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F. JENKIN.

DRIVING GEAR.

No. 297,407.

Patented Apr. 22, 1884.

Fig. 1.

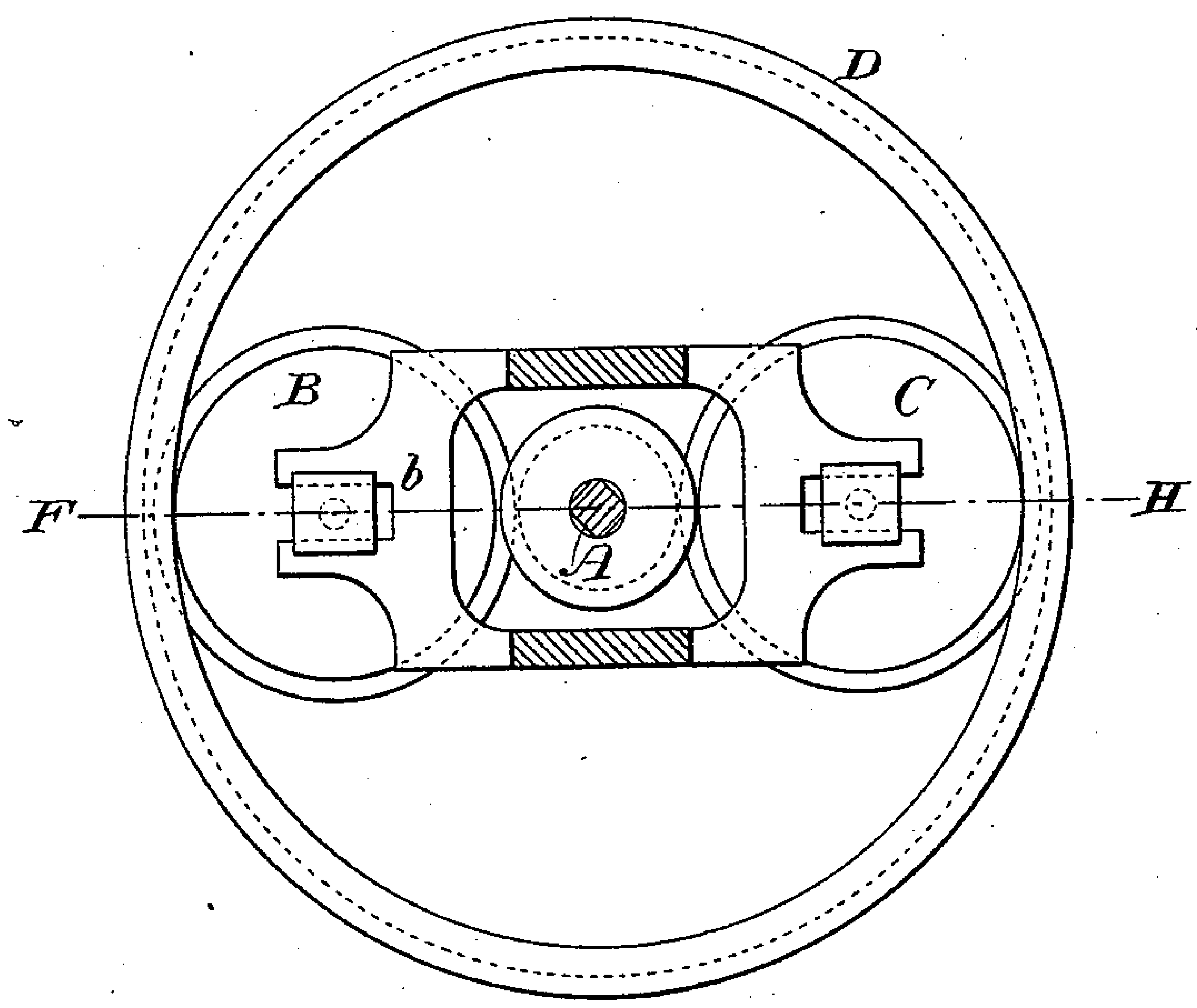

Fig. 1a.

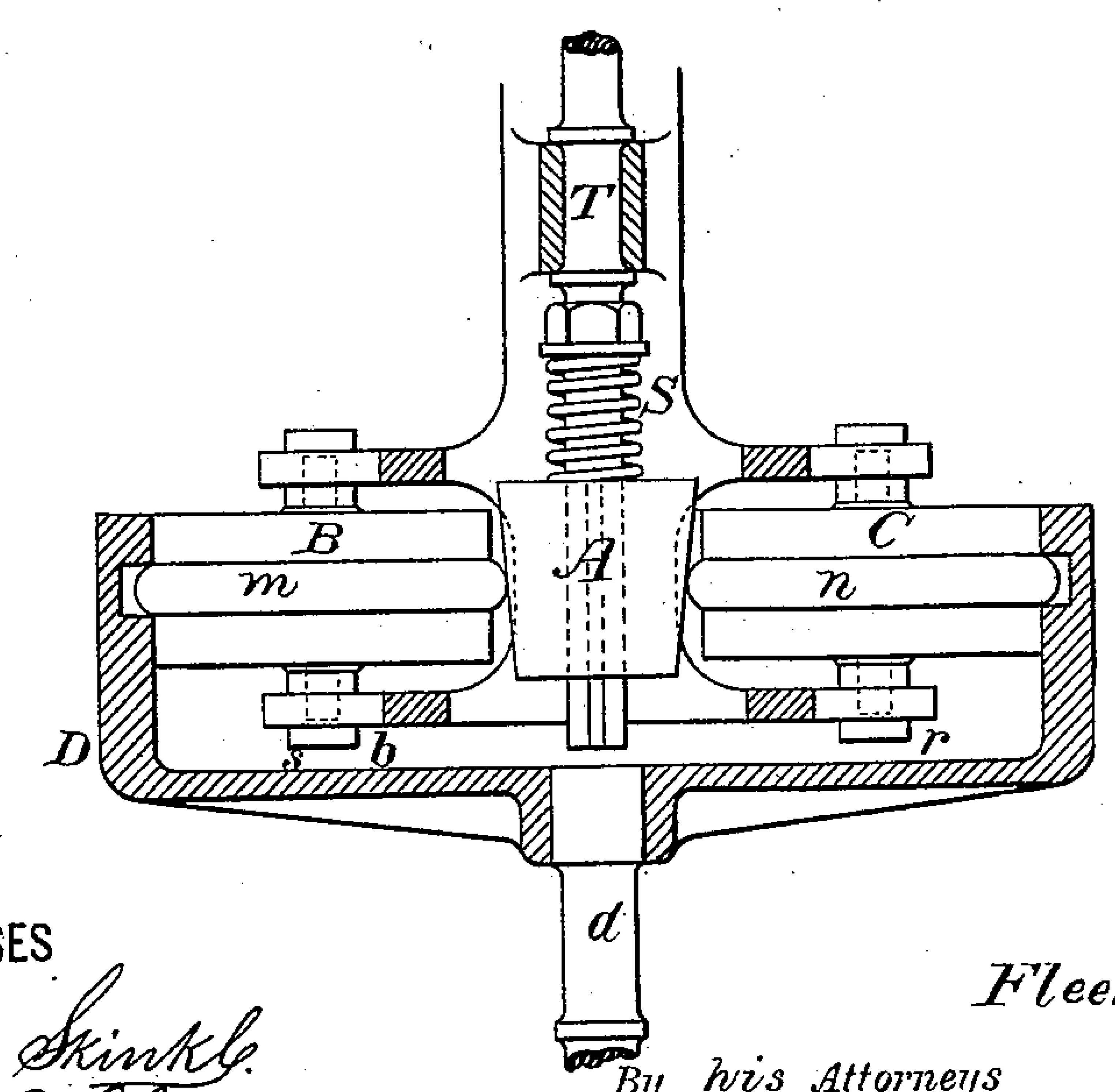

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Fig. 2.

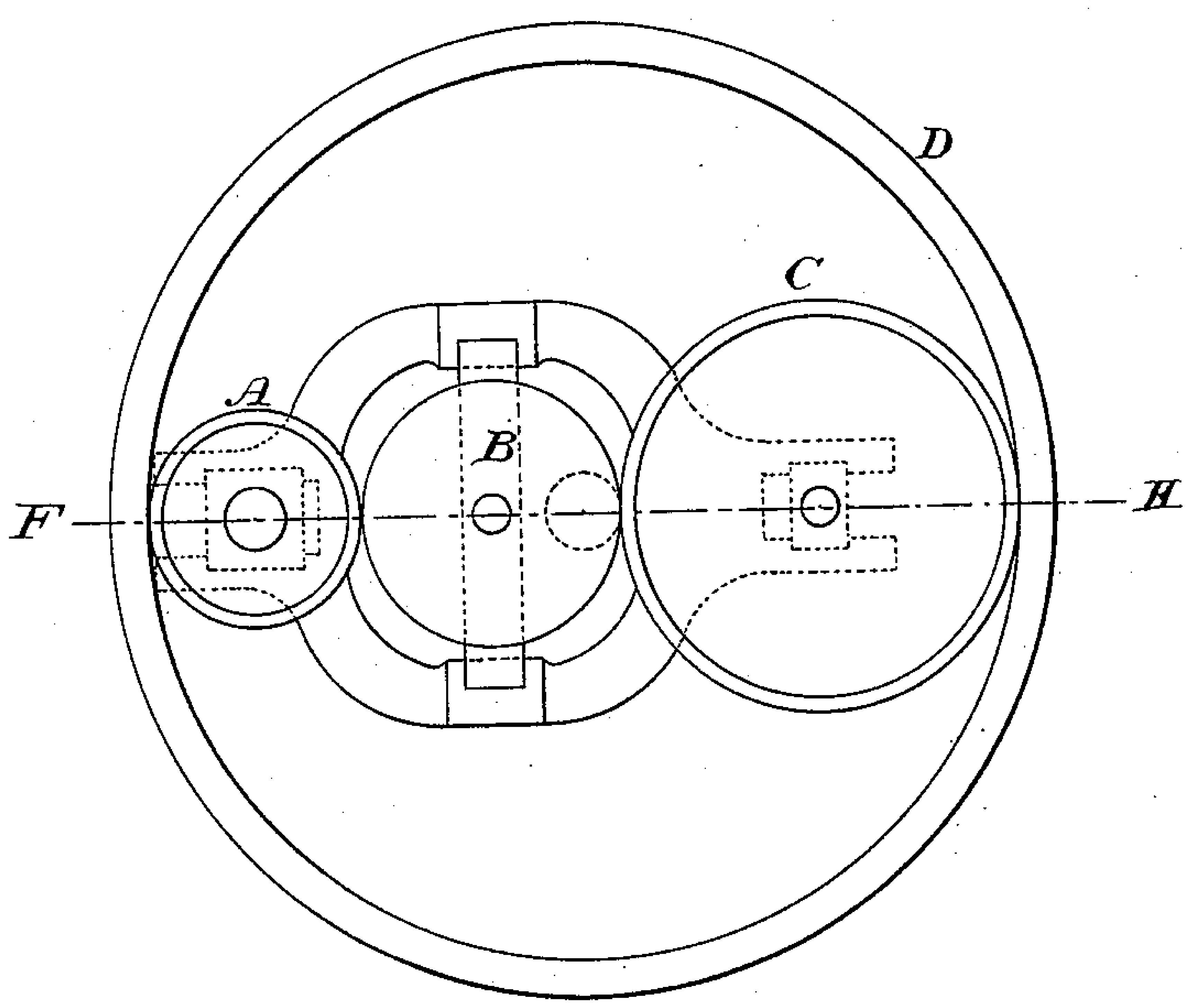
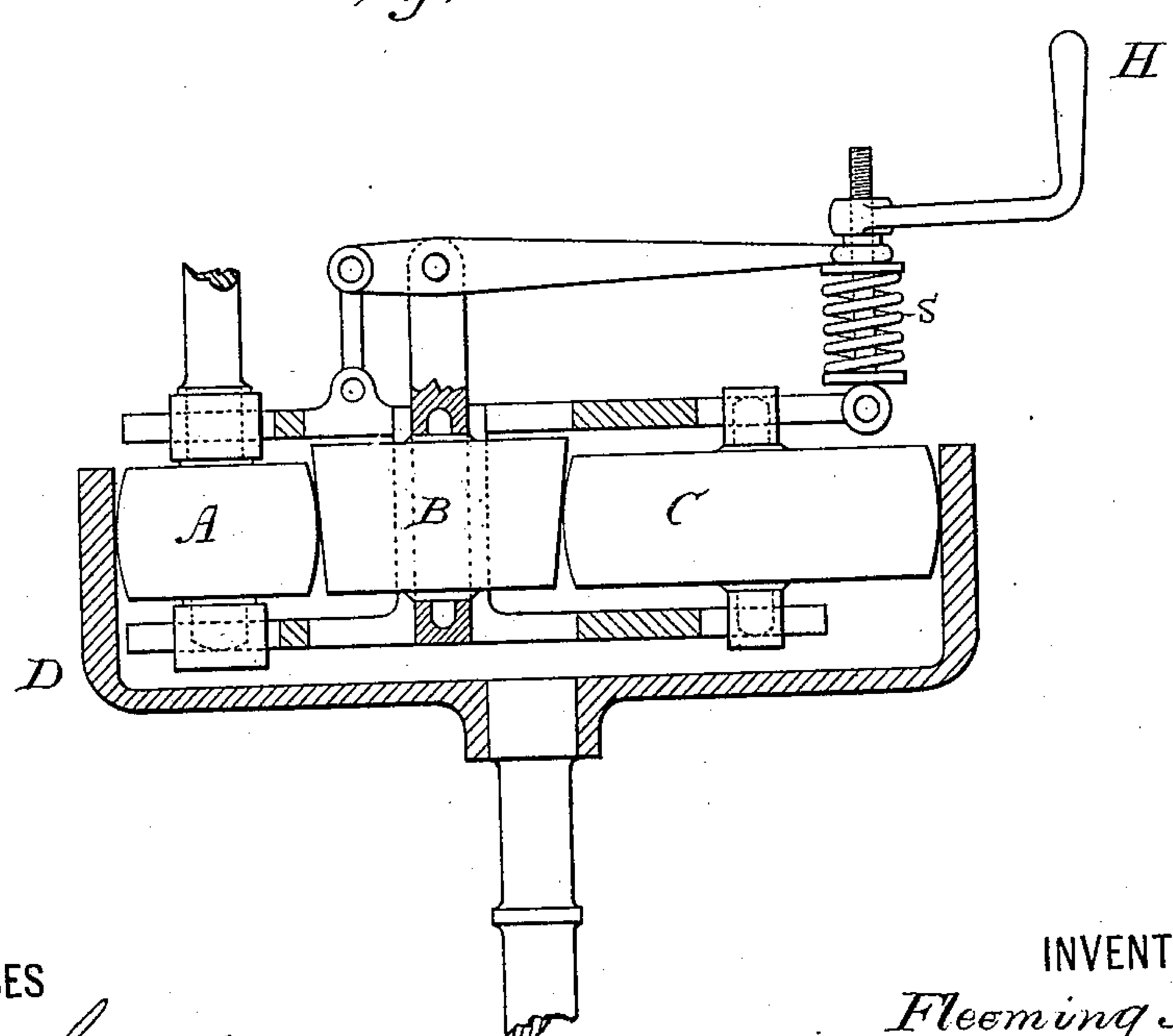


Fig. 2.a



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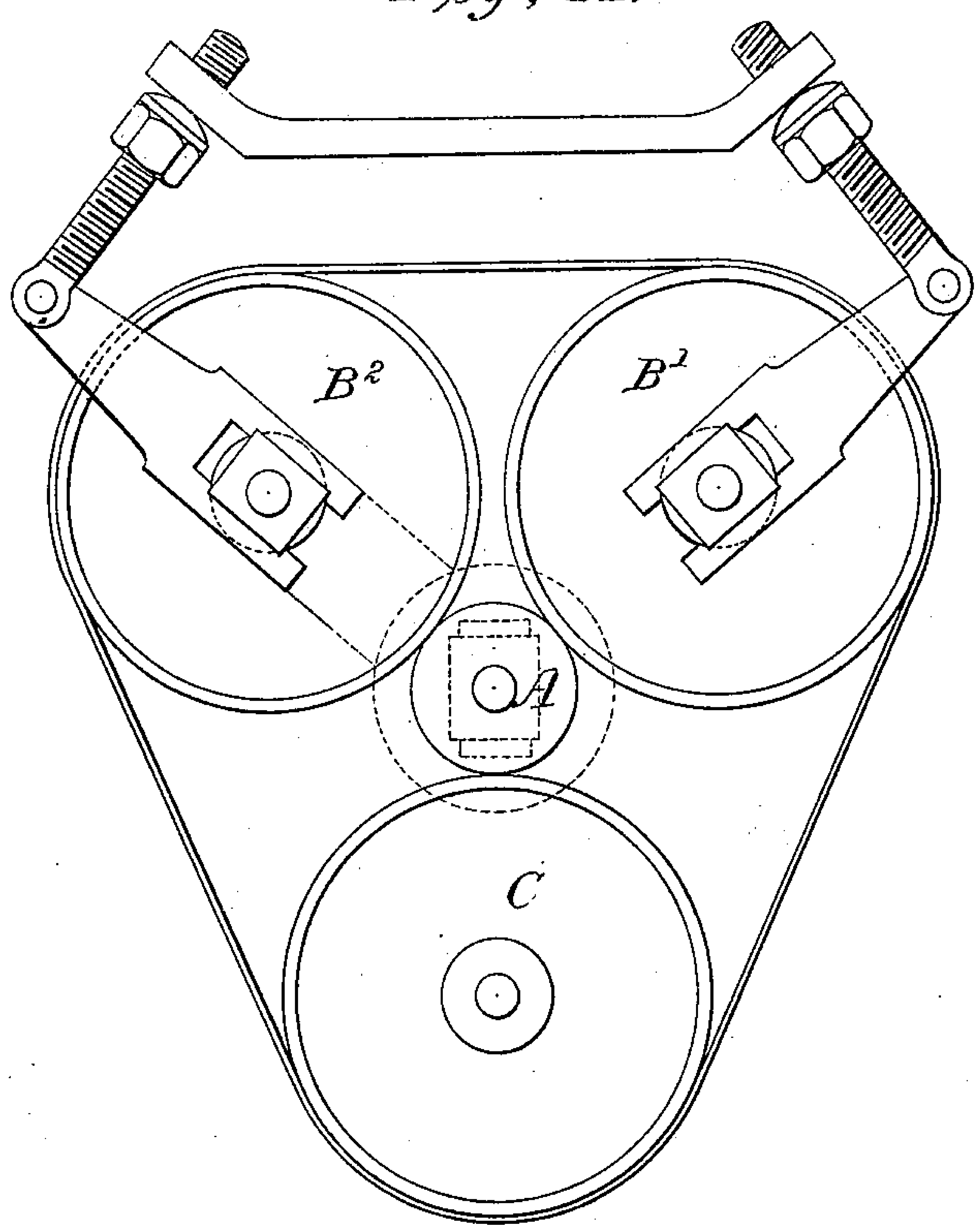
Fig, 21.



