S. CABOT.

SIGNALING SYSTEM.

APPLICATION FILED MAR. 10, 1906.

899,239.

Patented Sept. 22, 1908.

6 SHEETS—SHEET 1.

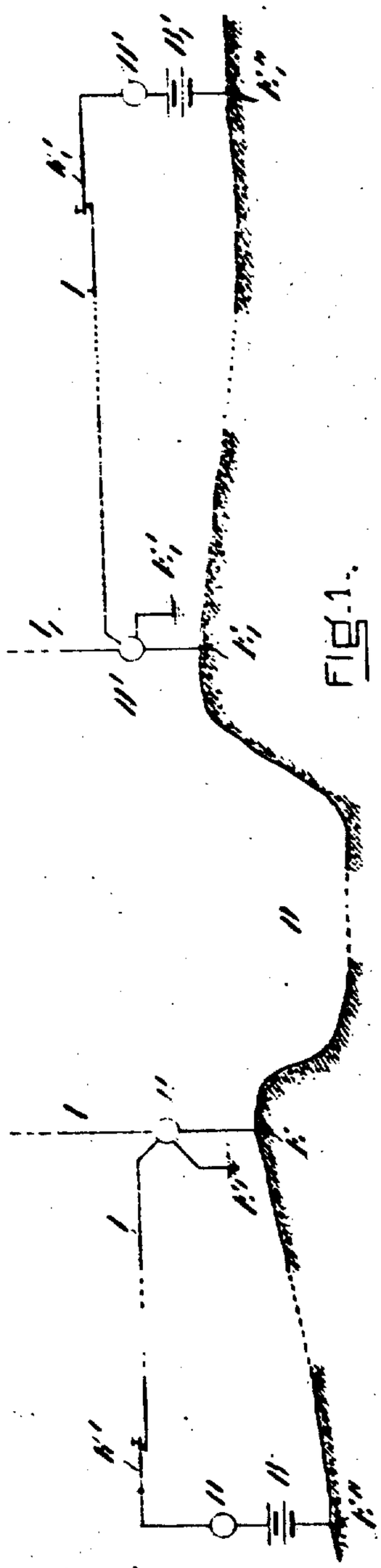

FIG. 1.

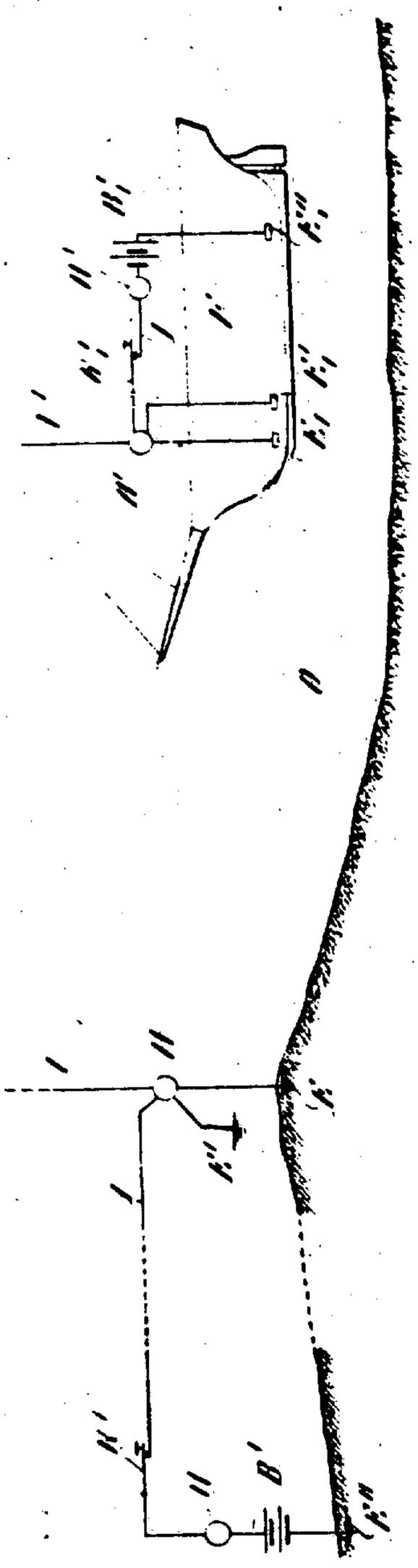

FIG. 2.

FIG. 3.

