

L. J. JEAN-BAPTISTE LE ROND.  
 ROTARY MACHINE.

APPLICATION FILED FEB. 8, 1908.

919,897.

Patented Apr. 27, 1909.

7 SHEETS—SHEET 1.

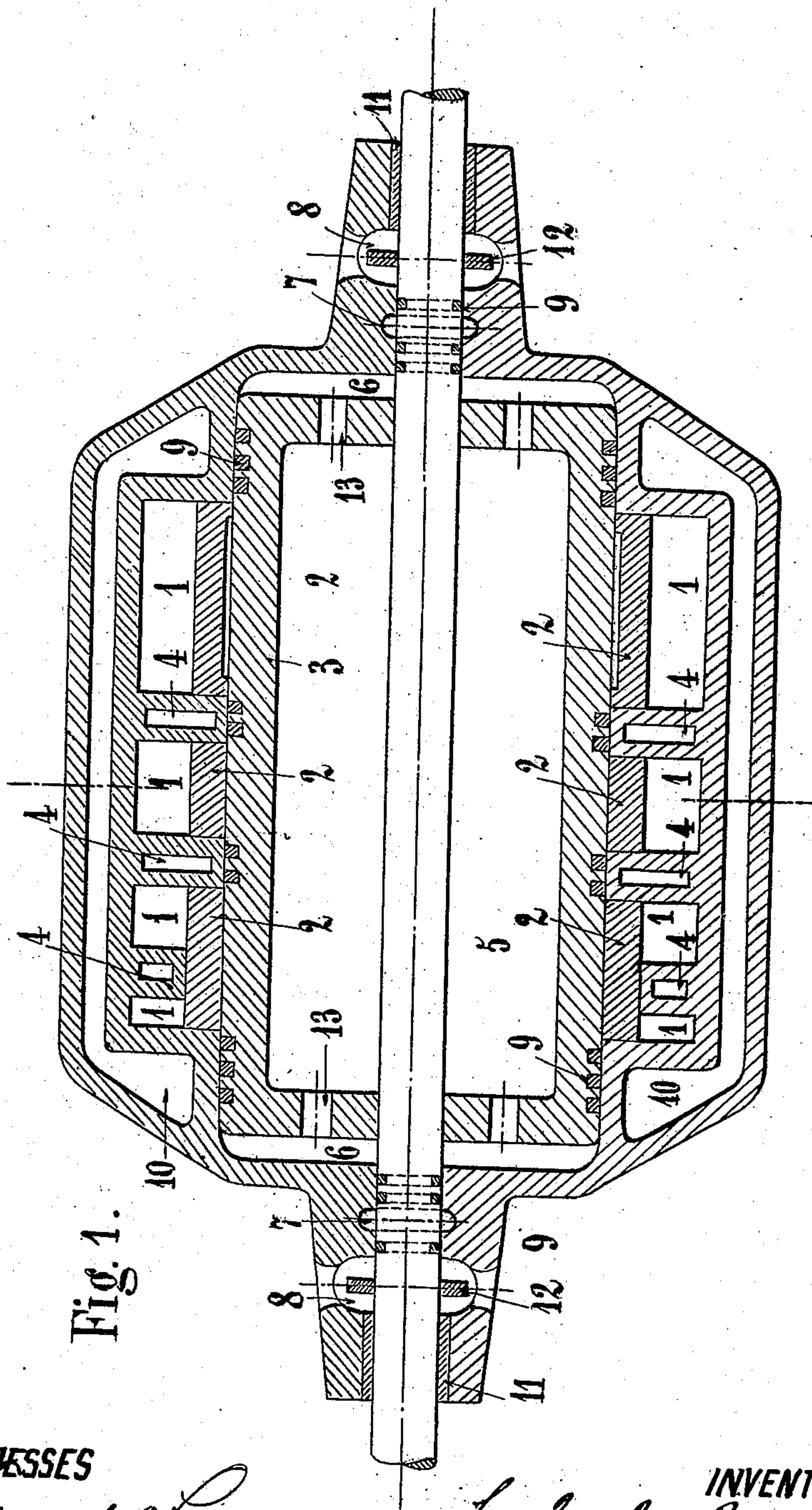


Fig. 1.

WITNESSES

*Edward A. Lee*  
*A. J. Suberlin*

INVENTOR

*Louis Jules Jean-Baptiste Le Rond*  
 BY *James G. Goss*  
 ATTORNEYS

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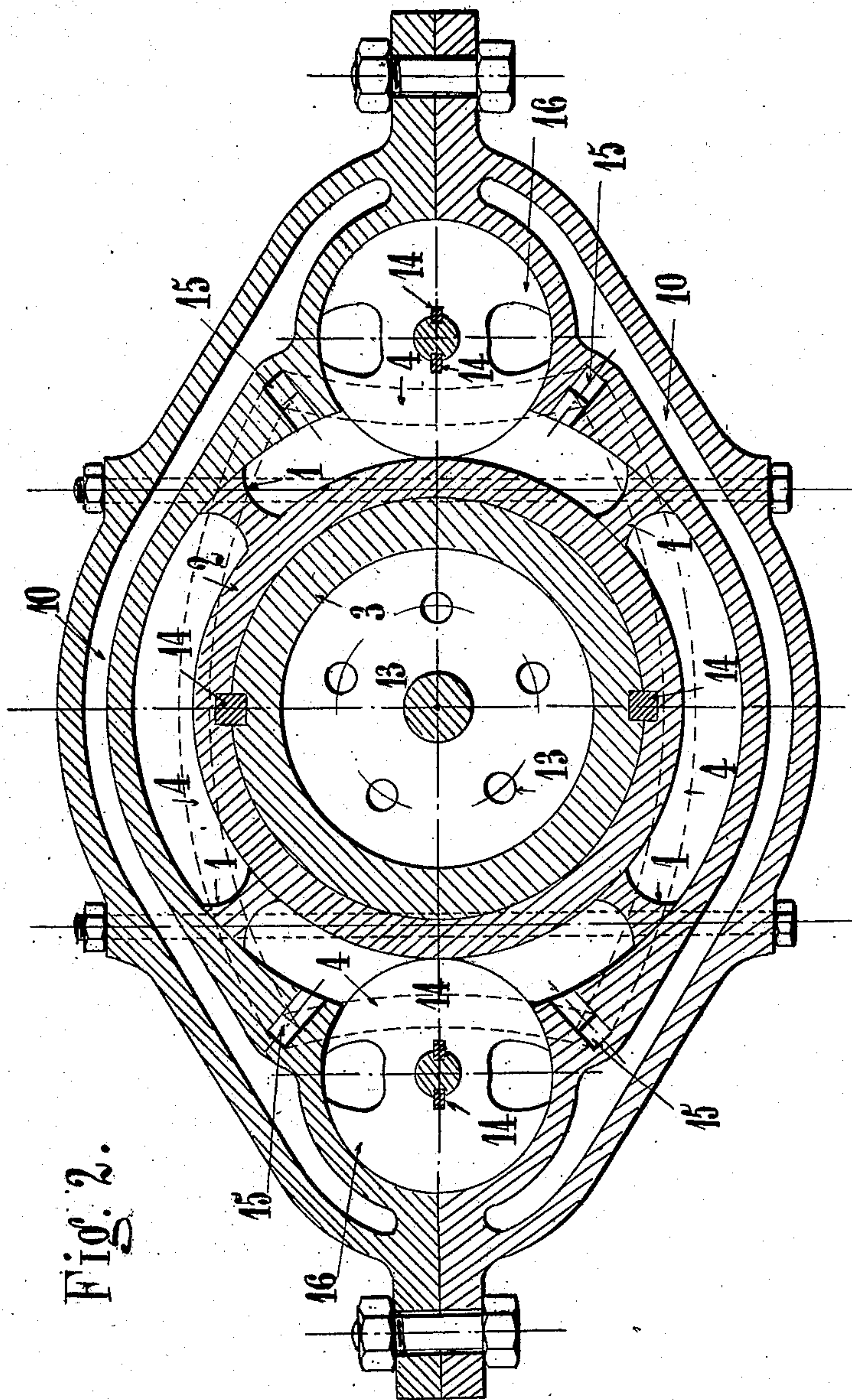


Fig. 2.

WITNESSES

*Edward M. ...*  
*H. J. ...*

INVENTOR

*Louis Jules Jean-Baptiste Le Rond*

BY

*James ...*  
ATTORNEYS



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Fig. 3.

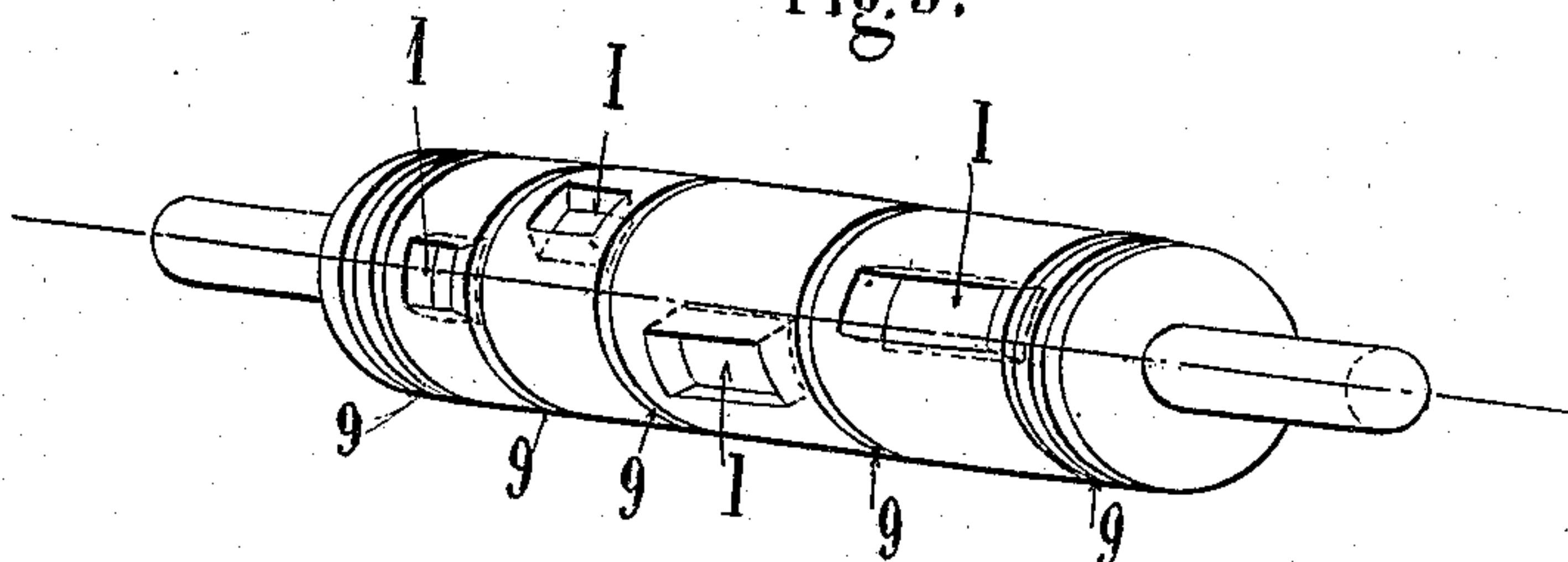


Fig. 5.

