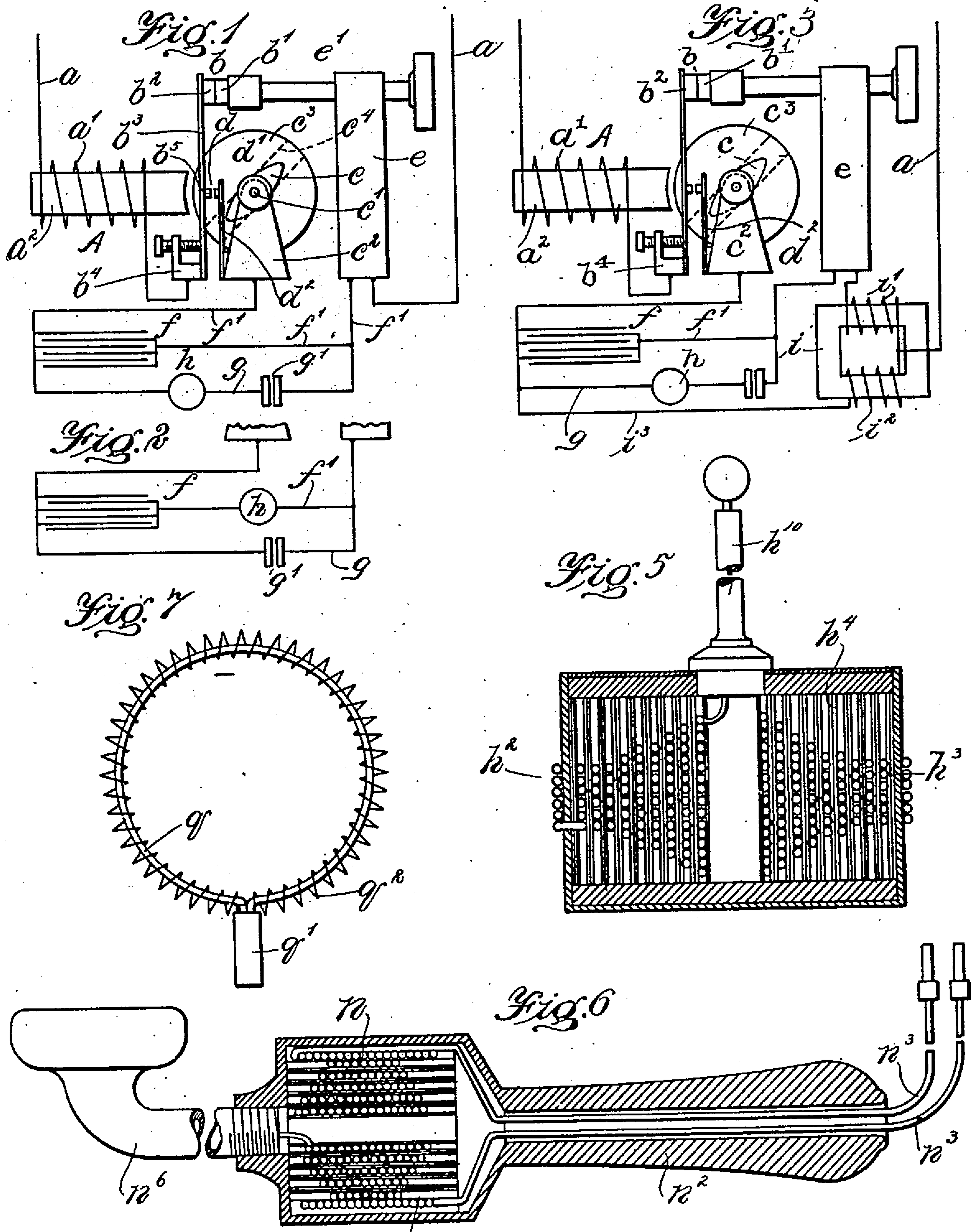
No. 831,599. PATENTED SEPT. 25, 1906.

R. C. BROWNE.

# INDUCTIVE SYSTEM.

APPLICATION FILED AUG. 19, 1904.

3 SHEETS—SHEET 1.




Witnesses.

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3 SHEETS—SHEET 2.

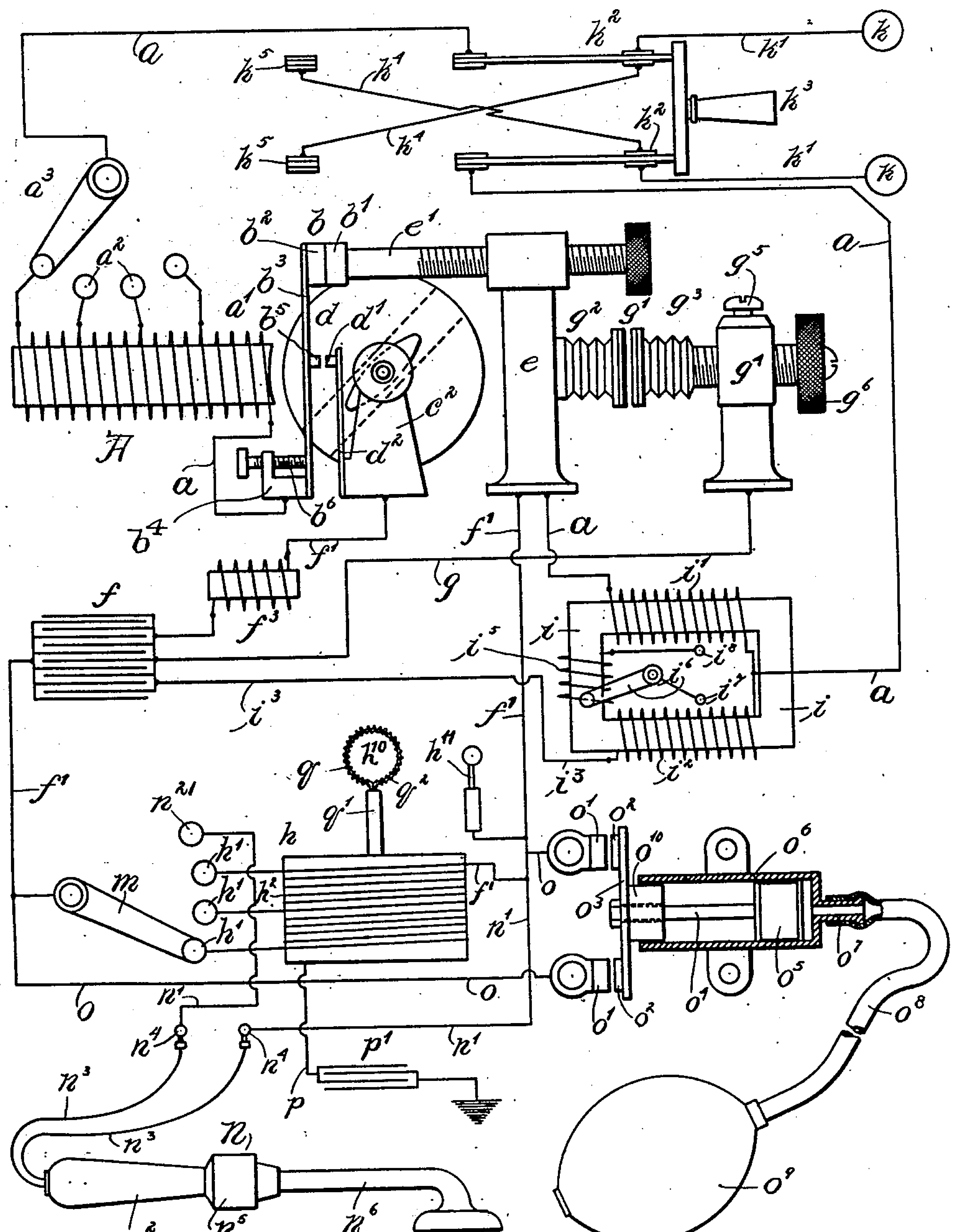

Fig. 4

Witnesses

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3 SHEETS—SHEET 3.