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6 SHEETS—SHEET 2

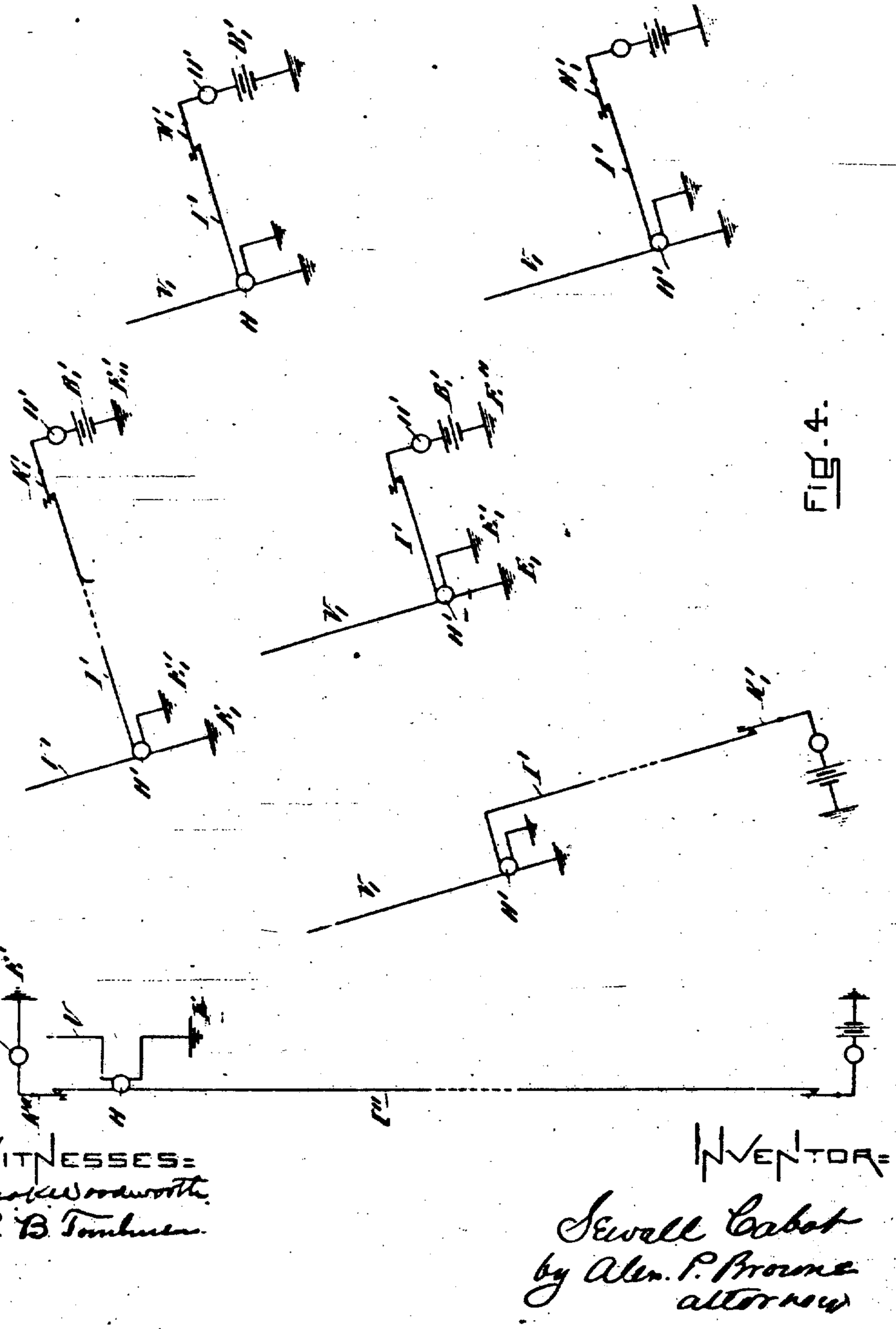

Fig. 4.

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6 SHEETS-SHEET 3

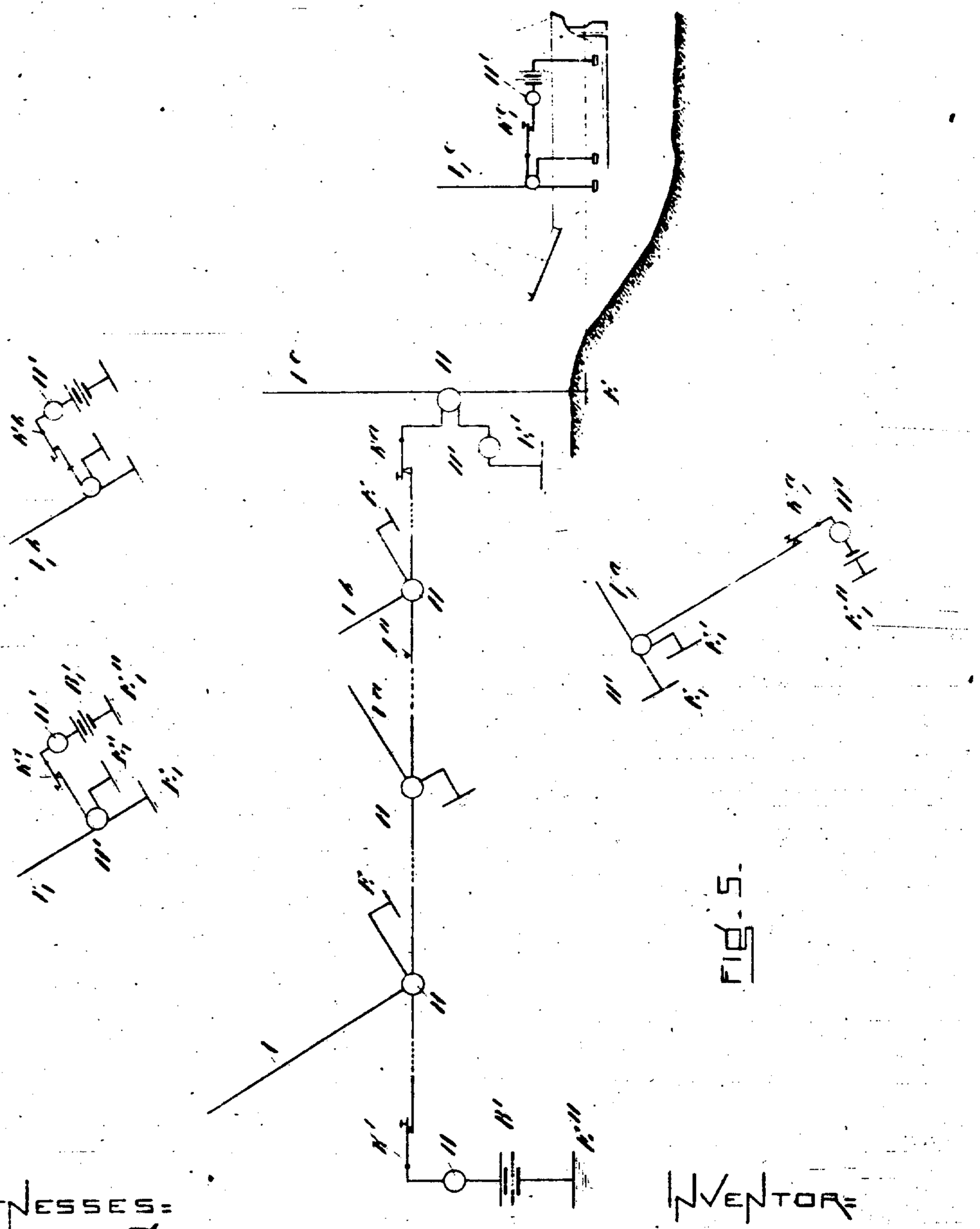

FIG. 5.

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6 SHEETS—SHEET 4.