Fig, 3.

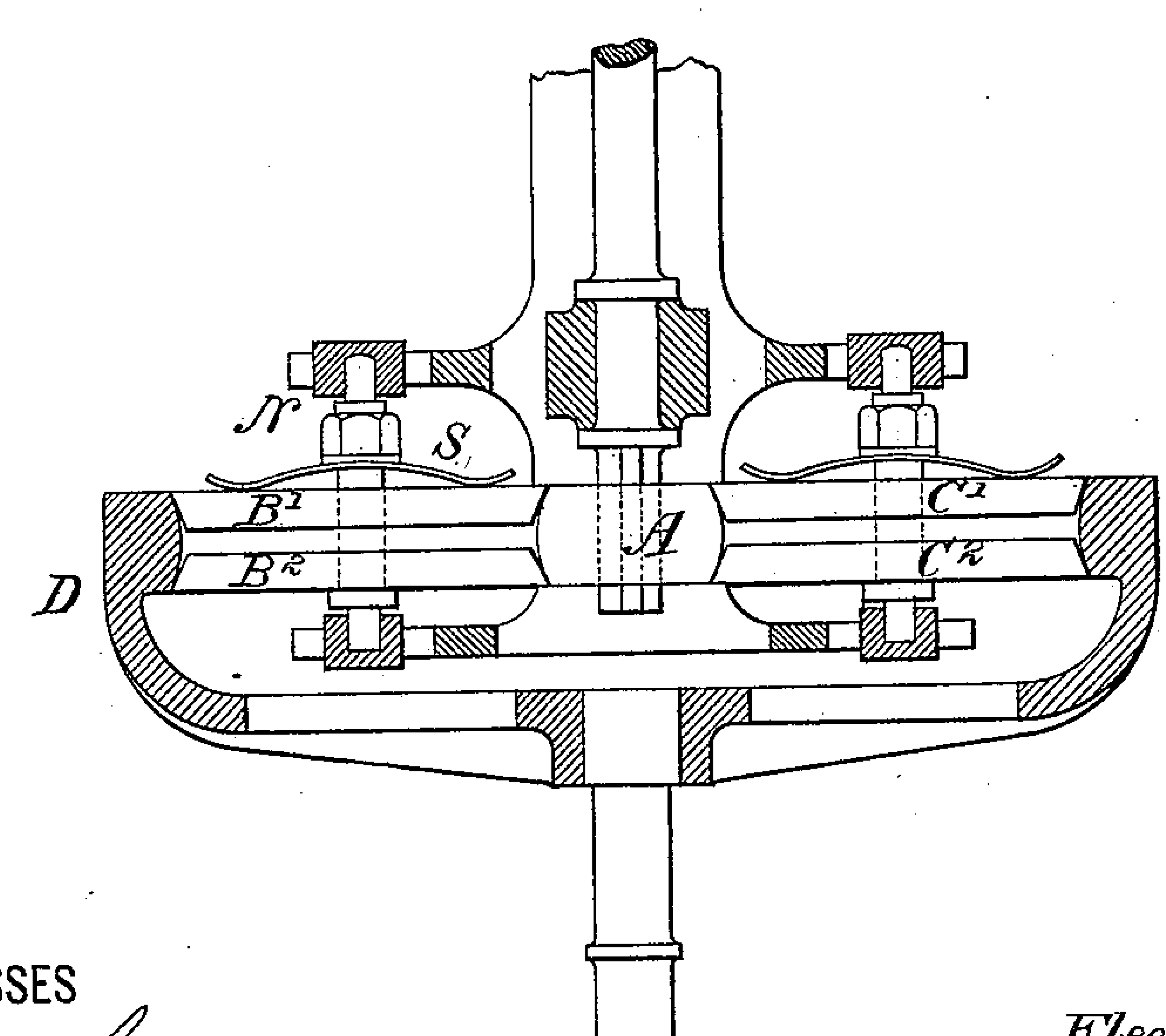


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Fig. 4.

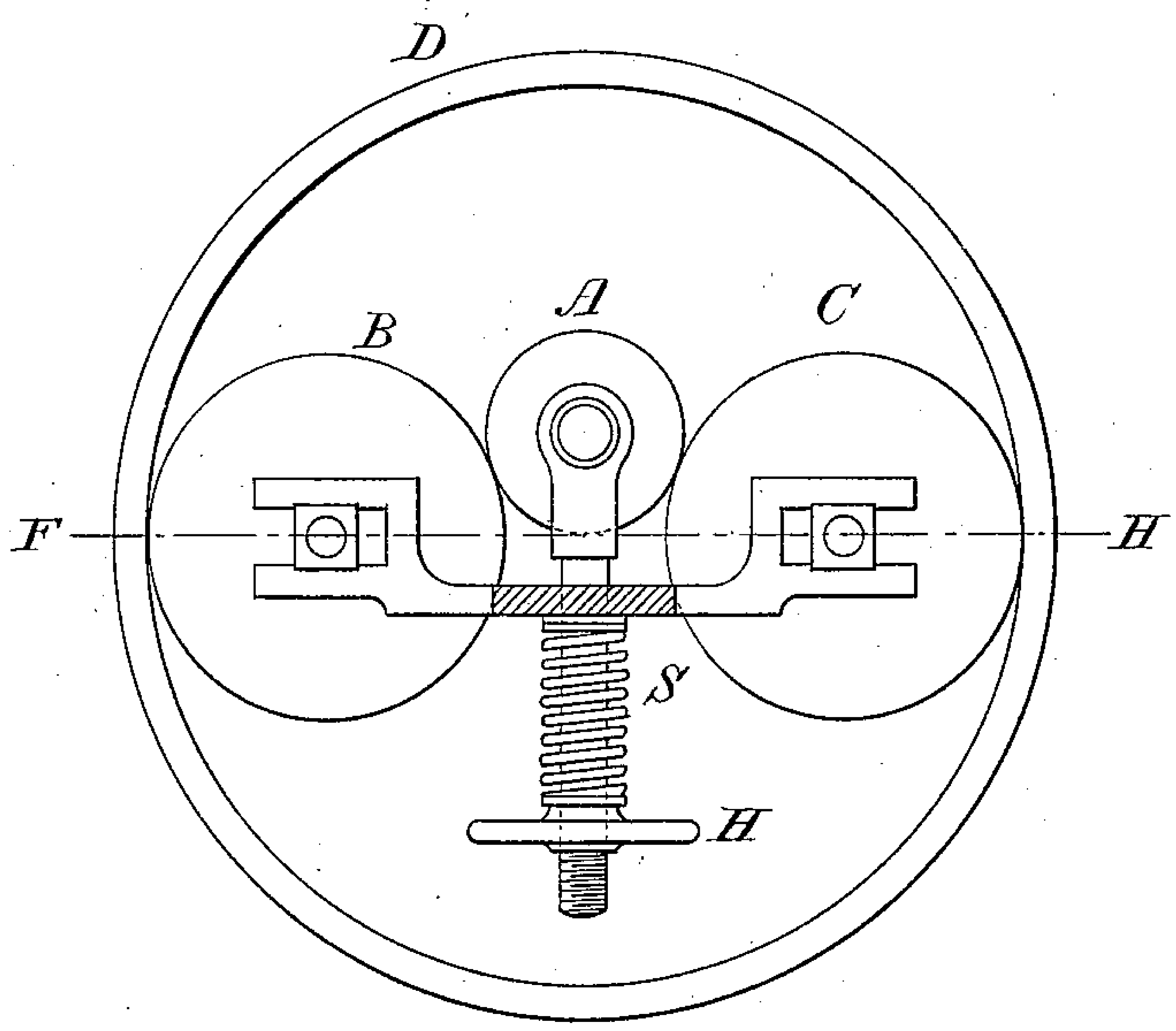
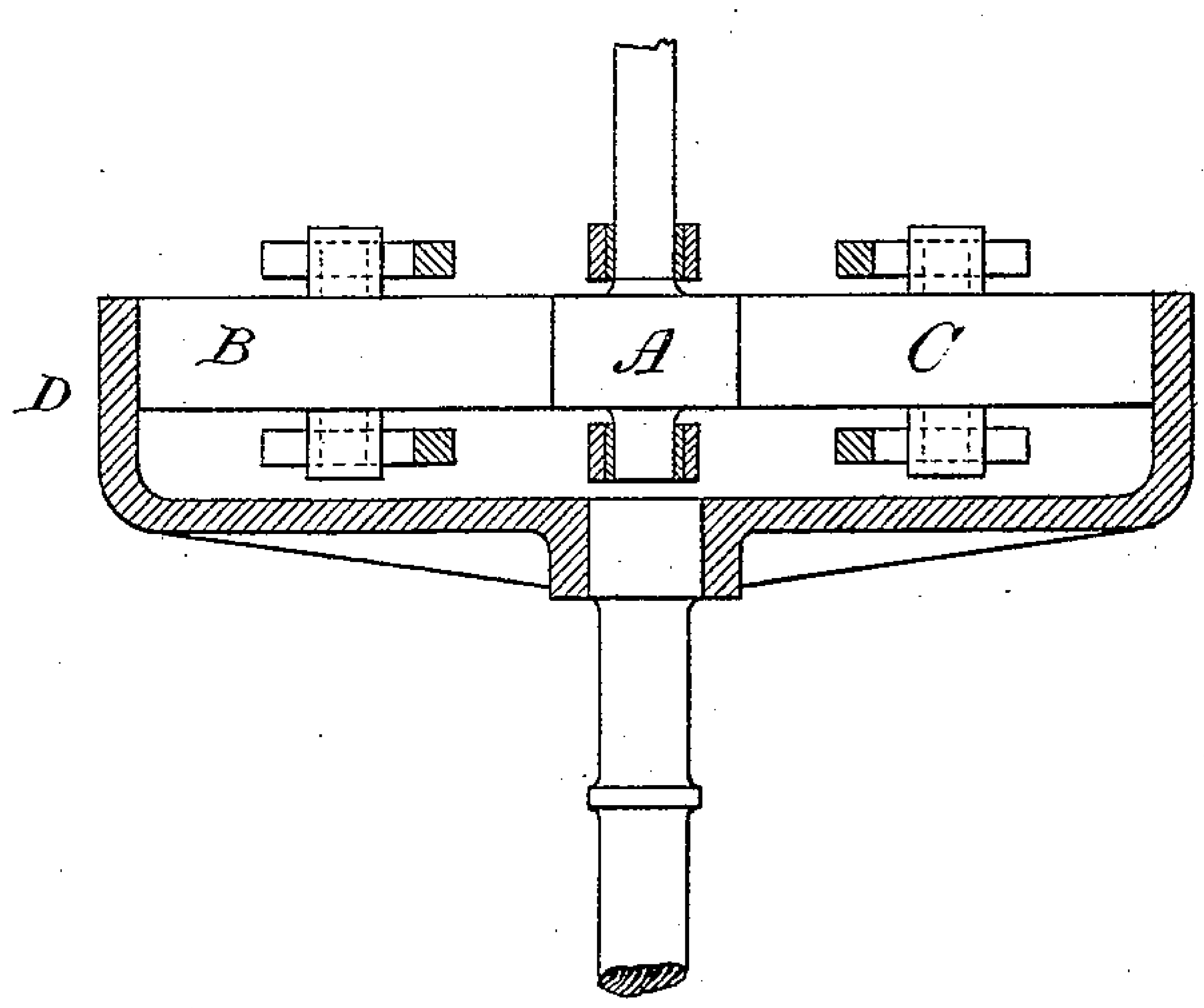


Fig. 4a



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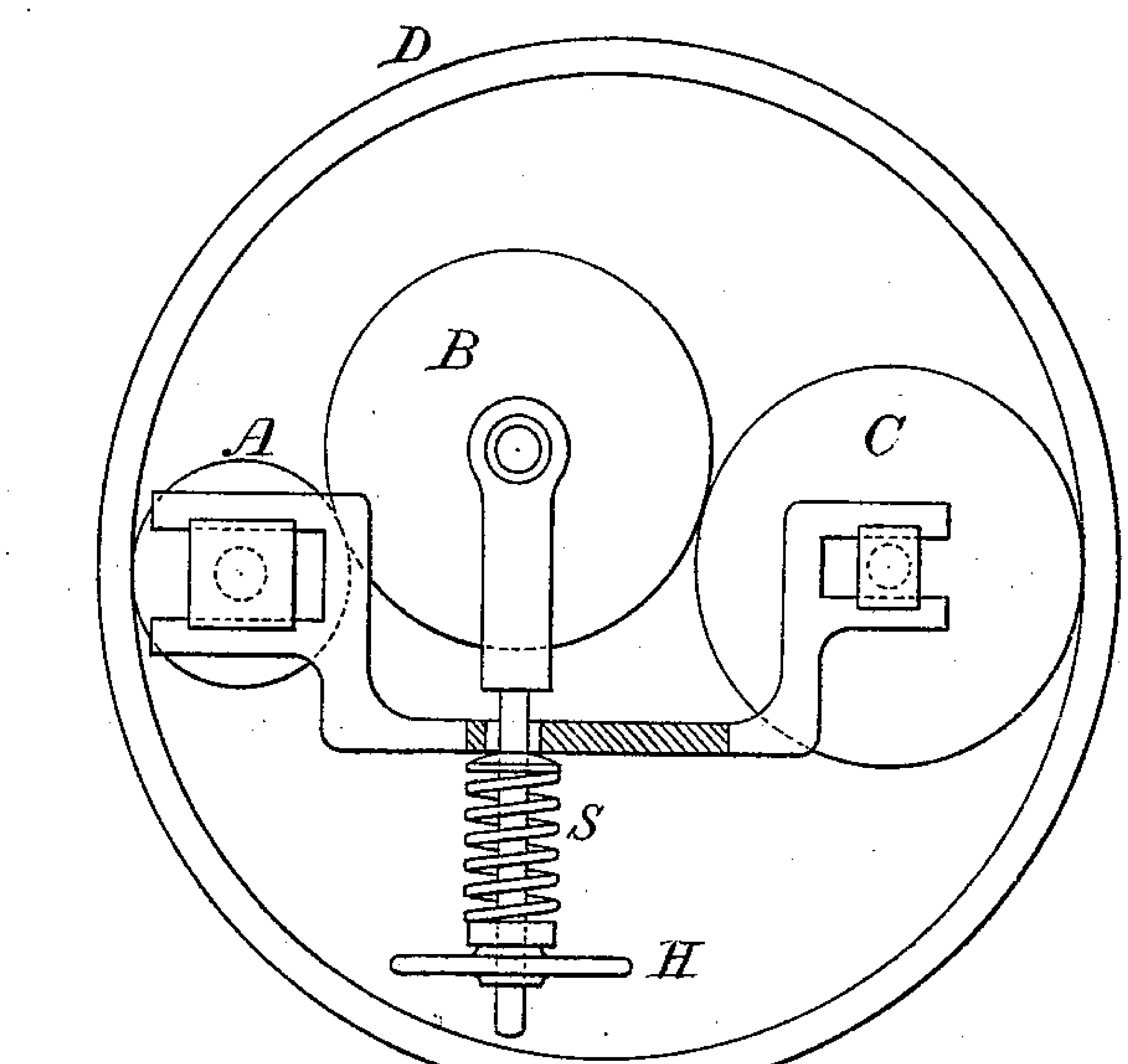
Fig, 5.



Fig, 5a.

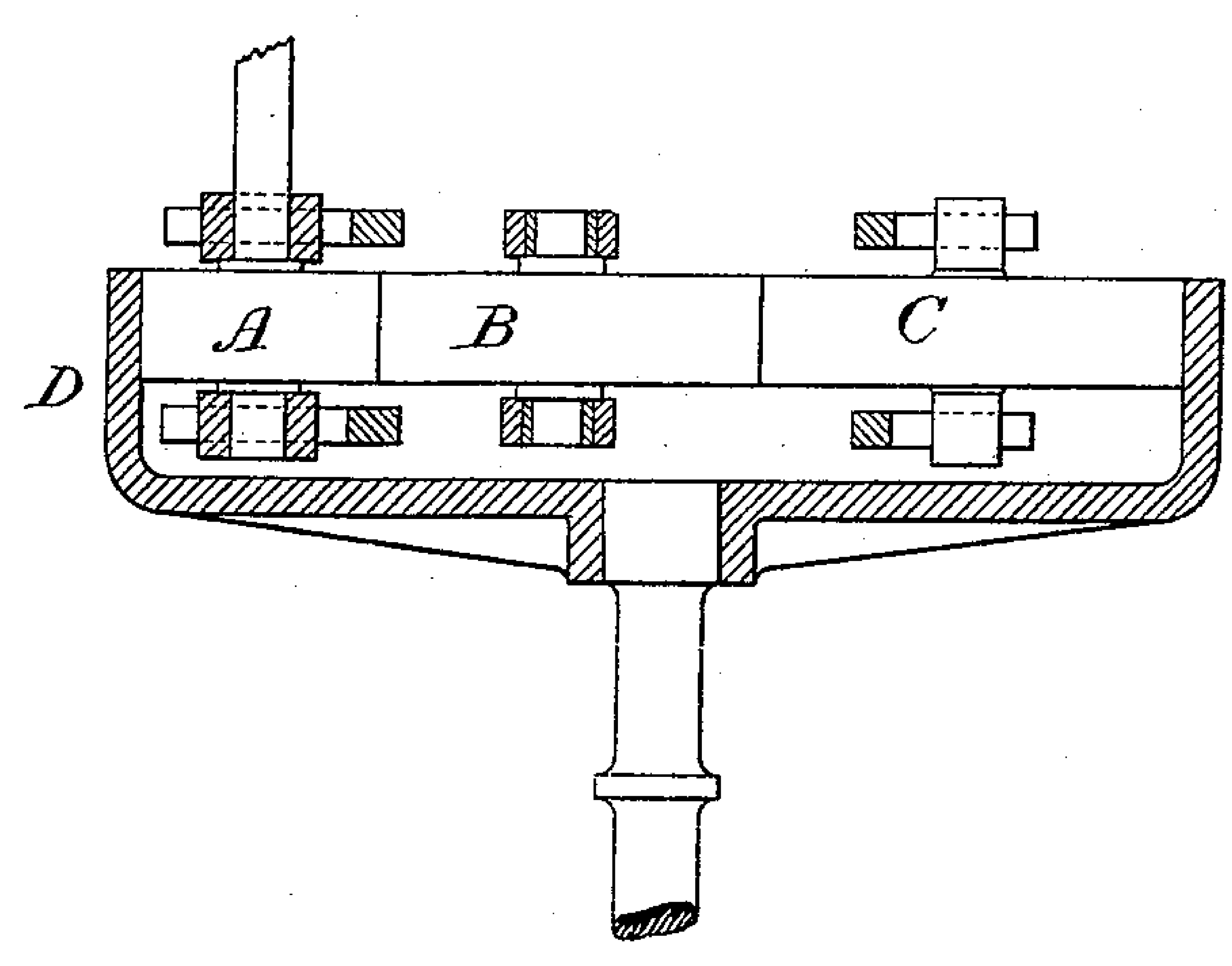


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Fig. 6.

