(No Model.)

4 Sheets—Sheet 1.

J. KELLER.

REGULATOR FOR DYNAMO ELECTRIC MACHINES.

No. 506,881. Patented Oct. 17, 1893.

Fig. 1

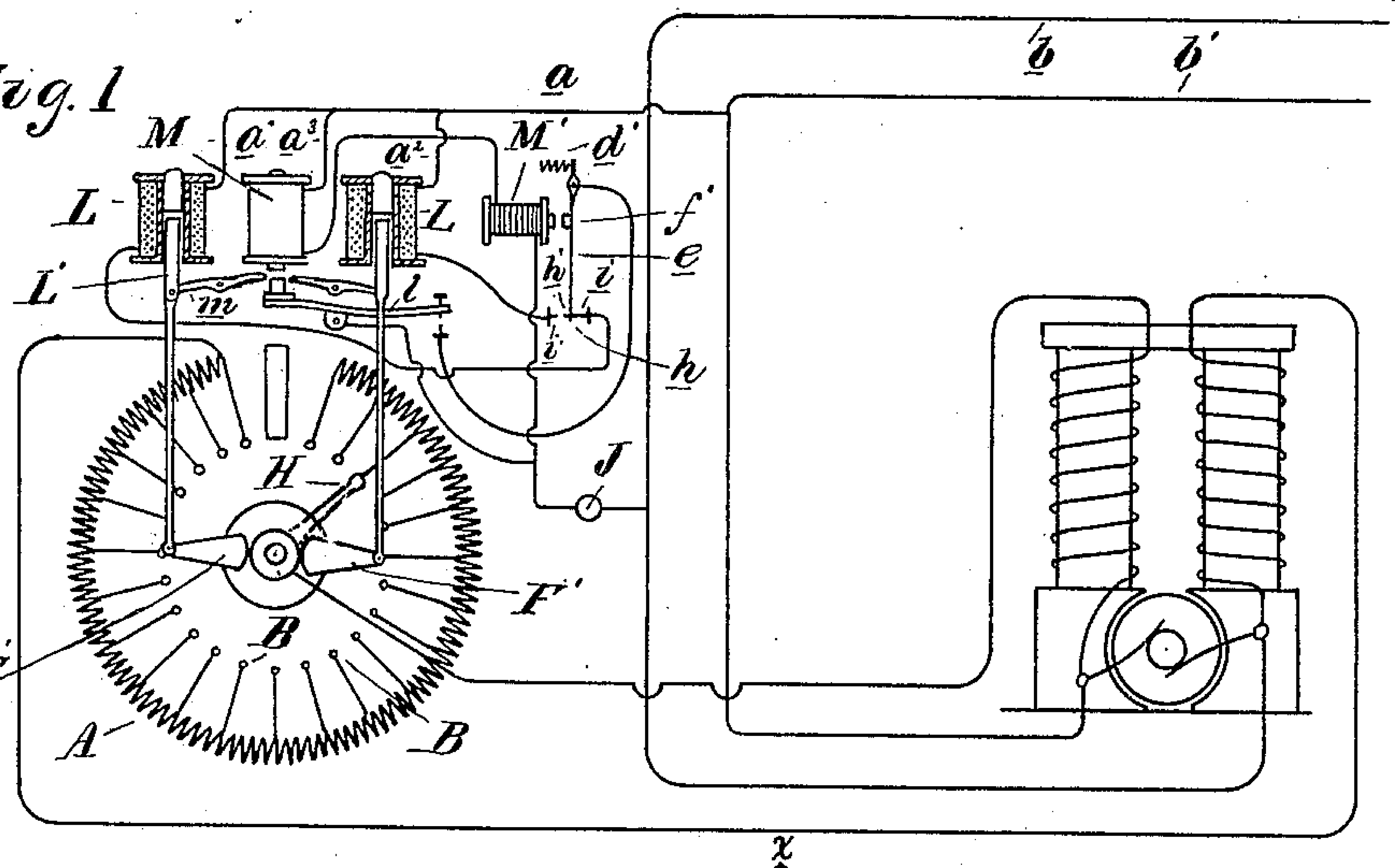
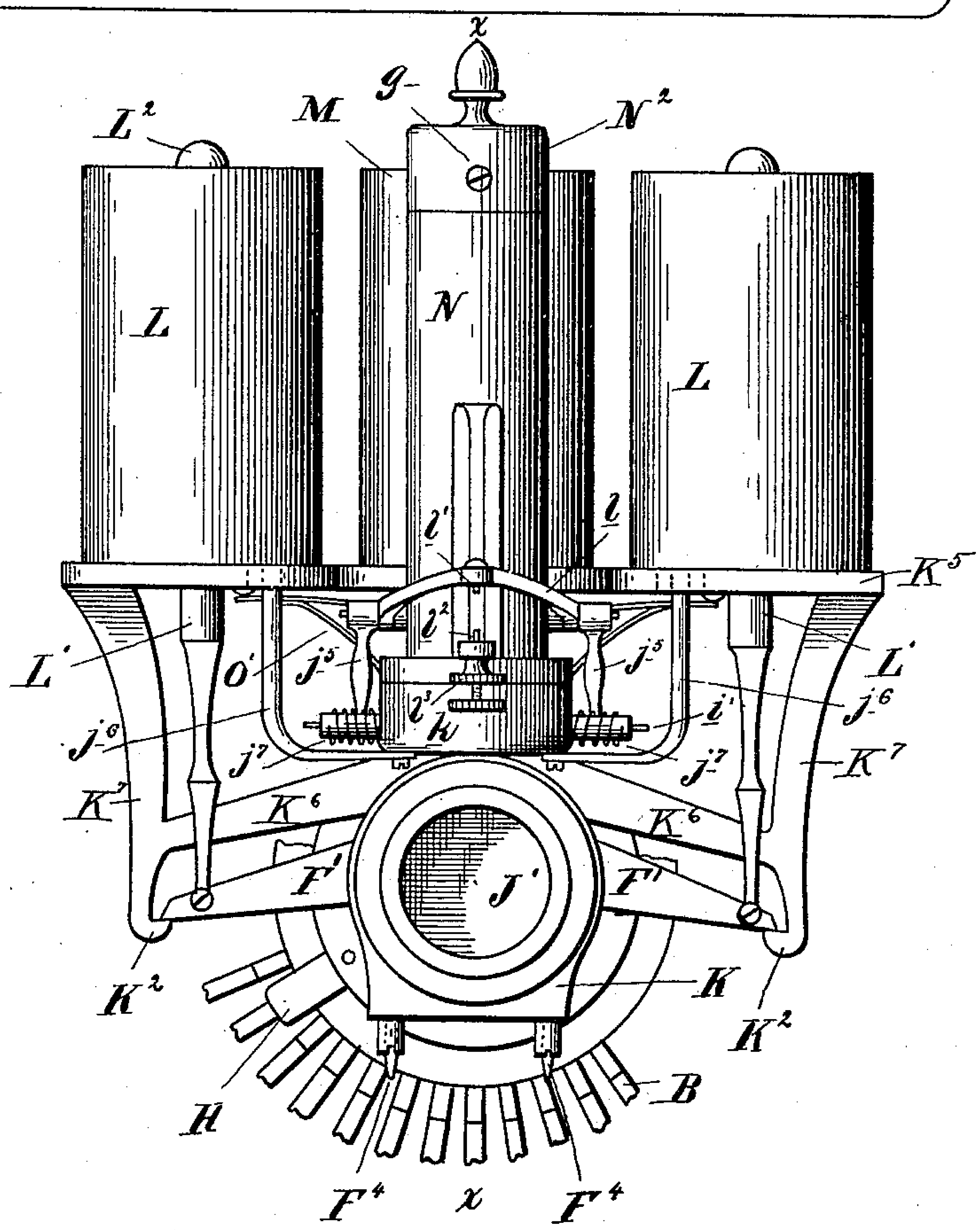


