S. CABOT.

SIGNALING SYSTEM.

APPLICATION FILED MAR. 10, 1906.

899,241.

Patented Sept. 22, 1908.

2 SHEETS—SHEET 1.

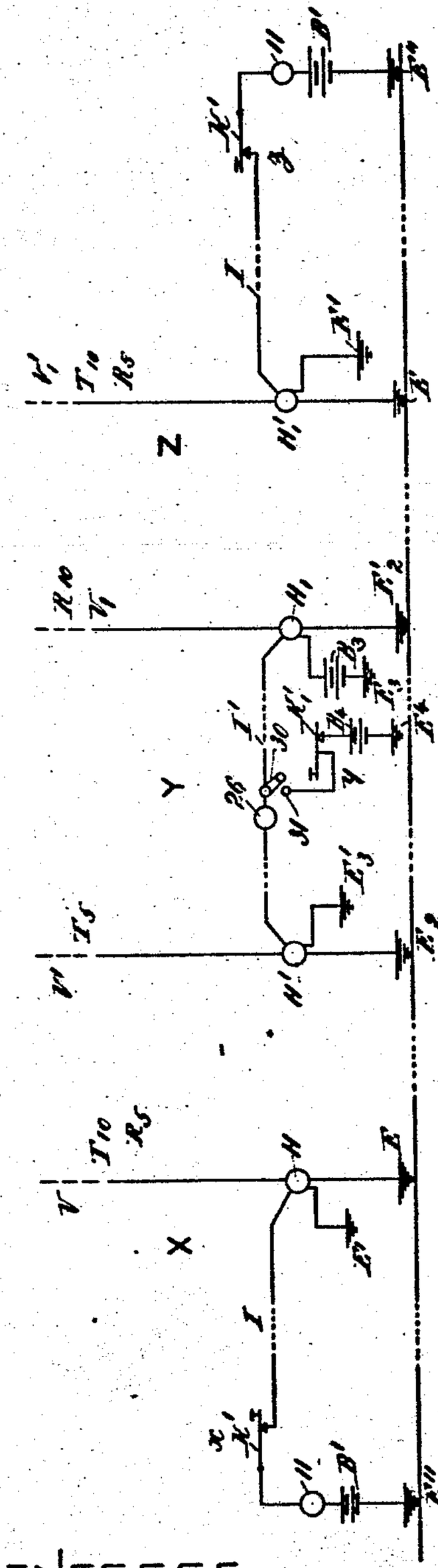

FIG. 1.

