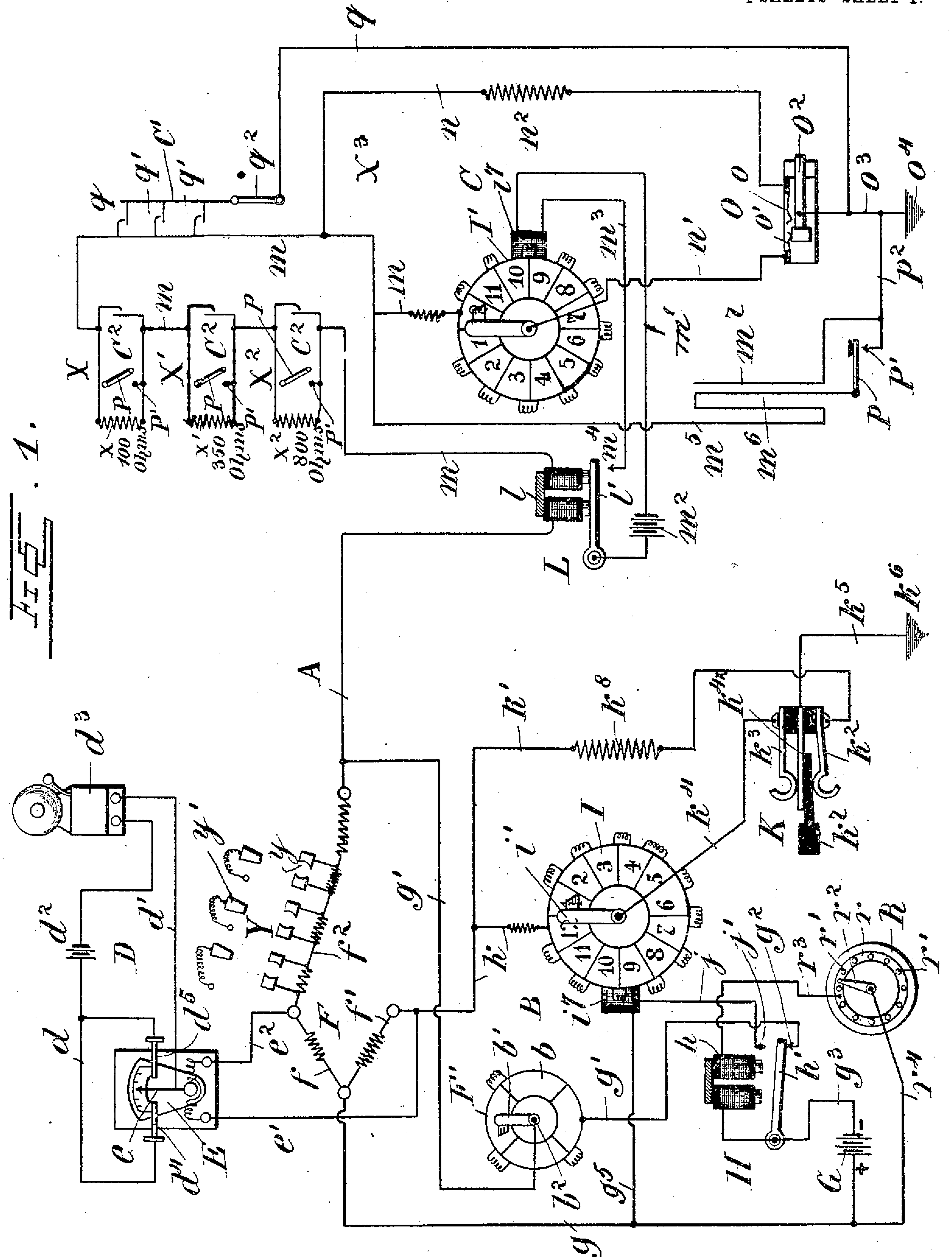
No. 791,961. PATENTED JUNE 6, 1905.

J. WEATHERBY, Jr.

BURGLAR ALARM SYSTEM.

APPLICATION FILED MAR. 31, 1904.

4 SHEETS—SHEET 1.



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4 SHEETS—SHEET 2.

Fig. 2.

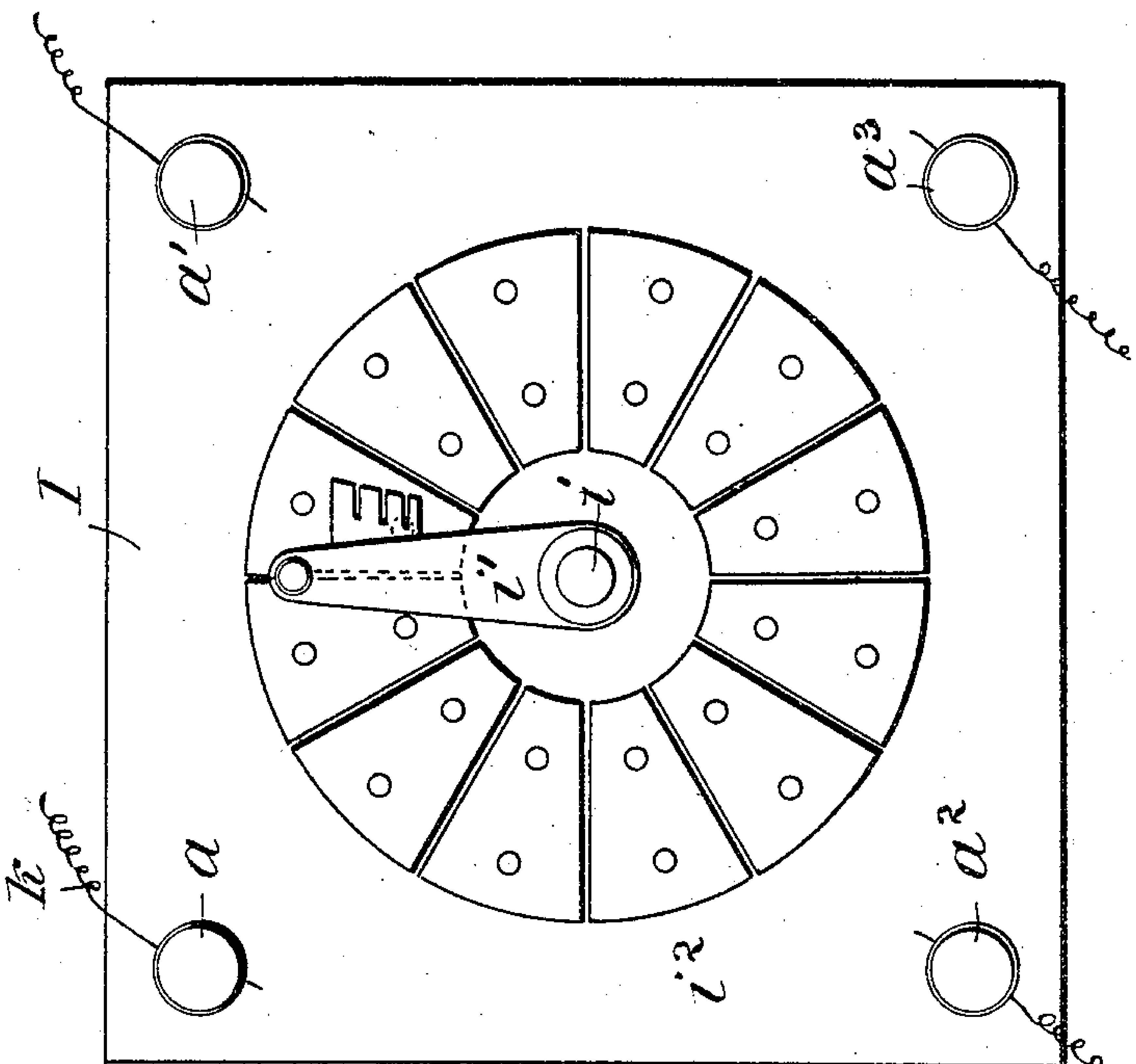
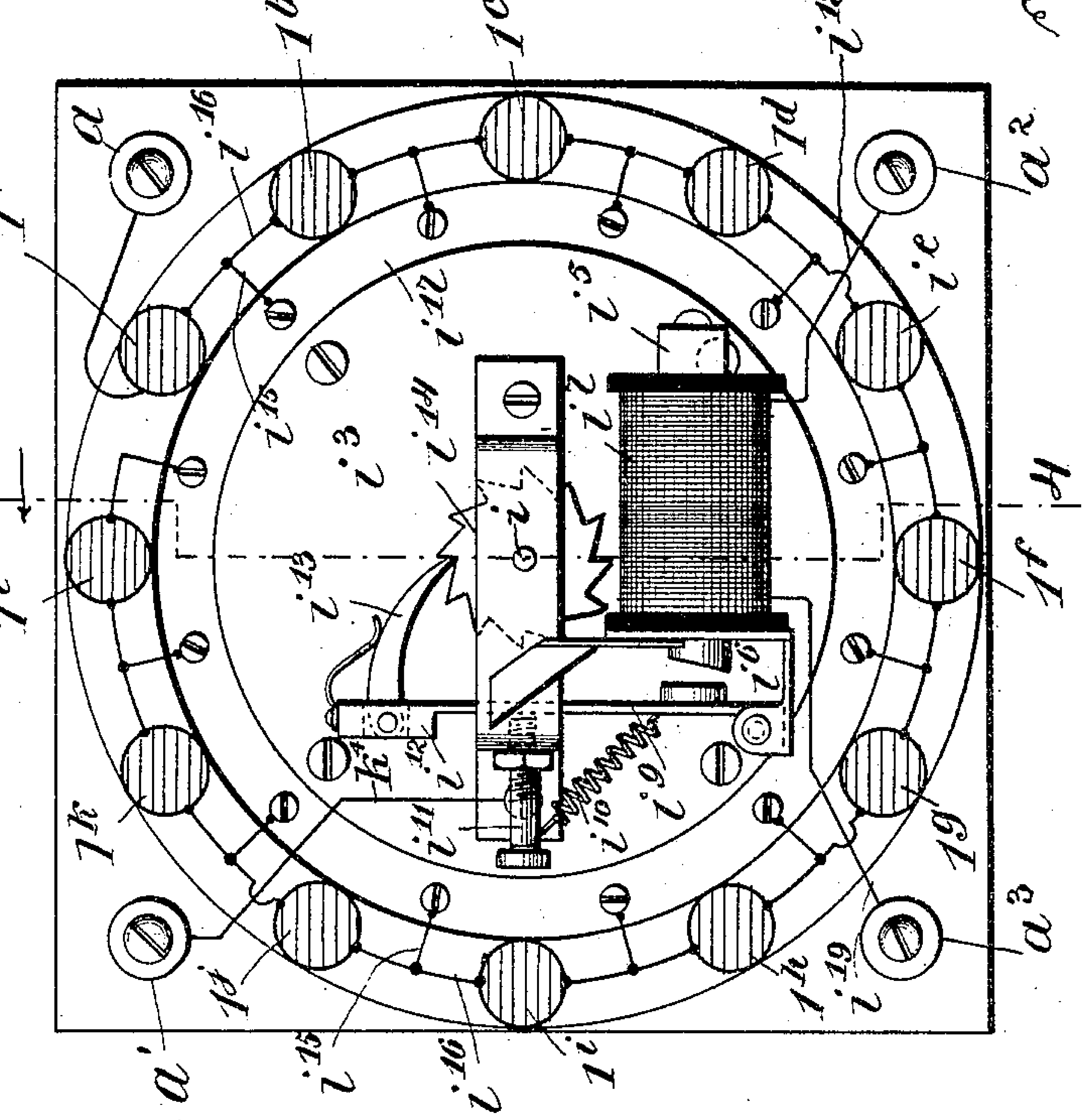