Fig. 2



Witnesses:

P. M. Hulbert

N. L. Lindop.

Inventor:

Jeremiah Keller

By Thos. S. Sprague & Son

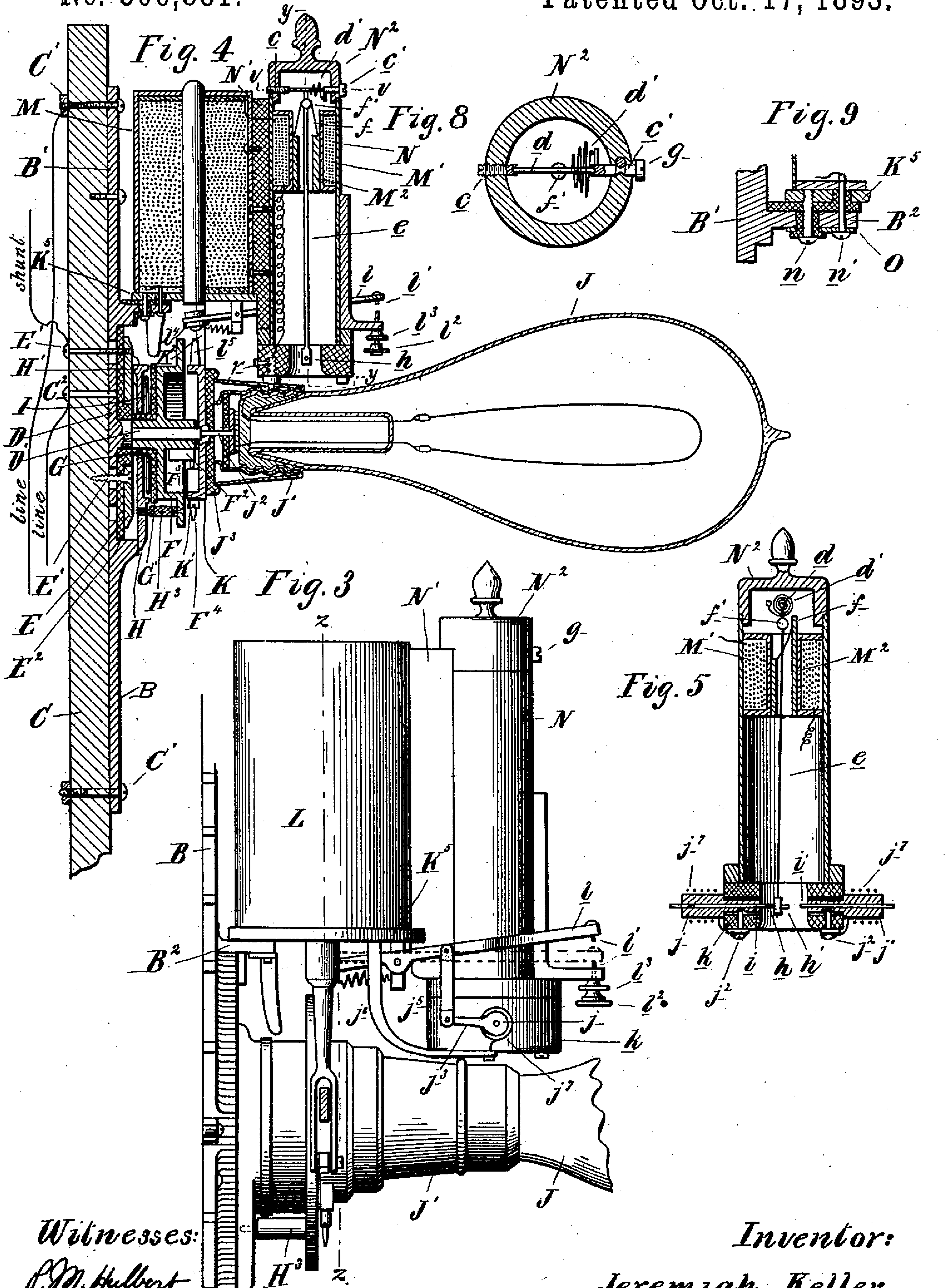
Att'ys

(No Model.) 4 Sheets—Sheet 2.

J. KELLER.

REGULATOR FOR DYNAMO ELECTRIC MACHINES.

No. 506,881. Patented Oct. 17, 1893.



Witnesses:
P. M. Hulbert
N. L. Lindop

Inventor:
Jeremiah Keller
By Thos. S. Sprague & Son
Att'ys

(No Model.)

4 Sheets—Sheet 3.

J. KELLER.

REGULATOR FOR DYNAMO ELECTRIC MACHINES.

No. 506,881.

Patented Oct. 17, 1893.