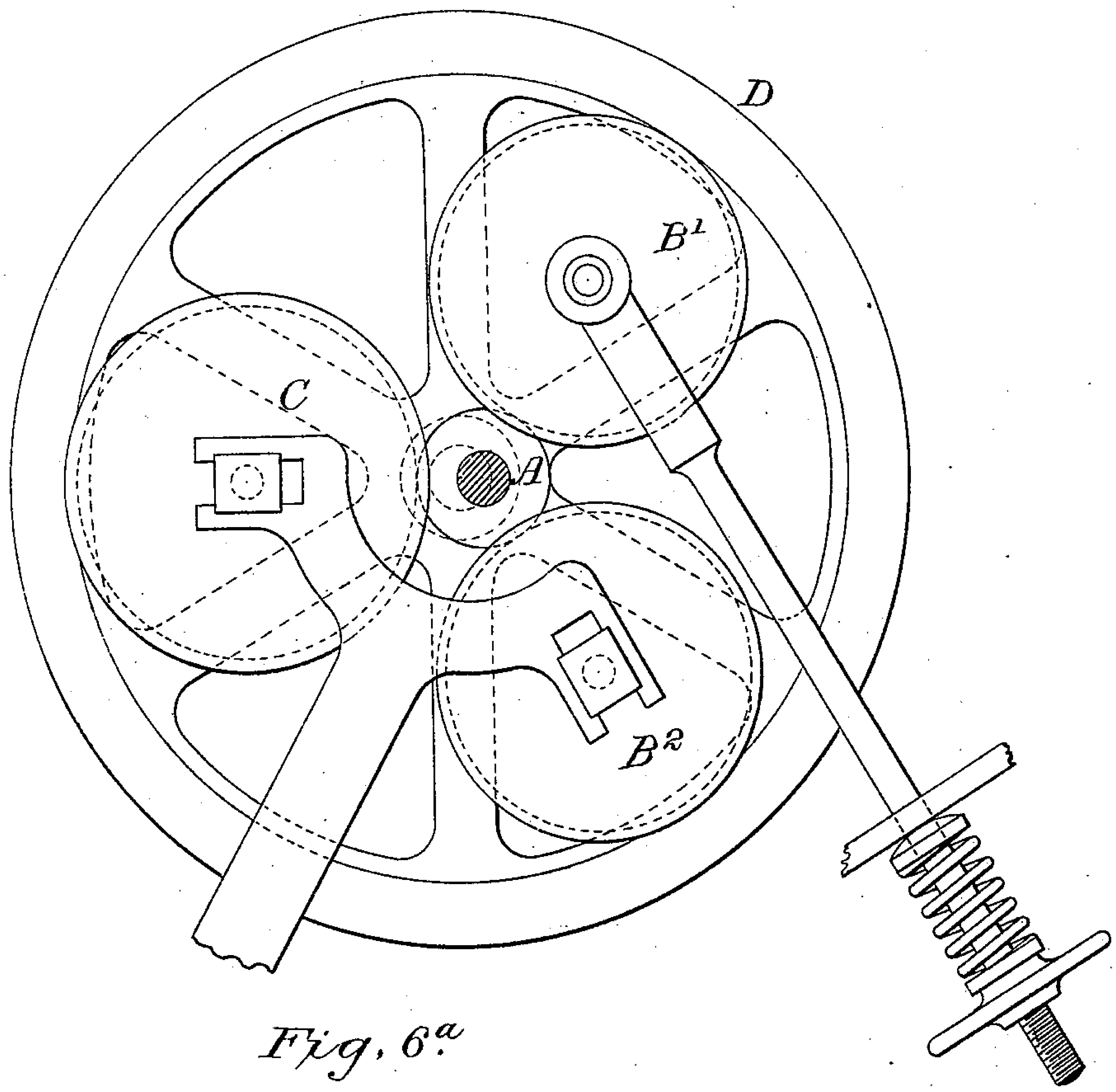

Fig. 6a.

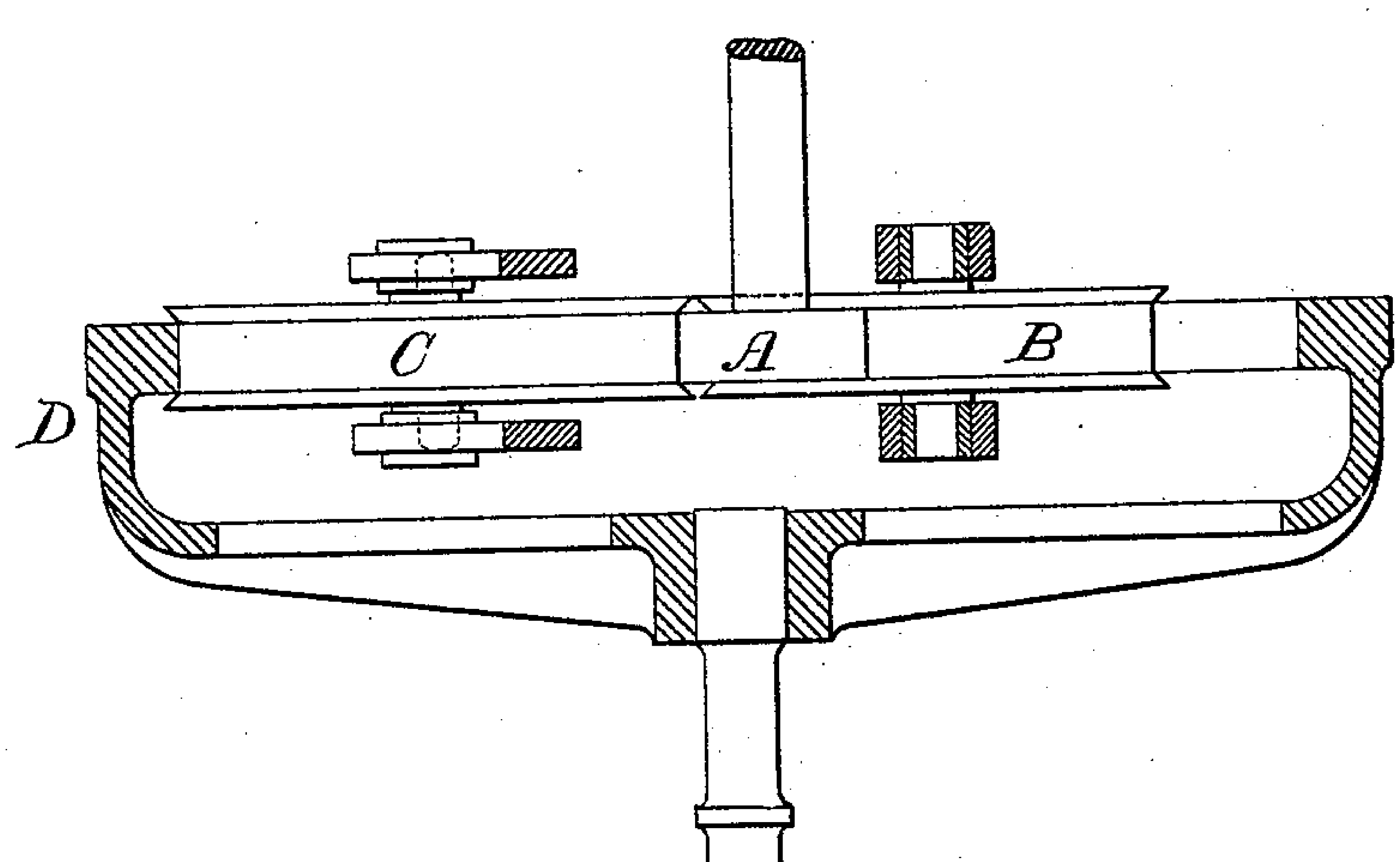

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Fig. 7.

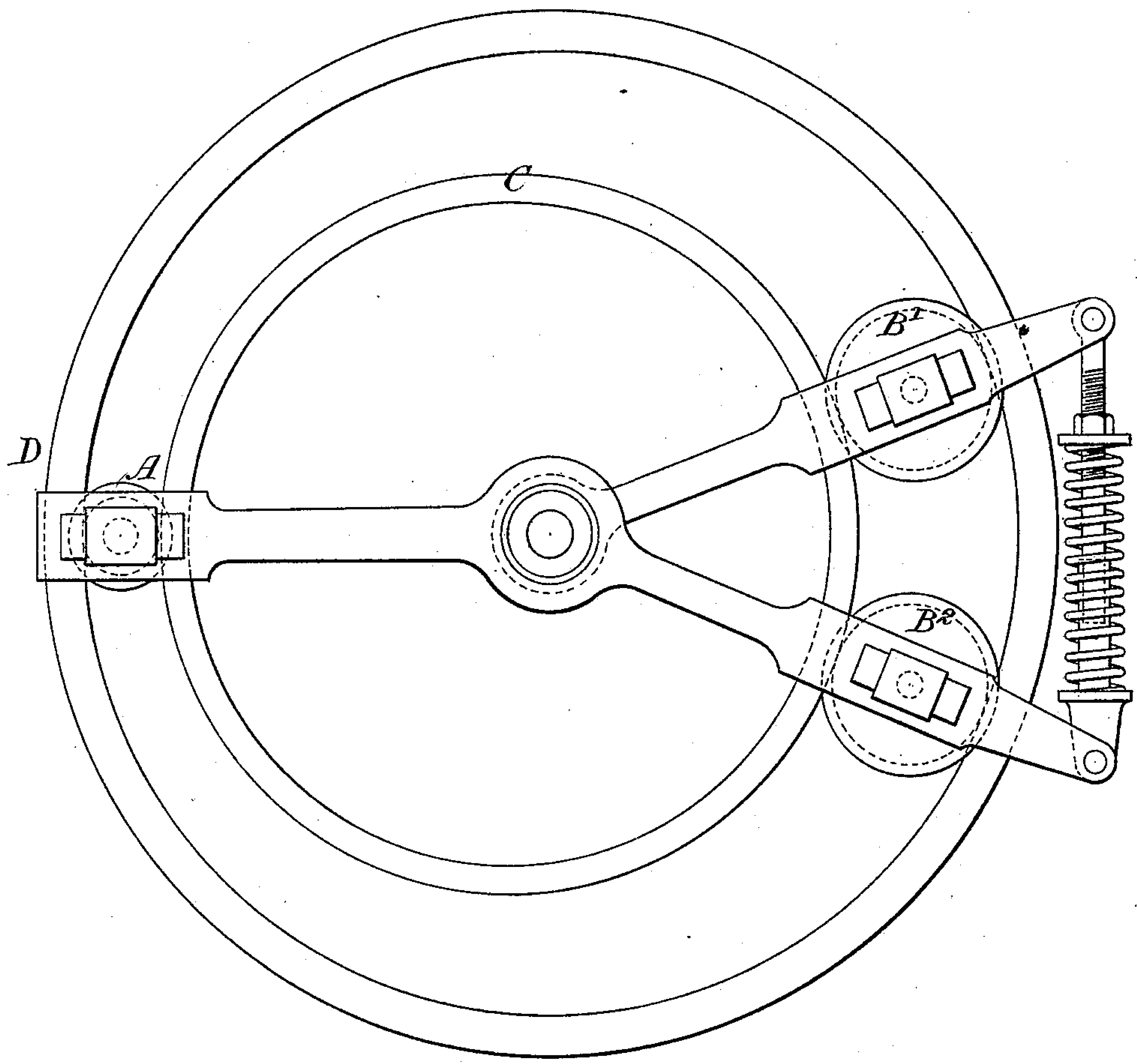
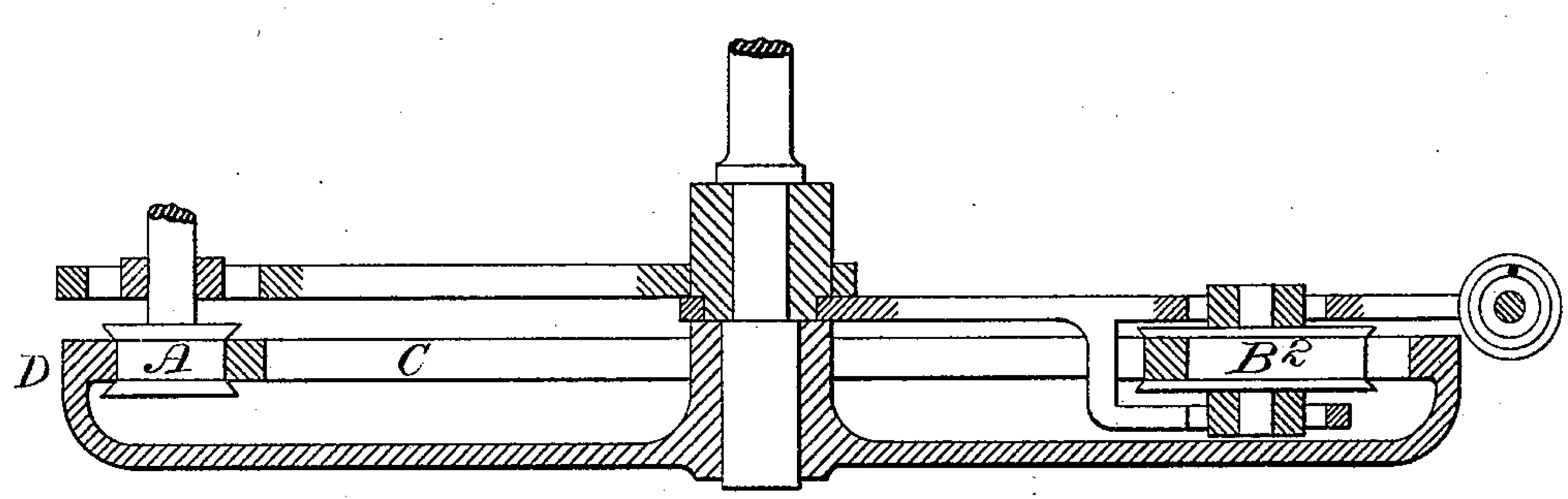


Fig. 7a.



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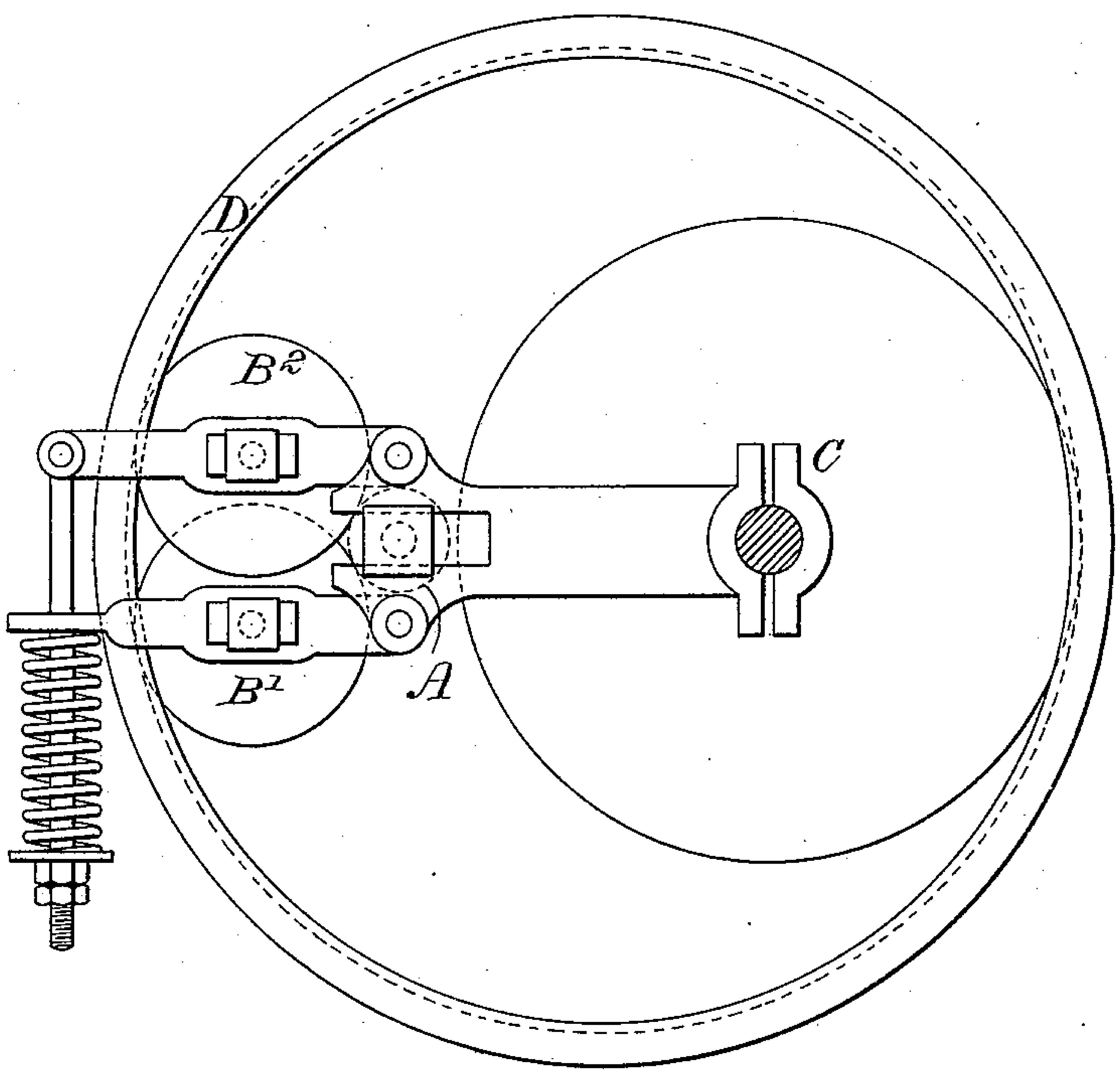
Fig, 8.