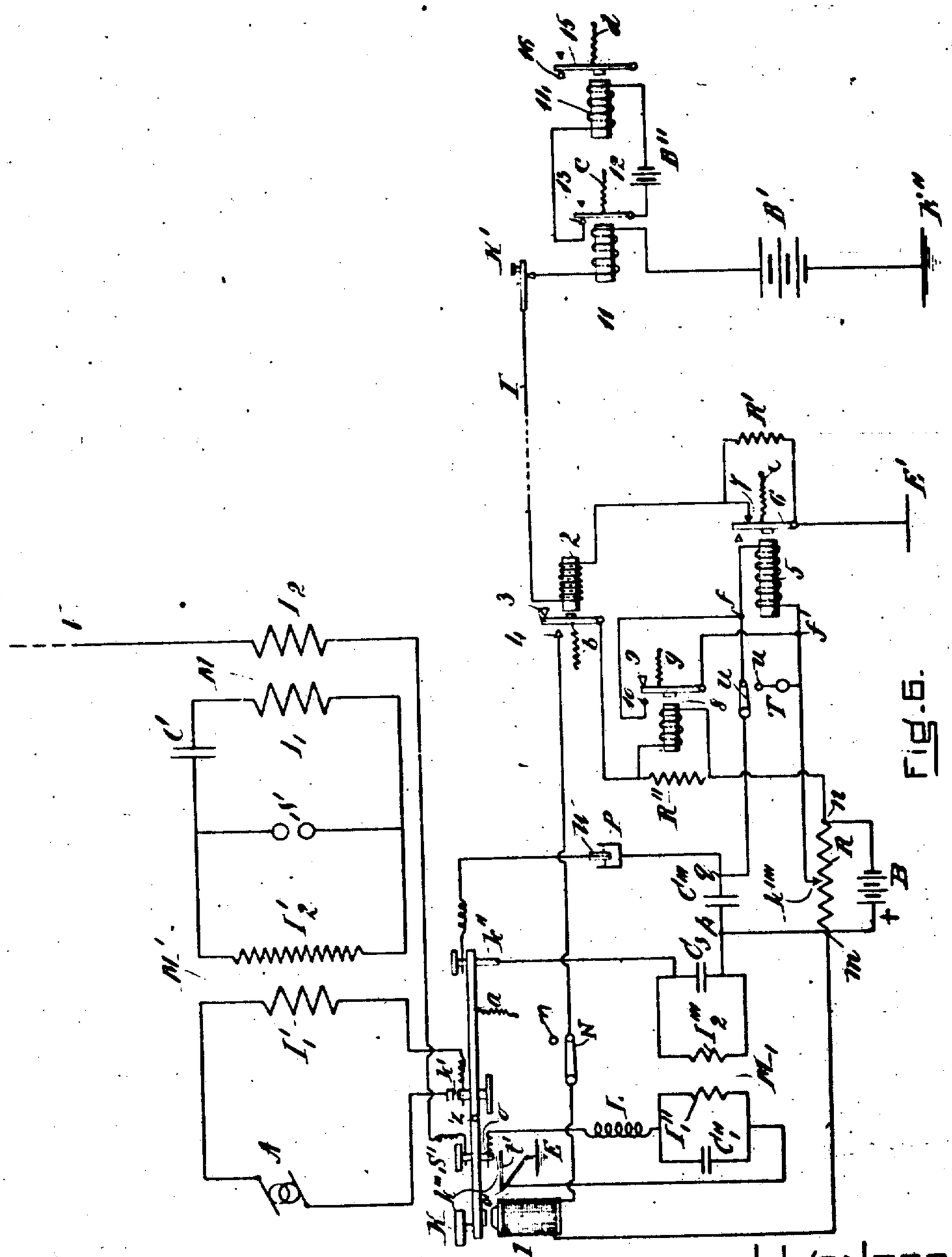

Fig. 6.

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5 SHEETS—SHEET 3

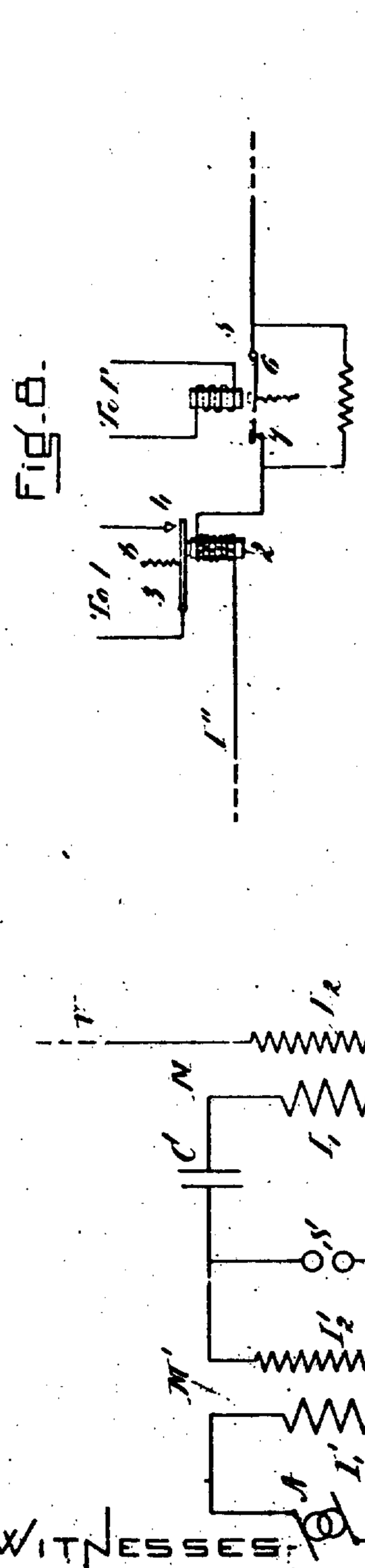

Fig. 8.

Fig. 7.

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UNITED STATES PATENT OFFICE.

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SIGNALING SYSTEM.

No. 899,239. Specification of Letters Patent. Patented Sept. 22, 1908.

Application filed March 10, 1906. Serial No. 305,260.

To all whom it may concern:

Be it known that I, SEWALL CABOT, a citizen of the United States, and a resident of Brookline, in the county of Norfolk and State of Massachusetts, have invented a new and useful Improvement in Signaling Systems, of which the following is a specification.

My invention relates to the art of transmitting intelligence from one station to another by means of electromagnetic waves, without the use of wires to guide the waves to their destination; and it relates more particularly to a complete system for transmitting and receiving such waves, which may be operated by and in connection with existing wire telegraph lines.

The general object of my invention is to provide a wireless telegraph system which may be operated by and in connection with existing wire telegraph systems without changing any of the operating features of such wire telegraph systems, but maintaining said operating features in their present form as in use today in the present state of development of commercial wire telegraph systems.

Another object of my invention is to provide a wireless telegraph transmitting system which may be operated by a wire telegraph transmitting operator located at a distance from said system; and a wireless telegraph receiving system, located at the same station as said transmitting system or at a different station, which may operate a sounder or other wire telegraph receiving apparatus located at a distance from said receiving system and which may be located at the same wire telegraph station as said transmitting operator.