Fig. 6

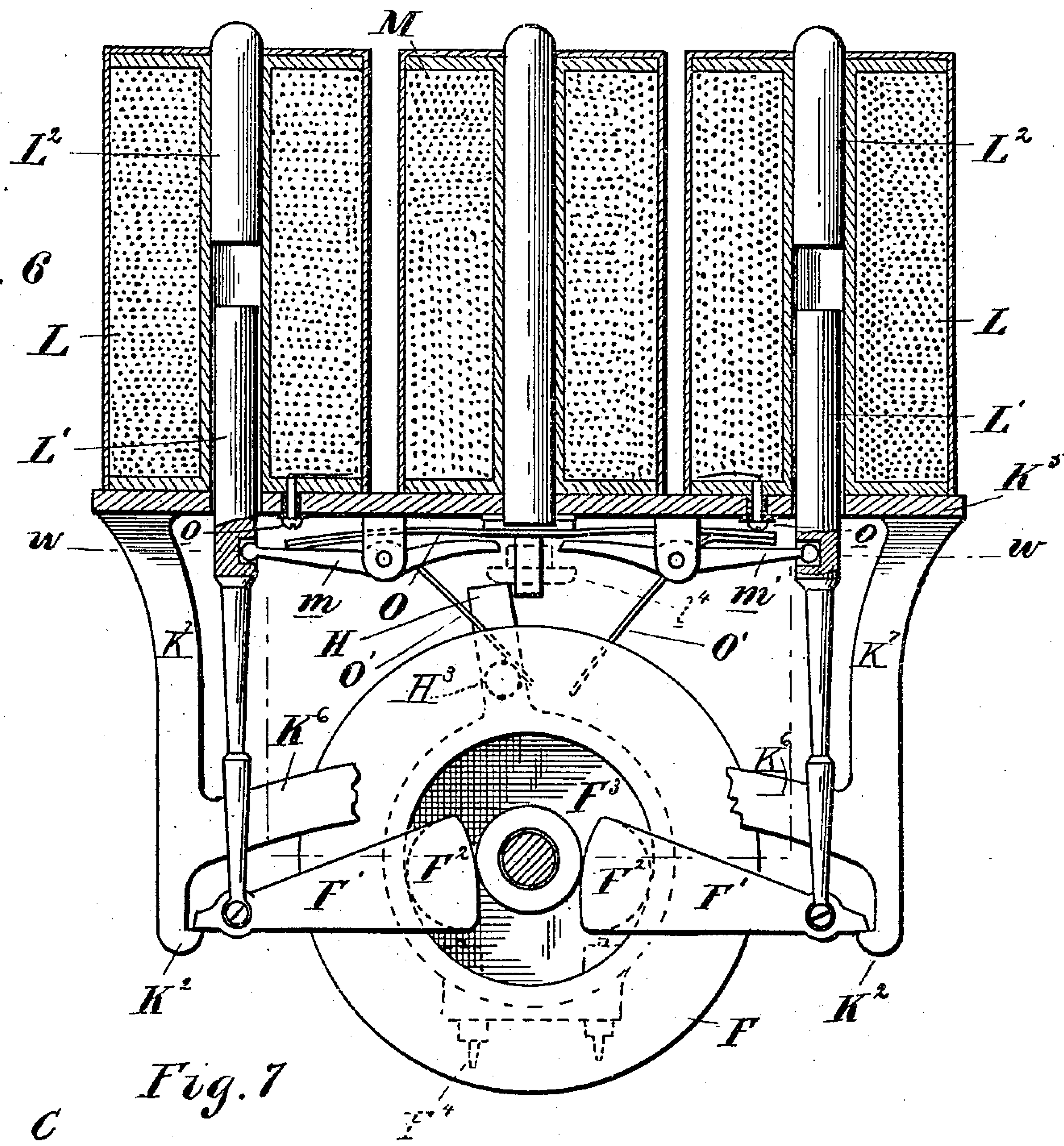
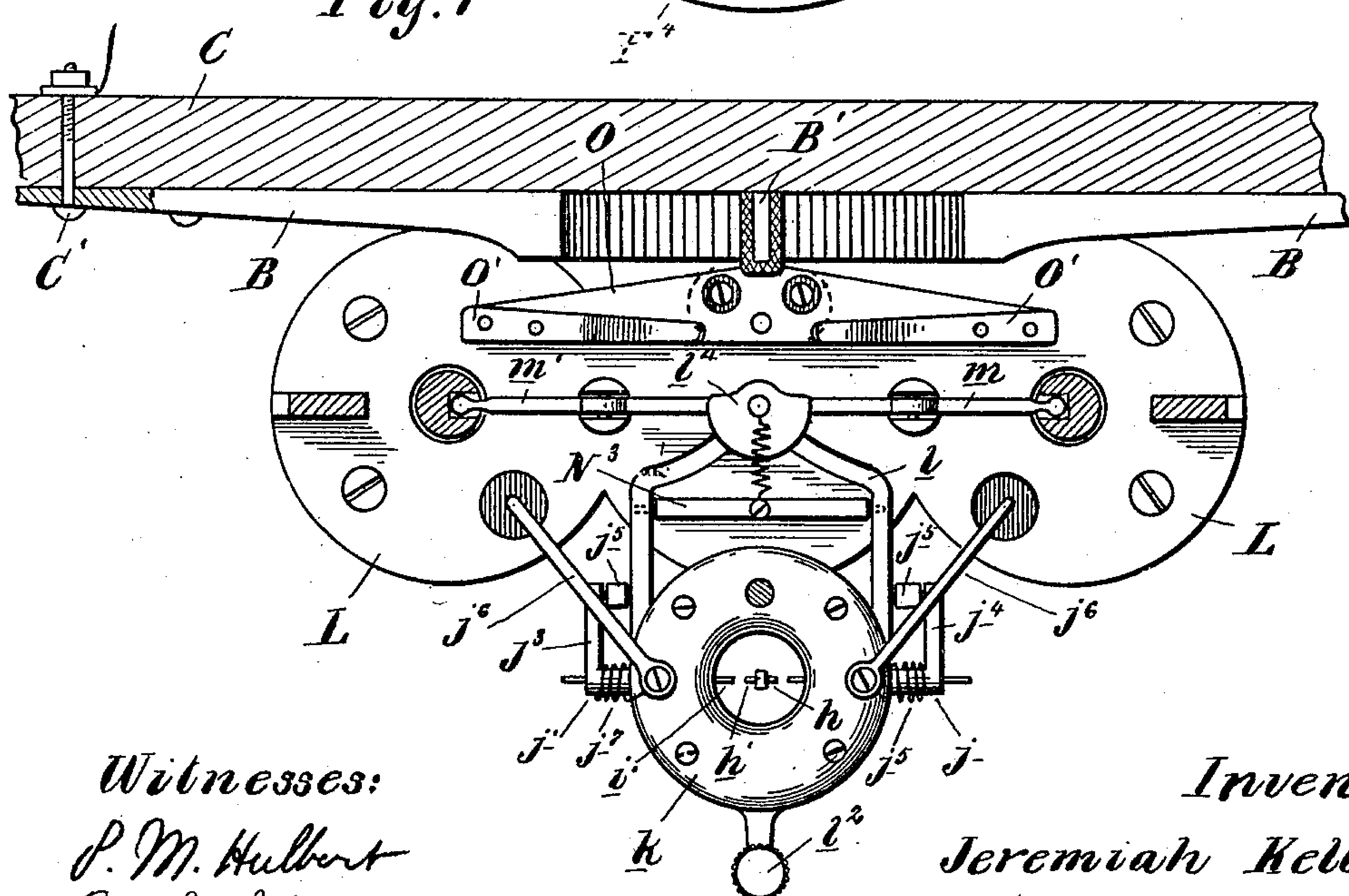


Fig. 7



Witnesses:

P. M. Hulbert

N. L. Lindop.

Inventor:

Jeremiah Keller

By Thos. S. Sprague & Son

Attys

(No Model.) 4 Sheets—Sheet 4.

J. KELLER.

REGULATOR FOR DYNAMO ELECTRIC MACHINES.

No. 506,881. Patented Oct. 17, 1893.

