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PATENT SPECIFICATION

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PROVISIONAL SPECIFICATION.

No. 21,291, A.D. 1923.

Improvements in Unidirectional Driving Devices.

I, GEORGE CONSTANTINESCO, of "Carmen Sylva," Beechwood Avenue, Oatlands Park, Weybridge, in the County of Surrey, a subject of the King of Great Britain and Ireland, do hereby declare the nature of this invention to be as follows:—

The present invention relates to unidirectional driving devices particularly to devices of the type described in my Patent Specification No. 205,293 in which a sliding member is provided between an oscillator and a rotor, the drive being transmitted by friction between the slider and the rotor.

The invention consists in a unidirectional driving device comprising an oscillator, a rotor and a slider so shaped that when pulled in one direction it exerts a wedging action between the oscillator and the rotor.

The invention further consists in an oscillator, rotor and slider between them, the slider being acted upon by a permanent force acting towards an external point in the direction which will cause wedging between the oscillator and the rotor for the direction of rotation desired.

The invention also consists in providing a second force acting on the slider in the opposite direction when desired, so arranged that the apparatus becomes reversible.

The invention also consists in constructing the device in such a manner that a virtual movement is possible at the beginning of the driving stroke through a minute angle between the oscillator and rotor, the coefficient of friction for this movement being very much less than the coefficient of friction between the slider and the rotor.

The invention also consists in the combination of a loose slider mounted eccentrically on the oscillator whose axis of rotation is coaxial with the rotor one surface of the slider having a friction contact with the rotor, while bearing contacts with very small coefficient of friction are provided between the oscillator and slider and between the rotor and oscillator, so that the coefficient of friction between the slider and rotor is very much higher than the coefficient of friction of the bearing contacts.

The invention also consists in a unidirectional driving device comprising a coaxial oscillator and a rotor, a ball race being provided between the oscillator and the slider which is placed eccentrically as regards its inner circumference and coaxially with the rotor and oscillator as regards its outer circumference, ball or roller bearings being provided between the oscillator and the rotor, while a small clearance is allowed between the outer circumference of the slider and rotor, a permanent force being provided acting on the slider towards an external point in one direction or the other according to the direction of rotation desired.

The invention further consists in a unidirectional driving device comprising an oscillator and rotor mounted coaxially with a slider between them, ball thrust bearings being provided between the oscillator and rotor and between the rotor and slider, while a plain face bearing is provided between the slider and the oscillator, the surfaces of the oscillator and slider which co-operate being inclined to the transverse plane through the apparatus at an angle less than the angle of friction between the slider and oscillator.

The invention further consists in a unidirectional driving device of the type described in which plain bearings are used

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between the rotor and oscillator and between the oscillator and the slider, while a special material is employed for the surface of contact of the slider and oscillator, so that the coefficient of friction between such slider and oscillator is very much greater than the coefficient of friction between the rotor and oscillator and the coefficient of friction between the oscillator and slider.

The invention also consists in the improved unidirectional driving device hereinafter described.

With the ordinary unidirectional driving devices in which an intermediate member is provided between an oscillator and a rotor locking readily occurs when driving in one direction, but considerable force may be required to release the locking mechanism when the direction of movement of the oscillator is reversed and such devices, unless constructed on correct principles, are entirely unsuitable for a device in which the oscillator moves at a comparatively high frequency, as in such case the release on the return stroke will either not take place, or take place too late. I have found that it is essential for such a device to operate in a satisfactory manner that the coefficient of friction between the rotor and the slider should be very much greater than the coefficient of friction between the oscillator and the slider and the coefficient of friction between the oscillator and the rotor; for example, if the bearing contacts are ordinary metal to metal bearings having the coefficient of friction say of 5 *per cent.* under load and special material surfaces are employed between the slider and the rotor, the coefficient of friction between the surfaces of the slider and the rotor must be of the order of say 20 to 30 *per cent.*; for example, if white metal bearings are employed between the oscillator and the slider and between the oscillator and the rotor, a substance such as dry leather or dry fabrics such as are known by the registered trade mark "Ferodo" or very small metallic surfaces must be employed between the slider and the rotor; especially if the gear is to be run completely immersed in oil, the bearings between the slider and the oscillator and between the oscillator and the rotor must be ball or roller bearings with plain metal or metal bearings of much higher coefficient of friction between the slider and the rotor.

In carrying the invention into effect according to one example in which the rotor surrounds the slider and the oscillator, the oscillator comprises a hollow shaft made integral or keyed to it with an eccentric. A ball or roller race is provided outside the eccentric and the slider fits freely around the outer member of the ball race. The external circumference of the slider is concentric with the oscillator and rotor and a small clearance is provided between the slider and the rotor which surrounds it. A permanent force acting towards a point external to the apparatus is exerted on the slider by means of a spring or other suitable means, this force acting on the slider in the direction opposite to that in which the rotation is required to take place.

The rotor comprises a member keyed to a shaft passing through and floating clear of the hollow shaft of the oscillator, while between the rotor and the hollow shaft of the oscillator ball or roller bearings are provided so that the friction between the slider and the rotor is very much greater than the friction between the oscillator and slider, or the friction between the rotor and oscillator.

With such an arrangement if ϵ is the radius of eccentricity, R the internal radius of the rotor, F the force exerted against the rotor in the radial direction and F_1 ths force acting on the rotor in the circumferential direction, $F_1 R = F\epsilon$ and if φ is the angle of friction, gripping between the slider and rotor will take place if $\frac{F_1}{F}$ which is equal to $\frac{\epsilon}{R}$ is less than φ.

It will be seen that this apparatus will be made reversible by providing a second permanent force when required acting instead of the permanent force above referred to; or if desired instead of external forces suitable fixed or adjustable stops may be provided with or without additional inertia as described in my Specification No. 205,293.

The direction of rotation can be reversed by simply bringing into action either one or other of the permanent forces.

According to another example of the invention, the oscillator, slider and rotor are arranged coaxially, a thrust bearing being provided between the rotor shaft and the oscillator and between the oscillator and the slider. The bearing surfaces of the slider and oscillator are in a plane inclined to the transverse plane through the apparatus at an angle φ which must be less than the angle of friction between the plane surfaces of the slider and the rotor.

In this case as in the previous example, the slider is acted tangentially on by an external force towards an external point, this force being made reversible for the

purpose of securing rotation in one direction or the other, as desired.

It will be seen that in the constructions above described only circular and plane surfaces are employed so that machining of the various parts is greatly facilitated. Also a wedging action in one direction or the other which is self releasing is obtained.

Dated the 22nd day of August, 1923.

W. GRYLLS ADAMS,
87, Victoria Street, London, S.W. 1,
Chartered Patent Agent.

PROVISIONAL SPECIFICATION.

No. 23,149, A.D. 1923.

Improvements in Unidirectional Driving Devices.

I, GEORGE CONSTANTINESCO, of "Carmen Sylva," Beechwood Avenue, Oatlands Park, Weybridge, in the County of Surrey, a subject of the King of Great Britain and Ireland, do hereby declare the nature of this invention to be as follows:—

The present invention relates to unidirectional driving devices of the type in which the drive is effected through an intermediate sliding member situated between an oscillator and a rotor.

In my Patent Specification No. 21,291/1923, I have described unidirectional driving devices comprising an oscillator a rotor and a slider so shaped that when the slider is pulled in one direction, it exerts a wedging action between the oscillator and the rotor, and in such specification I have also described arrangements in which ball thrust races are employed between the oscillator and the slider and between the oscillator and the rotor, while the friction between the slider and the rotor is considerably greater than the friction between the oscillator and rotor and between the oscillator and slider.

The present invention consists in providing between the slider and the oscillator a member having independent floating surfaces adapted to be driven round by the rotor, so that the points of contact which are under pressure are always changing even under heavy torque.

The invention further consists in providing between the oscillator and the slider a ball bearing and in providing ball bearings between the oscillator and the rotor, these ball bearings being arranged so that they are driven by the rotor.

The invention also consists in providing between the oscillator and the slider a floating ring driven by the rotor.

The invention also consists in the improved unidirectional driving devices hereinafter described.

In carrying the invention into effect according to one example, the rotor shaft passes axially through the oscillating member with a suitable clearance. A pair of ball races are provided between the oscillator and the rotor and a ball race is provided between the oscillator and the slider which is in plane contact on its other surface with the rotor, so that the friction between the slider and the rotor is considerably greater than the friction between the oscillator and the rotor, and the friction between the oscillator and the slider.

Suitable stops are provided on the rotor adapted to engage with lugs on the several ball races, so that these are caused to rotate with the rotor. As the races revolve about a different axis from the rotor the co-operating driving members must be allowed a sliding movement and a certain lost motion in the direction of rotation is also necessary.

By this means the points of contact which are under pressure in the ball races are always changing, even when a heavy torque is being transmitted.

According to another modification of the invention, I provide between the oscillator and the slider a floating ring, the bearing surfaces between the oscillator and the slider and between the slider and the rotor being plane surfaces. Suitable lugs or the like are provided on the rotor adapted to drive the floating ring in the direction of rotation.

With the apparatus as above described in which ball races are employed, owing to the small eccentricity necessary to obtain the grip between the oscillator and the slider, the elastic deformation of the balls and tracks of the mechanism allows an elastic angular movement of the oscillator relatively to the rotor, so that the effect of an elastic coupling is produced. If the angular oscillation of the oscillator is equal to or less than the above referred to angular movement, it is possible to stop the rotor and still run the driving shaft driving the oscillator even if all the articulations are rigid. The stresses allowed in the bearings should be not greater than those allowable to avoid too great deformation and

hysteresis losses owing to the compression and expansion of the balls and the tracks, so that the energy loss is a minimum and a variable speed torque mechanism may be obtained.

According to one form of the invention a single unidirectional driving device may be employed with a heavy flywheel on the rotor and also on the primary driving shaft which gives a very cheap and efficient combination. If two or more ratchtes are employed the use of a flywheel is not necessary. If a number of unidirectional driving devices are used on the same shaft driving a heavy mass from the same prime mover shaft, it is necessary that the angular oscillation of the oscillator should be less than the deformation possible in the balls and tracks without exceeding the safe limits of pressure. By making the angular oscillation due to the crank less than the angular motion due to the natural elasticity in the unidirectional driving device, any number of polyphase unidirectional driving devices can be mounted on the same rotor, so that an absolutely uniform motion of the rotor may be obtained. If the natural elasticity is insufficient, a corrugated sheet of hardened steel may be inserted between the slider and the rotor especially in cases in which the bearing surfaces are of white metal or other anti-friction material instead of ball bearings. The corrugations are also useful for the reason that they increase the co-efficient of friction between the slider and the rotor which, as previously stated, must be considerably greater than the co-efficient of friction between the oscillator and the slider and between the oscillator and the rotor.

In the above unidirectional driving devices, a permanent force to an external point may be provided acting on the slider in the direction opposite to the direction of rotation and by reversing this force, the direction of rotation of the rotor can be readily reversed; as shown in my Patent Specification No. 217,684. For driving in one direction only a permanent force which may be a spring acting between the slider and oscillator may be used; or stops, friction devices and the like as shown in my Patent Specification No. 205,293 may be employed.

Dated the 15th day of September, 1923.

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97, Victoria Street, London, S.W. 1,
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COMPLETE SPECIFICATION.

Improvements in Unidirectional Driving Devices.

I, GEORGE CONSTANTINESCO, of "Carmen Sylva," Beechwood Avenue, Oatlands Park, Weybridge, in the County of Surrey, a subject of the King of Great Britain and Ireland, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to improved means for converting an oscillating movement into a unidirectional movement by means of an oscillator, a slider or gripper and a rotor such as is described in my Specification 205,293.

In such apparatus as commonly employed, locking readily occurs during the driving stroke of the oscillator but considerable force may be required to disengage the gripper on the return stroke, and such apparatus, unless constructed on correct principles, is entirely unsuitable if the oscillator moves at a comparatively high frequency, as in such cases the release on the return stroke will either not take place, or will take place too late.

I have found that it is necessary that elastic relative movement should be possible during the driving stroke between the oscillator and the rotor, which movement may be obtained by the elastic give of balls, rollers or other elastic bodies, between the oscillator and the gripper, and also between the oscillator and rotor, the oscillator and gripper having eccentric surfaces or their equivalent. Such relative movement may be quite considerable under heavy load. It may amount to as much as 45° of angle or more, in special cases, depending on the value of the eccentricity in proportion to the diameter of the circle of the gripper. On the other hand, if the load is small, such movement will be small too.

According to one feature of the present invention, the apparatus is so constructed that the friction between the gripper and the rotor is considerably greater than the friction between the oscillator and the gripper, and is also so constructed that at the commencement of the driving stroke of the oscillator, movement through a substantial angle is possible between the oscillator and the gripper, owing to the elastic give of balls, rollers or other elastic bodies. At the end of the driving stroke, the balls, rollers or other elastic

bodies regain their original forms, and so return the oscillator and gripper to their original positions relatively to one another, thereby disengaging the gripper.