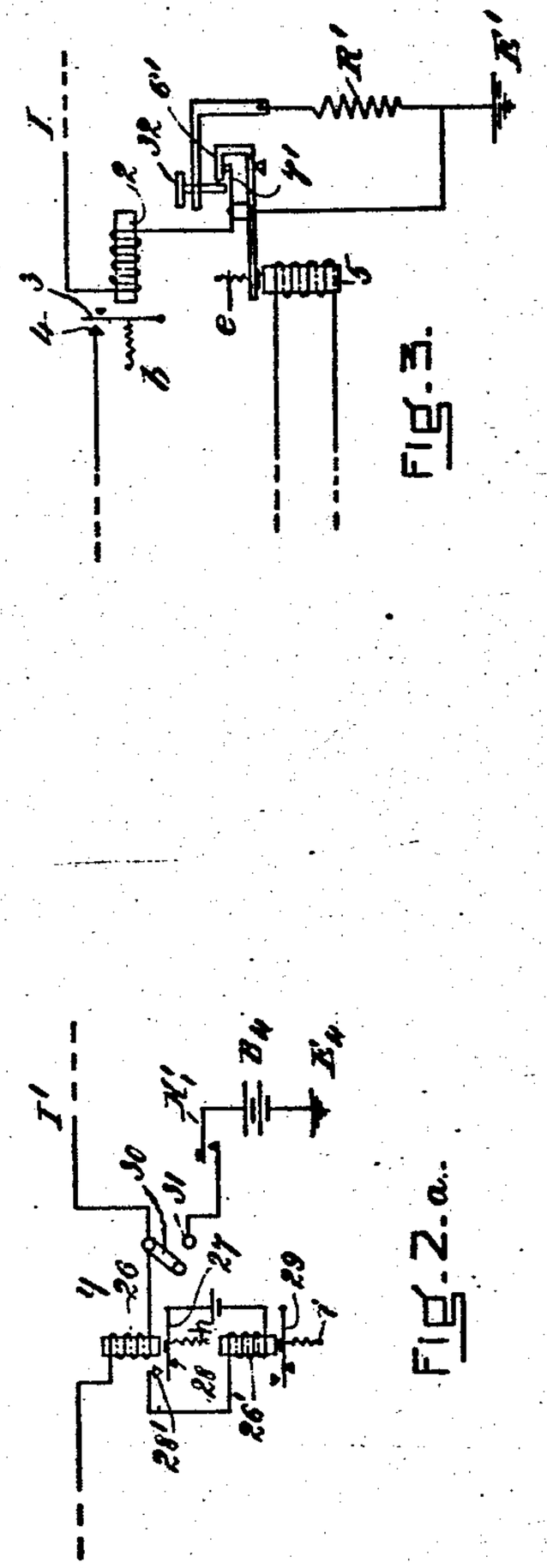

FIG. 3.

FIG. 2.a.

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2 SHEETS—SHEET 2.