*Fig. 9*

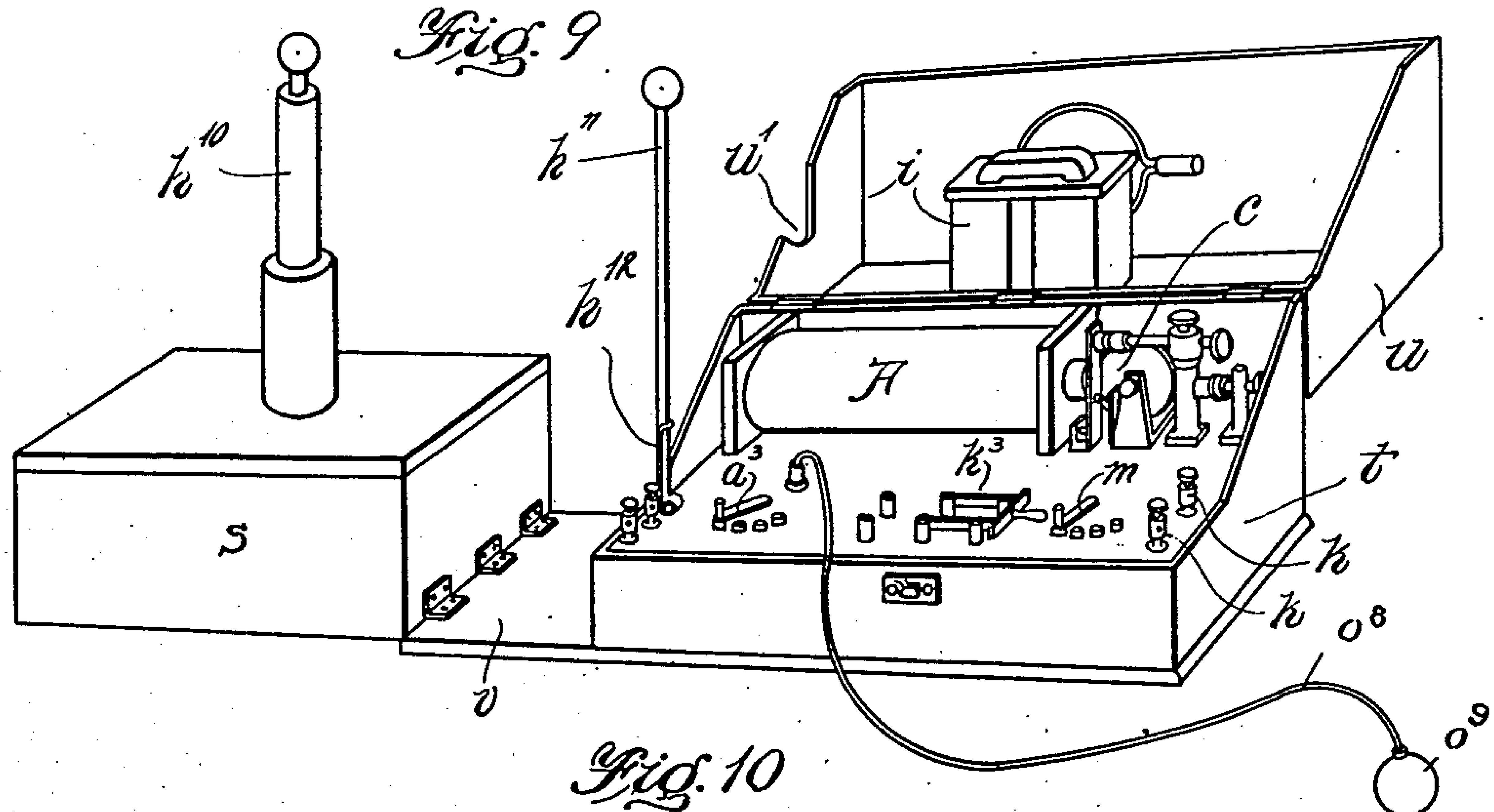



*Fig. 10*

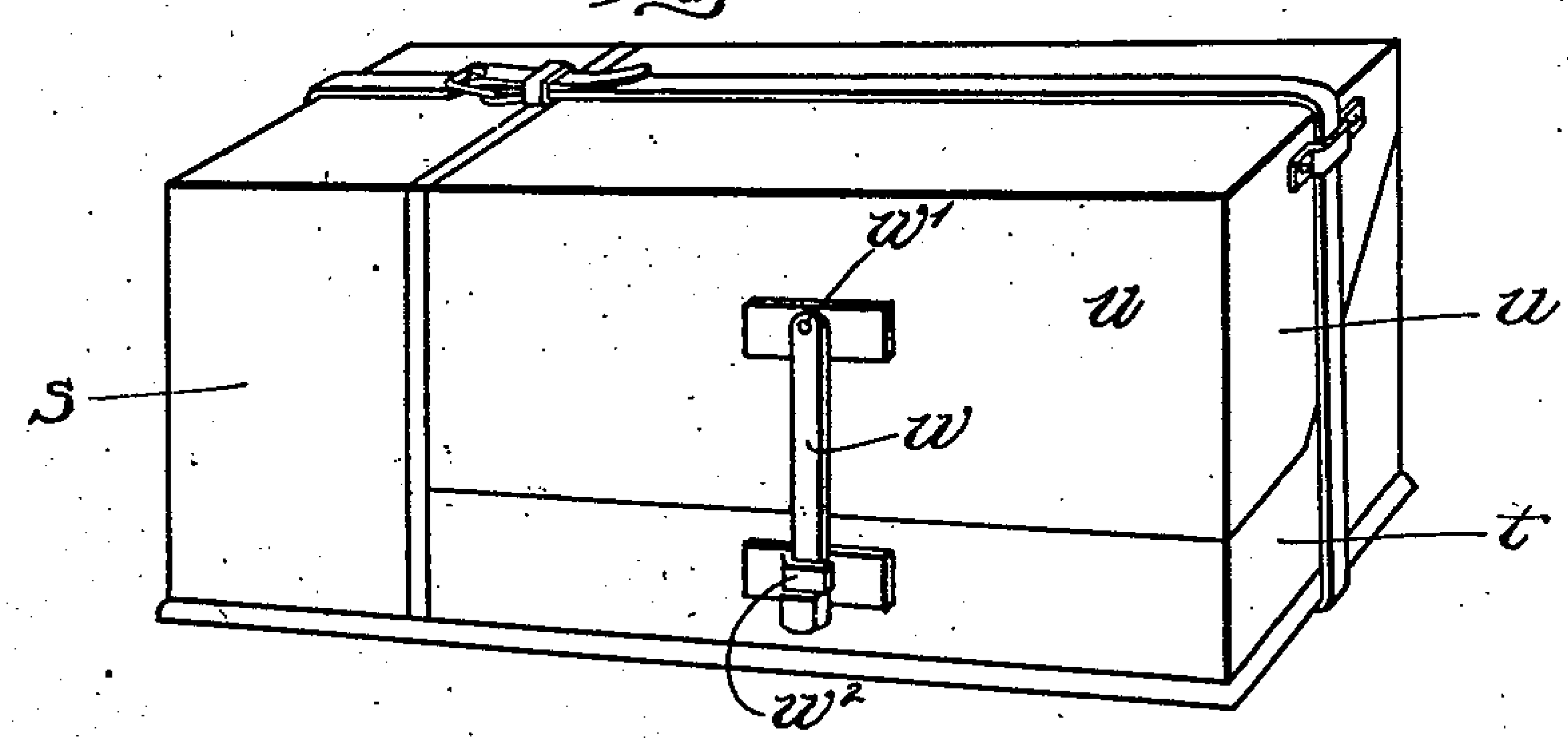
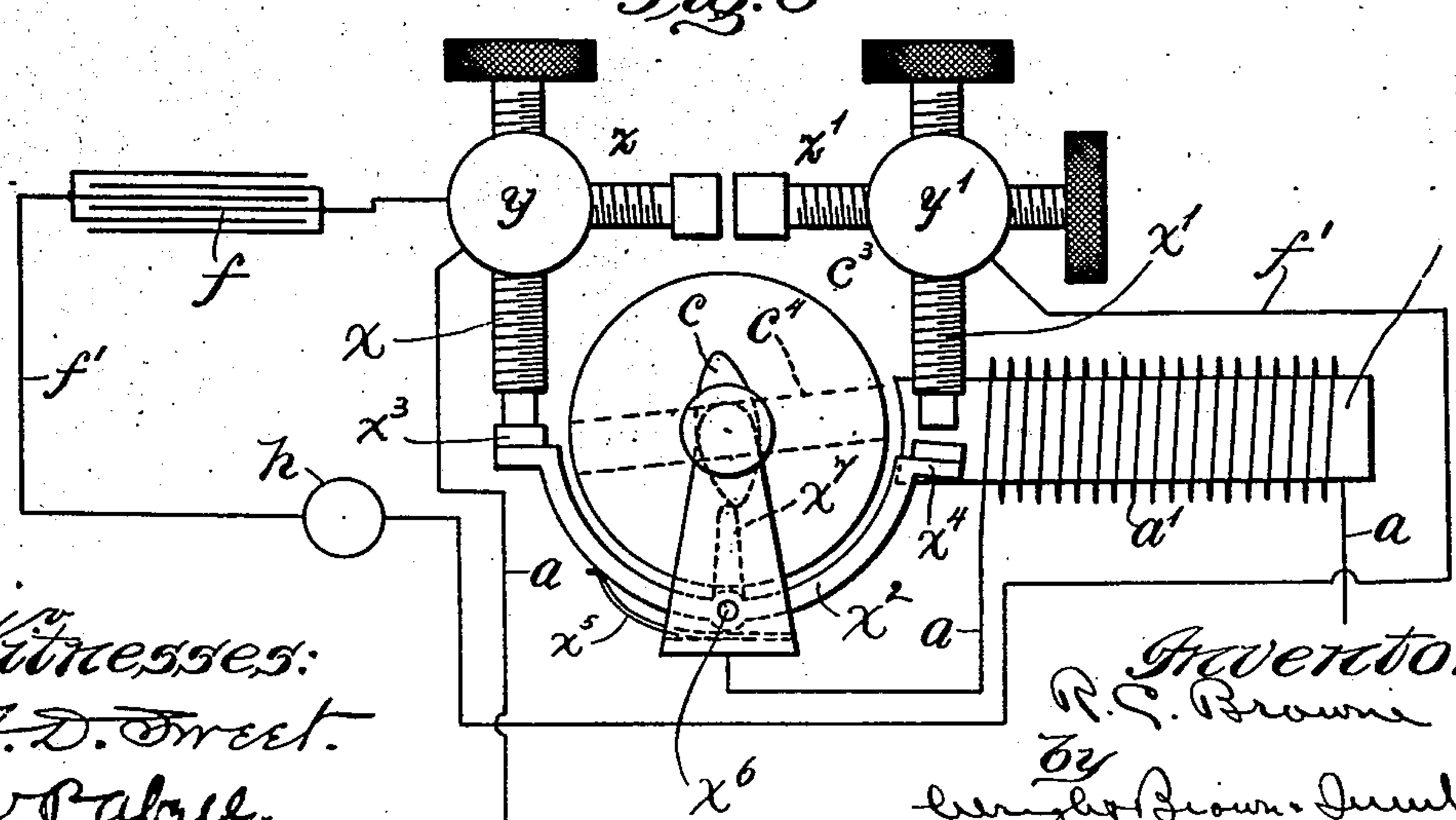



*Fig. 8*

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# UNITED STATES PATENT OFFICE.

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## INDUCTIVE SYSTEM.

No. 831,569. Specification of Letters Patent. Patented Sept. 25, 1906.

Application filed August 19, 1904. Serial No. 221,354.

*To all whom it may concern:*

Be it known that I, RALPH C. BROWNE, of Salem, in the county of Essex and State of Massachusetts, have invented certain new and useful Improvements in Inductive Systems, of which the following is a specification.

This invention has relation to methods and means of producing high-frequency electrical currents and the adaptation thereof for producing ozone and for therapeutical and X-ray purposes.

One of the objects of the invention is to provide a high-frequency-apparatus of such compactness and light weight that it may be conveniently carried by a physician for use at patient's residence.

Another object is to provide a system and an apparatus which may be employed without change in connection with either a direct or an alternating current in the generation of the high-frequency current.

The invention has, further, for its object to provide certain improvements both in the method and means for producing such currents, all as will be set forth fully in the following specification and pointed out in the claims.

It may be stated that the invention comprehends a system which is complex, since it operates differently when used in connection with direct and alternating currents, although the results produced are similar in that high-frequency currents are generated in either case at high efficiency. No change is necessary in adapting the apparatus for operation in connection with alternating or direct currents, the changes that take place being purely automatic.

Referring to the drawings, Figure 1 represents diagrammatically a simple form of the invention which is particularly applicable for continuous or direct currents. Fig. 2 represents a different arrangement of the condenser-circuit. Fig. 3 represents another embodiment of the invention which is quite similar to that illustrated in Fig. 1, except that there is the addition of a transformer to the condenser-circuit. Fig. 4 represents diagrammatically the preferred form of the invention which is applicable for use in connection with both alternating and direct currents. Fig. 5 represents a conventional section through an improved high-frequency transformer which I employ in connection with my system. Fig. 6 represents the section of an improved therapeutic appliance which I employ in the system and in which a high-frequency transformer is located in the handle thereof. Fig. 7 represents an improved terminal which I employ for producing ozone. Fig. 8 illustrates another form of interrupter or breaking mechanism which I may employ for interrupting the main circuit. Fig. 9 represents a perspective view of the assembled apparatus embodying the invention with the cabinet open. Fig. 10 is a perspective view of the same when folded together ready for transportation.

It will be understood at the outset that the invention is not limited to the particular system of wiring, the particular apparatus, or the details which I have seen fit to illustrate and shall hereinafter describe, as the invention is capable of other embodiments, and, further that the phraseology which I employ is for the purpose of description and not of limitation.

