No. 652,035.

Patented June 19, 1900.

M. MICHON.

ROTARY MOTOR.

(Application filed Aug. 30, 1899.)

(No Model.)

3 Sheets—Sheet 1.

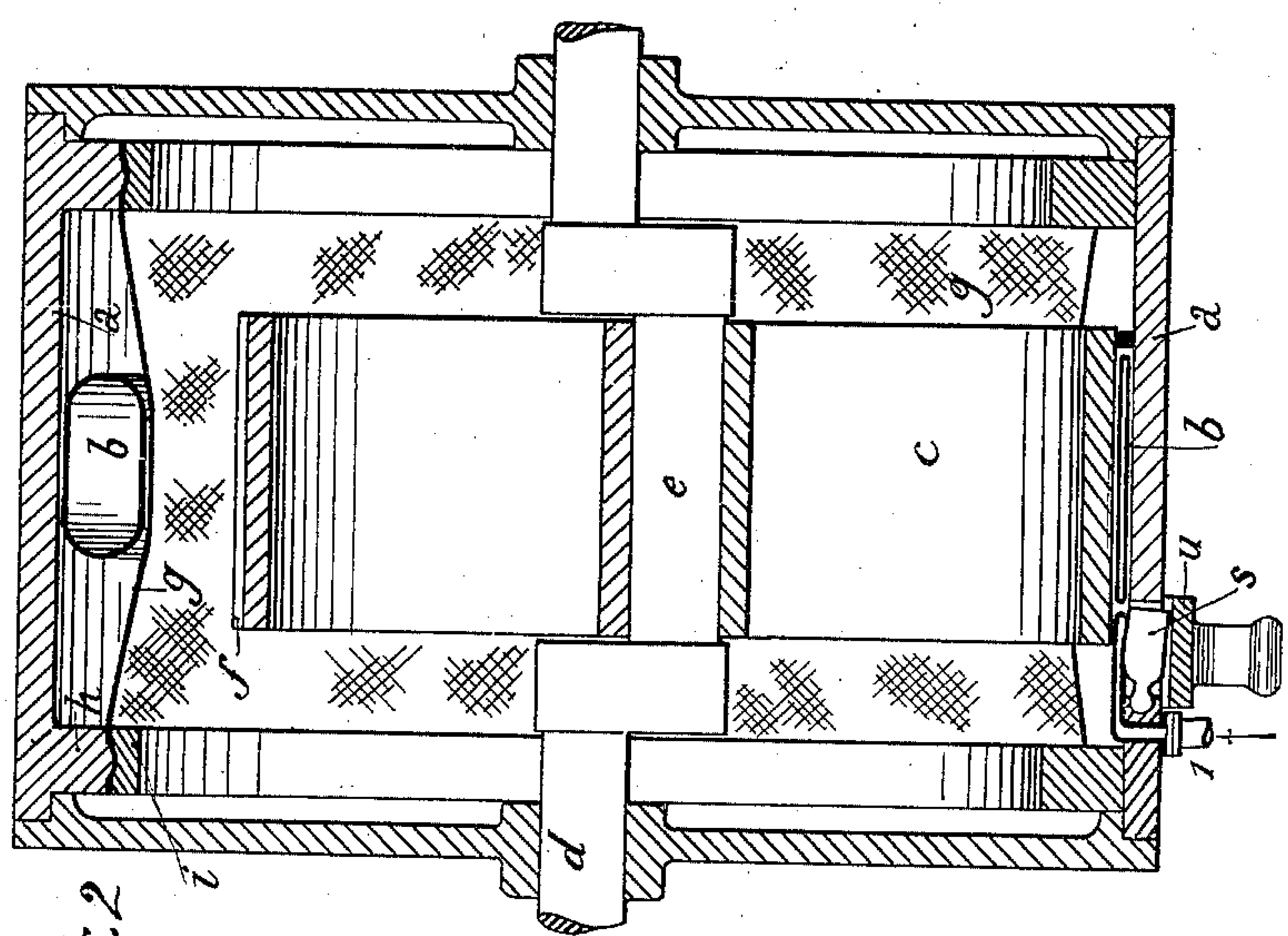

Fig. 2

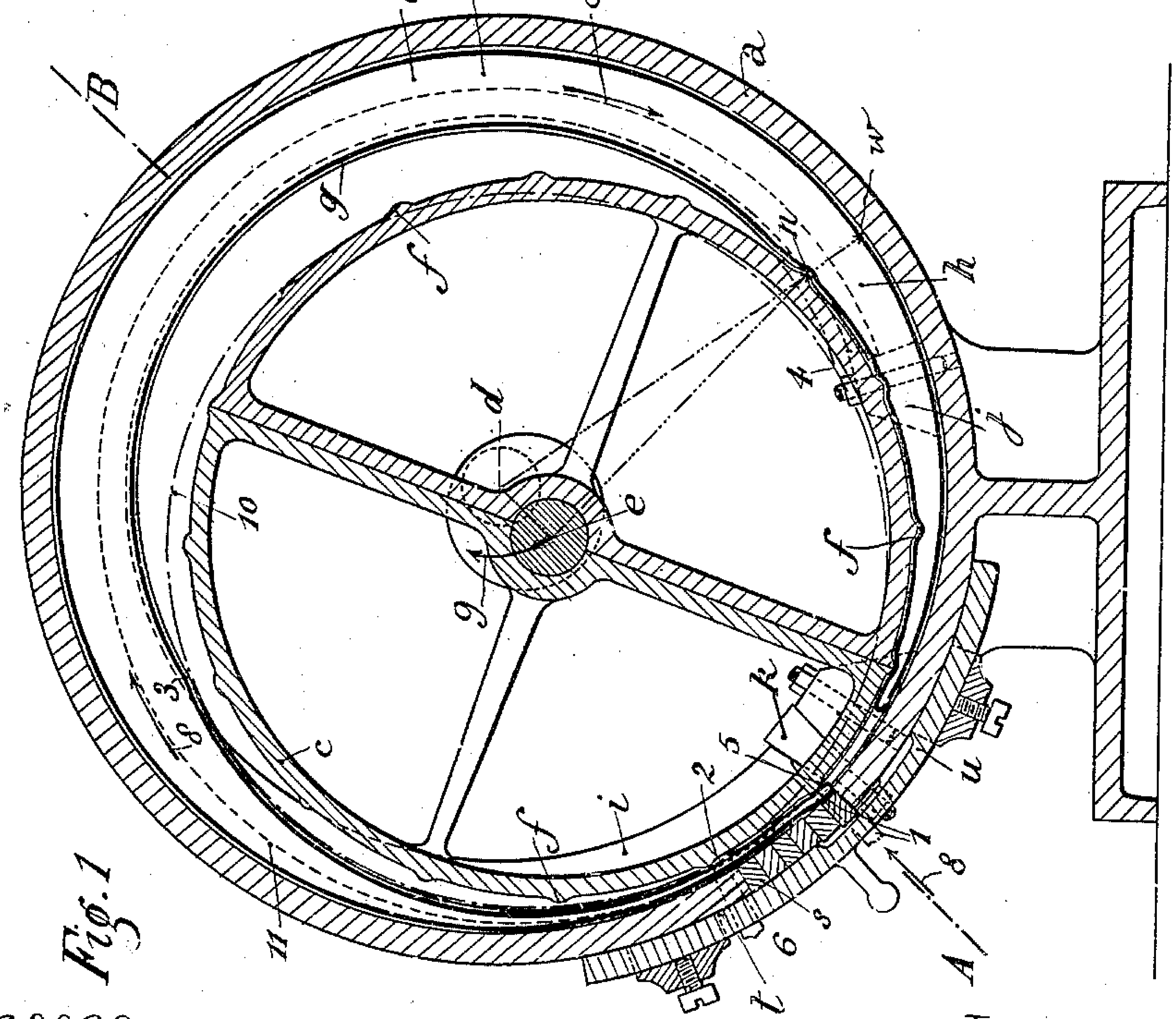

Fig. 1

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George Barry Jr.

