J. G. NOLEN.

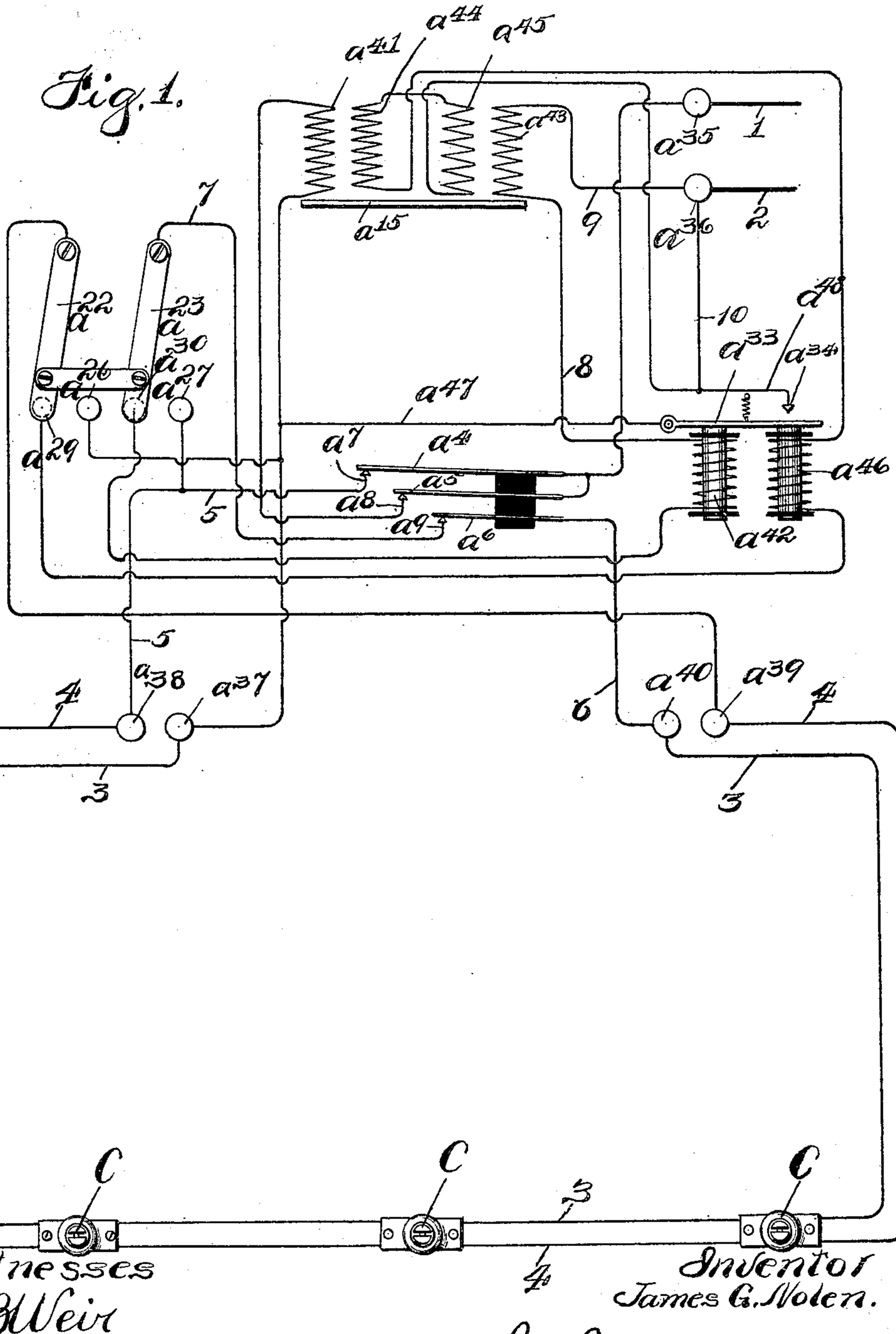
AUTOMATIC ELECTRICAL SIGNALING SYSTEM.

APPLICATION FILED FEB. 26, 1904.

978,629. Patented Dec. 13, 1910.

4 SHEETS—SHEET 1.

Fig. 1.



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4 SHEETS—SHEET 2.

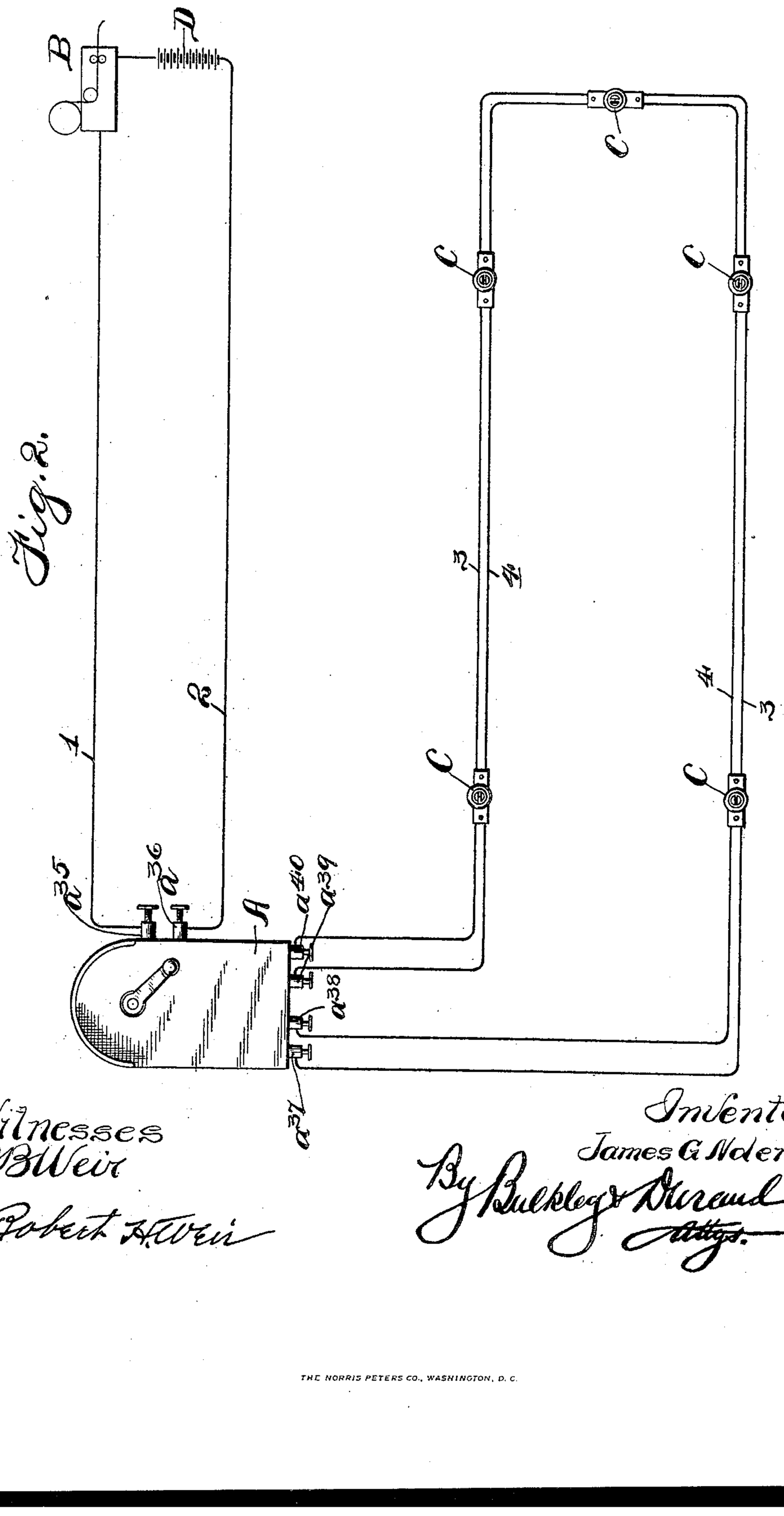

Fig. 2.

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4 SHEETS—SHEET 3.

Fig. 3.