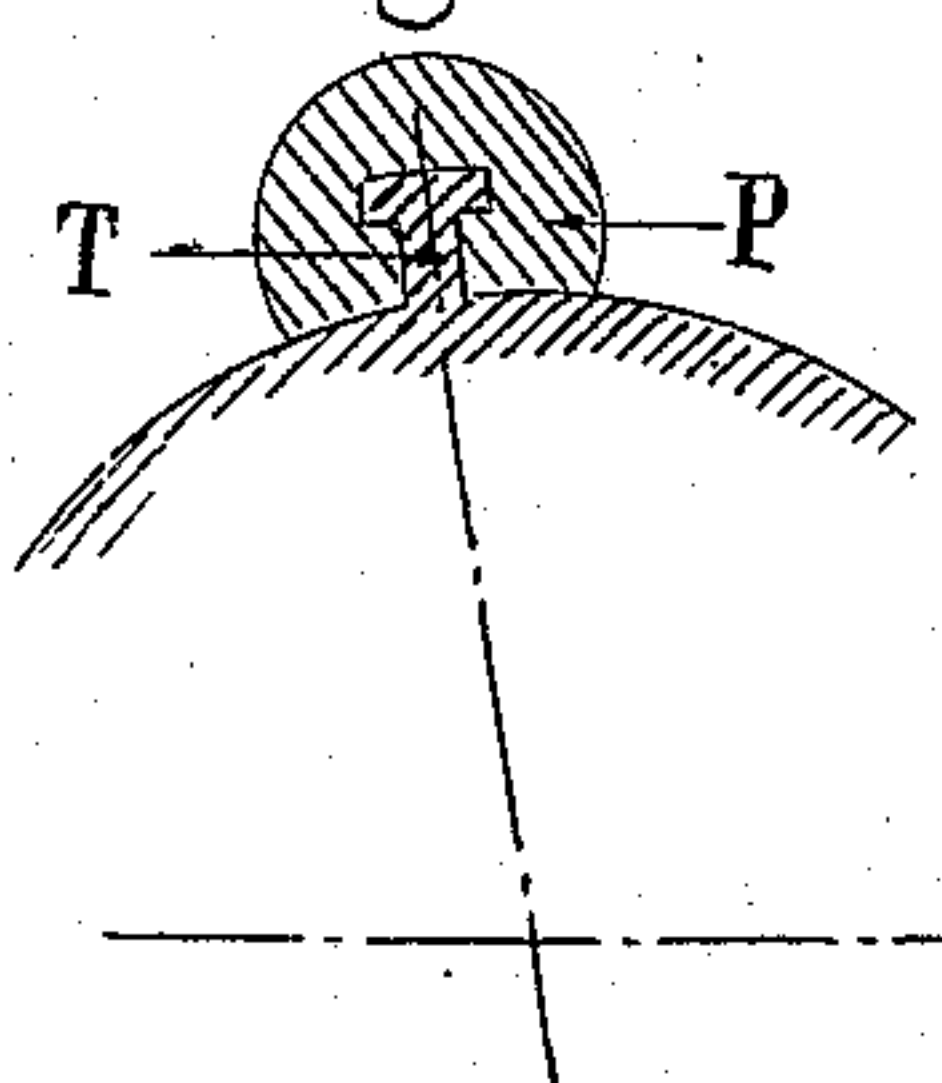


Fig. 4.

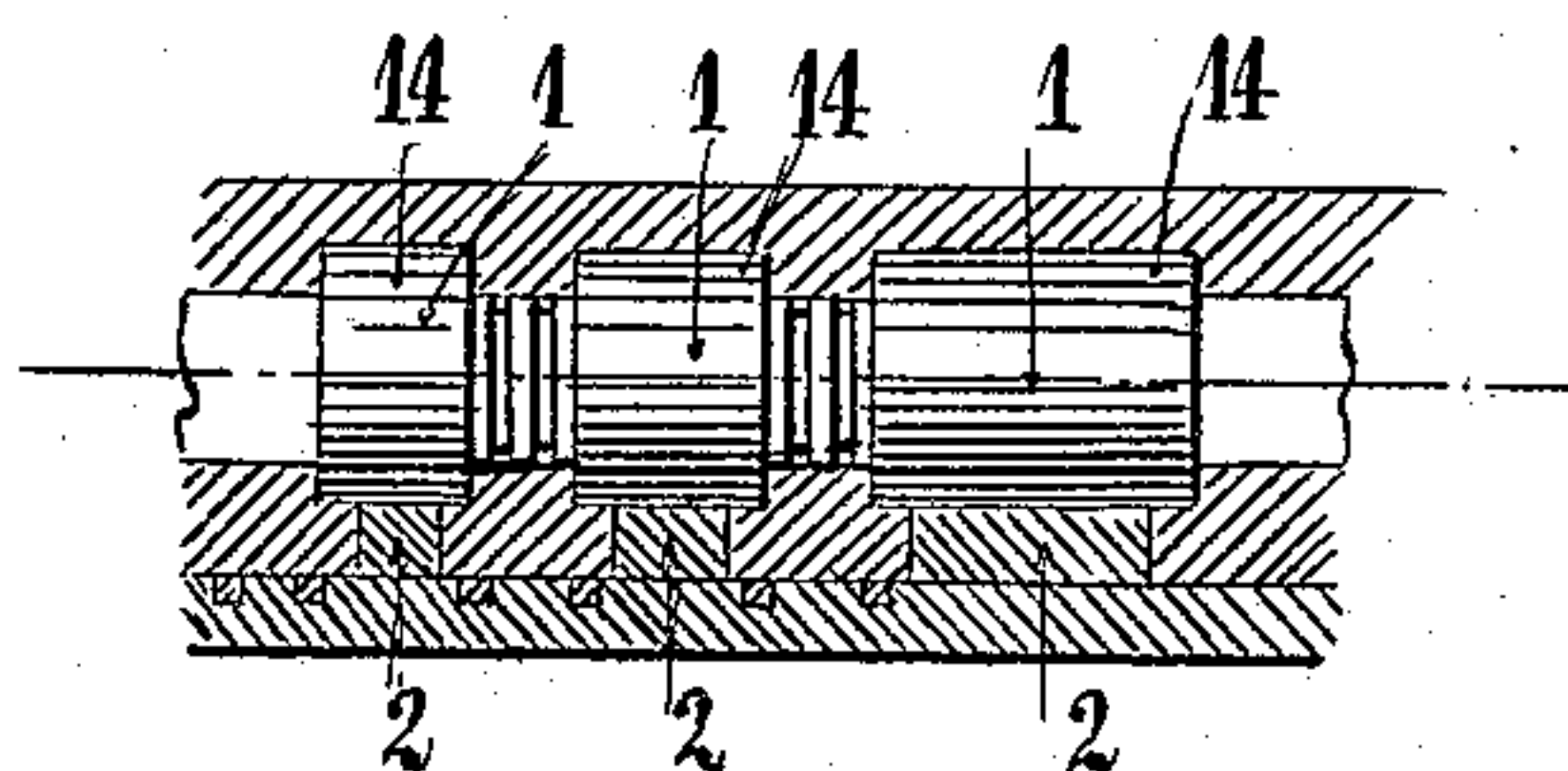
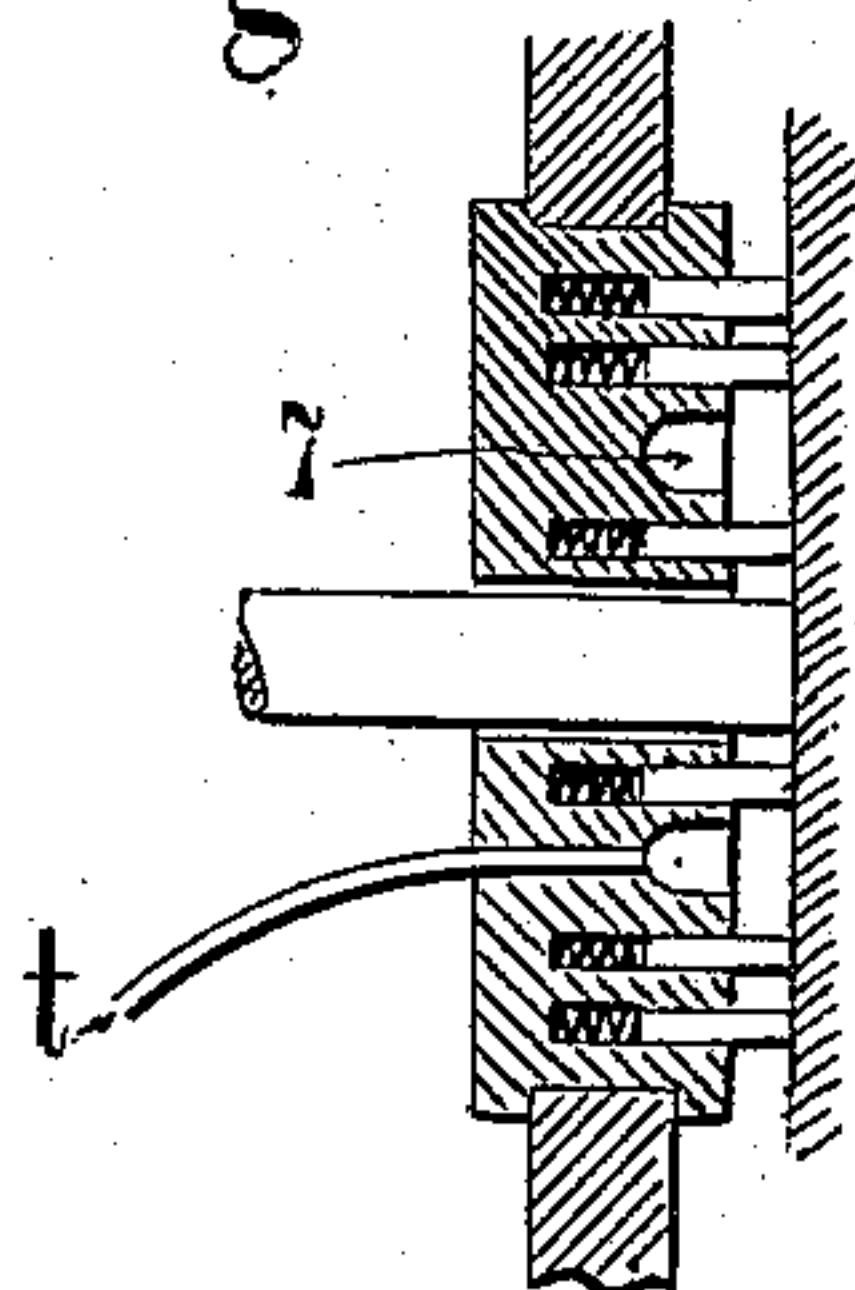


Fig. 6.



