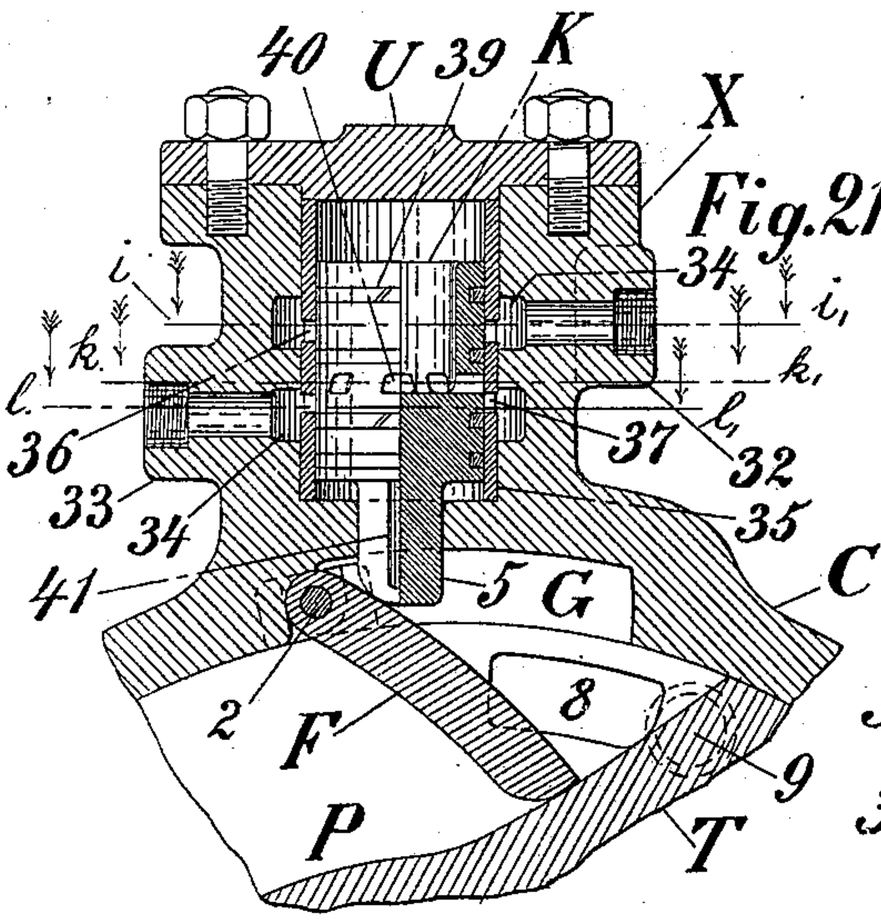


Fig. 22.

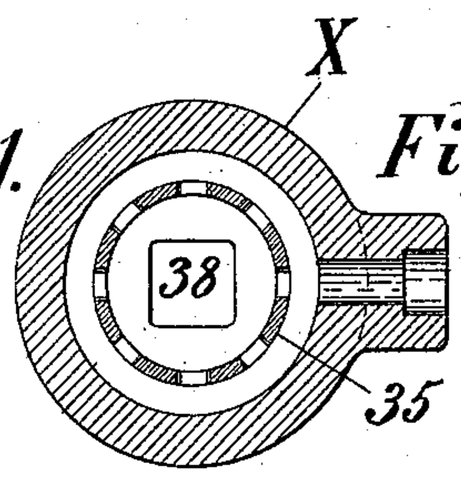


Fig. 23.

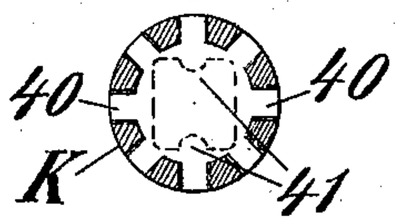
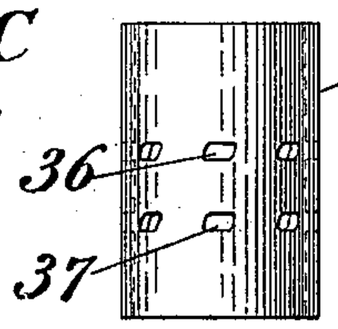


Fig. 24.