It may be observed that the amount of relative movement under a given load depends upon the degree of eccentricity and elasticity of the balls or other elastic bodies. It is therefore possible so to design the parts that when the reaction of the rotor reaches a given maximum, no movement is imparted to the rotor by the gripper.

Preferably the balls or rollers are free to rotate and also to circulate around their tracks with only a pure rolling motion.

The ball or roller bearings may be provided with floating rings which may be loose or driven by the rotor.

In one form of construction an annular gripper is loosely mounted eccentrically on the oscillator whose axis of oscillation is coaxial with the rotor, elastic bodies being interposed between the oscillator and the rotor; the outer circumference of the gripper is coaxial with the inner surface of the rotor, and means such as a spring is provided, tending to turn the gripper in one direction or the other, according to the direction of rotation desired, or to hold the gripper in its neutral position in a manner similar to that described in the Specification No. 217,684.

Means may be provided to vary this spring or other controlling force acting on the gripper so that the travel of this latter under inertia forces is varied, whereby the period of gripping during the driving stroke of the oscillator is varied with the result that variable speed and torque on the rotor is obtained.

In a modification I interpose between the gripper and the oscillator and between the oscillator and rotor, curved bars or corrugated sections or rings, immersed in oil, which are so arranged that they bend under load, whereby breaking of the oil film is avoided, and also provide the necessary elasticity required to produce angular motion between the gripper and the oscillator and between the oscillator and the rotor.

In another form of construction the oscillator and rotor are mounted coaxially with a gripper between them, ball or other elastic anti-friction thrust bearings being provided between the oscillator and rotor, and between the oscillator and gripper, while a plain face of high bearing friction is provided between the gripper and the rotor, the surfaces of the oscillator and gripper, which co-operate, being inclined to the transverse plane through the apparatus at an angle less than the angle of friction between the gripper and oscillator.

Referring to the accompanying drawings which show unidirectional devices constructed according to this invention, Figure 1 is an elevation partly in section, and Figure 2 is a transverse section on the line A—A, Figure 1. Figure 3 is a longitudinal section of a modification in which the slider is moved axially for engagement. Figure 4 is an elevation of Figure 3, and Figure 5 is a section on the line A—A, Figure 3. Figure 6 is a longitudinal section of a further modification of a form in which the ball races are caused to rotate by frictional means, and Figure 7 a transverse section on the line A—A, Figure 6. Figure 8 is a sectional side elevation of a complete double unidirectional driving device. Figure 9 is a sectional plan, Figure 10 is a section on the line A—A, Figure 9, while Figure 11 is a part section on the line B—B, Figure 9. Figures 12 and 13 are two sections at right angles of a unidirectional driving device for a locomotive. Figures 14 and 15 are details of the annular gripper shown in Figures 12 and 13. Figure 16 is a diagrammatic section showing a simple type of unidirectional driving device with the oscillator inside illustrating the principle of the invention. Figure 17 is a diagram showing the various centres in a slightly modified arrangement. Figure 18 is a diagram showing a simple type of device with the oscillator outside. Figure 19 shows a type of device in which the gripper is an incomplete ring arranged so that the rollers or balls can circulate around their track. Figure 20 shows a modified form with an incomplete ring gripper. Figure 21 shows a unidirectional driving device having two rows of rollers in order to increase the elasticity. Figure 22 shows a modification in which two eccentrics are employed.

Figure 23 shows a further modification in which the outer circle of the gripper is not concentric with the rotor. Figure 24 shows a modification of the invention in which the rollers are staggered. Figure 25 shows a modification in which the radial movement necessary to allow the angular motion is obtained by the use of curved sliding members with an oil film between them and the oscillator. Figure 26 shows a modified form of the apparatus working on the same principle.

In carrying the invention into effect, as illustrated at Figures 1 and 2, the rotor a surrounds the gripper b and the oscillator c is in the form of a hollow shaft d on which the eccentric d^1 is formed. A

ball or roller race *e* is provided outside the eccentric and the gripper fits freely on the outer member *f* of the ball race. The external circumference of the gripper is concentric with the rotor when in the neutral position, and a small clearance as shown at *g*, Figure 2, is provided between the gripper *b* and the rotor *a* which surrounds it. A permanent force acting towards an external point is applied by a spring such as *h* or other suitable means, means being provided to reverse the direction of this force or to hold the gripper in the mean position. The force in the forward or reverse direction acts on the gripper in the direction opposite to that in which rotation is required to take place, as described in my Patent Specification No. 217,684. The rotor *a* comprises a member keyed to a shaft *l* passing through and floating clear of the hollow shaft *d* of the oscillator, while between the rotor and the hollow shaft of the oscillator, as shown in the lower half of Figure 1, roller bearings *m* are provided so that the friction between the gripper and the rotor is very much greater than the friction between the oscillator and the gripper or the friction between the rotor and the oscillator, or long rollers may be employed as shown at m_1 in the upper right hand half of Figure 1 above the line BBB. To increase the friction between the gripper and the rotor the outer surface of the gripper *b* or preferably the inner surface of the rotor *a* is cut away as shown at *o* so as to obtain very high pressure per square inch between the gripper and the rotor and thus ensure the breaking of the oil film and consequent stiction. That part of the apparatus which is shown in elevation is similarly constructed, the oscillator and gripper driving the rotor in the same direction as the corresponding parts on the right hand side, but operating at a phase difference of 180 degrees as shown further in Figures 8—11.

With such an arrangement if ϵ is the radius of eccentricity, R the internal radius of the rotor where the gripper acts, F the force exerted against the rotor in the radial direction, and F_1 the force acting on the rotor in the circumferential direction $F_1R = F\epsilon$; and if φ. is the angle of friction gripping between the gripper and the rotor will take place if $\frac{F_1}{F}$ which is equal to $\frac{\epsilon}{R}$ is less than φ.

An angle φ of 5 *per cent.* is a practical figure if the gripper and rotor are hard steel surfaces, cut away as shown, the pressure per square inch being as high as possible without injury to the metal. Such local pressures may be as high as 10 to 100 tons per square inch for very hard surfaces.

It will be seen that this apparatus can be made reversible by merely reversing the direction of action of the permanent controlling force in the spring *h* Fig. 2. Or if desired, instead of external forces, suitable fixed or adjustable stops may be provided with or without additional inertia as described in my Patent Specification No. 205,293.

In the form of the invention shown in Figures 3, 4 and 5, the oscillator *c*, gripper *b* and rotor *a* are arranged coaxially, a thrust bearing 4 being provided between the rotor shaft and the oscillator and thrust bearing 5 between the oscillator and the gripper. The bearing surfaces of the gripper and the oscillator which are formed by the races of the thrust bearing are in a plane inclined to the transverse plane through the apparatus at an angle φ which must be such that the gradient of the ball track is less than the angle of friction between the plane surfaces of the gripper and the rotor. The oscillator and also the gripper are mounted on roller bearings 6, 7 respectively and ride on the rotor shaft. The gripper is acted upon by a constant force, to a fixed external point by suitable means for example, a spring in the position 8; and for the reversed direction of motion in the position 9, as shown in dotted lines, is provided, while the gripper can be kept in the mean position to give a free position as shown at 10, this spring being brought into action as desired.

The face of the gripper which cooperates with the rotor is castellated as shown at 11 to increase the friction by breaking up the oil film.

In the form of the invention shown in Figures 6 and 7, which is very similar to that shown in Figures 1 and 2, ball bearings 12 are provided between the oscillator and the gripper *b* and ball bearings 13 are provided between the oscillator *c* and the rotor *a*. Small ball bearings 14 are provided between the inner race of the ball bearing 12 and the oscillator and friction pads 15 and springs 16 are employed to give a frictional contact between the races and the rotor, so that during the idle period there is a tendency for these races to be carried round by the rotor.

A further example of the invention is shown in Figures 8, 9, 10 and 11. The primary shaft 21 carries a pair of eccentrics 22, 23, 180 degrees apart which oscillate a pair of intermediary shafts 24, 25 by means of straps 26, 27. The

shafts 24, 25 carry cranks 28, 29 which actuate a pair of oscillating members 30, 31 mounted within hollow rotors 32, 33 which are supported in ball bearings 34, 35 mounted in the casing 36 of the machine and are keyed to the secondary shaft 37. Between the oscillators 30, 31 and the rotors 32, 33, are grippers 39, 40 with ball races 41 between them and the oscillators. Ball races 42 are also provided between the oscillators and the rotors.

In this form of the invention each oscillator is driven by a pair of connecting rods 43, 44 at opposite ends of a diameter, one oscillator being driven by the connecting rods 43 and the other by the connecting rods 44. The grippers are acted on by a permanent force in one direction or the other or kept in the mean position by springs 45 mounted on a shaft 46 which can be turned about its axis by the handle 47 to exert pressure as shown by the dotted lines 50, Figure 11, or in the opposite direction, or to hold the springs 45 in the mean position as required. In the mean position the secondary shaft is free whereas rotation takes place in one direction or the other, according to the direction in which the forces are caused to act on the grippers.

In the locomotive driving device shown in Figures 12, 13, 14 and 15, the rotor *a* surrounds the gripper *b* and the oscillator which oscillates on the rotor shaft *l* is formed with a projecting annular portion *v* which forms the eccentric. Rows of roller bearings *y z* may be provided on each side of the oscillator extension *v* or elastic anti-friction bearings as shown in Figures 25 and 26.

The bearing surfaces of the gripper which is shown separately at Figures 14 and 15 comprises a number of hard steel pads which are renewable and which are fitted into sockets *s* formed centrally round the gripper.

The operation of this device is similar to the operation of those above described, the pads operating to break the oil film between the gripper and the rotor.

The method of operation of the driving device is illustrated at Figures 16 to 23.

Referring to Figure 16, the oscillator *c* oscillates about the centre *o* and is provided with a circular eccentric 1 whose centre is at o^1; between the eccentric 1 and the annular gripper *b* are rollers 3; a definite clearance is allowed between the outer circumference of the gripper and the inner circumference of the cylindrical rotor *a*. When the gripper is at its mean position and the rotor is free to rotate in either direction, the centres of the cam 1, gripper and rotor are all three in a straight line. When the gripper is moved by an external force through an angle α to the position shown in full lines, its centre moves to the point o^2 and gripping between the gripper and rotor takes place along a line parallel to the axis through the point A at which the line $O-O_2$ meets the rotor. The angle OAO_1 must be less than the angle of friction between rotor and gripper. In this position when the oscillator moves in the anti-clockwise direction after gripping takes place at A, there is a slight angular movement of the oscillator in advance of the movement of the rotor and gripper which are moved together owing to the slight movement allowed by the elasticity of the balls or bearing surfaces.

This movement is essential to the release when the motion of the oscillator is reversed as it allows a rolling movement to take place on the rollers or on the frictionless bearings between the oscillator and the gripper and simultaneously with a similar action on the bearings between the oscillator and the rotor not shown in Figure 16, but shown in Figure 13 at *y*, and in Figure 8 at 42. Further it will be seen that during the idle stroke of the oscillator the rollers or the like circulate around their track so that fresh and different lines of contact are subjected to stress at successive periods of engagement.

It will be noticed that at the moment of gripping, the centres O, O_1, O_2 are at the angles of a small triangle owing to the movement from the mean position of the centre of the gripper allowed by the clearance between the gripper and rotor and by the motion during gripping.

When the gripper is moved to the dotted line position, the drive takes place in the opposite direction, the contact pressure being transferred to the point B instead of A.

Also it will be seen that a number of adjacent rollers or the like take the stress at each engagement.

A similar arrangement is shown in Figure 17, but in this case the eccentricity is greater and the triangle formed by the points O, O_1, O_2 has a more obtuse angle than in Figure 16 and the pressure of gripping and angle of friction are higher. It is, however, necessary in order to avoid excessive stresses that the angle O_1, O, O_2 should not be too great.

Figure 18 is a diagram showing a simple type of driving device in which an external oscillator is employed. The oscillator *c* being suitably supported by anti-friction bearings not shown moves about the axis *o*. Between the inner

circumference of the oscillator, whose centre is at O_1, and the outer circumference of the gripper *b*, is a row of rollers 63. The rotor *a* is keyed to the secondary shaft *l* and a slight clearance is allowed between the circumference of the rotor and the inner circumference of the gripper. With the gripper and the oscillator in the position shown, the point of gripping is at A and the direction of drive is shown by the arrows marked on the rotor. The angle of friction φ is the angle OAO_1. A permanent force is caused to act on the gripper in one direction or the other through the pin 66.

In the form of the invention shown in Figure 19, the gripper *b* is in the form of a crescent instead of a complete ring. In this case the oscillator *c* may be of the form illustrated and keyed to the shaft 73. A clearance is provided between the gripper and the rotor *a* towards the horns of the crescent; the centres are as shown at Figure 17. This form of the invention may be arranged to drive in either direction as in the previous cases by exerting a force in one direction or the other on the gripper by means of springs or other means as shown by the dotted and full lines. In this case the rollers can also circulate around their track and the operation will be similar to that described with reference to the previous forms.