WITNESSES

Edward A. Bear  
H. J. Sukhter.

INVENTOR

Louis Jules Jean-Baptiste Le Rond  
BY James Cooper  
ATTORNEYS

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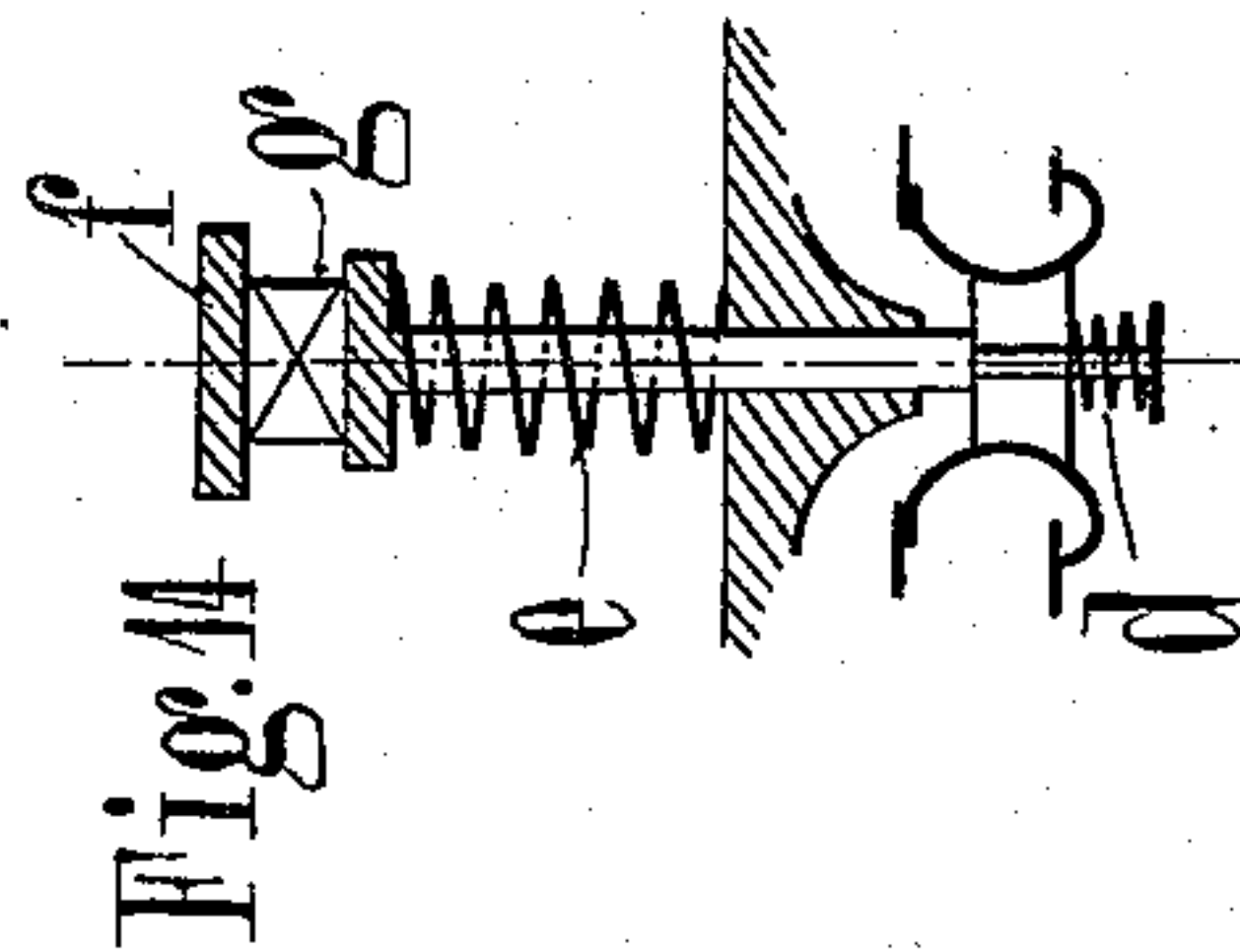
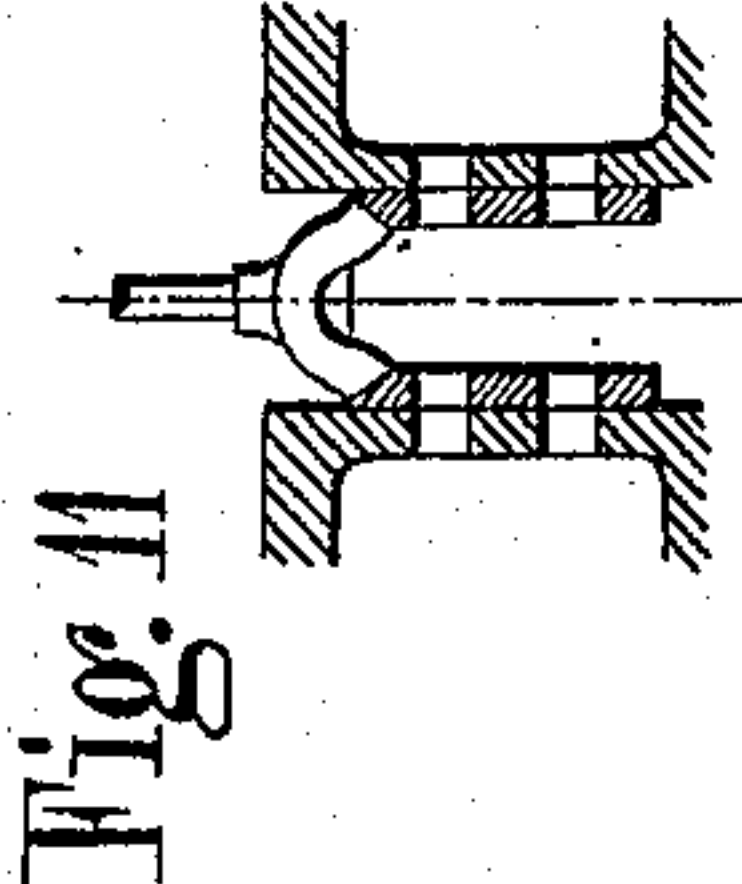