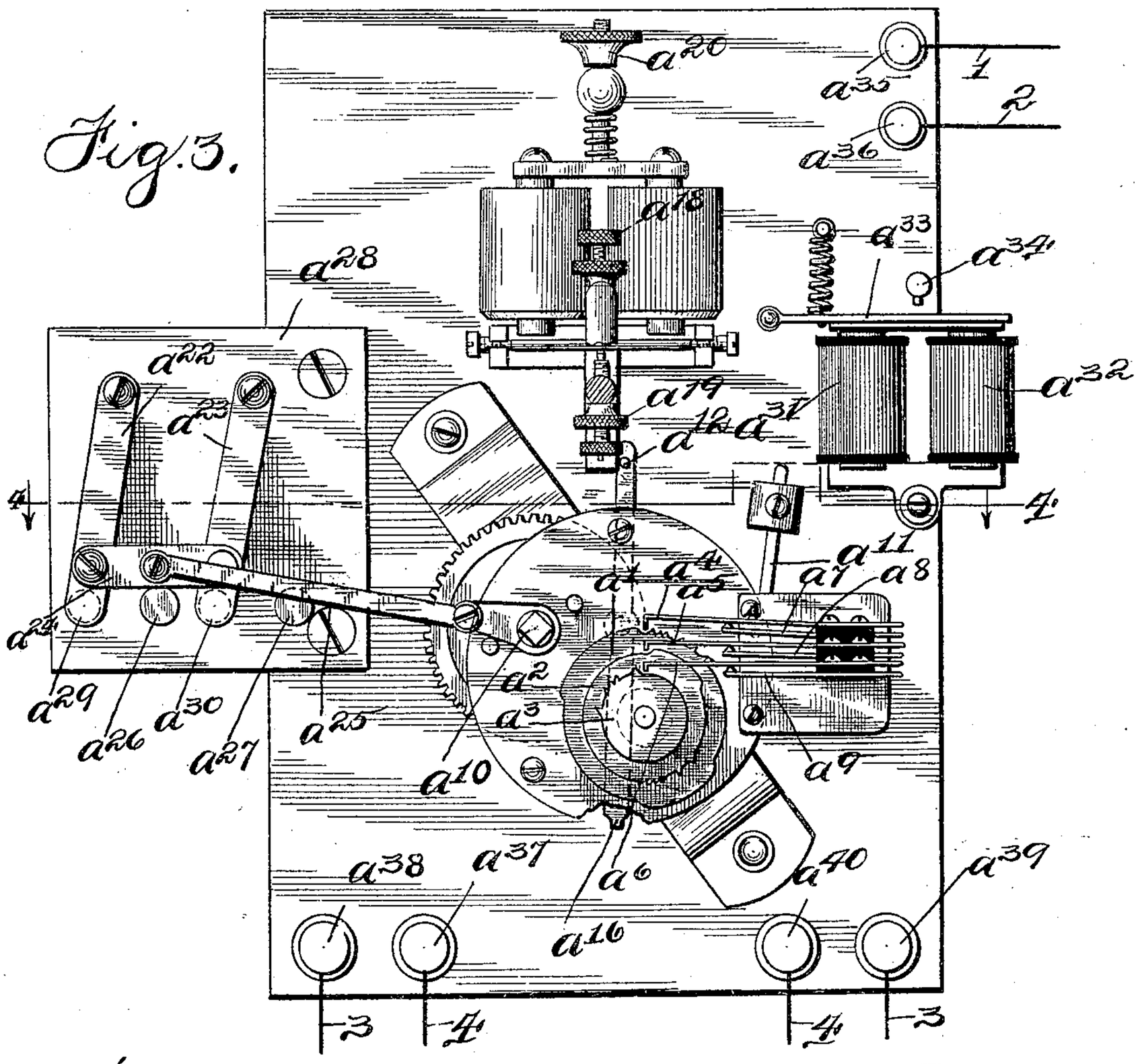
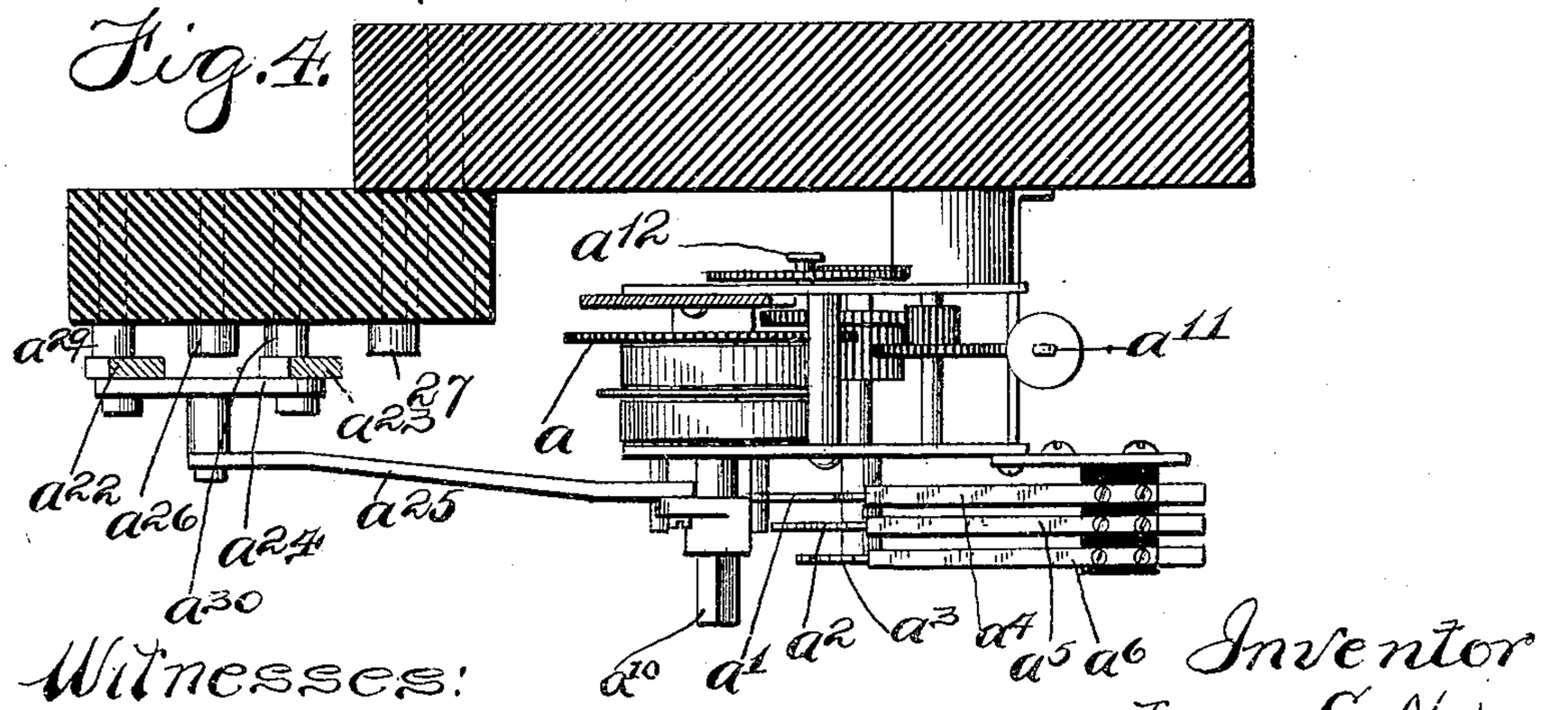


Fig. 4.



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4 SHEETS—SHEET 4.

Fig. 5.