A similar arrangement is shown in Figure 20. In this case the centre of oscillation of the oscillator is at O the eccentricity is represented by the distance OO_1 and the point at which gripping takes place by the letter A. Gripping will take place for the opposite direction of rotation at the point B which is symmetrically placed on the other side of the vertical plane through the axis of the apparatus. The arrow outside the rotor shows the direction of drive with the parts in the position illustrated in full lines. For the reverse drive the position of the pin 66 is indicated in dotted lines. In this case also the rollers circulate around their track, but it should be noted that the clearance between the horns of the crescent and the rotor must never be great enough to allow jamming of the rollers at this point.

In the form of the invention shown in Figure 21, there are two rows of rollers 81, 82 with a floating ring 83 between them. For the direction of rotation shown by the outside arrow, the controlling pin is in the position shown in full lines, the force being applied in the direction indicated by the arrow 8. In the mean position, the controlling pin 66 is in the central vertical plane.

In this type of the invention more elasticity is provided by reason of an additional row of rollers through which the pressure is transmitted. The floating ring 83 creeps around during the idle stroke and also during the working stroke, thus ensuring a proper rolling and circulation of the balls and always varying the line of contact under pressure.

In the form of the invention shown in Figure 22, two eccentrics are employed. The oscillator *c* is surrounded by a row of rollers 92 around which is placed a second eccentric 93 surrounded by a second row of rollers 94. The gripper *b* immediately surrounds this outer set of rollers and fits easily within the rotor *a*. In this case no clearance is required owing to the use of the two eccentrics. The pressure points for forward and reverse drive are shown at A and B respectively. The point O is the centre of oscillation of the eccentric and the inner track of the rotor. The point O_1 is the centre of the inner row of rollers and the point O_2 the centre of the outer row of rollers.

It should be noted that in this case there is no need of more than a working clearance, as the triangle $O\ O_1\ O_2$ is obtained by the use of two eccentrics.

Figure 23 shows a modified form of the apparatus in which the outer circle of the gripper *b* is not concentric with the rotor when in the neutral position. By arranging the gripper in this manner, it is possible to make it stronger than is the case where the circle of the gripper is concentric with the rotor in the mean position.

In the form of the invention shown at Figure 24 a larger bearing surface is made available by staggering the roller bearings. The oscillator *c* is supported within the rotor *a* by roller bearings 123, 124. The gripper *b* is supported on the oscillator on roller bearings 126 and can be pulled towards an external point in one direction or the other or kept in a neutral position by springs or other means connected to the sleeve 127. Roller bearings 128 may also be provided between the oscillator and the rotor shaft 129 for centreing. The rotor is supported within a fixed casing by roller or ball bearings 130. It will be noted that in the figure only the left hand half of a double apparatus is illustrated.

This modification of the invention works in a similar manner to the double mechanical valves above described, the

arrangement allowing for larger bearing surfaces.

In Figure 25 there are inserted between the oscillator *c* and the gripper *b* a number of curved bars 133 of hard steel or phosphor-bronze or like material. The dimensions of these bars should be such that the elasticity limit is not exceeded under the pressure which is produced between the oscillator and the gripper.

A modification somewhat similar is shown at Figure 26. In this case the bar 132 which may be continuous or not, as desired, is of corrugated form, the give required to allow motion being provided for by the flattening of the bar. The resistance to squeezing out of oil with devices as shown in Figures 25 and 26, is very considerable, so that the friction between the oscillator and the gripper is very much less than that between the gripper and the rotor with a consequence that during the gripping period, there is a slight motion between the oscillator and the gripper, while the gripper and the rotor move together.

The gripper has a movement relatively to the oscillator during the driving period, the possibility of this movement being due to the give allowed by the elasticity of the balls, rollers, or pads as shown in Figures 25 and 26. The movement of the gripper during the driving period depends on its inertia and also on the strength of the spring or other means by which it is pulled in the direction contrary to the direction of rotation. If the external force, therefore, acting on the gripper be varied the travel of the gripper and therefore the period of gripping may be varied and also the mean position of the gripper during motion may be altered as desired. The effect of varying the external controlling force is that the variations are produced proportionately on a very much larger scale. This property may be used in conjunction with sensitive governors which can only exert small variable forces on the gripper the secondary of which may thus be controlled and its torque varied so that it may be applied to cases in which a quick acting mechanism is required at certain periods; for example, for operating steam valves, hydraulic mechanism, steering gears and the like.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. In apparatus comprising a rotor and an oscillator having an eccentric or its equivalent, a gripper coacting therewith and having balls, rollers or other elastic bodies interposed between the oscillator and the gripper and between the oscillator and the rotor, the parts being so constructed that at the commencement of the driving stroke of the oscillator, movement through a substantial angle dependent upon the load takes place between the oscillator and the gripper, owing to the elastic give of the said balls, rollers or other elastic bodies, while at the end of the driving stroke the balls, rollers or other bearing surfaces regain their original forms and so return the oscillator and gripper to their original positions relatively to one another, thereby disengaging the gripper substantially as described.

2. In apparatus comprising a rotor and an oscillator having an eccentric, cam or its equivalent, a gripper coacting therewith and having balls, rollers or other elastic bodies interposed between the oscillator and the gripper and between the oscillator and the rotor, the oscillator and the gripper being so arranged that relative movement is possible between them owing to the elasticity of the ball, roller or other bearings and/or bearing surfaces, so constructing the parts that when the reaction of the rotor reaches a given maximum, no movement is imparted to the rotor by the gripper, substantially as described.

3. The combination of apparatus comprising a rotor, an oscillator having an eccentric or its equivalent, a gripper coacting therewith and having balls, rollers or other elastic bodies, interposed between the oscillator and the gripper and between the oscillator and the rotor, the oscillator and gripper being so arranged that relative movement takes place between them owing to the elasticity of the parts, a force applied by a spring or other means acting on the gripper to cause its engagement with the oscillator in one direction or the other, and means for varying or reversing the controlling force whereby the period or phase of gripping during the driving stroke of the oscillator is varied, thereby obtaining variable speed of, and torque on, or reversal of the rotor, substantially as described.

4. Unidirectional driving devices as claimed in Claim 1, 2 or 3, constructed with balls, rollers or pads which are free to circulate around their tracks.

5. Unidirectional driving devices as claimed in Claim 1, 2 or 3, having provided between the gripper and the oscillator a member capable of independent rotation so that the points of contact

at which the driving is exerted are continuously changing.

6. Unidirectional driving devices as claimed in Claim 1, 2 or 3, having provided between the oscillator and the gripper and between the oscillator and the rotor floating tracks loose or suitably driven by the rotor or otherwise.

7. A unidirectional driving device as claimed in Claim 1, 2 or 3, comprising an oscillator, rotor and gripper of circular form so arranged that their centres form a small triangle during the driving period.

8. A unidirectional driving device as claimed in Claim 1, 2 or 3, comprising an oscillator and rotor mounted coaxially with a gripper between them, ball or other elastic bodies being provided between the oscillator and rotor and between the oscillator and gripper, while the co-operating faces of the gripper and rotor are plane, and those of the oscillator and gripper are also plane but inclined at a small angle to the transverse plane through the apparatus.

9. A unidirectional driving device according to Claim 1, 2 or 3, and having co-operating surfaces comprising two cylindrical surfaces having between them curved pads or corrugated sections of rings immersed in oil and arranged so that they bend under load, whereby breaking of the oil film is avoided.

10. Unidirectional driving devices as claimed in Claim 1, 2 or 3, having a permanent force acting on the gripper with means for varying such permanent force or for changing the direction thereof, in order to vary the period or phase of grip, the mean position of the gripper, and/or the direction of rotation of the rotor.

11. The improved unidirectional driving devices hreinbefore described and illustrated in the accompanying drawings.

Dated the 6th day of May, 1924.

CARPMAELS & RANSFORD,
Agents for Applicant.
24, Southampton Buildings, London,
W.C. 2.

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[Wt. 1A—125/4/1925.]

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Fig.1.