Fig, 8a.

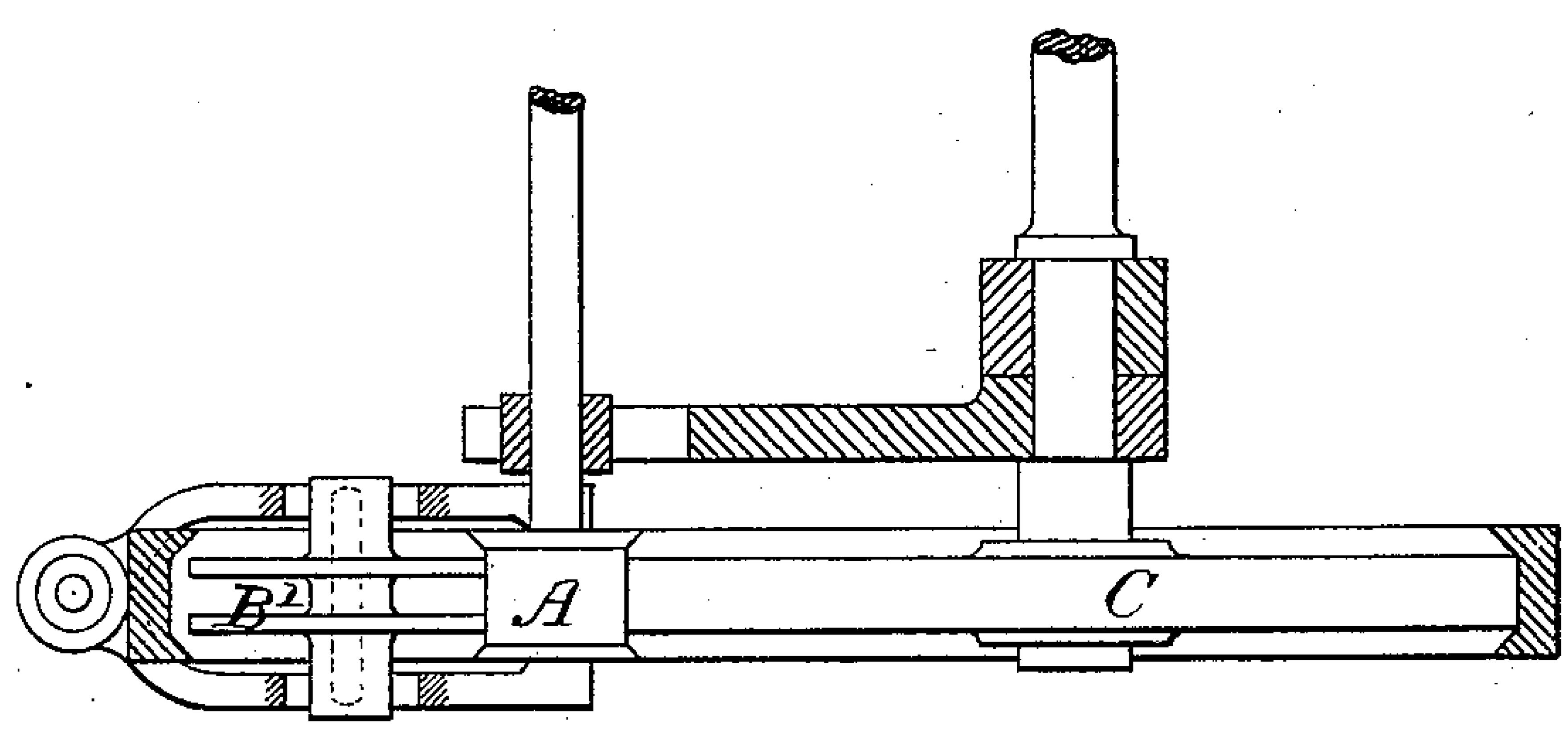


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Fig. 9.

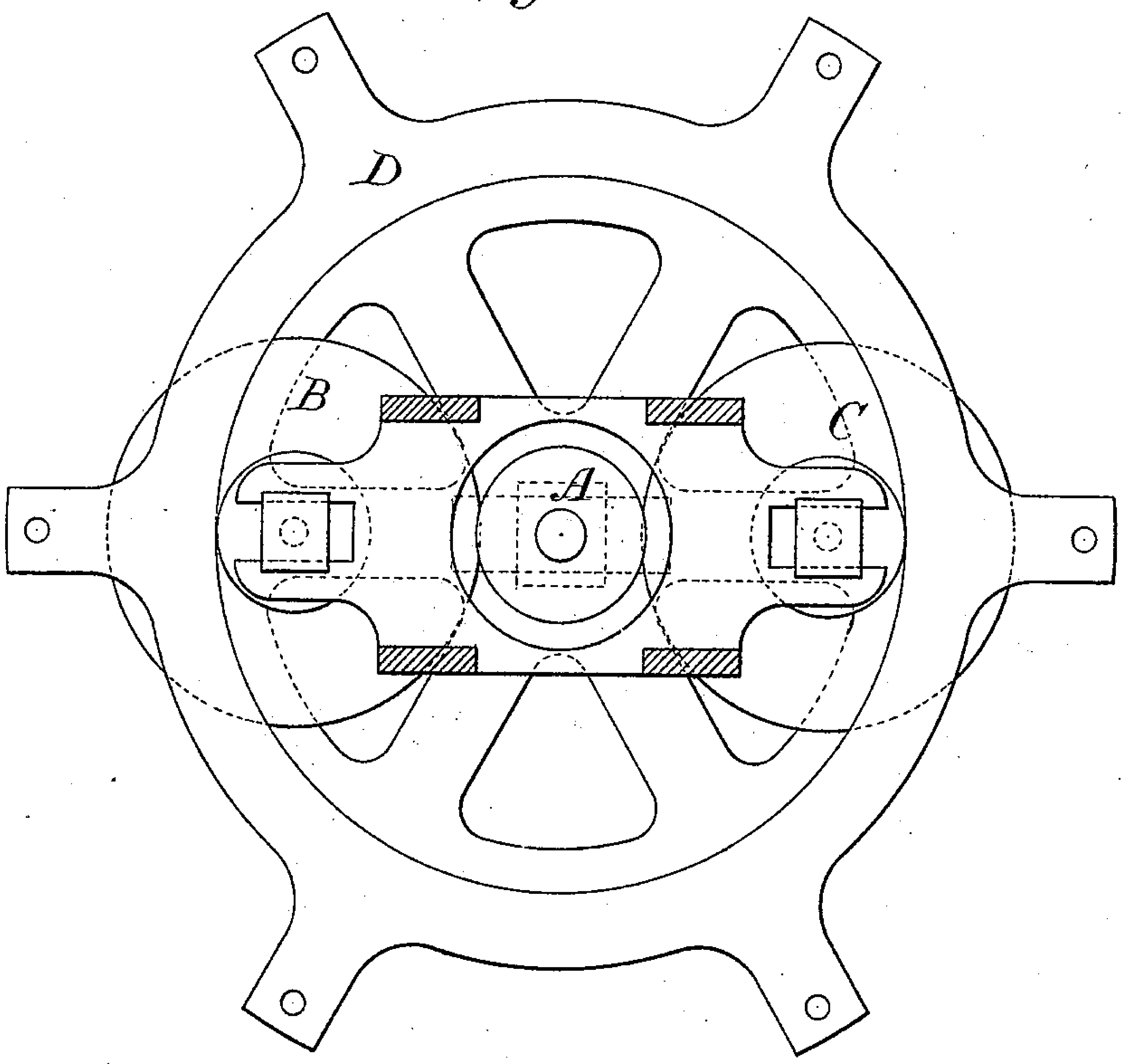
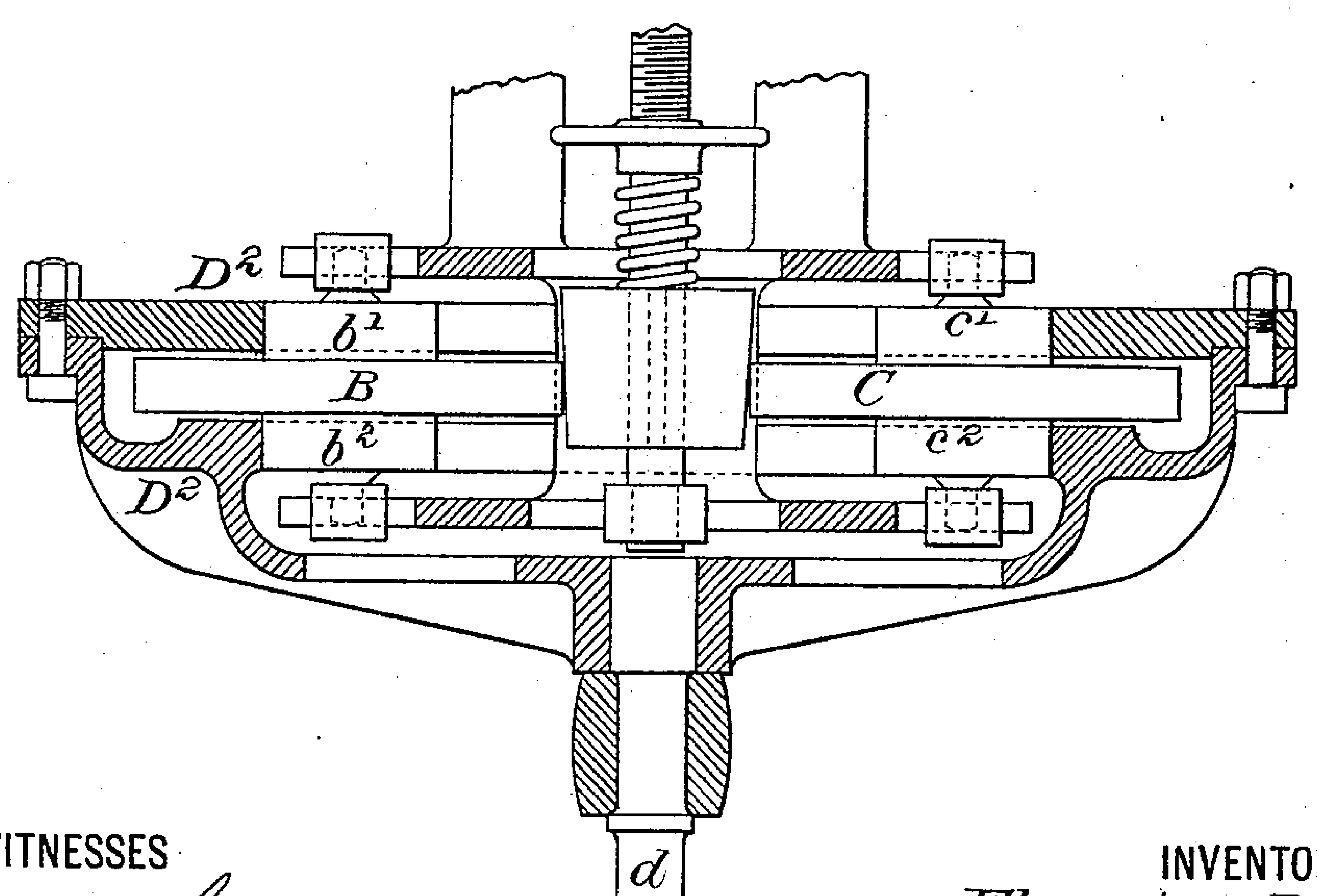


Fig. 9.ª



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Fig, 10.

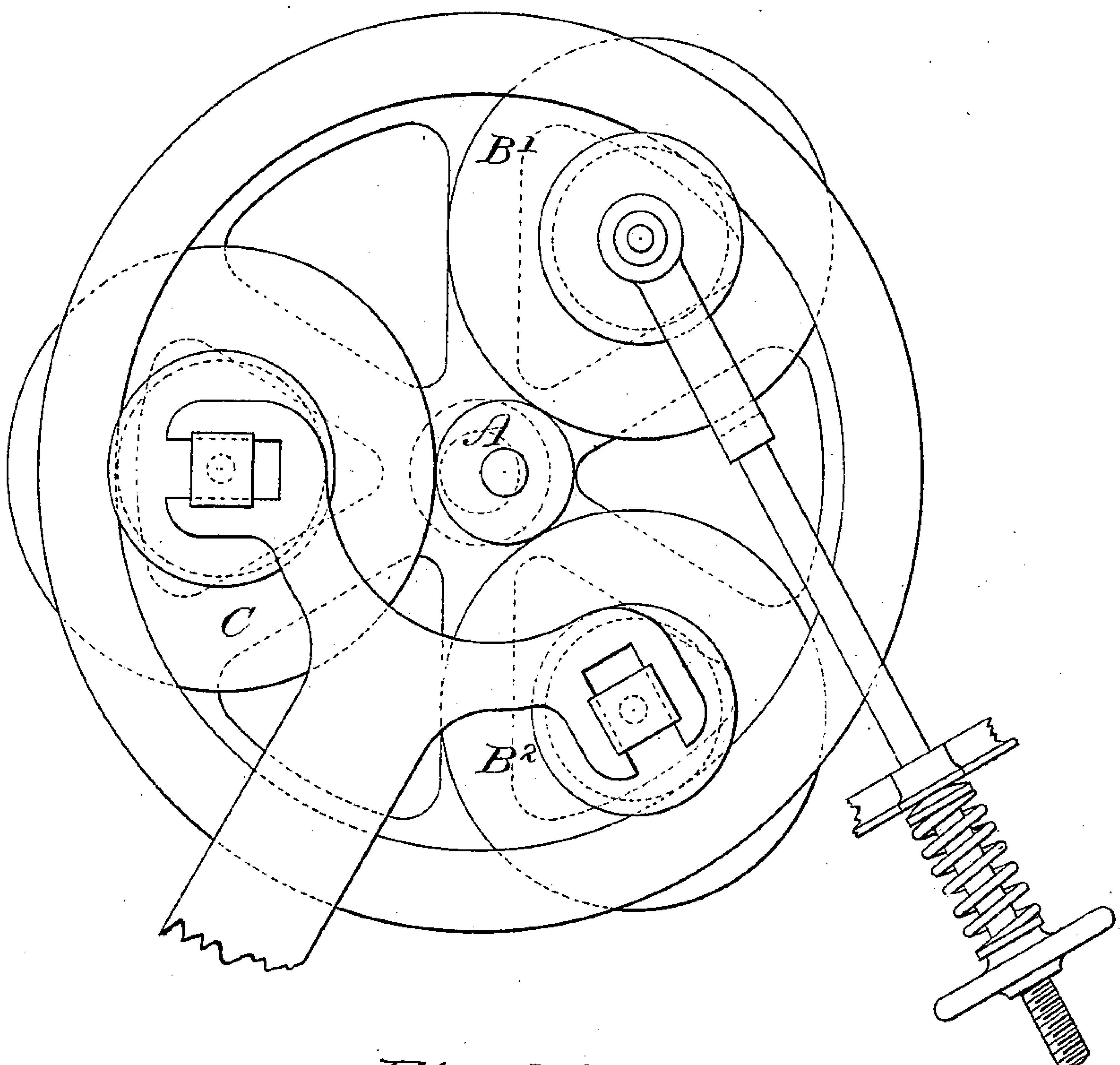

Fig. 10.a

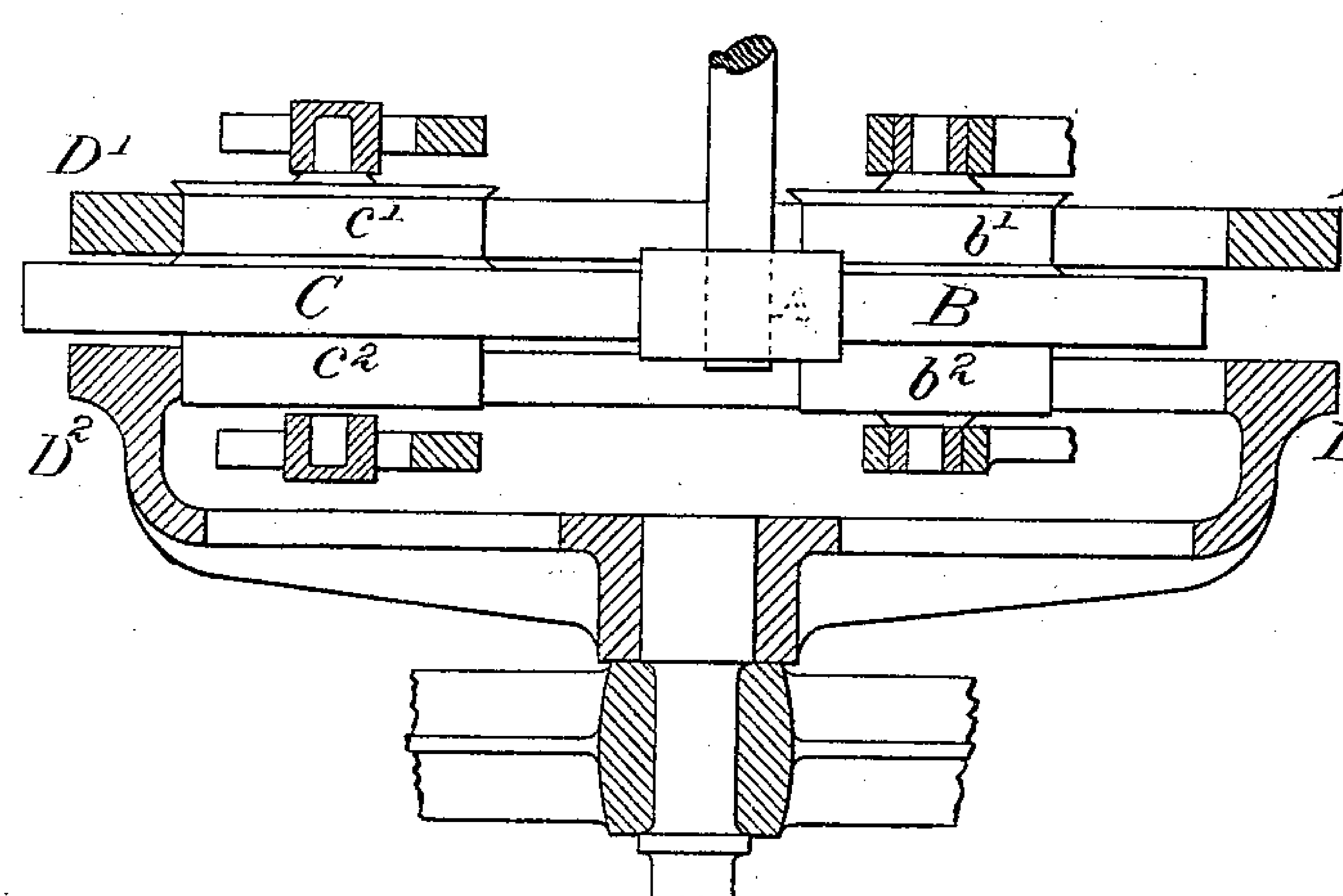

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Fig. 11.