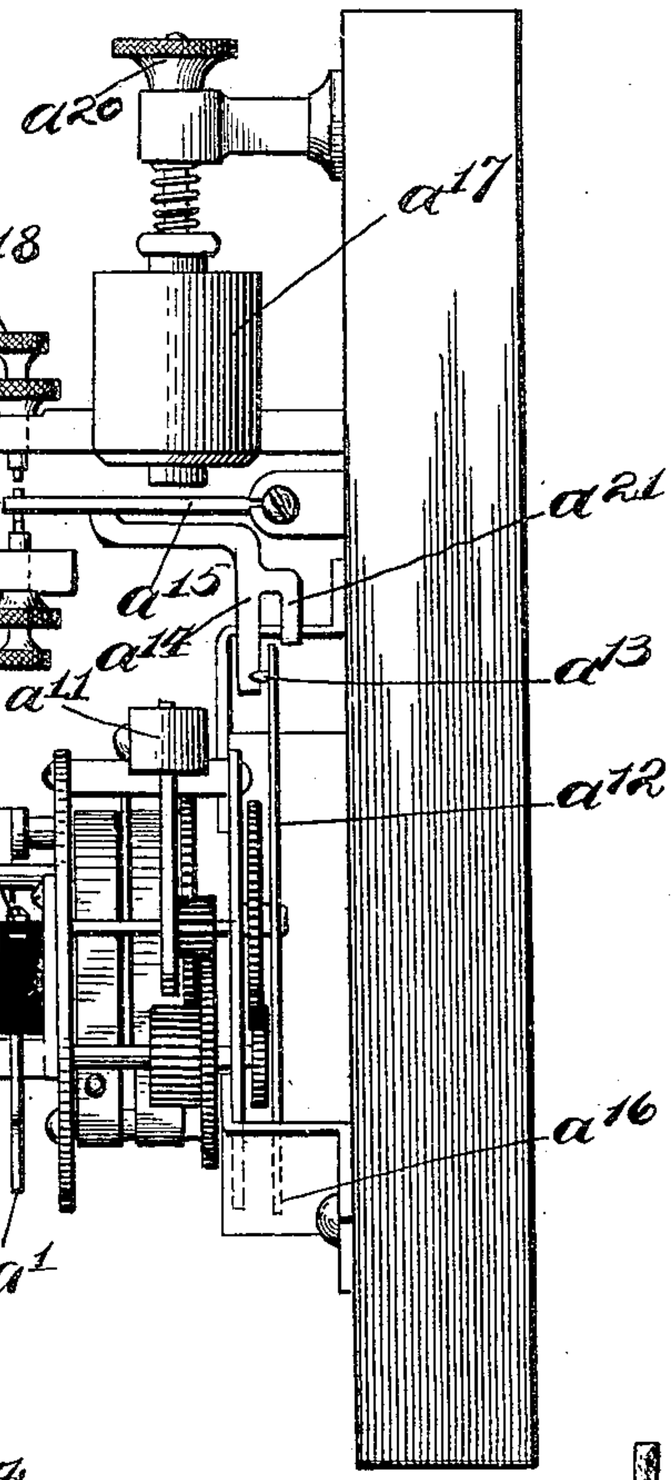


Fig. 8.

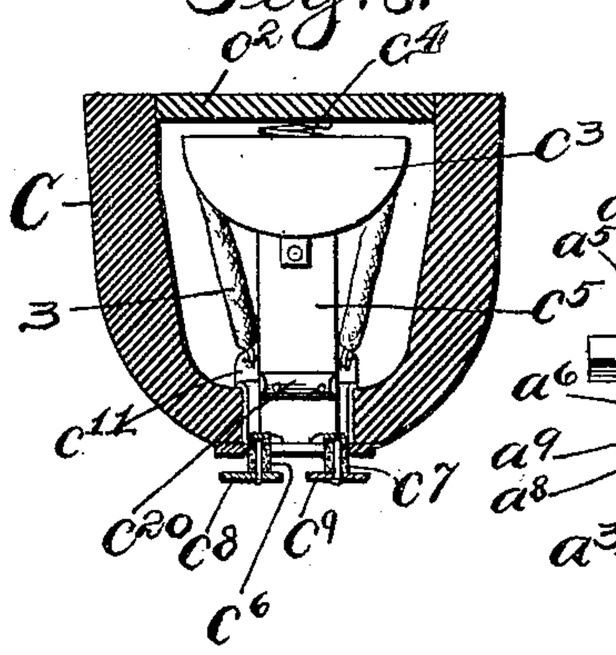


Fig. 6.

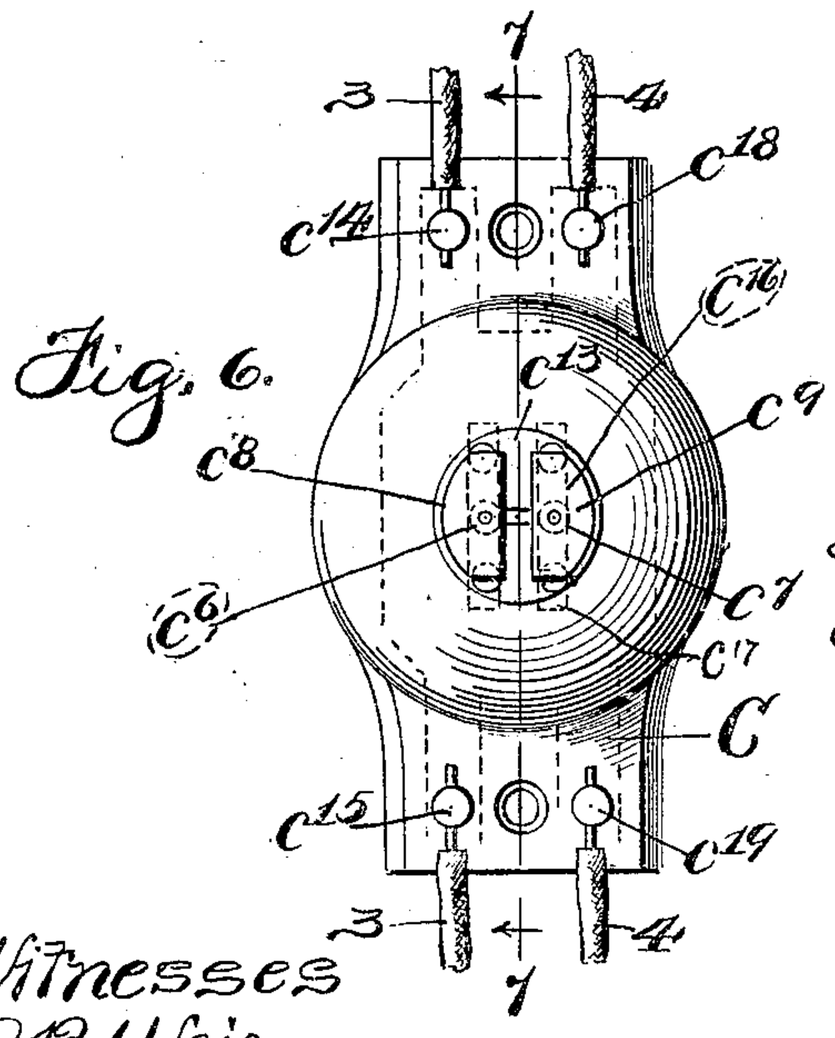
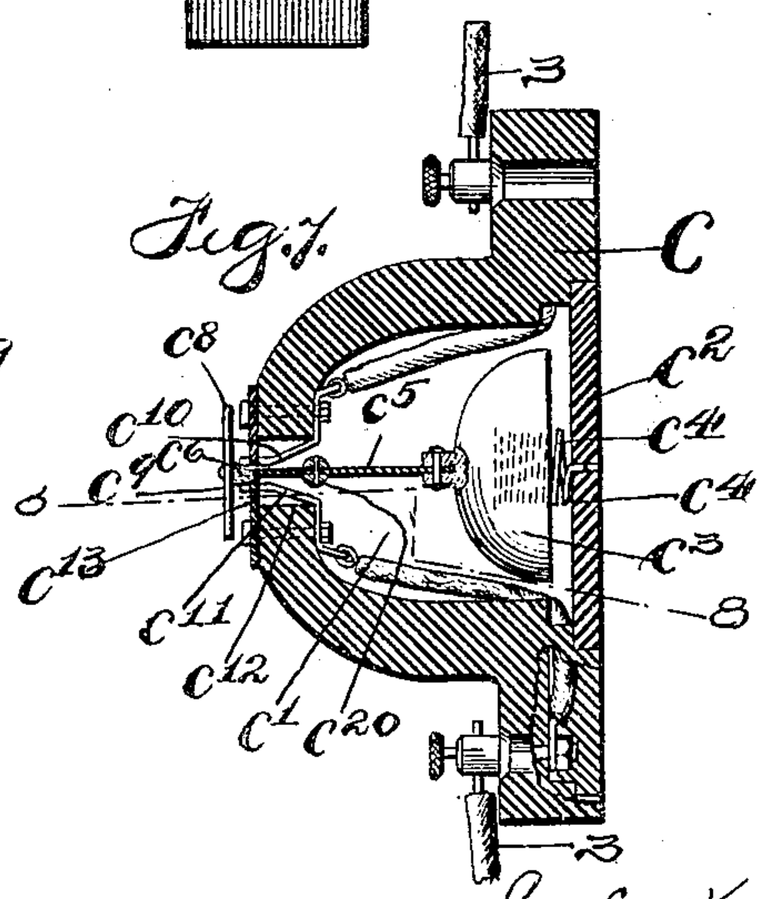


Fig. 7.



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UNITED STATES PATENT OFFICE.

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AUTOMATIC ELECTRICAL SIGNALING SYSTEM.