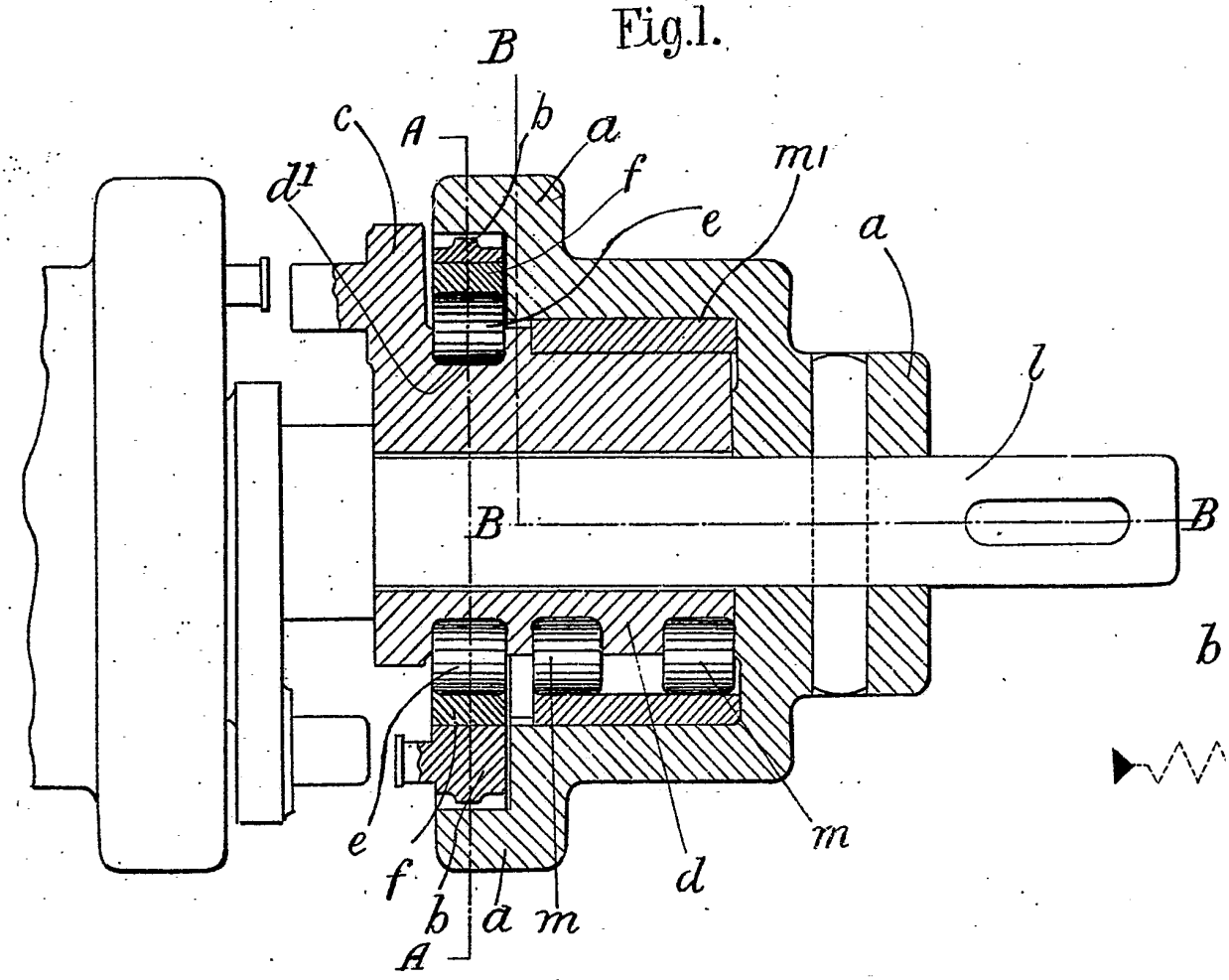

Fig.2

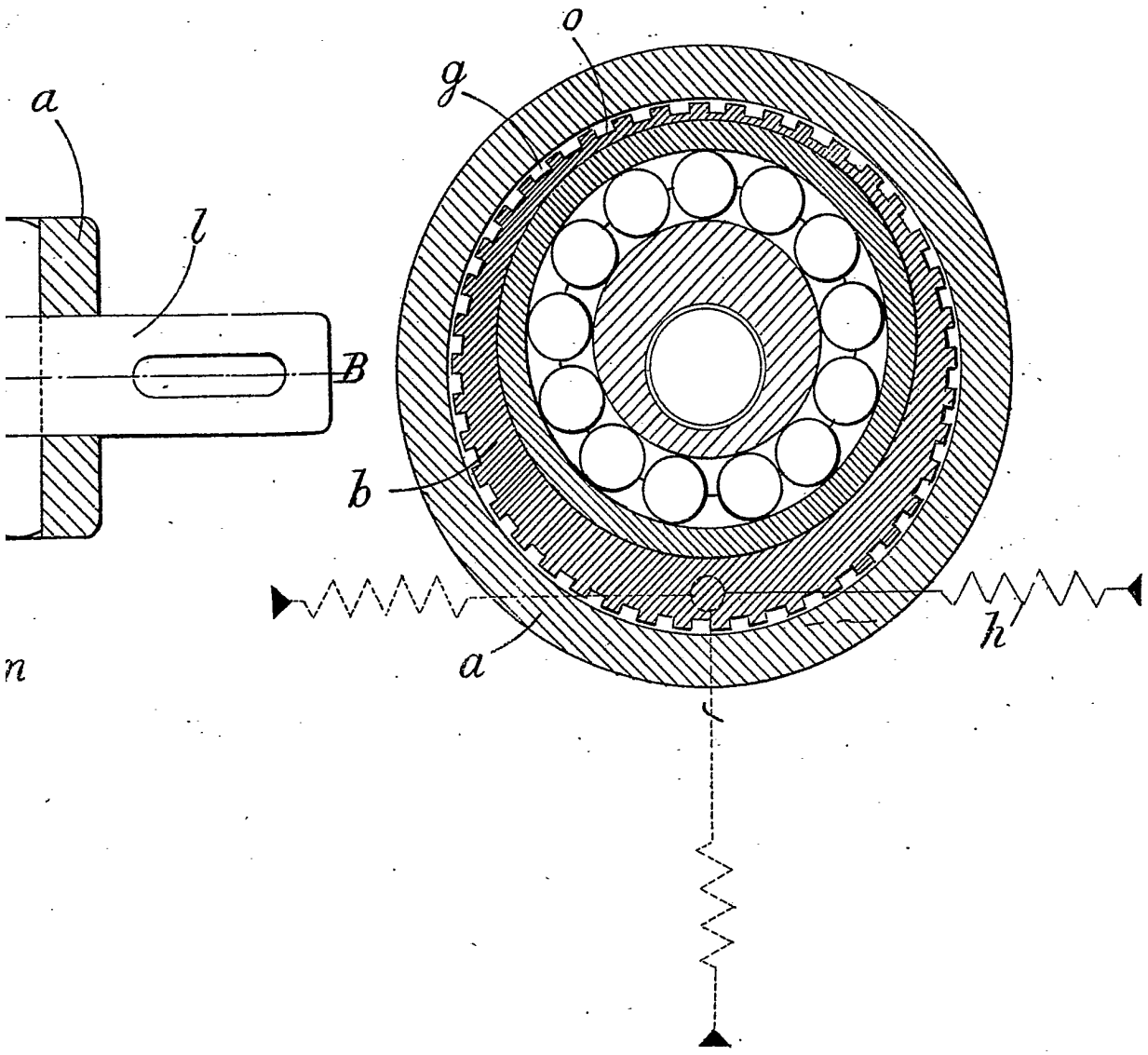

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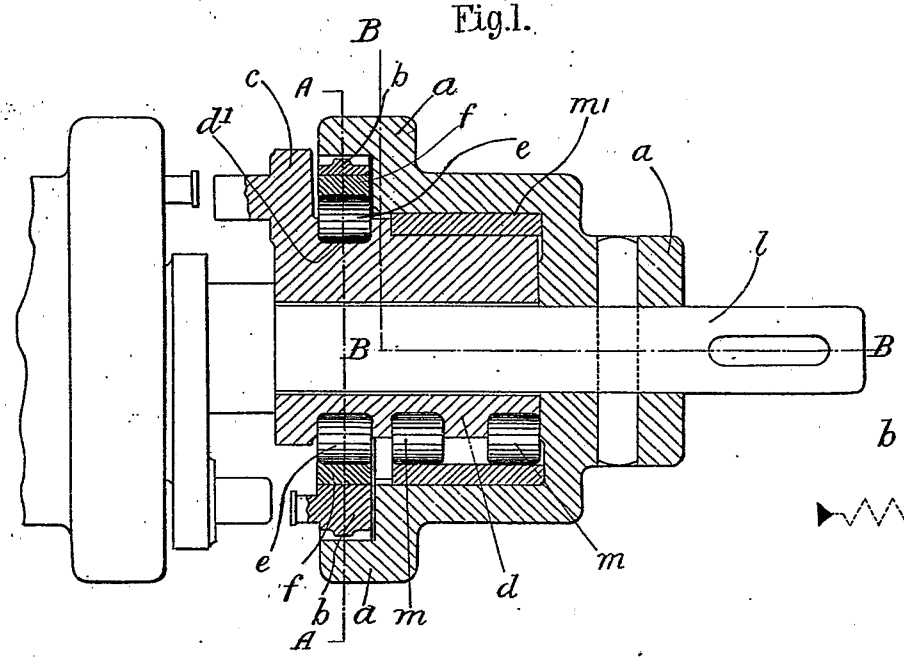
Fig.1.



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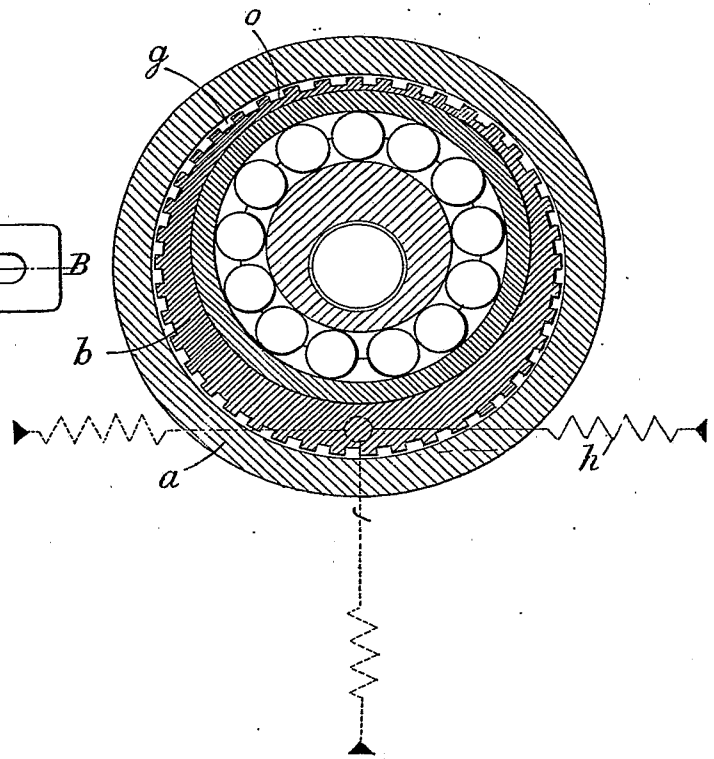

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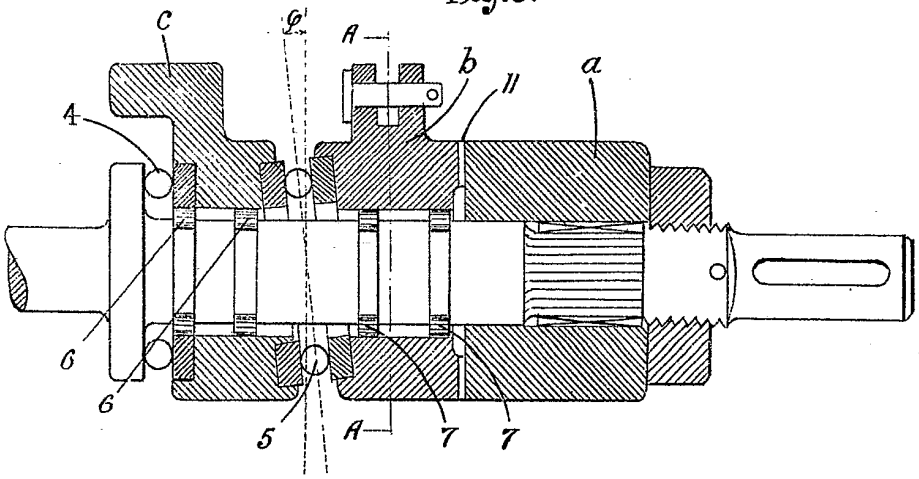

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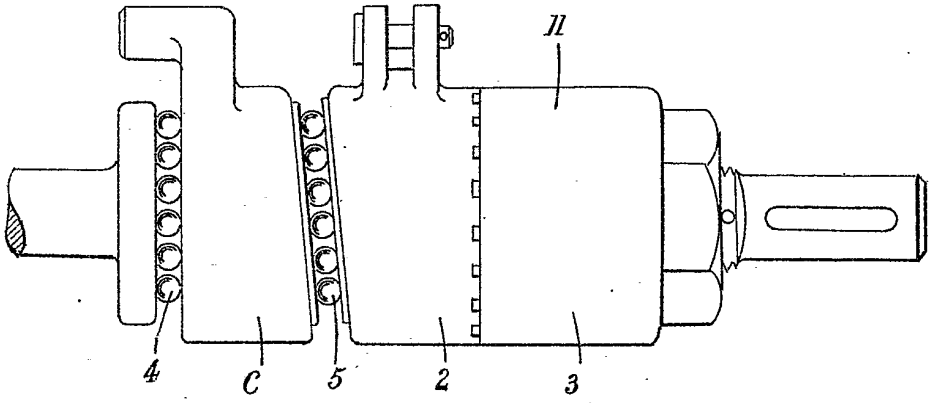

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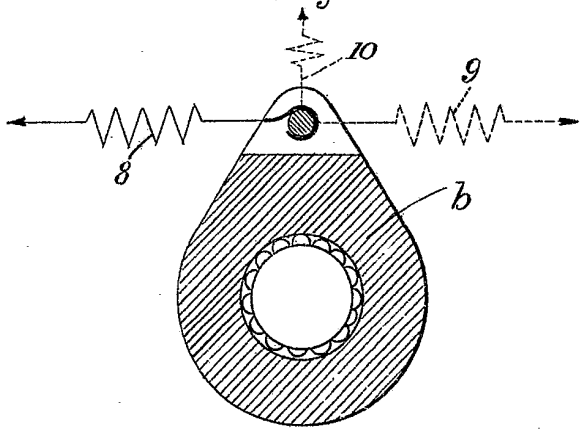

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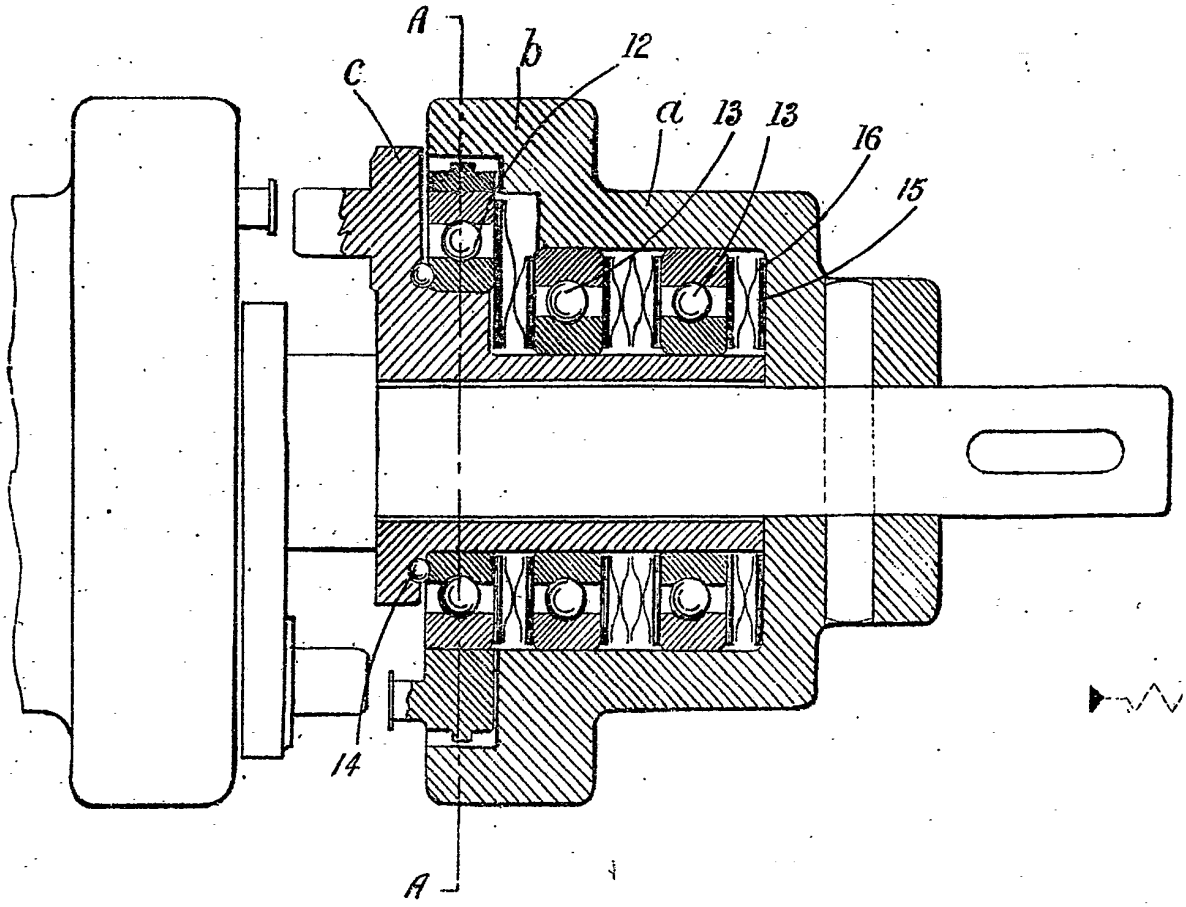
Fig. 6