Inventor:-
Maurice Michon
by attorneys
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THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

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Fig 3

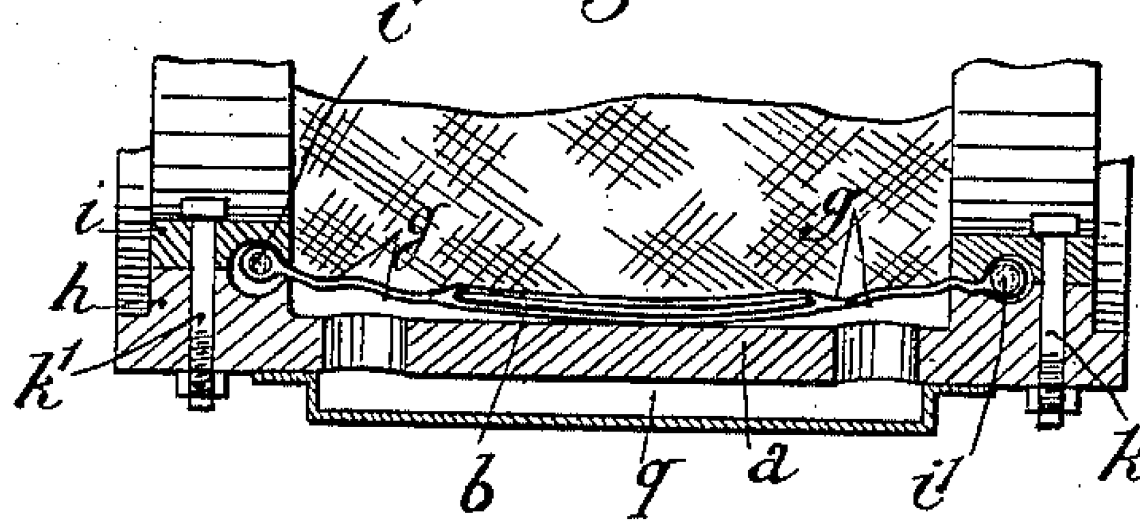


Fig 4