Other special objects of my invention are to provide wireless telegraph systems which may be operated by and in connection with existing wire telegraph systems, and which may be so located with respect to said systems as to bridge by wireless transmission gaps or stretches existing in said lines, over which it is difficult or expensive to maintain wire telegraphic communication, such for example, as bodies of water, which are at the present time spanned by cables; to operate, from a wire telegraph station located in a city, a wireless telegraph transmitting system located in the outskirts of said city and to relay a message received by a wireless telegraph receiving station so located to a wire telegraph station located in said city; to render possible communication between an inland wire telegraph station, for example, one located in an inland city, and vessels at sea; to repeat a wire telegraph message by means of a wireless telegraph system operated by and in connection with a wire telegraph system to a number of wireless telegraph stations, and then if desired to relay said message to other wire telegraph systems operated by said latter wireless telegraph stations; to relay a wire telegraph message by wireless telegraphy to one or more wireless telegraph stations located along the route of a wire telegraph main line, at points of small traffic development; and, in general, to employ wireless telegraphy to supplement existing wire telegraph systems in any and all possible ways, some of which are hereinafter set forth in the present application and others of which are set forth in my applications, Serial Nos. 305,261, 305,262, and 305,263, filed simultaneously herewith.

A further object of my invention is to provide a wireless telegraph system, which may be operated by and in connection with an existing wire telegraph system, or which may be operated independently of such system, and by means of which messages may be transmitted in back-stroke-Morse which shall be intelligible only at the particular receiving station or stations for which they are intended and by which they are translated into front-stroke-Morse, and which therefore cannot be picked up and read by a foreign station attuned to the frequency of the electromagnetic waves by which such messages are transmitted.

Other objects of my invention will hereinafter appear and will be particularly pointed out in the appended claims.

My invention may best be understood by having reference to the drawings which accompany and form a part of this specification, and which diagrammatically illustrate organizations of apparatus and circuits whereby the hereinbefore stated objects may be realized.

In the drawings, Figures 1, 2, 3, 4 and 5 are schematic views illustrating some of the various ways in which wireless telegraphy may be employed to supplement existing wire telegraph lines; Fig. 6 is a diagram of a combined transmitting and receiving wireless telegraph system and a wire telegraph

system so associated therewith that the wireless telegraph transmitting system may be operated by said wire telegraph system and said wire telegraph system may be operated by said wireless telegraph receiving system; and Fig. 7 is a diagram of a similar combined transmitting and receiving wireless telegraph system and associated wire telegraph system differing somewhat in detail from that shown in Fig. 6. Fig. 8 is a diagram showing how a combined transmitting and receiving wireless telegraph system may be associated with a wire telegraph trunk line.

I shall first describe the apparatus and circuit arrangements shown in Figs. 6 and 7 and then by reference to the schematic views shown in Figs. 1 to 5 inclusive, shall explain some of the various ways in which my invention may be employed.

In Figs. 6 and 7, V is an elevated conductor and E is its earth connection. M M' M_1 M'' M''' are transformers. I_1 I'_1 etc. are transformer primaries and I_2 I'_2 etc. are transformer secondaries. C C'' C_2 C_3 and C''' are condensers. L is an inductance. R R' R'' are resistances. K K' K'' are keys. S is a spark-gap. A is an alternating current generator or other suitable source of vibratory current. B B' B'' are batteries. I is a wire telegraph line the terminals of which are grounded at E' and E''.

I shall first assume that the switch N is on its contact *n*, thereby opening the circuit of the magnet 1 and battery B, and that the switch U is on its contact *u*, thereby disconnecting the magnet 5 from the circuit of the oscillation detector P and connecting the telephone T in said circuit. The key K may now be operated by hand, having been rendered independent of control by the wire telegraph system E' 2 I 11 B' E''. Upon the depression of the key K, the oscillation detector is rendered inoperative by opening its circuit at the point *k''* and upon a further depression of the key K the receiving system is short-circuited between the points *o* and *o'* by the contact of the screw *s'* with the spring *t'* which is grounded at E. It is immaterial whether the two operations just described occur simultaneously or successively, and if successively, it is immaterial which one occurs first.

Although I have found the means herein shown and described for rendering the receiver inoperative to be convenient for the purpose, it is to be understood that various other means may be devised for this purpose, and therefore that I do not wish to limit myself to an apparatus operated by the sending key for rendering the receiver inoperative by opening the receiver circuit. After the receiver has been rendered inoperative and the receiving system has been short-circuited between the points *o* and *o'* by the closure of the contact *k'''*, which at the same time grounds the transmitting system at the point E, a further depression of the key K closes the power circuit including the alternator A and primary I'_1 at the point *k'*. By means of the step-up transformer M' the current in the primary power circuit is translated into a high potential current in the circuit of the secondary I'_2 and this high-potential current charges the condenser C. The condenser C by discharging across the spark-gap S creates high-frequency, high-potential electrical oscillations in the circuit C S I_1 which by means of the transformer M are conveyed to the elevated transmitting conductor system V I_2 *o o'* E, preferably at increased potential. While I do not wish to limit myself to this feature, I prefer to employ a transformer M whose windings are so spatially related as to render the natural period of the sonorous circuit C S I_1 practically independent of the electromagnetic constants of the elevated conductor system. The oscillations so created in the elevated transmitting conductor system cause the radiation therefrom of electromagnetic waves which by means of the key K are broken up into front-stroke-Morse signals. Throughout the specification and claims wherever the word "Morse" occurs I desire to be understood as meaning the Morse code or any code suitable to wireless telegraphy, and inasmuch as the present invention involves a wireless telegraph transmitting system adapted to be operated from a distance by a wire telegraph system, and a wireless telegraph receiving system adapted to operate a wire telegraph receiving apparatus located at a distance from it, I prefer to employ the Morse code, although it will be apparent that any other code will serve my purpose equally well. I use the term "front-stroke-Morse signals" in the sense in which telegraphers employ it. In sending signals over a wire line by front-stroke-Morse, when the key is open the relay is on its back contact and the sounder operated by said relay is held by its spring against its up contact. When the key is closed the relay is on its front contact and closes the circuit of the sounder thereby bringing the sounder on its anvil or down contact. Back-stroke-Morse is the reverse of front-stroke-Morse, as will hereinafter be more fully explained.