Fig. 10

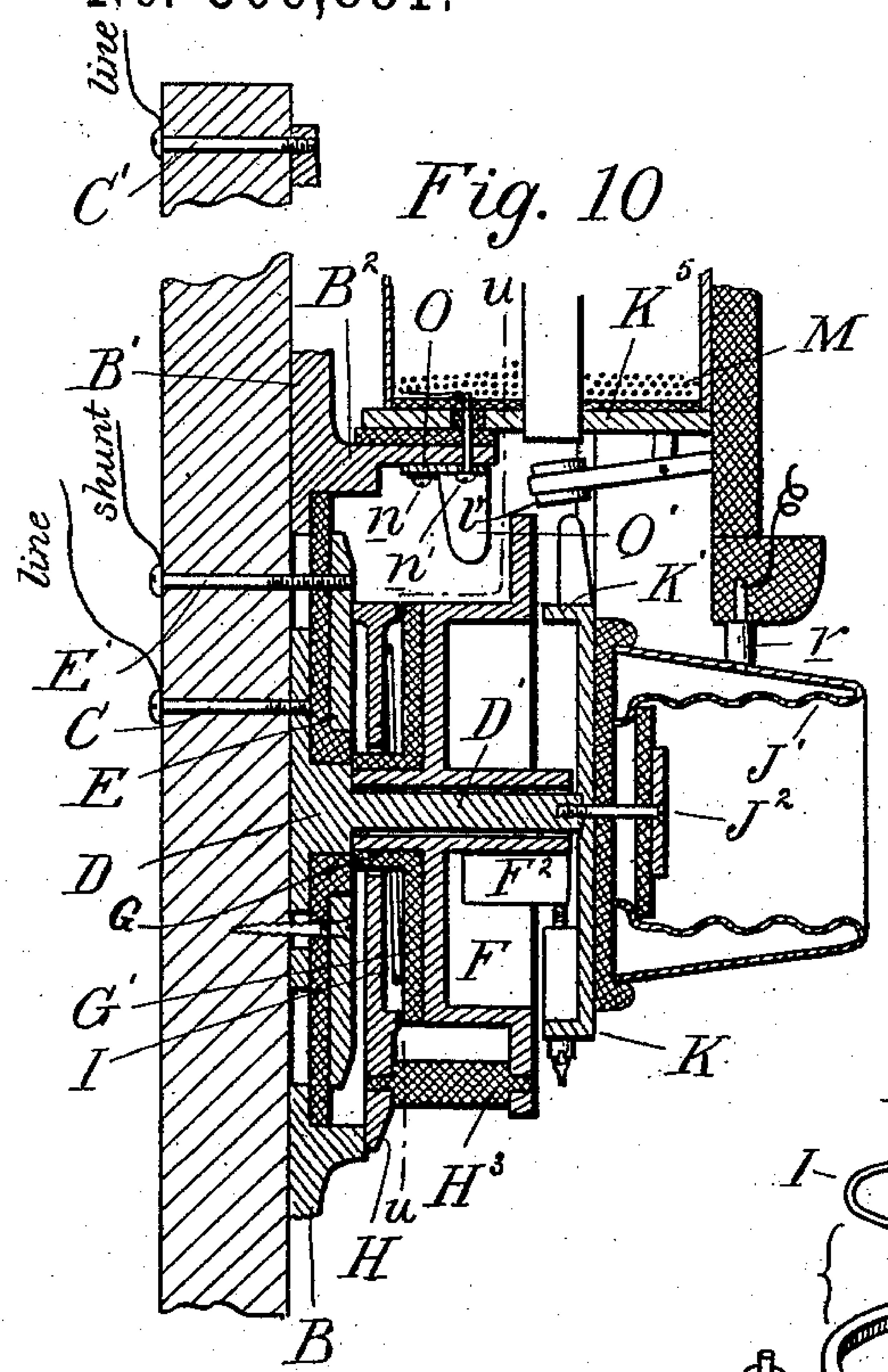


Fig. 11

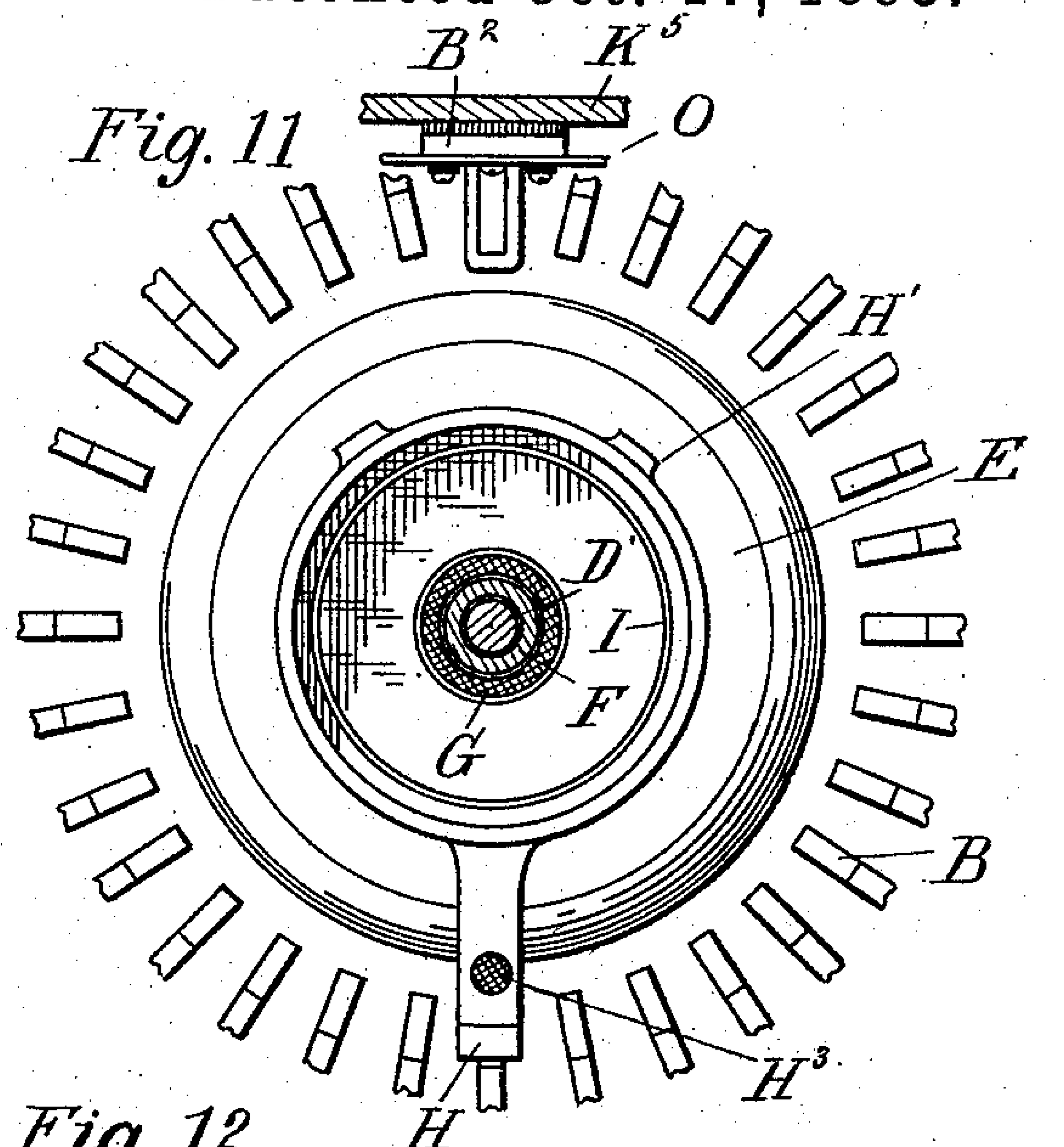


Fig. 12

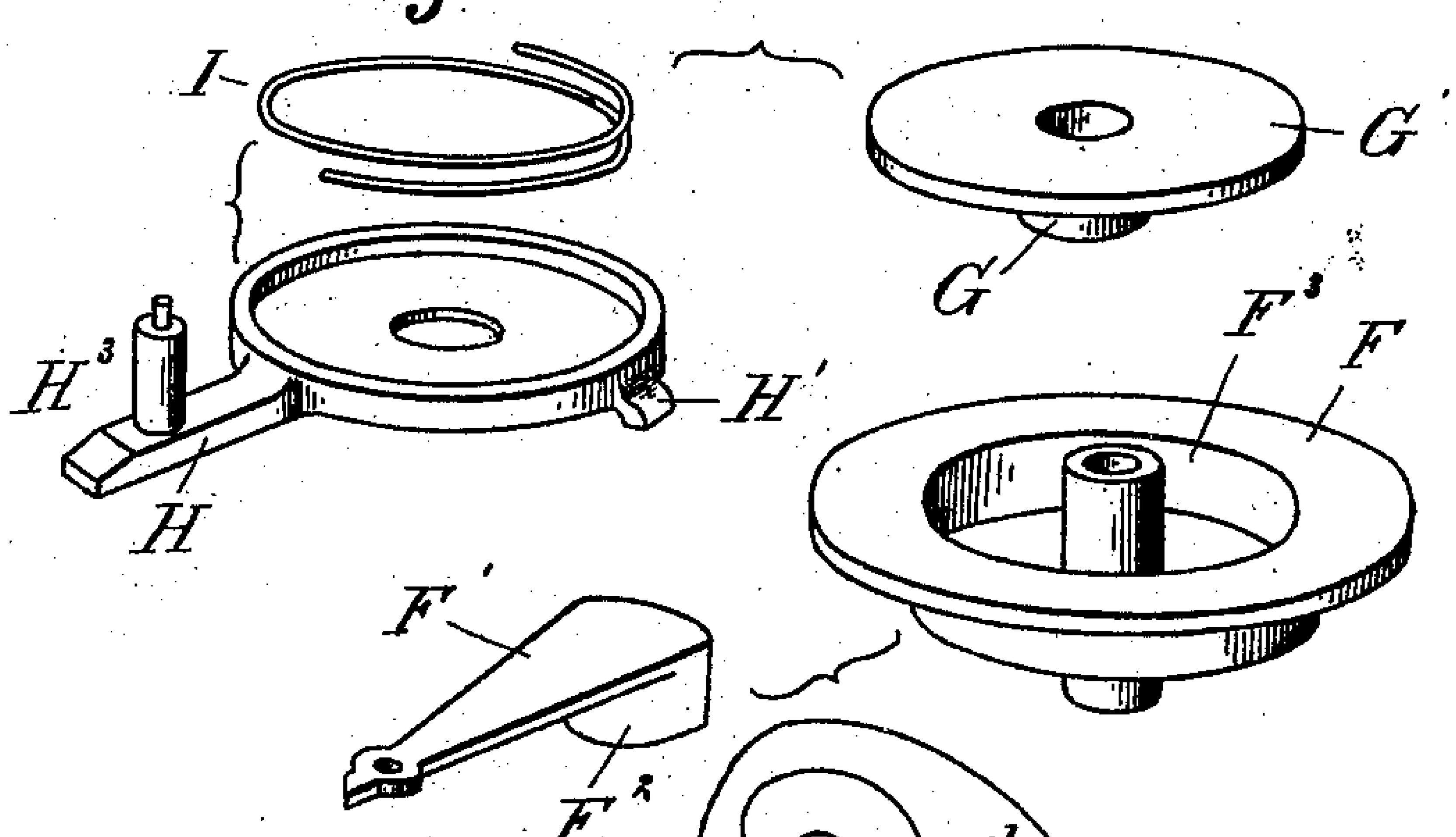


Fig. 13

