No. 780,769. PATENTED JAN. 24, 1905.

J. J. WOOD.

ELECTRIC METER.

APPLICATION FILED FEB. 11, 1904.

5 SHEETS—SHEET 1.

FIG. 1.

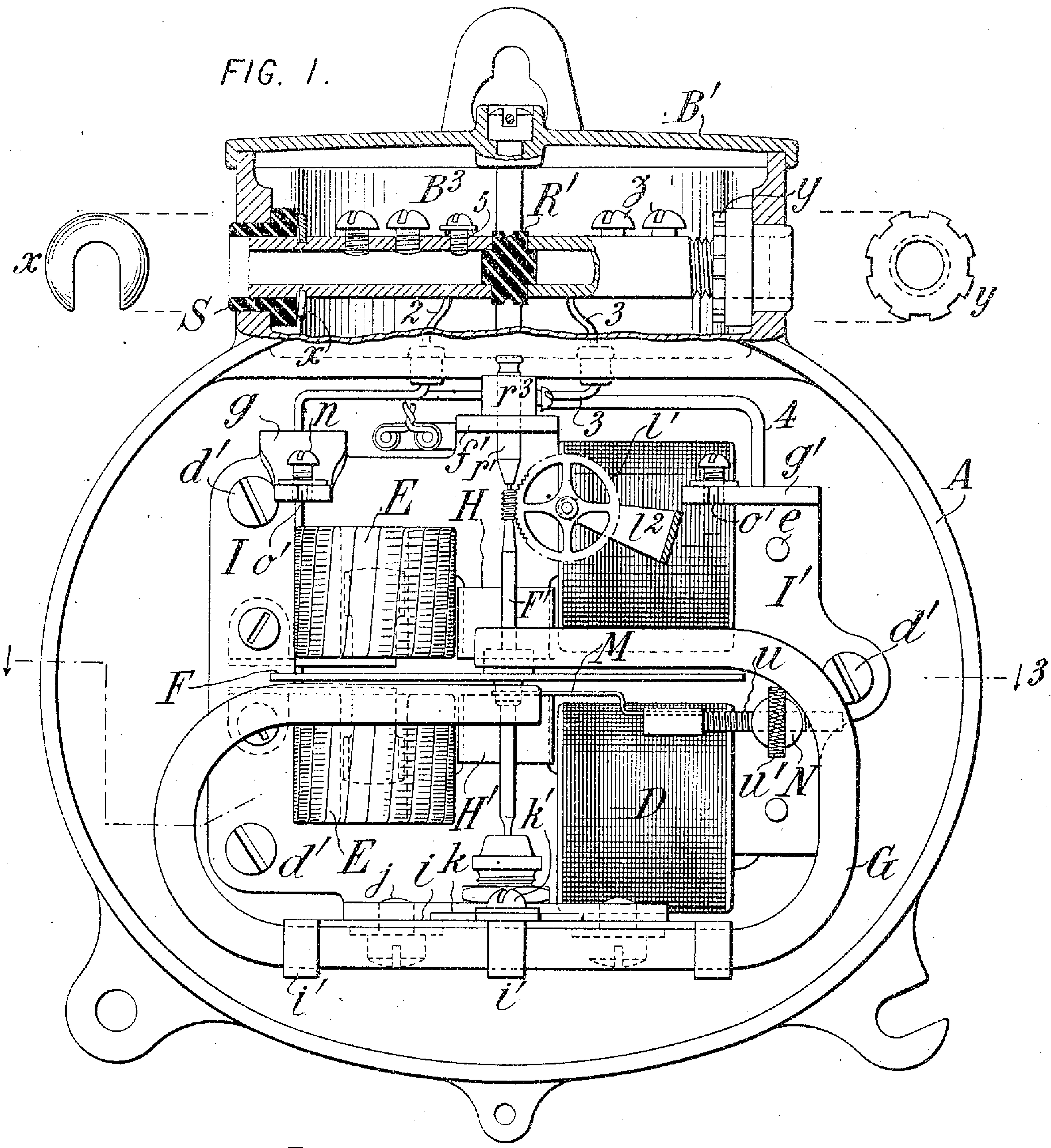
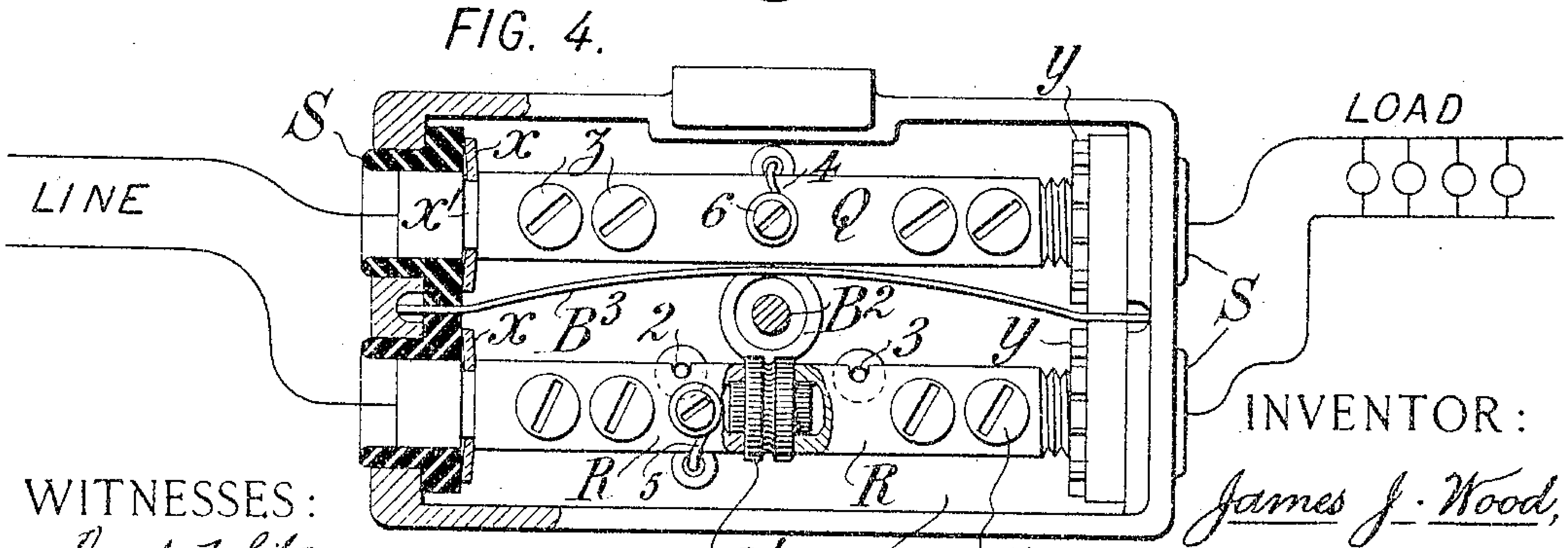


FIG. 4.



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5 SHEETS—SHEET 2.

FIG. 2.