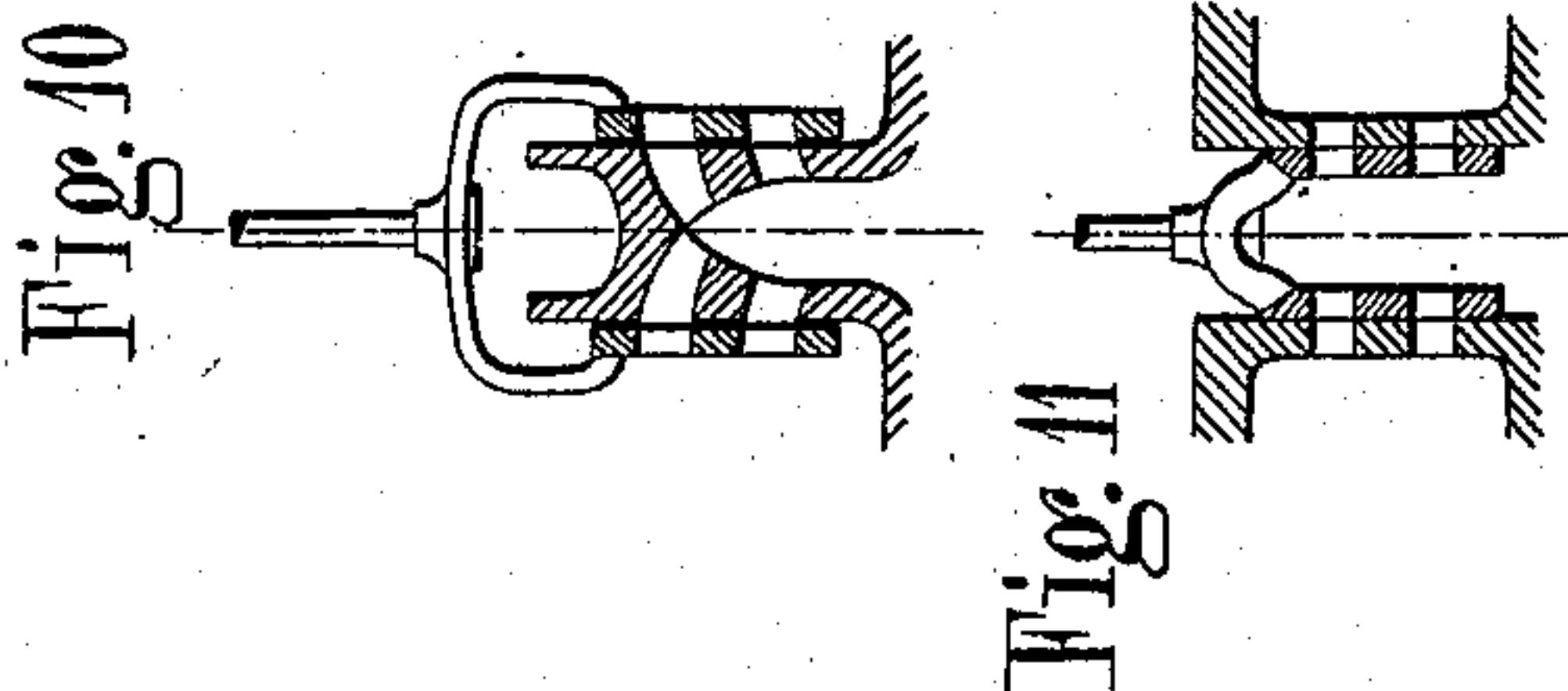
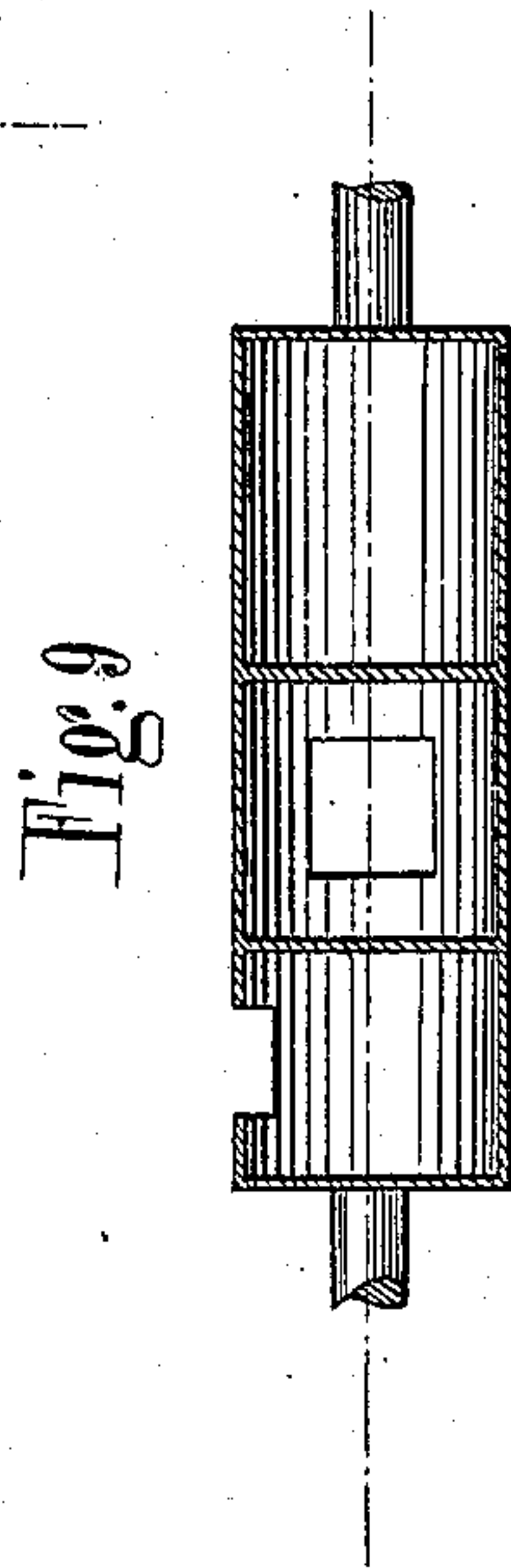
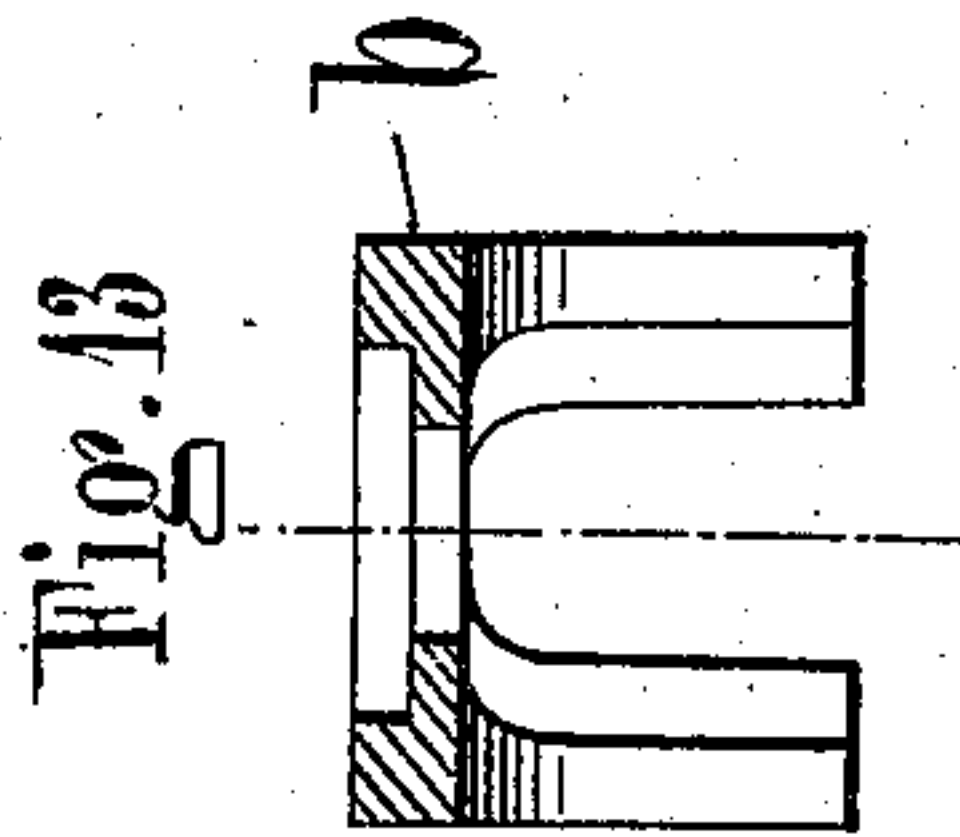
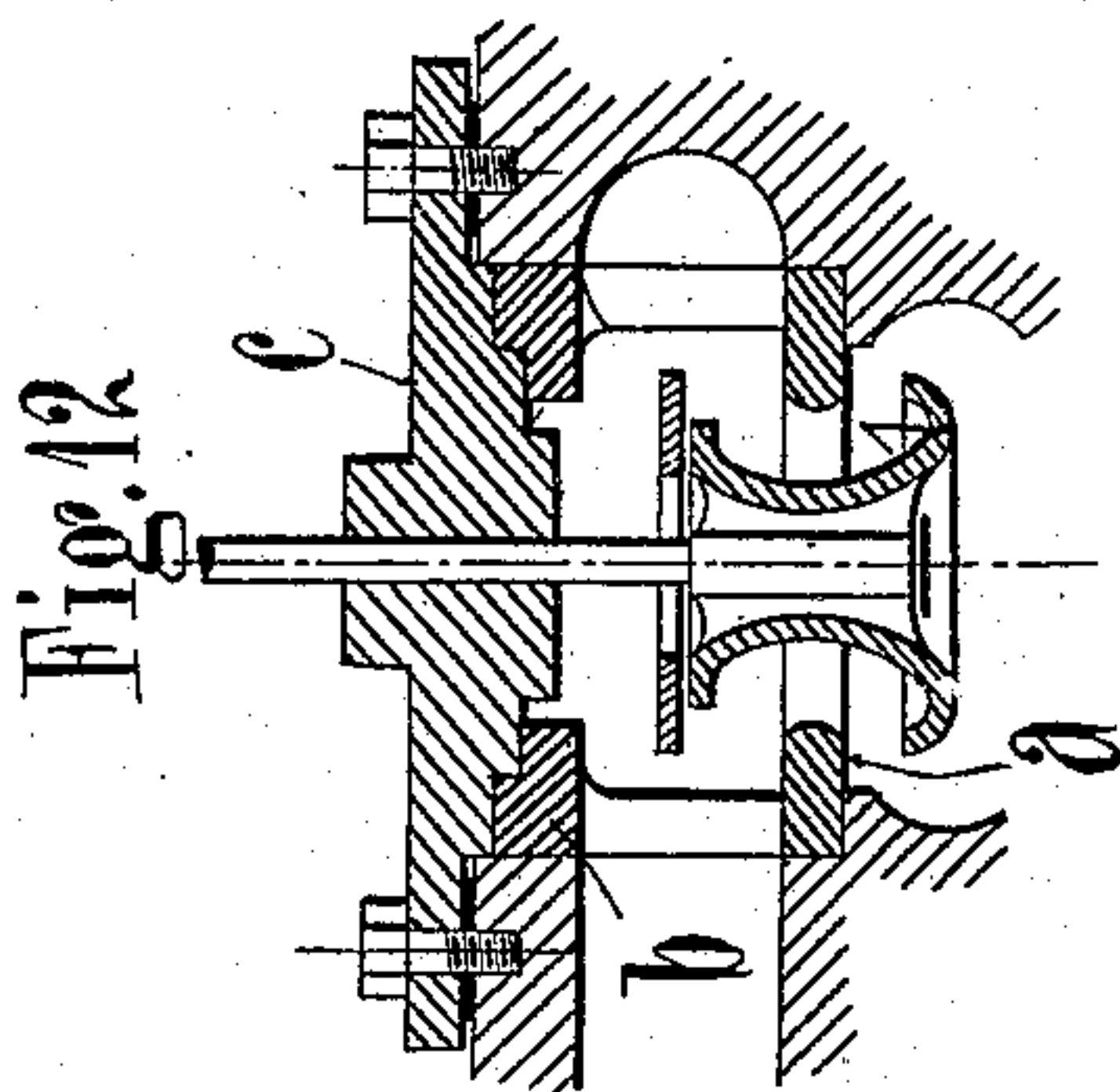
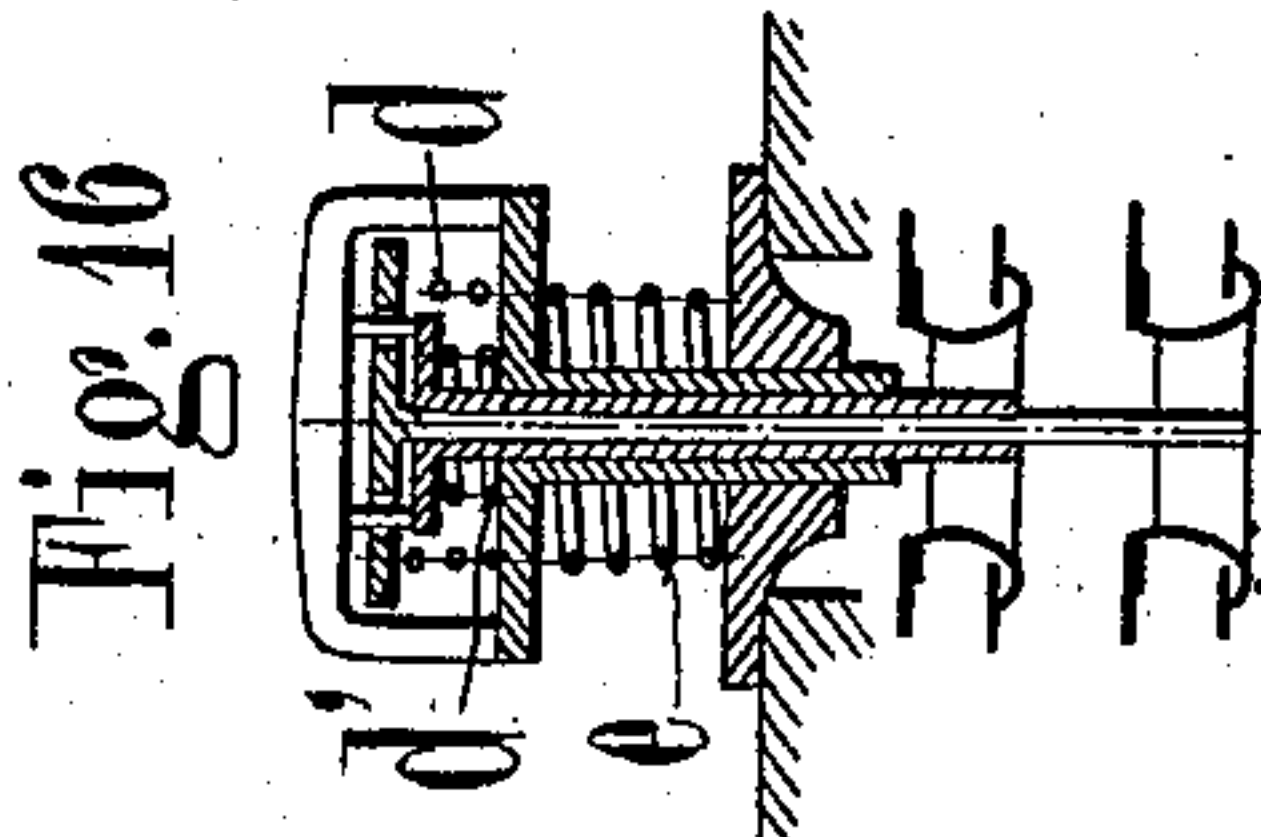
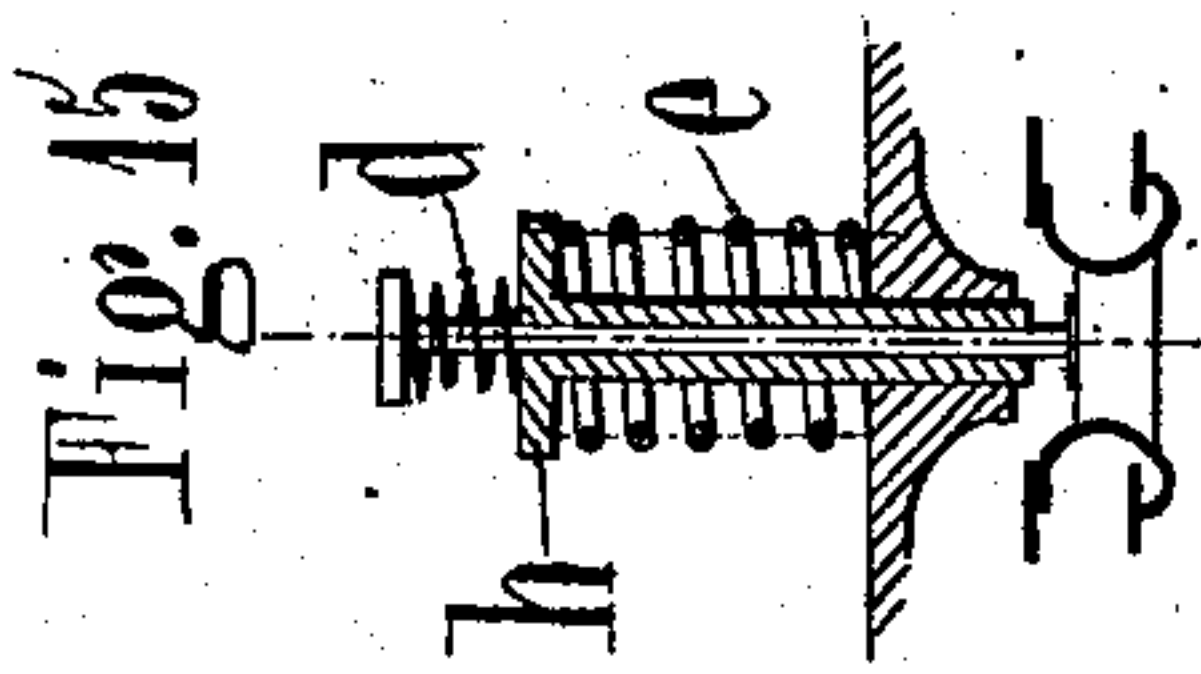