Fig. 3.



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4 SHEETS—SHEET 3

FIG. 4.

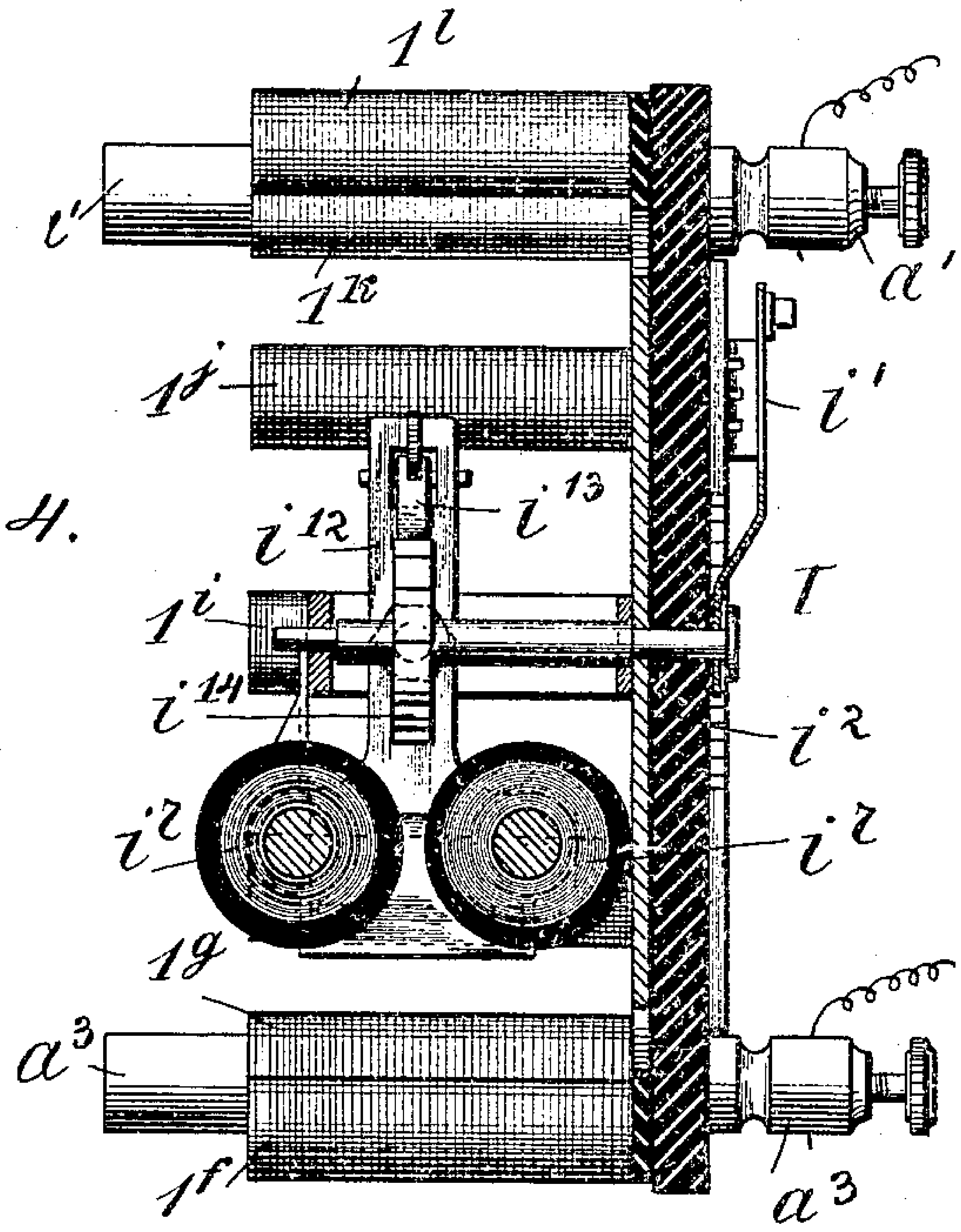
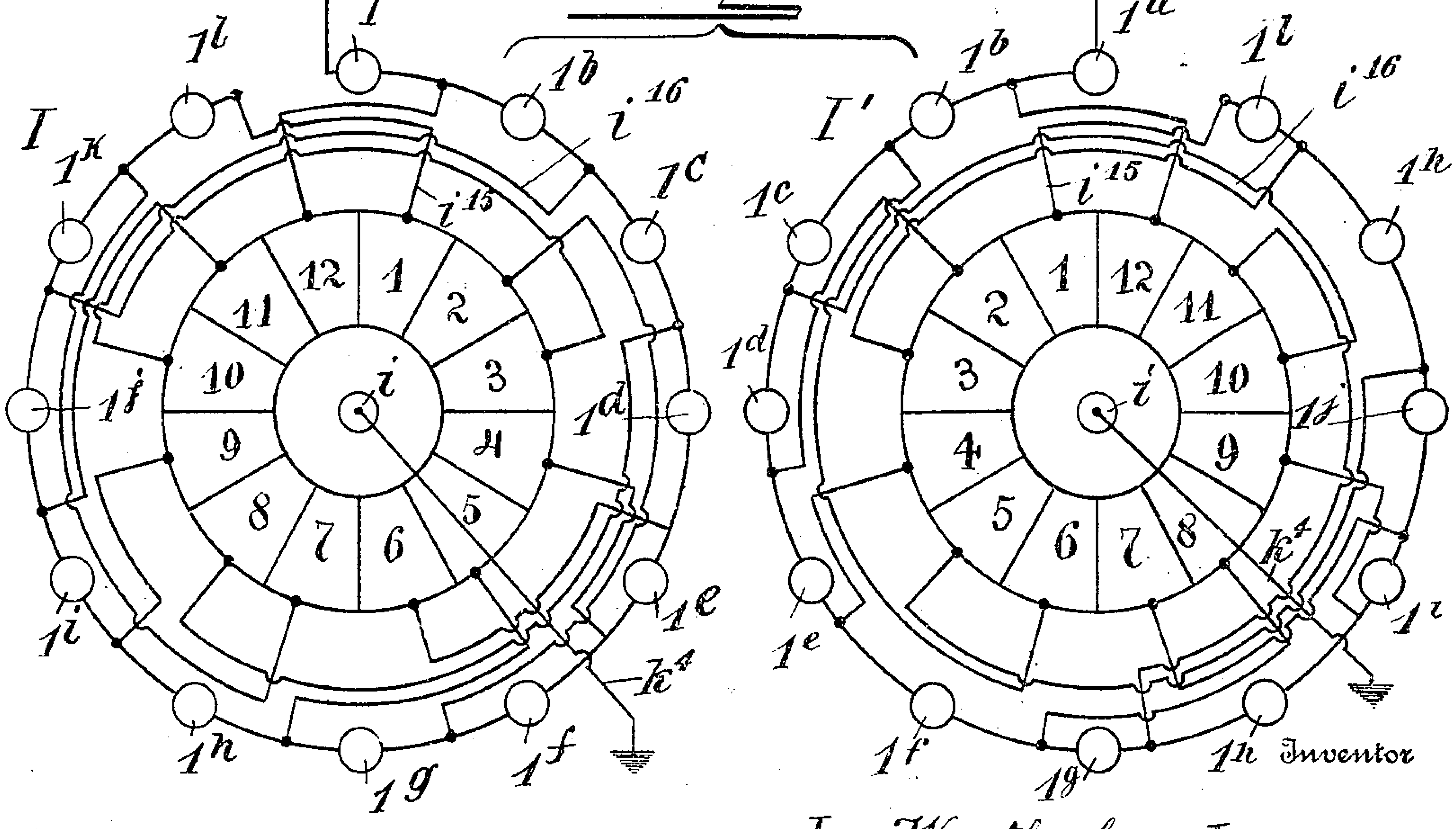