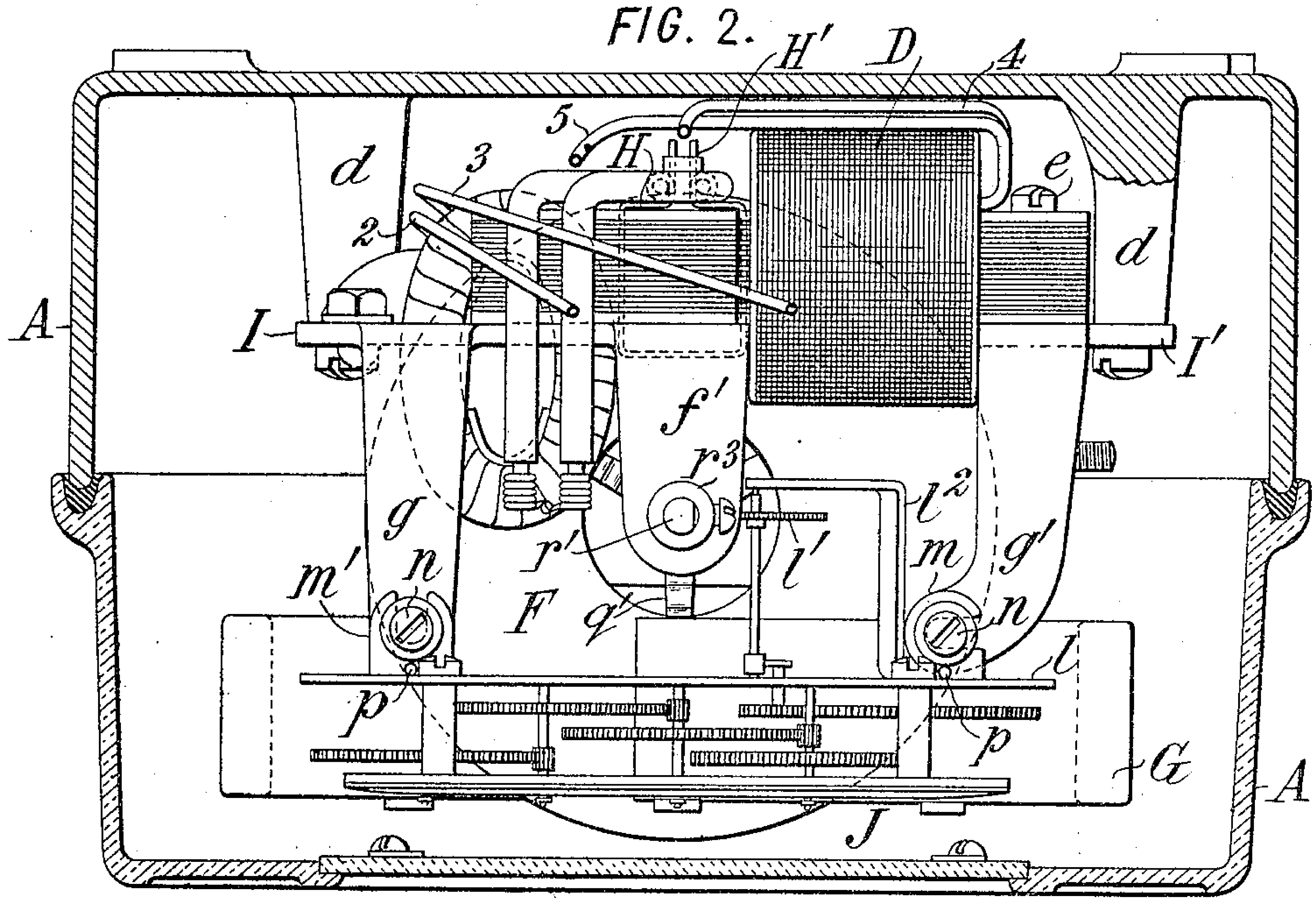
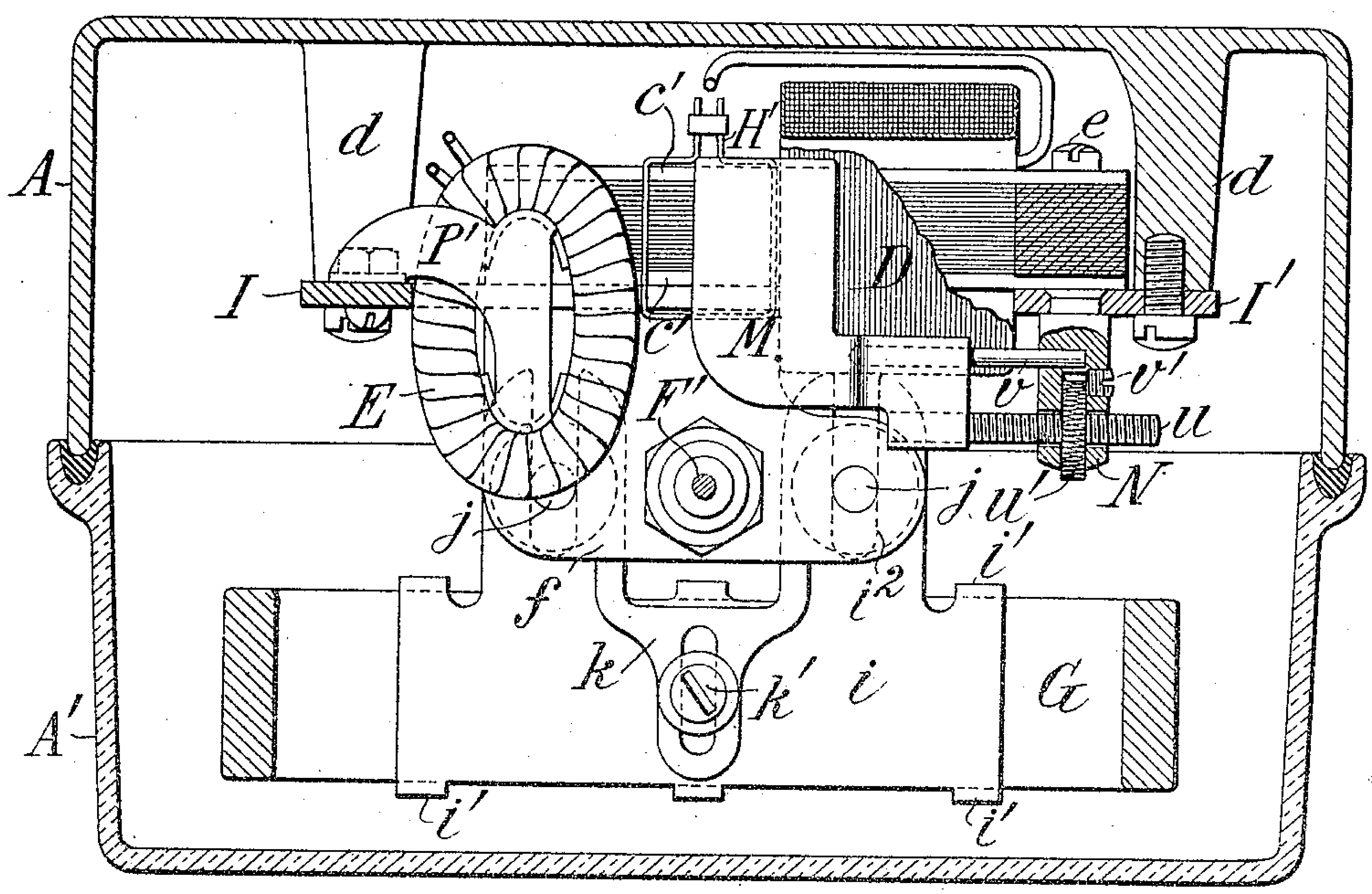


FIG. 3.



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5 SHEETS—SHEET 3.

FIG. 5.

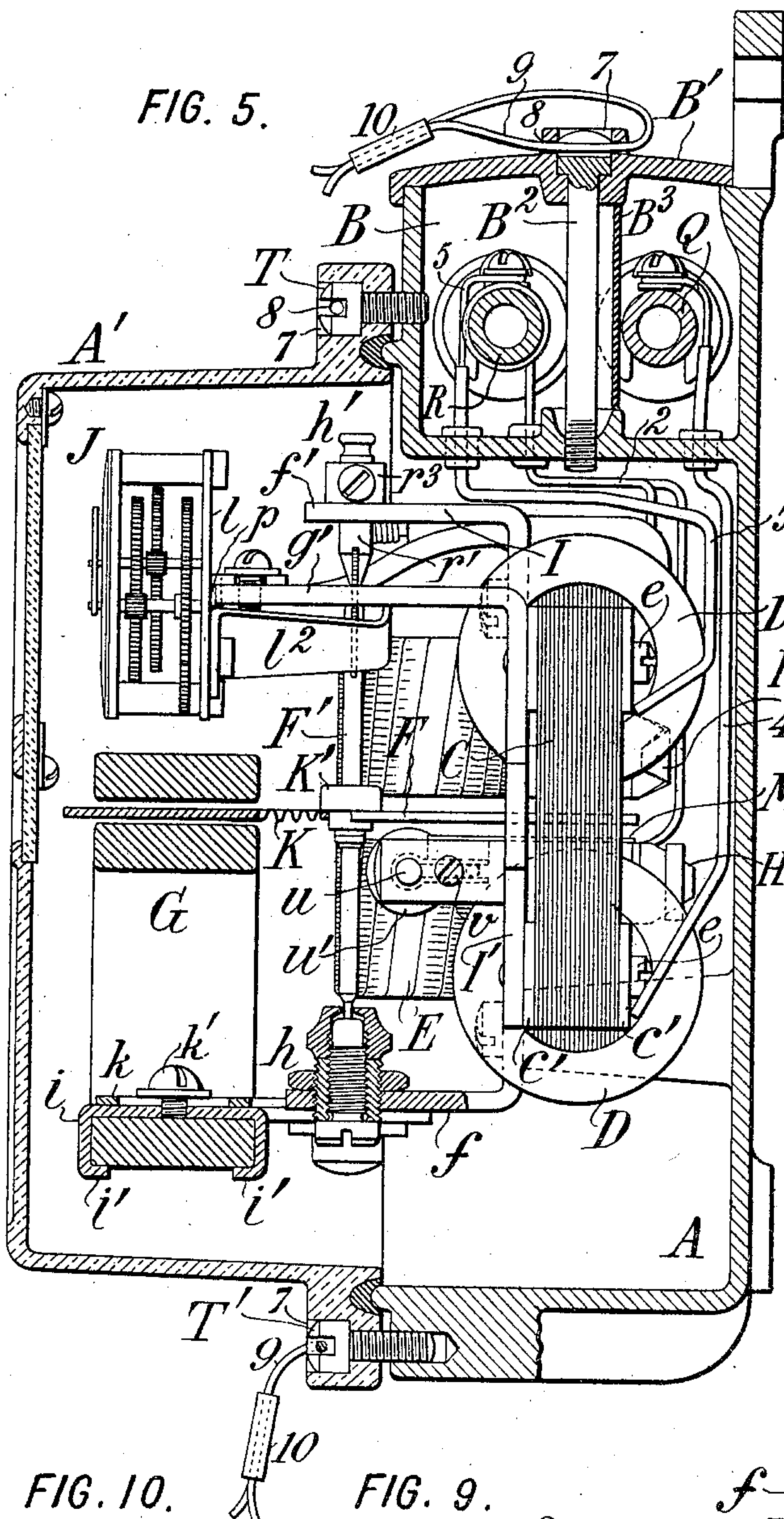


FIG. 6.

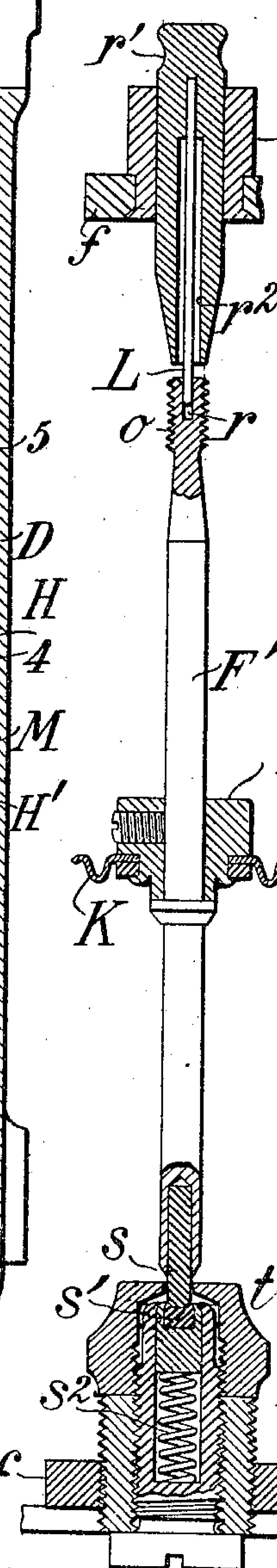


FIG. 7.

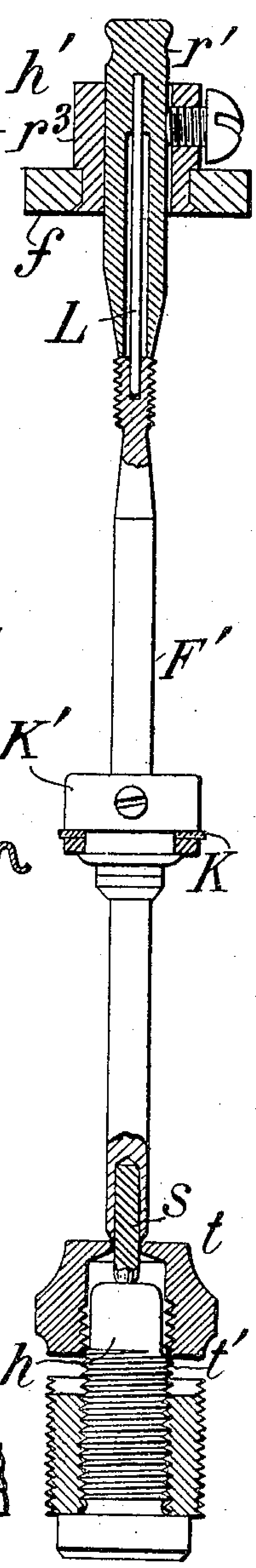


FIG. 10.