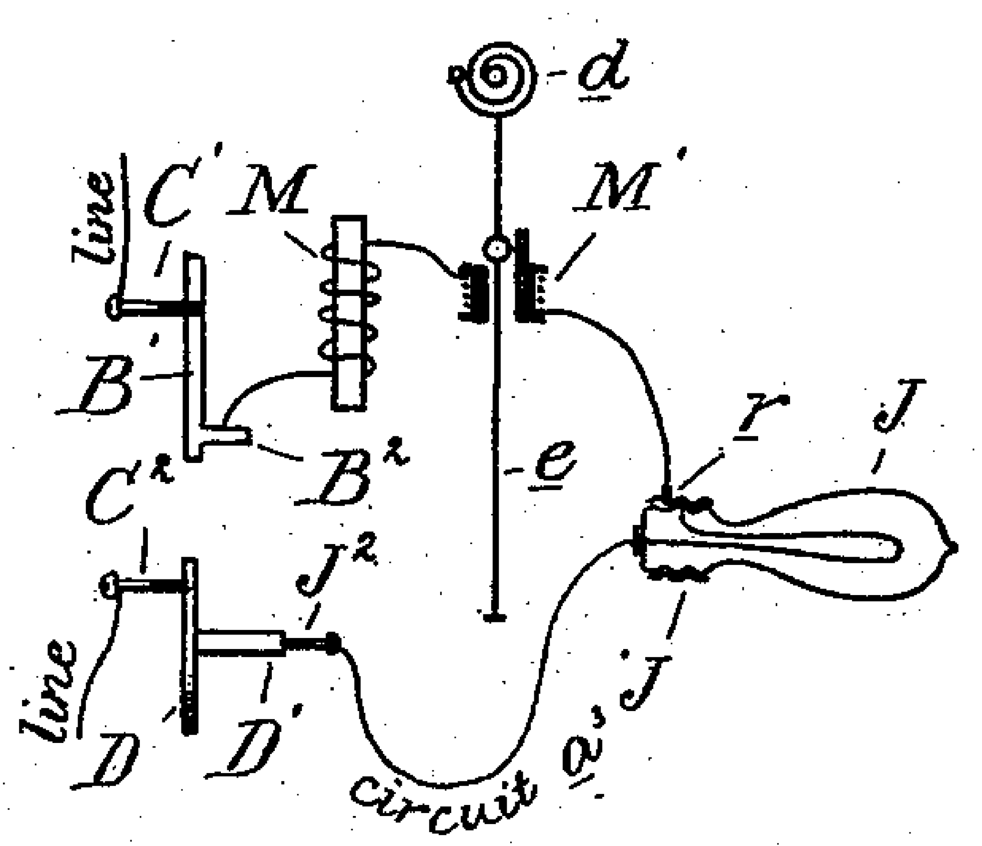
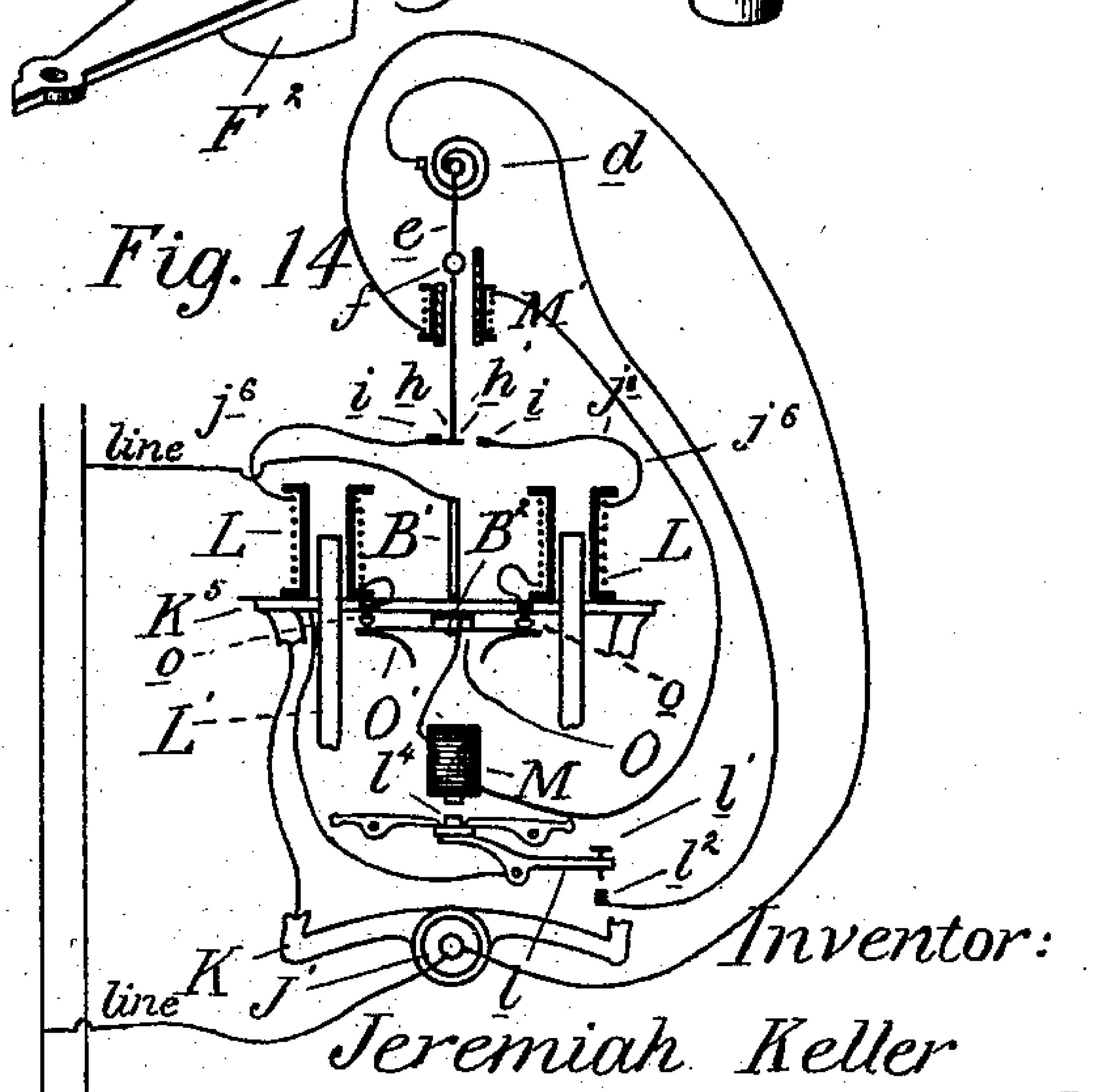


Fig. 14



Witnesses:
P. M. Hulbert
N. L. Lindop

Inventor:
Jeremiah Keller
By Thos. S. Sprague & Son
Attys.