In accordance with my invention I cause the flow of a current of electricity to be interrupted and at practically the same instant connect a condenser of any desired capacity across the break in the circuit, whereupon the current that would otherwise "build up," as it were, across said break or point of rupture in the circuit flows into the condenser. The condenser after receiving this rush of current is disconnected and is not again brought into connection with the circuit until another break occurs. This connection being entirely automatic the charging goes on until the condenser is filled to the point of rupture or to a point where it will discharge disruptively through a circuit arranged to receive it, which circuit may contain special transformers and other apparatus to utilize the high-frequency waves set up. In order that the rush of current into the condenser may be intensified, the main or interrupted circuit preferably contains a considerable amount of self-induction, particularly if it is continuous, and for further raising the voltage of the condenser I may connect to it the secondary coil of a transformer whose primary coil is in series connection with the main or interrupted circuit.

Referring to Fig. 1, which, as previously stated, is particularly applicable for employment in connection with the direct or continuous current, *a a* indicate the conductors of a continuous-current circuit, it being understood that said conductors are connected with a suitable generator and that the circuit includes necessary switches and other apparatus. Placed in the circuit $a$, which may be termed the "main" or "interrupted" circuit, is the interrupter or apparatus for intermittently breaking or interrupting it. The break is indicated at $b$, and it is formed by the separation of the stationary contact $b'$ and movable contact $b^2$ of an interrupter, the contact $b^2$ being mounted upon the end of a relatively long spring $b^3$, which is adapted to be forced away from the contact $b'$ by means of the cam or member $c$ on a shaft $c'$, journaled in uprights or bearings $c^2$. Interposed between the cam and the relatively long spring $b^3$ is a short spring $d^2$, so mounted that when the cam is rotated it will force the shorter spring outward, and the latter will engage the longer spring $b^3$ and will separate the contact $b^2$ from that of $b'$ to cause a break at $b$, and thus open the main circuit. The contact $b'$ is in series connection with the main circuit through the standard $e$ and the bar $e'$, whereas the spring $b^3$ and contact $b^2$ are in series with said circuit through the support $b^4$, to which the said spring is secured. $f$ indicates a condenser placed in a circuit $f'$, the wires or conductors of which are connected, respectively, with the post $e$ and the support or standard $c^2$. The spring $d^2$, which is connected with the support $c^2$, and the springs $b^3$ are provided with contacts $d'$ and $b^5$, respectively, which are engaged when the cam has rotated far enough to force said spring $d^2$ outward for the purpose of breaking the main circuit at $b$. By reason of this construction it will be seen that the condenser-circuit $f'$ will be connected with the main circuit across the break only at the instant of opening the main circuit and that since the spring $d^2$ is much shorter than the spring $b^3$ it will separate from the spring $b^3$ before the latter closes the break at $b$ and that consequently the condenser is disconnected from the main circuit before said circuit is again closed. The break in the condenser-circuit, which is intermittently closed by the contacts $d'$ and $b^5$ of the interrupter, is indicated at $d$. Around the condenser $f$ is connected another circuit (indicated at $g$,) for utilizing the discharges of the condenser, said circuit $g$ having an open break or gap $g'$ and a high-frequency transformer $h$ in series, said high-frequency transformer being illustrated conventionally in this figure, but hereinafter described in detail. On shaft C' is a momentum-wheel $c^3$, which is formed of brass or other non-magnetic electrically-conducting material and which has embodied in it a bar of iron or other magnetic material, (indicated at $c^4$.) The cam $c$ is formed with two leaves, and its major axis is parallel to the median line of the bar $c^4$ for a purpose to be described. The main circuit $a$ includes a self-induction device A, comprising a coil $a'$ and the core $a^2$, which is mounted radially with relation to the shaft C' and in proximity to the momentum-wheel $c^3$, so that the bar $c^4$ being rotated cuts the magnetic field of the said core, and the core therefore draws toward it that end of the bar which is nearest. As soon, however, as the bar approaches a line parallel with the core the main circuit is interrupted, and the momentum of the wheel is sufficient to carry it around until the opposite end of the bar comes within the magnetic field and is attracted by the core. The currents set up in the diamagnetic portion of the wheel, cutting the magnetic lines of force, serve as a drag to steady the rotation of the wheel. When an alternating current is on the main current, the wheel will not rotate, as will subsequently be explained.

In Fig. 2 another arrangement of the induction-circuit is illustrated, in which the high-frequency transformer $h$ is placed in the circuit $f'$, so that the rush of current that charges the condenser $f$ passes through it, as well as the overflow of said condenser.

In Fig. 3 another embodiment of the invention is diagrammatically illustrated and which is similar to that illustrated in Fig. 1, except that a low-frequency transformer $i$ is employed. The primary coil $i'$ of the said transformer is in series in the main-circuit, whereas the secondary coil $i^2$ is in a circuit $i^3$ around the circuit $g$ and the circuit $f'$. The main conductor $a$ is connected between the coils $i'$ and $i^2$, as illustrated. According to this arrangement the primary coil $i'$ of the transformer is connected with one side of the break $b$, and the secondary coil is connected with that side of the condenser $f$ which is connected with the short spring $d^2$. Consequently when the main circuit is broken at $b$ the rush of current flows into the condenser $f$ and the current from the secondary coil $i^2$ also enters the condenser practically simultaneously with the other current from the circuit $a$. The employment of the low-frequency transformer raises the voltage of the condenser $f$, and it intensifies the action of the apparatus when employed in connection with a direct current. Where an alternating current is used, the condenser is charged by the secondary of the low-frequency transformer.

In Fig. 4 I have illustrated the preferred form of the invention, which, like that in Fig. 3, is applicable for both alternating and direct currents. Fig. 4 is largely diagrammatical; but it illustrates in detail mechanical constructions and contrivances which are utilized in the apparatus. In this figure $k$ $k$ represent binding-posts which may be connected with the conductors of either an alternating or direct current circuit. They are connected by conductors $k'$ with the stationary contacts $k^2$ of a bipolar switch $k^3$. The said contacts $k^2$ are connected by crossed conductors $k^4$ with the contacts $k^5$ of said switch, so that said switch by this construction and arrangement fulfils the functions of a switch and commutator. From the switch $k^3$ lead the conductors *a a* of the main circuit, which includes the self-induction device A, the long spring $b^3$, with its contact $b^2$, the bar *e'*, with its contact *b'*, the upright *e*, and the primary coil *i'* of the low-frequency transformer *i*. The self-induction coil *a'* is divided in sections which are connected in series, but which are provided with the contacts $a^2$, so that by means of a switch $a^3$ one or more of said coils may be thrown onto line for the purpose of regulating the intake, and consequently the output, of the apparatus and adapting it to various voltages of constant currents. In this figure it is shown that the bar *e'*, which carries the contact *b'*, is threaded and is provided with a milled head of non-conducting material, by which it may be rotated to adjust it toward and from the contact $b^2$. It will be further seen upon examination of this figure that the spring $b^3$ may be adjusted by means of a screw $b^6$, which bears against its lower portion to adjust it toward and from the contact *b'* and the contact *d'* on the spring $d^2$. The condenser-circuit *f'* has placed in it in series a self-induction device, such as a choking-coil $f^3$, for further preventing disruptive charges taking place at the gap *d*, said choking-coil being placed between the condenser and the standard $c^2$ and the spring $d^2$. The remainder of the condenser-circuit *f'*, or that portion of the circuit for utilizing the discharges from the condenser and which includes the low-resistance conductor for connecting the condenser with the post *e*, includes a switch *m*, by means of which the discharge of the condenser may be regulated and directed. By means of this switch the circuit may be closed through the primary coils of the high-frequency transformer *h* or through a similar transformer in the handle of a therapeutic appliance *n*. The high-frequency transformer is illustrated in detail in Fig. 5 and will be subsequently described. It is sufficient here to state that the several series of primary coils are separately connected with stationary contacts *h'*. The gap *g'*, which corresponds with that indicated by the same character in Fig. 3, is formed by two corrugated bars $g^2$ $g^3$, whose faces are made of sterling silver or any other good conductor of heat which is also a conductor of electricity when either bright or oxidized. The bar $g^3$ is adjustably threaded into an upright $g^4$ and is secured after adjustment by a set-screw $g^5$. On the end of the bar $g^3$ is a milled head $g^6$, of insulating material, by which it may be rotated for adjustment. In Fig. 4 the gap is in series with the primary coils of the high-frequency transformer, there being a conductor *g*, leading from the post $g^4$ to the condenser. Leading into the same side of the condenser is the secondary circuit $i^3$, which includes the secondary coil $i^2$ of the low-frequency transformer *i*. The high-frequency transformer *h* or that in the appliance *n* may be connected to the condenser-discharge circuit *f'* separately. The therapeutic appliance *n* is arranged to be connected with said circuit *f'* by a branch circuit *n'*, which includes a stationary contact $n^{21}$, with which the switch *m* may be engaged and which is arranged in proximity to the stationary contacts *h'*. When the switch *m* is in contact with the contact $n^{21}$, the discharge from the condenser passes through the appliance *n* to the exclusion of the high-frequency transformer *h*, whereas when said switch engages any of the contacts *h' h'* the discharge from the condenser passes through the transformer *h* and not through the transformer in the appliance *n*. The appliance *n* itself will be subsequently described in detail.