WITNESSES

Mm. Lore

Saml. H. Kirkpatrick

INVENTOR.

John H. Meyer

BY

Thos. D. Mowlds

ATTORNEY.

UNITED STATES PATENT OFFICE.

JOHN H. MEYER, OF PHILADELPHIA, PENNSYLVANIA.

ROTARY ENGINE.

SPECIFICATION forming part of Letters Patent No. 601,854, dated April 5, 1898.

Application filed March 9, 1897. Serial No. 626,571. (No model.)

To all whom it may concern:

Be it known that I, JOHN H. MEYER, a citizen of the United States, residing at Philadelphia, in the county of Philadelphia and State of Pennsylvania, have invented certain new and useful Improvements in Rotary Engines, of which the following is a specification, reference being had therein to the accompanying drawings.

My invention relates to rotary steam-engines; and the object of my improvement is to make a two or more step receiver expansion-engine with exhaust to the atmosphere or to a condenser.

To accomplish the desired result, my improved engine is constructed with two, three, four, five, or more cylinders, with a steam-chest at one end and an exhaust-chest at the opposite end and between the several cylinders receivers, said receivers being always one less in number than the number of cylinders. The cylinders are made in two halves to receive the pistons and are joined together on a line through the center of the driving-shaft. The cylinders may have the same diameter and a difference in axial length or they may vary in diameter and length, as may be required; but they always increase in volume from the first cylinder, that receives the steam, toward the last cylinder, from which the exhaust issues. Parts of the several receivers are cast upon the several cylinders, and when the cylinders are joined together complete receivers are formed. The whole engine rests upon a proper foundation and is supported thereon by legs provided with flanges that will allow a slight sliding movement in the direction of the axis of the engine. Each cylinder is bored and faced to receive a piston having a moving fit and bears with its bosses on bushings fitted between each two cylinders. All of the pistons are keyed on one shaft, which revolves in bearings placed at ends of the engine. Each piston forms a disk, at the center of which is a boss to receive the driving-shaft. On the circumference of each disk is formed a rim having thereon two, three, or more radial extensions which I call "thumbs," placed equidistant from each other. There are also side rings to each piston. In this way there is formed in each piston two, three, or more pockets, and when the pistons are fitted in their respective cylinders the pockets are inclosed all around and form the chambers in which the steam does its work. Each of the cylinders has on its inner circumference two, three, or more recesses, according to the number of the flap-valves, located equidistant from each other. In these recesses are pivoted the flap-valves, curved to the circumference of the cylinder and pressed down into the pockets of the pistons by means of spiral springs or by steam-pressure. For this purpose there is formed on the outer surface of each cylinder, above each recess, an extension, bored out and closed at the outer end by means of a screw-plug, adapted to receive the spiral spring and spring-rod or a small steam-piston and rod to act upon the flap-valve. The flap-valves form the resistance-walls for the steam, which by its action drives the thumbs away from the said valves. By this means the revolution of the piston is obtained. The exhaust is also controlled by the action of the flap-valves. The extreme diameter of the pistons over the thumbs and side rings has a moving fit in the respective cylinders. The boundary-line of the thumbs in the front, being in the side in the direction of motion, is about a quarter-circle and is connected to the rim with a large fillet, so that the flap-valve will lift gradually at first. The boundary-line in the back of the thumbs is an epicycloid, with the length of the flap-valve (measuring from the center of the pivot-pin) as a radius of a circle rolling inside of another circle having a radius equal to the distance between the center of the shaft and center of the pivot of the flap-valve plus the length of the flap-valve measured from the center of the pivot-pin. By this construction of the rear of the thumb T, I secure the greatest possible ease of movement without jolt or jar and have at all times a practically steam-tight joint that will not allow any part of the incoming steam to pass under the free end of the flap-valve and retard the downward move-