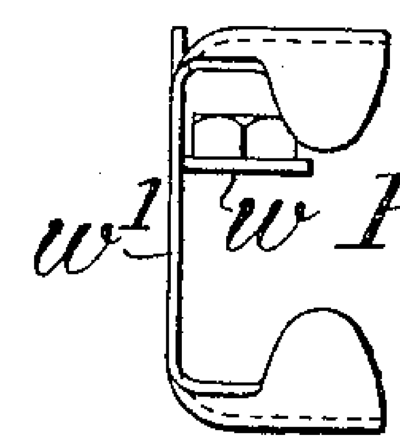


FIG. 9.

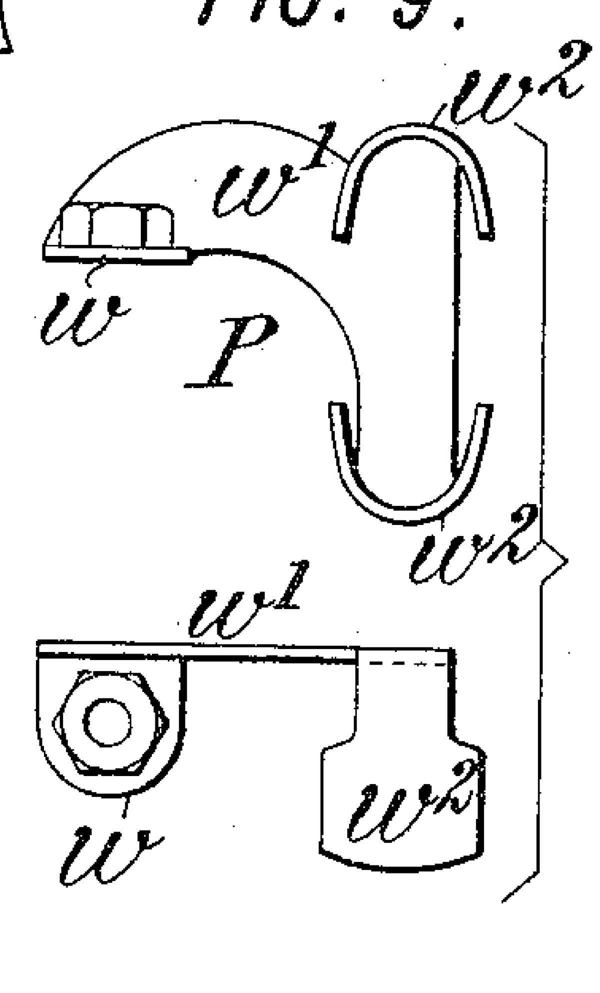
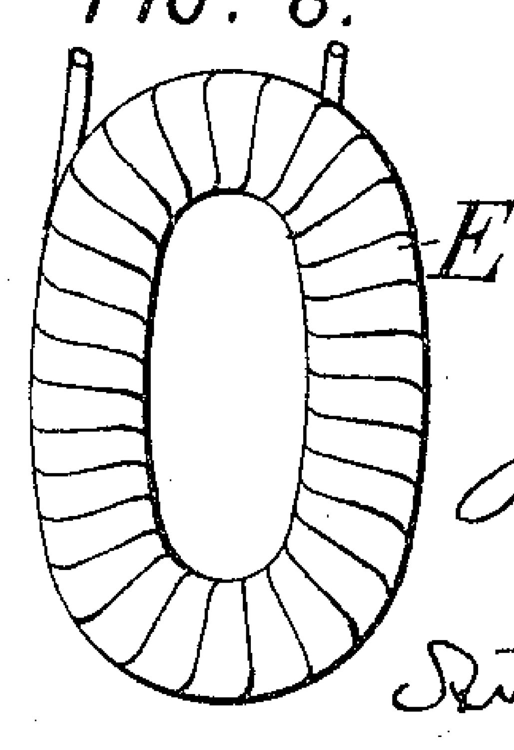


FIG. 8.



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5 SHEETS—SHEET 4.

FIG. 11

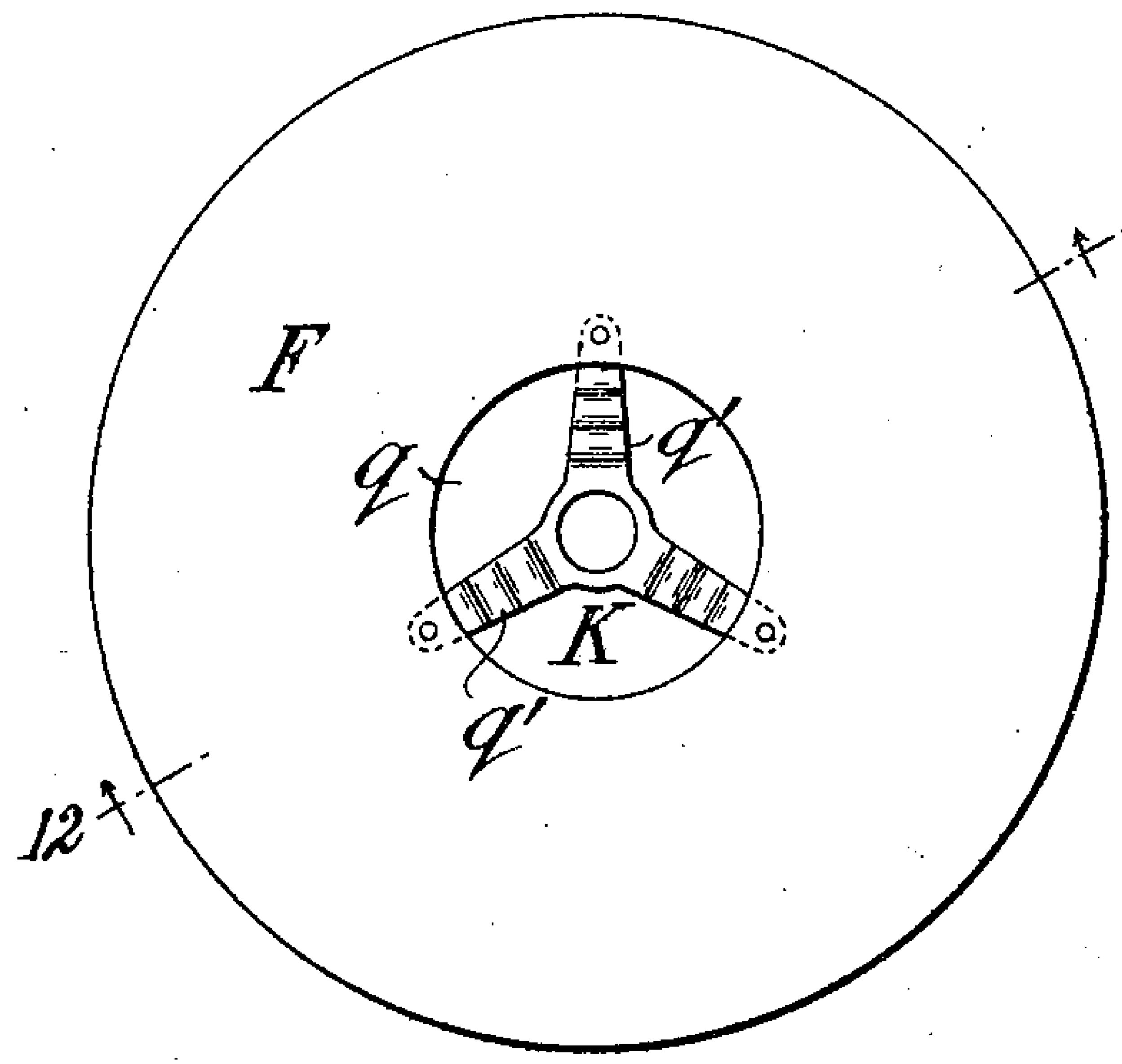


FIG. 18.

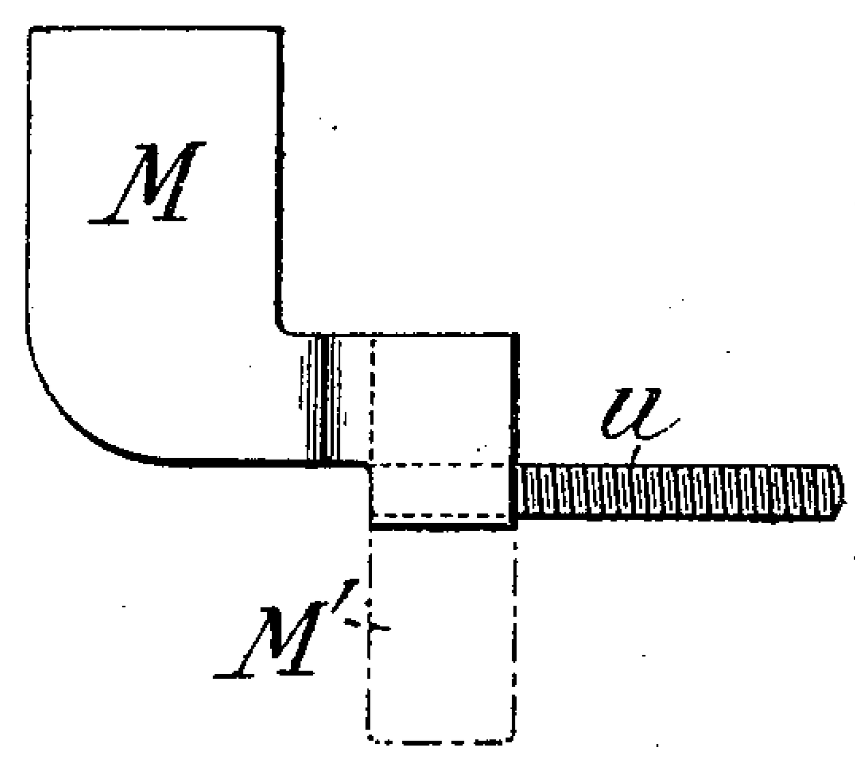


FIG. 19.

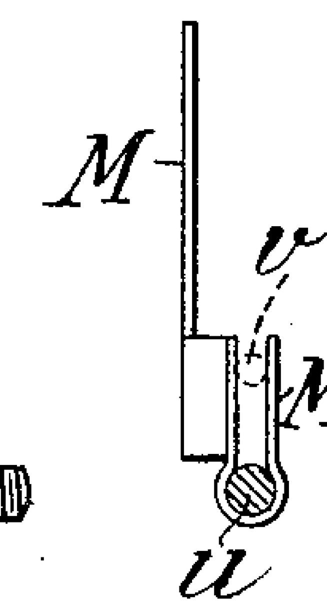


FIG. 12.