FIG. 5.

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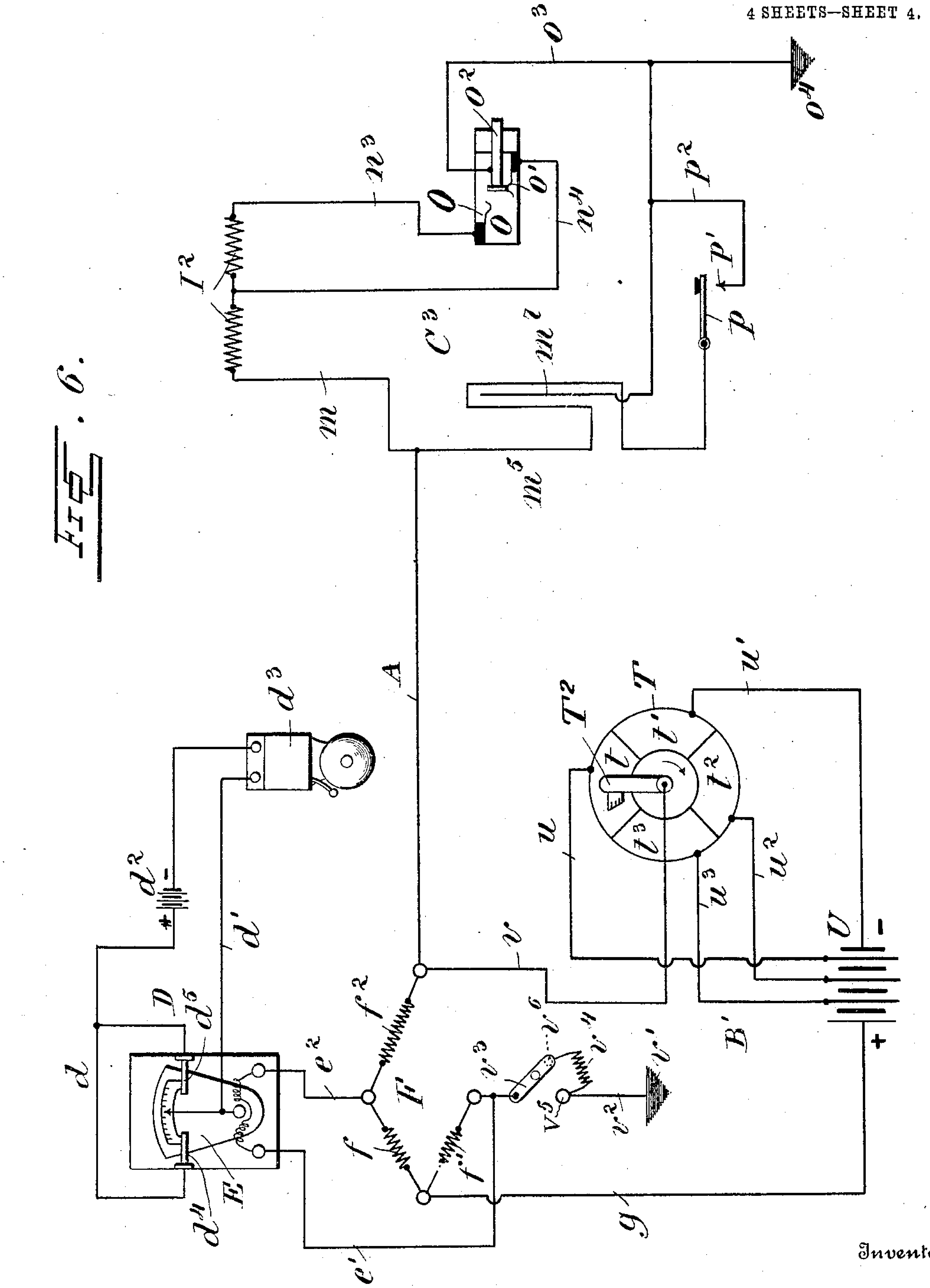
4 SHEETS—SHEET 4.

FIG. 6.

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No. 791,961. Patented June 6, 1905.

# UNITED STATES PATENT OFFICE.

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## BURGLAR-ALARM SYSTEM.

SPECIFICATION forming part of Letters Patent No. 791,961, dated June 6, 1905.

Application filed March 31, 1904. Serial No. 200,975.

*To all whom it may concern:*

Be it known that I, JOSEPH WEATHERBY, Jr., a citizen of the United States, residing at New Cumberland, in the county of Cumberland and State of Pennsylvania, have invented certain new and useful Improvements in Burglar-Alarm Systems; and I do declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to burglar-alarm systems of that type in which a bank, vault, residence, or other building or protected structure is electrically connected with a central station having means governed by instruments set into action to give an alarm at the central station when an attempt is made by an unauthorized person to tamper with the line or obtain access to the vault or structure.

The invention is of that type employing, in connection with a local alarm-circuit and a main alarm-circuit, a device, such as a galvanometer, influenced by variations in the electrical condition of the main circuit to give or operate an alarm, and particularly to such a system in which the amount of resistance, considered in its entirety, remains constant, while the resistance in the local portions of it is varied from time to time or the supply potential is rapidly changed.