ment of said valve. Each thumb has on the front an opening which turns inside the thumb toward the receiver side and toward the next following cylinders. These side openings in the thumbs pass along in front of a number of openings in the side walls of the cylinders toward the receiver. By the rotation of the pistons and the forward movement of the thumbs the flap-valves are lifted up into the recesses. After the thumbs have passed under the flap-valves they are forced down into the pockets of the pistons by means of springs or steam-pressure in the extensions. When the thumbs lift the flap-valves, the openings in the front part of the thumbs form the connections between the pockets and the receivers or, at the last cylinder, between the pockets and the exhaust. The parts of the piston-pockets in front of the thumbs and back of the flap-valves are nearly always in contact with a receiver or the exhaust until the thumb is near to the flap-valve, at which time the exhaust is closed to form, by a slight compression of the steam, a cushion to prevent shock on the flap-valves. In the side of the piston-pockets toward the steam-chest are long openings for the admission of steam. These long openings pass in front of circular openings in the corresponding cylinder or receiver wall, and in this way the steam is automatically admitted as long as these openings are in connection. The openings in the cylinder-walls or receivers are placed in such position that they will not come into contact with the long opening in each piston-pocket until the flap-valves are pressed a certain distance into the pockets. When the steam admission is closed, the expansion of the steam in each pocket and cylinder respectively takes place and is continued to the starting of exhaust by the lifting of the flap-valves by the next following thumbs.

In the accompanying drawings, Figure 1 is a longitudinal sectional elevation of one form of my improved engine, showing the cylinders in section at line $a\ a'\ a''$ of Fig. 2, and having the top flap-valves removed, but with an outside view of the driving-shaft and pistons in position. Fig. 2 is a vertical sectional view of the engine on line $b\ b'$ of Fig. 1, the thumbs and flap-valves being in a position to begin opening the ports for the admission of steam. Fig. 3 is an end elevation of the steam-chest end of the engine, the steam-chest cover been removed. Fig. 4 is an end elevation of the exhaust end of the engine, the exhaust-chest cover being removed. Fig. 5 is a vertical cross-section on line $c\ c'$ of Fig. 1, showing the position of the thumbs and flap-valves just before they begin to open the exhaust-ports in the thumbs. Fig. 6 is a plan view of the lower half of the cylinders with pistons and shaft removed. Fig. 7 is a half plan of the entire engine, cut through the center line of the shaft. Fig. 8 is a sectional view through part of one of the cylinders on line $a\ a'$ of Fig. 2, showing the spiral spring in section and the guide of the spring-rod in the screw-plug, the flap-valve being shown in the recess and the thumb of the piston directly under it. Fig. 9 is a sectional plan of part of the cylinders of the engine shown in Fig. 1 on line $e\ e'$ of Fig. 8. Fig. 10 is a sectional view of the half of the two pistons on line $d\ d'$ of Figs. 2 and 3. Fig. 11 is a plan, and Fig. 12 is a section at $f\ f'$ of Fig. 11, of the round steam-admission openings in the cylinders. Fig. 13 is a plan, and Fig. 14 is a section at $g\ g'$ of Fig. 13, of the exhaust-opening in the last cylinder when connected to a condenser. Fig. 15 is a longitudinal sectional elevation of an engine having five cylinders and four receivers, the cylinders being shown in section same as shown in Fig. 1, but with outside view of the driving-shaft and pistons in position. Fig. 16 is a cross-section at $h\ h'$ of Fig. 15, showing a section of one of the cylinders and piston, the thumbs and flap-valves being in such a position that the exhaust-ports in the thumbs are partially opened. Fig. 17 is an end view of the fourth cylinder of the engine shown in Fig. 15, the fifth cylinder being removed. Fig. 18 is a plan view of one of the sliding legs or supports for the engine. Fig. 19 is a side elevation of the sliding support. Fig. 20 is an end elevation of the sliding support and showing the manner of fastening the side pieces to the bed-plate. Figs. 21 to 24 show an arrangement of steam-pistons that may be used for pressing the flap-valves back into the piston-pockets instead of the springs shown in Fig. 8. Fig. 21 is a sectional view through part of a cylinder and piston and one of the flap-valves on line $b\ b'$ of Fig. 1, showing the manner of applying steam-pressure to force down the flap-valves in place of the spiral spring shown in Figs. 1 and 2, the thumb and flap-valve being in position to admit steam, the round admission-opening 9 having arrived at a point to communicate with the long opening 8. Fig. 22 shows a section on line $i\ i'$ of Fig. 21, corresponding also with a section on line $l\ l'$ of Fig. 21. Fig. 23 is a section of the piston shown in Fig. 21, through the rhomboidal openings on line $k\ k'$ of Fig. 21. Fig. 24 shows an outside view of the liner in the extensions with the two rows of rhomboidal openings.