978,629. Specification of Letters Patent. **Patented Dec. 13, 1910.**

Application filed February 26, 1904. Serial No. 195,500.

To all whom it may concern:

Be it known that I, JAMES G. NOLEN, a citizen of the United States of America, and resident of Chicago, Cook county, Illinois, have invented a certain new and useful Improvement in Automatic Electrical Signaling Systems, of which the following is a specification.

My invention relates to electrical signaling systems in general, but more particularly to fire-alarm and other similar systems, and especially to systems of that character in which it is highly desirable to provide means whereby an alarm-signal can readily be distinguished from a trouble-signal, so that the operator or attendant at the central station will have no difficulty in determining whether a signal received from a certain substation is intended to indicate the presence of fire, for example, at such substation, or merely to indicate that some of the circuit connections at the substation have been accidentally broken.

Generally stated, it is the object of my invention to provide improved means whereby a trouble-signal brought about by a rupture in a circuit conductor may readily be distinguished from an alarm-signal brought about by the operation of a suitable signal-initiating device, and to provide the apparatus in such form that it may readily and economically be installed and maintained, and, in the case of the employment of my invention as a fire-alarm system, in such shape that it will conform satisfactorily to certain rules and regulations imposed by the insurance companies and underwriters association, as, for example, with respect to the employment of normally charged or closed circuits.

A special object of my invention is to provide an improved construction of signal transmitting mechanism for use at a substation, said mechanism comprising normally wound-up clockwork, suitable make-and-break devices, and a releasing magnet, preferably all inclosed within a box, the whole resembling in form and construction the ordinary call-box.

Another object is to provide an improved form of signal-initiating device for use when my improved system is employed in giving fire-alarms, said signal-initiating device consisting of a thermostat adapted, when operated, to establish a cross-conducting path between two parallel conductors.

Still another object, and one which is important, as it is a matter which has given more or less difficulty in the past, is to provide improved apparatus and a circuit arrangement of such character that any desired number of signal-initiating devices, such as thermostats, may be employed in one building or at one substation, or that any number of substations may be connected with the same line—the line circuits being normally charged or closed—without impairing the efficiency or certainty of action of any part or portion of the system.

Another object is to provide an improved circuit arrangement whereby a differentially wound releasing magnet may be employed in the box for releasing the normally wound-up clockwork when a signal-initiating device is operated, or when a break occurs in any of the conductors leading through any of such signal initiating devices.

It is also an object to provide certain details and features of improvement tending to increase the general efficiency and serviceability of an electrical signaling system of this particular character.

The nature and advantages of my invention will, however, hereinafter more fully appear.

In the accompanying drawings,—Figure 1 is a diagram of the apparatus and circuit arrangement of a substation embodying the principles of my invention. Fig. 2 is a diagram of the entire system showing one of the box or signal transmitting mechanisms in front elevation, and illustrating the manner in which this box is connected up with the signal-receiving apparatus at the central station, and also with the thermostats at the substation at which the box is located. Fig. 3 is a front elevation of the said box with the covering or front portion of the casing removed. Fig. 4 is a section on line 4—4 of Fig. 3. Fig. 5 is a side elevation of the mechanism shown in Fig. 3. Fig. 6 is a face view of one of my improved thermostats, which constitutes the particular or specific form of signal-initiating device shown and described. Fig. 7 is a section on line 7—7 in Fig. 6. Fig. 8 is a cross-section on line 8—8, in Fig. 7.

As thus illustrated, and referring first to Fig. 2, it will be seen that my improved electrical signaling system is adapted for use in giving fire-alarm-signals, the box A,

which, as previously stated, and as will hereinafter more fully appear, is in the nature of an ordinary call-box, being connected with the signal-receiving apparatus B by means of the parallel line conductors 1 and 2, and also connected with the thermostats or signal-initiating devices C through the medium of the parallel conductors 3 and 4. As thus illustrated, it will be understood that the box A and the thermostats C are all arranged in a building or substation of the system, the thermostats being arranged in suitable places throughout the building to be protected; and it will also be understood that the usual recorder and other devices constituting the signal receiving apparatus B are located at the central station.

My improved signaling system is essentially of that character in which the line circuits are normally charged or closed—that is to say, of that particlar type in which battery current is normally flowing through the line circuit. Consequently, the battery D for supplying all necessary current is also located at the central station. With this arrangement, and with the system in its normal condition, there is a constant flow of battery current through the conductors 1 and 2, and also through the conductors 3 and 4.

In a general way, and before describing the various devices and details of construction, the operation of my improved system is as follows: Suppose that fire has occurred in the building in which the box A and thermostats C are located. In such case, the heat will, of course, cause at least one of the thermostats to operate. Each thermostat, when operated, establishes a cross-conducting path between the two parallel conductors 3 and 4. This serves, in a manner to be hereinafter more fully explained, to energize the releasing magnet in the box A, thereby setting the normally wound-up clockwork in operation. This clockwork, when thus set in operation, runs completely down, thereby causing the make-and-break devices in the box to transmit an alarm-signal over the line circuit to the central station. As herein shown and described, the said make-and-break devices are of such character that the alarm-signal, though practically continuous, is composed of five parts—that is to say, the clockwork in running down causes a portion of the make-and-break mechanism to first produce the well known impulses in a line-circuit including the conductor 4, to then produce the same character of impulses in a line circuit including the conductor 3, and to then produce a further make-and-break action in the circuit including conductor 3; and the first and second of these groups of impulses are then repeated, making five in all. In other words, the alarm-signal to indicate fire or some other abnormal condition, consists of a relatively long signal, which, although sent over the line circuit in five groups of impulses or "rounds" as they are called, is practically a continuous or unitary signal; while, as will hereinafter more fully appear, the trouble-signal—that is to say, the signal which is transmitted over the line circuit to indicate a rupture or break in either one of the conductors 3 and 4, for example,—consists of a shorter signal, as, for example, four and three rounds respectively. In this way, the attendant or operator at the central station is enabled to readily distinguish between a trouble-signal and an alarm-signal, the former being, as stated, shorter than the latter.

The preferred construction of the box A—that is to say, the internal arrangement of the box embodying the principles of my invention—is illustrated in Figs. 3, 4 and 5. As thus illustrated, the mechanism of the box comprises normally wound-up clockwork a, of any suitable known or approved construction, and adapted, when released by the operation of one of the thermostats C, or by a break in one of the conductors 3 and 4, to rotate the three make-and-break wheels a^1, a^2 and a^3, so as to produce the well known and well understood make-and-break action in the line circuit, resulting in the transmission of a signal to the central station. Preferably these three make-and-break wheels are not in the circuit, the necessary and rapid opening and closing of the circuit being obtained by lifting the springs a^4, a^5 and a^6 off from the anvils or contacts a^7, a^8, and a^9, and then allowing the same to come together again. To do this, it will be seen that it is only necessary to provide the three contact wheels with teeth, which are adapted to engage the bent end portions of the contact springs a^4, a^5 and a^6; and in order that the contacts a^4 and a^7 shall remain open while the teeth on the other wheels are operating the other contacts, it is also desirable to provide the rotary disk or wheel a^1 with cam-like or raised peripheral portions, as shown more clearly in Fig. 3. In order that the contacts a^5 and a^8 may remain open while the teeth on the wheel a^1 are operating the contacts a^4 and a^7, the wheel a^2 is provided with a cam-like periphery. Also, as shown in this figure, each disk is preferably of such character as to, when the clockwork is wound up, insure a normally closed condition of the three make-and-break contact devices. The said clockwork can be wound up in the usual manner by applying a key to the squared end portion of the spring-shaft a^{10}, and the running down of the clockwork, when once released, is, of course, controlled in the usual manner by an escapement device a^{11}. As stated, however, the clockwork can be of any suitable known or approved construction,

such, for example, as the clockwork employed in an ordinary messenger call-box.