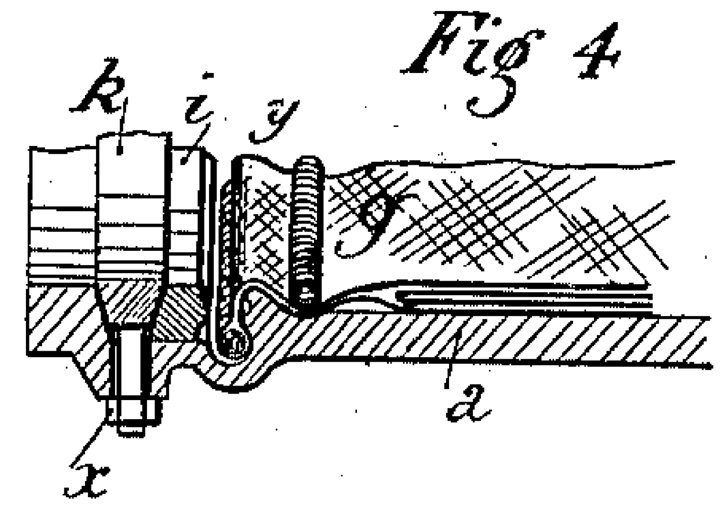


Fig. 14

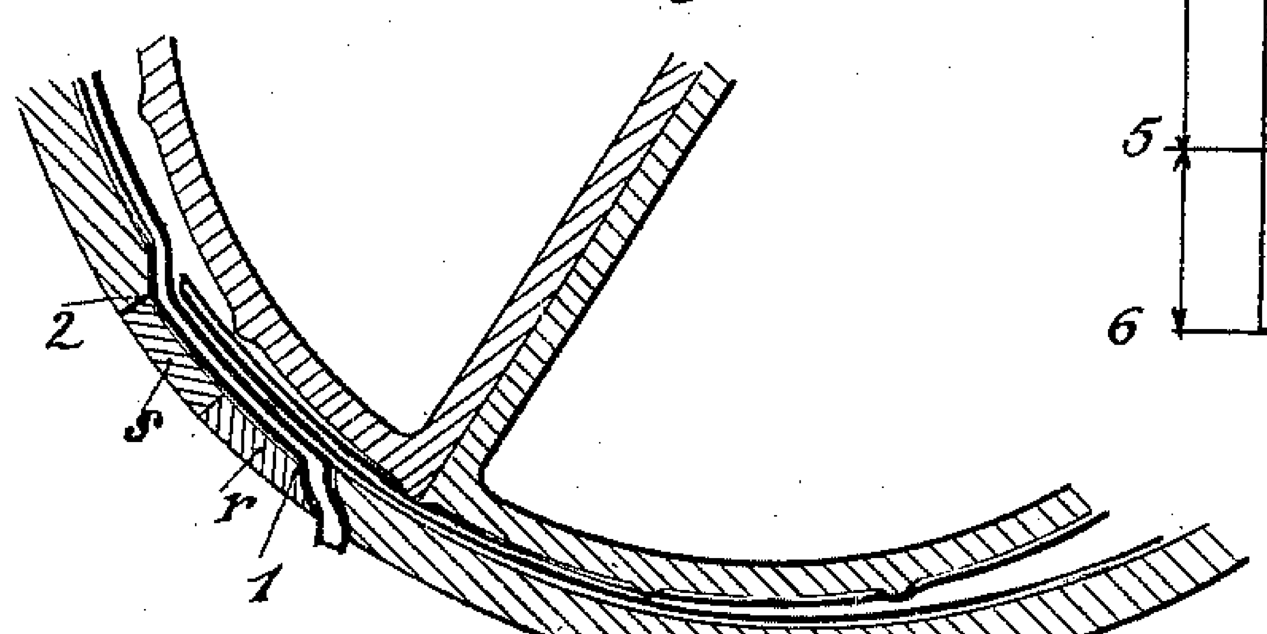


Fig 5

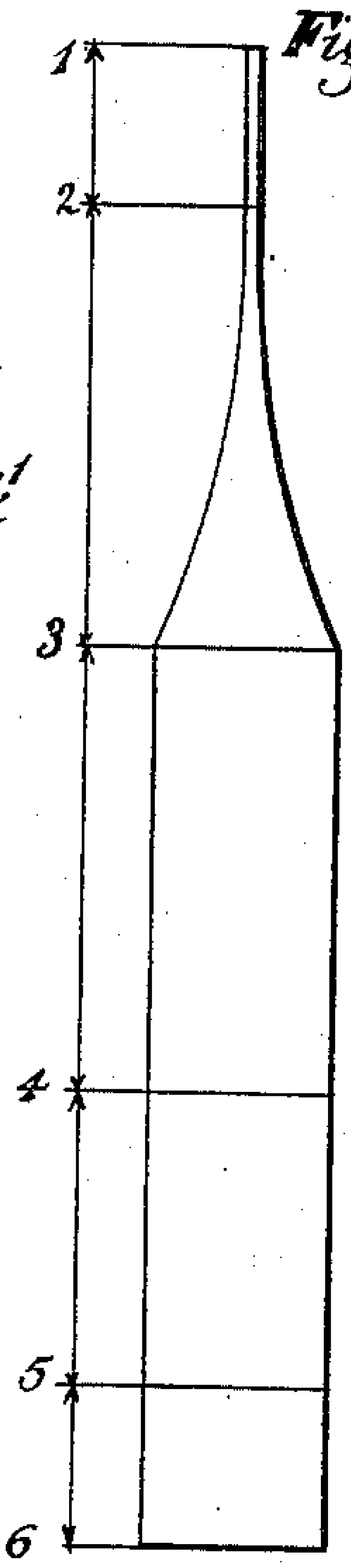


Fig 6

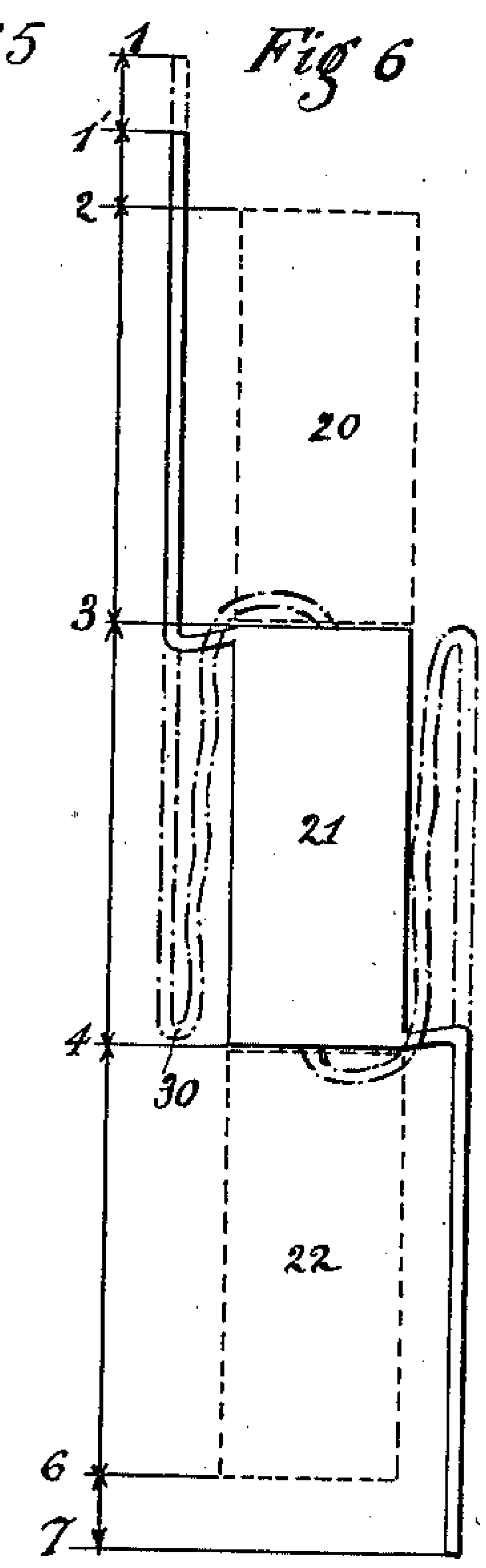


Fig 7

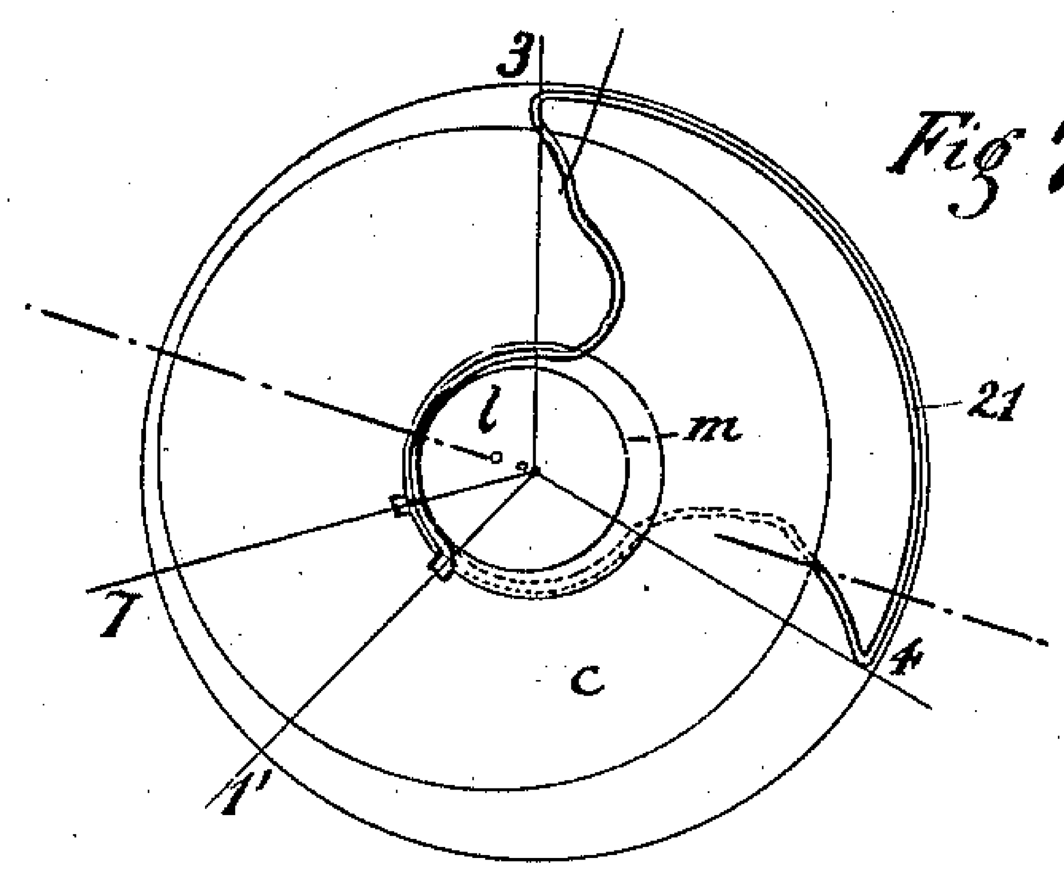
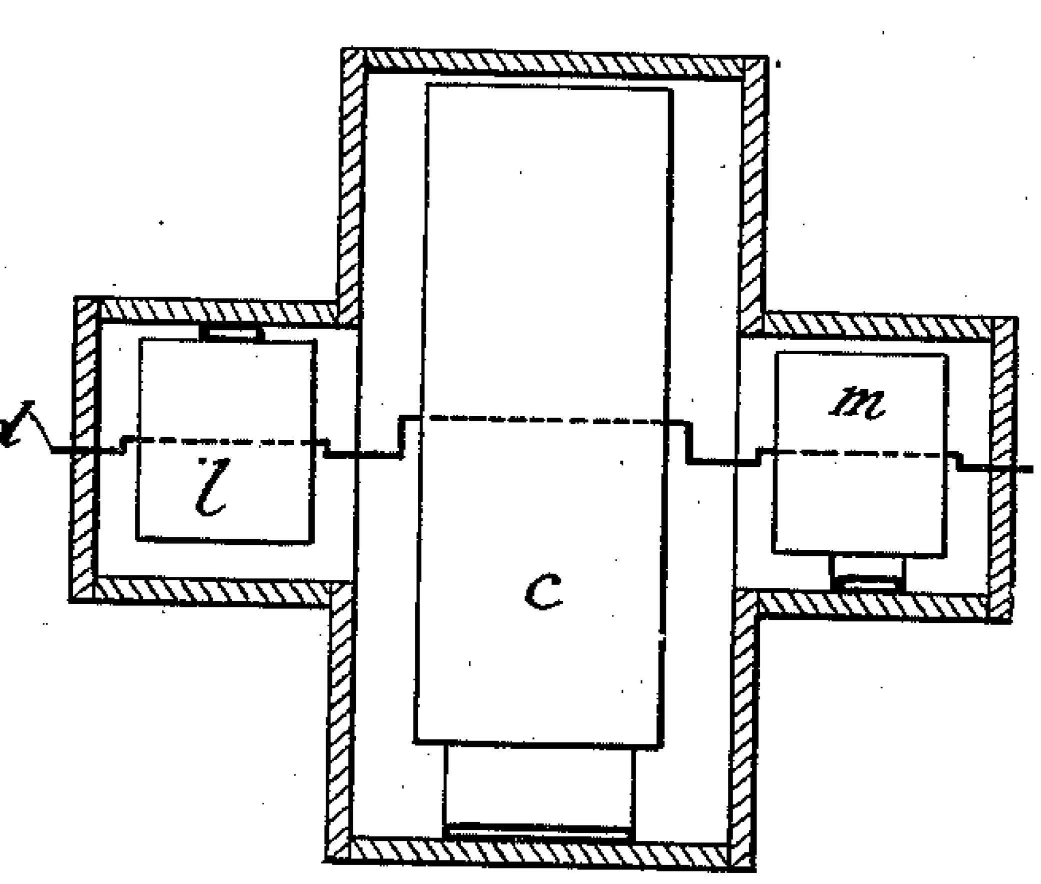