C C represent the several cylinders of the engine. These cylinders are made in two halves and joined together, as shown in Figs. 2 to 5.

R R are the receivers, located between the cylinders.

P P are the pistons.

T T are the thumbs or radial extensions, formed on the pistons P.

S is the steam-chest.

D is the steam-chest cover.

E is the exhaust-chest; V, the exhaust-chest cover.

J is the live-steam inlet, connected to the boiler.

O is the exhaust-outlet; B B, the bearings for the driving-shaft.

W is the driving-shaft, upon which all of the pistons are keyed.

F F are flap-valves placed equidistant from each other in recesses formed on the inside of the several cylinders.

X X are extensions formed on the outside of each cylinder.

G G are the recesses in the cylinder into which the flap-valves F are fitted.

H H are the bearings for the piston-bosses.

L L are bushings for the bearings H.

Y are sliding legs resting upon the foundation and partially supporting the engine.

Z are rigidly-bolted legs or supports under the exhaust end of the engine.

Q are flanges on the sliding legs Y.

N are beveled side pieces bolted to the bed-plate and resting against corresponding bevels formed on the flanges Q.

A is the foundation or bed-plate.

K K are steam-pistons placed in the cylinder extensions X to be used in place of the spiral springs 3. (Particularly shown in Figs. 1, 2, and 3.)

U is the cover for the extensions X when using the piston shown in Fig. 21.

M is a screw-plug for the extensions X when the spiral spring (shown in larger scale in Fig. 8) is used to press back the flap-valve.

1 1 are the side rings of the pistons P.

2 2 are pivot-pins for holding the flap-valves F in position.

3 3 are the spiral springs that press the flap-valves F back into the pockets of the pistons after they have been raised by thumbs T; 4, spring-rods for the spiral spring; 5, rod of the steam-piston K, (shown in Fig. 21;) 6, exhaust ports or openings in the front of the thumbs T. These openings turn on the inside of the thumbs and terminate on the side of the thumbs adjacent to the receiver of the cylinder next following.

7 are exhaust-openings in the cylinders C.

8 are long rectangular openings in the sides of the pistons toward the steam-chest.

9 are circular steam-admission openings in the cylinders C.

10 are bushings for the circular openings 9; 11, spring-catches for holding the bushings 10 in position; 12, soft conical cooper-rings surrounding the bushings 10; 13, packing-strips on the sides of the flap-valves F; 14, corrugated springs for pressing and holding the packing 13 into the required position; 15, packing-strips for the tops of the thumbs T; 16, corrugated springs for pressing the packing-strips 15 into position; 17, packing-pieces to form joint on the circumference of the side rings of the pistons P; 18, small springs for holding the packing 17; 19, water-grooves in the sides of the pistons P; 20, bushings for the exhaust; 21, spiral springs for the bushings 20; 22, stuffing-boxes for the exhaust-openings; 23, glands for stuffing-boxes 22; 24, stuffing-boxes for the cylinders C; 25, glands for stuffing-boxes 24; 26, flanges on the cylinders C, through which they are bolted together; 27, bolts for securing the two halves of the cylinders together; 28, flanges on the sides of the cylinders; 29, bolts in the flanges 28; 30, bolts for securing the leg Y to the bed-plate; 31, beveled edges on the flanges Q and side pieces of leg Y; 32, upper boss on the cylinder extension shown in Fig. 21; 33, lower boss on cylinder extension shown in Fig. 21; 34, grooves in the extensions; 35, liner in the extensions; 36, row of openings for the live steam in the liner shown in Figs. 21 and 24; 37, row of openings for the exhaust-steam in the liner; 38, opening in the bottom of the extensions of the cylinder for the spring-rods shown in Fig. 8 or the piston-rods shown in Fig. 21, that press the flap-valves down; 39, packing-rings for the small extension-piston K. These rings prevent the steam from passing between the piston K and the liner 35.