UNITED STATES PATENT OFFICE.

JEREMIAH KELLER, OF CANTON, OHIO.

REGULATOR FOR DYNAMO-ELECTRIC MACHINES.

SPECIFICATION forming part of Letters Patent No. 506,881, dated October 17, 1893.

Application filed October 10, 1891. Serial No. 408,380. (No model.)

To all whom it may concern:

Be it known that I, JEREMIAH KELLER, a citizen of the United States, residing at Canton, in the county of Stark and State of Ohio, have invented certain new and useful Improvements in Electric-Current Regulators, of which the following is a specification, reference being had therein to the accompanying drawings.

My regulator applies to such dynamos in which the shunt system is used in which the electro-motive force is kept constant while the magnetic intensity of the field in which the armature rotates is regulated according to the requirements by throwing resistance in or out.

Figure 1 is a diagram of my improved regulator. Fig. 2 is a front elevation. Fig. 3 is a side elevation. Fig. 4 is a vertical central section on line *x—x* Fig. 2. Fig. 5 is a vertical section on line *y—y*, in Fig. 4. Fig. 6 is a vertical section on line *z—z* in Fig. 3. Fig. 7 is a horizontal section on line *w—w* in Fig. 6, looking at the under side. Fig. 8 is a horizontal section on line *v—v*, Fig. 4, and Fig. 9 is an enlarged sectional view showing the manner of securing the shelf holding the motor magnets in position. Fig. 10 is an enlarged sectional view similar to Fig. 4. Fig. 11 is a sectional view on the line *u u* of Fig. 10. Fig. 12 shows in perspective, some of the parts detached, and Figs. 13 and 14 are diagrams showing the different circuits.

A represents diagrammatically the resistance used in connection with my regulator. It is as usual, a wire coil preferably inclosed in a separate box (not shown).

B represents a circular series of metallic contacts, to which the resistance is connected at intervals. The contacts B are preferably constructed in the form of metal bars, thickened at the inner ends and radially grouped around a common center. They are secured to an insulating base C by suitable screws C′, by means of which connection is made with the resistance.

D is a metallic disk secured to the insulating base in the center of the contacts, and provided with a central post forming a stub shaft D′.

E is a metallic washer secured to the base C by means of screws or bolts E′, and insulated from the metallic disk D and the stub axle D′, by means of the interposed insulating disk E^2.

F is an interiorly faced friction pulley sleeved with its hub upon the stub axle D′.

G is an insulating bushing sleeved upon the rear end of the hub of the friction pulley and provided with a flange G′ fitting against the back of said pulley.

H is a movable contact hand sleeved upon the insulating bushing G and provided with the heel H′. This contact hand is held in metallic contact with the inner ends of the contact bars B by the tension of a spring I interposed between it and the flange G′; the flange G′ being held in place by the friction pulley F, and the latter being held in place free to turn upon the stub shaft by the frame plate K, which is secured to the free end of the stub shaft. The frame-plate K has the cross-bars K^6 extending out therefrom and connected at their outer ends to the frame K^7.

J is an incandescent lamp attached to a lamp socket J′, which is secured by means of the screw J^2 to the inner end of the stub axle D′, an insulating plate J^3 being interposed between the lamp socket and the frame plate K. The latter is provided with a circular guide flange K′ corresponding with the rim of the friction pulley F, and forming in connection with the latter a guide for the arms of the gravity friction dogs F′, which engage in the annular recess F^3 formed between the rim and hub of the friction pulley, as shown in detail in Fig. 6. These dogs are on opposite sides of the stub shaft and are free to play in a vertical plane, being held in position by being inclosed between the friction pulley and frame plate which forms a housing. The heads F^2 of the friction dogs have the peculiar curved outline shown, whereby they will bind in the annular recess F^3, if the arms or free ends of the dogs are lifted up, more or less, from their normal positions in which they are supported loosely by two rests, provided for each dog, one rest being formed by a dependent projection K^2 on the lower end of the frame K^7, which supports the outer end of the dog and the other rest being formed by a set screw F^4, which is secured into the flange K′ of the frame plate K, and which supports the inner end or head of the dog. By adjusting the set screws F^4 up or down, the degree of lost motion required to cause the dogs to bind in the annular recess can be varied and made, if desired, so small that the slightest upward movement of either of the movable cores L′, which are pivotally connected to the outer ends of the dogs, will immediately cause one of the friction dogs to bind in the annular recess of the friction pulley, and thereby turn said friction pulley, and with it the contact hand to the right or left, said contact hand being forced to turn with it by being connected thereto by the stud H^3, which is made of insulating material.

L are a pair of electro-magnets, preferably inclosed in metallic casings, and provided with the movable cores L′, above mentioned, and with the fixed cores L^2, which extend only about one half the length of the helix. The cores L′ are extended downwardly and are pivotally connected to the dogs; the magnets L L, are secured upon a horizontal shelf K^5 formed on the frame K^7, and they form the actuating motor magnets of the device; their helices are included in branches of a motor circuit *a* formed between the main line conductors *b b′*. This circuit is divided into three branches a', a^2, a^3. Two of these branches a' a^2 include the motor magnets L respectively and the third branch a^3 includes the controller magnet M and potential magnet M′. The controller magnet M is inclosed in a metallic casing secured upon the shelf K^5, between the motor magnets L, and the potential magnet M′ is secured in the upper portion of a metallic casing N, which in turn is secured to the metallic casing of the controlling magnet M, with an insulating material N′ placed between.

The casing N is provided with a cap N^2 in which are secured diametrically opposite each other two pivot pins *c c′* in which is journaled a horizontal shaft *d*, to which is secured the pendulous armature lever *e* preferably made of fine aluminum ribbon. The core M^2 of the magnet M′ is hollow and is cut away at its upper end on one side to form on the opposite a magnetic pole *f*, which is adapted to attract a small armature *f′* which has preferably the form of a ball, and is secured upon the armature lever. A fine coil spring *d′*, which as will be seen hereinafter, regulates the potential of the current is coiled upon the shaft *d* and secured thereto at one end and at the other to the pivot pin *c′*, which is secured in position rotatably adjustable in any suitable manner, as by means of the set screw *g*, whereby the tension of the potential spring may be increased or decreased as required.

The lower end of the pendulous armature lever is provided on opposite sides thereof with contact points *h h′* adapted to make and break contact respectively with the stationary contacts *i i′*, formed by short pieces of fine wire, which are adjustably secured in line with the contacts *h h′*.