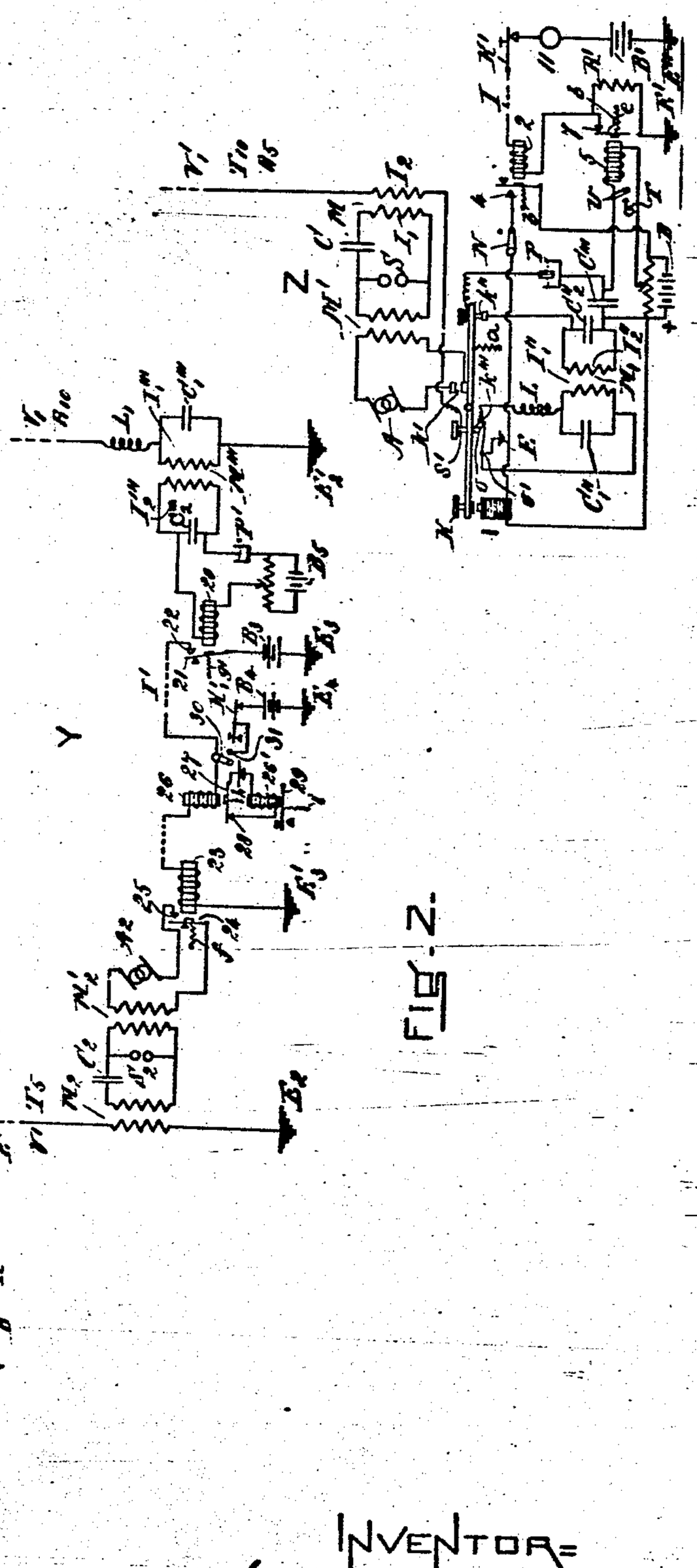

FIG. 2.

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UNITED STATES PATENT OFFICE.

SEWALL CABOT, OF BROOKLINE, MASSACHUSETTS, ASSIGNOR TO STONE TELEGRAPH AND TELEPHONE COMPANY, OF BOSTON, MASSACHUSETTS.

SIGNALING SYSTEM.

No. 899,241. Specification of Letters Patent. Patented Sept. 22, 1908.

Application filed March 10, 1906. Serial No. 305,262.

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 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 line, and by means of which a wireless telegraph message may be automatically relayed in either direction from one combined transmitting and receiving system to another combined transmitting and receiving system through the intermediary of a two-way wireless telegraph relaying system comprising a receiving system connected by a relatively short wire line with a transmitting system; to provide a way station in said relatively short wire line so that messages from either terminal station may be received at said way station and messages may be sent from the latter to either terminal station; and in general to employ wireless telegraph two-way relaying systems to supplement existing wire telegraph lines 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 application Serial No. 305,263 filed simultaneously herewith.

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, Figure 1 is a schematic view illustrating one way in which the system herein described may be employed to supplement existing wire telegraph systems; Fig. 2 is a diagram showing one form of apparatus and circuit arrangements embodying the principles of the present invention; Fig. 2^a is a diagram illustrating a modification of a detail of the way station circuits and apparatus, and Fig. 3 is a diagram illustrating a modification of a detail of construction whereby a wireless telegraph system may be operatively connected with a wire telegraph system.

In the figures, V is an elevated conductor, G is an earth connection, M is a transformer, I_1 and I_2 are transformers primaries and secondaries respectively, C is a condenser, L is an inductance, R is a resistance, K is a key, S is a spark-gap, A is an alternating current generator or other suitable source of vibratory current, B is a battery, I is a wire telegraph line; and the various elements are distinguished from each other by the employment of exponents and subscripts.

X and Z represent two terminal wireless stations each of which may be operated by a wireless telegraph operator manipulating the key K by hand, or by a wire telegraph operator located at the stations *x* or *z* some distance from said wireless station manipulating the wire telegraph key K′.

Y is an intermediate two-way wireless telegraph relaying system comprising a wireless

telegraph receiving system, a wireless telegraph transmitting system and a wire telegraph system operatively connected with said wireless systems.

Assuming first that the switch N is opened for the purpose of rendering the transmitting system independent of the wire telegraph line I and that the switch U is closed for the purpose of including the telephone T in series with the oscillation detector P and for the further purpose of rendering the said wire telegraph line independent of the wireless telegraph receiving system, the depression of the key K opens at k'' the circuit of the oscillation detector, thereby rendering the latter inoperative, and short-circuits at k''' the receiving system. A further depression of said key closes at k' the primary power circuit of the transmitting system and causes the radiation of electromagnetic waves from the elevated transmitting conductor system V I_2 s' o o' E. Other means, however, operated by the key K, may be employed for rendering the oscillation detector or receiver inoperative, and therefore I do not wish to limit myself to the particular means herein disclosed for performing this function. I prefer to so relate the windings of the transformer M that the natural period of the sonorous circuit C S I_1 is rendered practically independent of the electromagnetic constants of the elevated transmitting conductor system.