40 is a row of openings in piston K; 41, small grooves in piston-rod 5.

42 is the flange on the steam-chest to which the cover D is bolted; 43, bolts in flange 42.

44 is the flange on the exhaust-chest to which the cover V is bolted; 45, bolts in flange 44.

The flap-valves F form a joint at the pivoted end. They are fitted into the round bore of the pivot-pin heads, while the pivot-pins have an easy fit in the flap-valves F, and the flap-valves are pressed against by the steam, which also forms a joint of the opposite ends of the flap-valves F as they slide upon the rims of the pistons P and over the back boundary of the thumbs T. The sides of the flap-valves are provided with grooves, into which are fitted packing-strips 13, pressed against the inner sides of the rings of the pistons P by means of the light corrugated springs 14. The extreme radial ends of the thumbs T are also provided with grooves, into which are fitted the packing-strips 15, pressed out by the light corrugated springs 16. The circumferential joint of the piston sides at the pivot ends of the flap-valves is formed by means of the small pieces 17, fitted into the recesses of the cylinders C at the joint of pivots 2, and is pressed against the circumference of the sides of the rings of the pistons by the small springs 18. The side packing between the cylinder-walls and the sides of the piston P is formed by the water from the condensation of the steam, this water being driven into the corners by the centrifugal force and held in place by small water-grooves 19 on the outer side of the side rings of the pistons P. The exhaust-openings 7 in the receivers R and to the atmosphere do not need any packing for

joint, but when the last cylinder C exhausts into a condenser the exhaust-openings 7 in the cylinder-walls are provided with the bushings 20, pressed by light spiral springs 21 against the corresponding side of the piston P, and are also provided with the stuffing-boxes 22 and glands 23, similar to the packing used for the tubes of a surface condenser. To prevent leakage at the extreme ends of the engine, these ends of the cylinders C are provided with stuffing-boxes 24 and glands 25 around the driving-shaft in the usual manner for packing rotary engines.

To provide for the linear expansion that takes place in the direction of the axis when a number of the cylinders C are joined together and to avoid the friction that would necessarily be produced if the cylinders were all bolted together rigidly when more than one support upon the foundation is required, the leg Z is connected to the last of the cylinder C and firmly bolted to the foundation or bed-plate A, and the additional legs or supports Y that may be needed are bolted to the foundation with a sliding fit in the manner particularly shown in Figs. 18, 19, and 20.