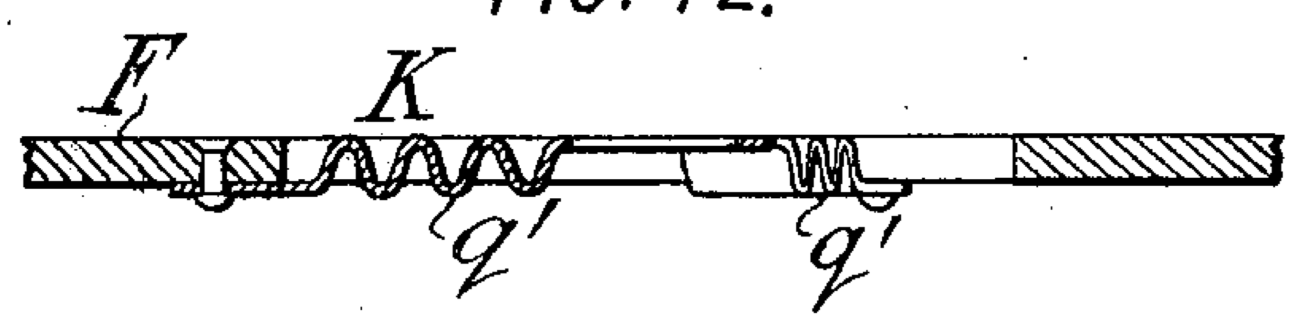
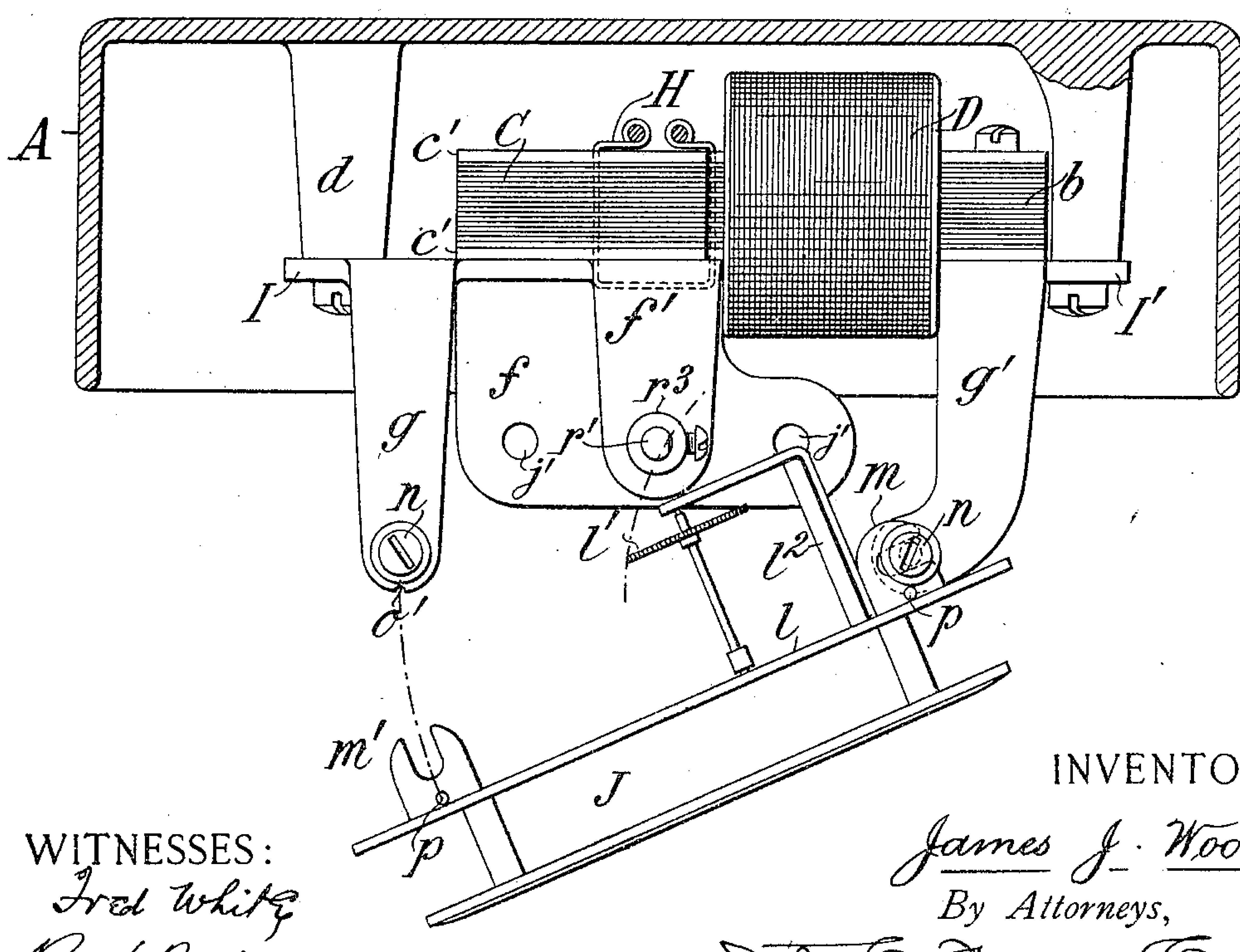


FIG. 17.



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5 SHEETS—SHEET 5.

FIG. 13.

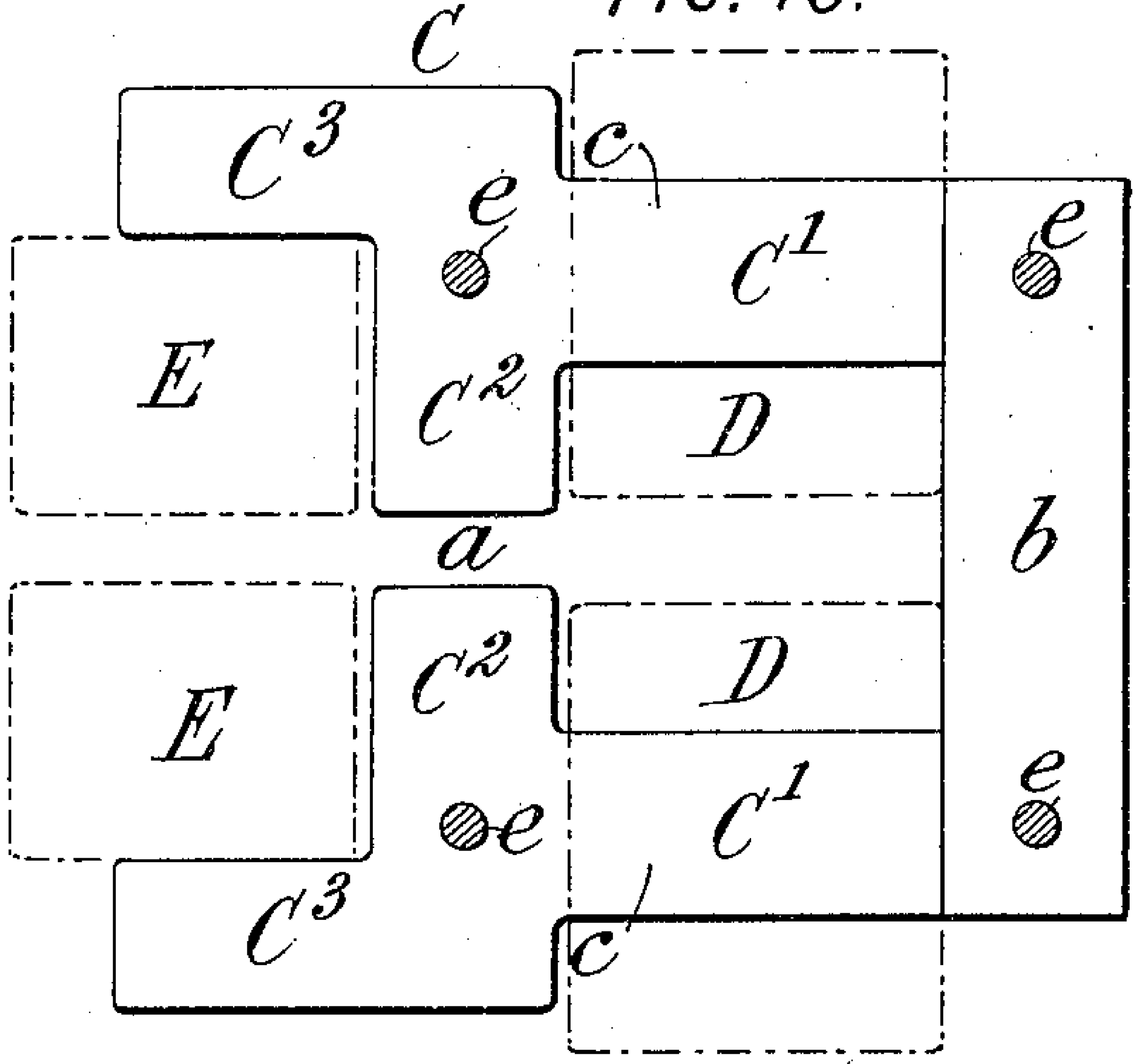


FIG. 16.