The stationary contacts *i i′* are preferably secured adjustably by frictionally engaging into apertures formed in the stub shafts *j j′*, which are journaled in an annulus *k* made of insulating material, and secured to the lower end of the casing N. The stub shafts *j j′* are held in position free to be rotated by the screws j^2, which engage into notches on the stub shafts; their free ends are provided with rock arms j^3 j^4 respectively, and these are pivotally connected by links j^5, of insulating material with the make and break lever *l*. This lever *l* carries at its front end the movable contact point *l′* below which is provided a fixed contact by the upwardly projecting end of the adjusting screw l^2, which is secured in metallic connection with the casing N and has a jam nut l^3; back from its front end the lever *l* is forked around the casing N and is pivotally connected to the ends of a cross bar N^3 secured to the under side of the shelf K^5 between the fork of the lever. The rear end of the lever *l* carries an armature l^4, which is opposed to the lower end of the core of the magnet M, and which is normally kept out of contact therewith by the weight of the armature, or in any other suitable way; a stop l^5 on the frame K, prevents the armature from falling too far.

The armature l^4 of the make and break lever *l* is adapted to be drawn away from its attracting magnet by the inner ends of the two tappet levers *m m′*, pivotally secured upon opposite sides on the under side of the shelf K^5, and engaging with their outer ends into recesses formed in the extensions of the movable cores L′ L′, as shown in Fig. 6.

To the under side of the shelf K^5 and insulated therefrom, is secured a leaf spring O, so as to leave the two opposite ends of the springs free, and these free ends are by the tension of the spring pressed into electric contact with the metallic contact buttons *o*, which are secured in insulating bushing in the shelf K^5, and have attached to them one terminal of the coils of the electro-magnets L respectively. To the free ends of the spring O are secured downwardly projecting metallic arms O′ against which the stud H^3 on the contact hand H is adapted to strike if the contact hand H should by its momentum or accidently overrun the contact bars representing the highest or lowest resistance respectively, causing thereby either one of the free ends of the spring O to break connection with its contact button, as the case may be.

The permanent electrical connections not already described of the different parts are as follows: One terminal of the shunt circuit is secured to one of the screws E′, which is electrically connected with the washer E, with which the heel of the contact hand H contacts; the contact hand itself then closes the shunt circuit through a variable amount of resistance according to the particular contact bar with which it happens to contact, each contact bar as stated being connected to the resistance by a screw C′. The circuit *a* is established preferably by providing the device with an extra contact bar B′, which is placed intermediate between the contact bars B representing the highest and lowest resistance respectively and instead of connecting this bar with the resistance it is connected by the screw C′ to one of the line conductors, while the other line conductor is connected to a screw C^2, which electrically connects it with the disk D and stub shaft D′. The extra contact bar B′, as shown in section in Figs. 4 and 9, has a bracket arm B^2, which projects under the adjoining portion of the shelf K^5, and to which the shelf is preferably secured, but in a manner to prevent any electrical connection therewith, and electrical connection is made from said bracket arm with the leaf spring O, and with one of the terminals of the coil M in any suitable manner, the drawings showing the leaf spring O directly secured to the bracket arm B^2, by two screws n which are insulated from the bracket and screwed into the shelf K^5, thus securing the latter to the bracket and a screw n' electrically connects the bracket with one of the terminals of the coil M. The other terminal of the coil M is connected to one of the terminals of the coil M′ and the other terminal of said coil M′ is connected to a binding screw r which is secured in the insulating ring k and connects the latter with the lamp socket J′. From thence connection is established through the lamp filament to the screw J^2, and stub shaft D′, thus closing the line circuit.

The motor circuit is completed from the bracket arm B^2 through the leaf spring O to the contact buttons o, to each of which one terminal of the coils L is secured. The other two terminals are electrically connected respectively to conductors j^6 leading to the ring K and the ends of said conductors are electrically connected to the contacts h h' respectively by the small wire coils j^7. From thence electrical connection is made by the pendulous armature lever to the casing N which is in metallic connection with the screw l^2 of the make and break contact, and when the contacts l' l^2 are closed, the circuit is completed through the lever l to the frame plate K, which as shown in Fig. 4, is in metallic contact with the stub shaft D′. Thus the circuit a divides into three branches. One of these branches includes the controlling magnets, M and M′, in series, and the other two branches include the motor magnets, one in each branch.

In practice, the branch through the controlling magnets M M′, is constantly closed, but as long as the current is not strong enough to enable the magnet M′ to overcome the tension of the potential spring d' and attract the armature f', the motor magnet circuit will be closed by the contact i, through that one of the motor magnets the operation of which turns the contact hand in such direction as to throw resistance out. This throwing out is done step by step as every time the motor magnet attracts its movable core, it will depress the armature l^4, and thereby break the circuit of the motor magnet.

Whenever the current becomes strong enough to enable the magnet M′ to attract its armature against the tension of the potential spring d', the motor circuit is closed by the contact i' through that one of the motor magnets, the operation of which turns the contact hand in the direction for throwing in resistance, and this throwing in of the resistance is accomplished again step by step through the operation of the lever m upon the lever l as in the case of the other motor magnets.

The object of my improvement is to effect very close regulation. To do this, friction has to be reduced and all momentum of the movable parts has to be prevented by making all these parts small and light. In this I have succeeded by my improvements, and my machine will start with a variation of one half volt, but as long as the current is normal my regulator is at rest, which with the regulators in present use has not been accomplished.

The arrangement and construction of the pendulous armature lever e, contributes largely to make the device extremely sensitive, and by means of the screw c the tension of the potential spring d' can be very accurately adjusted to maintain any desired potential of the current, and the manner it is suspended and housed forms a safe protection against accidental injury or derangement. The same care is taken to protect all the other parts where it is desirable, while the means of adjustment at the same time are easily accessible and exposed to the full light of the lamp, which also throws its full light upon the contact hand and contact bars.

The construction and arrangement of the contacts i i, I also consider of importance; these contacts are every time the lever l is moved partially rotated, and this prevents them from sticking fast or welding to the contacts h h' on the armature lever l. I also wish to call attention to the close regulation which is afforded to all the parts of the device. In the first instance the double friction clutch has the important advantage that every stroke of one of the movable cores of the magnets L moves the contact hand a fixed and invariable amount, which is not the case with the pawl and ratchet devices in common use in current regulators. Further the adjustments are such that the degree of movement of the contact hand can be varied from being almost imperceptible to a relatively large angle; this is accomplished by adjusting the screw l^2 up or down, thereby varying the amplitude of the movement of the lever l, which, of course, the higher the screw l^2 is adjusted up will break the current quicker and thereby shorten the stroke of the movable cores L′. The movement of the contact hand can also be slowed down or made faster by the adjustment of the screws F^4, which by raising and lowering impart to the friction dogs more or less lost motion, and as a matter of fact, the lost motion of said dogs may thus be almost entirely eliminated and the contact hands can be moved so fast step by step that the motion appears almost continuous.

The device is very conveniently constructed to be fastened against a wall so as to be in full view of the operator and care should be taken to fasten it so that the cores L′ have a free perpendicular movement to avoid friction.

The lower extensions of the cores L′ are preferably forked and straddle a cross bar K^6 of the frame, whereby they are vertically guided at the lower end and the ends of the levers m m' are preferably rounded off and engaged into square recesses in the cores L′ so as to create as little friction as possible. Of course some of the minor appointments of the device, such as the different electrical connections may be varied without changing the operation of the machine in any particular, but I have carefully worked out all the details to make the device very compact and not liable to get out of order, and it will be noted that I have always avoided to make electric connections by way of a pivot, which I consider faulty. Thus the coils j^7 for instance carry the current from the conductors j^6 to the contacts i i'.

What I claim as my invention is—

1. In an automatic electric current regulator, the combination with the stationary contacts and pivoted contact hand, of a pulley carrying said contact hand, and provided with an annular recess on one side, two gravity dogs arranged on opposite sides of the center of the pulley and provided with heads projecting into the annular recess and adapted to frictionally engage therein, a rest adapted to loosely support the heads of the dogs within the annular recess, and two motor magnets having vertically movable cores connected to the outer ends of the dogs, substantially as described.