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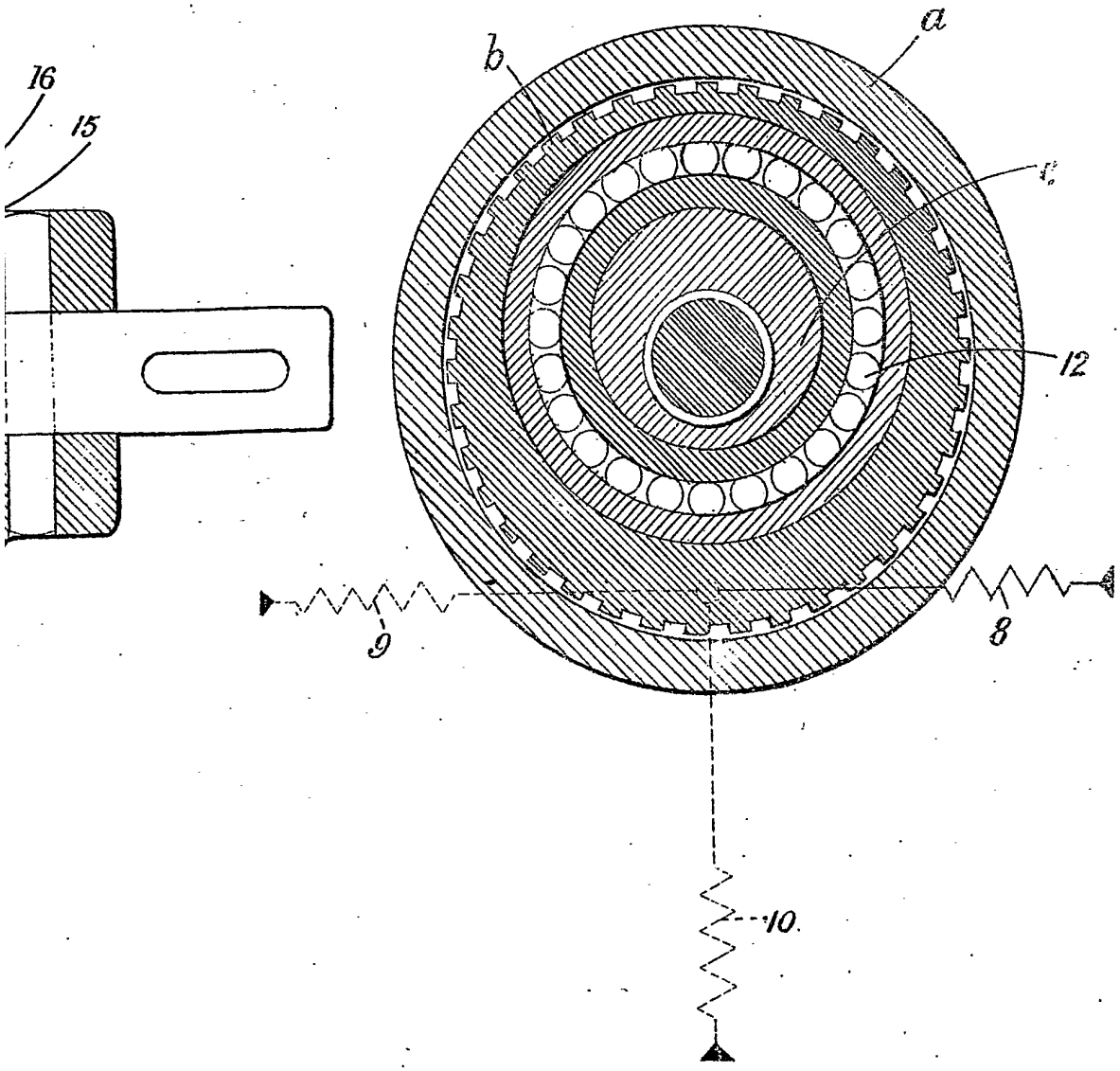

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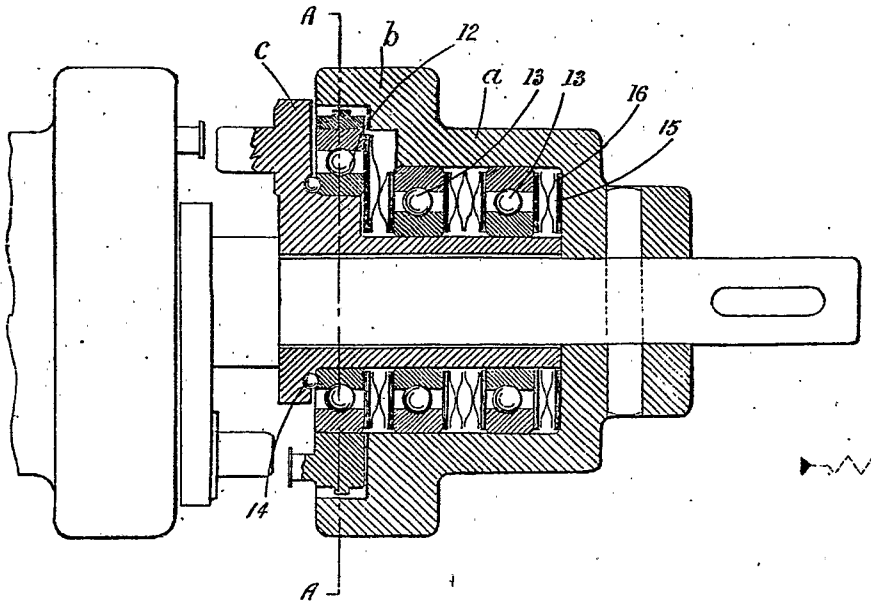
Fig. 6



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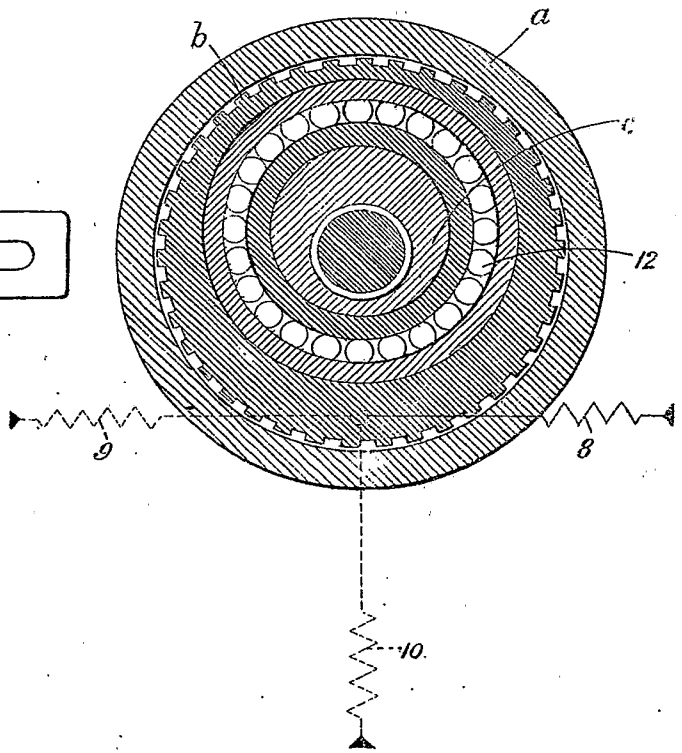

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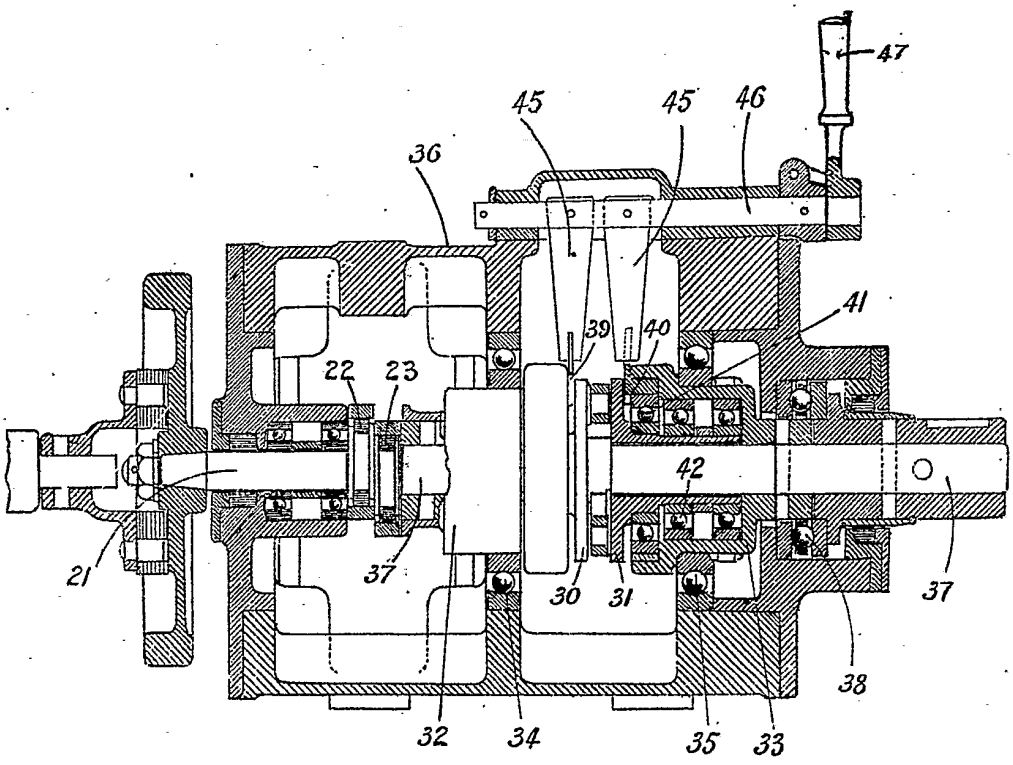

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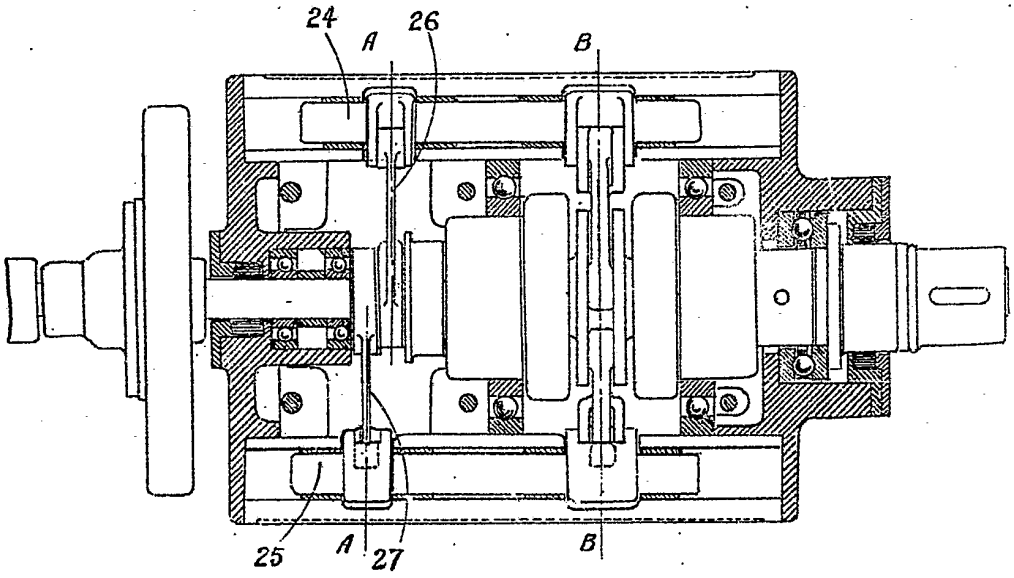

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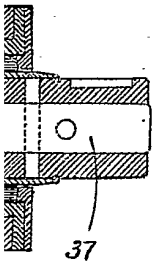

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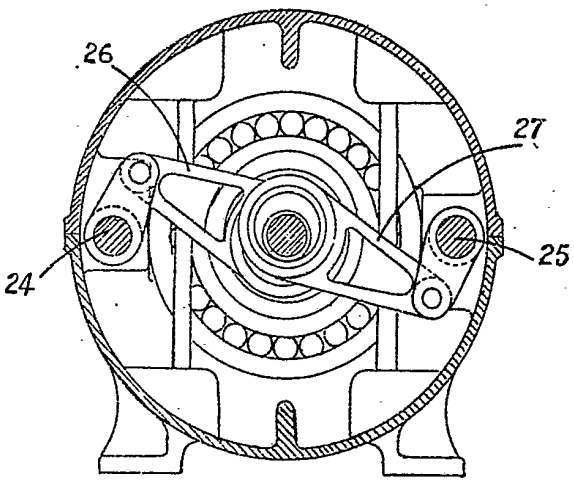

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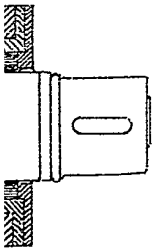