In the apparatus as thus described it is quite apparent that either a direct or an alternating current may be employed with equal facility. Where the alternating circuit is used, the momentum-wheel $c^3$ does not rotate, and there will be no break at *b* and no "make" at *d*. This is true for the reason that owing to the rapidity of the change of the lines of force of the core of the induction-coil the iron bar $c^4$ is not attracted with sufficient force to support it or to keep up its revolution. The current therefore will flow smoothly through the main circuit *a*, except of course for the alternations which are incidental to the circuit. This flow of the current, which includes the primary coil *i'* of the low-frequency transformer *i*, will induce a current of high voltage in the secondary $i^2$, which will charge the condenser *f*, owing to the fact that the condenser is connected directly across its terminals, one side being connected to one side of the secondary $i^2$ and the other side being connected to the post *e* and thence to the primary coil *i'*, which is in turn connected to the other terminal or end of the secondary $i^2$. Under these conditions the gap *d* is opened so as to force the condenser to discharge over the break at *g'*.

For the purpose of controlling the high-frequency transformer in the appliance *n* and that indicated at *h* I employ an improved switch of special design that is connected in the shunt around them. This shunt-circuit is indicated at *o*, and it contains the two stationary contacts *o' o'* in series. Owing to the exceptionally high voltage that is frequently present in either circuit of the apparatus, it is of great importance that there should be no possibility of the operator receiving a shock when manipulating this switch, especially since the operator may be in connection with the high voltage of the secondary of one of the high-frequency transformers. Consequently mechanism is provided by means of which the shunt or switch circuit $o$ may be opened and closed by fluid-pressure controlled by a bulb similar to that employed in controlling the shutter of a camera. The movable contacts of the switch are indicated at $o^2$ $o^2$, and they are carried by a cross-head $o^3$, which when the contacts $o^2$ $o^2$ are engaged with those of $o'$ $o'$ completes the shunt-circuit so as to cut out or short-circuit all of the induction devices. The cross-head of bar $o^3$ is mounted loosely upon the end of the piston-rod $o^4$ connected to a piston $o^5$ in a cylinder $o^6$, said piston and cylinder constituting a fluid-operated or pneumatic hammer. One end of the cylinder is open, but the other is closed except that it is connected by a nipple $o^7$ with a flexible conduit $o^8$, terminating in a compressible bulb $o^9$. Connected to the bar $o^3$ is a boss $o^{10}$, which will be engaged by the piston $o^5$ with a powerful blow to force the contacts $o^2$ against contacts $o'$. By contracting and expanding the bulb $o^9$ piston $o^5$ will be caused to move in one direction or the other and to impart a hammer-blow to the cross-head $o^3$ to engage or disengage the contacts, as the case may be. This hammer-blow is necessary in disengaging the movable contacts from the stationary contacts, owing to the welding of the contact-points together by reason of the action of the current. By the employment of the bulb-switch the operator may control the condenser-circuit with ease and without danger of receiving shock.

As the efficiency of the apparatus depends to a great extent on the proper construction of the high-frequency transformer placed in the condenser-circuit, I have devised one which answers every purpose and which I shall now describe in detail, it being illustrated conventionally on a larger scale in Fig. 5. The primary $h^2$ consists of any desired number of turns, preferably six or seven, of a low-resistance conductor wound into a single layer, so that the turns are all of equal length. The secondary $h^3$ consists of a different number of turns, more or less than the primary, according to whether it is desired to raise the voltage or power of the primary current or to lower it. As illustrated on the drawings the secondary is wound for the purpose of raising the power of the primary, in which event the secondary consists of a coil of, say, five hundred or six hundred turns of the conductor of comparatively low resistance as compared with the amount of current delivered. The coil is wound in layers insulated from one another by a plurality of sheets of paraffin-paper $h^4$ and is contained in a case filled with pitch or other insulating material. The layers in the center are relatively long in a direction axially thereof, and they decrease as they extend radially from the axis, or else larger wires are employed for the outer layers, this all being for the purpose of keeping a substantially uniform resistance and for the purpose of placing the greatest number of turns where the lines of force set up by the primary coil are weakest. I have found that if the resistance in the secondary is not uniform and the voltage generated in the various layers practically equal the coil will show a tendency to break down near the circumference. As illustrated in Fig. 5 the outer layer of the secondary is connected with the primary to reduce the voltage between the secondary and the primary and prevent a disruptive discharge from the secondary to the primary; but for the purpose of grounding the apparatus I may employ a grounding-line $p$, having a small condenser $p'$ placed therein. (See Fig. 4.) This condenser permits a wave or rush of current to flow into the ground when there is a similar discharge from the electrode which forms the other terminal of the secondary. This is not essential in the operation of the machine, but it is highly desirable to protect the system with which it is connected. A high-frequency transformer as thus described is compact and may be made in smaller size, so as to be placed in the handle of a therapeutic appliance—as shown, for instance, in Fig. 5. In this case the handle, which is of insulating material, as indicated at $n^2$, is hollow to receive the conductors $n^3$, which connect the primary coils with sockets $n^4$ in the circuit $n'$ in Fig. 4. In the hollow handle is also placed the high-frequency transformer, as indicated as a whole at $n^5$. The handle also carries the glass electrode $n^6$, into which one end of the secondary projects. An appliance of this character is especially applicable for the formation of ultra-violet rays for therapeutic purposes. In the high-frequency transformer illustrated in Figs. 4 and 5 the secondary is connected with an upstanding terminal or electrode $h^{10}$. A peculiar effect takes place in the coils thus wound, although long sparks and other phenomena commonly associated with high-voltage electricity may be obtained from the central terminal $h^{10}$. These peculiar discharges do not depend upon high voltage for their development, since if the number of turns in the primary be increased—that is, the ratio between the primary and secondary be changed—a central terminal or electrode $h^{10}$ may be connected to objects of large capacity, so as to do away with the discharge at that point, whereupon a very brilliant discharge takes place from the circumference of the high-frequency transformer-coil $h$ to the center. In fact, two separate discharges may be obtained at one and the same time—to wit, a discharge from the center of a soft feathery nature and a discharge from the circumference to the center of a heavy brilliant disruptive spark. I have mentioned this as illustrating the fact that the "brushes," so called, probably depend upon something other than voltage for their development, since I have often noticed that the soft feathery spark at the center has but little power to overcome resistance, except air, that the discharge has when more primary is used and the voltage is theoretically reduced.