The electromagnetic signal waves transmitted from the elevated conductor V by the depression of the key K actuate a receiving system at a distant station which may be and preferably is exactly like the system shown in Fig. 6, in which the key K is normally held in receiving position by the spring *a*. These waves create electrical oscillations in the elevated receiving conductor system V I_2 *s' o* L C''' I''' *o'* E and the energy of said oscillations is translated by the transformer M_1 to the resonant receiving circuit I'''_2 C_3 attuned

to the frequency of said waves, and preferably so related to the loop circuit C'', l'', that its natural period is practically independent of the electromagnetic constants of said elevated receiving conductor system. The oscillation responder P, which in the present case is shown as consisting of a cell containing an electrolyte and having as its anode W a wire about 1 mil. in diameter inclosed in glass so that only its end is exposed, is operated by the difference of potential developed by said oscillations across the terminals of the condenser C_3 and thereby current variations are produced in the circuit *m p* l''', *k''* W P *q* U *u* T *k''''* operating the telephone T, which preferably is a head telephone. If the operator fails to understand a signal or series of signals he signals "break" by depressing the key K and thereby transmitting electromagnetic signal waves to the transmitting operator at the station from which signals are being transmitted, and the latter, who always keeps his head telephone over his ears while sending, is enabled to receive the "break" signal between his own signal elements when his key is in its normal position.

It will be obvious that during transmission the difference of potential developed between the points *o* and *o'*, which form the terminals of the receiving system, is negligibly small and will not injure the delicate parts of said system, and also it will be apparent that the point of connection of the receiving system to the transmitting system during such transmission is a point having practically zero potential to ground. Although the apparatus above described whereby a receiving operator may signal "break" without injuring himself or his-receiving apparatus is the form preferred by me in practice and forms an essential element of the signaling system herein described, I do not wish to be limited to this particular arrangement for "breaking", inasmuch as other arrangements may well serve my purpose.

When the switches N and U are closed, the transmitting apparatus may be actuated by the wire telegraph system which includes the key K', and the receiving apparatus 11, 14 of said wire telegraph system may be actuated by the wireless telegraph receiving system.

The line l may form a part of an ordinary closed circuit wire telegraph system and the key K' may be of the ordinary type in use today, in which a lever-switch normally holds the line closed. The line being normally closed, the relays 2 and 11 are normally energized by the battery B' so that the magnet 1 is normally deënergized and the sounder 14 is normally energized. When the lever switch is moved from under the key K' the line l is opened and therefore the relays 2 and 11 are deënergized. The deënergization of the relay 11 results in the armature 12 being withdrawn to its back contact by the spring *c* thereby opening the circuit of the sounder 14 containing the battery B'' so that the spring *d* withdraws the hammer 15 to its up contact. Upon the deënergization of the relay 2 the spring *b* draws the armature 3 to its back contact 4 and closes the circuit of the magnet 1 and battery B thereby energizing the magnet 1. The energization of the magnet 1 causes the attraction of the key K whereupon follows the cycle of operations above set forth in connection with the description of the manual operation of said key. The wire telegraph operator at the key K' now commences to signal in the ordinary way. When he closes his key the relay 11 energizes the sounder 14 and brings the hammer 15 down upon the anvil 14 while the relay 2 opens the circuit of the magnet 1 and stops the transmission of electromagnetic waves. In transmitting a dot the key K' is held closed for, say, 1/10th of a second and for a like period of time the hammer 15 remains upon its anvil, while the magnet 1 remains deënergized, thereby stopping the transmission of waves for such period.

It will now be obvious that the character of the signals sent over the wire line is essentially different from the character of the signals transmitted by the electromagnetic waves and furthermore that these two sets of signals are essentially opposite in character. The signals sent over the wire line are called front-stroke-Morse signals, while those transmitted by electromagnetic waves are termed back-stroke-Morse signals. The back-stroke-Morse signals so transmitted are received by a system at a distant station which preferably is identical with that shown in Fig. 6. The oscillations created in the elevated receiving conductor system at said station operate the oscillation detector which, in lieu of operating the telephone receiver, energizes the relay 5. The energization of said relay causes the attraction of the armature 6 from its back contact 7, thereby cutting the resistance R' into the wire telegraph system and thereby reducing the current flowing in said system sufficiently to permit the spring *c* to draw the armature 12 of the relay 11 away from its front contact, but not sufficiently to permit the spring *b* of the relay 2 to draw its armature 3 away from its front contact. When the armature 12 is drawn away from its front contact, the circuit of the sounder 14 is opened and the hammer 15 is drawn to its up contact. When the operator at the key K' of the distant station closes his key, thereby stopping the transmission of waves, the relay 5 of the receiving station under discussion is deënergized and the resistance R', connected across the armature and back contact of said relay, is short-circuited by said armature which is drawn by the spring *c* against the contact 7. This in-

creases the current in the wire system and energizes the relay 11 which again attracts its armature 12 and brings the hammer 15 down upon the anvil. The transmitting operator at the key K′ of the distant transmitting station now raises his key to complete the signal element and again waves are radiated from the wireless telegraph transmitting station and the oscillation detector at the receiving station under discussion causes the relay 5 to cut the resistance R′ into the wire telegraph line thereby causing the spring *c* to open the circuit of the sounder and permitting the spring *d* to bring the hammer against its up contact.

It will now be observed that the operator at the distant transmitting station sends front-stroke-Morse over the line I; that the front-stroke-Morse wire signals are converted into back-stroke-Morse wireless signals; that said back-stroke-Morse wireless signals come into the wireless receiving station located at a distance from said wireless transmitting station; and finally that the received back-stroke-Morse wireless signals are converted into front-stroke-Morse wire signals at the sounder 14. No operator can read back-stroke-Morse, for the telegraph sounder speaks to an operator in a definite language and if in this language sounds should be produced where silences would be expected and vice versa, the language would be an unintelligible jargon much the same as that produced by running a phonograph backwards. Therefore no foreign wireless telegraph station attuned to the frequency of the waves by which the aforesaid back-stroke-Morse wireless signals are transmitted could read said signals without first providing the means herein described or other suitable means for converting them into front-stroke-Morse. The great advantage of secrecy in transmission therefore is attained by the present invention.

The apparatus shown in Fig. 7 is quite similar to that of Fig. 6 and operates in substantially the same manner. In Fig. 7 the circuit C_2 I''_2 I'''_1 is a resonant weeding-out circuit which is interposed between the loop circuit C'''_1 I''_1 and the resonant receiving circuit I'''_2 C_3, and the function of which is now well understood. Upon the depression of the key K in Fig. 7, the receiving system is short-circuited between the points *o o′* by the screw *s* pressing the spring *t* against the contact *o*. The switch J corresponds somewhat in function to the switch N of Fig. 6. When in the position shown, the key K may be controlled by the wire telegraph key K′, and when moved to the left so that *h* contacts *j*, *h′* contacts *j′*, and *i* leaves the contact *i′*, the wireless sending apparatus is independent of the wire telegraph line and may be operated by the key K″ at the wireless station. When the key K″ is cut in the magnet 1 is energized and when said key is depressed the magnet 1 is deënergized, thus the key K″ constitutes in connection with the magnet 1 the means at the wireless transmitting station for sending back-stroke-Morse wireless telegraph signals.