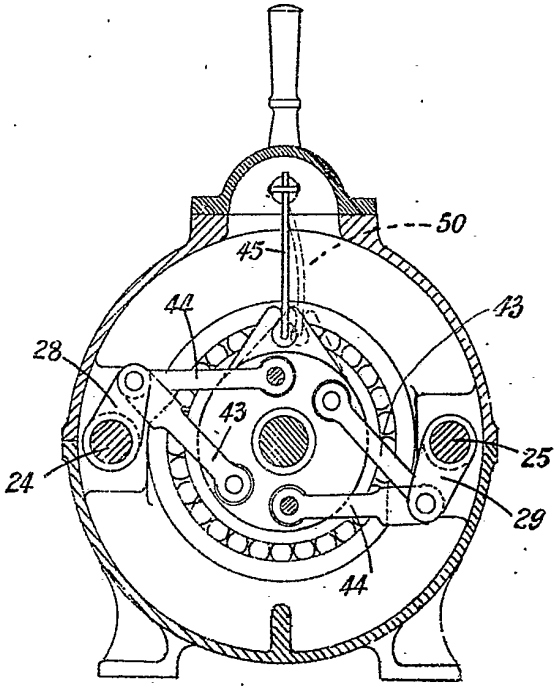

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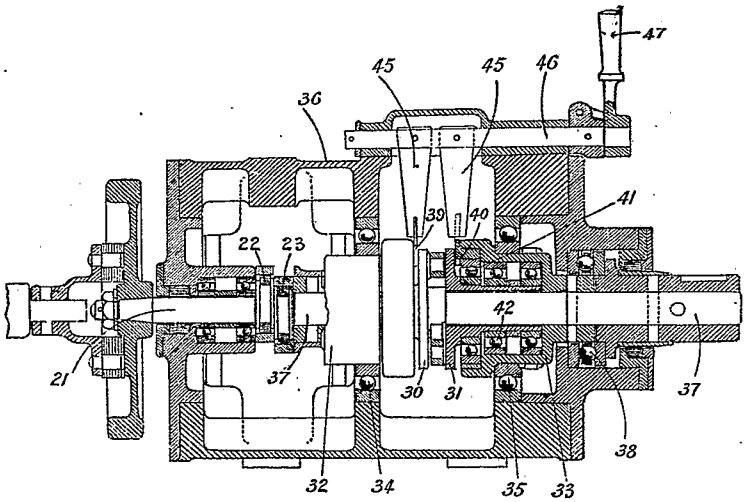

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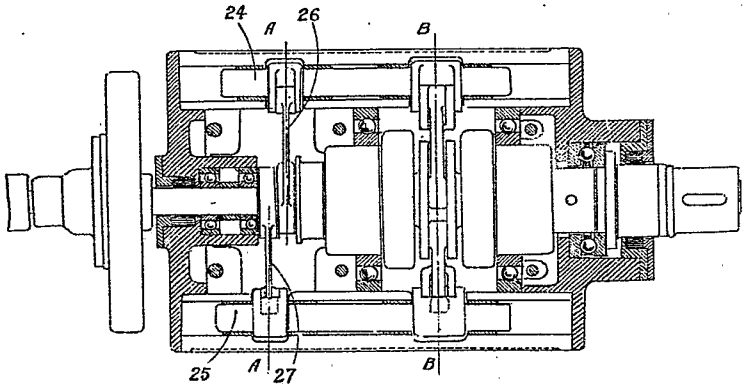

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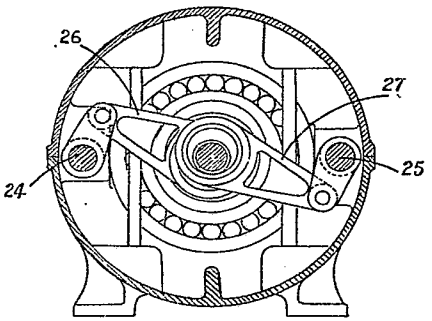

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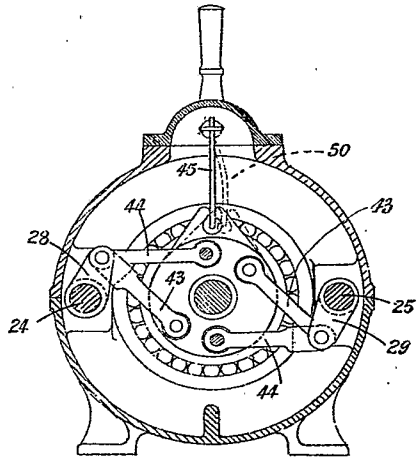

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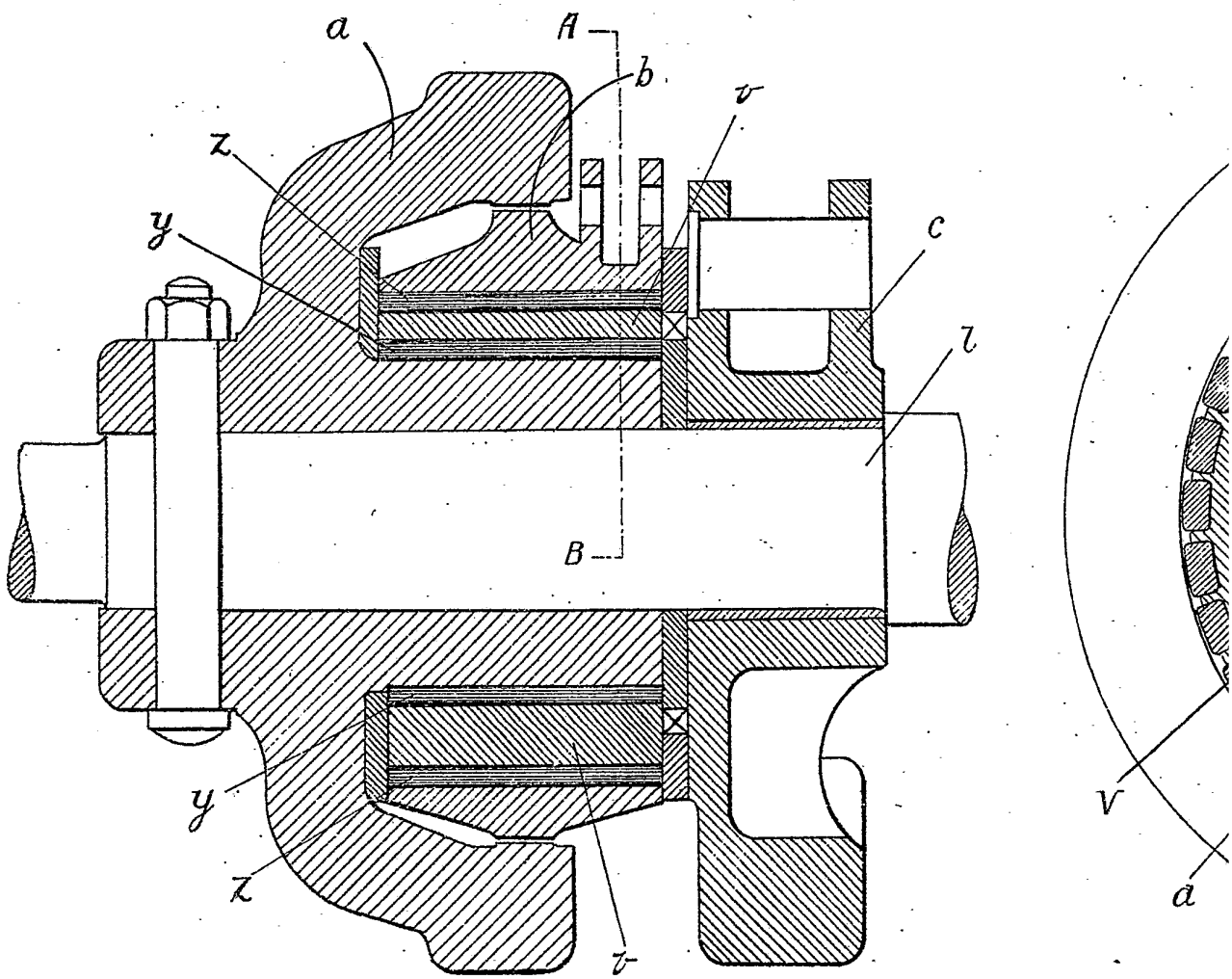
Fig. 12.



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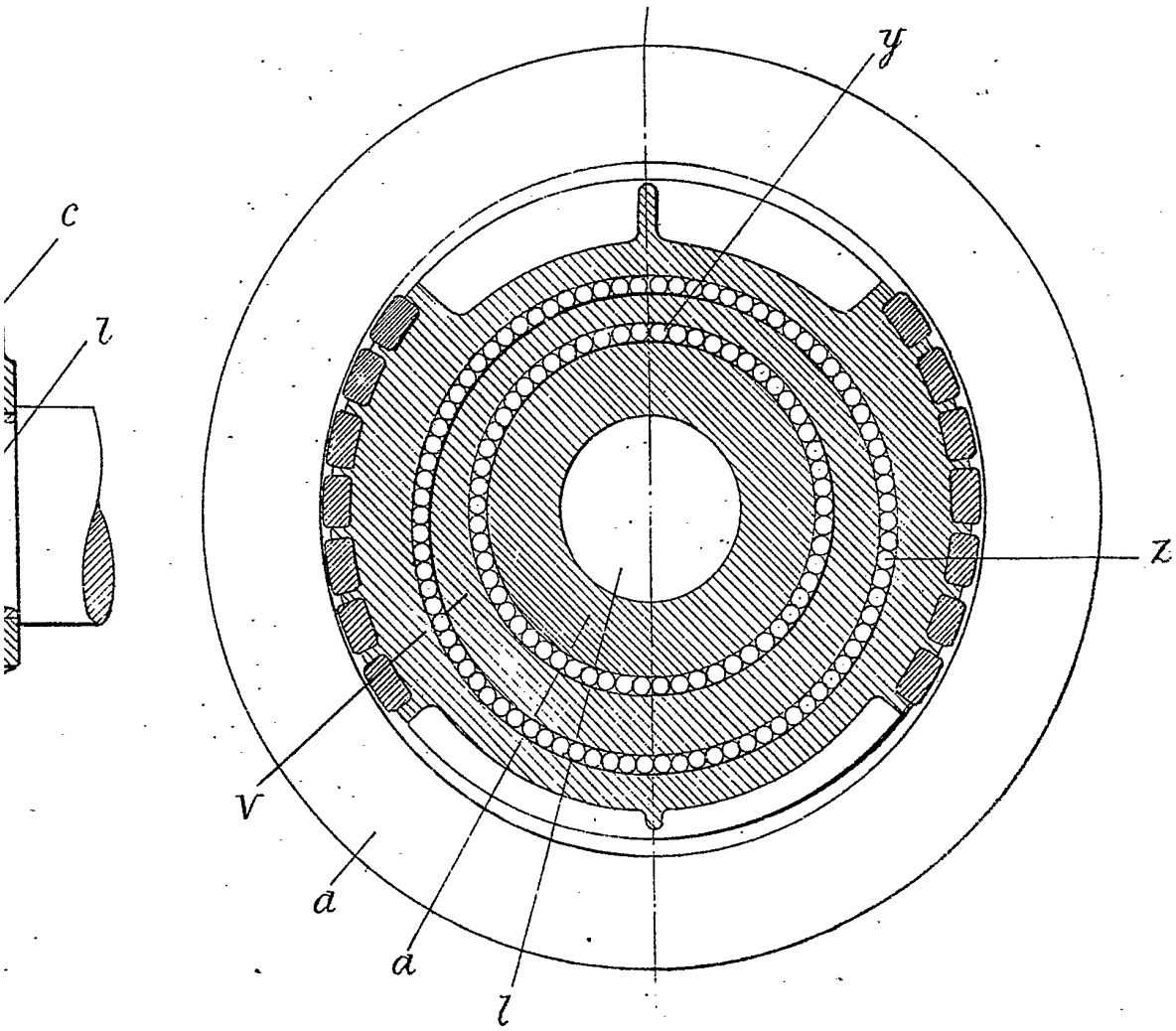

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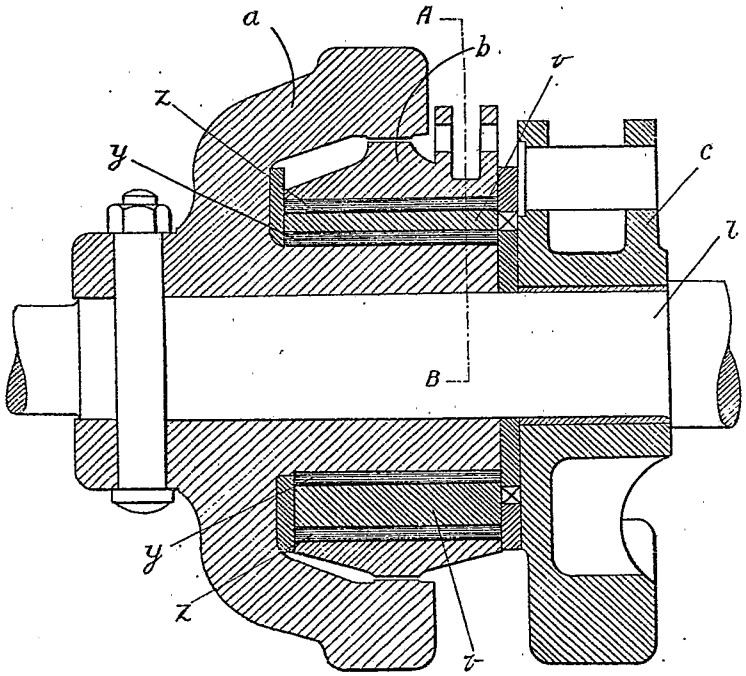