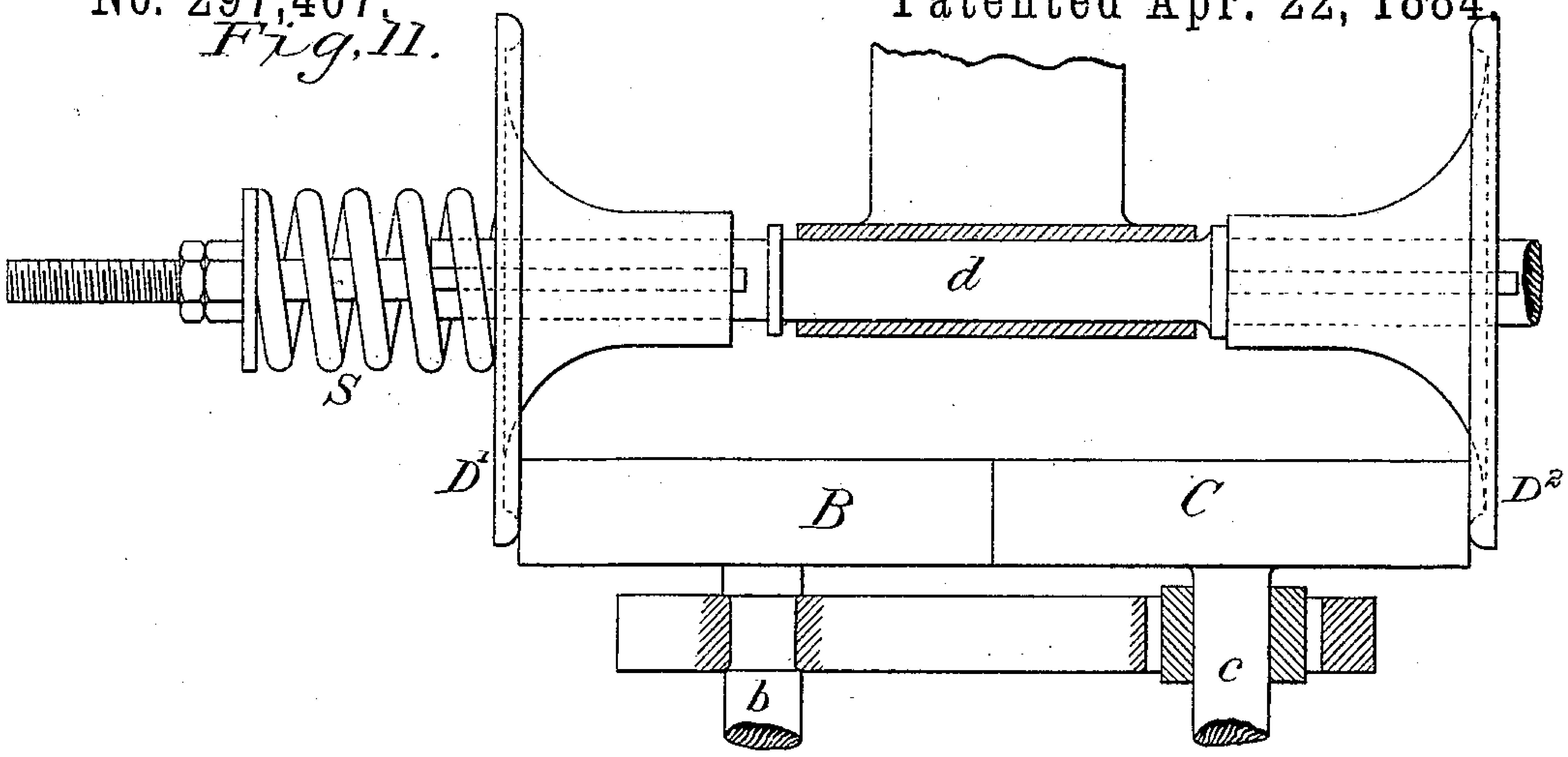

Fig. 12.

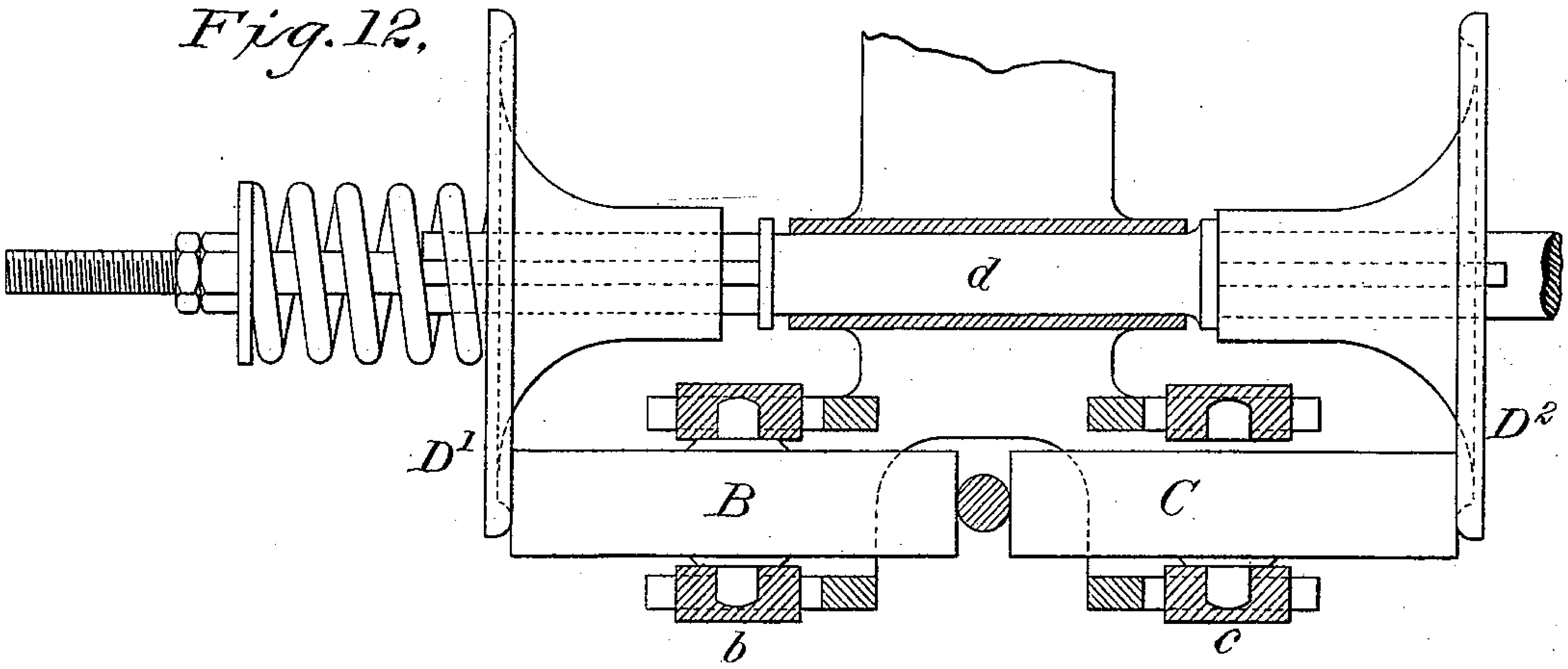

Fig. 13.

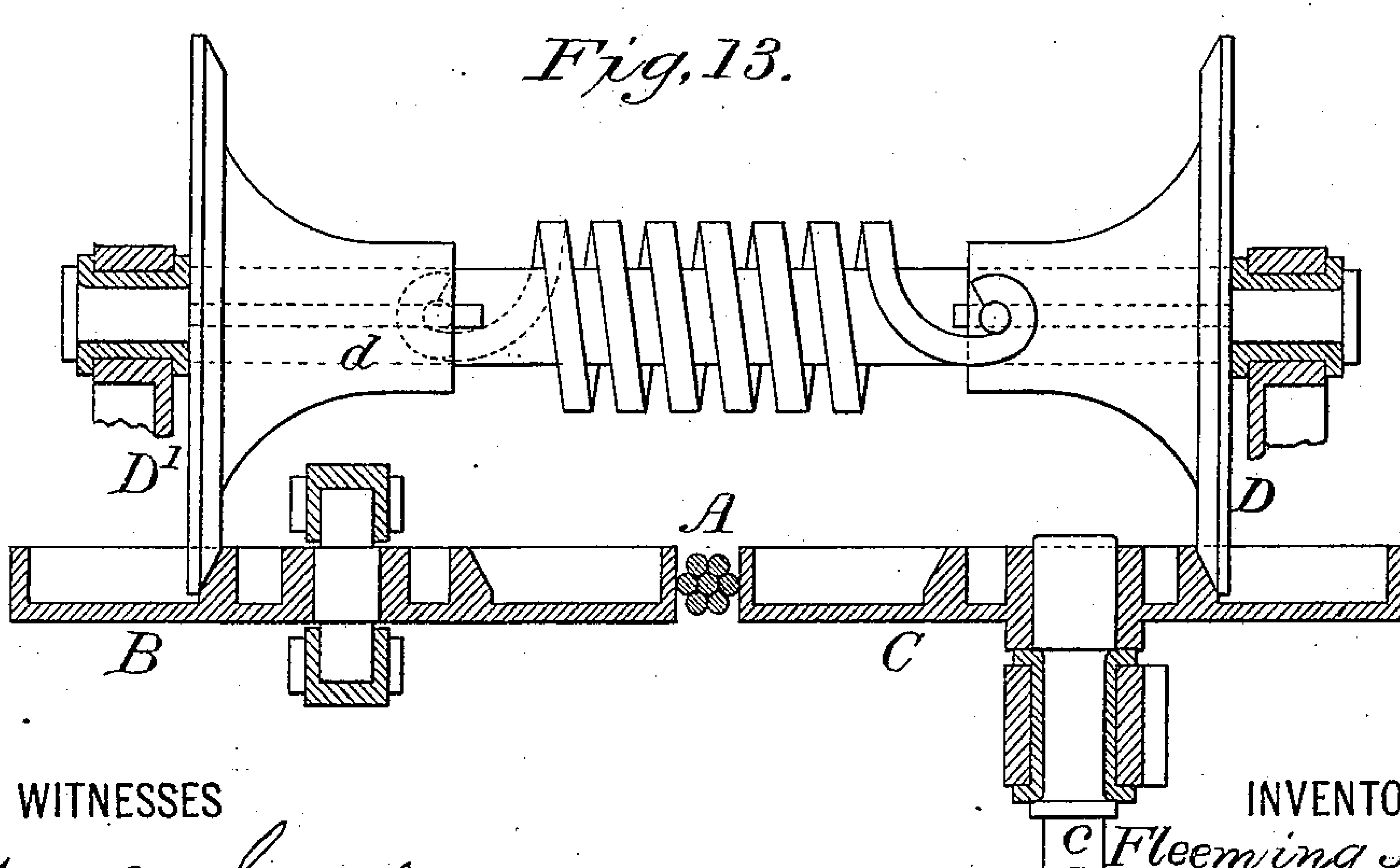

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Fig. 14.

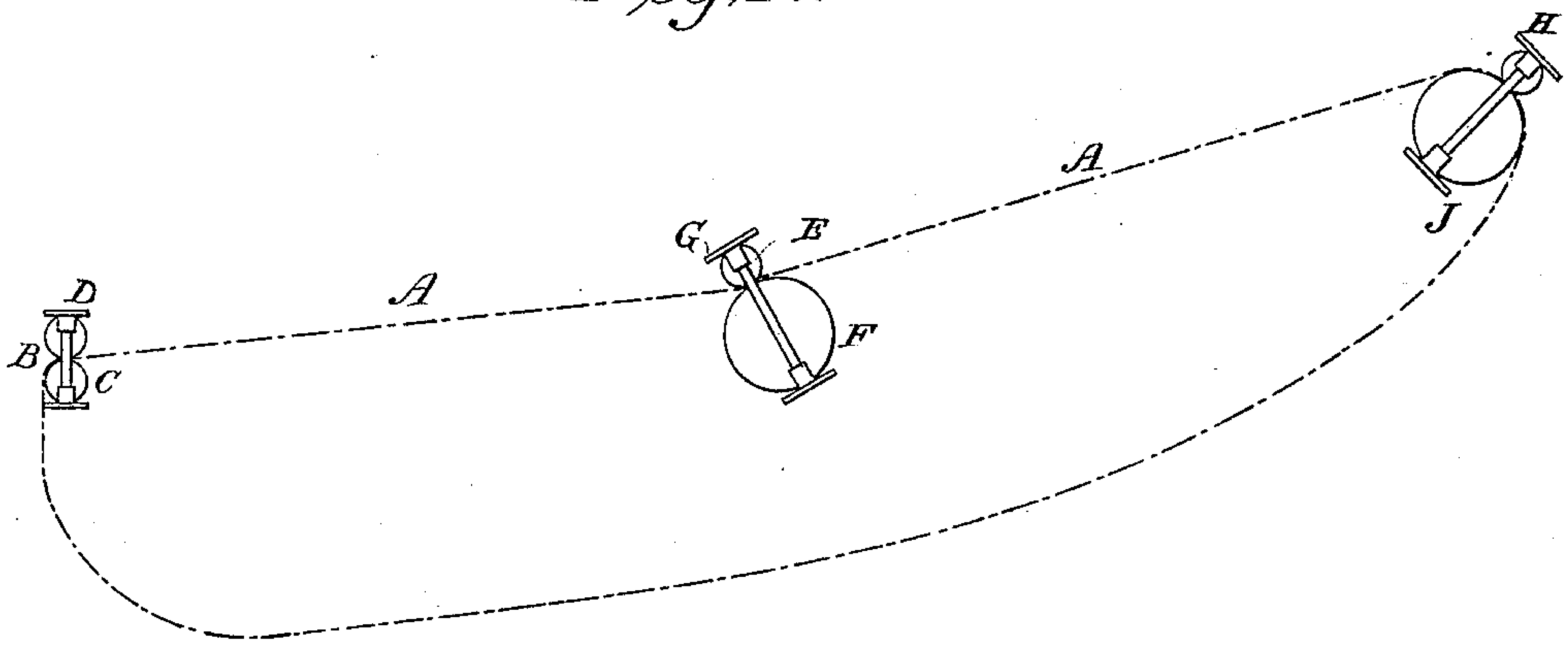
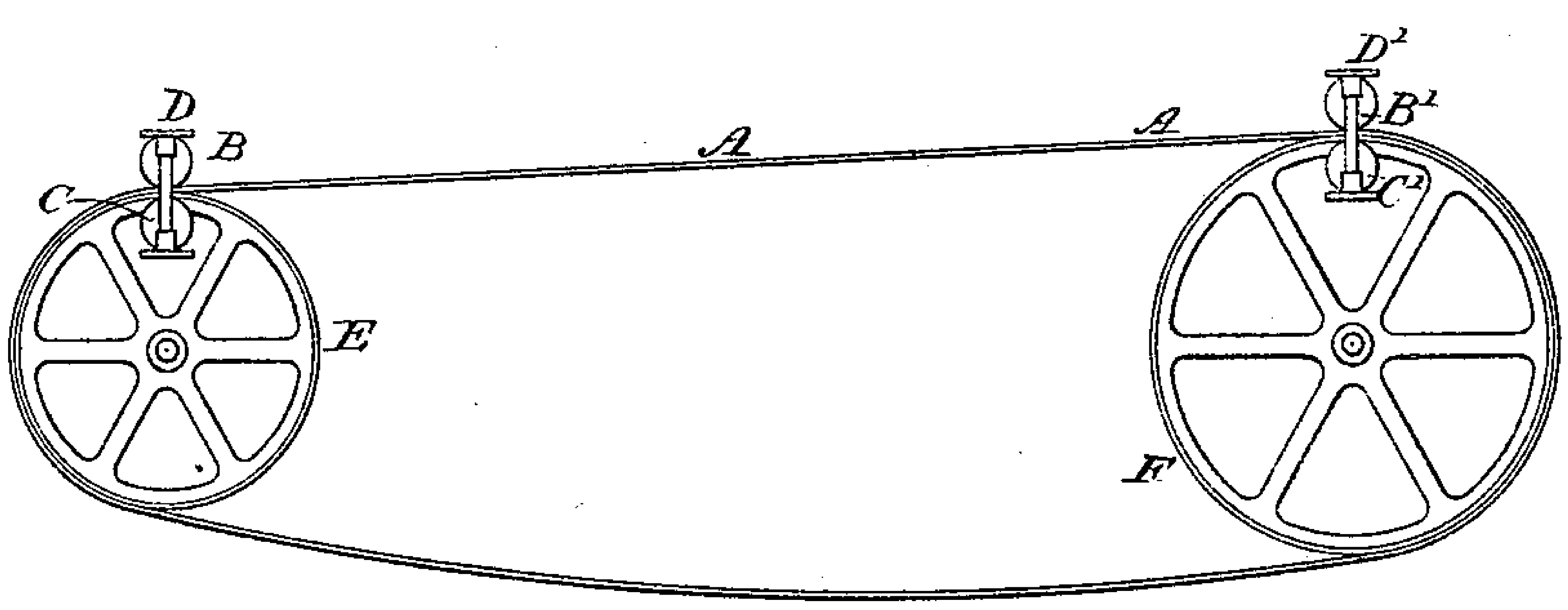


Fig. 15.