The object of my invention is to provide a system of this character which is designed to overcome objection to prior systems in which the influenced device—namely, the galvanometer—has invariably been arranged in series with the source of supply and resistance at the central station and protected point. When a galvanometer is arranged in series with these elements of the circuit, it is liable to be improperly influenced and to cause confusion from false signals due to variations in the potential of the source of supply. My invention obviates these objections by the arrangement of the galvanometer in a bridge in such manner that it is influenced by variations in the electrical conditions of the line as an entirety, but not from changes in the potential of the source of supply, and becomes influenced to give or operate a signal only when the resistance or electrical condition of one portion of the line varies from the other portion thereof.

A further object of my invention is to provide a system having resistances at the central station and protected points automatically governed, so that while one increases the other will decrease in like proportion the amount of resistance in circuit, so that while the resistance in local portions of the circuit is varied the total resistance in the entire circuit remains constant.

A still further object of the invention is to provide resistance means so operating as to decrease or cut out the resistance on one side of the circuit when the line is broken or tampered with or electrical connections are made upon the attempt of a person to enter the vault or other structure, this decrease or cutting out of the resistance causing the galvanometer to be influenced to give or operate a signal.

A still further object of the invention is to provide means whereby upon the opening of the door of the vault or other structure an alarm or signal will be given at the central station and compensating resistance thrown into the circuit to maintain the line in working order during the period the door remains open to maintain protection on other portions of the line. This enables an authorized person to at all times send a predetermined signal to the central office from the protected structure to notify central of the opening or closing of the door or other portion of the structure protected, thus giving proper notice to central that the door has been opened or closed by a properly-authorized party.

My improved system embodying the means for carrying these objects into practical effect further enables the potential of the feed-current or source of supply to be varied with any desired degree of rapidity without affecting the signal at the central station. The supply of a variable current may thus be controlled so as to prevent the resistance of the line from being determined by the use of resistance-measuring instruments, the variability of the current producing such wide or rapid fluctuation of the instrument as to prevent the resistance at the protected point from being ascertained.

With these and other objects in view the invention consists of certain novel features of construction, combination, and arrangement of parts, as will be hereinafter more fully described, and particularly pointed out in the appended claims.

In the accompanying drawings, Figure 1 is a diagrammatic view of a burglar-alarm system embodying my invention, showing several protected points or stations connected along a common line, the connections at one of said points appearing in detail. Fig. 2 is a front or face view of one of the automatic resistance devices. Fig. 3 is a rear view of the same. Fig. 4 is a section on line 4 4 of Fig. 3. Fig. 5 is a diagrammatic view showing the wiring of the resistances, and Fig. 6 is a view similar to Fig. 1, showing a modification in the system.

In the following description and claims it will be understood that by the term "bridge being balanced" or similar terms I mean the normal condition of the circuit when there is no difference of potential between the bridge-arms and that by the "bridge being unbalanced" or the "balance being broken" I mean that the resistance in the external circuit has been raised or lowered and there is change of potential between the bridge-arms, causing a portion of the current to pass through the galvanometer.

A in the drawings represents the line-wire of a closed main circuit, and B and C the portions thereof located, respectively, at the central station and protected structure.

Arranged at the central station is a local alarm-circuit D, including conducting-wires $d$ $d'$, a battery or suitable source of electrical supply $d^2$, a translating device—such as a bell, annunciator, or other desired aural or visual signal $d^3$—and contact-points $d^4$ and $d^5$. This local alarm-circuit is controlled by a galvanometer E or other similar device influenced by variations of potential between conductors. The needle or pointer $e$ of this instrument is adapted when at zero or neutral position, which is the position it occupies when the current in the main circuit is normal, to lie between the two contacts $d^4$ and $d^5$ and out of engagement with either of them; but when the current in the main circuit is varied either by an increase or a decrease the needle will be deflected and come into engagement with one or the other of said contacts, accordingly as the variation is by way of increase or decrease, and thereby close the circuit and cause the alarm $d^3$ to be sounded. The galvanometer instead of being connected in series, as in prior systems of this kind, is connected with the line A and portion B of the main circuit by conductors $e'$ and $e^2$, connected to portions of a bridge F, located in the main line. This bridge may be of the Wheatstone or any other suitable type. As shown, the bridge F is of the conventional Wheatstone type, consisting of the arms $f$ and $f'$ and the resistance or rheostat $f^2$, the conductor $e'$ being in connection with the arm $f'$, while the wire $e^2$ connects with the bridge between the arm $f$ and resistance $f^2$. The resistance $f^2$ of the bridge is connected to the line-wire A and exactly equals the resistance of the instruments in the portions B and C of the main-line circuit.

In the portion B of the main-line circuit at the central station is a supply-circuit, comprising a main battery G, which is connected on one side to the bridge F through a conductor $g$ and on the other side by conductors $g'$ and $g^3$. The conductor $g'$ is controlled by an automatic switch H, comprising an electromagnet $h$ and a pivoted armature $h'$, and in said conductor is a current-fluctuating device F', comprising commutator-segments $b$ and a contact-arm $b'$, the latter being mounted on a shaft $b^2$, which in practice may be rotated fast or slowly by a motor (not shown) to vary the potential of the feed-current without breaking or interrupting it, thus rendering it impossible for a meddler to determine the resistance along the line, owing to the fluctuations which would thus be caused in the resistance-measuring instrument. The armature $h'$ normally engages a contact-point $g^2$ at the adjacent end of the conductor $g'$, and thereby normally closes said circuit. When the circuit is closed, the current from the battery G flows from the positive pole, through a conductor $g$, to and through the arm $f$ of the bridge F, thence through the resistance $f^2$ of the bridge, thence back through the conductor $g'$ to and through the current-fluctuating device F', thence to contact-point $g^2$, through the armature $h'$, and back to the negative pole of the battery through a conductor $g^3$, connecting said negative pole of the battery with the electromagnet $h$. This is the course of one portion of the current divided by the bridge F. The course of the other portion of the current divided by the bridge will be hereinafter described. In the portion B of the circuit is also an automatic resistance device I comprising a commutator consisting of a series of segments arranged in a circle concentric with a shaft $i$, to which is connected a contact-arm $i'$, adapted to turn or rotate counter-clockwise in a circular path and successively engage said segments. The number of segments employed may vary as desired. In the present instance I have shown a commutator-plate composed of twelve segments, (denoted 1 to 12, inclusive,) said segments being mounted upon one side of an insulating-base $i^2$, through which project four binding-post $a$ $a'$ $a^2$ $a^3$. On the rear of the base-plate is a metallic bracket-plate $i^3$, supporting brackets $i^5$ and $i^6$, the latter serving, in connection with the plate $i^3$, as a bearing for the shaft $i$. Upon the brackets $i^5$ and $i^6$ an electromagnet $i^7$ is mounted. The cores of this magnet project through the bracket $i^6$, which carries a pivoted armature $i^9$. This armature is influenced by said electromagnet and is normally retracted by a spring $i^{10}$, attached to a set-screw $i^{11}$, forming a stop to limit the backward movement of an arm $i^{12}$, carried by said armature. This arm in turn carries a pivoted spring-actuated pawl $i^{13}$, which is adapted to engage a ratchet-wheel $i^{14}$, fixed on the shaft $i$. The teeth of this ratchet-wheel correspond in number to the number of segments of the commutator-plate and when successively engaged by said pawl turn the contact-arm $i'$ at each movement a distance of one segment, as will be readily understood. The segments are respectively connected by conducting-wires $i^{15}$ to resistance-coils $1^a$ $1^b$ $1^c$ $1^d$, &c., connected in series by conductors $i^{16}$ and supported upon a frame composed of spools of insulating material carried by a ring $i^{17}$ of similar material fixed to the back of the plate $i^2$. One of the end coils of the series is connected to the binding-post $a$, while the ends of the successive coils are connected to the segments 1 2 3 of the commutator-plate, the circuit being completed through the contact-arm $i'$ to binding-post $a'$. The electromagnet is connected to binding-posts $a^2$ $a^3$ by wires $i^{18}$ $i^{19}$. The resistances may represent any desired quantity of value. In the present instance I may represent each resistance-coil as of one hundred ohms resistance, and as the same are connected in series it will be seen that the movement of the contact-arm $i'$ around the commutator-plate will throw into the circuit a total resistance of twelve hundred ohms or any division thereof represented by the several segments. From the binding-post $a^2$, connected to the electromagnet $i^7$, leads a conductor $j$, having a contact $j'$ located in proximity to the contact $g^2$ of the wire or conductor $g'$. The armature $h'$ of the relay or automatic switch H is arranged to play between these two contacts $g^2$ and $j'$ and to alternately throw the alarm-circuit B and galvanometer E and the automatic resistance I into and out of circuit of the line, so that momentarily during the movement of the arm $i'$ of said automatic resistance the said circuit B and galvanometer E will not be affected by the changing resistance. Leading to the binding-post $a$ from the bridge-arm $f'$ is a wire $k$, connecting with a wire $k'$, leading to one of the spring-arms $k^2$ of a switch K, which has an opposing arm $k^3$, connected to the binding-post $a'$ by the wire or conductor $k^4$. Between the two arms $k^2$ and $k^3$ is a metallic contact-piece $k^{4\times}$, which is adapted to be normally engaged by said spring-arm and which is connected by a conductor $k^5$ with the ground at $k^6$. A switch plug or wedge $k^7$, composed of non-conducting material, is adapted to be interposed between either of said spring-arms and the conducting-plate $k^{4\times}$ to enable the operator to adjust the portion B of the circuit to suit a changed condition of the circuit when the door of the vault of the guarded structure is opened—as, for instance, during the working period of the day. For the purpose of meeting such conditions I provide in the conductor $k'$ a compensating resistance $k^8$, whose operation will be presently described.