2. In an automatic current regulator, the combination with the stationary contacts and pivoted contact hand of the friction pulley carrying said contact hand, the gravity friction dogs provided with rounding heads engaging into an annular recess in said pulley on opposite sides of its center, the adjustable rests loosely supporting the head of each dog and the two motor magnets having vertically movable cores connected to the outer ends of the dogs, all substantially as described.

3. In an automatic current regulator, the combination and arrangement of the series of contact bars radially arranged around a common center and mounted upon a vertical disk of insulating material, the stub shaft mounted in said center, the metal washer secured around the base of the stub shaft and insulated therefrom, the contact hand mounted upon the stub shaft and insulated therefrom, the friction pulley mounted upon the stub shaft and carrying the contact hand, and the spring interposed between said contact hand and friction pulley, substantially as described.

4. In an automatic current regulator, the combination and arrangement of the insulating disk A, the contact bars B radially secured thereto around a common center, the stub shaft D′ mounted in said center, the contact hand mounted upon said stub shaft, the friction pulley mounted upon said stub shaft and carrying the contact hand, the frame K^7 provided with the shelf K^5, the motor magnets L supported upon said shelf and provided with the vertically movable cores L′, the gravity friction dogs F′ actuated by said motor magnets and the rests K^2 and F^4 normally supporting the friction dogs, substantially as described.

5. In an automatic current regulator, the combination and arrangement of the series of contact bars B secured to an insulating disk A and radially arranged around a common center, the metallic disk D secured in said center and provided with the stub shaft D′, the metal washer E secured upon the disk D and insulated therefrom, the friction pulley F sleeved upon the stub shaft, the contact hand H mounted upon the stub shaft and provided with the heel H′, the spring I interposed between the contact hand and friction pulley, the insulating material G insulating the contact hand from the stub shaft and friction pulley, the plate or frame K secured to the end of the stub shaft, the friction dogs F′ engaging into an annular recess in the friction pulley and the adjusting screws F^4, substantially as described.

6. In an automatic current regulator, the combination with the stationary contacts vertically mounted upon a base around a common center, of a movable contact hand mounted in said center and an actuating motor device for said contact hand consisting of the revolving pulley F carrying said contact hand and provided with the annular recess F^3, the gravity friction dogs F′ arranged on opposite sides of said pulley and provided with the heads F^2, adapted to engage into said annular recess, the frame K provided with the annular rim K′, the adjusting screws F^4 secured in said frame and adapted to support the heads of the dogs, the fixed rests K^2 adapted to support the outer ends of the dogs, and the motor magnets L provided with the vertically movable cores L′, pivotally connected to the dogs, substantially as described.

7. In an automatic electric current regulator, the combination with the fixed contacts and movable contact hand for varying the resistance in the field circuit of the dynamo, of two motor magnets arranged in two branches of a motor circuit derived from the main circuit, a circuit controlling magnet actuated by variations in the current generated, for clos-

ing the motor circuit through one or the other of said motor magnets, and a make and break mechanism consisting of an electro magnet energized by the current generated, and an armature lever located in the motor-circuit and operated by the electro magnet to close the motor circuit and by the movement of either of the cores of the motor magnets to break the motor circuit, substantially as described.

8. In an automatic electric regulator, the combination with the fixed contacts and movable contact hand for varying the resistance in the field circuit of the dynamo, of the moter-magnets arranged in two branches of the motor circuit and having the movable cores, the adjustable friction clutches operated by the movement of said cores to turn the contact hand in opposite directions, and the controlling magnet actuated by variations in the current generated for closing the motor circuit through one or the other of the motor magnets, and the circuit closing electro-magnet energized by the current generated and provided with the make and break armature lever actuated by the attraction of its armature to close the motor circuit and by the movement of either of the cores of the motor magnets to break said circuit, substantially as described.

9. In an automatic electric current regulator, the combination with the fixed contacts and movable contact hand for varying the resistance in the field circuit of the dynamo, of the motor magnets located in two branches of a motor circuit in multiple arc with the main circuit, the movable cores of said motor magnets for turning the contact hand in opposite directions, the make and break lever located in the motor circuit, and provided with an armature, the electro magnet operated by the current generated to normally attract said armature and the tappets operated by the motor magnets to retract said armature, substantially as described.

10. In an automatic electric current regulator, the combination with the fixed contacts and movable contact hand for varying the resistance in the field circuit of the dynamo of the motor magnets energized by the current generated, through separate branches of a motor circuit and located on opposite sides of the contact hand, the fixed and movable cores of said motor magnets, the friction clutches operated by the movable cores to turn the contact hand in opposite directions, the adjusting devices for varying the throw of said clutches, the make and break lever located in the motor circuit and provided with an adjustable contact screw at one end and an armature at the other end, the electro magnet operated by the current generated to attract said armature and the tappets operated by the movable cores of the motor magnets to retract said armature, substantially as described.

11. In an automatic current regulator, the combination with the movable contact hand, of two motor magnets located in two branches of a motor circuit and operated by the current generated to turn said contact hand in opposite directions, to vary the resistance in the field circuit of the dynamo by the variation in the current generated, the contacts *o* in the branches of the motor circuit, the spring O located in the motor circuit and contacting with the contacts *o*; the arms O′ of said spring and the arm or stud H^3 on the contact hand, substantially as described.

12. In an automatic current regulator of the kind described, the combination of the controlling magnet M′ provided with a hollow core having pole *f*, projecting above the same the pendulous contact lever *e* suspended within said hollow core and provided at its upper end with the armature *f′* and having at its lower end contacts *h* and *h′*, a casing and the contacts *i* and *i′*, in the casing substantially as described.

13. In an armature current regulator of the kind described, the combination of the controlling magnet M′, provided with a hollow core having pole *f*, the casing N inclosing said magnet, the pendulous armature lever *e* suspended within the hollow core and provided with the armature *f′*, and contacts *h h′*, the insulating ring secured to the lower end of the casing, the rock shafts *j* and *j′*, journaled in said insulating ring and the contacts *i i′* frictionally held in axial aperture in said rock shafts, substantially as described.

14. In an automatic current regulator of the kind described, the combination of the controlling magnet M′ provided with a hollow core having pole *f*, the casing N inclosing said magnet, the pendulous armature lever *e* suspended within said hollow core, and provided with the armature *f′* and contacts *h h′*, the insulating ring at the lower end of the casing N, and provided with the contacts *i i′*, the shaft *d* on which the armature lever *e* is suspended, the centers *c c′*, in which said shaft is journaled, and the potential spring *d′* upon the shaft *d*, substantially as described.

15. In an automatic electric current regulator, the combination with the fixed contacts and movable contact hand for varying the resistance in the field circuit of the dynamo, of the motor magnets L located in the branches a' a^2, of the motor circuit *a* on opposite sides of the contact hand, the fixed cores L^2 and movable cores L′ of said magnets, the friction clutches operated by the movable cores to turn the contact hand in opposite directions, the make and break lever *l* located in the motor circuit *a* and provided with the armature l^4, the electro-magnet M operated by the current generated to normally attract the armature l^4, the tappets *m* operated by the cores of the motor magnets to retract said armature l^4, the controlling magnet M′ provided with a hollow core, the pendulous armature lever *e* lo-

cated in the motor circuit a and suspended within said hollow core and operated by the variations in the current generated to close the motor circuit through one or the other of the branches a' a^2, the contact i i', in said branches, the rock shaft j j' in which said contacts are mounted and intermediate connection between said rock shafts j j' and the make and break lever, substantially as described.

In testimony whereof I affix my signature in presence of two witnesses.

JEREMIAH KELLER.

Witnesses:

M. B. O'DOGHERTY,

N. L. LINDOP.