Fig. 8



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(No Model.) 3 Sheets—Sheet 3.

Fig. 9

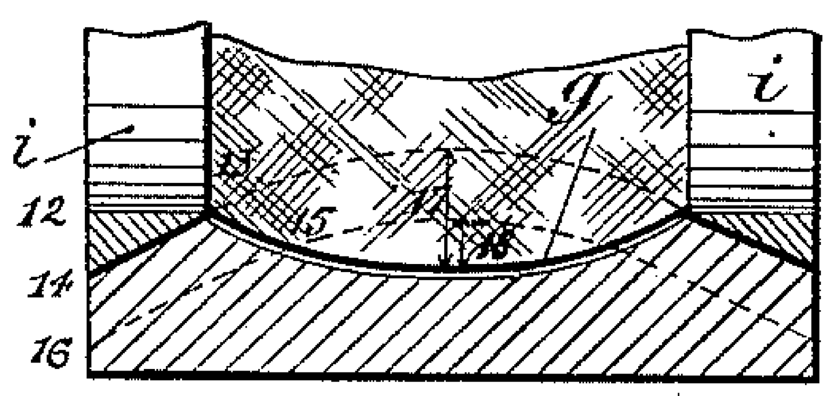


Fig. 10

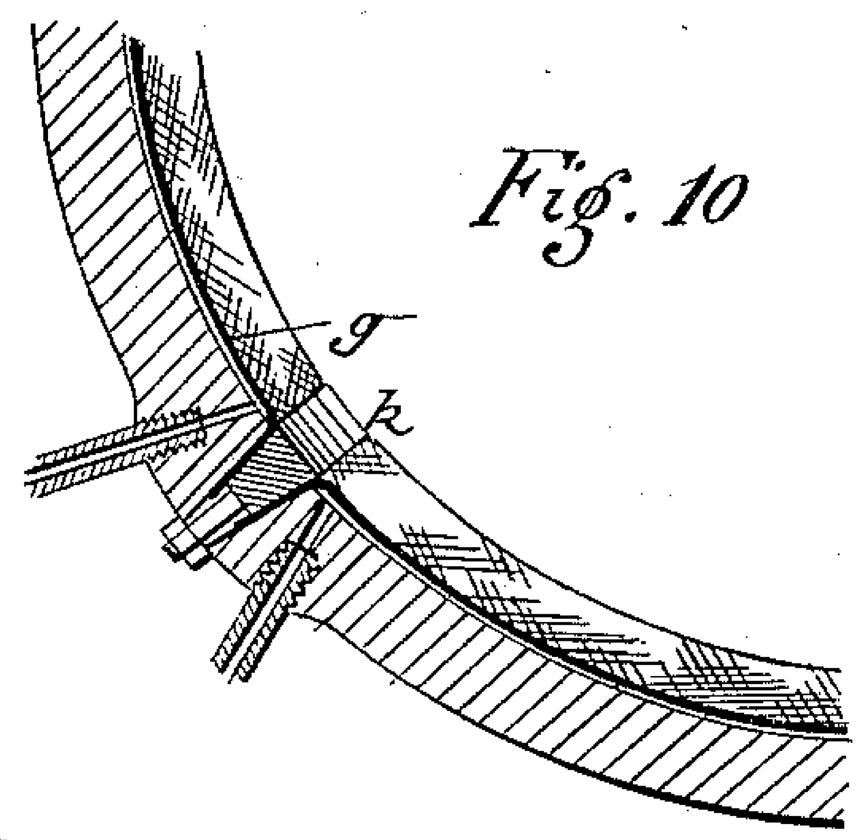


Fig. 11

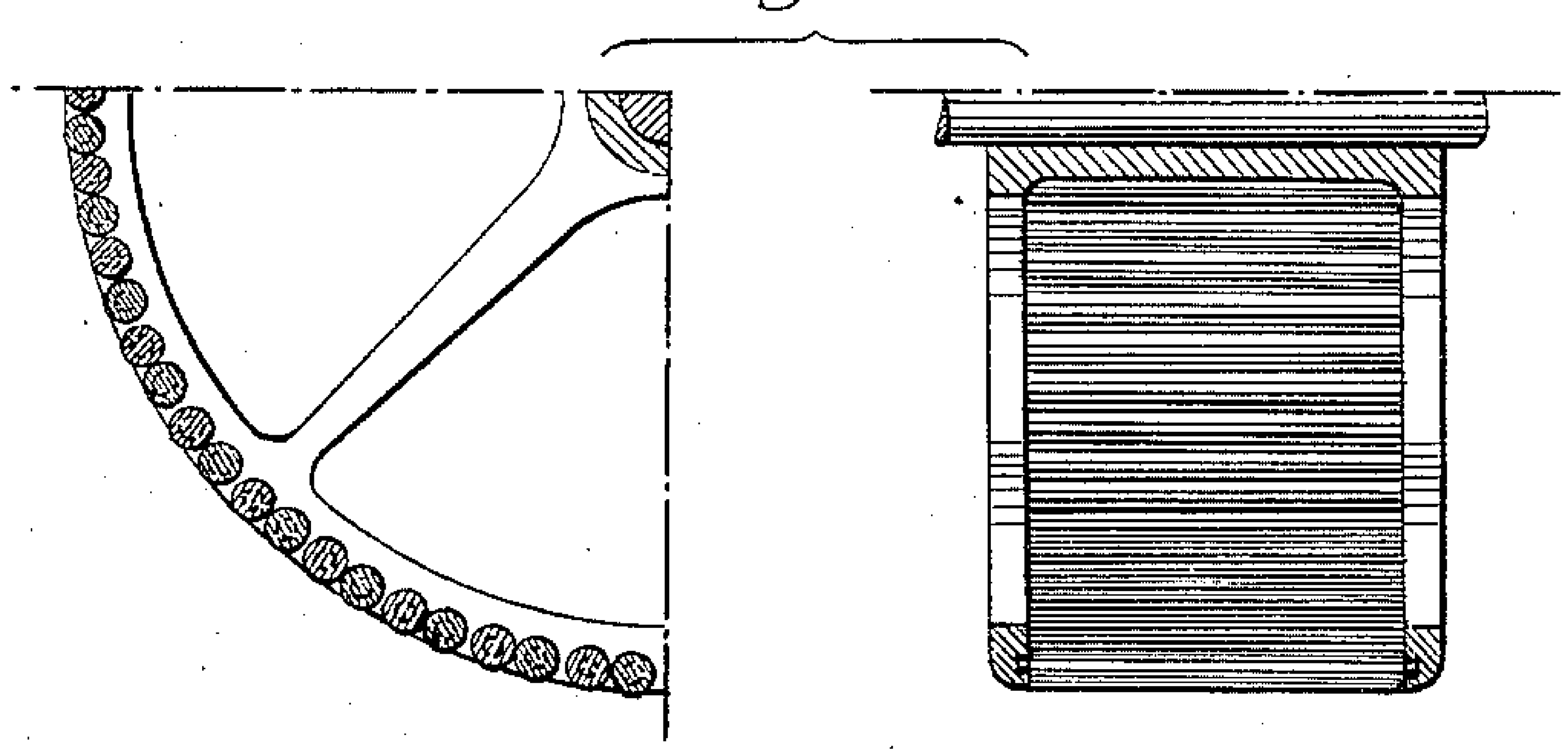


Fig. 12

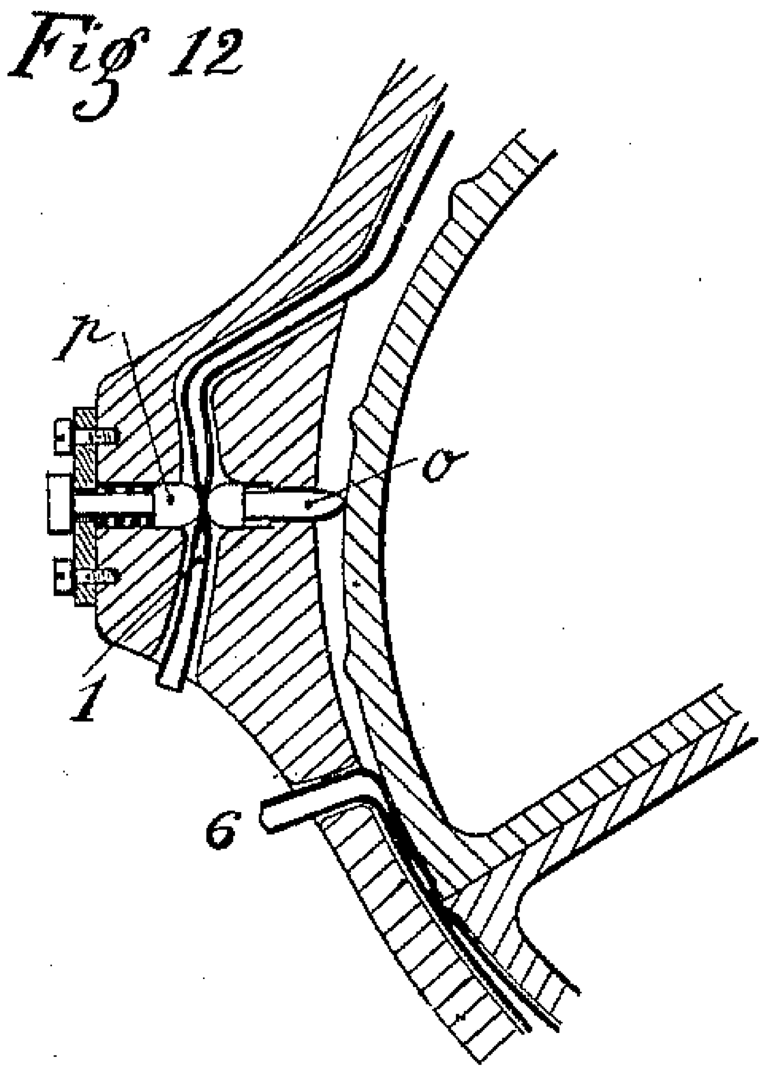


Fig. 13

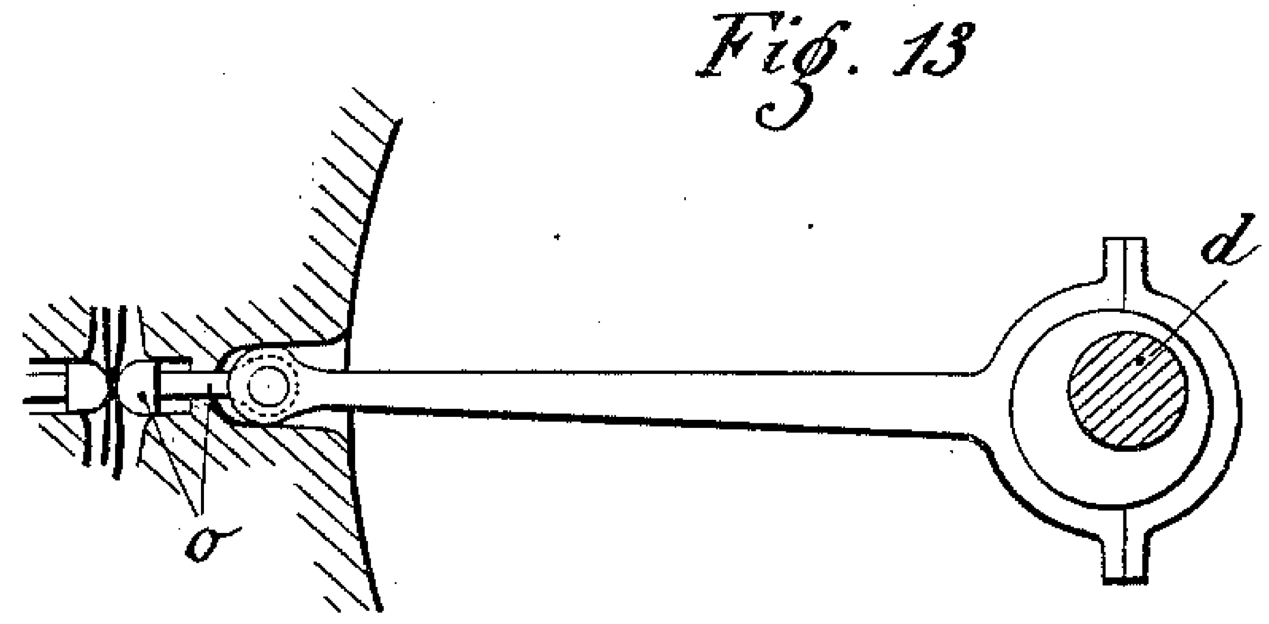
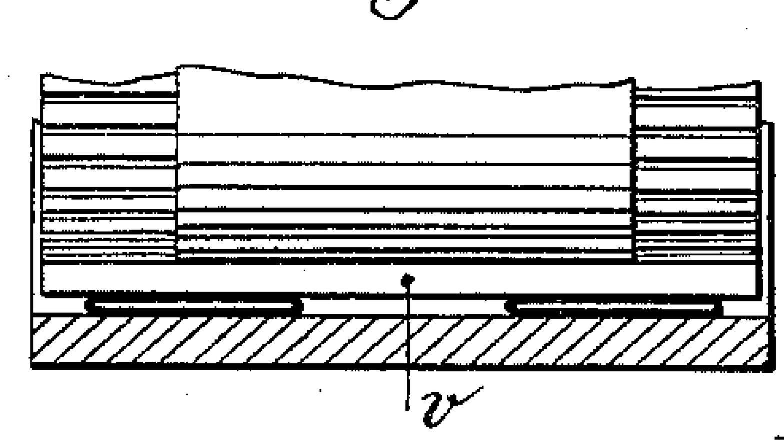


Fig. 15



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UNITED STATES PATENT OFFICE.

MAURICE MICHON, OF PARIS, FRANCE.

ROTARY MOTOR.

SPECIFICATION forming part of Letters Patent No. 652,035, dated June 19, 1900.

Application filed August 30, 1899. Serial No. 728,976. (No model.)

To all whom it may concern:

Be it known that I, MAURICE MICHON, engineer, a citizen of the Republic of France, and a resident of 1 Rue Chabanais, Paris, France, have invented a new and useful Improvement in Rotary Motors, of which the following is a specification.

This invention relates to a rotary motor of that kind comprising, primarily, as its essential parts an inflatable and collapsible tube, sleeve, or hollow body which lines in a circular manner the internal wall of a cylinder, in combination with a drum which is mounted loose on an eccentric part of a shaft which is concentric to the cylinder, the arrangement being such that the drum is capable of rolling over the hollow body and of keeping it in a collapsed condition and that on admitting a fluid under pressure into the hollow body behind the drum said fluid tends to inflate the hollow body, which thereby presses upon the rear part of the drum and compels it to roll and to cause the motor-shaft to rotate.

The improvement consists in certain novel combinations in such a motor, which are hereinafter described with reference to the accompanying drawings and the novelty of which I will point out in the claims.

Figure 1 of the drawings illustrates, by way of example, in a section transverse to its axis of rotation a motor embodying my improvement with a variable expansion without any closing device other than the drum, and in which, consequently, the hollow body makes more than one turn around its cylinder and its two ends are arranged side by side. Fig. 2 is a longitudinal section on the line A B of Fig. 1. Figs. 3 and 4 are sectional views of detail showing a mode of construction of the hollow body. Figs. 5 and 6 are diagrams of the hollow body unrolled, showing the width which may be given to it at different places. Figs. 7 and 8 are views of an arrangement which can be used for reducing the resistances. Figs. 9 and 10 are longitudinal and cross-sections, respectively, showing a mode of construction of the hollow body. Fig. 11 shows by two views a mode of construction of the drum. Figs. 12 and 13 are sectional views of parts showing closing devices which can be applied to the motor. Fig. 14 is a transverse section of parts of a motor in which the two ends of the hollow bodies are placed one upon the other. Fig. 15 is a longitudinal section of parts of a motor in which two hollow bodies are placed side by side.