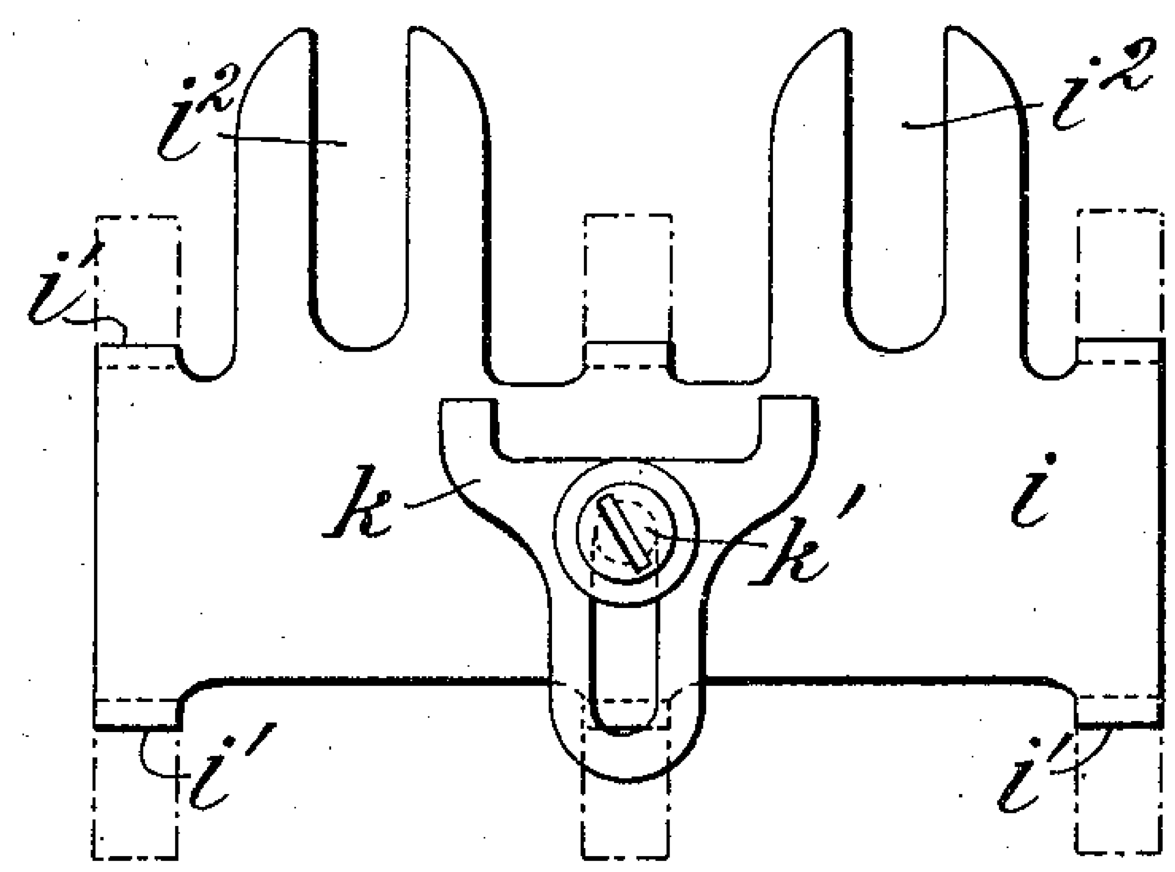


FIG. 14.

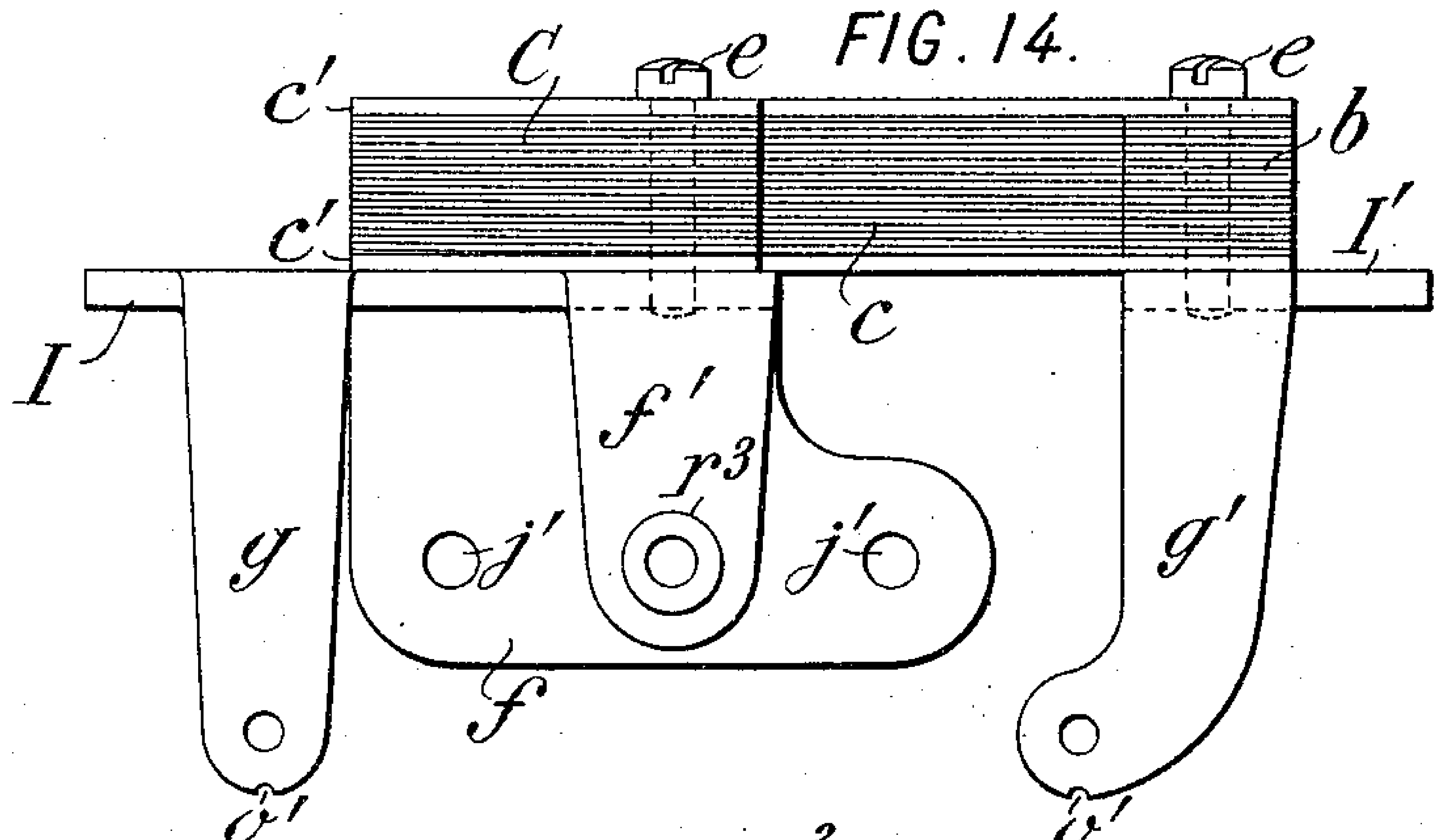
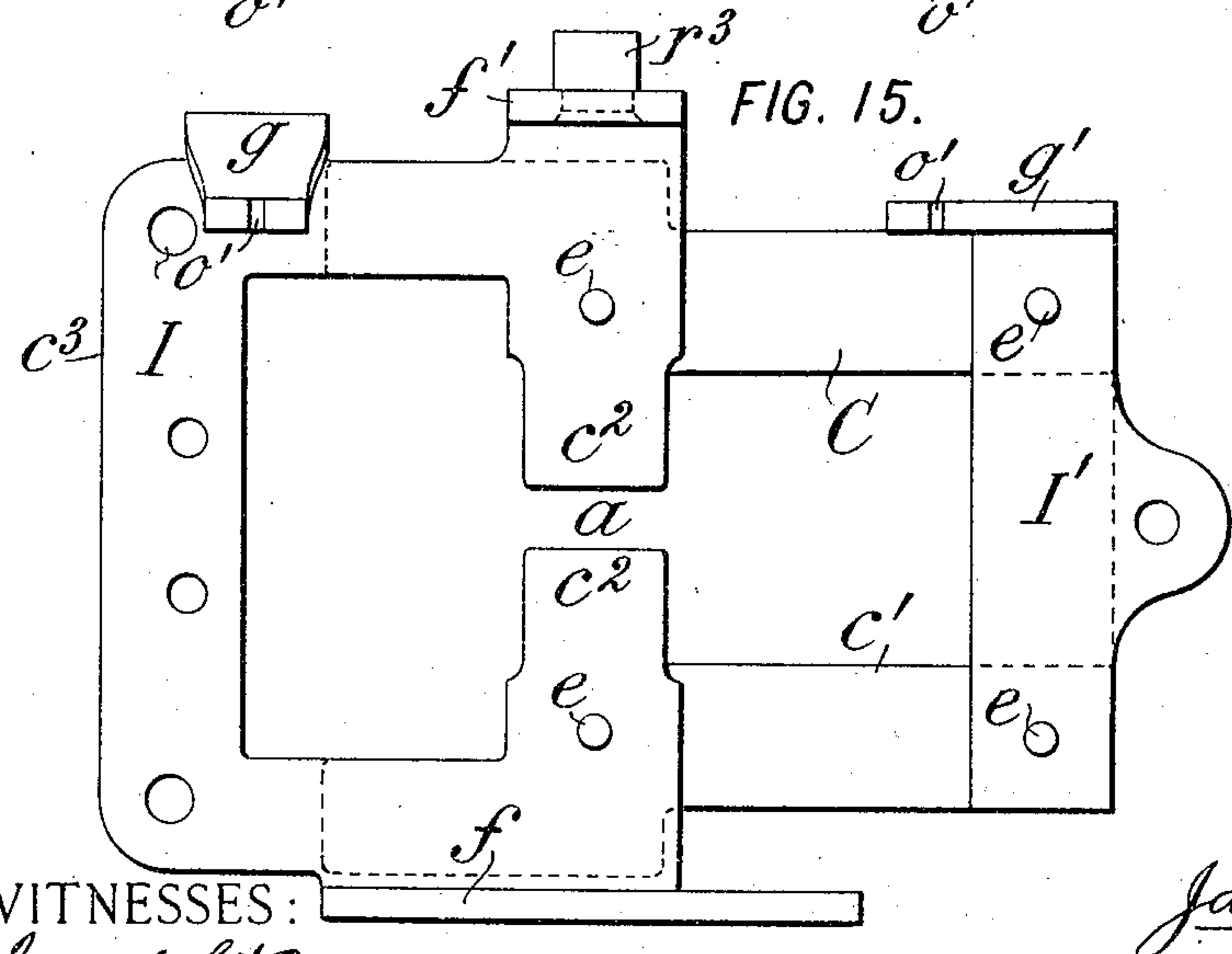


FIG. 15.



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INVENTOR:

James J. Wood,

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No. 780,769. Patented January 24, 1905.

UNITED STATES PATENT OFFICE.

JAMES J. WOOD, OF FORT WAYNE, INDIANA.

ELECTRIC METER.

SPECIFICATION forming part of Letters Patent No. 780,769, dated January 24, 1905.

Application filed February 11, 1904. Serial No. 193,210.

To all whom it may concern:

Be it known that I, JAMES J. WOOD, a citizen of the United States, residing at Fort Wayne, in the county of Allen and State of Indiana, have invented certain new and useful Improvements in Electric Meters, of which the following is a specification.

This invention relates to alternating-current electric meters or wattmeters of the induction-motor type.

The objects of this invention are to improve and cheapen the construction of such meters, render them more accurate and less liable to derangement, to make their parts more readily accessible, while affording greater security against their being tampered with, and to protect their delicate parts from the damaging effect of the vibration incident to the alternating current.

The accompanying drawings illustrate a wattmeter constructed according to the preferred embodiment of this invention.

