No. 607,239. Patented July 12, 1898.

L. W. HILDBURGH.

TELEGRAPH.

(Application filed June 2, 1897.)

(No Model.) 3 Sheets—Sheet 1.

Fig. 1

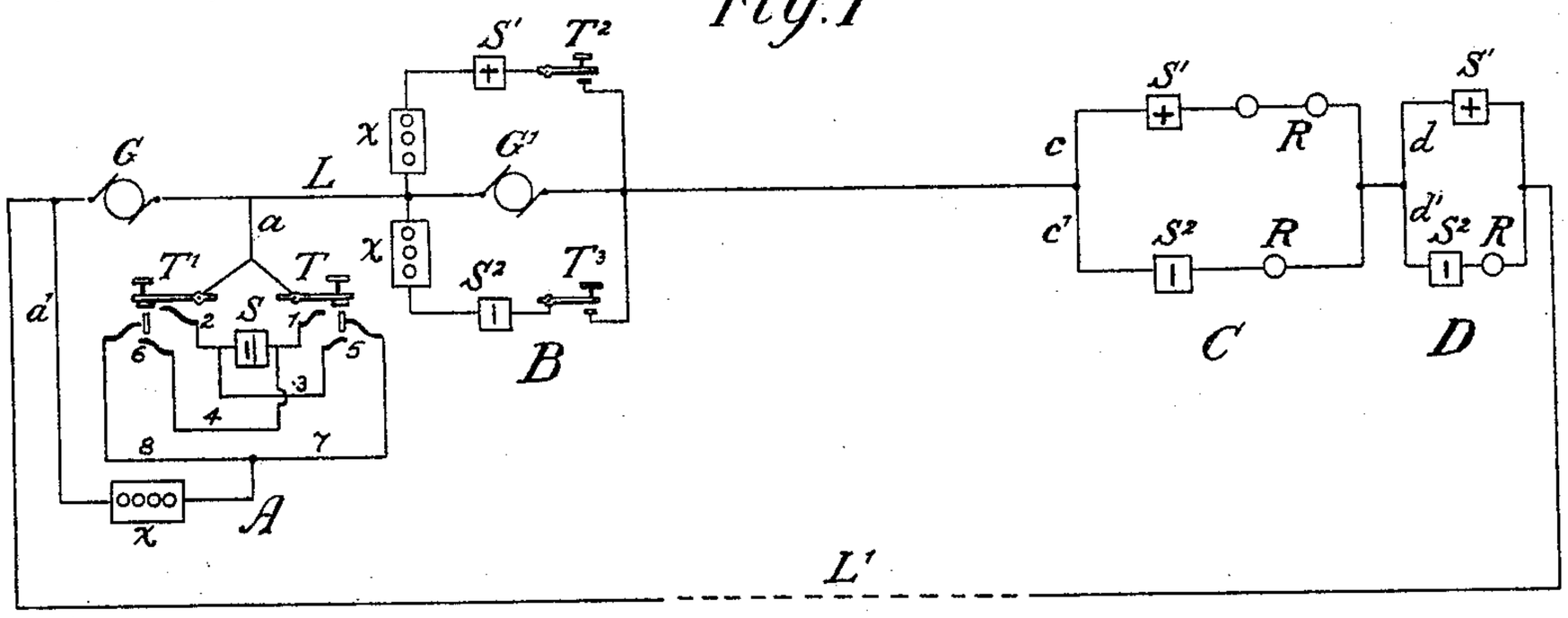


Fig. 2.