In the figures, *a* indicates the cylinder, and *b* the hollow body lining its internal surface. *c* is the drum, which rolls on the hollow body, and *d* is the motor-shaft, on the eccentric portion or crank *e* of which this drum is mounted free to turn. The circumference of the drum is tangent to the hollow body when deflated; but, further, the drum may be provided at its periphery, at certain intervals of distance, with ribs *f*, which by compressing the material of the hollow body insure the tightness of the closing. A similar effect might be obtained and the friction might be diminished by forming the periphery of the drum of rollers, as shown in Fig. 11. The cylinder may, however, be constructed in any suitable manner, the essential condition of its construction being that it shall be fluid-tight from one end to the other. In the examples shown in Figs. 1 and 2 of the accompanying drawings it is formed of a tube or sleeve of a suitable supple or elastic material situated between the wall of the cylinder and a canvas band *g*, each edge of which is fixed between a circular rib *h*, formed or fixed to the cylinder, and the tightening-ring *i*. The height at each point of the rib or fixed ring *h*, as also the tension of the band *g*, are selected in such a manner that the tube always assumes the extent of inflation which is convenient, as hereinafter explained. The fluid under pressure entering the tube at 1 and advancing in the direction of the arrows 8 inflates the tube behind the drum, and thus compels the latter to advance and to cause the shaft *d* to rotate, as indicated by the arrow 9. When during this movement the drum moves near to the exhaust-orifice 6, it must not be hindered by that part of the hollow body which is situated in front of it and which is filled with fluid under pressure. The inflation of this part must therefore be so limited that the drum shall not touch the said part when it arrives opposite the exhaust. (Position indicated by the circle 10.) For this purpose the hollow body must be shaped or bound by the band *g* in such a manner that the inflation shall be *nil* from 1 to 2, (upon which part the drum rolls during the expansion,) and shall then increase gradually up to a point 3, where it reaches its maximum. The height of the rib h must naturally follow a similar progressive increase, which is indicated by the dotted curve 11 in Fig. 1. From 3 to 4 the inflation of the hollow body retains its maximum amount, and the same applies consequently to the height of the rib h. It will be noticed that when the hollow body has assumed its maximum inflation at 4 the drum has arrived opposite the exhaust (position 10) and in its part which is comprised between the point 4 and the exhaust 6 the hollow body can only have an inflation which is equal to that which is necessary in order that it shall bear against the drum. This inflation cannot possibly increase subsequently, because as soon as the drum leaves the position 10 deflation is produced. The result of this is that from 4 to 6 it is useless to limit the inflation by means of the band g, because there is no tendency to produce any excessive inflation at that point. For this reason in the example shown the rib h and the ring i are stopped short at 4. At this point the ring abuts against a stop-piece j. It is kept tight throughout its extent on the edges of the band g by reason of the action which is exerted upon it by the wedge-shaped head of a tightening-bolt k. The tightening of the ring i may also be produced in any other suitable manner—such as, for example, by means of bolts k', provided at suitable points, as shown in Fig. 3. The band g may be made of one or more thicknesses. It may cover either simply the tube b, as shown in Fig. 2, or it may envelop it completely, as shown in Fig. 3. In any case its edges instead of being fixed between the rings h and i, may be provided with attachment-beads i' which are received into grooves formed by the rings, as shown on the left hand of Fig. 3. The beads may be made in any suitable manner—such as, for example, of a cord of metallic wire. Further, the above-mentioned modes of attachments may also be combined together—that is to say, the band g may be tightened between the rings and it may be provided with beads, which are received in the grooves formed by said rings. This arrangement is illustrated on the right hand of Fig. 3; also, the rings i may be made in such a manner as to act by lateral thrust, as shown in Fig. 4. In this case each of the rings i, which is divided into segments, exerts a tightening action by reason of the thrust which is exerted upon it by the wedge-shaped segments k when the nuts x are screwed up. Long coiled springs y, which encircle the cylinder, may be employed with advantage for the purpose of keeping the lateral parts of the envelops in place in recesses of the cylinder in order that they shall not form a bead on the passage of the drum. This arrangement by avoiding all prominences in the interior of the cylinder facilitates the placing side by side of several hollow bodies or parts of a hollow body on the same drum. For the same purpose—that is to say, in order to diminish the injurious resistance which is opposed to the advance of the drum by that part of the hollow body that receives the motive fluid—the hollow body may be contracted at its admission part where said resistance might be produced—that is to say, at that part which is comprised between 1 and 3. I have shown this arrangement in Figs. 1 and 2 of the accompanying drawings, as also in Fig. 5, which illustrates on a smaller scale the development of the hollow body. The first part of the hollow body comprised between the admission-orifice 1 and the point 2, which is situated opposite the exhaust-orifice 6, never acts with motive effect and serves solely as a conduit to admit the fluid into the remainder of the hollow body. It may therefore