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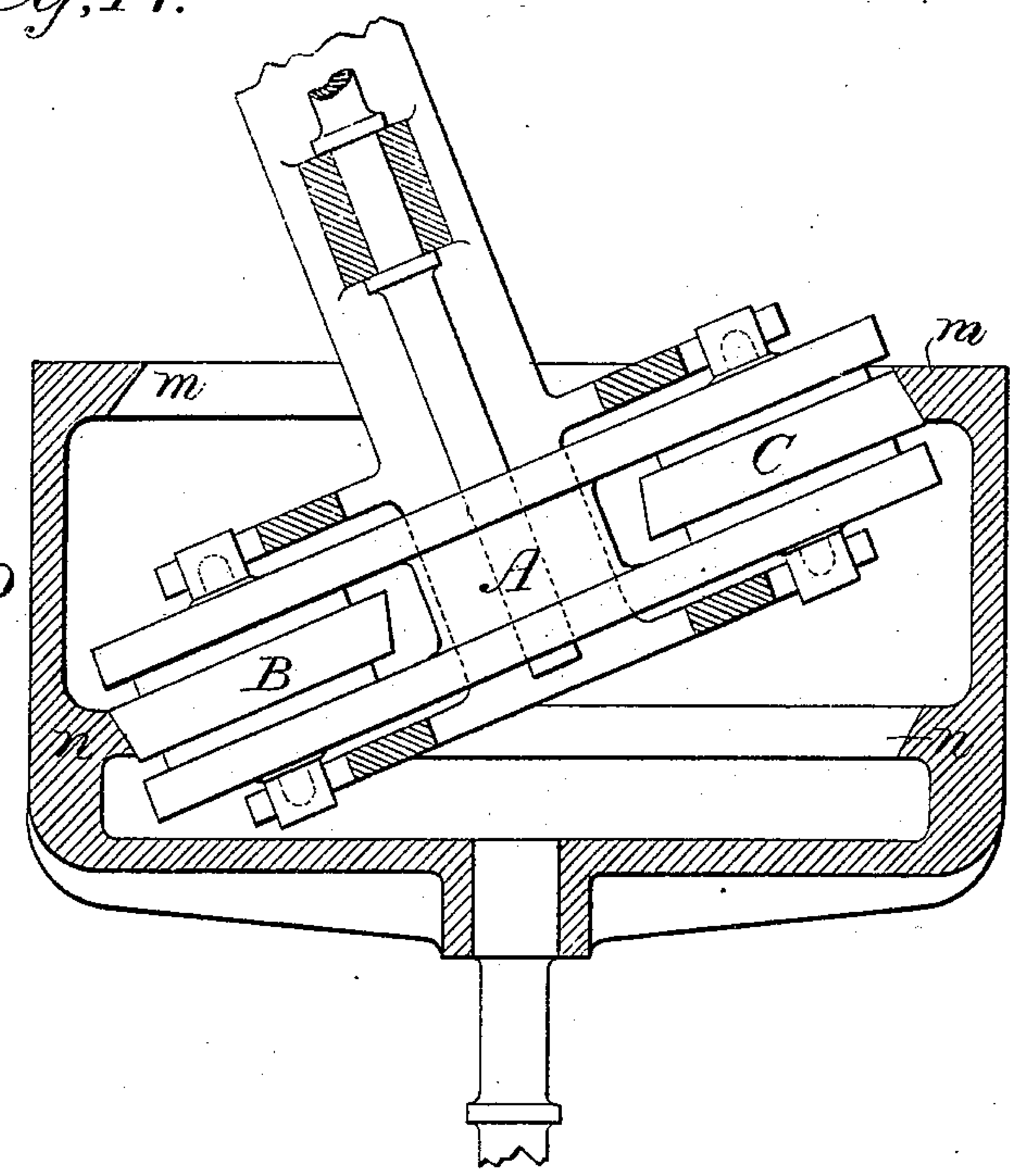
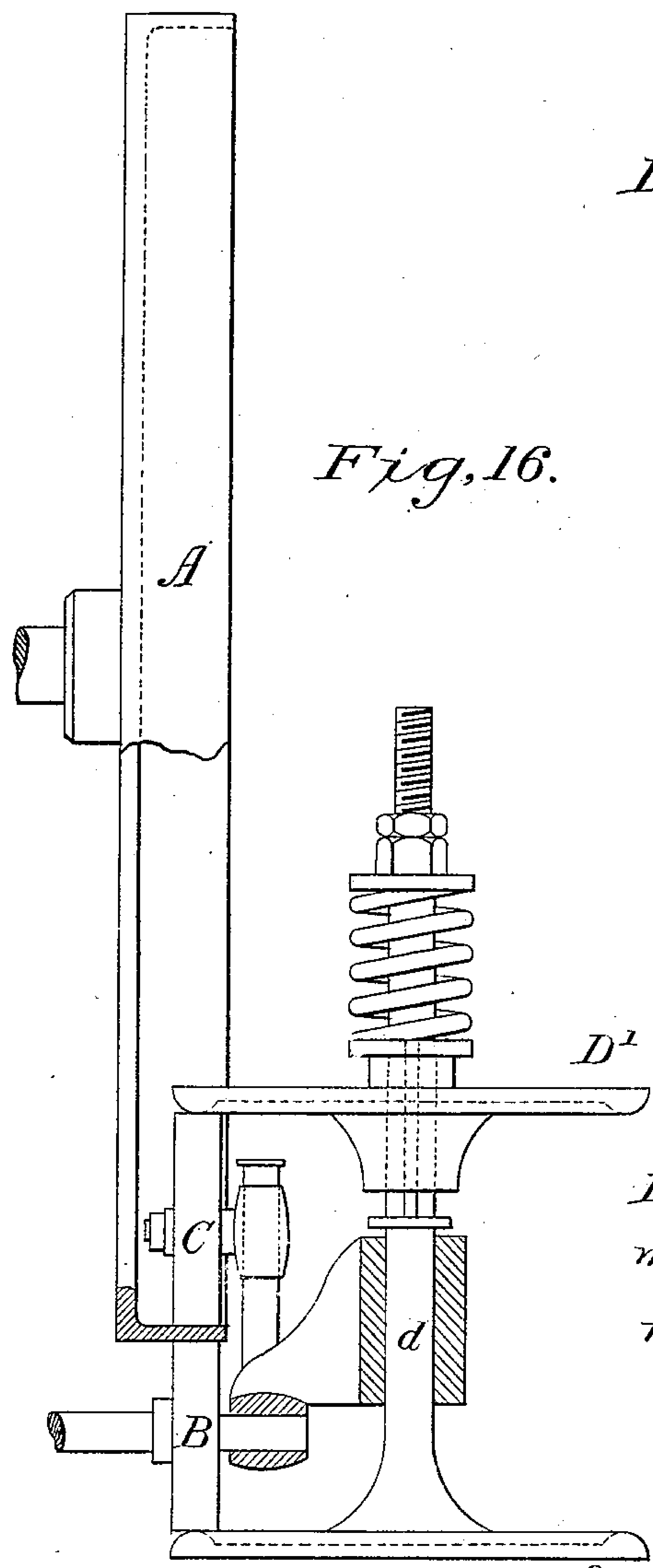
Fig, 17.



Fig, 16.



Fig, 17.a

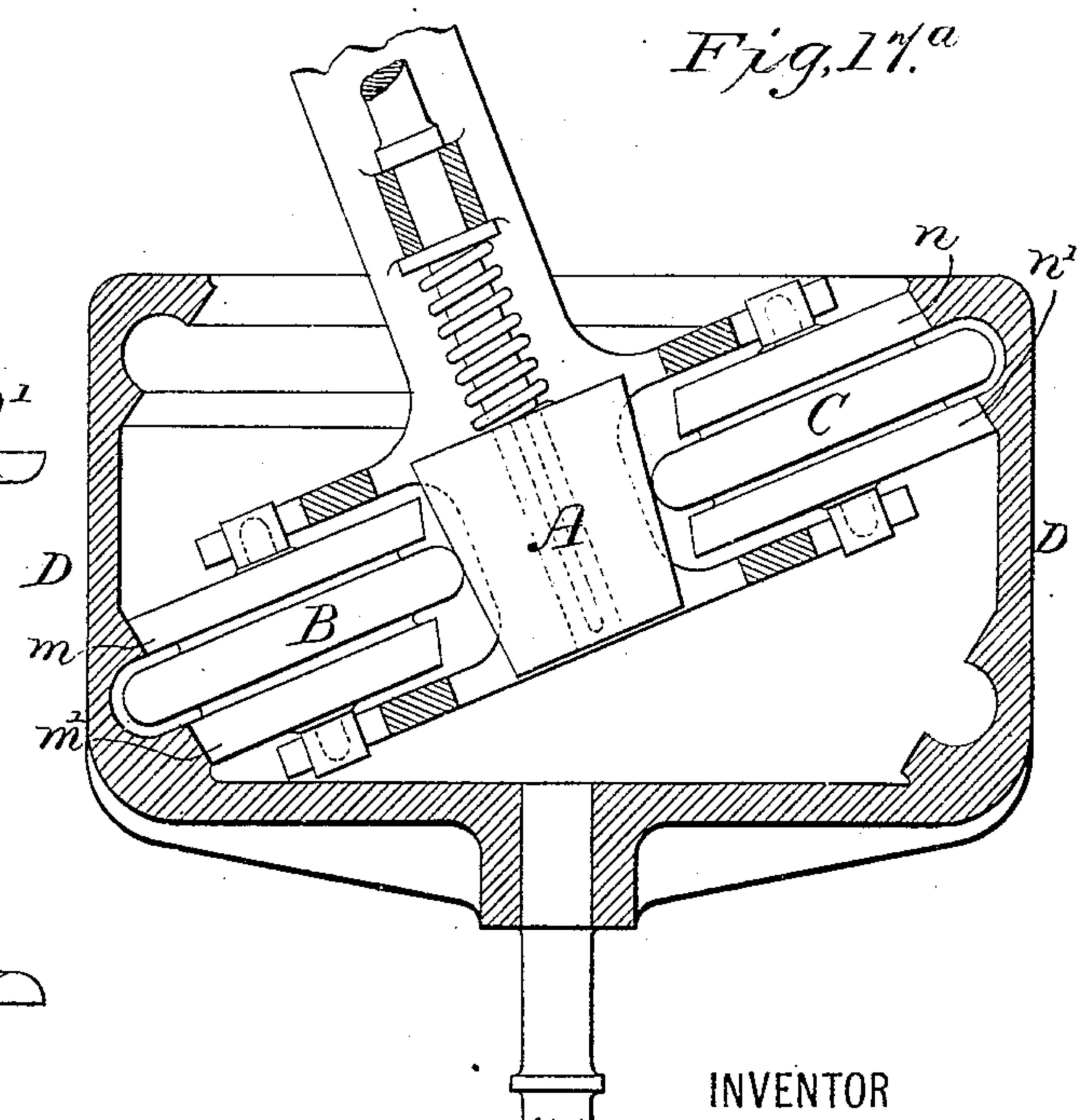


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Fig. 19.

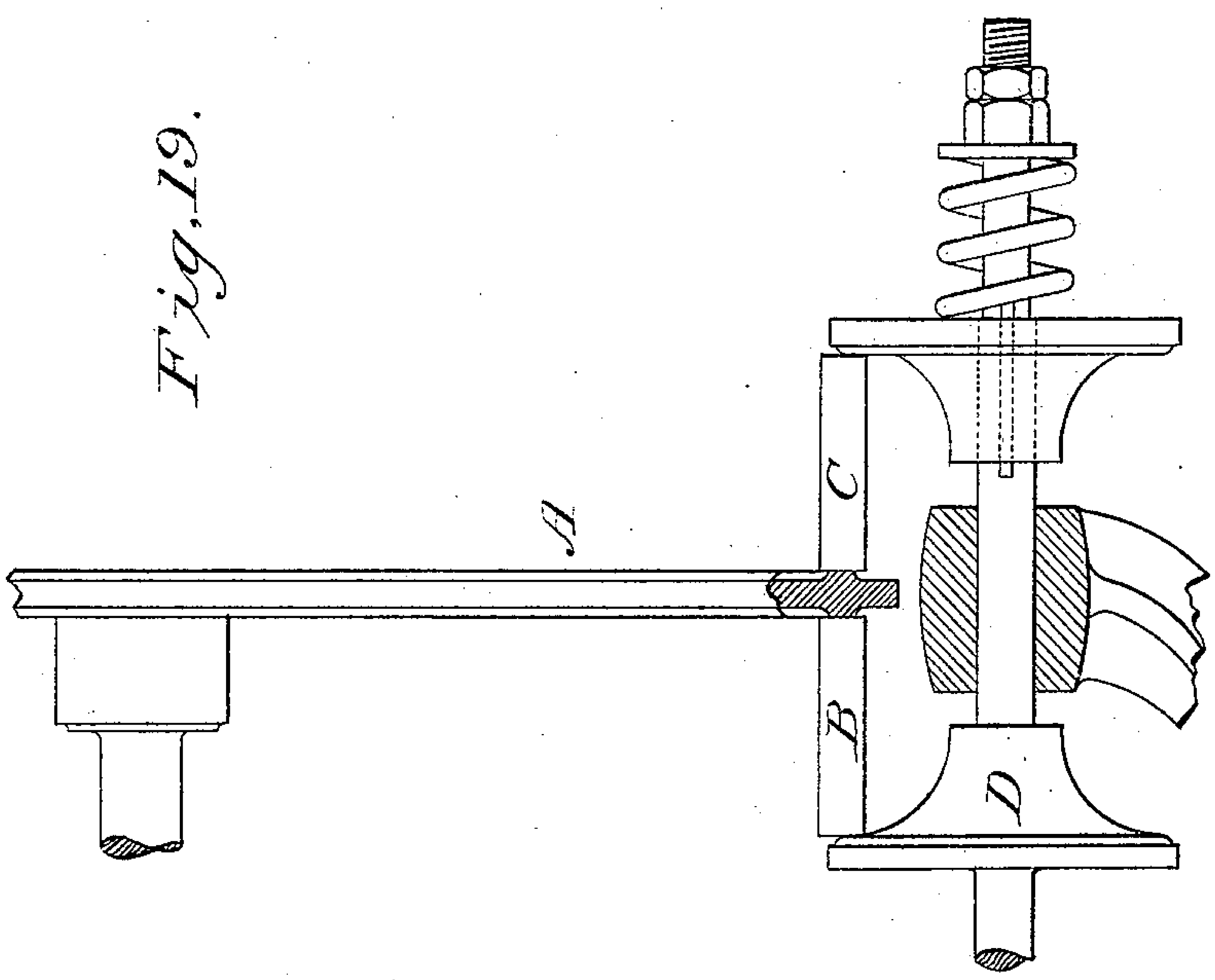
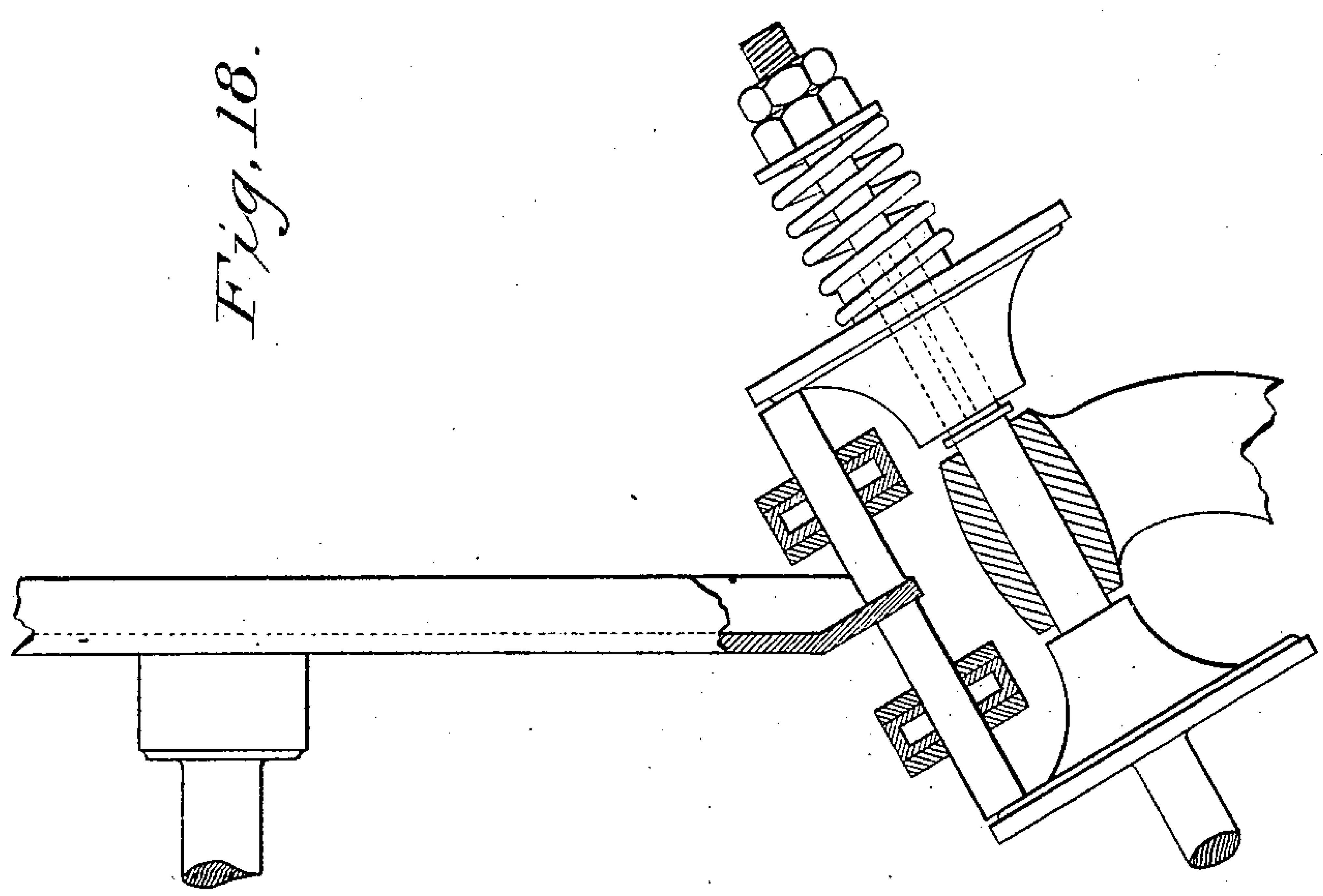


Fig. 18.