When the key K, in either Fig. 6 or 7 resumes its normal position (the position shown in said figures), a sudden impulse of current from the battery B, which, with the resistance R and variable contact *k′′′′*, constitutes a potentiometer, may flow through the relay 5 and cause a fluttering of the relay 11. To prevent this I may connect the relay 8 across the terminals of the resistance R″ which is included in the circuit of the magnet 1 and connect the armature 9 and front contact 10 of said relay in shunt to the terminals *f f′* of relay 5. When the relay 2 is energized and the circuit of the magnet 1 is thereby opened, the inductive kick from the winding of relay 8 through the resistance R″ will serve to maintain the shunt around the terminals of the relay 5 until the contact *k″* is closed, so that the impulse of current caused in the circuit of the oscillation responder and relay 5 by such closure will be shunted around said relay 5 by the circuit *f* 10 9 *f′*. In the normal position of the key K the spring *g* holds the armature 9 against its back contact. However, this device may be dispensed with by employing potassium hydroxid as the electrolyte for the oscillation detector.

In the schematic views shown in Figs. 1 to 5 inclusive, the reference characters have the same significance as in Figs. 6 and 7. H in these schematic views represents the wireless telegraph receiving and transmitting systems and the means associating them with the line wire I which are shown in Figs. 6 and 7. Fig. 1 represents a signaling system comprising two wire systems I and I′ separated by a body of water D which in existing lines would be bridged by a cable involving a considerable first cost and a large annual cost for maintenance; or the character D may be supposed to represent a gap or stretch in the wire line over which it is difficult to maintain wire communication. By the present invention the use of cables to span the gap D is obviated and it is possible to maintain through transmission between the terminal stations under conditions where otherwise such through transmission would be impossible, without changing any of the operating features of the existing wire lines I I′, but maintaining said operating features in their present form as in use today. This is accomplished as indicated in Fig. 1 by bridging the gap D by wireless telegraphy. The operation is as follows: The operator at the left hand station opens his key K′ by moving the lever-switch from under the key in the usual

manner, and thereby deënergizes the relay 2, shown in Figs. 6 and 7, and thus causes the radiation of electromagnetic waves from the vertical V. The vertical V_1 absorbs a portion of the energy of these waves and thereby operates the relay 5, shown in Figs. 6 and 7, and, consequently, the receiving relay 11′, shown at the right hand side of Fig. 1. Signaling now proceeds in the usual way, the operator at key K′ sending front-stroke-Morse, the vertical V transmitting back-stroke-Morse, the vertical V_1 receiving back-stroke-Morse and finally the relay 11′ responding in front-stroke-Morse. In all existing wire telegraph lines it is essential that the receiving operator be able to "break" when he fails to understand a portion of a message, and this, in single wire closed circuit systems, he does by simply opening his key. When this occurs the sounder at the transmitting station will not respond in unison with the movements of the transmitting operator's key, so therefore the transmitting operator closes his key and receives such instructions as to repetition of the message as the receiving operator desires to send. It will be obvious that wireless telegraphy cannot be used to supplement wire telegraphy unless some means is provided whereby a receiving operator may "break" the distant transmitting operator through the intermediary of the wireless system which is employed to supplement the wire system. In the present case the receiving operator at one terminal station may "break" the transmitting operator at the other terminal station in the same way as in wire telegraphy, namely, by the simple expedient of opening his key. For example, if the receiving operator at the key K′, moves the switch lever from under his key and so opens his line I′, the relay 2 at H′ will be deënergized and waves will be radiated by V_1 which will be received by V and create in the receiving apparatus at H electrical oscillations which, when the key K at H, shown in Figs. 6 and 7, is in its normal position will operate the relay 5 at H and thereby cause the armature 12 of the relay 11 to fall back and to remain on its back contact even when the key K′ is closed. The transmitting operator at key K′ will therefore know that the receiving operator to whom he is sending has "broken" and he will close his key and receive instructions concerning a repetition of the message. So far as he is concerned the operation of "breaking" is just the same as if the receiving operator at key K'_1 were looped onto his line by wire connections instead of being looped onto his line by wireless.

Fig. 2 represents how I employ my invention to communicate by wire-wireless between an inland wire station and a ship at sea. The apparatus in this case is identical with that shown in Figs. 6 and 7, except that the "wire line" I′ is a short line or circuit which may be a few feet in length and which is employed for the purpose of permitting the conversion of back-stroke-Morse wireless into front-stroke-Morse wire. It is obvious that by this system an operator at, say, Albany could communicate with a vessel off Cape Hatteras by sending wire messages to Atlantic City, where the vertical V and associated apparatus H may be supposed to be located, and converting by said apparatus H his wire messages into wireless, and it is obvious that the operator at the key K'_1 on the ship F may communicate with the operator at Albany, "breaking" him if desired, just as if he were looped onto the wire line I.

In commercial wireless installations it is practically impossible to locate the wireless transmitting and receiving system in a city, and Fig. 3 shows how by means of the present invention the wireless system may be located in the outskirts of a city, as at H, and be operated by a key K′ in the heart of the city and also operate by means of the waves received from a distant station the receiving apparatus 11 located in the heart of the city.

In Fig. 4, I″ is a wire trunk line associated with the vertical V by means of the apparatus H, shown in detail in Figs. 6 and 7, just as in said figures the wire I is associated with the wireless system. The wire line in Fig. 4 is grounded at E′ which corresponds in function with the ground E′ in Figs. 6 and 7, although it may be located a thousand miles away from the system V H E, at a terminal station. The key K^a and relay 11^a are located at said terminal station. As will be obvious from an examination of Figs. 6 and 7, the wire line I″ includes the winding of relay 2 and the back contact 7 and armature 6 of relay 5, and the two latter elements are shunted by the resistance R′. The combined wireless transmitting and receiving systems V_1 H′ E_1 may all be attuned to the frequency of the waves transmitted by the system V H E, and each of them may be associated with a wire line I of greater or less length.