Fig. 7

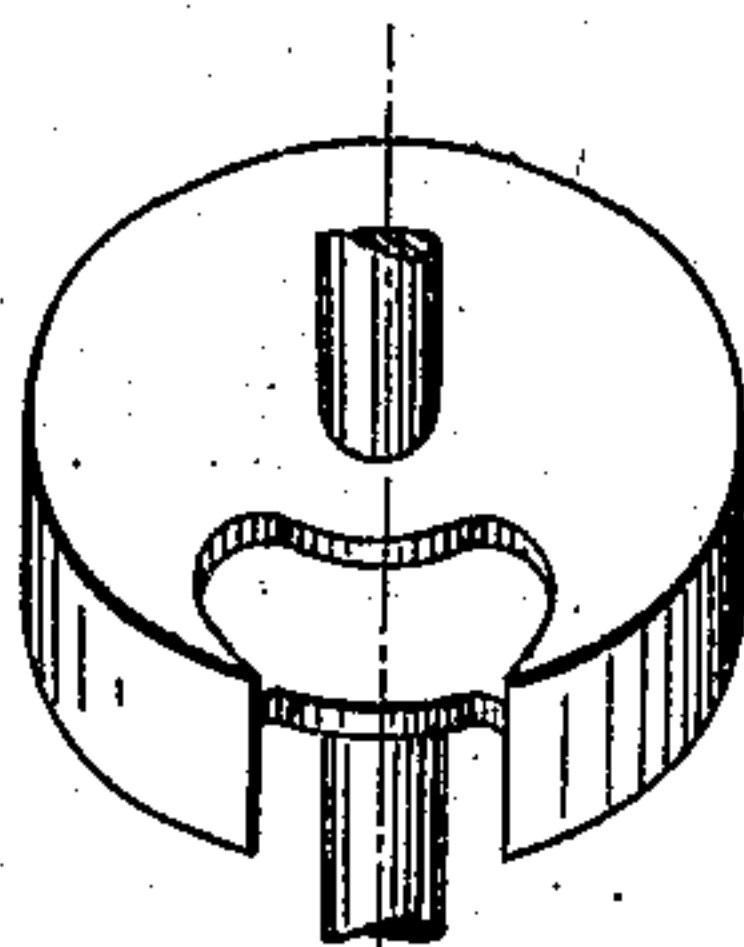
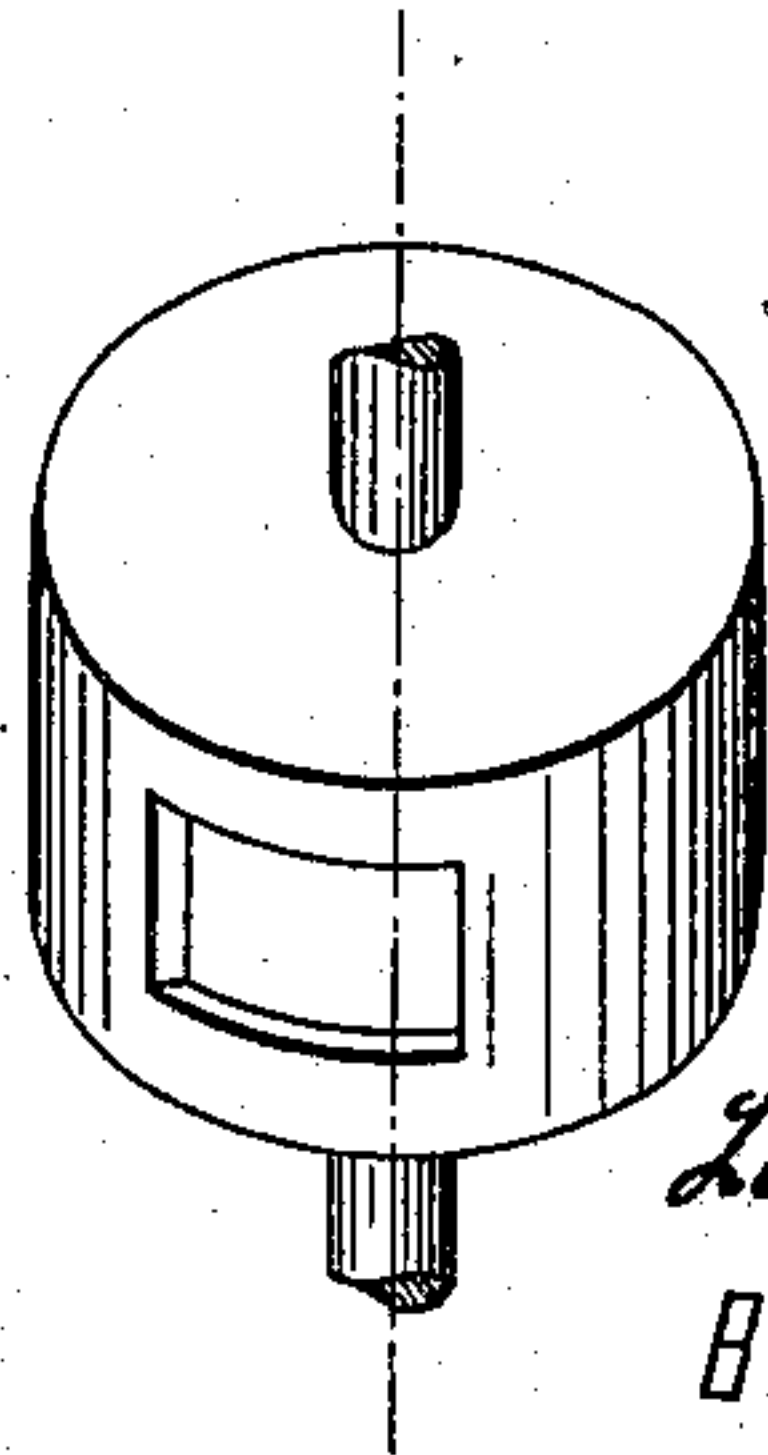