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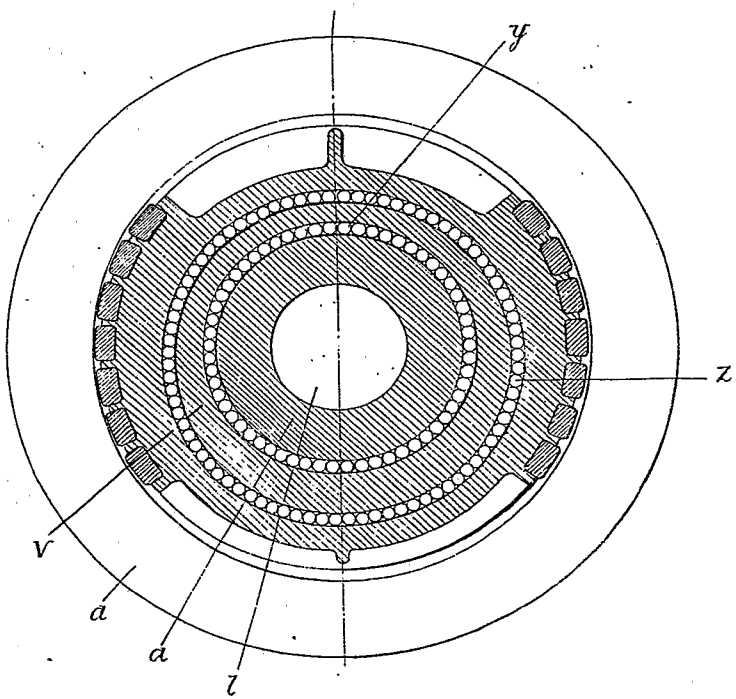

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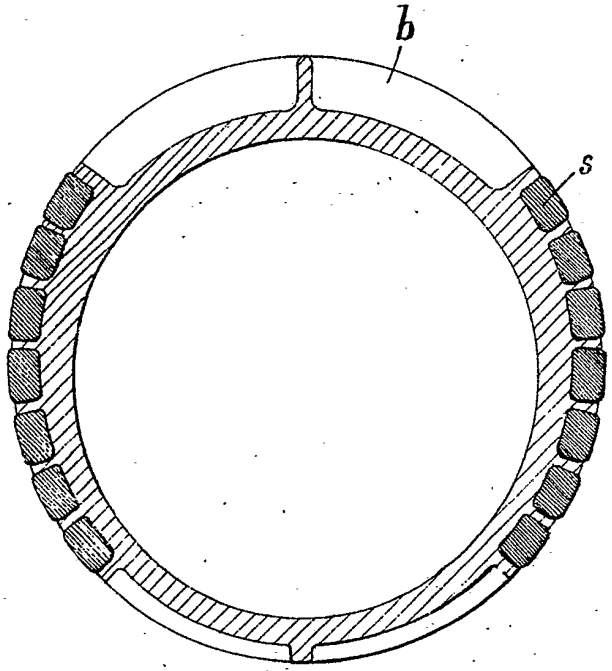
Fig. 14.



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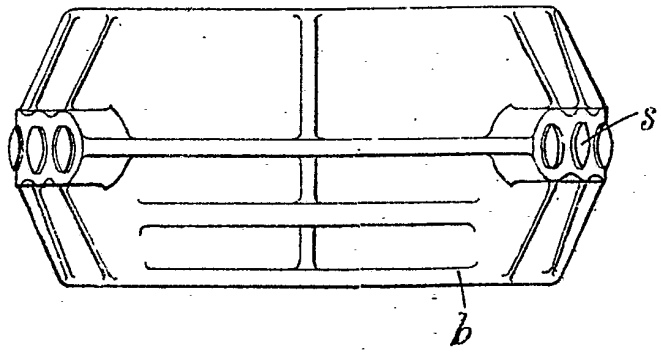

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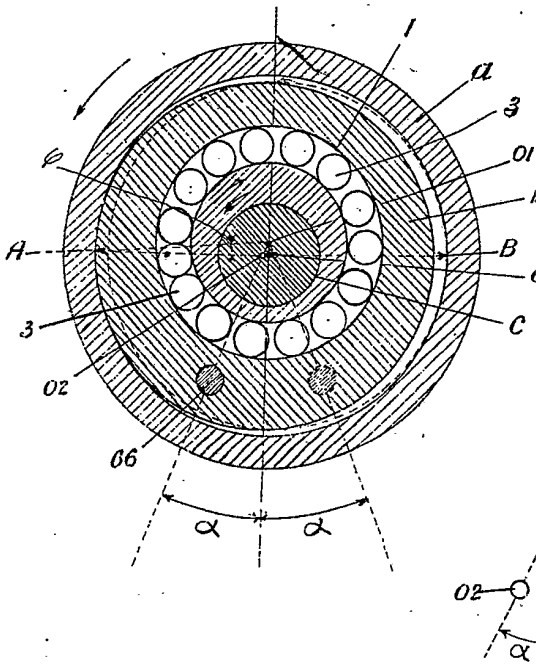

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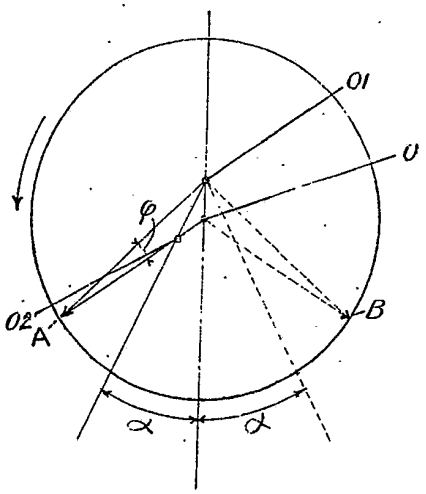

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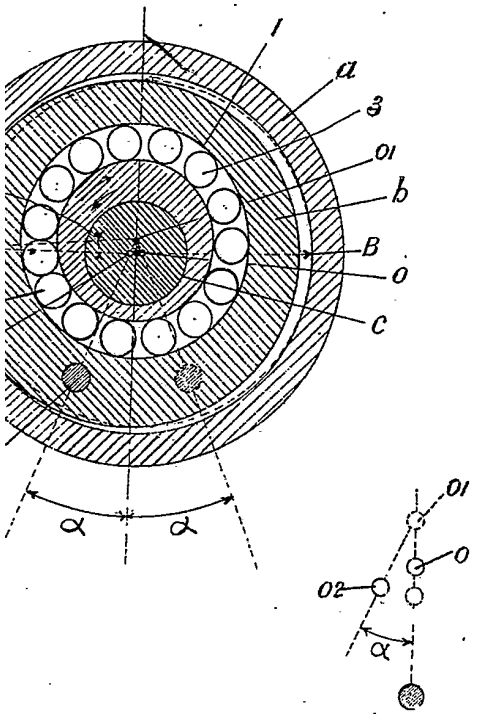

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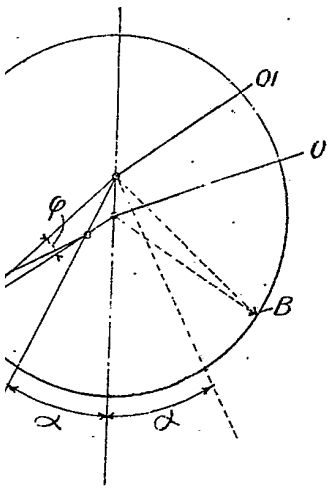

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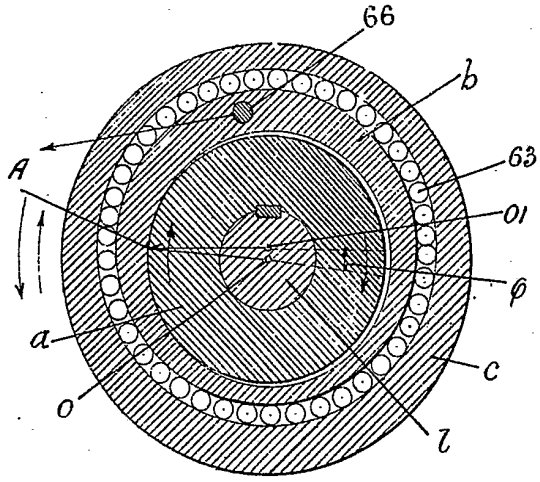

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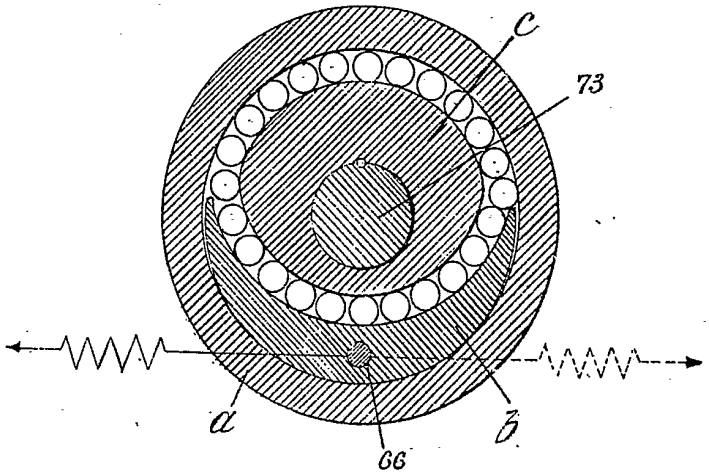

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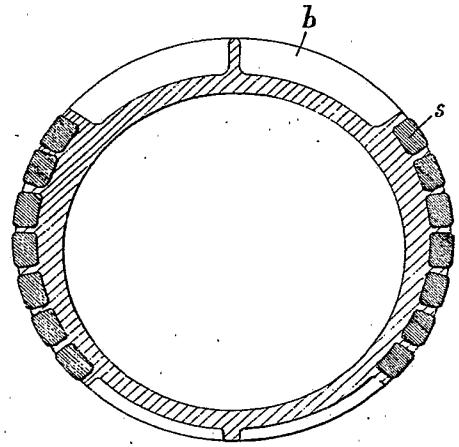
Fig. 14.



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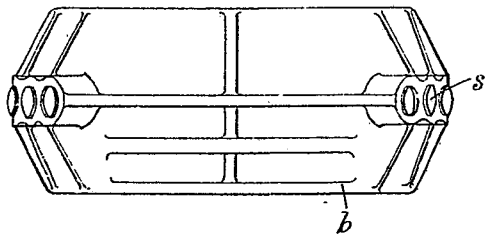

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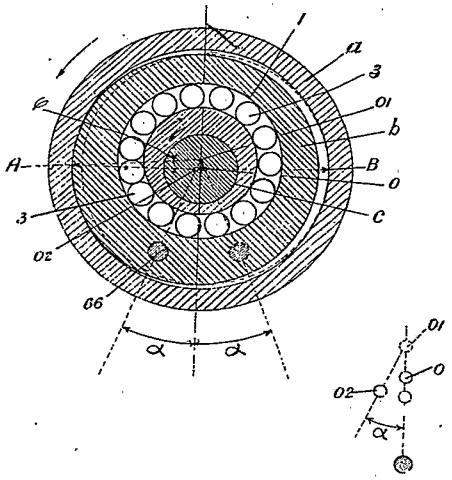

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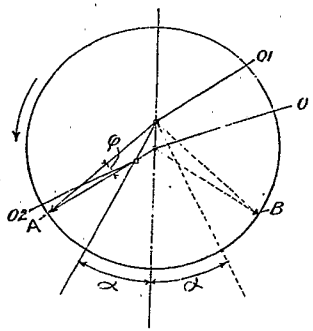

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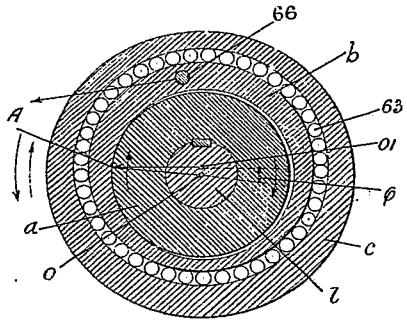

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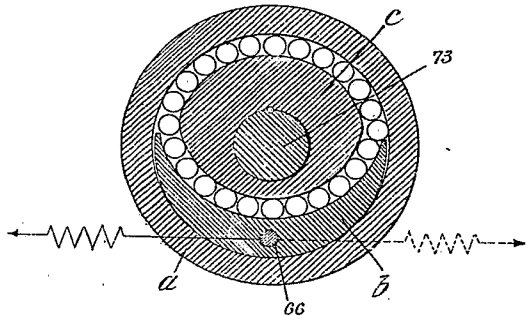

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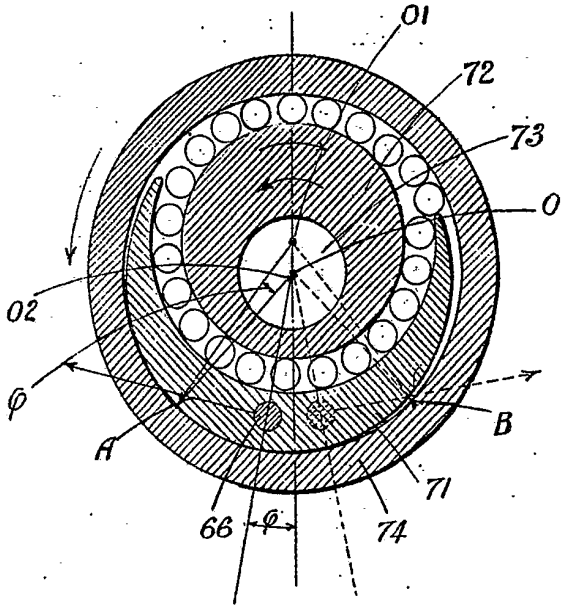
Fig.20.