By means of the system shown in Fig. 4 the wire messages, transmitted from one terminal station to the other and through all way stations in the usual manner by front-stroke-Morse, are converted into back-stroke-Morse wireless and received at the various wireless systems which are within the sphere of influence of V H E. By the latter they are converted into front-stroke-Morse and sent along the wire lines I. If desired these wire lines may not extend outside of the station-house as explained above in connection with the line I′ on the ship F shown in Fig. 2. Any operator at any of the keys K'_1 may communicate with the ter-

minel stations at which the keys K' and K* are located, or with any of the way stations on the line I'' just as effectively as if such operator were connected with the line I'' by wire.

In Fig. 5, I'' represents a trunk line similar to the correspondingly lettered trunk in Fig. 4, and is provided at various points with the combined transmitting and receiving apparatus V H E, V* H E, etc. Located at points of small traffic development along the route of said trunk line are combined transmitting and receiving systems V_1 H' E_1, V^*_1 H' E_1, each attuned to a different one of the systems associated with the trunk line. In view of the preceding explanation it will be apparent that each operator at the keys K', K*, etc. may put himself into communication with the operators at the terminal stations of the trunk line and at any of the way stations along said line, and furthermore that the operators whose stations are located on the main line may put themselves into communication with the operators whose stations are located as aforesaid along the route of said line at points of small traffic development where it would not pay to maintain a wire line.

Fig. 8 is a fragmentary view, in which the reference numerals and characters have the same significance as in Figs. 6 and 7, and which shows how the combined transmitting and receiving wireless systems are associated with the trunk lines I'' in Figs. 4 and 5.

As indicated the winding of the magnet 5 is connected with the oscillation detector P, the complete connections being the same as those shown in Figs. 6 and 7.

While I have specifically described an electrolytic receiver or oscillation detector as suitable for use in the systems shown in Figs. 6 and 7, it will be obvious that any suitable wireless telegraph receiver may be substituted for said electrolytic receiver without departing from the spirit of my invention.

While I have shown the relay 5 merely conventionally, in the usual manner, it will be obvious that any relay which can be operated by a wireless telegraph receiver may be employed.

I do not wish to be limited to the exact form of apparatus or circuit arrangements which I have herein shown and described for the purpose of more fully disclosing my invention, inasmuch as said apparatus and circuit arrangements are capable of a wide range of variation without departing from the spirit of my invention. For example, in lieu of shunting the armature 6 and back contact 7 of the relay 5 with the resistance R', many other hold-over devices may be employed for controlling and operating the receiving apparatus 11, 14 without actuating the relay 2 and the sending device 1 which is controlled thereby.

I claim,—

1. In a signaling system, a wireless telegraph system and a wire telegraph system operatively associated therewith.

2. In a signaling system, a combined transmitting and receiving wireless telegraph system and a wire telegraph system operatively associated therewith.

3. In a signaling system, a wireless telegraph receiving system, a wire telegraph system, and means so associating said systems that said wire telegraph system may be operated by said wireless telegraph receiving system.

4. In a signaling system, a combined transmitting and receiving wireless telegraph system, a wire telegraph system, and means so associating said systems that said wireless telegraph transmitting system may be operated by said wire telegraph system and said wire telegraph system may be operated by said wireless telegraph receiving system.

5. In a signaling system, a wireless telegraph receiving system, a wire telegraph system including a receiving apparatus, and means controlled by said wireless telegraph receiving system for operating said receiving apparatus.

6. In a signaling system, a wireless telegraph receiving system, a wire telegraph system including a receiving apparatus and electromagnetic means controlled by said wireless telegraph receiving system for operating said receiving apparatus.

7. In a signaling system, a combined transmitting and receiving wireless telegraph system including a sending device and an oscillation detector, a wire telegraph system, means controlled by said wire telegraph system for operating said sending device and means controlled by said oscillation detector for operating said wire telegraph system.

8. In a signaling system, a combined transmitting and receiving wireless telegraph system including a sending device and an oscillation detector, a wire telegraph system including a key and a receiving apparatus, means controlled by said key for operating said sending device and means controlled by said oscillation detector for operating said receiving apparatus.

9. In a signaling system, a wireless telegraph transmitting system including a sending device, electromagnetic means for operating said sending device, a circuit having an associated source of electrical energy and including said electromagnetic means, and a wire telegraph line including means for controlling said circuit.

10. In a signaling system, a wireless telegraph transmitting system including a sending device, electromagnetic means for operating said sending device, a circuit having an associated source of electrical energy and including said electromagnetic means, a wire

telegraph line, means in said line for normally holding said circuit open, and a key in said line for controlling said means.

11. In a signaling system, a wireless telegraph transmitting system, including a sending device, electromagnetic means for operating said sending device, a circuit having an associated source of electrical energy and including said electromagnetic means, a relay having its back contact and its armature connected in said circuit, and a circuit including the winding of said relay, a key and a source of electrical energy, whereby when said key is closed, said armature will be drawn to its front contact and thereby open the first mentioned circuit.

12. In a signaling system, a wireless telegraph receiving system, including an oscillation detector, a wire telegraph line including a receiving apparatus and electromagnetic means controlled by said oscillation detector for operating said receiving apparatus.

13. In a signaling system, a wireless telegraph receiving system including an oscillation detector, a wire telegraph line including a receiving apparatus and having the back contact and armature of a relay connected thereto, and a circuit controlled by said oscillation detector and including the winding of said relay.

14. In a signaling system, a wireless telegraph receiving system, including an oscillation detector, a wire telegraph line including a receiving apparatus and having the back contact and armature of a relay connected thereto, a resistance shunted around said contact and armature, and a circuit controlled by said oscillation detector and including the winding of said relay.

15. In a signaling system, a wireless telegraph receiving system including an oscillation detector, a wire telegraph line including a receiving apparatus, and means controlled by said oscillation detector for increasing the resistance of said wire telegraph line without breaking the continuity of said line.

16. In a signaling system, a wireless telegraph receiving system including an oscillation detector, a wire telegraph line including a receiving apparatus and having the back contact and armature of a relay connected thereto, a circuit controlled by said oscillation detector and including the winding of said relay, and means operated by said relay for increasing the resistance of said wire telegraph line without breaking the continuity of said line.

17. In a signaling system, a wireless telegraph receiving system including an oscillation detector, a wire telegraph line including a receiving apparatus and a source of electric current, and means controlled by said oscillation detector for decreasing the current in said line without breaking the continuity of said line.

18. In a signaling system, a combined transmitting and receiving wireless telegraph system including a sending device and an oscillation detector, a wire telegraph system including a receiving apparatus, means controlled by said wire telegraph system for operating said sending device, and means controlled by said oscillation detector for operating said receiving apparatus without operating said sending device.