The circuit C at the guarded or protected structure includes an automatic rheostat I', corresponding in construction with the automatic resistance I at the central station and adapted to operate simultaneously therewith to vary the respective resistance of local portions of the line and maintain a determined resistance along the line as an entirety. The parts of this automatic resistance device I' correspond to those of the automatic resistance device I, and the coils of these two devices are calibrated for an exact resistance relation. The hands of the two automatic resistance devices move counter-clockwise, or in the same relative direction; but the order of the segments of the commutator-plates thereof is reversed, so that when the contact arm or hand of the device I throws in the greatest resistance the contact-arm of the automatic resistance device I' will throw in its least resistance, thus maintaining a corresponding resistance along the line as an entirety while varying the resistance of the local portions thereof. Thus it will be understood that in maintaining a resistance of thirteen hundred ohms along the line as an entirety the movement of the contact-arm of the resistance device I from segment 1 to segment 12 will change the resistance at the local portion B from the least to the highest and that the corresponding movement of the arm of the resistance I' in its same relative movement from commutator-segment 12 to commutator-segment 1 will reversely change the resistance of the local-circuit portion C from highest to lowest, the resulting entire resistance along the line, however, remaining the same, as the total amount of resistance thrown in by the two automatic resistance devices will amount to thirteen hundred ohms. Thus upon a further forward movement the contact-arm of the resistance device I will engage the segment 11, which is shown in Fig. 5 as connected in series with nine of the resistance-coils, representing nine hundred ohms, while the contact-arm of the resistance device I' will engage the commutator-segment 2, which is shown in said Fig. 5 as connected in series with four of the resistance-coils, representing a resistance of four hundred ohms, an entire total of thirteen hundred ohms, thus automatically increasing or decreasing the resistance at one portion of the line and correspondingly decreasing or increasing the resistance at the other portion of the line, while maintaining a determined resistance represented by the sum of the resistances along the line as an entirety. Instead of having the resistances of the resistance devices I and I′ arranged to give a progressively increasing or decreasing resistance, the units or segments of which have like individual value and a corresponding sum-total value representing a collection of one or more of these units, the segments of the two commutators may be so connected with the resistances thereof and calibrated that the resistance in each portion of the circuit will vary widely or irregularly from the highest to the least or from the least to the highest resistance or any combination of the units, thus making it practically impossible for even one highly skilled in the art to meddle with the system without operating the alarm or signal of the circuit D, since the exact amounts of resistance and the combination in the cycle must be known before the system can be defeated, which is practically a matter of impossibility.

Fig. 5 shows the resistances I I′ arranged to cause great variations of resistance in localized portions of the circuit. Thus when the contact-arm of resistance device I is on the commutator-segment 1 said segment is connected in series with twelve of the resistance-coils. At the same time the corresponding contact-arm of resistance device I′ will be on segment 12, which is connected in series with only one of the resistance-coils, thus making a total of thirteen hundred ohms for the circuit. The next movement of the said contact-arms will place the contact-arm of device I on segment 2, which is connected in series with six of the resistance-coils, equaling six hundred ohms, while in device I′ the contact-arm will be on segment 11, which is connected in series with seven of the resistance-coils, equaling seven hundred ohms, making the total resistance in the circuit thirteen hundred ohms. The next movement of the contact-arms will place the arm of device I on segment 3, which is connected in series with ten of the resistance-coils, equaling one thousand ohms, while in device I′ the contact-arm will be on segment 10, which is connected in series with three of the resistance-coils equaling three hundred ohms, thus again making the aggregate resistance in the circuit thirteen hundred ohms. I do not desire to limit myself to the exact arrangement of the resistance devices herein shown and described, as modifications may be made therein without departing from the spirit of the invention and within the scope of the appended claims.

The operating mechanism of the contact-arm of the resistance I′ is controlled by an automatic switch L, comprising an electromagnet $l$ and an armature $l'$, influenced thereby, the said magnet being connected to the line-wire A and to one side of the circuit C through a conductor $m$, while the armature $l'$ is adapted to open and close a local operating-circuit in the circuit C, said local operating-circuit comprising a conductor $m'$, containing a local battery $m^2$ and leading from the armature $l'$ to the binding-post $a^2$ in circuit with the electromagnet of the resistance I′, and a conductor $m^3$, having a contact-point $m^4$, adapted to be engaged by the armature $l'$ and leading to the binding-post $a^3$ of the resistance device I′, which completes the circuit through said electromagnet. Normally the magnet $l$ is energized and attracts the armature $l'$ away from contact $m^4$, thus breaking said local circuit; but when the resistance is varied at central through the medium of the resistance device I the switch H automatically cuts off the flow of current through the line A, and magnet $l$ is deënergized, and the armature $l'$ drops into contact with the conductor $m^4$ and closes the said local circuit at the guarded point, thereby energizing the magnet of the resistance device I′ to move the contact-arm of the commutator thereof to change the resistance.

In the circuit C are also conductors $n$ and $n'$, the former connecting with the conductor $m$ and resistance-coils of the resistance I′ and through the shaft $i$ with a contact-spring $o$ of a governing device O, and the latter leading from the conductor $m$ to another contact-spring, $o'$, of the device O. This device O also includes a movable bolt or plunger $o^2$, connected with a conductor $o^3$, leading to ground at $o^4$. This device O is a circuit-shifter, which is governed by the opening of the door of the safe or vault of the protected structure to operate the alarm $d^3$ when the door is opened or closed or may be operated as a switch when local protection alone is used. When the plunger is in closed position, as shown, the second portion of the circuit divided by the bridge F is completed, the course of the current being from the positive pole of battery G to and through conductor $g$, arm $f'$ of bridge F, to conductor $k$, to and through elements of automatic resistance I, to wire $k^4$, spring-arm $k^3$ of switch K, strip $k^{4\times}$, to earth at $k^6$, through wire $k^5$, thence from the earth $o^4$ at protected point to conductor $o^3$, thence through plunger $o^2$ of circuit-shifter O to contact $o'$, thence through wire $n'$ to and through elements of automatic resistance I′, conductor $m$, the several local protected points X X′ X², to and through magnets of switch L, to line A, wire $g'$, to and through current-fluctuator F′, contact-point $g^2$, armature $h'$ of switch H, conductor $g^3$, back to the negative pole of battery G. When the door is opened, however, the plunger $o^2$ is moved to contact with the spring $o'$, thereby disconnecting the automatic resistance and establishing a compensating circuit through the conductor $n$. In the conductor $n'$ is a resistance $n^2$, forming, with the resistance $k^8$ of the conductor $k'$ at central station, compensating resistances, forming a fixed resistance along the entire line to take the place of the resistance devices I and I′, as will be hereinafter described.