Should the spring 3, that presses down the flap-valves F, not be suitable for large engines, I have designed a steam-piston K (see Figs. 21 to 24) to do the same work and receive pressure and exhaust automatically by the motion of the flap-valves. To accomplish this result, the extensions X of the cylinders have internally the two grooves 34 and outside for each groove a boss. The upper boss 32 is bored to receive the connection for the admission of live steam, while the lower boss 33 is bored to receive the connection for the exhaust, which is connected either to the exhaust side of the same cylinder or to the next following receiver. The extensions X are bored out to receive the liner 35, fitted steam-tight into the bore of the extensions. In this way the grooves 34 form passages for steam. The liner 35 has therein the two rows of rhomboidal openings 36 and 37. The upper row 36 is in contact with the upper passages 34 and form the admission-openings, while the lower row 37 is in contact with the lower passage 34 and form the exhaust openings. The piston K, which is moved inside the liner 35 by the action of the flap-valves F on the piston-rod 5, which extends through the opening 38 in the bottom of extension similar to the spring-rod 4, has therein one row of rhomboidal openings 40, which, when the flap-valves are moved by the thumbs T so far that they begin to enter the recesses G, come in contact with the row of holes 36 in the liner, and the steam enters beyond the piston and presses with the rod 5 against the flap-valve. As soon as the thumbs have passed the flap-valves F the steam beyond the pistons acts and the flap-valves are pressed into the pockets of the pistons back of the thumbs. When the thumbs have moved so far that the openings 8 and 9 for admitting steam into the piston-pockets come into contact with each other, the flap-valves F and the pistons K have moved so far inside that the openings 40 in the pistons K come in contact with the holes 37 in the liner and the exhaust of the steam beyond the piston begins, while the admission of the steam beyond the piston has already closed at a point where the flap-valve has left the recess G. To prevent a shock of the pistons K at the bottom of the extensions X, there are small vertical grooves 41 in the piston-rod 5. These grooves allow some of the admission-steam from the main cylinder-pistons P′ to enter the liner of the pistons K, and thus form cushions for said pistons K. The operations described are repeated as each thumb comes in contact with the flap-valves.

The admission of steam, the cut-off, and the exhaust, respectively, for all of the pockets in one cylinder take place at the same time, and the number of such admissions, cut-offs, and exhausts for one revolution of each piston are the same and corresponds to the number of thumbs on each piston.

I have shown each cylinder with three of the extensions X and three flap-valves F, the piston having thereon three of the thumbs T. This construction I would consider the most practical; but the number of extensions, flap-valves, and thumbs may be increased, and under some circumstances each cylinder may have only one extension and one flap-valve, the piston having but one thumb. These parts may also be embodied in an engine having only one cylinder.

The sliding leg or support Y is shown rigidly attached to the engine and sliding upon the bed-plate; but this support Y may be secured rigidly to the bed-plate and the engine allowed to slide over the top of it.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. In a rotary engine the combination of a steam-cylinder C, having pivoted on the inner circumference thereof a valve F, with a piston P having a moving fit in the cylinder and provided with a valve-lifting thumb T, the said cylinder C being provided with suitable inlet and exhaust ports for the steam, and the piston P having the side rings 1, 1, provided on one side with the inlet-ports 8, and the curved exhaust-port 6 extending from the front of the thumb to the side thereof next the exhaust side of the cylinder and connecting the interior of the piston with the exhaust-ports 7, substantially as shown.

2. In a rotary engine the combination of a cylinder C, provided with inlet and exhaust ports and having flap-valves F, pivoted therein, and means for holding said flap-valves in contact with the periphery of the piston, with a piston P having the side rings 1, 1, mounted in said cylinder and having thereon the lift-

ing-thumb T, provided with the curved exhaust-port 6 extending from the front to the side of the thumb next to the exhaust side of the cylinder for the purpose of connecting the interior of said cylinder directly with the exhaust-ports, as set forth.

3. In a rotary engine the combination of two or more steam-cylinders of different volumes mounted upon a single driving-shaft, each of said cylinders having pivoted on the inside thereof a series of flap-valves F, with the pistons P, having thereon the side rings 1, 1, and between said side rings the extending thumbs T, operating the flap-valves, the several cylinders being provided with suitable inlet and exhaust ports and connected with a steam-supply, each piston having in the side ring 1 thereof the inlet-port 8, and in the extending thumbs the curved exhaust-ports 6, forming a connection with the exhaust-ports 7 of the cylinders, substantially as shown and for the purpose described.

4. In a rotary engine the combination of two or more steam-cylinders having therein steam-inlet ports, and increasing in volume from the first cylinder that takes steam to the last one that exhausts, with the receiver R located between each two of the cylinders, and the several series of the flap-valves F, pivoted on the inner circumference of each cylinder, and a series of pistons P, having the side rings 1, 1, and mounted on the same driving-shaft and having moving fit in their respective cylinders, and each of said pistons having thereon a series of valve-lifting thumbs T, provided with the curved exhaust-ports 6, that extend through said thumbs from the front to the side thereof and through the adjacent side ring 1 and register with exhaust-ports in the sides of the cylinder, substantially as shown.