The electromagnetic signal waves transmitted from the elevated conductor V by the depression of the key K at the station X actuate the wireless telegraph receiving system of the relaying system Y which is provided with the elevated conductor V_1, and the oscillation detector P' associated with said system causes the operation of the wire telegraph system I'. The operation of said wire telegraph system effects the energization of the transmitting system of said relaying system which is provided with the elevated conductor V'. The electromagnetic signal waves radiated from said conductor create electrical oscillations in the elevated receiving conductor system V'_1 I_2 s' o L C''_1 I''_1 o' E at the station Z and the energy of said oscillations is translated by the transformer M_1 to the resonant receiving circuit I''_2 C''_2 attuned to the frequency of said waves and preferably so related to the loop circuit C''_1 I''_1 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 a wire about one mil. in diameter inclosed in glass so that only its end is exposed, is operated by said oscillations and causes current variations in the circuit including the telephone T, at said station Z.

As shown the terminal stations X and Z are provided with identical apparatus so that it will be seen that the transmitting apparatus at Z operates exactly as that above described in connection with X, and also that the receiving apparatus at X operates exactly as that above described in connection with Z.

At either station X or Z if an operator fails to understand a signal he signals "break" by depressing his 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 T over his ears while sending, is enabled to receive the "break" signal between his own signal elements when his own key is in its normal position.

It will be obvious that the aforesaid "breaking" operation is rendered possible by the fact that during transmission the difference of potential existing between the terminals 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 by the further fact 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 so that during said transmission the receiving system will have practically zero potential whereby the receiving operator may with safety maintain the head telephone T in position.

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, I do not wish to be limited to this particular arrangement for "breaking" inasmuch as other arrangements may serve my purpose.

The method employed by me for relaying wireless telegraph signals from the station X to the station Z by means of the relaying system Y is essentially the same as that described in the patent to Stone No. 717,510, dated Dec. 30, 1902, to which reference may be had. The wireless telegraph receiving system of the relaying system Y is attuned to the frequency of the waves transmitted by the wireless telegraph transmitting systems at the terminal stations X and Z, as indicated conventionally by the symbols R_{10} and T_{10}, R designating "receiving", T designating "transmitting" and 10 representing an arbitrarily chosen frequency. The wireless telegraph transmitting system of the relaying system Y is adapted to transmit waves of the frequency to which the wireless telegraph receiving systems at the terminal stations are attuned, as indicated by the symbols, T_5 and R_5 where T and R have the same significance as above and where 5 represents an arbitra-

rily chosen frequency different from that represented by 10.

It will now be understood that the sonorous circuits S C I_1 of the terminal stations X and Z, and the elevated conductor system V I_2 *s' o o'* E at said stations, as well as the resonant receiving circuit I_2''' C_2''' and the elevated receiving conductor system V_1 L_1 C_1''' I_1''' E_2' of the relaying system, are all attuned to the same frequency which as above stated is represented by the symbol 10. It will also be understood that the elevated receiving conductor systems V I_2 *s' o* L I_1'' C_1'' *o'* E and the resonant receiving circuits I_2'' C_2'' at the terminal stations, as well as the elevated conductor system V' E_2 and its associated sonorous circuit S_2 C_2 M_2 of the relaying system, are all attuned to the same frequency, being that frequency which is represented by the symbol 5 and which as above stated is different from that which is represented by the symbol 10. Still assuming that the switches N and U are closed, it will be understood in view of the foregoing that the waves radiated by the transmitting system at X are selectively absorbed by the receiving system of the relaying system Y and operate the oscillation detector P' thereby causing the energization of the relay 20. The energization of relay 20 causes the armature 21 to contact the front stop 22 of said relay and thereby closes the line I' through the battery B_3 and relay 23. The armature 24 of said relay 23 is attracted to its front stop 25 and thereby closes the primary power circuit including the alternator A_2 and the primary of the transformer M_2', thereby causing the energization of the transmitting system of the relaying system Y. The resulting electromagnetic waves radiated by said transmitting system are selectively absorbed by the receiving system at the terminal station Z, in which the key K normally is held in the position shown, and operate the oscillation detector P thereby creating current variations in the circuit of the telephone T. Similarly when the operator at station Z depresses his key K, the resulting electromagnetic waves are selectively absorbed by the receiving system of the relaying system Y, operate the wire telegraph line I', and cause the radiation of waves from the transmitting system of said relaying system, and the latter waves are selectively absorbed by the receiving system of the terminal station X thereby producing signals in the telephone T at said station.