In order that a suitable signal may be transmitted to the central office to indicate the intention of a proper person or official of the bank or other protected structure to open or close the door, a signal-transmitter of preferred form, such as an ordinary Morse key or circuit-closer $p$, is provided in a conductor $m^5$, connecting with the conductor $m$, and is adapted to engage a contact $p'$, connected to a conductor $p^2$, leading to ground at $o^4$ and in electrical connection with the conductor $o^3$. When this key is depressed to sound a predetermined signal, the automatic resistance I′ will be shunted out, thus unbalancing the bridge F and operating the alarm $d^3$ accordingly at the central station. The conductor $m^5$ is shown as having coiled deflections or suitable connections at $m^6$ in such relation to a conductor $m^7$, normally out of connection with said conductor $m^5$, but in connection with the conductor $p^2$, that when the portions of the said conductors $m^5$ and $m^7$ are bridged or connected at the point $m^6$ a variation of resistance will occur which will cause the operation of the galvanometer at the central station and the sounding of the signal $d^3$. These elements $m^6$ and $m^7$ represent a circuit-closer which is embedded in the wall of the vault or safe of the protected structure and so related, as set forth, that when an attempt is made to drill through or into said wall the circuit will be closed in the manner described to warn the central office of such attempt.

If it be desired to guard the doors or windows of the protected structure, a local open circuit C′ may be provided by running a conductor $q$ from the wire $o^3$ and providing circuit-closers $q'$ to connect the same with the conductor $m$ to short-circuit the automatic resistance or compensating resistance, thus unbalancing the bridge to operate the galvanometer and sound the alarm. A switch $q^2$ may be provided to connect the circuit C′ with or disconnect it from the circuit C.

The resistance devices I and I′ are automatically controlled primarily from the signal-station through the medium of a time device, such as a clock or chronometer R, the dial or face of which is provided with a ring or similar conductor $r$, having sockets arranged at desired intervals apart to receive contact pins or pegs $r'$, which are adapted to be engaged by the minute-hand $r^2$. These pins may be so arranged that the hand $r^2$ will contact therewith at any preferred regular or irregular intervals during the path of movement of said hand around the dial. Connected to the ring $r$ is a conductor $r^3$ and to the hand $r^2$ a conductor $r^4$, which lead, respectively, to the electromagnet $h$ of the switch H and the conductor $g$ adjacent to the main battery G.

It will be understood, of course, that several structures to be protected may be controlled by the same bridge, each structure having a determined resistance differing in value from the resistances of the other structures, and when any one or any number of these resistances is or are shunted out a compensating resistance or resistances of equal value may be taken out in the bridge at the central station. Such an arrangement is shown in Fig. 1, in which several structures X X′ $X^2$ $X^3$ are connected in series in the same line-circuit, the local circuits $C^2$ of the stations X X′ $X^2$ containing resistances $x$ $x'$ $x^2$ of different values, as indicated. To enable the bridge to be balanced when one or more of the resistances are shunted out, as when the doors of a safe or vault at one or more of the stations are opened, the coils of the resistance $f^2$ of the bridge are connected in series with a multiple switch Y, having a series of sockets $y$ to receive pegs $y'$, by which one or more of the coils may be thrown in or shunted out. By this means the resistance of the bridge may be regulated to compensate for variations in the resistance of the line, so as to afford the proper protection to the structures whose doors remain closed while others are open, as will be readily understood.

The operation is as follows: Assuming the parts to be in the position shown in Fig. 1, in which the contact-arm of the resistance device I engages the one-hundred-ohm-resistance segment 1, while corresponding arm of the resistance device I′ engages the twelve-hundred-ohm-resistance segment 12, thus making a total resistance of thirteen hundred ohms plus the resistance of the automatic switch L, line, and the protected points X, X′, and $X^2$ along the entire line, it will be seen that as an equal amount of current flows from battery G through conductor $g$ to arm $f$ of resistance F and through bridge resistance $f^2$ to the line A, as from wire $g$ to arm $f'$ of resistance F to and through conductor $k$ and thence through the line including the resistances at both the central station and protected point and the earth, there is no difference of potential through the divided portions of the bridge, and thus no current flows through the conductors $e'$ and $e^2$ and galvanometer and alarm-circuit D from the bridge F. Hence as no current normally passes through the galvanometer the galvanometer will not be influenced by variations in strength in the source of current-supply, such as by changes in the strength of the battery G, and therefore no confusing deflection of the needle from such cause or improper sounding of the signal can occur, and all necessity of adjusting the parts to compensate for any such variation in the source of supply, as in systems in which the galvanometer is in series, is avoided. When in its movement the hand $r^2$ of the chronometer engages one of the contact-pins $r'$, a circuit is closed through wire $r^4$, battery G, wire $g^3$, the electromagnet $h$ of the automatic switch H, and thence back through wire $r^3$ to the conducting-ring $r$, thus energizing the magnet $h$, which attracts the armature $h'$, moving it out of engagement with contact $g^2$ and into engagement with contact $j'$ of conductor $j$, thereby allowing a current to pass from the negative pole of battery G to contact $j'$, thence to the magnet $i^7$ of the automatic resistance device I and through the conductor $g^5$ back to battery through wire $g$, thus actuating the armature $i^9$ and adjusting the pawl $i^{13}$ to move the ratchet-wheel $i^{14}$ the distance of one tooth, whereby the contact-arm $i'$ is caused to move from the resistance-segment 1 to the resistance-segment 12, thus inserting into the line a resistance of twelve hundred ohms in the place of one hundred ohms, as before. During this operation the movement of the armature $h'$ from contact $g^2$ to contact $j'$ cuts out the supply-current from the main-line circuit, so that no current passes through the bridge F or line A, thus deënergizing the magnet $l$ of the switch L and allowing the armature $l'$ thereof to drop into engagement with the contact $m^4$, thus closing the local circuit at the protected point, allowing a current to pass from battery $m^2$ through conductor $m'$ to the electromagnet $i^7$ of the automatic resistance device I′, causing the operation of the armature $i^9$ and pawl $i^{13}$ thereof and the movement of the ratchet-wheel $i^{14}$ the distance of one tooth, thus adjusting the contact-arm of the said resistance device I′ from engagement with the twelve-hundred-ohm segment 12 to the one-hundred-ohm segment 1. This operation reverses the amount of resistance thrown into the line at the central station and protected structure, thus varying the resistance in local portions of the circuit, while maintaining a total resistance in the entire circuit of thirteen hundred ohms plus the resistance of the line, earth, switch L, and the local protected points X, X′, and X². In the operation of the two resistance devices I and I′ in thus varying the resistance in the local portions of the line the contact-arm of the former may be moved somewhat quicker than the contact-arm of the latter and for a short interval throw a greater or less amount than the normal resistance in the line, thus varying the total resistance of the circuit without affecting the galvanometer E, as the switch H cuts the bridge F during this operation out of the main circuit, thus allowing no change of potential between the conductors $e^2$ and $e'$, and consequently no transmission of a current through the galvanometer E. Upon the movement of the chronometer-hand $r^2$ out of engagement with the pin $r'$, as described, the current through the local switch-circuit at the central station is broken and the armature $h'$ of the switch H moves back into engagement with the contact $g^2$, thus reëstablishing normal conditions.

Of course it will be understood that the time device R, which constitutes, in effect, a controlling-switch, may be omitted, as well as the automatic switch H and a hand-switch employed in lieu thereof. The use of the automatic mechanism is, however, preferred.