For the purpose of providing a complementary electrode I employ one which is indicated at $h^{11}$ and which is illustrated as in connection with the condenser-circuit $f'$.

In the production of ozone or oxygen gas from the atmosphere by the action of high-frequency currents of electricity other conditions than high voltage must be considered, since a discharge of electricity through the air or other mixed gases containing oxygen does not necessarily produce ozone, and, indeed, in the case of the atmosphere a discharge of high-frequency or other high-voltage electricity is as apt to form nitrous or nitric acid as ozone. To produce the best ozonizing effect, the frequency of the currents should be adjusted either by varying the size of the condenser $f$ or by inserting a predetermined amount of self-induction into the primary $h^2$ or the secondary $h^3$ of the transformer $h$, though preferably it is inserted in the primary. This effect may be secured to a certain extent by cutting in a greater or less number of turns of the primary. Another condition that to a great extent governs the amount and purity of the ozone generated by the passage of the high-frequency current into the atmosphere is the nature of the surface of the electrode that comes in contact with the gases. This should not be either pointed or blunt, as a large knob, for in the one case the point of contact between the electrode and the gas is too small for any considerable amount of gas to be acted upon, whereas in the other case it requires too great a strain or voltage for the discharge to take place into the said gases. I find the most efficient ozone-generator to be obtained by the use of the smallest amount of metal consistent with strength in a form that will present a number of rounded faces to the surrounding gases and at the same time preserve an arc-like structure. Consequently I preferably convey the high-frequency current to a ring or series of rings of some suitable wire covered with an open helical spring stretched somewhat longer than the wire about which it is coiled, so as to cause each convolution to stand out prominently by itself when the wire about which it is coiled is bent into the form of a circle, as illustrated in Fig. 7. Referring to said figure, $q$ indicates a supporting-ring whose terminals are inserted in a socket $q'$, formed in the electrode $h^{10}$. The wire helix $q^2$ is coiled about the sustaining and supporting ring $q$. It is quite evident that more than one of these rings may be employed and that they may be arranged at angular planes so as to approximate a sphere.

Referring to Fig. 4, it will be observed that on the core of the low-frequency transformer $i$ there is a coil $i^5$ of another secondary circuit, the various coils of which may be connected by a switch $i^6$ with a terminal $i^7$. To said terminal and another terminal $i^8$ may be connected a circuit for connecting low-voltage miniature lamps to facilitate the placing of electrodes in cavities of the body or one containing a cautery-knife or other appliance that it may be desired to use. It is not at all essential that this secondary circuit should be wound upon the transformer $i$, since it may be wound, if desired, upon the core $a^2$ of the induction-coil $a'$. In fact, one of the coils $a'$ may be employed for this purpose

One of the important features of the invention is the arrangement and relation of the various parts of the apparatus hereinbefore described in order that their full efficiency may be obtained, since the system as above described largely depends for its efficiency upon the arrangement and relation of the various parts, inasmuch as the preferred form of the apparatus is one for the use of physicians. The apparatus is consequently portable, so that a physician may move it from place to place and connect it where possible with the ordinary house-lighting circuit. The entire apparatus is contained within a quadrilateral or oblong dust-tight cabinet having a smooth exterior. This cabinet consists of three different members which may be folded together and secured in their folded positions. These members are indicated, respectively, at $s$, $t$, and $u$. They are all supported upon a base $v$, the member $t$ being rigidly secured thereto, the member $s$ being hinged thereto, and the member $u$ being complemental to and hinged to the member $t$, so as to fold thereupon, as shown in Figs. 9 and 10. The member $t$ forms, as it were, a separate case, of which the member $u$ is the cover. Within the case $t$ is placed the condenser $f$, the condenser $p'$, and the switch mechanism, which is indicated in Fig. 4 at O and which includes the piston and cylinder $o^5$ $o^6$ and the parts connected therewith. The tube or conduit $o^8$ extends through an aperture in the top of the case $t$ to the cylinder. Upon the surface of the case is mounted the induction-coil, (indicated as a whole at A,) the make-and-break mechanism, (indicated as a whole at C,) the switch $a^3$ for the induction-coil, the switch $k^3$, and the switch $m$, hereinbefore described. The terminals of the main circuit are connected with the binding-posts $k$ $k$, which are also located upon the surface of the case $t$. The cover or member $u$ carries the low-frequency transformer $i$ and may be swung about its hinges to occupy the position shown in Fig. 10, there being such vacant space upon the surface of the case $t$ that when the cover is folded down the transformer $i$ fits between the various parts of the apparatus located upon the said case. The electrode $h^{11}$ in the condenser-circuit is pivoted to the top of the case $t$, near the left end thereof, and is normally held upward by a relatively stiff spring $h^{12}$, though it, too, may be folded down so as to occupy a plane substantially parallel to the top or surface of the case $t$. To the base $v$, which projects laterally beyond the case or member $t$, is hinged the case or member $s$, in which is placed the high-frequency transformer $h$ and from the top or upper surface of which projects the secondary terminal or electrode $h^{10}$, which is suitably insulated by rubber or other insulating material. This terminal or electrode is in alinement with the terminal or electrode $h^{11}$, so that when the member $s$ is folded into a closed position the said terminal or electrode engages the terminal or electrode $h^{11}$ and forces the latter toward a prone position until they both lie in the space between the case $t$ and the cover or member $u$, one end of the cover $u$ having an opening $u'$ to receive the base of the terminals $h^{10}$. In closing the cabinet the case or member $s$ is swung from the position which it occupies in Fig. 9 to the position shown in Fig. 10. Then the cover or member $u$ is swung forward to the position shown in Fig. 10, this having the effect of locking the member or case $s$ securely in its folded position. A latch member $w$, pivoted to the cover $u$ at $w'$, is engaged with a catch $w^2$ on the front of the case $t$. This latch when the cabinet is unfolded serves as a support for the free end of the cover $u$. A strap or band may be passed lengthwise around the cabinet to effectively hold the parts together and to serve as a means by which it may be transported or carried from place to place.

It will be understood that the various parts of the system or apparatus are properly connected together and are suitably insulated so that they will perform their functions in the most efficient manner.

Where there are electrical connections between the apparatus and the several members of the cabinet, they are preferably connected through the hinges by which the said members are attached to each other or to the base $v$. The case may be made in various sizes, as desired, for different purposes, although the particular cabinet which I have illustrated as embodying the invention measures sixteen by eight by eight inches, this size being given for the purpose of illustrating with what compactness the various parts of the system and the apparatus are arranged and related.