5. In a rotary engine the combination of the series of steam-cylinders C, having between each two of the cylinders, the receivers R, and having on one side of each cylinder, the inlet-ports 9, the first of said inlet-ports being connected with the steam-chest and the others with the several receivers and on the opposite side of said cylinders the exhaust-ports 7, connected with the several receivers and with the outlet on the last cylinder; with the flap-valves F, pivoted to the inner circumference of the cylinders and provided with suitable means for forcing said valves down after they have been raised, and the pistons P, all mounted on the same shaft and having thereon the side rings 1, 1, and inlet-ports 8, registering with inlet-ports 9, in the cylinders and provided with the extending thumbs T, having the exhaust-ports 6, that register with the exhaust-ports 7, in the cylinders as the pistons turn around, all arranged substantially as shown.

6. In a rotary engine, the combination of a cylinder C, flap-valves F, pivoted on the inside of the cylinder, extensions X, located on the outside of the cylinder and connected with a steam-supply and having therein the steam-piston K, and rod 5, pressing upon the flap-valve, with the piston P, having thereon the thumbs T, and side rings 1, 1, the cylinder and piston P, being each provided with suitable inlet and exhaust ports and connected with a steam-supply, substantially as shown.

7. In a rotary engine, the combination of the cylinder C, having therein the pivoted flap-valve F, and on the outside the closed extensions X, bored out to fit the liners 35, having therein the openings 36 and 37, with the pistons K, operating-rods 5, pressing against the flap-valves F, substantially as shown.

8. The closed top extension X, having on the side thereof an opening that connects with a steam-supply and on the opposite side a similar opening for the exhaust, in combination with the liner 35, fitting into said extension and having therein the two rows of openings 36 and 37, and the small piston K, having therein the openings 40 and the extending rod 5, that presses against the flap-valves, substantially as shown and for the purpose described.

9. In a rotary engine, the cylinder C, a steam-inlet port provided with a bushing movably secured in the cylinder and held in sliding contact with the side of the piston by the pressure of the ingoing steam on the outer surface of the port, substantially as shown.

10. In a rotary engine, the cylinder C, the steam-inlet port 9, provided with a bushing movably secured in the cylinder C, and surrounded by the conical packing-ring 12 and held in sliding contact with the side of the piston P, by the pressure of the ingoing steam, substantially as shown and described.

11. In a rotary engine, the cylinder C, the exhaust-port 7, provided with a bushing movably secured in the cylinder C, and held in sliding contact with the side of piston P, by means of the spring 21, substantially as shown and described.

12. A piston for rotary engines composed of the two side rings 1, 1, having a moving fit in the cylinder and inclosing between them a central portion having thereon the extending thumb T, the side rings 1, 1, being provided with inlet and exhaust ports respectively above the said central portion, and the thumb T having therein the curved exhaust-port 6 that extends from the front of the thumb to the outside of the piston passing through the side ring 1 that lies next to the exhaust side of the cylinder, substantially as shown.

13. In a rotary steam-engine the combination of a cylinder C provided with an inlet and exhaust port on opposite ends thereof and having pivoted on the inner circumference a valve F, with a piston P provided with valve-lifting thumb T, having therein the curved exhaust-port 6 extending from the front of the thumb to the side thereof next to the ex-

haust side of the cylinder; and the two side rings 1, 1, having a moving fit in the cylinder; the forward one of said side rings being provided with a steam-inlet port that registers at intervals with the inlet-port on the front end of the cylinder and the rear one of said side rings having therein an exhaust-port that registers with the curved exhaust-port in the thumb T and communicates with the exhaust-opening in the rear end of the cylinder, as shown.

In testimony whereof I affix my signature in presence of two witnesses.

JOHN H. MEYER.

Witnesses:
THOS. D. MOWLDS,
SAML. H. KIRKPATRICK.