Should an authorized person now desire to open the door of the vault or other structure at the guarded point, he moves the Morse key $p$ into engagement with the contact $p'$ a predetermined number of times, thus short-circuiting the resistance I′, allowing the bridge F to become unbalanced and the current to flow through the galvanometer a corresponding number of times to close the local alarm-circuit D at the central station through the contact $d^5$, thus closing said circuit D to sound the alarm $d^3$, which makes a corresponding number of strokes. Upon the door being thrown open the plunger or switch element $o^2$ engages the contact $o$ before entirely moving out of engagement with the contact $o'$, and thus prevents breaking of the line-circuit and operation of the switch L, which would of course increase or decrease the resistance above or below the normal point and affect the galvanometer. Then as the door is swung fully open the plunger $o^2$ maintains contact with the contact $o$, but is moved out of engagement with the contact $o'$ and cuts out the resistance I′ and throws into the circuit the compensating resistance $n^2$. This operation of course unbalances the bridge and operates the galvanometer-needle to sound the alarm $d^3$, thus notifying the operator at central that the authorized person has opened or closed the door. The operator upon receiving this signal withdraws the insulated switch-plug $k^7$, allowing the spring-arm $k^3$ to move into engagement with the switch-strip $k^{4\times}$, thus allowing a portion of the current to pass through the resistance device I and the remainder to pass through the conductor $k'$ to prevent any break in the line and any change of position of the armature $l'$ of the switch L. The operator then inserts the plug $k^7$ between the strip $k^{4\times}$ and spring-arm $k^3$, thus cutting the resistance device I out of the circuit and allowing the compensating resistance $k^8$ to remain in the circuit. The two compensating resistances $k^8$ and $n^2$ together yield a resistance equal to the normal resistance on the line afforded by the automatic resistance devices I and I′, line instruments, &c., and thereby maintain a constant resistance on the line during the period the door of the vault or safe is kept open, thus keeping the bridge in perfect balance. When the authorized person at the protected point desires to close the door of the vault or structure, he again moves the key into engagement with the contact $p'$ to send a predetermined signal to the central station, and after doing so upon swinging the door shut the plunger or contact device $o^2$ will first move a sufficient distance to connect the two contacts $o$ and $o'$, thus preventing any break in the line-circuit or operation of the switch L, and then upon the final closing of the door the switch $o^2$ will become disconnected from the contact-point $o$ and engage the contact-point $o'$, thus cutting out the resistance $n^2$ and throwing in the resistance I'. During this operation there will be a change of potential between the bridge-arms $f$ and $f'$, resistances $f^2$, and line-circuits, which will cause the operation of the galvanometer, the needle of which will close the circuit D and operate the alarm $d^3$. Upon hearing this alarm the operator at central disengages the switch-plug $k^7$ from between the spring-arm $k^3$ and strip $k^{4\times}$ and restores it to its position between the switch-arm $k^2$ and strip $k^{4\times}$, thus cutting out the compensating resistance $k^8$ and throwing in the automatic resistance I, thereby reëstablishing normal conditions of the system, which remain during the entire period the door of the vault or structure is kept closed. The local protection at the guarded point afforded by the open circuit C' may remain constant during either position of the vault-door to prevent unauthorized persons from obtaining access to the structure through doors or window or interfering with other portions of the structure protected thereby, the closing of either switch $q'$ short-circuiting the resistance I' or $n^2$, thereby affecting in the manner previously described the galvanometer and causing it to sound the signal $d^3$. The open circuit C' may be cut out entirely by means of the switch $q^2$. This operation does not interfere with the operation or protection of the local protected points X X' X².

If while the door is either open or closed any attempt is made to drill into the body of the safe or vault, the drill will bridge the connections $m^5$ and $m^7$, and thereby short-circuit the resistance I' and affect the galvanometer and cause the sounding of the signal $d^3$.

As before described, the resistance-coils of the relays or automatic switches I and I' may be connected up to more or less irregularly or widely vary the resistance in the local portions of the circuit at each successive operation instead of progressively increasing or decreasing the resistance, and it is preferred to have them operate in this manner, as all the changes or combinations must not only be known, but the character thereof determined, before the system can be defeated, which is practically a matter of impossibility. Even if these combinations are absolutely known, it would be impossible to insert a compensating resistance of the same value in the line at any point.

It will be understood, of course, that the resistance of protective points X X' X² is controlled from the bridge resistance and not by compensating resistances $n^2$ and $k^8$ of protected point X³, (shown and described in detail.)

In the modification shown in Fig. 6 the automatic resistance devices at central and the protected point are dispensed with and a commutator T is arranged in the main battery-circuit B' at central and is connected to the battery-cells and operated by a motor (not shown) in such manner as to fluctuate the supply-current from a high to a low value, and vice versa. The same effect may also be obtained by using resistances on the commutator in place of the battery connections. The commutator-plate T is here composed of a series of segments $t\ t'\ t^2\ t^3$, as in the resistance devices previously described; but these segments are connected by conductors $u\ u'\ u^2\ u^3$ to the cells of a battery U. The contact-arm T² of the commutator is connected by a conductor $v$ to the line A and resistance $f^2$ of the bridge F and is designed to be constantly rotated at a desired speed to cut in or out more or less cells and fluctuate the current-supply. At the central station the arm $f'$ of the bridge F and conductor $e'$ have a ground connection at $v'$ through a conductor $v^2$, in which is a switch $v^3$ and a compensating resistance $v^4$. In the circuit C³ at the protected point a conductor $n^3$ is connected to the contact-spring $o$ and conductor $m$ and is provided with a resistance-coil I², and a conductor $n^4$ connects the other contact-spring $o'$ with said resistance intermediate of its length. When the plunger or switch $o^2$ is connected with the spring $o'$, as shown, which is the position of said switch when the door is open, the resistance at the protected point is reduced substantially one-half, thus changing the potential of the bridge, causing the galvanometer at central station to close the local signal-circuit and sound the alarm $d^3$. Upon receiving this signal the operator, who has been previously warned in the manner before set forth of the intention of an authorized person at the protected point to open the door, moves switch $v^3$ from point $v^5$ to point $v^6$, thus switching in the compensating resistance $v^4$, restoring the normal bridge-balance for protection during the time the door is open. When the door is closed, the plunger $o^2$ engages contact $o$, throwing in the whole of the resistance I², thus breaking the balance of the bridge, allowing the current to operate galvanometer and sound the alarm $d^3$. The operator at central then restores normal conditions by moving switch $v^3$ from point $v^6$ back to $v^5$, thus cutting out compensating resistance $v^4$. The system is then ready for normal operation, with the door of the vault or protected structure closed.

It will be observed that the arm $f$ and rheostat $f^2$ of the bridge F are connected across the supply-circuit at central and constitute two constant resisting values, that the arm $f'$ of the switch forms a third resisting value which is connected with an outside or main controlling-circuit forming a fourth resisting value, and that said third and fourth resisting values are connected across the supply-circuit in parallel with the first two named resisting values. These two sets of values are equal and normally balance the bridge; but when the outside circuit resistance is changed the balance of the bridge is broken and the instrument E is operated, as will be apparent from the foregoing statement of operation.

From the foregoing description, taken in connection with the accompanying drawings, the construction and operation of the invention will be readily understood without requiring a more extended explanation.

Various changes in the form, proportion, and the minor details of construction may be resorted to without departing from the principle or sacrificing any of the advantages of this invention.

Having thus described my invention, what I claim, and desire to secure by Letters Patent, is—

1. In an electric burglar-alarm system, the combination of a balanced electric circuit, means to vary the resistance in localized portions thereof, without unbalancing the circuit, and means, independent of the resistance-varying means, to vary the potential of the electric current in said circuit.

2. In an electric burglar-alarm system, the combination of a balanced electric circuit, automatically-operating means to vary the resistance in localized portions thereof, without unbalancing the circuit, and automatically-operated means, independent of the resistance-varying means, to vary the potential of the electric current in said circuit.

3. In an electric burglar-alarm system, the combination of a balanced electric circuit, means to vary the resistance in localized portions thereof, without unbalancing the circuit, and means, independent of the resistance-varying means, to vary the strength of the electric current in said circuit.

4. In an electric burglar-alarm system, a main-line circuit forming a limb of a Wheatstone bridge, a galvanometer connected with the divided portions of the bridge, a switch-armature in the line-circuit, an electromagnet for the switch-armature, a controller connected with the said electromagnet, a localized-resistance-varying device connected with the main line, and an electrically-operated actuating mechanism for said localized-resistance-varying device, in a connection, including the switch-armature, with the main line, substantially as described.

5. An electric burglar-alarm system comprising a main-line circuit forming a limb of a Wheatstone bridge, a galvanometer connected with the divided portions of the bridge, a switch-armature in the line-circuit, an electromagnet for said switch-armature, a controller connected with the said electromagnet, a localized-resistance-varying device in circuit with the main line, an electrically-operated actuating mechanism for said localized-resistance-varying device in a connection, including the switch-armature, with the main line, an electromagnet and another localized-resistance-varying device in the main-line circuit, an electrically-operated actuating mechanism for the last-mentioned localized-resistance-varying device, an electric circuit therefor independent of the main-line circuit, and a switch-armature to close said independent electric circuit, said switch-armature being normally maintained in position to open said circuit by the last-mentioned electromagnet, substantially as described.