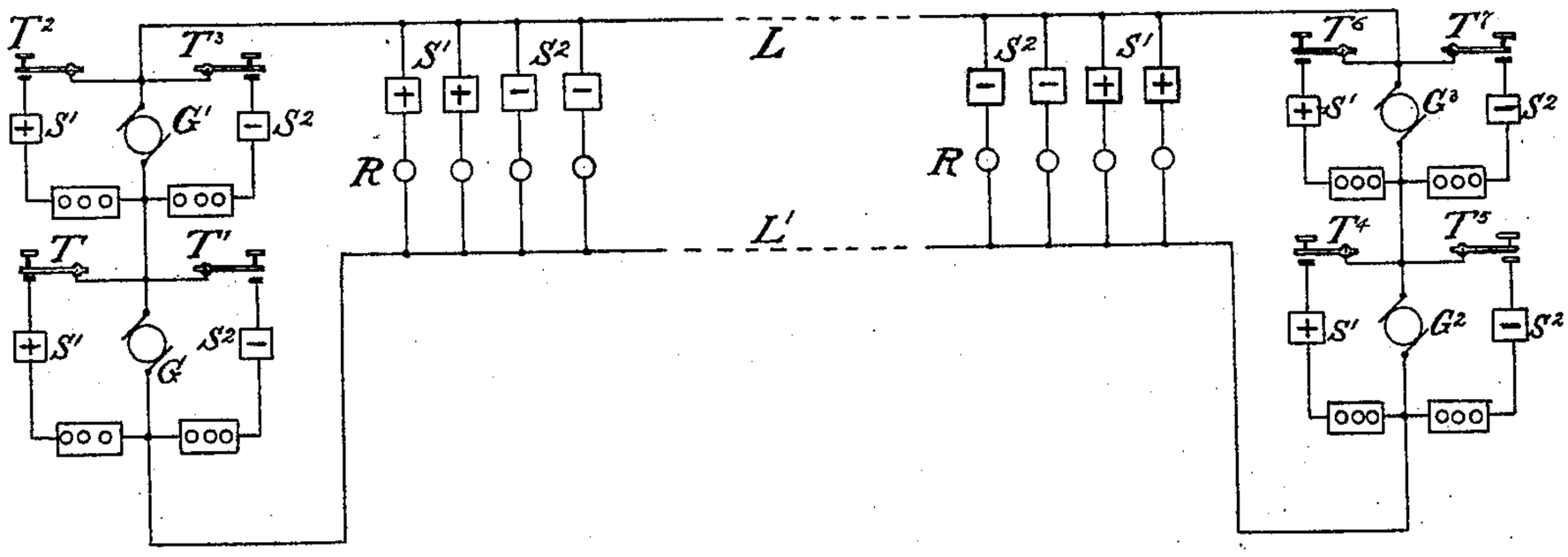
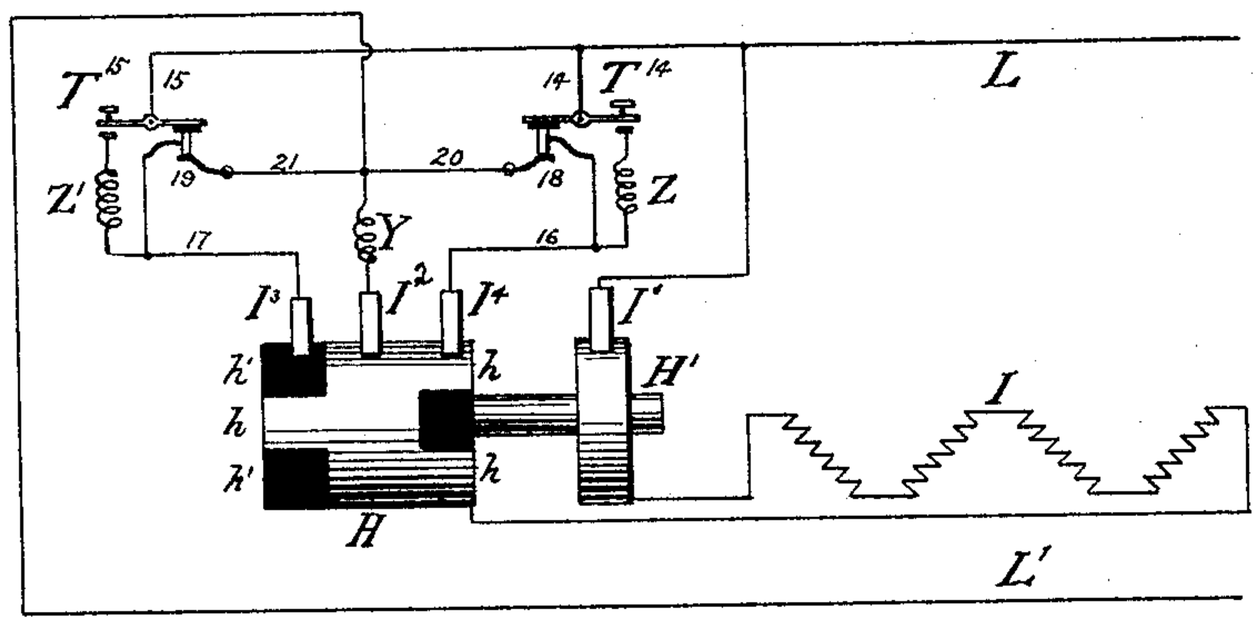


Fig. 9.



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(No Model.) 3 Sheets—Sheet 2.

Fig. 3.