As shown in Fig. 5, one of the clockwork shafts is provided at its rear end with a double-ended arm a^{12}, having one end provided with a pin a^{13} adapted to normally—that is to say, when the clockwork is wound up—engage the downwardly projecting finger a^{14} carried by the releasing-magnet armature a^{15}. The other end of the arm a^{12} has a finger a^{16}; and a magnet a^{17} for releasing the normally wound up clockwork is arranged to act on the armature a^{15}. Preferably, this releasing magnet a^{17} is provided with two cores, each core being differentially wound, whereby the maintenance of current through all four windings tends to keep the magnet in a normally deënergized condition. The said armature and magnet can otherwise be constructed and mounted in any suitable or desired manner; and the vibrations of the armature can be limited by a pair of oppositely arranged screw stops a^{18} and a^{19}; and the position of the magnet relative to the armature can be adjusted accurately through the medium of the adjusting screw a^{20}, which latter is attached to the yoke of the magnet. With respect to the feature of preventing the clockwork from running entirely down when a trouble-signal is sent in, so as to insure a reserve signaling power to enable the box to transmit an alarm-signal, should fire occur before the repair can be made in the conductor, the said armature is also provided with a second shorter finger a^{21}, which is adapted, when the armature becomes "frozen" to the magnet, to be engaged by the finger a^{16}. In this way, it will readily be seen that the clockwork is incapable, when released, of running entirely down, except when the magnet is deënergized at the end of the first complete rotation of the three wheels a^1, a^2 and a^3 in unison. In other words, the clockwork, in order to run entirely down, must be released, and the magnet must then release the armature, so as to permit the finger a^{16} to pass the armature finger, a^{21}. As a means for insuring the transmission of an alarm-signal should fire occur shortly after the transmission of a trouble-signal indicating a break in both of the conductors 3 and 4 has been completed, and as will hereinafter more fully appear, the said box is also preferably provided with a switch adapted to be operated by the clockwork. This switch, as shown in Fig. 3, for example, may consist of a pair of metal bars a^{22} and a^{23}, pivoted at their upper ends and connected at their lower ends by a yoke a^{24}. The said yoke may connect with an arm on the spring shaft a^{10}, through the medium of a link a^{25}. After the clockwork has been released, and before the finger a^{16} revolves to a point where it can engage the armature finger a^{21}, the said switch is shifted to a position which brings the bar a^{22} into engagement with the contact point a^{26}, and the bar a^{23} into contact with the contact point a^{27}; both contacts and the switch bars being mounted on the plate a^{28}. Normally, the free end of the bar a^{22} rests upon the contact a^{29}, while the free end of the bar a^{23} normally rests upon the contact a^{30}. In order that the breaking of both conductors 3 and 4 shall not leave the apparatus without an available signaling path, and so as not to thereby prevent the transmission of a trouble-signal to indicate that a break has occurred in both conductors, the said box is also preferably provided with a relay comprising a couple of spools a^{31} and a^{32}. The coils of these two magnets or spools are, as illustrated, connected in parallel, each being in series with two of the coils in the magnet a^{17}.

With the box in its normal condition, the magnet a^{17} is deënergized, owing to the differential winding of its coils; but the relay magnets a^{31} and a^{32} are, of course, at such times energized. This relay, which, when deënergized, closes a signaling path, is provided with a normally attracted armature a^{33}, adapted, when released by the relay magnets, to engage an anvil or stationary contact a^{34}. The box may also be provided, of course, with a pair of binding posts a^{35} and a^{36}, to which the line conductors leading from the central station are attached, and with binding posts a^{37}, a^{38} and a^{39}, a^{40}, to which the thermostat conductors 3 and 4 are connected.

For the broader purposes of my invention, the signal-initiating devices C can be of any suitable known or approved construction. These signal-initiating devices may be of any character which will enable them, when operated, either by fire or manually or in any other way, to establish a short circuit or cross-connection from one parallel conductor to the other. For example, the said signal-initiating devices, when the system is to be employed for giving fire-alarms, are in the nature of thermostats, as illustrated in Figs. 6, 7 and 8. In said figures, the body c of the device is made hollow and thereby provided with a chamber c^1. A plate c^2 covers this chamber. The said chamber contains a weight c^3 adapted to be connected with plate c^2 by a spring c^4. Normally, the said weight is held in the position shown through the medium of a mica stem c^5 having its lower or outer end adapted to normally bear against the two masses of solder c^6 and c^7. The mass of solder c^6 is suitably joined to a metal plate c^8, while the other mass of solder c^7 is likewise joined to a similar plate c^9; it being observed that these two metal plates are separated sufficiently to prevent electrical contact between them. The mass of solder c^6 serves as a

medium of electrical connection between the two metal strips c^{10} and c^{11}, which are suitably secured in the chamber c^1 and arranged to project through the opening c^{12} of the body c, which latter is composed of porcelain or other suitable similar material. The ends of these strips c^{10} and c^{11} may project through an opening in the mica plate c^{13} secured to the outer surface of the body and arranged to cover the said opening c^{12}. With this arrangement, there is preferably a slight space between the said mica plate c^{13} and the outer metal plates c^8 and c^9. The strips c^{10}, c^{11} are connected with binding posts c^{14} and c^{15}, which latter can be connected, say, with the terminal portions of the wire or conductor 3. In this way, the strips c^{10} and c^{11}, connected by the mass of solder c^6, serve as the means for normally preserving the electrical continuity of the conductor 3. In a similar way, the strips c^{16}, c^{17}, normally connected by the mass of solder c^7 are connected with binding posts c^{18} and c^{19}, thus normally preserving the continuity of the conductor 4. The plates c^8 and c^9, which are of metal, serve to concentrate the heat upon the two masses of solder, the balance of the structure, as explained—that is to say, the plate c^{13} and the body c—being of non-heat-conducting material. In this way, the thermostat responds readily to fire, the heat melting the two masses of solder; and as soon as these two masses of solder become sufficiently softened they are pushed out from between their allotted metal strips by the action of the spring c^4, the tension of this spring being normally sustained by the two masses of solder through the medium of the flat mica strip c^5. This is true, it will be seen, when the thermostat is arranged in the position shown in Figs. 6 and 7; but if the thermostat is secured to the ceiling, then the pressure of the weight c^3 is added to the force of the spring c^4, and in this way contributes to the thrust necessary to enable the mica strip c^5 to remove the masses of solder from between the strips immediately upon a slight softening of the solder. When this is done, it will be seen that a break or rupture is produced in the conductors 3 and 4, thus interrupting the flow of current through these two conductors. But this is only momentary, for the reason that the stem or flat mica strip c^5 is provided with a brass or other metal circuit-closing contact c^{20}. Consequently, when the solder is ejected from between the strips, a break or gap is momentarily produced in each conductor, and this is immediately followed by a closing of each gap or break through the medium of the metal contact c^{20}. In other words, the operation of the thermostat is accompanied by a quick make-and-break action in both the conductors 3 and 4, due to the melting of the solder, and the instantaneous closing of the gaps thus produced by the contact c^{20}. Thus, upon the insertion of the contact c^{20} between the members of the two pairs of strips, there is a cross-conducting path formed between the two conductors 3 and 4. Generally stated, therefore the thermostat when operated establishes a cross-connection between the two conductors.

Referring now to Fig. 1, which is a diagrammatic view of the circuit connections of the box A, it will be seen that normally there are two parallel conducting paths included in the line circuit and extending between the binding posts a^{35} and a^{36}. It will also be seen that these two conducting paths include the two parallel thermostat conductors 3 and 4, in which the thermostats are located. For example, one of these two parallel conducting paths includes the coil a^{41} of the magnet a^{17}, the coil a^{42} of the relay, and another coil a^{43} of the said releasing magnet a^{17}. And this conducting path also includes the conductor 3 and the make-and-break device consisting of the contacts a^5 and a^8. The other conducting path includes another coil a^{44} of the releasing magnet, the fourth coil a^{45} of the releasing magnet, and the other coil a^{46} of the relay. And this conducting path also includes the conductor 4 and the make-and-break device consisting of the contacts a^4 and a^7. A third, but normally open conducting path, arranged parallel with the other two conducting paths, includes the releasing magnet-coil a^{41}, the contact a^{34}, and the armature a^{33} of the relay, and the conductors a^{47} and a^{48}. And this third conducting path also, it will be seen, includes the contacts a^5 and a^8. But, as will hereinafter more fully appear, the armature a^{33} and contact a^{34} are adapted to also serve as part of other circuits. Thus, as stated, there are three parallel conducting paths extending between the binding posts a^{35} and a^{36}, the first conducting path including the thermostat conductor 4, and the second path including the thermostat conductor 3. These two conducting paths are, of course, normally closed, while the third conducting path includes the normally open contacts of the relay. It will be understood that the coils a^{41} and a^{44} are differentially wound on one core of the releasing magnet, and that the coils a^{43}, a^{45} are differentially wound on the other core of said releasing magnet. In this way, the normal flow of current through the normally closed or charged line circuit including the conductors 3 and 4 in parallel, serves to neutralize the coils of the releasing magnet in the manner characteristic of differentially wound electro-magnet devices, and as is well understood. The balance of the connections shown in this diagram (Fig.