If a receiving operator at either terminal station fails to understand a portion of a message, he immediately depresses his key K and signals "break", and the transmitting operator at the other station receives said signal in his telephone T between his own signal elements when his key is in normal position.

It is of course to be understood that the distance separating the terminal stations is too great to be bridged by the wireless transmission from the transmitting systems of either of the terminal stations, and that the relaying system is placed approximately midway between said terminal stations. For example, the station X may be situated on the outskirts of New York city, the transmitting and receiving systems of the relaying system may be situated on opposite sides of the city of New Haven, and the terminal station Z may be situated on the outskirts of Boston. It will be obvious that means should be provided in the wire line I' to take care of the traffic from New York to New Haven and vice versa and from Boston to New Haven and vice versa, and such means I provide in the form of the way station *y*. When the terminal stations are operated by means of the keys K this way station is provided with the apparatus shown in Fig. 2ª in which 26 is a front contact relay and 26' is a sounder whose hammer 29 is normally held against its up contact by means of the spring *i*. When the wire line I' is closed by the relay 20 the armature 27 closes the sounder circuit at the front contact 28', and when said relay 20 is deënergized the spring *h* draws the armature 27 against its back contact and permits the spring *i* to retract the hammer 29 to its normal position. Thus it will be seen that the hammer 29 follows synchronously the movements of the keys K. The key K'_1 at the way station *y* is a Morse key of the ordinary type grounded at E_4 through the battery B_4 and adapted to be connected to the line I' by throwing the switch 30 over on its contact 31. When the way station operator hears either New York or Boston calling New Haven, he closes the switch 30, opens his key and answers the calling station. The calling station then transmits the message which is received by the way station operator who may answer by manipulating his key thereby energizing the relay 23 and causing the radiation of signal waves from the elevated conductor system V' E_2. Obviously the way station operator can "break" the terminal station communicating with him and either terminal station can "break" the way station operator.

The wire telegraph stations *x* and *z* may be located at long distances from their respective wireless stations being connected therewith by the wire telegraph lines I, I, or they may be located in the same station house as said terminal stations X and Z, the lines I, I being short conductors. The advantage of employing the keys K' and short conductors I has been more fully explained in my application (Serial No. 305,260, filed simultaneously herewith) and is, that thereby backstroke-Morse wireless signals may be transmitted from the terminal stations and trans-

lated into front-stroke Morse at the end of the transmission system. As explained in said application it is practically impossible to locate a wireless station in a city, and therefore it will be seen that the wire telegraph stations x and z may be located in the cities above referred to and be connected with the wireless stations X and Z by means of the wire lines I, I. Under these circumstances the way station y will be provided with the apparatus shown in Fig. 2, which consists of the back contact relay 28 and the back stroke key K'_1, and the switches N and U at the terminal stations will be placed in the positions shown in Fig. 2. The operation is as follows:—If New York wishes to communicate with Boston, the operator at x opens his key K', thereby deënergizing the relay 11 and opening the circuit of the sounder 14, and also deënergizing the relay 2. The spring c draws the armature 12 of the relay 11 away from its front stop 13 and the spring d draws the hammer 15 of the sounder 14 against its up contact, while the spring d draws the armature 3 of the relay 2 against the front contact 4 and thereby closes the circuit of the battery B and magnet 1. The magnet 1 operates the key K and energizes the primary power circuit at station X thereby effecting the radiation of waves from the elevated conductor V. Said waves operate the oscillation detector P' and thereby result in the energization of relay 20 which closes the line I' through the battery B_3. The energization of the relay 26 thereby effected opens the circuit of the sounder 26' and permits the spring i to retract the hammer 29 against its up stop. The closure of said line through said battery also energizes the relay 23 and effects the radiation of waves from the elevated conductor system V' E_2 which waves operate the oscillation responder or receiver P at station Z and cause the energization of the relay 5. The armature 6 of said relay thereby is attracted against the tension of its spring e and cuts the resistance R' into the circuit I. The current in said circuit which includes the battery B', thereby is reduced sufficiently to permit the relay 11 to open the circuit of the sounder 14 (see details of relay 11 and sounder 14 at station x), but without operating relay 2, and the hammer 15 of said sounder thereby is drawn to its up contact. The sounders all along the transmission line are now in exactly the same condition as when a wire telegraph operator on an ordinary wire telegraph line opens his key. When the operator at x closes his key, the armatures 12 and 15 of the relay and sounder 11 and 14 at his own station and at the station z, as well as the armatures 27 and 29 of the relay and sounder 26 and 26' at the way station y, synchronously follow the movements of said key thereby producing front-stroke-Morse signals. If the way station operator wishes to "break" the terminal station operators he closes the switch 30 and signals "break" in the usual manner. As will be obvious, the way station operator may put himself into communication with either terminal station and the operators at x and z may "break" said way station operator in the usual manner. It will be obvious also that an operator at either terminal station x or z, may "break" the other through the intermediary of the wireless telegraph relaying system Y in the usual manner.