In the drawings, Figure 1 is a front elevation, the front shell of the case and the totalizer being removed and the upper part or connection-chamber of the case being mainly in vertical section. Fig. 2 is a horizontal section through the inclosing case, showing the operative parts of the meter in plan. Fig. 3 is a horizontal section in the planes of the lines 3 3 in Fig. 1. Fig. 4 is a plan of the top part or connection-chamber of the meter-case, partly broken away, in horizontal section. Fig. 5 is a vertical transverse mid-section through the meter-casing, showing the operative parts of the meter, partly in side elevation and partly in vertical mid-section. Figs. 6 and 7 are sectional elevations viewed at right angles to each other of the armature-spindle and its bearings, Fig. 6 showing the parts in operative position and Fig. 7 showing them displaced for shipment. Fig. 8 is a plan of one of the series coils. Fig. 9 is a plan and front elevation of the support therefor. Fig. 10 is a side elevation of said support. Fig. 11 is a plan of the armature or disk. Fig. 12 is an enlarged fragmentary diametrical section of the armature and the flexible arms or spokes connecting it to the spindle. Fig. 13 is an elevation of the laminated core or field-magnet, the shunt and series coils being indicated in dotted lines. Fig. 14 is a plan of the field-magnet core and the supporting plate or plates attached thereto. Fig. 15 is a front elevation of the parts shown in Fig. 14. Fig. 16 is a plan of the plate for supporting the damping-magnet and its gage. Fig. 17 is a sectional plan showing the meter partly dismantled, the front case being removed and the totalizer disconnected and swung outward. Fig. 18 is a plan of the friction adjustment detached, Fig. 19 being an edge view of the same.

Referring to the drawings, the operative parts of the meter are shown inclosed, as usual, within a casing, the main or rear part or shell of which is marked A, and the front or removable part is A'. The upper part of the rear shell A is formed with a connection-chamber B, Fig. 5, separated by a partition from the mechanism-space beneath and closed by a lid B'.

The operative parts of the meter comprise, generally speaking, those elements or members which are usual in induction-motor wattmeters—that is to say, a laminated core C, (shown separately in Fig. 13;) shunt-coils D D thereon, wound, as usual, of numerous turns of fine wire; series coils E E, (one of which is shown detached in Fig. 8,) wound of suitably large wire which carries the current to be measured, located adjacent to the armature; the armature or disk F, mounted on its spindle F', so as to rotate in suitable bearings, and a damping-magnet G, applied as a magnetic brake to the armature. The instrument comprises also short-circuited coils H H' for adjusting the phase relation between the series and shunt magnetism. These parts and their accessories may be constructed and adapted to operate in any manner known or usual with meters of this class or according to any suitable modification thereof, since in their general features they form no part of this invention. For example, it is not essential that there be two shunt coils or windings D D or two series coils or windings E E, although preferably for symmetry these should be duplicated, as shown.

The laminated core is built up, as usual, of thin plates of iron clamped together between outer plates. The shape of the core is shown in Fig. 13. Instead of forming a closed or substantially closed magnetic circuit it forms a substantially open circuit having legs C′ C′, around which are placed the shunt-coils D D, approaching poles $C^2 C^2$, forming between them a suitably wide air-gap *a*, within which freely turns the armature-disk, and beyond these poles it is formed with outwardly-projecting legs C^3 C^3, partly projecting between which are the series coils E E. This construction insures that a large proportion of the magnetic flux induced by the shunt-coils D D shall traverse the air-gap and by eliminating any closed magnetic circuit between the outer legs C^3 eliminates the iron effect from the series coils and renders the meter equally accurate under all practical conditions of varying voltage, frequency, or wave-curves. If the iron passed into the series coil or around it, it would seriously affect the accuracy of the instrument when used with varying wave forms, frequencies, and voltages. On the other hand, if the projections as shown were not there the torque of the meter would be somewhat less. The laminated field is preferably built up of stacks of punchings comprising sections *b* and *c c*, the former abutting against the ends of the latter, as shown in Fig. 13. Each of the sections *c* comprises a leg C′, pole C^2, and leg C^3. The stacks of punchings forming the sections *c c* are clamped together between thicker outer plates *c′ c′*, Fig. 14, which are of the same shape, except that they are longer, so that they overlie the ends of the stack of punchings *b*, screws *e* being put through holes in the punchings and engaging the outer plates to draw the punchings together. The entire core thus constructed is fastened by the same screws *e* to a supporting-plate comprising two plates or sections I I′, which in turn are supported by being fastened by screws *d′ d′* to three posts or lugs *d d*, projecting from the back plate of the main shell A of the casing. The plates I I′ support the other operative parts in manner to be described. The plate I is formed with projections c^2, conforming to the pole-pieces C^2, (see Fig. 15,) with top and bottom portions, which fit over the core-legs C^3, and with a connecting part c^3 between these, the opening between this connecting part and the legs C^2 serving to receive the series coils E E. The plate I has a forward projection *f* from its lower edge and two forward projections *f′* and *g*, respectively, from its upper edge. The plate I′ has a forward projection *g′* from its upper edge. These plates I and I′ are preferably punched out of hard brass and have their projecting portions *f f′ g g′* bent or struck up from the body of the plate. The two plates when fastened by the screws *e e* to the core serve, substantially, as one plate, the space between them receiving the shunt-coils D D, which are slipped over the legs C′ C′ of the core before the section *b* is put in place and before the plate I′ is fastened on. The forward projections *f f′* of the plate I serve as brackets or supports for the bearings of the armature-spindle. The lower or jeweled bearing *h*, Fig. 5, which in general is of the ordinary construction, is fastened in the middle hole of the projection *f*. The upper bearing *h′* is fastened in a hole through the upper bracket or projection *f′*.

The damping-magnet G is fastened in the supporting-plate *i*, Fig. 3, preferably by means of ears *i′ i′*, bent under the magnet, as shown, and the plate *i* in turn is supported by being fastened to the forward projection or bracket *f* of the plate I, being clamped thereto by means of set-screws *j j*, which engage the two outer holes *j′ j′*, Fig. 14, in the projecting bracket *f*. To enable the damping effect of the magnet G to be varied by adjusting it radially toward or from the pivotal axis of the armature, the set-screws *j j* are caused to engage elongated slots i^2, Fig. 16, so that by loosening the set-screws the magnet G may be adjusted forward or back to any desired position, where it will be held by retightening the set-screws. To enable the magnet to be conveniently removed bodily, these slots i^2 are made open-ended, as shown. Such bodily removal of the damping-magnet is necessary in order to get access to some other parts of the meter—as, for example, to dismount the armature. Hence when it is removed it is desirable that it should be readily replaceable in exactly the same adjustment that was given to it when originally adjusting or collaborating the meter. This is provided for by means of a gage *k*, fastened to the magnet or to its plate *i* by means of a set-screw *k′*, passing through an elongated slot in the gage, as shown. When the damping-magnet has been correctly adjusted, the gage *k* is pushed back until its legs abut against the front surface of the bracket or supporting projection *f*, and the screw *k′* is then tightened. Subsequently this screw *k′* is to be left untouched unless the meter requires readjustment. If at any time it becomes necessary to remove the damping-magnet, it is only necessary to slacken the screws *j j* and pull the magnet forward. When replacing the magnet, it is only necessary to push it back until the legs of the gage *k* again abut against the bracket *f*, whereupon by retightening the screws *j j* the magnet is restored with its original adjustment unimpaired.

The totalizer J is in general of usual construction, comprising a train of gears mounted between front and back plates. The back plate *l* constitutes the supporting-base and is formed with ears *m* and *m′*, projecting rearwardly and fastened by set-screws *n n* to the forward projections or brackets *g g′*. As best seen in Fig. 17, the ears *m m′* have open-ended slots which engage the screws *n n*, one of these slots opening rearwardly and the other laterally. As shown, the slot in the ear g opens toward the right, while that in the ear m' opens toward the rear. This arrangement enables the totalizer to be very easily swung out of the way in order to disconnect it from the armature-spindle or to get access to the parts in the rear. The object of this construction is to enable the person testing or adjusting the meter in case of undue friction to determine quickly whether the friction is located in the armature spindle and disk or in the totalizing mechanism train. To do this, it is only necessary to loosen the screws n n and swing out the totalizer at its left-hand end, as shown in Fig. 17, using the right-hand screw as a pivot. If it is desired to remove the totalizer altogether, it is then only necessary to displace it toward the left to disconnect the ear m from its screw. The totalizer-train is, as usual, driven by means of a worm and worm-wheel from the armature-spindle, the worm o being at the top of the spindle (see Figs. 1 and 6) and engaging the worm-wheel l', Fig. 1, which, as usual, is mounted on a spindle having its rearward bearing in a bracket-arm l^2, Fig. 2. The arrangement of the worm-wheel l' relatively to the right-hand screw n is such that swinging the totalizer around the latter as a center in the manner shown in Fig. 17 has the effect of displacing the worm-wheel freely out of mesh with the worm, but without springing its spindle or bearing. In replacing the totalizer it is important that the worm-wheel be brought into very accurate mesh with the worm, and to insure this accurate replacement of the parts I provide additional gages, which are brought into correct engagement before the screws n n are retightened. These gages consist, preferably, of small notches o' o', formed at the front ends of the bracket-arms g g', as shown in Fig. 14, and engaged by small pins p p, inserted in holes drilled through the ears m m', as shown in Figs. 2 and 17. When originally assembling the meter, the totalizer is brought into its exact position, so that the worm and worm-wheel shall accurately mesh together, whereupon the holes are drilled for the pins p p, so as to intersect the front edge of the brackets g g', to thereby form the notches o' o', after which the pins are fixed in these holes, so that subsequently whenever the pins are correctly entered into the notches and the screws n n tightened the totalizer is restored to the correct position.