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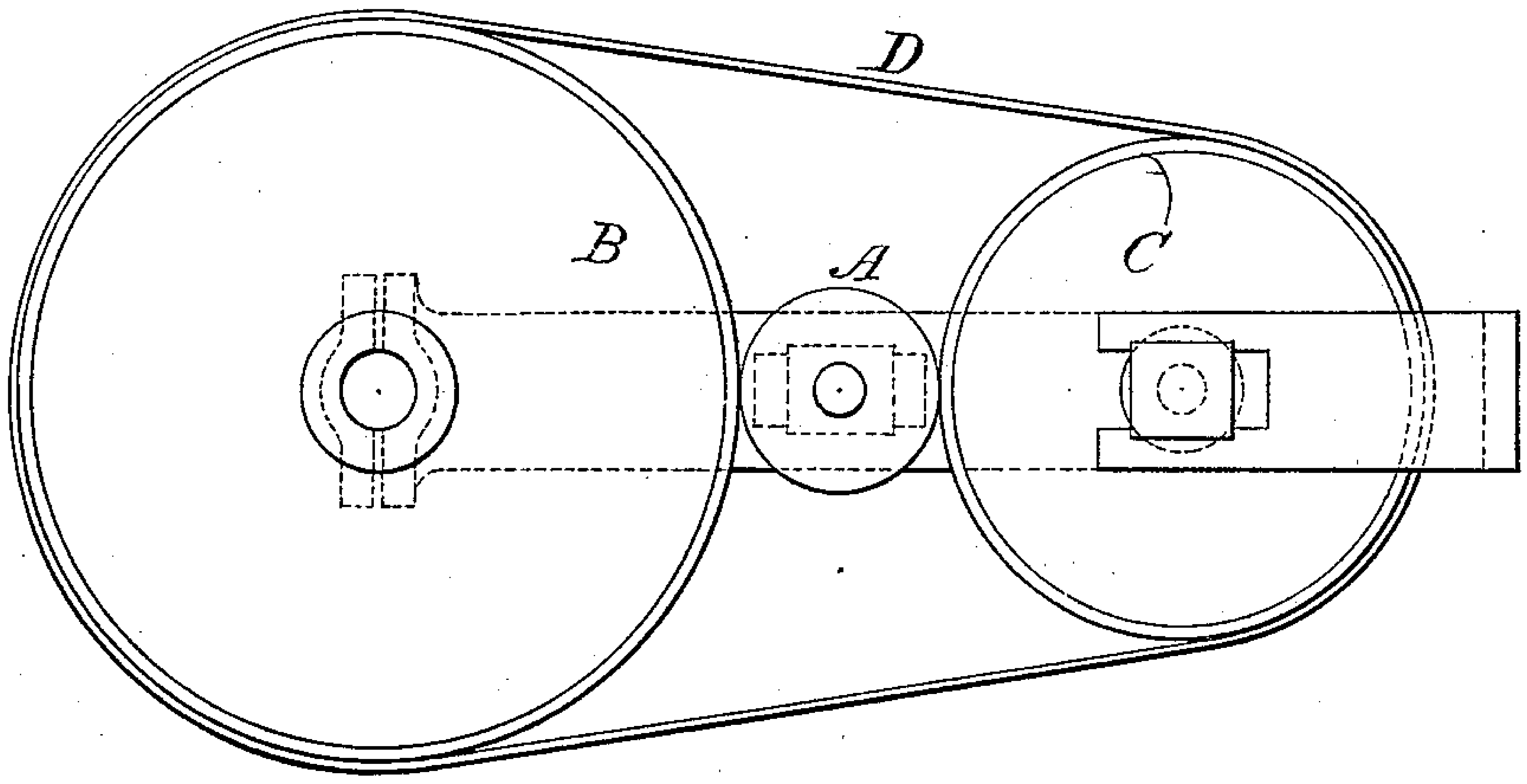
Fig, 20.



Fig, 20a.

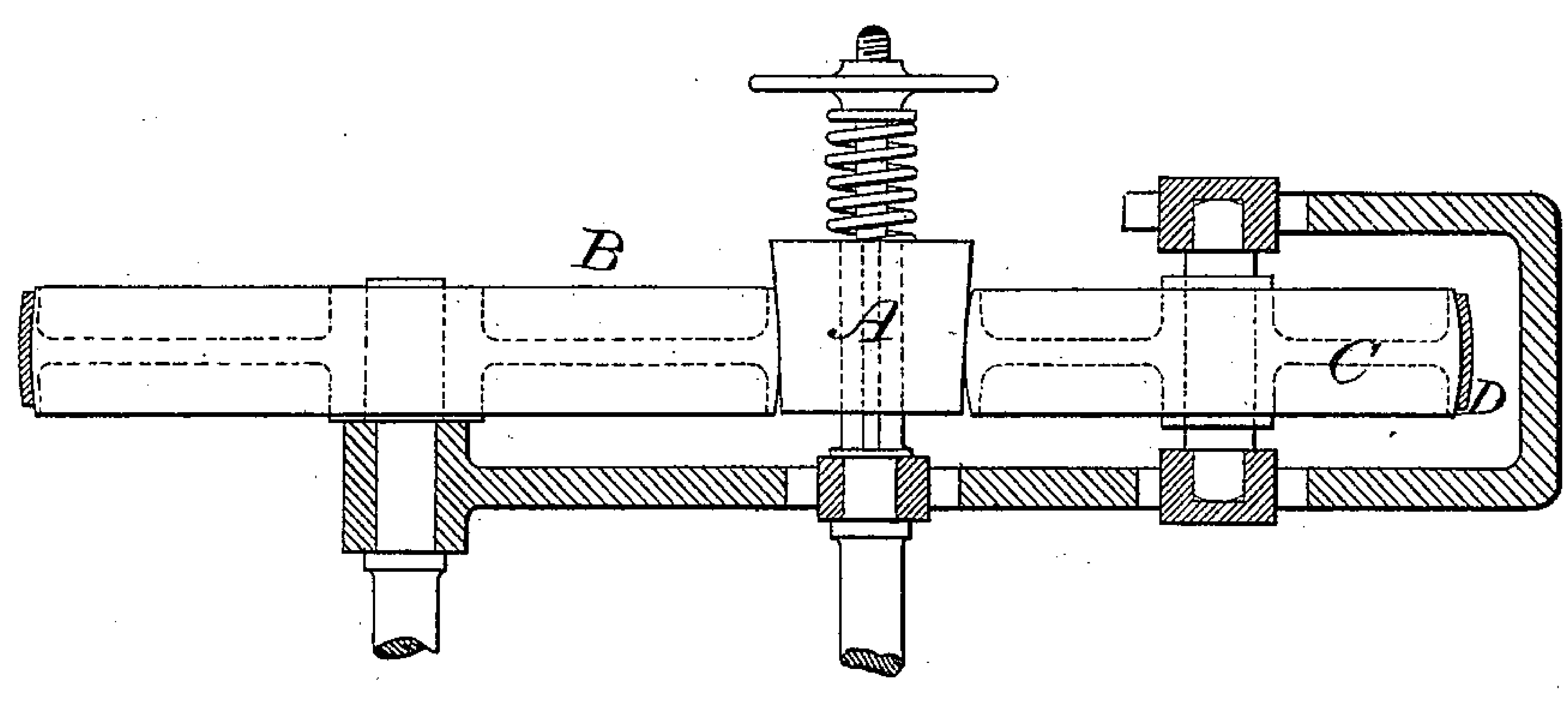


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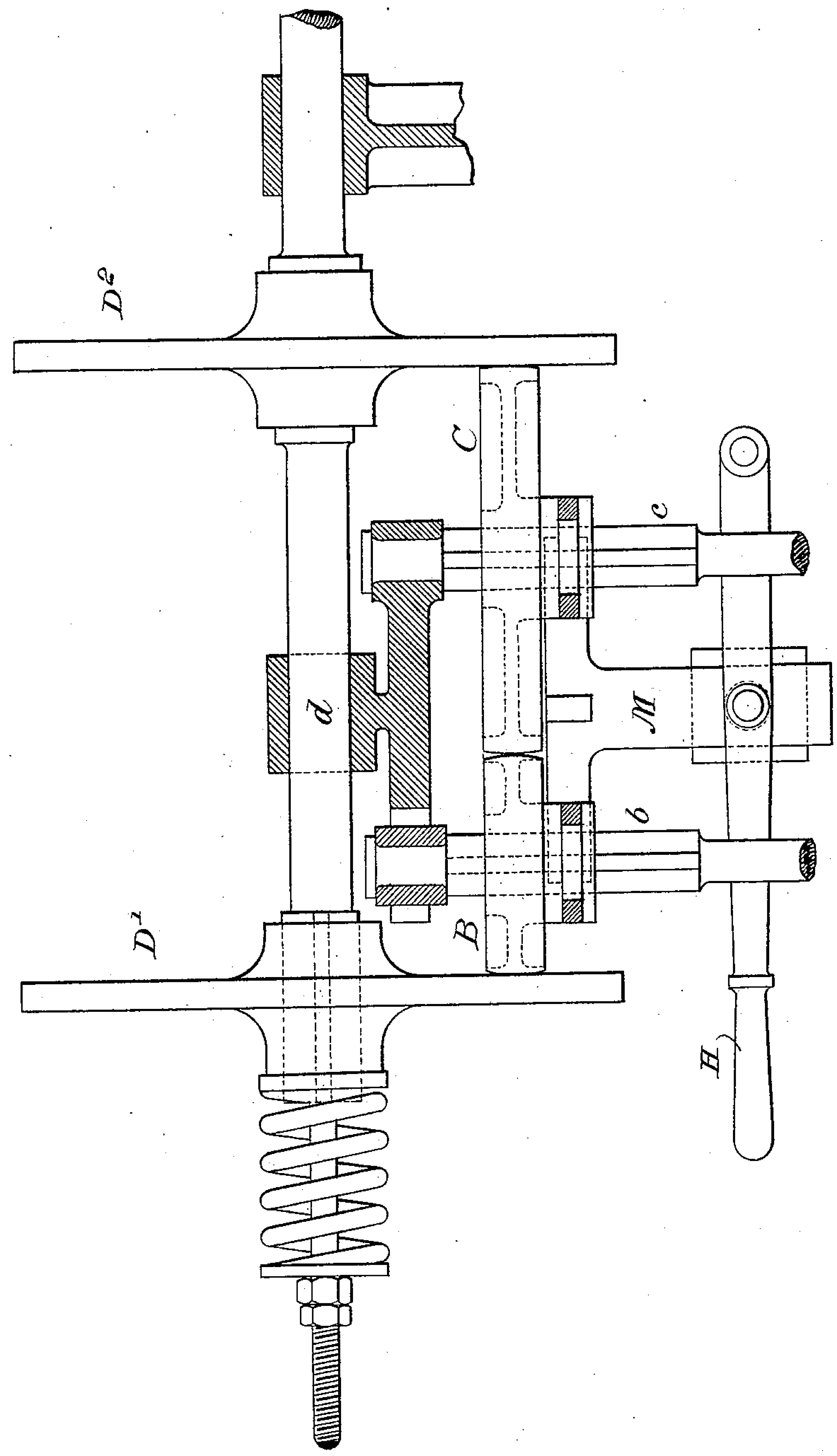
Fig. 22.



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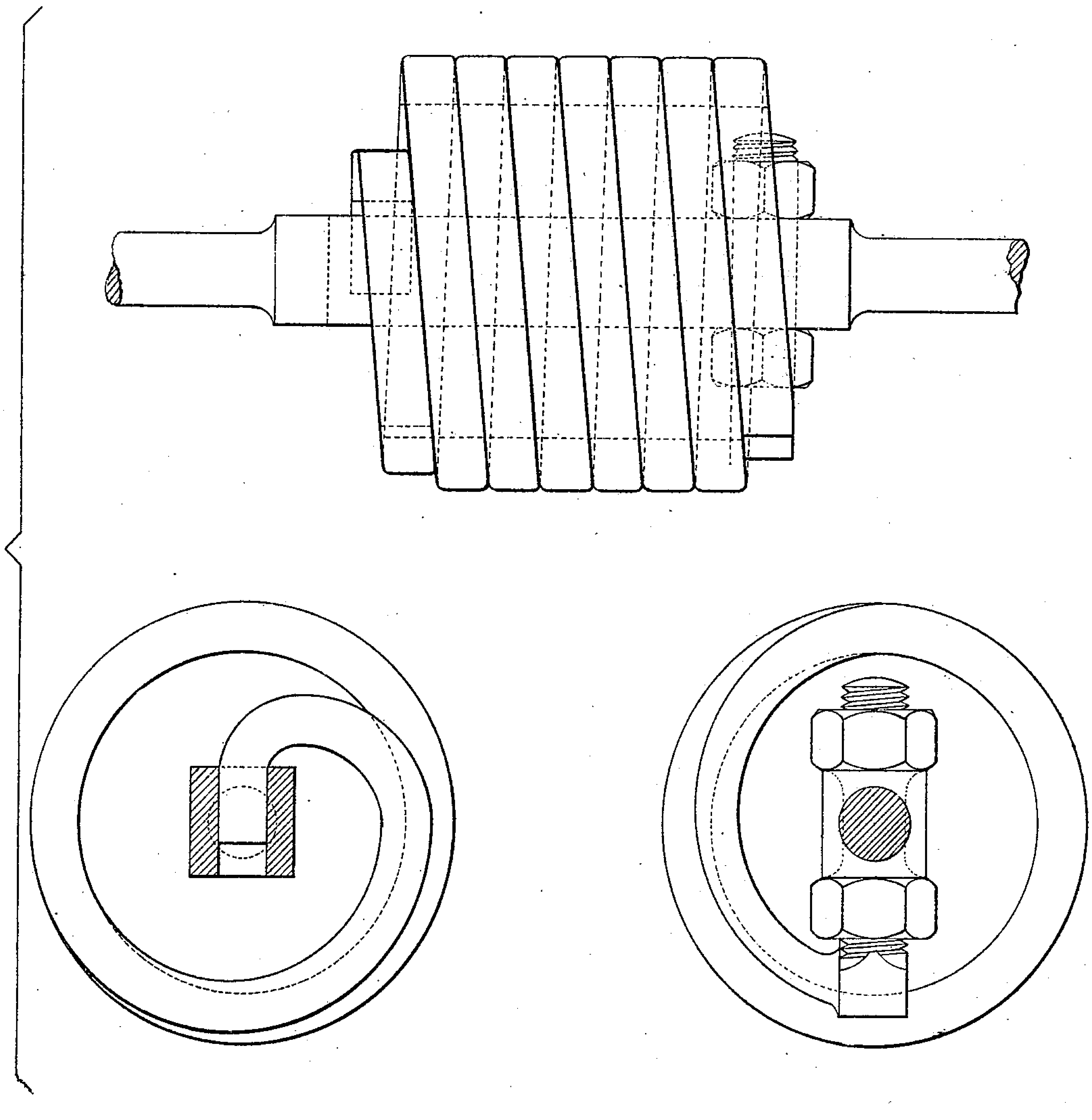

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UNITED STATES PATENT OFFICE.

FLEEMING JENKIN, OF EDINBURGH, SCOTLAND.

DRIVING-GEAR.

SPECIFICATION forming part of Letters Patent No. 297,407, dated April 22, 1884.

Application filed July 12, 1883. (No model.) Patented in England April 14, 1883, No. 1,913; in France May 21, 1883, No. 155,568; in Austria August 16, 1883, No. 20,212, and in Belgium December 10, 1883, No. 63,486.

To all whom it may concern:

Be it known that I, FLEEMING JENKIN, a subject of the Queen of Great Britain, residing at 3 Great Stuart Street, Edinburgh, Scotland, have invented certain new and useful Improvements in Driving-Gear, (for which I have received Letters Patent in Great Britain, No. 1,913, dated April 14, 1883; in France, No. 155,568, dated May 21, 1883; in Austria, No. 20,212, dated August 16, 1883, and in Belgium, No. 63,486, dated December 10, 1883,) of which the following is a specification.

My invention has for its object the diminution of the loss by friction in transmitting power by gearing, and in many cases subsidiary advantages would follow its adoption. When toothed wheels are employed, unnecessary friction takes place, chiefly at the surfaces of the teeth. Noise and liability of breakage are further disadvantages of toothed gearing. When belting is employed, unnecessary friction takes place, chiefly at the bearings. There is also a loss from the bending of the belts, and there is a difficulty in regulating their tension. When what is sometimes called "frictional gearing" is used, such that the transmission of power depends on the friction between two solid wheels, usually grooved still more unnecessary friction is caused at the bearings, and the conical grooves usually employed cause a loss by grinding at their surfaces. None of these defects are found in nest-gearing. My invention applies only to gearing consisting of circular wheels or circular wheels and racks, which racks may, however, be flexible. It does not apply to toothed wheels or to frictional gearing the pitch-surfaces of which are elliptical or spiral or other non-circular forms. In all the varieties hereinafter described the improvement is obtained by the application of one common system—namely, the reduplication of parts so arranged that the pressure required to produce adhesion by friction shall not cause pressure to be put on the bearings. I have given the name of "nest-gearing" to gearing made in accordance with my invention.