1) will, however, be best understood by considering the various operations and circuit connections which take place when one of the thermostats C is operated, or when a break occurs in either one or both of the conductors 3 and 4.

Suppose that the thermostat C, shown at the right in Fig. 1, is operated by heat in the usual and well known manner. The releasing of the thermostat operates, as explained, to first open both of the conductors 3 and 4, to then instantly close the gaps thus momentarily formed between the two conductors, and, in addition, the thermostat, when released in this manner, establishes a sort of short-circuit or cross connection between the two conductors. The alarm-signal having been initiated in this way through the medium of the thermostat as a signal-initiating device, it is obvious that the effect of so doing is to energize the releasing magnet—the current flow through the coils being unbalanced by the formation of a short circuit around the coil a^{41}. The effect of unbalancing the differentially wound releasing magnet in this manner is obvious. It permits current to flow through contacts a^4 and a^7, conductor 4 and the cross-connection of the operated thermostat, directly around the coil a^{41}, thereby cutting out the resistance of this coil, and thus unbalancing the flow of current through the two parallel conducting paths in which the differential windings of the releasing magnet are included. This, of course, serves to energize the cores of the releasing magnet, causing it to attract its armature a^{15}, and in so doing the normally wound-up clockwork is released by reason of the finger a^{14} being lifted out of engagement with the finger a^{13}. The clockwork thus released by the unbalancing of the resistance in the two parallel conducting paths and by the consequent energizing of the normally deënergized releasing magnet, rotates the shaft a^{10}, and, also, through the medium of the clockwork wheels, rotates the shaft upon which the toothed wheels a^1, a^2 and a^3 are mounted. These three wheels or disks, each having a group of teeth for a properly determined portion of its periphery, rotate in unison, and as each has a group of teeth positioned at a different point in its circumference than the others, it is obvious, that, first, the disk a' will act to rapidly open and close its allotted make-and-break device; that this make-and-break device will then remain open while the next group or set of impulses is being transmitted by the disk a^2 and its allotted make-and-break device; and that the first make-and-break device will then remain open while the third or last make-and-break device is being operated by the third and, as illustrated, smallest of the three disks or wheels. It will also be seen that the second make-and-break device remains open while the first make-and-break device is being operated, but that the third make-and-break device always remains closed while the second make-and-break device is being operated; it being understood that the largest wheel or disk operates the first make-and-break device, and that the third or smallest wheel operates the third and last make-and-break device.

The third make-and-break device can, and preferably does, remain closed during the operation of the first make-and-break device. The initial rotation of the three disks causes the teeth on the disk a^1 to engage the spring a^4, thereby causing the first make-and-break device to transmit a group or "round" of impulses through a line circuit including at such time the line wire 1, the binding post a^{35}, the contacts a^4 and a^7, the conductor 5, the binding post a^{38}, the conductor 4, the cross-conducting path of the operated thermostat C, the conductor 3, the binding post a^{40}, the conductors 6 and 7, contacts a^6 and a^9, the relay coil a^{42}, the conductor 8, the releasing magnet-coil a^{43}, the conductor 9, the binding post a^{36}, through the line wire 2, and thence through the battery D and the signal receiving apparatus B to the other line wire, this being the path of least resistance. The magnets a^{31} and a^{32} are sufficiently sluggish to hold their armature a^{33} during the momentary rupture of the magnetizing circuit due to the passage of a tooth of a signaling wheel beneath its associated pen. Over this completed line circuit, the wheel a^1, through the medium of its teeth and the contacts a^4 and a^7, transmits a "round" as it is called. The rotation of these three wheels continuing, the wheel or disk a^2 is next brought into play, its teeth engaging the spring a^5, and thereby causing a successive opening and closing of the contacts a^5 and a^8; and, during this action, it will be observed that the cam or raised peripheral portion of the disk or wheel a^1 keeps the contacts a^4 and a^7 separated. The contacts a^5 and a^8, when operated in this manner, transmit a group of impulses constituting the second "round" of an alarm-signal. This second "round" of the alarm-signal is, it will be seen, transmitted over a line circuit similar in every respect to the circuit through which the first "round" was transmitted, but with the exception that the circuit of this second "round" includes the contacts a^5, a^8, the releasing magnet-coil a^{41}, and the binding-post a^{37} and the thermostat conductor 3, instead of the contacts a^4, a^7, and the conductors 5 and 4; but from the wire 3 on, the circuit for this second "round" is, as stated, the same as the circuit for the first "round." The rotation of the three wheels continuing, the teeth on the third or smallest wheel a^3

are then brought into play, these teeth engaging the spring a^6, and thus causing a make-and-break action by successively opening and closing the contacts a^6 and a^9; and during the operation of this third make-and-break device in this manner, the cam portion on the periphery of the wheel a^1 keeps the contacts a^4 and a^7 open, while the contacts a^5 and a^8 remain closed. In this way, a third "round" is transmitted over a line circuit which, it will be seen, is identical with the circuit over which the second round was transmitted. At this point in the operation of the signal transmitting mechanism, it will be seen that the switch bars shift their resting contacts into engagement with the contacts a^{26} and a^{27}. In this way, the completion of the first rotation of the three wheels or disks is accompanied by an opening of the normally closed circuits of all of the coils, both of the releasing magnet and the relay, with the result that the normally open contacts a^{33} and a^{34} are caused to close, and that the armature a^{15}, previously attracted by the energization of magnets 41 and 43, is allowed to return to its normally depressed or unattracted position. Such being the case, the finger a^{16} is permitted, at the end of the first rotation of the three wheels, to pass the armature finger a^{21}, thereby allowing the signal transmitting mechanism to continue its operation. The rotation of the three wheels or disks thus continuing, the wheel a^1 causes the contacts a^4 and a^7 to transmit a fourth "round" through a closed line-circuit including these contacts, and also including the conductors 3 and 4, and, for example, the switch-bar a^{22} and contact a^{26}, the conductor a^{47}, the contacts a^{33} and a^{34}, and the conductors a^{48} and 10 to the line terminal a^{36}. This is immediately followed by a fifth "round" brought about by the engagement of the teeth on the wheel a^2 with the spring a^5; and the circuit of this fifth "round" is, it will be seen, the same as the circuit of the fourth "round," with the exception that the impulses of this fifth and last "round" of the alarm signal are transmitted through the contacts a^5 and a^8, and the coil a^{41}, rather than by way of the short-circuit around this coil, in the manner explained. It is obvious that, with the arrangement shown at least, the second rotation of the three wheels is not accompanied by the transmission of a "round" through the medium of the third and smallest of the wheels. Consequently, it will be seen that an alarm-signal, when the system is in its normal condition, is as follows:

Alarm-signal system in normal condition.—One "round" through the first make-and-break device, another "round" through the second make-and-break device, and a third "round" through the third make-and-break device, making three "rounds" in all for the first rotation of the wheels; and then another "round" through the first make-and-break device, followed immediately by an additional "round" through the second make-and-break device, making five "rounds" in all. Thus, with the arrangement shown and described, an alarm-signal of five "rounds" will be understood to indicate the presence of fire at the point where the box is located.

Suppose that a double break should occur in the conductors 3 and 4—that is to say, suppose that both conductors should become accidentally broken or ruptured. In such case, current ceases to flow through the coils of both the releasing and relay magnets, with the result that the relay contacts a^{33} and a^{34} are closed. This provides a path for the flow of current from one line terminal to the other, the said current-path including the contacts a^5, a^8, the releasing-magnet coil a^{41}, and the relay contacts a^{33} and a^{34}. Current flowing through this path energizes the releasing magnet, causing the latter to attract its armature, and thereby releases the normally wound-up clockwork of the signal transmitting mechanism. The said clockwork, when thus set in operation, causes the wheel a^2 to transmit a "round" over a closed line circuit including the path of current-flow just mentioned. The first and third make-and-break devices cannot, it will be seen, operate to transmit signal impulses during the rotation of the three wheels in unison. Also, it will be seen, that the armature a^{15} of the releasing magnet remains attracted or "frozen" as it is called to the releasing magnet upon the termination of the complete rotation of the three wheels, owing to the fact that, with a break in both of the conductors 3 and 4, there is, at such time, no available short-circuit around the coil a^{41}. Consequently, the finger a^{16} strikes the armature finger a^{21} at the end of a complete rotation of the three wheels; and in this way the clock-work is only permitted to run half-way down when a double break occurs in the manner stated. Obviously, then, the trouble-signal transmitted to the central station when a double break occurs in the thermostat conductors, is as follows:

Trouble-signal, to indicate a double break.—A round is transmitted over a line-circuit by the second make-and-break device, the first and third make-and-break devices not operating, and the clockwork only running half-way down. In this way, the transmission of a single "round" will be understood to indicate trouble in the nature of a break in the circuit conductors. Suppose, however, that only the conductor 3 is accidentally ruptured or broken. In such case, the releasing magnet is obviously unbal-

anced and energized to attract its armature. The normally wound clockwork having been released in this manner, the only available circuit for signaling includes the conductor 4 and the coils a^{44}, a^{45}, and a^{46}, and over this circuit the wheel a^1 then causes the contacts a^4 and a^7 to transmit the impulse of a "round." Following this, the contacts a^4 and a^7 are opened, the remaining relay magnet thereupon deënergized, and consequently the wheel a^2 caused to transmit a "round" through the magnet a^{41} and contacts a^{33} and a^{34}. The wheel a^3, obviously, has its circuit broken in line 3 and can transmit no signal. At the end of the rotation of the three wheels and upon the shifting of the switch bars a^{22} and a^{23}, the releasing magnet is deenergized inasmuch as there is a short circuiting path formed around the coil a^{41} by pen a^4, wire 4, switch-bar a^{22}, contact a^{26}, wire a^{47}, armature and contact a^{33} and a^{34}, and wire 10. The armature a^{15} is, therefore, released to permit further running of the clockwork and a second rotation of the wheels. Upon this second rotation, the wheels a^1 and a^2 each transmit a "round" through the contacts a^{33} and a^{34}, but the wheel a^3, which works only upon current through wire 3, cannot operate to transmit a signal.

In the case of a break only in the conductor 4, the first make-and-break device does not operate on the first rotation, since its only available circuit during such rotation is the now-broken line 4. The deënergization of the relay magnet, however, resulting from the opening of contacts a^5—a^8 by wheel a^2, causes the closure of contacts a^{33}—a^{34}, and a subsequent "round" from wheel a^2 through the path a^5, a^8, a^{41}, a^{47}, a^{33}, a^{34}, and 10. This same path works as a short circuit during the passage of wheel a^3 thereby preventing the transmission of a "round" from the contacts a^6—a^9. Upon the shifting of switch-bars a^{22} and a^{23}, the releasing magnet is short-circuited through the path a^4, a^7, 5, a^{27}, a^{23}, 7, a^9, a^6, a^{40}, 3, a^{37}, a^{47}, a^{33}, a^{34}, and 10, so that the wheels a^1, a^2, and a^3, are permitted to rotate a second time, during which rotation wheels a^1 and a^2 each transmit a signal. Wheel a^3 is short-circuited through magnet a^{41} and contacts a^{33}—a^{34}, and so transmits no signal. The signal, therefore, resulting from a single break in either conductor is as follows:

Trouble-signal to indicate a single break.—A break in the conductor 3 results in the transmission of "rounds" through the first and second make-and-break devices, followed by "rounds" from both the first and second make-and-break devices on their second rotation. A break in the conductor 4 results in the transmission of a "round" from the second make-and-break device on the first rotation of the wheels, followed by "rounds" from the first and second make-and-break devices on their second rotation.

Suppose that fire should occur shortly after the transmission of a signal for a rupture of both conductors. In such case, if a thermostat is operated at the right of the double-break, then a short-circuit is immediately formed about the coil a^{41}. This short-circuit includes the contacts a^4 and a^7, the contact a^{27} and the switch-bar a^{23}, the contacts a^6 and a^9, the binding-post a^{40} and a portion of the conductor 3, the cross or short-circuit connection of the operated thermostat C at the right of the break, a portion of the conductor 4, the binding-post a^{39}, and the switch-bar a^{22} and contact a^{26}, together with the conductor 10. Thus a path of low resistance is formed around the coil a^{41}, with the result that the releasing-magnet is instantly deënergized and allows its armature to fall; it being seen that the line circuit including the short-circuit around the said coil also includes the now closed contacts a^{33} and a^{34}. The partially woundup clockwork having thus been released by the disengaging of the finger a^{16}, the three wheels a^1, a^2, and a^3 rotate in unison. During such rotation, the wheel a^1 causes the first make-and-break device to transmit a "round" over a line circuit including the short-circuit now existing around the coil a^{41}, and including also the contacts a^{33} and a^{34}. After this, the wheel a^2 then causes the second make-and-break device to transmit another round through a line circuit including the coil a^{41} and the contacts a^{33} and a^{34}. The third make-and-break device does not, it will be seen, operate at this time. In a somewhat similar manner, the operation of the thermostat at the left of a double break would establish a short-circuit connection between the conductors 3 and 4 at the point where the thermostat is located. This, of course, would permit current to flow around the coil a^{41} by way of a low resistance path, including the conductor 5, the binding-post a^{38}, a portion of the conductor 4, the cross or short-circuit connection of the operated thermostat, a portion of the conductor 3, and the binding-post a^{37} and conductor 10. The flow of current being thus diverted or caused to flow around the coil a^{41}, the releasing-magnet allows its armature to rise and release the partially wound-up clockwork. This is immediately followed by the transmission of the "round" over a line-circuit, including the short-circuit around the coil a^{41}, and including also the contacts a^{33} and a^{34}. The operation of the first make-and-break device, in this manner, is immediately followed by the operation of the second make-and-break device, resulting in the transmission of another "round" directly through the coil a^{41} and the said relay contacts. So, in this way, a double break does

not leave the system incapable of transmitting an alarm-signal over the line-circuit in the event of fire occurring shortly after such a break, and with the arrangement shown such signal for fire is as follows:

Alarm-signal, both thermostat conductors having been broken.—The operation of a thermostat at either side of a double-break, results in the formation of a short-circuit around the energized coil of a releasing-magnet, causing the latter to become de-energized. This allows the armature of the releasing-magnet to fall, and in so doing to dis-engage the finger a^{16}. The clockwork then runs down, and in so doing transmits one "round" through the first make-and-break device, and another "round" through the second make-and-break device. Two "rounds" will, therefore, be understood to indicate the presence of fire at the point where the box is located. It will be observed that the occurrence of fire immediately after the break of both conductors 3 and 4, renders the signal identical with a simple break of line 3. The rapidity of operation of the devices, however, makes it highly improbable that confusion would result from this coincidence, since the interval of a fraction of a minute between the occurrence of fire and the completion of operation of the wheels after a break in line 3, would be readily noticeable.

Suppose that a short-circuit or cross-connection should be accidentally established between the two conductors 3 and 4; or that some one, perhaps an attendant in the building where the thermostats are distributed, should maliciously tie the two thermostat conductors together so as to electrically unite them. In such case, it is obvious that the short-circuit thus established between the two conductors and around the coils a^{41}, a^{44}, and a^{45} is sufficient to unbalance the releasing magnet, causing the latter to attract its armature. The clockwork then runs entirely down, causing the first and second make-and-break devices to operate successfully and transmit two "rounds" to the central office; and then, at the end of the first rotation of the three wheels, the short-circuit around the coil a^{41} being still present in the apparatus, the clockwork continues to operate the three wheels, and to thereby cause the first and second make-and-break devices to operate and transmit two more "rounds" over the line circuit; it being observed that during both rotations of the three wheels, the third make-and-break device is not operated to transmit a "round." The signal which indicates trouble of this nature is, therefore, as follows:

Signal, indicating either the accidental or malicious crossing or short-circuiting of the thermostat conductors.—The clockwork is released, and the three make-and-break devices are operated to transmit four "rounds" over the line-circuit. It will be seen that this signal is identical with the signal transmitted on the occurrence of a break in line 3 previously described.