be of a uniform section, just sufficient for the admission of the fluid. This part is situated in the cylinder by the side of the last portion 5 6 of the hollow body, and this is the more easy because the envelop g does not exist at that part. From 2 to 3 the hollow body must exert upon the drum a gradually-increasing effect, because its inflation must increase from zero to the maximum. For this reason I have made it of a section which is also gradually increasing, as shown in Fig. 5. From 3 to 6 the section remains constant. It will, however, be remarked that that part of the hollow body which exerts its full action upon the drum is comprised between the points 3 and 4, because from the point 4 onward the inflation, being limited by the drum itself, diminishes progressively. As the portion of maximum utility is limited between the points 3 and 4 the other parts of the hollow body may without inconvenience be considered as not being motive, and they may have simply the dimensions which are necessary for the admission and the exhaust. This is shown in Fig. 6. It is to be noted that the two lengths 2 3 and 4 6 are equal, because they correspond to distances reckoned on the drum from the tangential point 2 6 up to the points of maximum inflation 3 or 4, which are symmetrical relatively to the tangential point. It is to be noted also that the expansion would not be changed in any way if there were set off at 6 7 one-half of the length 1 2, so long as the two ends of the hollow body shall always be arranged side by side for a length:

$$1' \ldots . 2 + 6 \ldots . 7 = 1 \ldots . 2.$$

Under these conditions the two parts—first, the admission part 1′ to 3, and, second, the exhaust part 4 to 7—are absolutely identical. They may therefore be taken one for the other—that is to say, the motor is reversible. The length 3 4 depends obviously on the relative sizes of the cylinder and of the drum and on the extent of the inflation. Now on one hand it is well that the drum should be as large as possible in order that the hollow part shall be able to act on a large portion of its circumference without excessive inflation, and on the other hand there must be a well-defined relation between these three quantities (the diameters of the cylinder and of the drum and the inflation of the hollow body) in order to give a maximum effect. In fact, the thrust exerted by the hollow body upon the drum is wholly utilized for propulsion only when it is exerted tangentially to the cylinder described by the axis of the crank e, Fig. 1, and in order that this thrust of complete utilization shall be able to be produced it is obvious that, calling z the maximum inflation, there should be

$$z \geqslant n\,w.$$

But I have

$$n\,w = d\,w - d\,n = d\,w - \sqrt{e\,d^2 + e\,n^2}.$$

Whence I get

$$z \geqslant d\,w - \sqrt{e\,d^2 + e\,n^2},$$

$d\,w$ being the radius of the cylinder, $e\,d$ the radius of eccentricity of the crank e, and $e\,n$ the radius of the drum. While taking the above conditions into account, by suitable choice of inflation and of the diameter of the drum with relation to the diameter of the cylinder the arrangement can always be made such that the length 3 4 shall be an exact fraction of the circumference of the cylinder—for example, one-third. Then the three wide portions 20 21 22 of three identical hollow bodies can be placed end to end in the manner shown in Fig. 6. The drum is therefore acted upon successively by the three hollow bodies—that is to say, during the whole of its movement; also, in the same sequence of ideas the surface of the cylinder might be lined with a large number of hollow bodies having very short inflatable portions arranged end to end. In this case it might be well to make the arrangement such that each inflatable part shall only become inflated after the drum has passed beyond it. This may be effected with ease by prolonging the admission-duct up to the outlet end of the inflatable part and in causing it to return upon itself, so as to end at the entry end of the said inflatable part, as indicated in dotted lines in Fig. 6. It will, in fact, be perceived that so long as the drum rolls from 1′ to 4 it will act to close the duct 1′ to 4, and will thus prevent the motive fluid from entering the inflated part 21; but as soon as the drum moves beyond the bend 30 the fluid has free access to the part 21 and inflates it. Moreover, it is obvious that it is not indispensable that the bend 30 should face the end of the discharge from the inflatable part. Its position depends solely on the moment when the inflation is desired to be produced.

I have just explained that in order to lessen the objectionable resistance opposed to the drum by the admission part of the sleeve and at the same time to insure reversibility of the motion I make the parts 1′ to 3 and 4 to 7 tubes of small action. It is obvious that I would further lessen resistance if I shortened these parts. I realize this, as indicated in Figs. 7 and 8, by employing auxiliary cylinders of small diameter, at the internal surface of which I arrange the distribution-passages 1′ to 3 and 4 to 7 and corresponding auxiliary drums mounted, like the main drum, upon suitable bent or eccentric parts of the motor-shaft d. The action is absolutely the same as when there is only one cylinder and drum. During the displacement of the three drums from 1′ to 3 the small admission-drum l makes the corresponding part of the sleeve fluid-tight. At 3 it ceases to act; but when the motor-drum c comes into action, since it begins to roll on the inflatable part 21, over which it then passes from 3 to 4, it leaves it at the latter point; but then the small discharge-drum m tightens in its turn in rolling from 4 to 7 on the discharge part of the sleeves. This application of small auxiliary drums facilitates the end-to-end arrangement of the inflatable parts, such as 20 21 22, Fig. 6, belonging to several sleeves.