Fig. 8



WITNESSES

*Edward Star*  
*H. J. Suberter*

INVENTOR

*Louis Jules Jean Baptiste*  
*Le Rond*

BY

*James L. Taylor*  
ATTORNEYS

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Fig. 10<sup>a</sup>

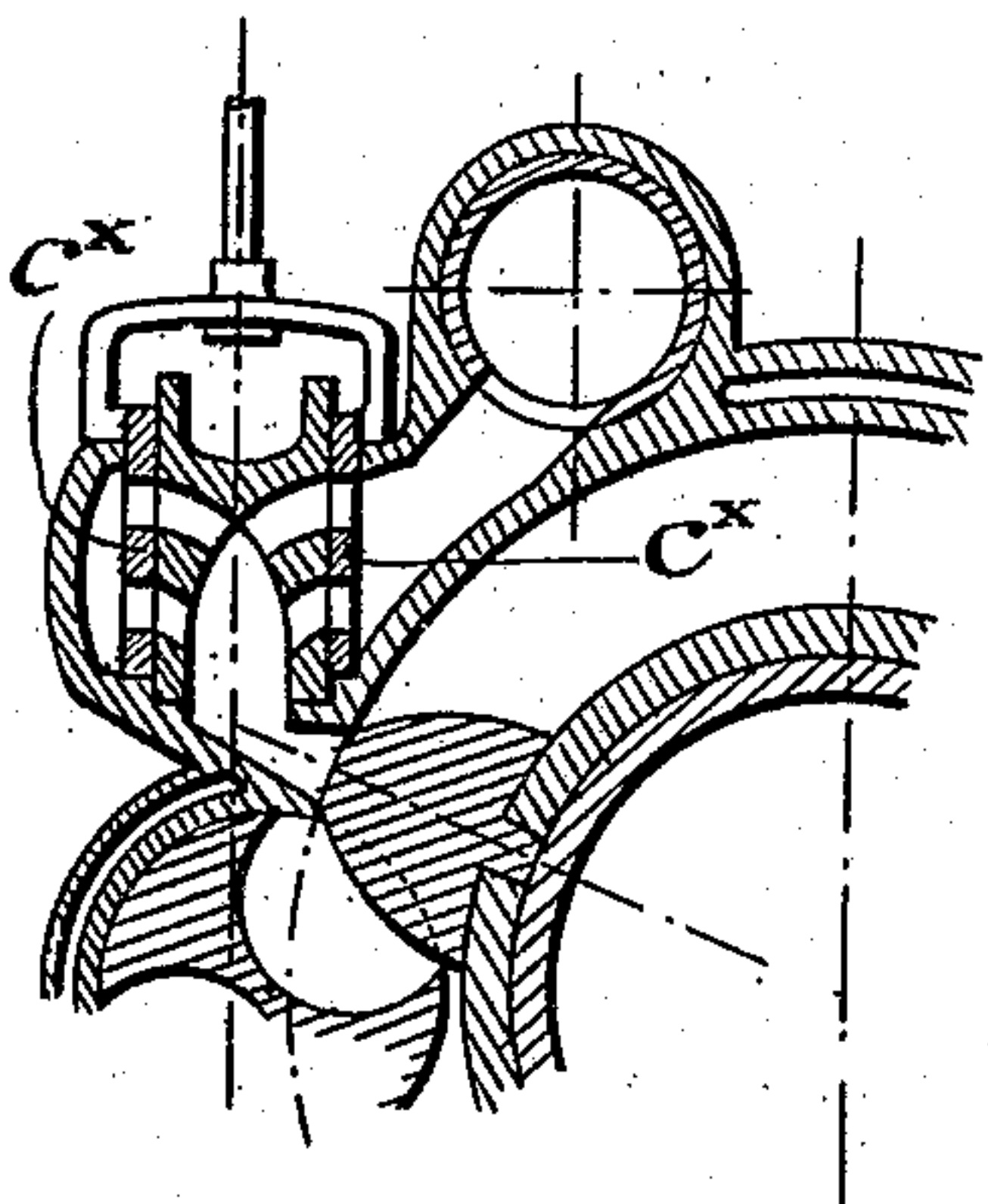


Fig. 12<sup>a</sup>

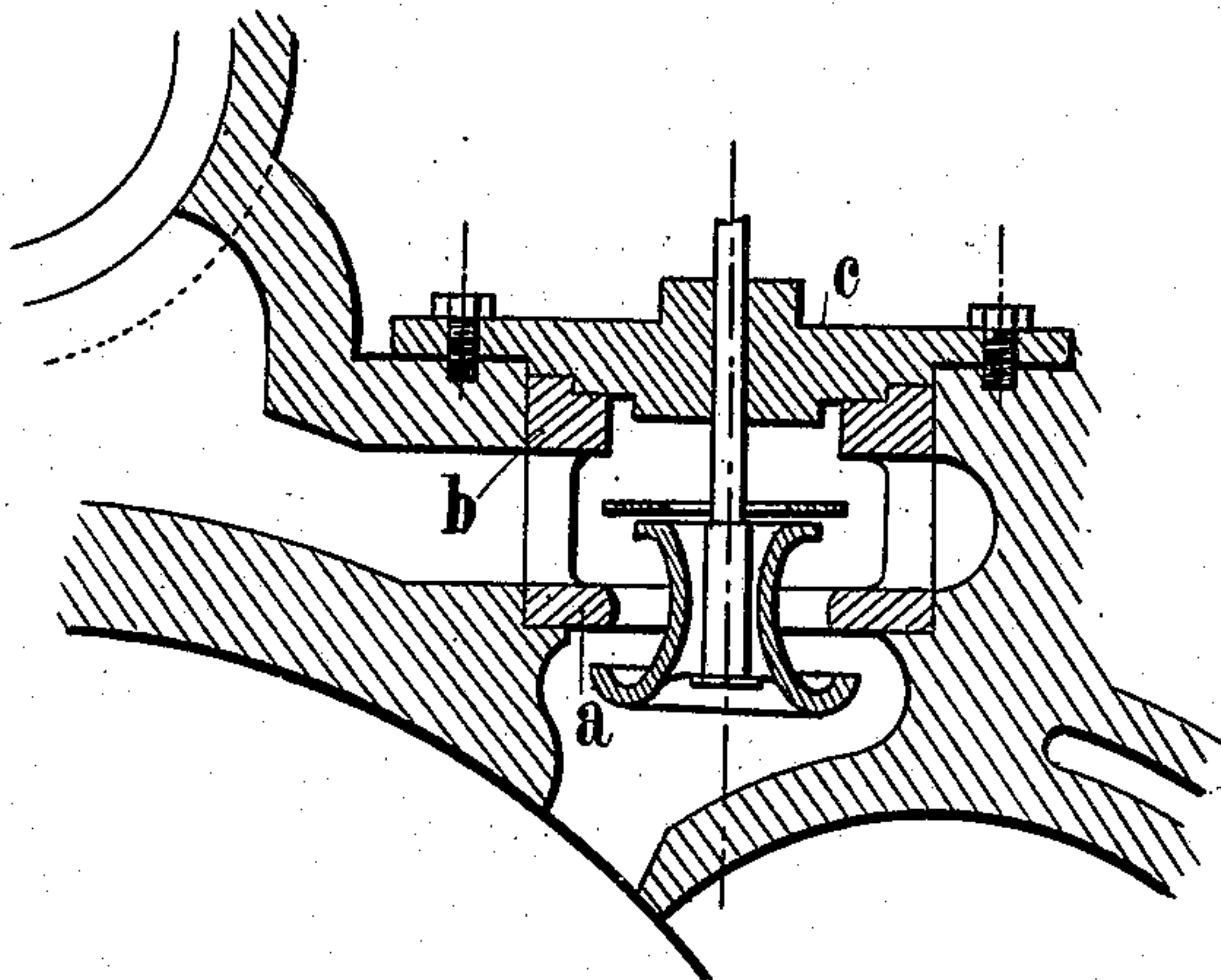
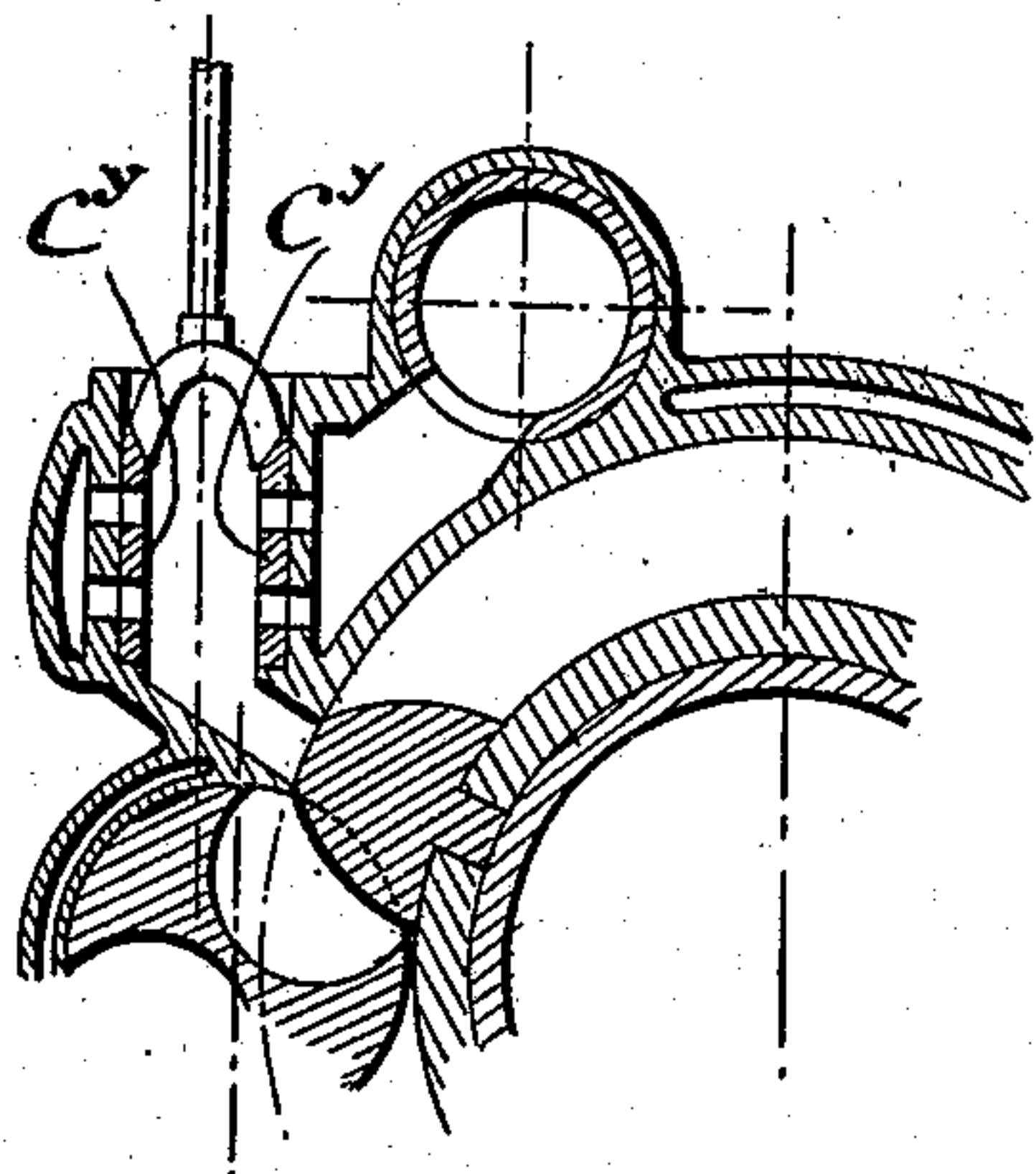