It is quite apparent that various changes may be made in the apparatus and the parts thereof as herein described. For instance, in Fig. 8 I have illustrated another form of interrupter or make-and-break appliance which may be used to produce similar results achieved by that illustrated in Fig. 4. In this case the momentum-wheel $c^3$ is provided with the bar of magnetic material $c^4$, but it is arranged at a right angle to the leaves or the májor axis of the cam $c$. $x$ $x'$ indicate stationary contacts with which may be engaged the ends of an arc-like oscillator $x^2$, having contact-points $x^3$ $x^4$ on its ends. The oscillator is so formed that the two contact-points $x^3$ $x^4$ cannot possibly at the same time be in contact with the stationary contacts $x$ $x'$. A spring $x^5$ bears against the oscillator to hold the point $x^3$ normally against the contact $x$. The oscillator is pivoted at $x^6$ and is provided with an upwardly-projecting lug or pin $x^7$, the end of which may be engaged by the ends of the cam $c$. As the wheel $c'$ rotates for the purpose of disconnecting the point $x^3$ from the contact $x$ and of engaging the point $x^4$ with the contact $x'$ the contacts $x^3$ and $x$ form a gap corresponding to that at $b$ in Fig. 4, whereas the contacts $x^4$ and $x'$ form a gap similar to that at $d$ in said figure. The supports $y$ $y'$ for the contacts $x$ $x'$ are utilized to support adjustable posts or bars $z$ $z'$ for the formation of a gap similar to that at $g'$ in Figs. 1 and 2, and their faces are covered with silver or similar material, as hereinbefore described. The core $a^2$ of the induction-coil $a'$ is arranged at substantially a right angle to the pin or projection $x^7$, so that when a continuous current is used from the main circuit $a$ the momentum-wheel will be caused to rotate, as previously described. The condenser-circuit $f'$ is similar to that illustrated in Fig. 1. When the main circuit is interrupted, the waves increase to their greatest amplitude, and as soon as the contact $x^4$ approaches the contact $x'$ there is a rush of current into the condenser. This appliance may be employed with the apparatus in the same relation as shown in Fig. 4. It is also evident that the self-induction coil $a$ and the low-frequency transformer I may be combined into an autotransformer without departing from the spirit and scope of the invention. Furthermore, both sides of the condenser $f$ may be connected to springs similar to those at $d^2$ and $b^3$ in Fig. 4 and both work together to entirely cut out the condenser $f'$ from the main circuit after it has received its first rush of current from the break $b$. It is quite apparent that, if desired, the breaks may be made by the aid of any other motor, either of a rotary or vibrating type, and that various other changes may be made, if desired.

Having thus explained the nature of the invention and described a way of constructing and using the same, although without attempting to set forth all of the forms in which it may be made or all of the modes of its use, I declare that what I claim is—

1. An inductive system comprising a condenser, a main circuit having an intermittently-formed break, and means for connecting said condenser to said circuit across said break and then disconnecting it therefrom.

2. An inductive system comprising a condenser, a main circuit having an intermittently-formed break, and means for automatically connecting said condenser in said circuit across said break only when said break is formed.

3. An inductive system comprising a main circuit, means for intermittently breaking said circuit, a condenser normally disconnected from said main circuit, and means for connecting said condenser to said main circuit across said break subsequent to the actual formation of said break.

4. An inductive system comprising a main circuit, means for intermittently breaking said circuit, a condenser normally disconnected from said main circuit, and means for connecting said condenser to said main circuit across said break and disconnecting it from said circuit prior to the close of said break.

5. An inductive system comprising a normally disconnected condenser, a main circuit connected with a source of electrical energy to receive a current of electricity, means interrupting the main circuit until the electrical waves of the current are at their greatest amplitude, and means for the connecting the condenser to said circuit to receive the rush of current.

6. An inductive system comprising a main circuit having self-induction therein, a condenser-circuit and means for intermittently connecting said condenser-circuit to said main circuit to cause a current to flow in but one direction in said condenser-circuit and into the condenser.

7. An inductive system comprising a condenser, a main circuit, a secondary induced-current circuit, and means for charging the condenser with current from the main circuit and from the secondary induced-current circuit.

8. An inductive system comprising a main circuit having an intermittently-formed break, a secondary circuit in inductive relation to the main circuit, a condenser, and means for simultaneously charging the condenser with current from the secondary circuit and from the main circuit across the break therein.

9. An inductive system comprising a main circuit having in series connection, a normally-closed interrupter, and the primary coil, of a low-frequency transformer; a condenser in series connection with the secondary coil of said transformer, and means in consequence of which said interrupter is operated when a direct current is passed through the main circuit but is inactive when an alternating current is passed through said main circuit, whereby said system is equally operative with either of said currents.

10. An inductive system comprising a main circuit having in series connection, a normally closed interrupter, means operated by a continuous current only for intermittently operating said interrupter to break the main circuit, a condenser, means for connecting said condenser to said main circuit across the break formed by said interrupter, and means in inductive relation to the main circuit for intensifying the current delivered to the condenser when a direct current is on the main circuit, and for charging the condenser when an alternating current is on said main circuit, whereby said system is equally operative for both alternating and direct currents.

11. An inductive system comprising a main circuit having in series connection, a normally closed interrupter, and the primary coil of a low-frequency transformer; a condenser-circuit having in series connection the secondary of said transformer and a condenser; and means operated by direct current in the main circuit for intermittently operating said interrupter and connecting the condenser-circuit across the break caused thereby in the main circuit, said means being inactive to permit the interrupter to remain inactive when an alternating current is on the line.

12. An inductive system comprising a condenser, a main circuit and inductive means operative at all times without a manual change for charging the condenser by secondary induction when an alternating current is passed through the main circuit and for charging the condenser by self-induction when a direct current is passed through said main circuit.

13. An inductive system comprising a main circuit having a self-induction device, a normally closed interrupter and the primary coil, of a low-frequency transformer in series connection; a condenser-circuit having in series connection the secondary coil of said transformer and a condenser; a motor caused to operate by the self-induction device when a direct current is passed therethrough; a normally open interrupter placed in the condenser-circuit, and means actuated by said motor for intermittently opening the first-mentioned interrupter and closing the second-mentioned interrupter to connect the condenser-circuit across the break formed in the main circuit.

14. An inductive system comprising a main circuit, a condenser-circuit, a normally closed interrupter in the main circuit, a normally open interrupter in the condenser-circuit, and automatically-operated means for closing the last-mentioned interrupter and

opening the first-mentioned interrupter to connect the condenser-circuit across the break in the main circuit.

15. An inductive system comprising a main circuit, a condenser-circuit, a normally closed interrupter in the main circuit, a normally open interrupter in the condenser-circuit, and automatically-operated means for closing the last-mentioned interrupter and opening the first-mentioned interrupter to connect the condenser-circuit across the break in the main circuit, and thereafter opening the normally open interrupter and then closing the normally closed interrupter, all in the order named.

16. An inductive system comprising a main circuit having an electromagnet, a diamagnetic electrically-conducting momentum-wheel having a magnetic bar diametrically therethrough, rotatable through the magnetic lines of force of the core of said magnet, whereby the ends of said bar are successively attracted by said core and the electric currents set up in said diamagnetic portion of said wheel operate as a drag to even the motion thereof, an interrupter in series connection with said induction-coil in said main circuit, and means operated by said wheel for operating said interrupter to intermittently break said circuit when either end of said bar approaches the said core.

17. An inductive system comprising an intermittently-interrupted circuit containing self-induction, a condenser, and means in consequence of which the condenser may be connected across the point of rupture in said intermittently-interrupted circuit, to receive a succession of rushes or inflows of current prior to its discharge.

18. An inductive system comprising an intermittently-interrupted circuit containing self-induction, a condenser of any desired capacity, and means in consequence of which said condenser may be charged by a succession of rushes of current taken from the intermittently-interrupted circuit prior to its discharge.

19. An inductive system comprising an intermittently-interrupted circuit containing self-induction, a condenser with means for connecting it across the point of rupture in the main circuit, and self-induction device placed between the condenser and the interrupter circuit.