Referring to Fig. 1, the schematic view therein shown illustrates very simply the manner in which relayed wireless transmission may be effected between a wire telegraph terminal station x and a distant wire telegraph terminal station z through the intermediary of a wireless relaying system Y provided with a way station y.

In lieu of the resistance R' shunted around the terminals of the armature 6 and back contact 7 of the relay 5, I may substitute a continuity-preserving key of the usual type such for example as shown in Fig. 3, by means of which the resistance R' is normally shunted by the armature 6' and the spring tongue 7', so that the relay 11 normally holds the sounder circuit closed on the front contact 13. When the receiver P is operated and the relay 5 thereby energized, the resistance R' is cut into the circuit of the line I, the tongue 7' being forced against the screw 32 and thereby held out of contact with the armature 6'.

It will be obvious that many other continuity-preserving or hold-over devices may be employed to prevent the deënergization of the relay 2 and the consequent energization of the wireless transmitting system, during the operation of the receiving apparatus 11, and therefore I do not wish to limit myself to either of the devices which for the purpose of more fully disclosing my invention I have described somewhat in detail.

It will be obvious that any suitable means may be employed for associating the wireless and the wire telegraph systems hereinbefore described, such for example as the means disclosed in my application 305,261, filed simultaneously herewith.

I do not wish to be limited to the exact forms of apparatus and circuit arrangements herein disclosed, inasmuch as many modifications may be made therein by those skilled in the art without departing from the spirit of my invention.

I claim,

1. In a signaling system, a station comprising a wireless telegraph transmitting system adapted to transmit electromagnetic waves of one frequency and a wireless telegraph receiving system attuned to a different frequency; a two-way wireless telegraph re-

laying system located at a distance from said station and comprising a wireless telegraph receiving system attuned to the frequency of the waves developed by said transmitting system, a wireless telegraph transmitting system adapted to develop electromagnetic waves of the frequency to which the first mentioned receiving system is attuned, and a wire telegraph system operatively associated with the wireless telegraph systems of said relaying system; and another station located at a distance from said relaying system and comprising a wireless telegraph transmitting system adapted to develop electromagnetic waves of the frequency to which the wireless telegraph receiving system of said relaying system is attuned and a wireless telegraph receiving system attuned to the frequency of the waves developed by the wireless telegraph transmitting system of said relaying system.

2. In a signaling system, two terminal stations, each comprising a combined transmitting and receiving wireless telegraph system, both transmitting systems being adapted to develop electromagnetic waves of one frequency and both receiving systems being attuned to waves of another frequency, and an intermediate relaying system comprising a wireless telegraph receiving system attuned to the frequency of the waves developed by said transmitting systems, a wireless telegraph transmitting system adapted to develop waves of the frequency to which the terminal station receiving systems are attuned and a wire telegraph system operatively associated with the transmitting and receiving systems of said relaying system.