My system not only permits the end-to-end arrangement of the motor parts of several sleeves, but it permits also the side-by-side arrangement of several sleeves or inflatable parts of the sleeves. In this case, if desired, the action of all the sleeves may be transmitted to the single drum by means of rigid bars, such as v, fixed across all the sleeves, Fig. 15.

By placing several sleeves side by side, so that their orifices are not on the same lines, but regularly distributed over the circumference of the cylinder, there may be obtained, as in the case of inflatable parts placed end to end, a uniform push of the sleeves upon the single drum during its whole rotation.

In all cases it is not indispensable that the cylinder should have a rectilineal profile. It may be concave or convex, provided that the periphery of the drum has a corresponding form. When the cylinder a has a concave interior surface, as shown in Fig. 9, the sleeve can consist of a simple flexible band fixed to the cylinder by its two margins, the interior surface of the cylinder forming the other wall of the sleeve. Such flexible band is the equivalent of the sleeve or tube a.

Fig. 9 shows an arrangement which can be adopted for fixing to the cylinder the two margins of the band g, to which is then reduced the flexible part of the sleeve. It is seen that the margins of the band are fixed to the cylinder by the circles i. In the places where there is little inflation it suffices to increase the section of the circles i, so as to lessen the active width of the band. Thus at the places where the circles i have their smallest section 12 13 14 the sleeve can have its greatest inflation 17, while at the places where the circles have great section 12 13 15 16 the sleeve can have only the reduced inflation 18.

Fig. 10 shows how in the case of the arrangement Fig. 9 the two ends of the band g can be stopped by means of a wedge k, if the motor is not an expansive one.

It is to be understood that the sleeve, consisting, as I have just said, of a single flexible wall, suits all the modes of working out the system that have been indicated above—the use of expansion, of small drums, and auxiliary distribution-cylinders, &c.

As to the mechanical rendering tight for an organ other than the drum in order simply to obtain expansion without providing more than one turn of the sleeve or to provide less than one turn with or without expansion it is obvious that this can be carried out by means of distributers of one of the known kinds. It is, nevertheless, preferable to effect this by means of an organ acting like the drum—that is to say, by crushing the sleeve. I shall indicate, by way of example, several arrangements that can be employed for this purpose.

In Fig. 12, o indicates a blade which forms the means of tightening. The drum before it reaches the point of escape 6 meets the projecting edge of this blade, forcing it outward, so that its head presses on the end of the admission-passage l of the sleeve, so that this passage is quite closed at the moment when expansion should begin or escape should take place. When the drum, advancing, reaches the sleeve again and can itself tighten, it leaves the blade o so that the admission-passage is open. A spring-abutment p allows the blade o to yield to the push of the drum without ceasing to close the passage.

In the arrangement shown in Fig. 13 the closing blade o is jointed to the rod of an eccentric on the motor-shaft d. The blade o might be actuated by any other analogous mechanism. Thus it might be attached to a lever caused to oscillate on a pivot by means of a cam or eccentric on the motor-shaft d.

I have now to describe the arrangements that I may employ to vary the expansion either in the case where the two ends of the sleeve pass over each other or in the case where they are placed side by side. In both cases expansion begins at the moment when the drum, rolling on the part 4 to 6 of the run, comes to squeeze the part 1 2. In order to vary the expansion, it suffices to vary the point where this squeezing begins, and this I found on the following observation: The squeezing can only be produced if the sleeve when it is pressed by the drum cannot bend outward—that is to say, it finds support on the outside on a resting-surface; otherwise it can swell outward, allowing fluid to pass.

In the case where one end of the sleeve passes over the other, Fig. 14, expansion takes place from 1 to 2, if in this space the admission part of the sleeve rests on a rigid support, which may consist, for instance, of two plates r and s. If the plate r is withdrawn, expansion takes place only while the drum rolls over the plate s. It can therefore be understood that it is easy to regulate the expansion at will by the use of interchangeable plates, such as s, of various dimensions.

In the case where the two ends of the sleeves are near each other I can use the arrangement shown in Figs. 1 and 2. From 1 to 2 the admission end of the sleeve rests on plates s, which are hinged, as shown in Fig. 2, so that they can rock outward under the pressure of the sleeve. Nevertheless these plates only so rock when they are not held by the unrecessed part t of a slide u, so that in order to vary the expansion this slide u has only to be moved the one way or the other.

I may finally mention that when the motor is employed with an elastic fluid the expansion of which causes cooling the reduction of temperature can be corrected by the circulation of some hot fluid. Fig. 3 shows, for instance, an arrangement that may be adopted for this purpose. It is seen that under the side parts of the envelop g the cylinder a has holes by which it is put in communication with a circular channel q, which receives hot fluid. The movement of the envelop by the inflation of the sleeve produces the desired circulation.

I claim—

1. In a rotary motor, the combination of a cylinder, an inflatable and collapsible hollow flexible body which lines the internal wall of said cylinder and which has an inlet-orifice at one end and an exhaust-orifice at the other end, a shaft concentric with said cylinder and having an eccentric part, a drum mounted loosely on said eccentric part of the shaft to roll over and collapse the said hollow body at its contact therewith, and means for limiting the inflation of that part of said hollow body which presents itself in front of the drum while the latter approaches the exhaust-orifice, substantially as and for the purpose herein described.

2. In a rotary motor, the combination of a cylinder, an inflatable and collapsible hollow flexible body which lines the internal wall of said cylinder and which has an inlet-orifice at one end and an exhaust-orifice at the other end, a shaft concentric with said cylinder and having an eccentric part, a drum mounted loosely on said eccentric part of the shaft to roll over and collapse the said hollow body at its contact therewith, and a band attached at its edges to the interior of the cylinder for limiting the inflation of that part of said hollow body which presents itself in front of the drum while the latter approaches the exhaust-orifice, substantially as herein described.

3. In a rotary motor, the combination of a cylinder, an inflatable and collapsible hollow flexible body which lines the internal wall of said cylinder and the ends of which, provided respectively with inlet and exhaust orifices, overlap each other, a shaft concentric with said cylinder and having an eccentric part, a drum mounted loosely on said eccentric part to roll over and collapse said hollow body at

its contact therewith, and means independent of the drum for positively limiting the inflation of that part of said hollow body which presents itself in front of the drum while the latter approaches the exhaust-orifice, substantially as herein described.

4. In a rotary motor, the combination of a cylinder, an inflatable and collapsible hollow flexible body which lines the internal wall of said cylinder and the ends of which, provided respectively with inlet and exhaust orifices, overlap each other, a shaft concentric with said cylinder and having an eccentric part, a drum mounted loosely on said eccentric part to roll over and collapse said hollow body at its contact therewith, a band attached to said cylinder for limiting the inflation of that part of said hollow body which presents itself in front of the drum while the latter approaches the exhaust-orifice, and a yielding support for the exterior of said hollow body at and near the inlet end thereof, substantially as herein described.

In testimony that I claim the foregoing as my invention I have signed my name, in presence of two witnesses, this 16th day of August, 1899.

MAURICE MICHON.

Witnesses:
EDWARD P. MACLEAN,
ALCIDE FABE.