20. An inductive system comprising an intermittently-interrupted circuit containing self-induction, a condenser, a self-inductive device, a circuit for utilizing the discharge of the said condenser and means for intermittently connecting said condenser and self-inductive device across the point of rupture whereby only the rush of current which charges the condenser passes through said self-induction device.

21. An inductive system comprising a main circuit having a normally closed break, a condenser-circuit having a normally open break, and a circuit for utilizing the discharge of said condenser having a permanently-open break, substantially as described.

22. An inductive system comprising a main circuit having a normally closed break, a condenser-circuit having a normally open break, a circuit for utilizing the discharge of said condenser having a permanently-open break, substantially as described, and means for substantially simultaneously opening the normally closed break, and closing the normally open break for the purpose set forth.

23. An inductive system, comprising a condenser, a circuit having means for utilizing the discharges from said condenser; a shunt-circuit around said means, and a switch in said shunt-circuit, whereby said means may be short-circuited or cut out by said switch and said shunt-circuit.

24. An inductive system, comprising a condenser, a circuit having means for utilizing the discharges from said condenser, and a fluid-operated means for closing said circuit.

25. An inductive system, comprising a condenser, a circuit having means for utilizing the discharges from said condenser, a switch controlling said circuit, fluid-operated means for operating said switch, and a manually-operated bulb for forcing fluid into the said switch-operating means.

26. A high-frequency apparatus comprising a source of electrical energy, a condenser, a circuit having means for utilizing the discharges from said condenser, a switch for controlling said means, and fluid-actuated mechanism for operating said switch.

27. An inductive system comprising a condenser, a low-resistance circuit for utilizing the discharge of said condenser and including an air-gap, and the primary of a high-frequency induction-coil, and a switch for controlling said low-resistance circuit.

28. An inductive system comprising a condenser, a low-resistance circuit for utilizing the discharge of said condenser, a high-frequency transformer whose primary is in said low-resistance circuit, said transformer consisting of a primary having a number of helical turns and an inclosed secondary wound in superimposed layers of substantially equal or increasing resistance from the circumference toward the center.

29. An inductive system comprising a condenser, a low-resistance circuit for receiving the discharge of said condenser, a high-frequency transformer whose primary is in said low-resistance circuit, said transformer consisting of a primary having a number of helical turns and an inclosed secondary wound in superimposed layers with the turns in the layers decreasing in number from the center toward the circumference.

30. An inductive system comprising a condenser, a low-resistance circuit for utilizing the discharge of said condenser, a high-frequency transformer whose primary is in said low-resistance circuit, said transformer consisting of a primary having a number of helical turns and an inclosed secondary wound in superimposed layers with the turns of the layers increasing in number as the lines of force set up by the primary decrease in intensity.

31. An inductive system comprising a high-frequency transformer whose secondary terminates in a ring with an inclosing helix of electrically-conducting material.

32. An electrode for high-frequency current system comprising a helix bent to bring its ends adjacent.

33. A high-frequency apparatus comprising a portable cabinet having folding members separately supporting or containing the essential elements of said apparatus, and when unfolded maintaining said elements in a predetermined relation.

34. A high-frequency apparatus comprising a portable cabinet, having hinged members or cases separately supporting or containing the essential elements of said apparatus, whereby when said members or cases are folded together said elements are all contained within the interior walls of said cabinet.

35. A high-frequency apparatus comprising a portable cabinet, having folding members or cases and also comprising the essential elements of a high-frequency system, which elements are respectively supported or contained by said members or cases in predetermined relation when in operation.

36. A high-frequency apparatus comprising a portable cabinet having folding members separately containing or supporting the essential features of a high-frequency system, one of said folding members containing the high-frequency transformer.

37. A portable high-frequency apparatus comprising a portable cabinet consisting of folding members, containing and separately supporting a transformer, a condenser, and a high-frequency inductor, and electric connections for placing the apparatus in proper circuit relations, said members when unfolded maintaining the transformer, the condenser and the high-frequency inductor in a predetermined relation.

38. A portable high-frequency apparatus comprising the essential elements of a high-frequency system, and a portable cabinet, said cabinet consisting of independent members in hinged connection and adapted to be swung about their respective hinges to bring said elements into operating relation.

39. A portable high-frequency apparatus comprising the combination with a high-frequency transformer and a terminal electrode therefor, a condenser, means for charging said condenser, and circuit connections, of a cabinet comprising hinged members for containing said recited elements, one of said members containing the high-frequency transformer and having said electrode projecting therefrom.

40. A portable high-frequency apparatus comprising a portable cabinet consisting of two hinged members and means for locking them when folded or closed together, a high-frequency transformer and an electrode in one of said members, a condenser and an electrode in the other of said members, and a condenser-circuit including the last-mentioned electrode extending from the transformer to the condenser, said members when opened or unfolded maintaining said electrodes in operative relation.

41. A portable high-frequency apparatus comprising a portable cabinet consisting of two hinged members and means for locking them when folded or closed together, a high-frequency transformer and an electrode in one of said members, a condenser and an electrode in the other of said members, and a condenser-circuit including the last-mentioned electrode extending from the transformer to the condenser, said last-mentioned electrode being hinged to its cabinet member so as to fold into the cabinet when the latter is closed.

42. A portable high-frequency apparatus comprising a cabinet consisting of a base having a member fixed thereon, a second member hinged to said base and adapted to close against the first-mentioned member, a third hinged member, and the essential elements of a high-frequency system supported by or contained in said members respectively, and concealed within said cabinet when said members are closed together.

43. A switch for high-voltage circuits comprising a movable member, a stationary member, and fluid-operated means for moving said movable member in either direction with a hammer-blow.

44. A switch for high-voltage circuits comprising a movable member, a stationary member, fluid-operated hammer for moving said movable member, and a device delivering fluid under compression to said hammer.

45. A switch for high-voltage circuits comprising a movable member, a stationary member, fluid-operated hammer for moving said movable member with a hammer-blow, a compressible bulb, and a flexible conduit for connecting said bulb to said fluid-operated means.

46. An inductive system comprising a condenser, means for charging said condenser, a high-frequency transformer operated by said condenser, a therapeutic electrode connected with one terminal of the secondary of said

transformer, and a condenser connected between the opposite terminal of said secondary and the ground.

47. An inductive system, comprising a condenser, a main circuit, and automatic means for charging said condenser by the self-induction of the main circuit when a direct current is supplied to the said main circuit and for charging said condenser by the secondary induction of the said main circuit when an alternating current is supplied to the said main circuit.

48. An inductive system comprising a condenser, a main circuit, and automatic means for charging said condenser by the self-induction and secondary induction of the said main circuit.

49. An inductive apparatus comprising a main switch, an intermittently-formed break, and a primary of a low-frequency transformer, all in series in a main circuit; an intermittently-formed break, a choking-coil, a condenser, a variable primary of a high-frequency transformer, and a switch in multiple circuit around the same, all connected around said first-mentioned break; a secondary of said low-frequency transformer having its terminals connected to opposite sides of said condenser; a secondary for said high-frequency transformer having one terminal terminating in a helix, a condenser connected between the opposite terminal of said secondary and the earth; a selective switch for selecting the desired number of turns of the primary of said high-frequency transformer; an independent handle-supported high-frequency transformer in duplicate connection to the first-mentioned high-frequency transformer; and means in connection with the said handle-supported transformer for holding therapeutic electrodes substantially as set forth.

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

RALPH C. BROWNE.

Witnesses:

EDWARD H. ADAMS,

MARY B. MOODY.