A serious difficulty contended with in alternating-current meters is the vibration of the armature and its spindle, which produces an objectionable humming noise and causes a rapid wear of the jewel forming the lower bearing for the armature-spindle. An important object of the present invention is to obviate these disadvantages and produce a substantially silent meter in which the jewel shall be subjected to no greater wear than if the vibration incident to the alternating magnetic fields were eliminated. To this end the armature instead of being made as a disk fixedly attached to its spindle is formed with a large central opening, so that the armature is, in effect, washer-shaped and is yieldingly connected to the spindle by means of a suitable flexible or elastic connection constructed, preferably, as spokes of thin corrugated spring metal. The armature is best shown in Figs. 5 and 11, Fig. 5 showing its central opening q, which in the preferred construction is bridged by a three-armed connecting-piece or spider K. This spider is preferably punched from a thin sheet of highly-elastic metal, such as phosphor-bronze, its three arms being then cross-corrugated in the manner shown, on an enlarged scale, in Fig. 12, thereby forming three radial spokes q' q'. The outer ends of these spokes are riveted to the armature-disk F, while the center of the spider K is fastened to a hub K', Figs. 6 and 7, which in turn is fastened by a set-screw or otherwise on the spindle F'. By this construction the vibrations induced in the armature are almost wholley taken up in the corrugated spokes, so that but little vibration is communicated to the spindle. This improvement greatly diminishes the humming noise of the meter and reduces the wear of the jewel to a minimum. While the use of yielding spokes of cross-corrugated sheet metal is preferred, any other suitable yielding connection between the armature and spindle may be substituted, this connection being either in the nature of yielding or elastic spokes or of any other suitable form or arrangement, the invention in this respect being susceptible of a wide range of variation. To more effectively diminish vibration and noise, I combine with the yielding intermediary between the armature and spindle a yielding intermediary between the spindle and its bearing-support. The latter yielding intermediary may be any sort of vibratory bearing adapted to take up or absorb a large part of the vibration of the spindle and being applied, preferably, to its upper end diminishes the vibration that is transmitted to its lower end, and hence diminishes the wear of the jewel. I have found that such yielding bearing alone is insufficient to suppress the vibration and render the meter silent and that the yielding intermediary between the armature and spindle if used alone is insufficient to render the meter silent; but by applying both these yielding intermediaries in combination I find that they so coöperate with one another as to effectually absorb the vibration and suppress noise. The vibratory bearing for the spindle is best made of a pin or wire of resilient metal, as tempered steel, long and slender enough to afford the requisite freedom of vibration, fixedly supported at one end, and effecting the pivotal engagement at its opposite end. The preferred construction is that shown in Figs. 6 and 7, where the upper end of the spindle is counterbored to form a socket r and a fixed journal or pivot-pin L is provided, projecting down into this socket. The pivot L is best made of a pin of resilient wire, preferably piano-wire, its upper end being driven tight into a socket in a bearing-sleeve r', which for the greater portion of its length is counterbored at r^2, forming a long tubular chamber in which the pivot-pin L may vibrate. This construction facilitates the lubrication, since the socket r serves as an oil-cup to retain the oil required for lubrication.

I make no claim herein to a spindle having an oil-receiving socket in its upper end entered by a flexible pin, this being claimed in my application Serial No. 231,843, filed November 8, 1904.

The bearing-piece r' is fastened by a set-screw in a boss r^3, fixed on the bracket-arm f', so that the bearing-piece can be readily adjusted to the desired height. The lower or jeweled bearing, which is clearly shown in Fig. 6, presents in itself no novelty. The lower end of the spindle has a hardened pivot-pin s inserted, the rounded lower end of which rests on and turns against the jewel s', which is fixed in a plug pressed up by a spring s^2 to prevent shocks damaging the jewel during careless handling or otherwise. It is common to provide means for elevating the spindle in order to lift the pivot s off from the jewel during transportation, this means commonly consisting of a screw-cap t, formed with female threads, which engage male threads t', formed upon the exterior of the lower bearing h'. The defect of this device heretofore has been that it was possible to screw up the cap too high, and thereby clamp the spindle too tightly against the upper bearing, with the consequent liability of springing or injuring some of the delicate parts of the meter. This is prevented by an improved construction, (shown in Fig. 7,) the screw-threads t' being omitted from the upper part of the bearing h and terminating at such point that when the cap has been screwed up just far enough to lift the spindle to the desired height above the jewel its threads will run off the male threads, so that any further turning of the cap cannot lift it any higher. In this position the central hole in the cap engages the lower part of the spindle and holds it centered, the cap being held centered by the engagement of its threaded portion with the unthreaded upper part of the lower bearing. The spindle when thus lifted is forced or clamped tightly against the lower end of the upper bearing-piece r', the latter being set at such height that the upper end of the spindle will bear against it upon the screwing up of the cap t to its extreme height, where its threads disengage with those of the lower bearing. The spindle is thus firmly held, so that neither spindle nor jewel can receive any injury during transportation. The same movement elevates the armature-disk, so that it bears against the overlying pole of the damping-magnet G, whereby it is held against injury by any shocks incident to transportation.

Although the moving parts are made of extreme lightness and friction is reduced to the minimum, nevertheless the friction is sufficient to affect the accuracy of the meter at starting and under a very light load (such as one incandescent lamp) unless compensated for. It is usual to employ a compensating device adapted to increase the starting-torque or just balance the static friction. A suitable expedient is an adjustable plate M, preferably of copper, which overlies the lower pole-piece C^2 between it and the armature, and is adjustable to uncover more or less of the pole-piece. Other forms of friction adjustment are known. With any such friction adjustment difficulty is experienced in making an exact adjustment of the position of the adjustable piece. To facilitate the adjustment or readjustment of this piece and enable it to be securely held after adjustment, I provide it with an adjusting device. (Shown best in Fig. 3.) The plate M is punched from sheet metal, with a projecting tongue M', (shown in dotted lines in Fig. 18,) which is bent under it, and in the eye formed by the bend is soldered a screw-threaded rod u. This rod passes loosely through a hole in a post N, fixed conveniently to the plate I', and which has a slot in which turns an adjusting-nut u', engaging the threads on the rod u. Fixed in the post N is a guide-pin v, which projects parallel with the rod u and enters between the main plate M and its folded-under tongue M' in the position indicated in dotted lines at v in Fig. 19. The elasticity of the sheet metal causes it to grasp the pin v firmly enough to prevent any looseness or rattling. A set-screw v', screwing in a hole in the post N, bears against the nut u' to hold it in place after adjustment. To adjust the plate M, it is only necessary to turn the nut u', (the set-screw v' being loosened,) whereby the screw-rod u is propelled to right or left and advances or retracts the plate M. When the correct position is attained, the screw v' is tightened. This affords a very simple and inexpensive mounting and adjusting and fastening means for the plate M. While it is preferable to make the tongue M' integral with this plate, yet this is not essential, as any construction of tongue that will yieldingly embrace the guide-pin v will answer.

The series coils E E are mounted on special supports P P'. The supports P P' are alike, except that they are relatively inverted. Each has an ear w, preferably reinforced by soldering a nut to it, as shown, for attachment by a suitable screw to the supporting-plate I, a bracket-arm w' in a plane perpendicular to that of the ear—that is to say, extending horizontally parallel to and adjacent to the armature—and two rounded lugs $w^2 w^2$, projecting into the coil and engaging the opposite ends thereof, these lugs being elastic and pressing outwardly, so as to hold the opposite ends of the elliptical coil with great firmness. The support P for the upper coil E has its lugs w^2 projecting upwardly, while the support P' for the lower coil E has these lugs projecting downwardly, as clearly shown in dotted lines in Fig. 1. The projecting plates w' are spaced sufficiently apart to enable the armature to freely revolve between them. By this construction the removal of two fastening-screws, one for each support, enables the series coils to be disconnected.

The means for making circuit connections with the instrument will now be described.

The connection-chamber B incloses tubular posts of novel construction. (Shown in Figs. 1, 4, and 5.) The connection-chamber is formed of a rectangular box traversed interiorly by the binding-posts Q R R, these being arranged, preferably, on the same level, so as to be equally accessible from the top when the cover B' is removed. The rear binding-post Q is constructed of a tube, preferably of brass, the opposite ends of which are inclosed in insulating-bushings S S, placed in holes through the end walls of the connection-chamber box. These bushings are introduced from the interior and have flanges on their inner ends. The binding-post Q is constructed to serve also as a clamping-stud for holding the bushings in place and exerting outward pressure against them, tending to force their flanges tightly against the inner faces of the end walls of the box. To this end the binding-post is provided near one end with a flange or spring-collar x, adapted to bear against the flange of one bushing, and at the other end it is screw-threaded and engaged by a nut y, which is screwed out to bear against the flange on the opposite bushing. This nut is preferably peripherally notched, as shown to the right of Fig. 1, so that it may be turned by a key from above. The flange or collar x is preferably made removable, so that it may be applied to the binding-post after the latter is in place within the box. Accordingly it is made in the shape of a washer, as shown at x to the left of Fig. 1, and the binding-post tube is formed with a groove x', forming a reduced neck adapted to enter the notch in the flange or washer x. The flange or washer x is also made concave or dished and of elastic metal, so that it serves as a spring-washer in order that when tightened against the bushing it will elastically follow up the bushing in case the latter should shrink, and thereby keep the parts firm and tight. The parts are put together by first placing the bushings in their holes in the box, then introducing the tube Q from the left through the bushing, screwing the nut y on its threaded end, pushing it through into the opposite bushing, so as to expose the groove x', and pushing the washer x down into this groove, then tightening the nut y to force the tube toward the left and put the spring-washer under tension, after which the binding-screws $z z$ are inserted. The portion of the bushing S which is within the opening through the casing surrounds the screw-threaded end of the tube and insulates it from the casing, while the flange of the bushing serves similarly to insulate the nut from the casing against which it is pressed. The binding-posts R R differ from the binding-post Q only in that the metal tube is divided at the middle and an insulating-piece R' is inserted in order that the current shall pass around this insulation through the series coils. Otherwise the construction is identical with that of the binding-post Q. The right-hand binding-post R can be inserted from the top, fitted to the left-hand one, which is inserted from the left through the bushing, and thereupon the two be manipulated as one in precisely the same manner as in assembling the binding-post Q. The binding-posts R R are formed with notches at one side, into which are soldered the series wires 2 3, which form the terminals of the series coils E E and which from said coils pass up through insulating-bushings fitted in holes in the bottom of the chamber B. The terminal wires 4 5 of the shunt-coils D D are connected, respectively, to the binding-posts Q and R. The wire 4 passes up through an insulating-bushing into the chamber B and at its end is clamped by a screw 6 to the binding-post Q, while the other end of the shunt-circuit 5 passes up through another insulating-bushing and is clamped by a similar screw to the binding-post R. The circuit connections are made in the manner indicated in diagram in Fig. 4, the line-wires being connected on the left and the load-wires on the right. The wires are usually bared for a short distance, their bared ends being thrust into the binding-posts, with the insulation on the wire passing into the insulating-bushings S and pressing tightly against the end of the binding-posts, whereupon the screws z are tightened on them. When all the connections are thus made, the cover B' is put in place and fastened down by its fastening-screw B^2. To prevent any possible short-circuiting from one binding-post or its connections to the other, as by the careless use of a screw-driver, the chamber B is divided by an insulating-partition B^3, made of any insulating board or plate, which is sprung in, as shown in Fig. 4, its ends entering grooves or notches in the end walls of the chamber. The connection-box and binding-post construction thus described presents several advantages. It is extremely simple and cheap, and the parts can be put together with the utmost facility. The tightening of one nut y clamps fast simultaneously the two bushings at opposite ends. The spring-washer x takes up a considerable amount of shrinkage in the bushings before the parts can become loose. Even if the shrinkage should be such as to loosen the parts, the bushings cannot come out nor can the circuit connections become loose or be rendered accessible, so that they could be tampered with without breaking the seal. The shunt-circuit connection is made wholly within the chamber, so that it is protected from tampering and by the same seal used to protect the other connections, and means is provided for guarding against any accidental short circuit in case connections are made while the current is on.