I will proceed to describe a number of varieties of nest-gearing, all designed in accordance with my system, and shown in the accompanying drawings, in which—

Figure 1 is a plan view, partly in section, and Fig. 1ª a view partly in elevation and partly in section, showing one form of nest-gearing. Fig. 2 is a plan, and Fig. 2ª a view partly in elevation and partly in section, of a modification. Fig. 3 is a view partly in elevation and partly in section of another modification. Fig. 4 is a plan view, partly in section, and Fig. 4ª a view partly in elevation and partly in section, of another modification. Fig. 5 is a plan view, partly in section, and Fig. 5ª a view partly in elevation and partly in section, of another modification. Fig. 6 is a plan view, partly in section, and Fig. 6ª a view partly in side elevation and partly in section, of another modification. Fig. 7 is a plan and Fig. 7ª a view partly in elevation and partly in section, of another modification. Fig. 8 is a plan view, partly in section, and Fig. 8ª a view partly in elevation and partly in section, of another modification. Fig. 9 is a plan view, partly in section, and Fig. 9ª a view partly in elevation and partly in section, of a modified form of gearing. Fig. 10 is a plan, and Fig. 10ª a view partly in elevation and partly in section of another modification. Fig. 11 is a view partly in elevation and partly in section of another modification; Fig. 12, a similar view of another modification; Fig. 13, a similar view of another modification. Fig. 14 is a view in elevation of another modification; Fig. 15, a similar view of another modification. Fig. 16 is a view partly in elevation and partly in section of another modification; Fig. 17, a like view of another modification; Fig. 17ª, a like view of another modification; Fig. 18, a like view of another modification; Fig. 19, a like view of another modification. Fig. 20 is a plan, and Fig. 20ª a view partly in elevation and partly in section, of another modification. Fig. 21 is a plan view of another modification. Fig. 22 is a view partly in side elevation and partly in section of another modification; and Fig. 23 shows a compressible coiled steel roller.

First: In order to multiply or reduce the angular-velocity ratio to such moderate extent as would, with toothed wheels, be effected by a spur-wheel and pinion, I employ, Fig. 1, a smooth roller, A, of small size, working between two smooth cylindrical rollers, B and C. These three rollers are pressed together by the internal surface of a ring on a fourth wheel, D, and the three wheels inclosed by this ring form what I call a "nest." The rollers are kept by suitable bearings (easily seen in the drawings Figs. 1 and 1^a) so that their centers lie on the line F H, being one diameter of D; but the spindles of B and C run in bushes such as shown at *b*. These bushes are absolutely free to move in the line F H. I also arrange so that the spindles *d* of D and *a* of A shall have so much play relatively to one another that no force employed to press A, B, C, and D together can bring any pressure on any bearing. A very slight relative motion is all that is required, and less elaborate methods of giving the freedom may be employed than that represented. The mere play in a bush may be sufficient; but it must be clearly understood that to take full advantage of my invention the axis of only one shaft can be fixed in position. The other must be free to move relatively to this shaft in the manner described. The surface velocities of the outside of A and the inside of D are the same, and their angular-velocity ratio is the inverse ratio of the radii of these two surfaces. The smaller roller A may be outside B and C, as shown in Fig. 2, and is then pressed directly against the inside of D. The rollers A, B, and C may be equal or unequal. If they are unequal, we shall have four different angular-velocities all inversely proportional to the several radii. In this as in the previous arrangement, the bearings allow absolute freedom to the centers A, B, and C to adjust themselves on the line F H relatively to that of D; or, what would come to the same thing, absolute freedom is given to three of the centers to adjust themselves relatively to the fourth. In consequence of this freedom the normal pressure by D on the inner rollers and the reciprocal normal pressure by the inner rollers on D and the normal pressure between the inner rollers themselves cause no pressure on any bearing. This normal pressure may therefore be of any desired or necessary amount to secure adhesion without causing any injurious friction. The rollers or rings must be so strong as not to be sensibly deformed by the pressure.

The reduplication of parts spoken of above is seen from the following consideration: In Fig. 1, D is driven both by B and C; in Fig. 2, D is driven both by A and C.

The necessary tightening may be effected in three ways.

First, by initial adjustment. This may depend on accurate turning when all the rollers are sensibly rigid; otherwise one or more of the rollers may be made somewhat elastic, as by giving an india-rubber tread to the rollers, or by forming one or more of these out of a stout coil or helix of steel capable of compression as to diameter by elongation of the coil in the direction of the axis. This compression as to diameter is compatible with the retention of a truly cylindrical form. When these modes of tightening are employed, the cylindrical surfaces of A, B, C, and D will all be such as are generated by a straight line revolving parallel to the axis of each roller. Figs. 2, 3 show one mode of carrying out this method. The spring is fast at one end to the shaft and in a slot at the other end.

Second, by the end movement of one roller—such as A—made slightly taper for this purpose. The simplest form of this mode of tightening is shown in Fig. 1^a, which is a sectional elevation of the gear shown in plan in Fig. 1. In this case a small projection, *m* and *n*, is formed on B and C. A corresponding hollow is then formed in the ring of D, so that the straight lines on B and C may bear against a straight line in D. These lines will in practice be narrow, flat surfaces. The end-pressure is shown as produced by a spring, S, on the shaft *a*. The roller A slides on a feather. The end-pressure is taken by the collar T and the end plates, *r s*; but these are details which may be much varied. In Fig. 2^a—the sectional elevation of Fig. 2—I have shown A and C slightly bulged, so as to clear the cone B. No recess is then required in D. In this drawing I have also shown a handle, H, by which the spring S might be tightened, so as to vary the pressure while the gear was in motion. This gives one form of friction-clutch. The rollers in this variety bear only on points. The end-pressure is taken in a manner analogous to that of Fig. 1. In Fig. 3 the rollers A and D are bulged and the tightening is effected by pressing together two cones, B' and B^2, by the nut N and the spring S. In this figure C' and C^2 are shown similarly adjustable; but this is not necessary. No end-pressure is produced by tightening in this arrangement, in which, however, the bearing-surfaces are still only points.

A third mode of tightening is given by jamming one of the three rollers between two others by a sidewise movement. A simple form of this arrangement is shown in Fig. 4. The centers of A, B, and C are not in one straight line, and the handle H, with the spring S, jams the roller A between B and C. This jamming action causes an injurious pressure on the bearings of A, B, and C perpendicular to the line F H; but if the center of A is very nearly on the line F H, this injurious pressure may be very small, and we have the advantage that the rollers bear on lines, not points. Figs. 5 and 5^a show the same arrangement when A is next D. By a still further reduplication a pair of rollers, B' B^2, Figs. 6 and 6^a, may be substituted for the single roller B. The three centers of C, B', and B^2 then form a triangle, and A runs between these three rollers. By placing A more or less eccentrically, the tightening of the rollers can be effected by varying the shape of the triangle of the centers of C, B', and B^2.

To effect this we simply have to move one of the three rollers, as B′, so as to wedge it between A and D, by forcing it into a narrower part of the space between these rollers. In this as in all other cases the position of only one axis is absolutely fixed. A may have a hollow axis, and the axis of D may pass quite through it. An obvious but convenient modification of this arrangement is shown in Fig. 7, where A, as in Fig. 2, bears directly against D. C is shown as the hollow spindle, and the tightening is effected by forcing B′ and B^2 apart. In these arrangements the bearings of one, or indeed of two, parts may be dispensed with. Thus, in Figs. 7 and 7^a, if A, B′, and B^2 are carried by a frame, the roller C may be a floating ring carried by shoulders, as shown. The outer ring, D, might also be similarly carried. This mode of tightening by lateral movement is especially convenient, as allowing a bearing along a line with no coning, no special fitting, the fewest possible number of bearings, and the simplest possible mode of tightening or slackening the gear, for it is obvious that if B were simply a handle we should have here a friction-clutch. With this "eccentric tightening," as it may be called, it is possible to adopt the corrugated surface of what has often been called "frictional gearing"—that is to say, the cylindrical surface may consist of one or more V-grooves and projections so placed that the projection is jammed in the V by the lateral pressure. An analogous arrangement is shown in Figs. 8 and 8^a, the special point in this figure being the overlapping of B′ and B^2.

The arrangements so far described are varieties of the first form of nest-gearing, which may be substituted for a simple pinion and spur-wheel. I give the name of "simple concentric nest-gearing" to this arrangement, (the name is derived from the simplest form, as shown in Fig. 1;) but the name is applicable to all the varieties, even though no two of the rollers may be concentric.

When it is desired still further to multiply or reduce the angular-velocity ratio, I employ a second form, which I will call "multiple concentric nest-gearing," a simple form of which is shown in Figs. 9 and 9^a. I employ, as before, a small cylindrical roller, A, now placed between two rollers, B and C, and bearing against these where they are of comparatively large diameter. These wheels have smaller concentric cylindrical surfaces b' b^2 and c' c^2, which bear against the inner surface of the ring D. In this arrangement the surface velocity of D relatively to that of A is diminished in the ratio of the diameter of B to b' or of C to c', which ratio should be the same in the two rollers. Calling this ratio m, and calling n the ratio of the diameter of D to that of A, the angular velocity of A will be $m\ n$ times that of D.

The arrangements as to centers are analogous to those described for the first form, and it is desirable that, as shown, the smaller cylindrical surfaces of B and C should be divided into two parts, one on each side of the surface of larger diameter. This larger portion then revolves inside a groove or cage connecting the two parts of the ring D. This arrangement keeps the resultants of all the pressures in one plane. The two parts of D′ and D^2 need not be connected. One of the two parts might be floating and carried by grooves, and prevented from tripping by any suitable means. In Figs. 10 and 10^a one such plan is shown. D′ is the floating ring. The means for tightening are analogous to those in the first form. Fig. 9 shows the employment of the cone or end movement. Fig. 10 shows the eccentric tightening or lateral movement.

The third variety of nest-gearing, which I will now describe, is one by which the direction of the axis of rotation can be changed, as well as the angular-velocity ratio. Fig. 11 shows the means of changing the direction of the axis ninety degrees, as by bevel-gearing. Two cylindrical rollers, B and C, are pinched between the inner side surfaces of the two parts D′ D^2 of cylindrical wheels keyed on a shaft, d, parallel to the common perpendicular to the axes of B and C. The pinching is most simply effected by a stout spring, S′, forcing D′ and D^2 together, for which purpose D′ slides on a feather; but other modes of pinching analogous to those described above may be employed. Thus the edges of B and C might be slightly bulged and the inner surfaces of D′ and D slightly coned, instead of being flat. Then, by pressing the shaft d down on B and C, the pinching might be effected. A sidewise pressure on one of the two rollers B and C might also be employed to jam these between D′ and D^2. The surface velocity of D′ and D^2 is at the point of bearing the same as that of the surface of D and C, and the angular-velocity ratio is inversely proportional to the radii. To avoid grinding action, the surfaces of D′ and D^2 should touch those of B and C only at a point or very small surface. This is easily secured by slightly rounding the surfaces of D′ and D^2, as shown in Fig. 11; or these surfaces might be flat and B and C slightly rounded. The surfaces of D′ D^2 might be beveled to fit part of similarly-beveled surfaces of B and C, these rollers being divided into beveled and simple rings, as in Fig. 17 and 17^a. This, however, will introduce some end-pressure; but it has the advantage of making the pinching contact on a line instead of on a point. The two rollers B and C need not be of the same diameter. The centers of B and C are free to approach. In Fig. 11 the bearing of C is shown as a bush working in a slot. No pressure applied by S′ puts any pressure on any of the shafts b, c, or d. Any of the shafts may obviously be the driver, and any other the follower. I call this arrangement "right-angle nest-gearing." It may, however, be used for parallel driving, as when b is the driving-shaft and c the driven shaft. The portion D′

d D^2 then acts simply as a pinching arrangement in substitution for the circular nest-wheel described above.

My fourth modification consists in the combination of a rack action with the right-angle nest-gearing. This arrangement is shown in Fig. 12, where the rack is represented by a rope or rod, A. The arrangement would be still better suited for a flat bar or rail. It is clear that if the framing be fixed and the shaft d is turned the straight rod, rope, or rail A will be forced along, rolling between the surfaces of B and C. The pinching action of D′ and D^2 secures the necessary adhesion both between D′ B, D^2 C, B A, and C A, with no force exerted on any bearing. This gearing may, as stated above, be employed to drive the rack; or if the rack be stationary—such as the rail of a railway or the rope or rod of a telepherage-line—the rack action will cause the gearing or carriage to move along the rack. By an obvious modification, either b or c might be the driving-shaft. I call this gearing "rack nest-gearing." A slight modification is shown in Fig. 13. The faces of D′ D^2 bear on several cylindrical surfaces of B and C smaller than those which pinch A. This makes a compact arrangement, and when c is the driving-shaft friction is saved by the reduction of the speed of d. In the figure bevel-surfaces are shown; but this will usually introduce some objectionable end-pressure. It is clear that the surfaces need not be beveled; but the contact will then be at a point only.

My fifth arrangement is shown in Fig. 14. The rope or flexible band A of the preceding figures is driven by the nest. B C D is used to drive other nests, G E F and H I J, placed in any position. The slack or return part of the rope A′ may have no tension on it, and the friction on the axles is only that caused by the actual pull transmitted. The arrangements for producing adhesion cause no friction on any bearing. The pinching-nest may be placed at any point on the periphery of the pulleys. Thus B and C pinch the belt at the point where it is tangent to the pulleys; but I H pinch it when already wrapped round the pulley. The latter arrangement requires less force to produce adhesion, and still less would be required if in the nest H I J the pinching action were put closer to the slack end. I call this arrangement "belt nest-gearing with external pinching." A modification is shown in Fig. 15. The belt A is pinched against the pulleys E and F by right-angle nests B C D and B′ C′ D′. Thus B bears against the outer surface of A, pressing it against the outer surface of E, while C bears against the inner concentric surface of E. The ring of E and the belt A are pinched precisely as the rope or rail are pinched in Fig. 12. I call the arrangement in Fig. 15 "nest belt-gearing with internal pinching."

My sixth arrangement is shown in Fig. 16. I gear two flat pulleys, A and B, so as to run like the ideal pitch-surfaces of a spur-wheel and pinion, by means of a pinching arrangement analogous to that used for the nest rack action. The action of B C D′ D^2 is obvious from the drawing. The bearing-rings of D′ D^2 must bear the same ratio to each other as the internal and external surfaces of A. Just as B is in external gearing with A, so C is in internal gearing with A, and might conveniently be employed as driver or driven wheel. Similarly, the shaft d might be the driver or driven shaft, and this arrangement gives a second mode of changing the direction of the axis. It forms a second right-angle nest-gearing. When A and B are the driver and driven rollers, I call this arrangement "parallel nest-gearing."

In the nest-gearing described so far the axes have either been parallel or at right angles; but the system is applicable when the directions of the axes are inclined in any direction; and I will now describe nest arrangements for inclined intersecting axes.

I will now show the modifications of all the types, but will describe the modifications of the leading types required for this purpose. As the first example, I select the first-described concentric nest-gearing. In this gearing let the axis of D, Fig. 17, be inclined to the direction of the three parallel axes of A, B, and C. If B and C were simply rounded, they would press on path, which might be two parallel circles, as at m and n, but on a smooth barrel inside D; but if the inclination be at all considerable, shoulders such as are actually shown at m and n will be desirable to prevent the slipping of B and C lengthwise inside the barrel. To prevent grinding and give a larger bearing than a simple point, these shoulders and the surfaces of B and C should be beveled, as shown, so as to run like the pitch-surfaces of bevel-wheels. Suitable flat surfaces are then provided, as shown, for the bearings between A, C, and B. In Fig. 17 the tightening would be effected by a lateral movement, or by an eccentric arrangement. In Fig. 17 a modification of the arrangement of the bevel-surfaces is shown, admitting the tightening by a cone or endwise movement. The double cone might also be employed. Tightening might also be effected by varying the angle between the axes, jamming the nest by means of a couple.

As my eighth arrangement, I will describe the modification of my sixth arrangement, by which it becomes an example of an oblique nest. The rim of A, instead of being at right angles to the plane of the wheel, is dished or beveled, as shown by Fig. 18, and then gripped by the right-angle nest B C D. B and A may be driver and follower, or D and A, or probably C and A. The action is obvious. Fig. 19 shows one case of this gearing when B and C run in a plane at right angles to that of A. This may be used either as a form of parallel gearing or right-angle gearing.

In my ninth modification the place of the solid pinching-ring D of my first concentric gearing may be taken by a flexible belt, D, as shown in Figs. 20 and 20^a. We then have gearing more closely resembling some arrangements already in use. In the flexible nest-gearing hereinafter described there are, moreover, improvements in the method of producing at will exactly the desired pressure between the rolling-surfaces, and yet leaving absolute freedom to two of the axes to arrange themselves relatively to the third as regards distance and parallelism. In Fig. 20 the tightening is effected by a cone, as in my concentric nest-gearing. This forms both a convenient method of producing the right amount of pressure between A B and A C, and also a convenient mode of throwing the axis A out of gear without stopping B and C. Thus A may be withdrawn entirely from contact and B and C left running with the strap loose and the bushes of B and C bearing against limiting-stops. When it is desired to start A, it is again gradually introduced endwise. In Fig. 21 a flexible nest-gearing is shown in which the eccentric system already described for concentric nest-gearing is applied to tighten the belt. By increasing the distance between the arms of B′ and B^2, the belt is tightened at pleasure. The three rollers B′, B^2, and C may be used as a frictionless bearing for the end of the shaft A, left free to move in all directions, except endwise.

My tenth modification is an arrangement of nest-gearing by which angular-velocity ratios may easily be varied. Fig. 22 shows this arrangement. The rollers B C in a right-angle nest are mounted on a frame, M, actuated by a handle, H. By this handle they can be made to approach the axis *d* or recede from it, sliding on their shafts *b* and *c*. In this way the angular-velocity ratio of *b* to *d* or *c* to *d* can be varied at pleasure. A similar modification might be employed in the oblique gearing shown in Fig. 18.

It is obvious that, although A is generally described as the driver and D as the follower, any one or more of the set of rollers may be drivers or followers. It is also obvious that in all of the arrangements, so long as the relative movements remain the same, any part can be chosen as the fixed part or frame.

I claim—

1. The improved system of frictional gearing wherein the reduplication and arrangement of parts cause the required pressure to produce adhesion by friction without causing pressure on the bearings, substantially as shown and described.

2. The combination of the series of rollers arranged in a nest, as described, and means by which to adjust frictional contact or surface pressure between the rollers without causing pressure on their bearings, substantially as hereinbefore set forth.

3. The combination of the series of rollers arranged in a nest, as described, the rack, and means by which to adjust frictional contact or surface pressure between the rollers and between the rack and contiguous rollers without causing pressure on the roller-bearings, substantially as and for the purpose hereinbefore set forth.

4. The combination of the series of rollers arranged in a nest, as described, and the spring (or springs) by which to adjust frictional contact or surface pressure between the rollers without causing pressure on their bearings, substantially as and for the purpose hereinbefore set forth.

5. The combination, with an endless band, of one or more nests of gearing, the reduplication and arrangement of parts constituting such nest or nests being such, substantially as described and shown, as to produce adhesion by friction without causing pressure on the bearings, as set forth.

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