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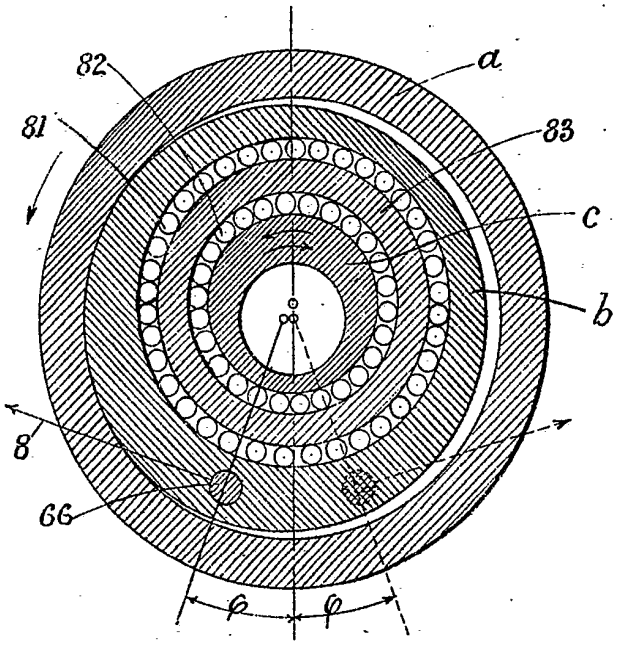

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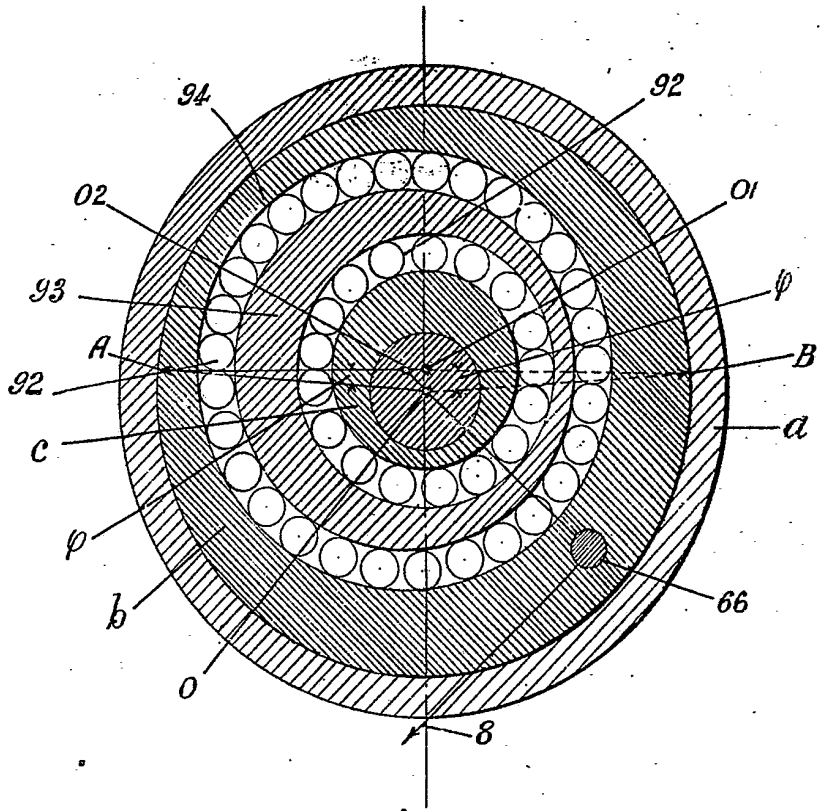

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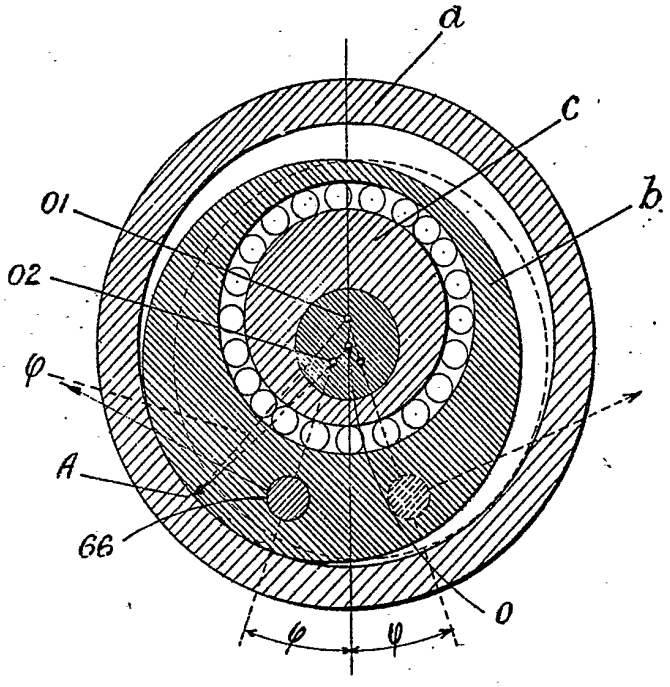

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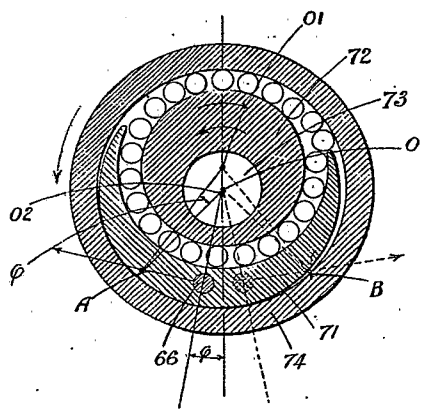
Fig.20.



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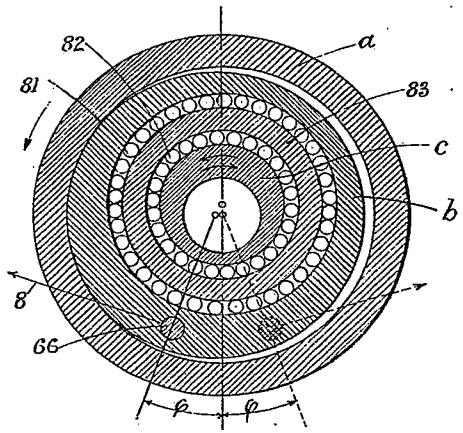

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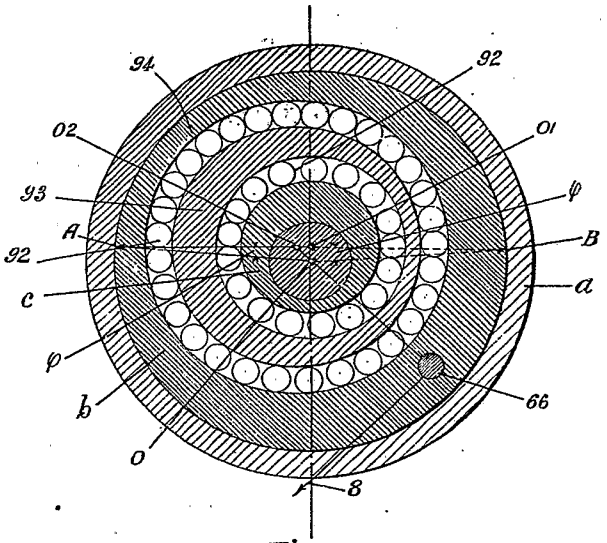
Fig.22.



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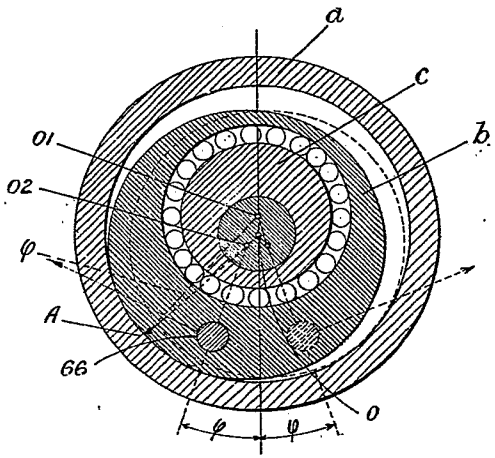

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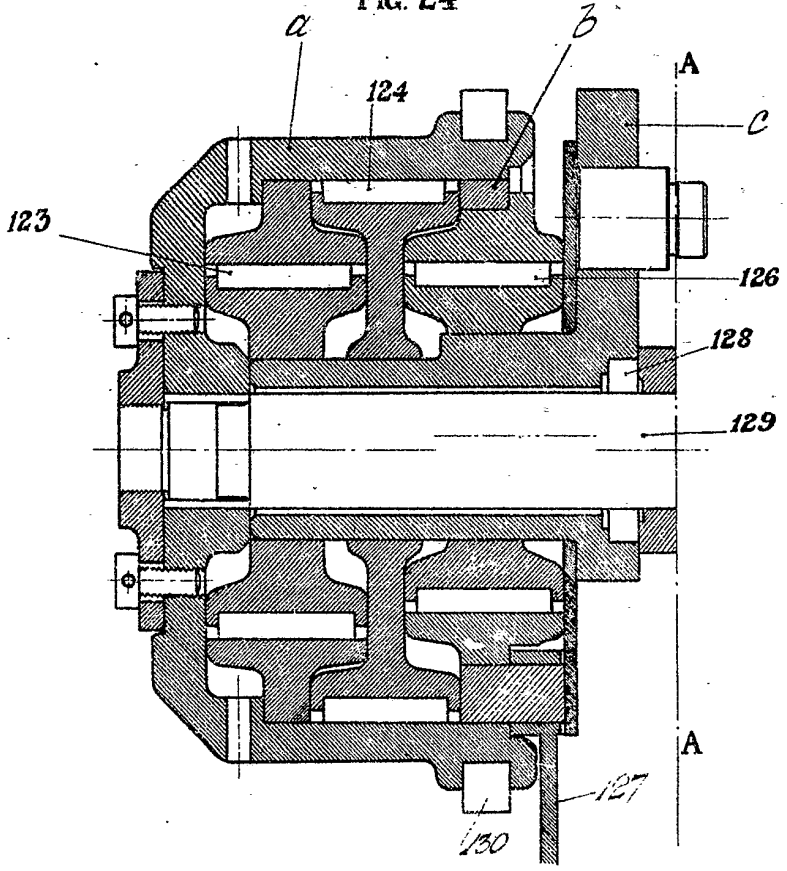
SHEET 11

FIG. 24.



SHEET 12

FIG. 25.

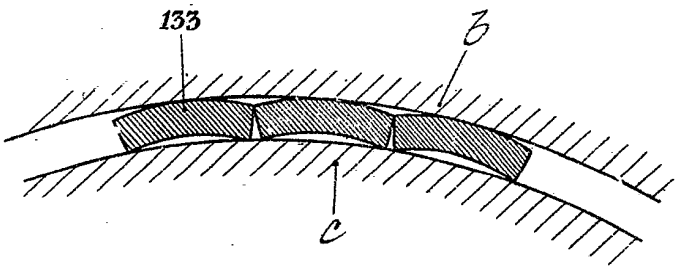
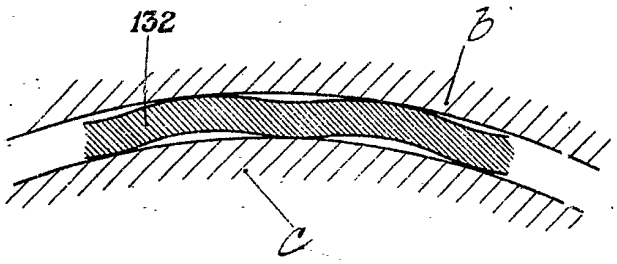


FIG. 26.



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