Fig. 11<sup>a</sup>



WITNESSES

*Fannie Fish*  
*Henry J. Suberlin*

INVENTOR

*Louis Jules Jean Baptiste Le Rond*  
BY *Lopez Lopez*  
ATTORNEYS



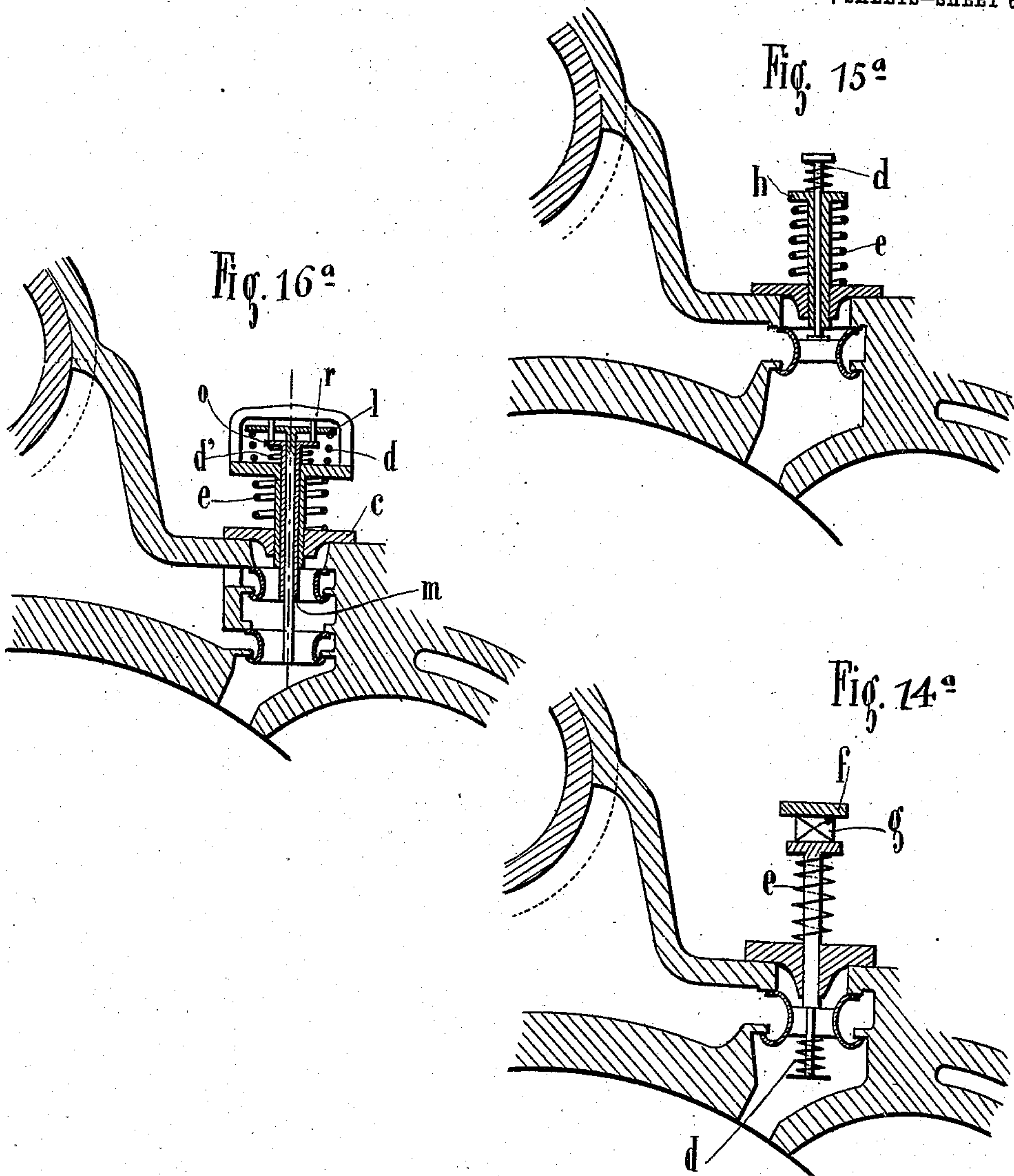
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7 SHEETS—SHEET 6.



WITNESSES

*Fannie Fisk*  
*Henry J. Suberbie.*

INVENTOR  
*Louis Jules Jean Baptiste Le Rond*  
 BY *Francis G. Gouge*  
 ATTORNEYS

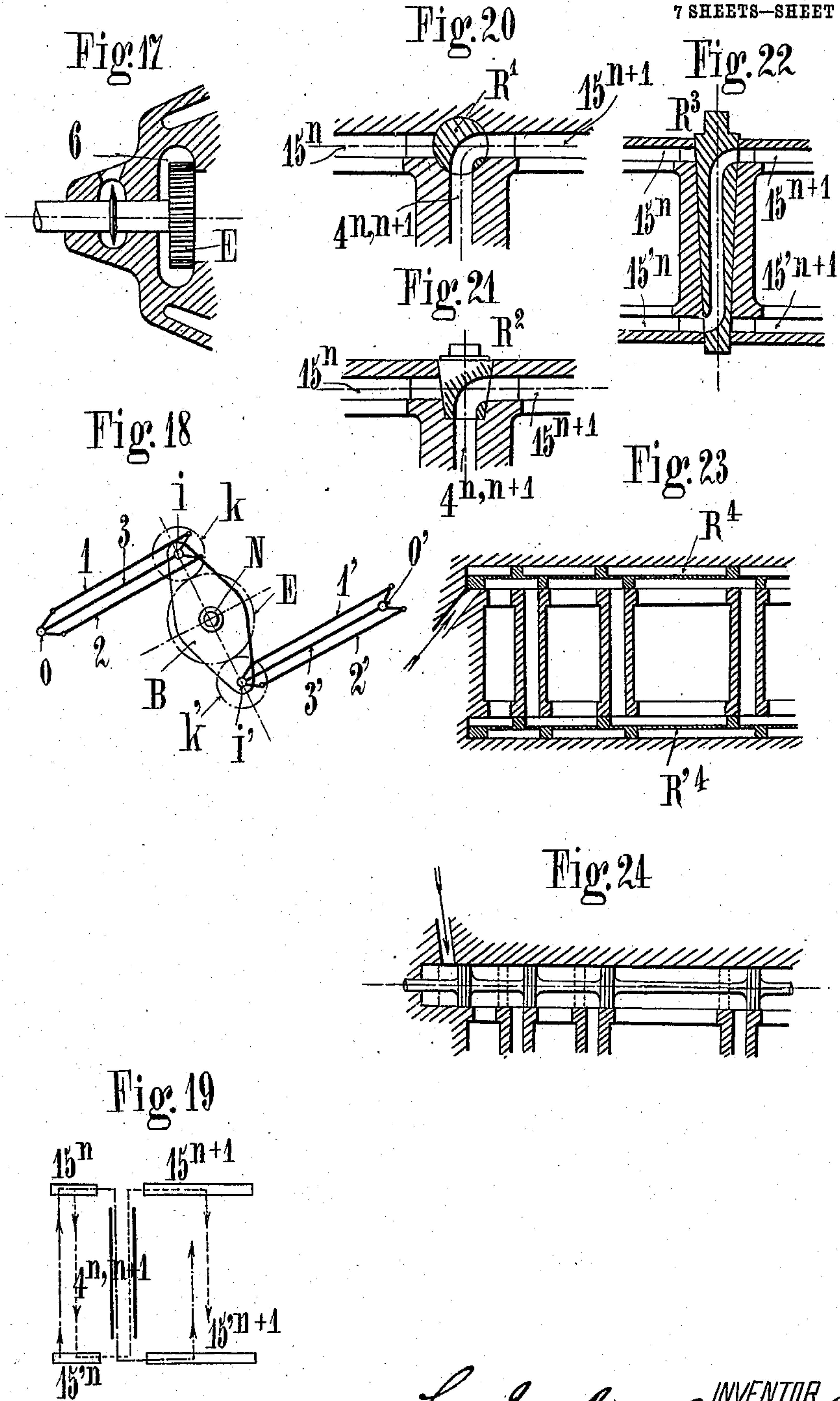
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7 SHEETS—SHEET 7.



WITNESSES

Edgard Allen  
H. J. Suhrbier.

INVENTOR  
Louis Jules Jean Baptiste Le Rond  
BY Louis Dupre.  
ATTORNEYS



# UNITED STATES PATENT OFFICE.

LOUIS JULES JEAN-BAPTISTE LE ROND, OF PARIS, FRANCE.

## ROTARY MACHINE.

No. 919,897.

Specification of Letters Patent.

Patented April 27, 1909.

Application filed February 8, 1906. Serial No. 300,179.

*To all whom it may concern:*

Be it known that I, LOUIS JULES JEAN-BAPTISTE LE ROND, a citizen of the Republic of France, and resident of Paris, France, have invented new and useful Improvements in Rotary Machines, which improvements are fully set forth in the following specification.

This invention relates to a rotary machine which can work as a motor, as a pump or a combination of motors and pumps, and is characterized by certain improvements in the construction of rotary machines generally, the object of which is to improve their construction, to render their regulation automatic and to increase the tightness of their joints.

In order to make the explanation as clear as possible, a machine according to this invention is illustrated, by way of example, in the accompanying drawings.

Figure 1 is a longitudinal section of the new machine, Fig. 2 is a cross-section, Fig. 3 shows a special arrangement of the obturating cylinder, Fig. 4 shows another special arrangement of the obturating cylinders, Fig. 5 shows a special method of securing the piston, Fig. 6 shows a leak-preventing device, Fig. 7 shows a hollow obturator of the same width as its chamber, Fig. 8 shows a hollow obturator of the construction shown in Fig. 4, Fig. 9 shows a hollow obturator of the construction shown in Fig. 3, Fig. 10 shows an outer distributing cylinder when the machine has distributing parts, Fig. 10<sup>a</sup> is an enlarged view of the cylinder shown in Fig. 10, showing the manner in which it is mounted in the machine, Fig. 11 shows an inner distributing cylinder for use in the same case, Fig. 11<sup>a</sup> is an enlarged view of the cylinder shown in Fig. 11 and the adjacent parts. Fig. 12 shows—for use in the same case—a construction of balanced valve, Fig. 12<sup>a</sup> is an enlarged view of the valve shown in Fig. 12 and the adjacent parts. Fig. 13 is a detail view of Fig. 12, Fig. 14 shows a compensating device for the valve shown in Fig. 12, Fig. 14<sup>a</sup> shows the manner of mounting the compensating device shown in Fig. 14. Fig. 15 shows another compensating device for the same valve, Fig. 15<sup>a</sup> shows the mounting of the compensating device shown in Fig. 15. Fig. 16 shows the application of the same device to the case of four steam passages, Fig. 16<sup>a</sup> shows the manner in which the device illus-

trated in Fig. 16 is mounted. Fig. 17 shows the arrangement of the toothed wheel in the equilibrium chamber 6 of Fig. 1, Fig. 18 shows another arrangement of toothed wheel gear for transmitting movement to the various spindles, Fig. 19 is a diagram of the different paths of the steam for forward driving and reversing, Fig. 20 shows a two-way cock for reversing, Fig. 21 shows a bent cock for the same purpose, Fig. 22 shows a special cock for the same purpose, Fig. 23 shows compound cocks replacing a whole series of simple cocks, Fig. 24 shows a multiple slide valve having the same object.

The novel features of the invention will be described, by way of example, in connection with a machine of the system covered by French Patents Nos. 111,538 and 213,573 granted to me, respectively, on June 13, 1902, and June 21, 1904. In these patents there are described rotary machines having compound expansion and embodying rotating pistons and obturators. One of these machines is shown in Figs. 1 and 2 and is composed of a certain number of annular chambers in which the pistons 1 rotate, said pistons being fixed to the motor-shaft and rotating synchronously with the obturators, which are designated by reference numeral 16. As shown in the drawings, the pistons 1 are carried by rings 2 which can slide longitudinally on a cylinder 3, being keyed to the latter by means of fixed keys 14 or by any other arrangement permitting the longitudinal sliding of the rings, while preventing their angular displacement with respect to said cylinder. The obturators 16 are fixed to shafts which also have a sliding connection with them. This connection is obtained by means of keys 14, as shown, or by any other suitable arrangement.

In the casing or shell of the machine, which is formed in two parts, there are formed: a steam jacket, intermediate conduits, and different chambers, such as 6, 7 and 8, the function of which will be hereinafter explained. The chambers 4 are steam ports which establish communication with the ports 15 of the successive chambers.

The main shaft is journaled in bearings supported between the parts of the casing. The cylinder 3 is itself fixed at one of its extremities to said shaft, which supports it and is capable of being slid to the other extremity. These connections are established, as has been said, either by the use of fixed keys or any other suitable arrangement effecting



the same results. Thus, as shown in Fig. 5, the piston, denoted by P, could slide on a fixed support T.