6. An electric burglar-alarm system comprising a main-line circuit forming a limb of a Wheatstone bridge, a galvanometer connected with the divided portions of the bridge, a switch-armature in the line-circuit, a localized-resistance-varying device, a compensating resistance, means to include either of them in and cut the other out of the main-line circuit, an electromagnet for said switch-armature, and a circuit-closing controller in a connection, including said electromagnet, with the main line, an electrically-operated actuating mechanism for said localized-resistance-varying device in a connection, including the switch-armature, with the main line, an electromagnet in the main-line circuit, another localized-resistance-varying device, another compensating resistance, means to include either of them in and cut the other out of the main-line circuit, an electrically-operated actuating mechanism for the last-mentioned localized-resistance-varying device, an independent electric circuit therefor, and an armature to close said independent circuit, said armature being normally maintained in position to open said circuit by the last-mentioned electromagnet, substantially as described.

7. An electric burglar-alarm system comprising a main-line circuit, forming a limb of a Wheatstone bridge, a galvanometer connected with the divided portions of the bridge, a switch-armature in the line-circuit, a localized-resistance-varying device, a compensating resistance, means to include either of them in and cut the other out of the main-line circuit, an electromagnet for said switch-armature, and a circuit-closing controller in a connection, including said electromagnet, with the main line, an electrically-operated actuating mechanism for said localized-resistance-varying device in a connection, including the said switch-armature, with the line, an elec-

tromagnet in the main-line circuit, another localized-resistance-varying device, another compensating resistance, means to include either of them in and cut the other out of the main-line circuit, an electrically-operated actuating mechanism for the last-mentioned localized-resistance-varying device, an independent electric circuit therefor, an armature to close said independent circuit, said armature being normally maintained in position to open said circuit by the last-mentioned electromagnet, and means to cut both of the last-mentioned localized-resistance-varying devices and the last-mentioned compensating resistance out of the main line, for the purpose set forth, substantially as described.

8. An electric burglar-alarm system comprising a main-line circuit including a localized-resistance-varying device, the coils of a controller-switch and a second localized-resistance-varying device, an actuating-circuit for the latter opened and closed by the controller-switch, a controller in a connection, including an electromagnet, with the main line, and a switch-armature operated by said electromagnet and included in a circuit, excluding said electromagnet, with the main line.

9. In an electric burglar-alarm system, the combination of a circuit forming a limb of a Wheatstone bridge, a galvanometer connected to divided portions of the bridge, a translating device controlled by the galvanometer, means to vary the resistance in localized portions of the circuit and means to exclude the bridge from said circuit while varying the resistance, to prevent operation of the galvanometer, substantially as described.

10. In an electric burglar-alarm system, the combination of a circuit forming a limb of a Wheatstone bridge, a galvanometer connected to divided portions of the bridge, a translating device controlled by the galvanometer, automatic means to vary the resistance in localized portions of the circuit, and automatically-operated means to exclude the bridge from said circuit while the resistances are being varied in localized portions thereof, substantially as described.

11. A burglar-alarm system having a controlling-circuit forming a limb of a Wheatstone bridge, a signal in balanced bridged resistance with said controlling-circuit and adapted to be operated by an unbalancing of the resistance upon certain variations in said circuit, means for changing the resistance in said circuit, and means for throwing in a compensating resistance and cutting out the variable resistance, substantially as described.

12. In an electric burglar-alarm system, the combination of a circuit forming a limb of a Wheatstone bridge and including varying localized resistances, means to cut out such resistances, and means to substitute a resistance therefor to keep the bridge in balance while the varying localized resistances are cut out, substantially as described.

13. In an electric burglar-alarm system, the combination with a supply-circuit, means to vary the potential of the current in such circuit, and a signal, of a series of guarded stations, a bridge, of which the supply-circuit is a limb, governing said signal, a resistance at each station, means at each station to cut out its resistance to unbalance the bridge, and operate the signal, and means for varying the normal resistance of a limb of the bridge to compensate for the cutting out of the resistance at one or more stations, substantially as described.

14. In an electric burglar-alarm system, the combination with a supply-circuit forming a limb of a Wheatstone bridge and including a resistance at a guarded point, means to cut out such resistance to unbalance the bridge, and means to substitute a resistance to restore the balanced condition of the bridge while the last-mentioned resistance is cut out, substantially as described.

15. An electric burglar-alarm system comprising a main-line circuit including a localized-resistance-varying device, the coils of a controller-switch and a second localized-resistance-varying device, an actuating-circuit for the latter opened and closed by the controller-switch, a controller in a normally open connection with the main line for closing and reopening said connection, a switch-armature in the main line, an electromagnet for said switch-armature included in said controller connection, a Wheatstone bridge, one limb of which is formed by the main-line circuit and a galvanometer connected with the divided portions of the bridge and operated by a difference of potential therein.

16. In a burglar-alarm system, a main line forming a limb of a Wheatstone bridge, a galvanometer connected with the divided portions of the bridge, a local alarm-circuit, controlled by the galvanometer a source of supply, and an automatic resistance at the central station, in combination with an automatic resistance, a compensating resistance, a circuit-adjuster to include either the automatic resistance or the compensating resistance in the main line, a local battery-circuit, and an electric switch at the protected point, substantially as described.

17. In a burglar-alarm system, a main line forming a limb of a Wheatstone bridge, a galvanometer connected with the divided portions of the bridge, a local alarm-circuit controlled by the galvanometer, a supply-circuit, and means for raising and lowering the potential in the supply-circuit, at the central station, in combination with a resistance, a compensating resistance, a circuit-changer to include either the automatic resistance or the

compensating resistance in the main line, and a signal-key at the protected point, substantially as described.

18. An electric burglar-alarm system comprising a main-line circuit forming a limb of a Wheatstone bridge, localized-resistance-varying devices for the main-line circuit, compensating resistances, and means to include either the localized-resistance-varying devices or the compensating resistances in the main-line circuit and thereby maintain a constant resistance in the line to prevent the unbalancing of the bridge.

19. An electric burglar-alarm system comprising a main-line circuit forming a limb of a Wheatstone bridge, localized-resistance-varying devices and compensating resistances, each included in a connection with the main-line circuit, and means to close said connections to include either the localized-resistance-varying devices, the compensating resistances, or one of either of them in the main-line circuit and thereby maintain a constant resistance in the line to prevent the unbalancing of the bridge.

20. In a burglar-alarm system, the combination with a supply-circuit and a signal at the central station, of a main-circuit series of guarded stations, a bridge of which the main circuit is a limb governing said signal, a resistance at each station, means at each station to cut out its resistance to unbalance the bridge and operate the signal, and means for varying the normal resistance of a limb of the bridge to compensate for the cutting out of the resistance at one or more stations, substantially as described.

21. In a burglar-alarm system, the combination with a main localized resistance, of a bridge-controlled signal, circuit-varying devices at the central station and guarded structure, and means for cutting out said localized-resistance-varying devices and inserting constant resistances in lieu thereof, substantially as described.

22. In a burglar-alarm system, the combination with a main localized resistance, of a bridge-controlled signal, circuit-varying devices at the central station and protected point, compensating resistances at the central station and protected point, a signal-operating device at the protected point, and switches at the central station and protected point to cut out the localized-resistance-varying devices and throw in the compensating resistances in lieu thereof, substantially as described.

23. A burglar-alarm system having a main line forming a limb of a Wheatstone bridge, a galvanometer connected with the divided portions of the bridge, a local-alarm circuit controlled by the galvanometer, a source of supply for the main line, a compensating resistance and current-fluctuating device at the central station in series with the main line, in combination with a resistance and compensating resistance, a circuit-adjuster, and a signaling instrument at the protected point, substantially as described.

24. An electric burglar-alarm system having a main-line circuit, a varying resistance, a compensating resistance, and means to include either the variable resistance or the compensating resistance in the line-circuit and exclude the other therefrom.

In testimony whereof I have hereunto set my hand in presence of two subscribing witnesses.

JOSEPH WEATHERBY, Jr.

Witnesses:
VERDA V. SHOCKLEY,
JAMES F. NAYLOR.