A novel mode of sealing the meter-case will now be described.

The front shell A′ is fastened to the rear shell by two screws T and T′, Fig. 5. These, with the screw B^2, which fastens down the cover B′, require to be sealed in order that any opening or tampering with the meter may be detected. For this purpose the heads of these screws are inclosed each in a countersink or recess 7, the nick or slot for receiving the screw-driver is made somewhat wider than usual, and a small hole 8 is drilled through the walls of the recess or housing in line with the nick in the screw-head, and through this hole and the coinciding nick is passed the seal-wire 9, to which is applied a lead or other seal 10 in any usual manner. The screw-head closely fills the recess or countersink, so that even if the wire were to be pulled or pried up as far as possible out of the nick any attempt to turn the screw would result in shearing off the wire, and thus such tampering would be detected. Heretofore seals have been made by drilling a hole through the housing and screw after the latter was inserted, which is not only difficult and expensive, but weakens the screw. Washers have also been placed on top of the screw and the sealing-wire threaded through them; but these washers are liable to be lost and can be raised up and the screws turned back, allowing access to the interior of the meter-case. The present improvement affords equal security, requires no special screw, admits of the holes being drilled during the making of the parts and irrespective of their final assembling, and enables the screws to be tightened to within a half-turn at any time that the shell and cover are applied.

It must not be inferred from the particularity with which the preferred construction shown is described that this invention is limited to the details thereof, since, in fact, the invention is susceptible of a wide range of modification or variation without departing from its essential features.

I claim as my invention the following-defined novel features, substantially as hereinbefore specified, namely:

1. In an electric meter, a disk armature having a large central opening, its spindle passing centrally through said opening, and yielding supporting means interposed between the disk and spindle.

2. In an electric meter, an annular disk armature, its spindle, and flexible spokes connecting them.

3. In an electric meter, an annular disk armature, its spindle, and corrugated sheet-metal spokes connecting them.

4. In an electric meter, an annular disk armature, its spindle, and an interposed spider having arms of flexible material supporting said disk.

5. In an electric meter, an annular disk armature, its spindle, and interposed elastic supporting means.

6. In an alternating-current meter, the combination of a disk armature, coils generating an alternating field in which said armature turns, a spindle for said armature, a yielding intermediary between the armature and spindle, and a yielding intermediary between the spindle and its bearing-support.

7. In an electric meter, an armature-spindle, a lower bearing therefor, and a lifting device therefor having a limited range of movement so that it cannot lift the spindle too high.

8. In an electric meter, an armature-spindle, a lower bearing therefor, and a lifting device therefor comprising a screw-cap engaging a threaded part, the threads on the latter terminating at such level as to be disengaged by those on the cap when the spindle is lifted to the desired limit.

9. In an electric meter, a core forming an open magnetic circuit with an air-gap and outturned legs extending beyond said air-gap and widely separated so as to avoid any closed magnetic circuit between them.

10. In an electric meter, a core forming an open magnetic circuit with pole-pieces approaching each other and forming between them an air-gap, a shunt-winding applied within said pole-pieces, and a series coil arranged beyond them, with a disk armature revolving in said air-gap and in proximity to said series coil.

11. In an electric meter, a core forming an open magnetic circuit comprising connected legs C′ C′, pole-pieces C^2 C^2, and outturned legs C^3 C^3, with a shunt-winding on said core generating a magnetic flux through the legs C′ C′ pole-pieces C^2 C^2 and air-gap between said pole-pieces and without any closed magnetic circuit between the legs C^3 C^3.

12. In an electric meter, a core comprising sections or stacks of punchings *b c c*, the section *b* abutting against the ends of the sections *c c*, and pairs of outer plates *c′ c′* embracing between them the sections *c c* and overlapping and embracing the ends of the section *b*, with screws *e* passing through holes in the punchings and engaging the plates *c′ c′* for drawing them together and holding the sections together.

13. In an electric meter, a core, a support-

ing-plate in two sections fastened against the core with a space between them, and shunt-coils surrounding the core and confined in said space.

14. In an electric meter, a core, a supporting-plate in two sections I I′ fastened against the core, said plate-sections having bracket-arms for supporting the totalizer, and upper and lower bracket-arms for supporting the armature-spindle bearings.

15. In an electric meter, a totalizer having rearwardly-projecting ears with slots opening respectively rearwardly and laterally, combined with supporting-brackets having set-screws for engaging the slots in said ears.

16. In an electric meter, a totalizer having rearwardly-projecting ears with open slots, combined with supporting-brackets having set-screws for engaging said ears, and gaging-pins and notches formed on the totalizer and brackets respectively for insuring the correct location of the totalizer relatively to its supports.

17. In an electric meter, a totalizer having rearwardly-projecting ears, combined with brackets having set-screws for engaging said ears, one of said ears formed with an open slot whereby by loosening the set-screws the totalizer may be swung around the other ear as a pivot.

18. In an electric meter, a damping-magnet, a supporting-plate fastened thereto, a supporting-bracket to which said plate is fastened, said plate and bracket provided respectively with slots and set-screws permitting of an adjustment of the damping-magnet, and a gage fastened to said magnet adapted to locate the position to which the magnet is adjusted and enable it if removed to be replaced to the same position.

19. In an electric meter, a damping-magnet, a supporting-plate fastened thereto projecting rearwardly and having slots, a supporting-bracket having set-screws engaging said slotted plate to permit the adjustment of the magnet, and a gage fastened adjustably to said magnet and adapted to abut against said bracket, for the purpose set forth.

20. In an electric meter comprising a core having a polar projection, a winding for energizing the core, and an armature rotating adjacent to said projection, a friction adjustment comprising a plate adjustable relatively to said core, a screw secured to said plate, a nut engaging said screw, and a fixed support for said nut, whereby the turning of said nut displaces said plate.

21. In an electric meter, a friction adjustment comprising a plate M, a screw *u* fastened thereto, a fixed support N through which said screw passes and having a recess, and a nut engaging the screw and turning in said recess.

22. In an electric meter, a friction adjustment comprising a plate M, a screw *u* fastened thereto, a fixed support N through which said screw passes and having a recess, a nut engaging the screw and turning in said recess, and a set-screw screwing in said support and adapted to be tightened against said nut.

23. In an electric meter, a friction adjustment comprising a plate M having a yielding tongue M′, a screw adjustment for displacing said plate, and a fixed guide-pin *v* embraced between said tongue and plate.

24. In an electric meter, a friction adjustment comprising a plate M having a projecting tongue M′ bent back on it and forming an eye, a screw *u* fastened in said eye, a fixed guiding-pin *v* extending parallel with said screw and embraced between the tongue and plate, and adjusting means engaging said screw for displacing the plate.

25. In an electric meter, a series coil and a support therefor comprising a plate having lugs entering the coil and pressing outwardly against it.

26. In an electric meter, a series coil and a support therefor comprising a plate having a fastening-ear, a bracket-arm, and two lugs entering the coil and pressing outwardly against it.

27. In an electric meter, a supporting-plate I, a core, two series coils E E confined between the core and said plate, and supports for the coils comprising plates fastened to the plate I and having lugs entering the coils.

28. In an electric meter, a series coil, and a support therefor comprising a plate having a bracket-arm, two lugs projecting therefrom entering the coil at opposite points and pressing outwardly against it, each lug expanded laterally to form rounded ears engaging the opening within the coil.

29. In an electric meter, binding-posts formed of two alined tubular metallic sections, an insulating-piece uniting their adjacent ends, and insulating-supports for their outer ends.

30. In an electric meter, binding-posts adapted to receive at one end of the casing the line-wires and at the other end the load-wires, the one formed of a continuous tube Q, and the others of a divided tube R R, with an interposed insulation R′ and supports for the outer ends of said divided tube.

31. In an electric meter, a casing formed with a connection-chamber partitioned off from the main chamber, and binding-posts in said connection-chamber adapted to receive both the line and the load wires, the series winding of the meter connected between two of said binding-posts, and the shunt-winding connected between one of the same two and a binding-post for the opposite line-wire, all the meter connections being inclosed within said connection-chamber.

32. In an electric meter having a casing, insulating-bushings entering opposite holes in the casing and flanged on their inner ends, a binding-post comprising a tube with its ends

engaging said bushings, and means engaging said tube for forcing the bushings from each other to hold them in their respective holes.

33. In an electric meter having a casing, insulating-bushings entering opposite holes in the casing and flanged on their inner ends, a binding-post comprising a tube with its ends engaging said bushings, a flange on said tube engaging one bushing and a nut thereon engaging the other to force the bushings from each other to hold them in their respective holes.

34. In an electric meter having a casing, insulating-bushings entering opposite holes in the casing and flanged on their inner ends, a binding-post comprising a tube with its ends engaging said bushings, said tube being formed with a groove near one end, a detachable collar entering said groove to form a flange on the tube, and a nut screwing on the opposite end of the tube.

35. In an electric meter having a casing, insulating-bushings entering opposite holes in the casing and flanged on their inner ends, a binding-post comprising a tube with its ends engaging said bushings, and means engaging said tube for forcing the bushings from each other, said means including a resilient part adapted to yield as the parts are tightened, and subsequently to expand and take up any shrinkage of the bushings.

36. In an electric meter having a casing, insulating-bushings entering opposite holes in the casing and flanged on their inner ends, a binding-post comprising a tube with its ends engaging said bushings, a spring-washer engaging said tube near one end and bearing on one bushing, and a nut screwing on the tube near the other end and bearing on the other bushing.

37. In an electric meter, binding-posts, and an insulating-partition separating the binding-posts of opposite potential to protect against accidental short-circuiting.

38. In an electric meter, a casing having a fastening-screw with its head entering closely within a deep socket, a hole through said socket coinciding with the nick in the screw-head, and a seal-wire traversing said hole and nick, whereby the turning of said screw will shear the wire.

In witness whereof I have hereunto signed my name in the presence of two subscribing witnesses.

JAMES J. WOOD.

Witnesses:

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