19. In a signaling system, a combined transmitting and receiving wireless telegraph system including a sending device and an oscillation detector, a wire telegraph system including a receiving apparatus, means controlled by said wire telegraph system for operating said sending device, and means controlled by said oscillation detector for reducing the current in said wire telegraph system sufficiently to operate said receiving apparatus but not sufficiently to operate said sending device.

20. In a signaling system, a combined transmitting and receiving wireless telegraph system including a sending device and an oscillation detector, a wire telegraph system including a receiving apparatus, a relay in said wire telegraph system operating said sending device only when said wire telegraph system is opened, and a relay controlled by said oscillation detector for reducing the current in said wire telegraph system sufficiently to operate said receiving apparatus without opening said wire telegraph system.

21. In a signaling system, a wireless telegraph transmitting system, a wire telegraph system, means so associating said systems that said wireless telegraph transmitting system may be operated by said wire telegraph system and means for rendering said wireless telegraph transmitting system independent of said wire telegraph system.

22. In a signaling system, a wireless telegraph receiving system, a wire telegraph system, means so associating said systems that said wire telegraph system may be operated by said wireless telegraph receiving system, and means for rendering said wire telegraph system independent of said wireless telegraph receiving system.

23. In a signaling system, a combined transmitting and receiving wireless telegraph system, a wire telegraph system, means so associating said systems that said wireless telegraph transmitting system may be operated by said wire telegraph system and said wire telegraph system may be operated by said wireless telegraph receiving system, means for rendering said wireless telegraph transmitting system independent of said wire telegraph system and means for rendering said wire telegraph system independent of said wireless telegraph receiving system.

24. In a signaling system, a combined

transmitting and receiving wireless telegraph system including a sending device and an oscillation detector, a wire telegraph system including a key and a receiving apparatus, means controlled by said key for operating said sending device, means controlled by said oscillation detector for operating said receiving apparatus, a circuit connected in shunt to said last mentioned means, and means associated with and operated by the first mentioned means for closing said circuit.

25. In a signaling system, a wireless telegraph transmitting system and means for sending back-stroke-Morse signals thereby, in combination with a wireless telegraph receiving system adapted to receive said signals and means associated with said wireless telegraph receiving system for converting said signals into front-stroke-Morse signals.

26. In a signaling system, a wire telegraph system, means for sending front-stroke-Morse signals thereby, and means associated with said wire telegraph system for repeating said signals into a wireless telegraph transmitting system and for converting said signals into back-stroke-Morse signals, in combination with a wireless telegraph receiving system adapted to receive said wireless telegraph signals and means associated with said wireless telegraph receiving system for repeating said signals into a wire telegraph system and for converting said signals into front-stroke-Morse.

27. In a signaling system, a wireless telegraph system including a sending device and a receiving device, a wire telegraph system associated with said wireless telegraph system and means operated by said receiving device for operating said wire telegraph system without operating said sending device.

28. In a signaling system, a wireless telegraph receiving system and means associated therewith for operating a wire telegraph receiving apparatus located at a distant point.

29. In a signaling system, a wire telegraph system, means associated therewith for operating a wireless telegraph transmitting system from a distant point, a wireless telegraph receiving system located at a distance from said wireless telegraph transmitting system, and means associated therewith for operating a receiving apparatus located at a distance from said wireless telegraph receiving system.

30. In a signaling system, a wireless telegraph transmitting system, means for operating the same by a wire telegraph system, a wireless telegraph receiving system and means for operating a wire telegraph system thereby.

31. In a signaling system, a wireless telegraph transmitting system, means for operating the same by a wire telegraph system, a wireless telegraph receiving system, means for operating a wire telegraph system thereby, and means whereby the wire telegraph operators may "break" through the intermediary of said wireless telegraph systems.

32. In a signaling system, a wire telegraph system, a wireless telegraph transmitting system operated thereby, a wireless telegraph receiving system, and a wire telegraph system operated thereby.

33. In a signaling system, a wire telegraph system, a wireless telegraph transmitting system operated thereby, a wireless telegraph receiving system, a wire telegraph system operated thereby and means whereby the terminal-station wire-telegraph operators may "break" through the intermediary of said wireless telegraph systems.

34. In a signaling system, a wire telegraph trunk line, a wireless telegraph transmitting system associated therewith and operated thereby for transmitting by electromagnetic waves the signals sent over said trunk line, a plurality of wireless telegraph receiving systems, all attuned to the frequency of the waves transmitted by said wireless telegraph transmitting system and located within the sphere of influence of said wireless telegraph transmitting system, and means whereby the operators at said wireless telegraph stations may communicate with the operators on said trunk line.

35. In a signaling system, a wire telegraph trunk line, a wireless telegraph transmitting system associated therewith and operated thereby for transmitting by electromagnetic waves the signals sent over said trunk line, a plurality of wireless telegraph receiving systems operated by said electromagnetic waves, and a plurality of wire telegraph lines each associated with and operated by a different one of said wireless telegraph receiving systems.

36. In a signaling system, a wire telegraph trunk line, a plurality of wireless telegraph transmitting systems each adapted to transmit electromagnetic signal waves of a definite frequency, means so associating said systems with said trunk line that the wire telegraph signals are converted into wireless telegraph signals, and a plurality of wireless telegraph receiving systems located along the route of said trunk line at places of small traffic development and each adapted to be actuated by a different one of said wireless telegraph transmitting systems.

37. In a signaling system, a wireless telegraph transmitting system and means associated therewith for sending back-stroke-Morse signals thereby.

38. In a signaling system, a wireless telegraph receiving system, adapted to receive back-stroke-Morse signals, and means associated therewith for converting said signals into front-stroke-Morse signals.

39. A home station, a wireless station, a wire circuit from the home station to the

wireless station, wireless sending apparatus at the wireless station including its generator and spark coil, a relay at the wireless station controlled by said wire circuit, a second relay controlled by the first relay for controlling the wireless sending apparatus.

40. A home station, a wireless station, a wire circuit from the home station to the wireless station, wireless sending apparatus at the wireless station including its generator and spark coil, and a back-stroke contact relay at the wireless station controlled by the wire circuit for controlling the wireless sending apparatus.

In testimony whereof, I have hereunto subscribed my name this 8th day of Mch. 1906.

SEWALL CABOT.

Witnesses:
E. B. TOMLINSON,
GEO. K. WOODWORTH.