3. In a signaling system, two terminal stations, each station comprising a wireless telegraph transmitting system, both transmitting systems being adapted to develop electromagnetic waves of the same frequency, and each station comprising also a wireless telegraph receiving system, both receiving systems being attuned to the same frequency, being a frequency different from that of the waves developed by the aforesaid transmitting systems, in combination with an intermediate relaying system comprising a wireless telegraph receiving system attuned to the frequency of the waves developed by the transmitting systems at the terminal stations, a wireless telegraph transmitting system adapted to develop electromagnetic waves of the frequency to which the receiving systems at the terminal stations are attuned, and a wire telegraph system operatively associated with the wireless telegraph transmitting and receiving systems of said relaying system.

4. In a signaling system, two terminal wireless telegraph stations, an intermediate two-way wireless telegraph relaying system and a wire telegraph way station apparatus operatively connected with said relaying system.

5. In a signaling system, two terminal wireless telegraph stations; an intermediate two-way wireless telegraph relaying system comprising a wireless telegraph receiving system, a wireless telegraph transmitting system and a wire telegraph system operatively associated with said receiving and transmitting systems; and a wire telegraph transmitting and receiving apparatus associated with said wire telegraph systems.

6. In a signaling system, a combined transmitting and receiving wireless telegraph system at a station comprising a transmitting system adapted to develop electromagnetic waves of one frequency, a receiving system attuned to electromagnetic waves of a different frequency, an oscillation detector and a sending device arranged to render the oscillation detector inoperative during the operation of the transmitting system.

7. In a signaling system, a combined transmitting and receiving wireless telegraph system comprising a transmitting system adapted to develop electromagnetic waves of one frequency and including a sending device, and comprising also a receiving system attuned to electromagnetic waves of a different frequency and including an oscillation detector, in combination with means operated by said sending device for rendering said oscillation detector inoperative during the energization of said transmitting 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 receiving apparatus, means controlled by said wire telegraph system for operating said sending device and a continuity-preserving key controlled by said oscillation detector for operating said receiving apparatus without operating said sending device.

9. 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 a continuity-preserving key controlled by said receiving device for operating said wire telegraph system without operating said sending device.

10. In a signaling system, a wireless telegraph transmitting system and a wireless telegraph receiving system at a station, a wire telegraph system operatively associated with said wireless telegraph systems, a two-way wireless telegraph relaying system located at a distance from said station, a wireless telegraph transmitting system and a wireless telegraph receiving system at another station located at a distance from said

relaying system, and a wire telegraph system operatively associated with the last mentioned wireless telegraph systems.

11. In a signaling system, a combined transmitting and receiving wireless telegraph system at a station, a wire telegraph system operatively associated with said wireless telegraph system, a two-way wireless telegraph relaying system located at a distance from said station, a combined transmitting and receiving wireless telegraph system at another station located at a distance from said relaying system, and a wire telegraph system operatively associated with said last mentioned wireless telegraph system.

12. In a signaling system, two terminal stations each comprising a wireless telegraph transmitting and receiving system, wire telegraph systems associated respectively with the wireless telegraph system at said terminal stations, and an intermediate two-way wireless telegraph relaying system.

13. In a signaling system, two terminal stations each comprising a combined transmitting and receiving wireless telegraph system, wire telegraph systems operatively associated respectively with the said wireless telegraph systems at the said terminal stations, and an intermediate two-way wireless telegraph relaying system.

14. In a signaling system, two terminal stations each comprising a wireless telegraph transmitting and receiving system, wire telegraph systems associated respectively with the wireless telegraph systems at said terminal stations, an intermediate two-way wireless telegraph relaying system, and means whereby the terminal station operators may "break" through the intermediary of said wireless telegraph relaying system.

15. In a signaling system, two terminal stations each comprising a combined transmitting and receiving wireless telegraph system, wire telegraph systems operatively associated respectively with the wireless telegraph systems at said terminal stations, an intermediate two-way wireless telegraph relaying system, and means whereby the terminal station operators may "break" through the intermediary of said wireless telegraph relaying system.

16. In a signaling system, an intermediate two-way wireless telegraph relaying system, having in combination a wireless telegraph transmitting system adapted to develop electromagnetic waves of definite frequency, a wireless telegraph receiving system adapted to selectively absorb the energy of electromagnetic waves of different frequency, a wire telegraph system operatively associating said transmitting and receiving systems, and auxiliary apparatus associated with said wire telegraph system.

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

SEWALL CABOT.

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