The obturators can be either solid, as indicated in Fig. 2, or hollow, as shown in Figs. 7, 8 and 9. They may have the same width as the working chambers, as in Fig. 1, or be wider, as in Fig. 4. Or the obturators carried by the same shaft might be formed by a series of cylinders, as indicated in Figs. 1 and 4, or a single cylinder, as indicated in Figs. 1 and 9. In this last case packing rings 9 are used to insure tight joints between the different chambers. These packing rings 9 are shown in Fig. 1 as being mounted on the periphery of the cylinder 3 in such a way as to form tight joints between the chambers.

The foregoing arrangements have for their object to reduce to a minimum leaks between the different parts. In particular the arrangements of the fixed keys or similar devices for the pistons, cylinder, rings and obturators have for their object to permit variations in expansion with minimum play, each movable part moving freely in its chamber.

In the casing or shell there are formed different chambers independent of the working chambers. The chambers 6 at the two ends of the machine are put into communication by conduits 13 which have for their object to avoid end-thrust; they can also be put in communication with each other, with the atmosphere or any other desired medium, and particularly serve as a steam jacket.

The small chambers 7, which are formed in the casing adjacent to the bearings 11, are leak-preventers which have for their object to prevent the escape of steam or the entrance of air. They are formed between packing rings 9 on the main shaft. When it is necessary to prevent the entrance of air into the casing, said chambers 7 may be filled by steam which arrives in a stream through a small pipe *t*, as shown in Fig. 6, which shows a modification of the leak-preventing arrangement, which in this case acts upon the ends of the cylinder instead of upon the shaft.

Adjacent the bearings 11 the casing of the machine is further provided with small chambers 8. Applied to the shaft within these chambers are hydro-extracting disks 12. When the machine is in operation the rotation of these disks prevents the water or steam from penetrating into the bearings.

The packing rings 9 can be made in two parts which adhere by the difference in the coefficient of expansion, for example, they may be made of bronze with an envelop of iron in case the machine is to be operated by steam or other heating agent, or they can be of iron having an envelop of bronze if the machine produces cold, as in a pneumatic machine. The adherence can also be effect-

ed mechanically, for example, by clamping the rings between the parts of the machine, and the machine can be made in two parts, as shown in Figs. 1 and 2, or any number of parts constituted and assembled in any suitable manner, for example, by means of bolts arranged as shown in Fig. 2.

The preceding arrangements are equally applicable to motors, pumps or combinations of motors and pumps.

As parts of the distributing gear, valves or any similar devices can be used.

The following constructions may be cited by way of example:

1. *Cylinders acting as valves.*—Movable cylinders provided with ports, slide in the interior or outside a fixed cylinder provided with corresponding openings and can be controlled either by a releasable valve by providing its spindle with a suitable elastic tappet, or in any other manner. Fig. 10 shows a movable outside cylinder  $c^x$  and Fig. 11 a movable inside cylinder  $c^y$ . The cylinders can be made either with or without segments, grooves or other packing devices. Several similar cylinders can be arranged side by side in the same distributing chest and controlled by one and the same rod to which they are connected by means of straps, collars or in any other suitable manner.

2. A device applicable for enabling the above mentioned cylinders to be easily fixed or for balanced or non-balanced valves. Fig. 12 shows, by way of example, the arrangement in question applied to a balanced valve with double seat. In that figure the upper bearing is shown detachable. The bottom seat is constituted by a detachable washer *a* resting on a suitable ground ledge, a packing ring being interposed if necessary. The upper seat forms a portion of a box *b* (Figs. 12 and 13), the bottom of which rests on the seat *a*. Finally, the disk *c* rests on the box *b* which presses the seat *a* on the ledge. The joint of the disk can be made by means of any suitable elastic packing.

3. For high speed valves, with single or double seat, independently of the elastic tappet mentioned before which does away with the noise, it might be advantageous to provide the rod with an elastic device absorbing the momentum of the valve and its spindle, and similar in its action to the buffers of railway cars. Figs. 14 and 15 show two examples of this device, the valve being, moreover, controlled in any desired manner. In the diagrammatic Fig. 14, the small spring *d* absorbs the shock due to the momentum of the valve and its spindle, when pulled back by the spring *e*. *f* shows, by way of example, a tappet provided with an elastic buffer *g*. Fig. 15 shows a construction of the same device in which the spring *d* is outside. The elastic tappet can then be, for instance, annular in order to receive the shock from *h*.



By means of the same system, not only one, but two or more valves can be controlled by a single spindle (Fig. 16) as good a joint being obtained for each valve as if it were the only one.

The inventor reserves to himself the right to substitute the action of steam in suitable small cylinders, for that of the return or compensating springs, or of both, by controlling the valve spindle either directly or by means of levers, rods, cranks or in any other way. In a cylinder such as those described, the admission of steam can, moreover, be always open or closed in a suitable manner at any desired point of the stroke, in order to obtain a uniform return or compensating effort, either increasing or decreasing. He also reserves to himself the admission of steam or air or a liquid to the opposite face of the piston, in order to produce a braking effect, if necessary.

Any suitable arrangements of toothed wheels or similar parts can be used for insuring synchronous rotation of the spindles of the machine. The two arrangements described below will be found advantageous.

1. The toothed wheels can be arranged on the spindles inside the casing of the machine in one of the equilibrium chambers arranged at the ends, for instance at E (Fig. 17), so as to expand like the rest of the machine and not have any more play when the apparatus is hot than when it is cold.

2. For obtaining the same result, the following device can be used: A beam B is mounted in any desired manner, provided it can rotate about the axis of the driving shaft H to which is secured the toothed wheel E. This beam supports the spindles  $i$  and  $i'$  of the toothed wheels  $k$  and  $k'$ , having the desired ratio with E. The rotation of the spindles  $i$  and  $i'$  is transmitted by rods, chains or any suitable manner to the spindles  $o$  and  $o'$ .

In Fig. 18, by way of example, the motion of the spindle  $i$  is transmitted to the spindle  $o$  by means of orthogonal cranks or eccentrics connected by rods 1 and 2. The relative positions and the transmission of motion are thus insured in a reliable manner. The two spindles can, moreover, be connected by a distance rod 3, although this is not essential.

In any case, the beam automatically takes up the desired position, whatever be the expansion of the machine, and as the wheels have the same temperature as their support their play does not vary. Consequently the relations of speed and of keying of the spindles N,  $o$  and  $o'$  and of the parts which they support, remain the same whatever be the variations of temperature.

The engine can be reversed simply by reversing the direction of circulation of steam in the chambers and in the passages. Any reversing device giving this result can, therefore, be applied.

Some simple constructions of the reversing gear in a machine with two obturators or two acting sectors, such as are described at the beginning of this specification, will now be shown, by way of example.

First of all, the intermediate conduits can have the two positions shown in Fig. 2.

It is only necessary to point out that in any case the problem is reduced to connecting, either in one or in the other direction, the ports of two successive chambers  $n$  and  $n+1$  with the intermediate conduit 4  $n, n+1$  (Fig. 19). But, whether the Fig. 19 be in any horizontal, vertical or inclined plane, the problem remains the same, and the direction of rotation will change according as steam will follow the dotted or the chain-dotted path. This result can, however, be obtained by means of single, rotating, two-way cocks, such as  $R^1$ , Fig. 20; or bent cocks, such as  $R^2$ , Fig. 21; (or of special type, such as the cock  $R^2$ , Fig. 21); or of special type, such as the cock  $R^3$ , Fig. 22, which replaces two cocks  $R^2$ ; or compound cocks, such as  $R^4$ , Fig. 23. It will be seen that the latter cock replaces all the cocks corresponding to a series of ports  $15^1 15^2 \dots 15^n + 1$ . Four cocks, such as  $R^4$ , are sufficient for all reversing, whatever be the number of successive chambers.

As a last example, Fig. 24 shows the arrangement of piston valves equivalent to the cock  $R^4$ . A single manipulation brings it from the position in full lines to the dotted position which effects the reversing.

These various devices bring about, in one and the same manner, the reversing, and are given as an example of the numerous arrangements that are possible and which the inventor reserves to himself the right to apply whenever necessary.

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

1. A rotary machine comprising a casing, a cylinder rotatable therein, a plurality of rings capable of longitudinal movement on said cylinder, pistons carried by said rings, and rotatable obturators coacting with said pistons.

2. In a rotary machine of the character described, the combination of a casing, a cylinder rotatable therein, rings slidable along said cylinder but fixed against independent rotation, pistons carried by said rings, and rotatable obturators coacting with said pistons at opposite sides of the casing and capable of endwise sliding movement.

3. In a rotary machine of the character described, the combination of a casing, a cylinder rotatable therein, a plurality of rings slidable longitudinally along said cylinder but fixed against rotation independently thereof, radially extending pistons carried by said rings, obturator shafts within



the casing at opposite sides thereof, and rotary obturators mounted on said shafts and coacting with said pistons, said obturators being fixed against angular movement on their shafts but capable of longitudinal movement thereon.

4. In a machine of the character described, the combination of a casing formed in two united parts having the plane of their joint passing through the axis of the casing, a shaft supported by the two parts of the casing, a cylinder turning in said casing and separated at its ends from the walls of said casing by chambers, rings carried by said cylinder, pistons carried by said rings, and obturators coöperating with said pistons.

5. In a machine of the character described, the combination of a casing, a cylinder rotatable therein and spaced from the ends thereof, said cylinder having an interior chamber and conduits in the ends thereof leading to said chamber, pistons carried by said cylinder, and obturators to coöperate with said pistons.

6. In a machine of the character described, a casing of generally cylindrical form constituting a working chamber and subject to changes in temperature through contact with the working fluid, the chamber being provided with end bearings for a shaft and divided in a plane passing axially through the bearings, a shaft mounted in the bearings and rotatable therein, the shaft being grooved annularly within the bearings, packing rings seated in the grooves in the shaft and having normally a diameter equal to that of the bearings, the packing rings being com-

posed of material having a different coefficient of heat-expansion from the material of the bearings, so as to expand relatively thereto and bind tightly within the bearings when the machine is at working temperature, and a rotatable member of the machine mounted on the shaft and within the working chamber formed in the casing.

7. In a machine of the character described, a casing provided with a plurality of obturator-chambers arranged co-axially and in line with each other, a common shaft passing through the several chambers, and a plurality of separate obturators mounted upon the shaft and located in the chambers, the obturators being fixed against rotation with respect to the shaft but free to move longitudinally thereon.

8. In a machine of the character described, a casing, a rotary member operating therein, a power shaft on which said member is mounted, the shaft being journaled in the casing, valve mechanism comprising a rotary shaft journaled in the casing, and connections between the power shaft and the valve-mechanism shaft for actuating the latter, said connections having provision for compensating for the expansion and contraction of the casing due to changes in the temperature of the casing.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

LOUIS JULES JEAN-BAPTISTE LE ROND.

Witnesses:

EMILE LEDRET,  
HANSON C. COXE.