From the foregoing, it is now readily apparent that my improved signaling system is of such character that it may be employed for various purposes, as, for example, in giving alarm-signals to indicate the presence of fire in the building or buildings to be protected. It will also be seen that with the improved construction and circuit arrangement, a constant and very thorough supervision may be maintained over the system, trouble of different kinds being immediately reported to head-quarters in the form of trouble-signals easily distinguishable from the alarm-signals. Also, I find that in systems embodying the principles of my invention, the system may be quite extensive, any number of thermostats being included in the apparatus, or any number of "risks" as they are called, being connected with one line, for example, without at all impairing the efficiency or certainty of the system as a whole. Preferably, the thermostats are adapted to first produce a double-break in the two thermostat conductors, as described, and to then establish the short-circuit or cross-connection between the two conductors. This is for the reason that while the mere crossing of the two thermostat conductors would easily unbalance the flow of current through the releasing magnet to an extent to release the clockwork, it is, perhaps, barely possible that this would not always be true. Therefore, I prefer, as stated, to employ a thermostat, or, more broadly stated, a signal-initiating device, which will first open the two parallel conductors so as to momentarily deënergize the relay, thereby allowing the contacts to close and establish a closed line-circuit including the coil a^{41} of the releasing-magnet. Thus there are two ways, so to speak, of energizing the releasing-magnet, as it may be energized by momentarily interrupting the current-flow through all of its coils, except one, in the manner just stated, or by establishing a short-circuit around one of its coils. In this way, the thermostats or signal-initiating devices, cannot possibly fail to, when operated, sufficiently energize the releasing-magnet to release the clockwork, and thereby set in motion the means for transmitting an alarm-signal. It will also be understood that the resistance of the various coils can be adjusted or regulated in accordance with the conditions of any particular case. I have, however, obtained good results by employing releasing-magnet coils of 75 ohms resistance each, and relay coils each having a resistance of 10 ohms. This, however, as stated, may be varied in any manner that may be found necessary or de-

sirable. It will also be understood that the teeth of the three wheels a^1, a^2, a^3 can be so formed or arranged on the peripheries of the wheels, that each "round" will be quite different from the others. In this way, the different signals can be readily recognized or distinguished from each other, and the exact box to which the signal is sent be readily determined. In fact, the construction of the box or master-box, as I term it, can be modified or changed to suit requirements, and in various ways that may be found necessary or desirable.

What I claim as my invention is:

1. An electrical signaling system comprising a signal receiving instrument and a source of current supply at one station, a line circuit, parallel branches connected with said line and constituting a normally charged supervisory circuit at another station, signal initiating devices in said parallel branches, and a plural impulse signal transmitter adapted and arranged for actuation by suitable variation in the conditions in said branches, said signal transmitter involving make-and-break devices one included in each branch of the circuit.

2. An electrical signaling system comprising a signal receiving instrument and a source of current supply at one station, a single line circuit extending to another station, a plurality of parallel branches constituting a continuation of said line at said other station, signal initiating devices associated with said parallel branches and arranged for actuation to vary the circuit conditions in said branches, and a plural impulse signal transmitter arranged for actuation by a suitable variation in the circuit conditions in said parallel branches, said plural-impulse transmitter involving a plurality of make and break devices one of which is included in each of the parallel branches.

3. An electrical signaling system, comprising a signal-receiving apparatus and a source of current at one station, a master-box and a plurality of thermostats at another station, suitable line connection between the two stations, and two parallel conductors arranged in loop-form for connecting said thermostats with said box, each thermostat having two masses of easily fusible conducting material serving normally to preserve the electrical continuity of the two parallel conductors, and the said box containing a plurality of suitably operated normally closed make-and-break devices constituting the medium of electrical connection between the two parallel conductors and the line, whereby said parallel conductors constitute parallel conducting paths of a normally charged line circuit.

4. An electrical signaling system, comprising a suitable signal-receiving apparatus, a master-box, suitable line connection between the master-box and the signal-receiving apparatus, means for supplying current, a plurality of signal-initiating devices, and a plurality of parallel conductors connecting said signal-initiating devices with said box, the said master-box containing suitably operated and normally closed make-and-break devices connecting the said parallel conductors with the connection between the box and the signal-receiving apparatus, whereby the said parallel conductors constitute parallel conducting paths of a normally charged signaling circuit energized from the same source as the line connectors.

5. An electrical signaling system, comprising suitable signal-receiving apparatus, a master-box, suitable connection between the master-box and the signal-receiving apparatus, means for supplying all necessary current, a plurality of signal-initiating devices, and a plurality of parallel conductors connecting said signal-initiating devices with said box, the said master-box including in its internal equipment normally wound-up clockwork and a releasing magnet, together with normally closed make-and-break devices connecting the parallel conductors with the connection between the master-box and the signal-receiving apparatus, and the said releasing-magnet having differential windings also serving as medium of electrical connection between the said parallel conductors and the connection between the master-box and the signal-receiving apparatus, whereby the said parallel conductors constitute parallel conducting paths of a normally charged signaling circuit.

6. An electrical signaling system, comprising suitable signal-receiving apparatus, a master-box, suitable connection between the master-box and signal-receiving apparatus, means for supplying all necessary current, a plurality of signal-initiating devices, and a plurality of parallel conductors connecting said signal-initiating devices with said box, the said master-box including in its internal equipment normally wound-up clockwork and a releasing-magnet, together with normally closed make-and-break devices connecting the parallel conductors with the connection between the master-box and the signal-receiving apparatus, and the said releasing-magnet having differential windings also serving as medium of electrical connection between the said parallel conductors and the connection between the master-box and the signal-receiving apparatus, whereby the said parallel conductors constitute parallel conducting paths of a normally charged signaling circuit.

7. An electrical signaling system, comprising suitable signal-receiving apparatus,

a master-box, suitable connection between the master-box and signal-receiving apparatus, means for supplying all necessary current, a plurality of signal-initiating devices, and a plurality of parallel conductors arranged in loop-form and connecting said signal-initiating devices with said box, the said box containing a plurality of suitably operated make-and-break devices, adapted and timed to include the said parallel conductors successively in the signaling circuit during the transmission of a signal, and adapted to normally connect all of the parallel conductors with the connection between the said box and the signal-receiving apparatus, whereby said parallel conductors constitute parallel conducting paths of a normally charged signaling circuit, but are used successively in the transmission of a signal over said circuit.

8. An electrical signaling system, comprising suitable signal-receiving apparatus and a source of current at one station, a master-box and a plurality of signal-initiating devices at another station, line connection between the two stations, and a plurality of parallel conductors connecting the signal-initiating devices with said box, the said master-box containing a third and normally open parallel conductor, and containing also a plurality of suitably operated and normally closed make-and-break devices, connecting all three parallel conductors with the line, whereby the two parallel conductors outside of the box constitute parallel conducting and signaling paths of a normally charged signaling circuit.

9. An electrical signaling system, comprising suitable signal-receiving apparatus, a master-box, suitable connection between the box and the signal-receiving apparatus, means for supplying all necessary current, a plurality of signal-initiating devices, each signal-initiating device having a plurality of parallel conducting paths and provided also with means which, when operated, serve to momentarily open said conducting paths, and then close the same and establish a cross-conducting path between them, and a corresponding number of parallel conductors connecting said signal-initiating devices with said box, the said box containing suitably operated and normally closed make-and-break devices connecting said parallel conductors with the line, whereby said parallel conductors constitute parallel conducting paths of a normally charged signaling circuit.

10. An electrical signaling system, comprising as necessary elements thermostats provided with parallel conducting paths, each conducting path including a mass of fusible conducting material, and each thermostat being provided with means adapted when operated by the melting of the fusible material to immediately close the gap thereby produced in the parallel conducting paths and in addition establish a cross-conducting path between the same; and a signal-transmitting box, provided with normally wound-up clockwork, and a normally de-energized releasing magnet, said magnet having parallel coils included in circuit with said parallel conducting paths.

11. In an electrical signaling system, a main line circuit, including at a central station a source of current supply, a signal responsive device, and at a station to be supervised parallel supervisory circuit branches, and a transmitter adapted to transmit plural impulse signals associated with said circuit and arranged to indicate by distinguishable signals the rupture of either supervisory branch and by a signal distinguishable from one of the before mentioned signals the crossing of said branches.

12. In an electrical signaling system, a main line, a source of current supply therefor, a signal receiving apparatus, and a transmitting apparatus involving a releasing electro-magnet, said releasing magnet having four coils arranged to normally balance the magnet, said coils being coupled in series with the couples arranged in parallel, a supervisory circuit loop interposed in series between the coils of one of the couples, and means for establishing a connection between said loop and the line beyond the coils in parallel with one of said coils in series with the loop.

13. In an electrical signaling system, a main line circuit divided at an area to be supervised into two parallel branches, a signal transmitting box having two make-and-break devices one arranged in each of said parallel branches, a normally open connection in parallel to the portion of one of said branches outside of the box, and means for closing said normally open connection upon the rupture of both branches.

Signed by me at Chicago, Cook county, Illinois, this 20th day of February, 1904.

JAMES G. NOLEN.

Witnesses:

SEVERINUS B. CHABOWSKI,

WM. A. HARDERS.