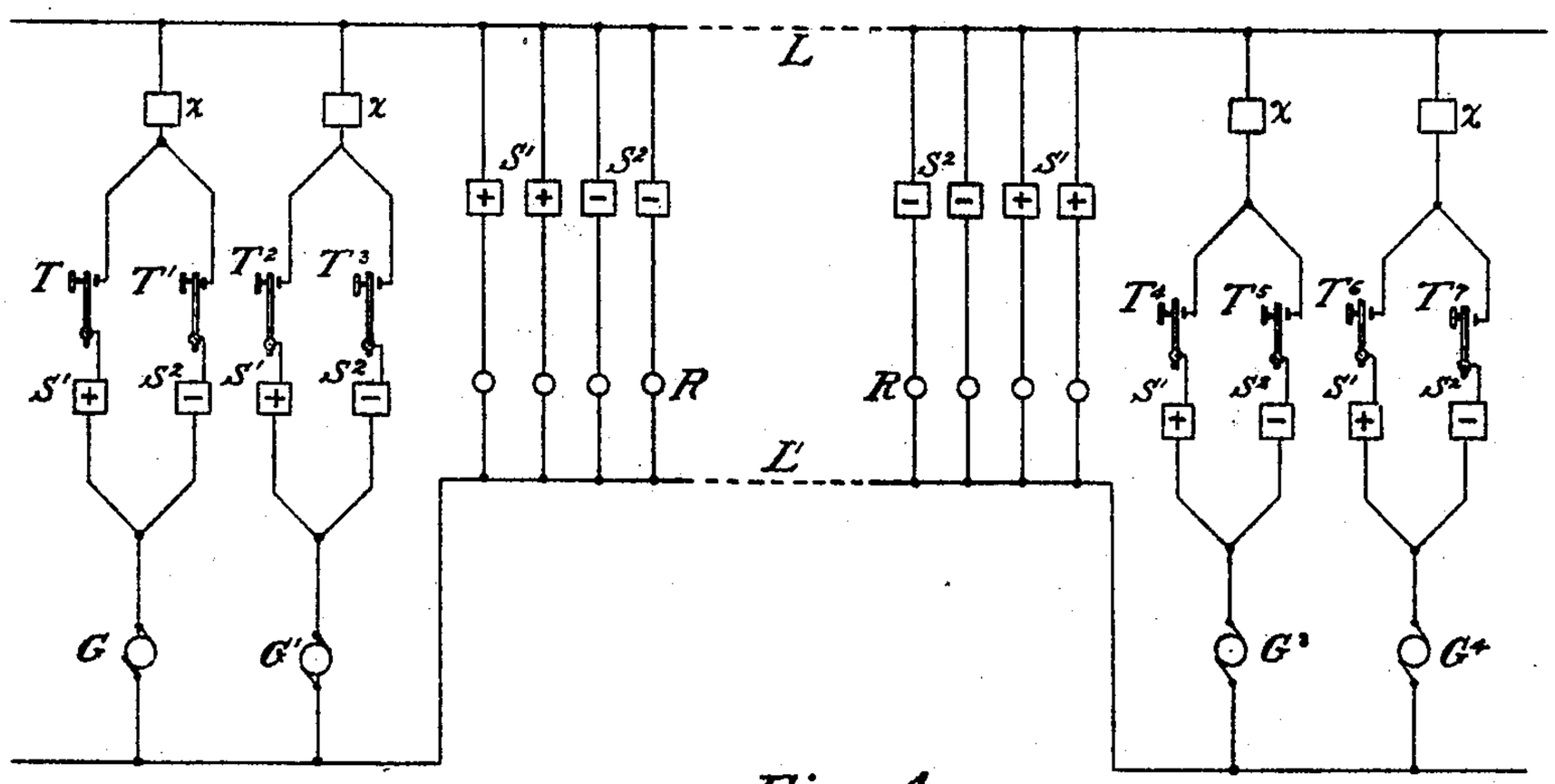


Fig. 4

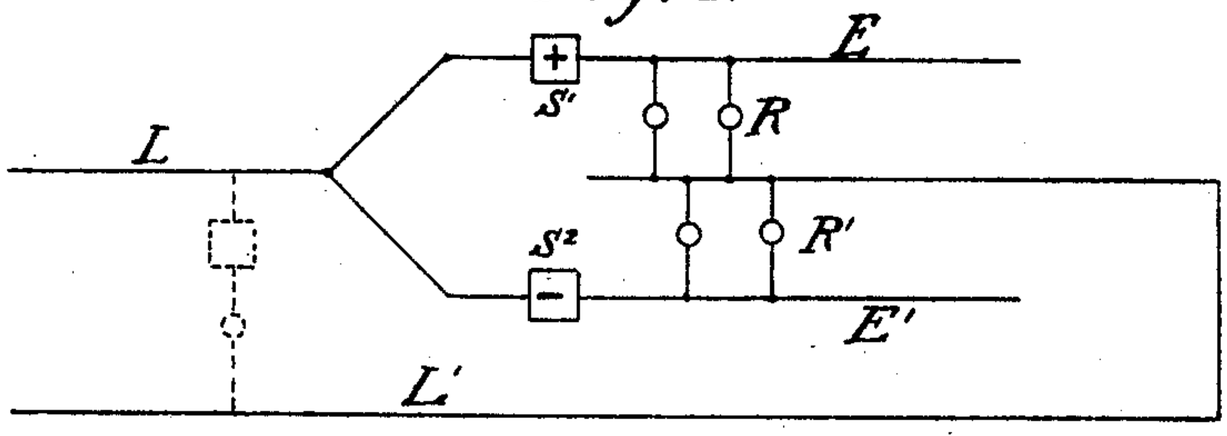


Fig. 5.

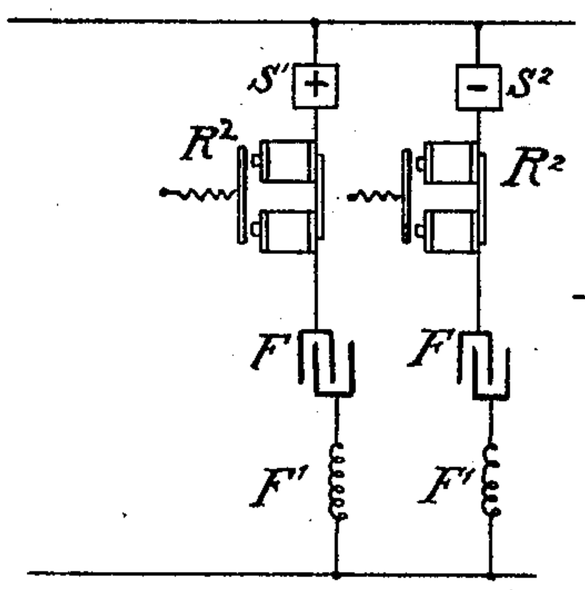
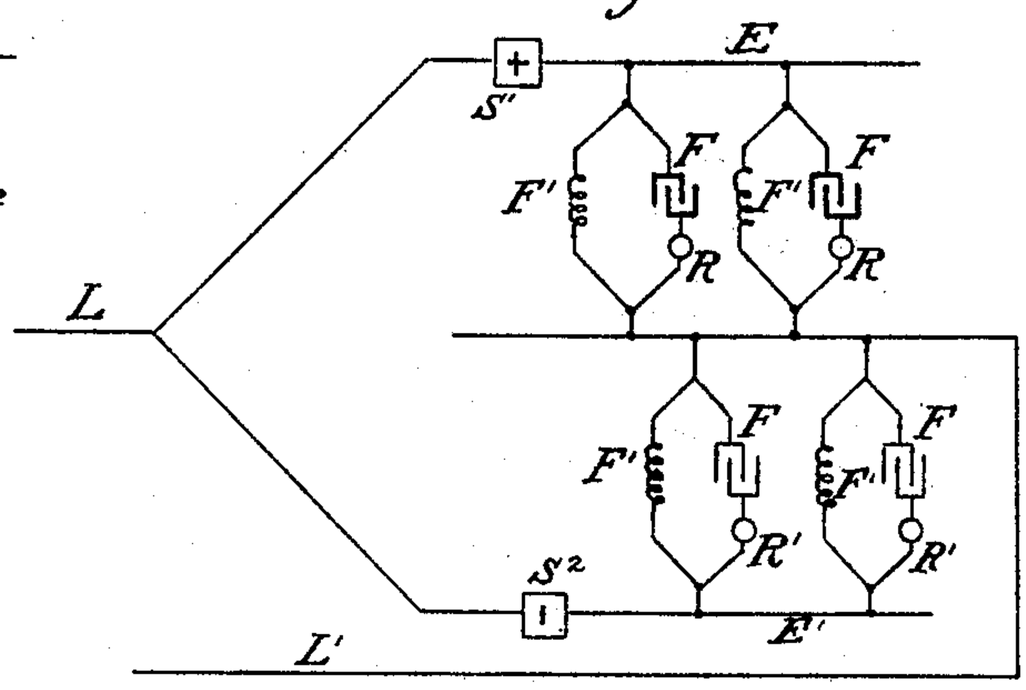


Fig. 6.



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TELEGRAPH.

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(No Model.) 3 Sheets—Sheet 3.

Fig. 7.

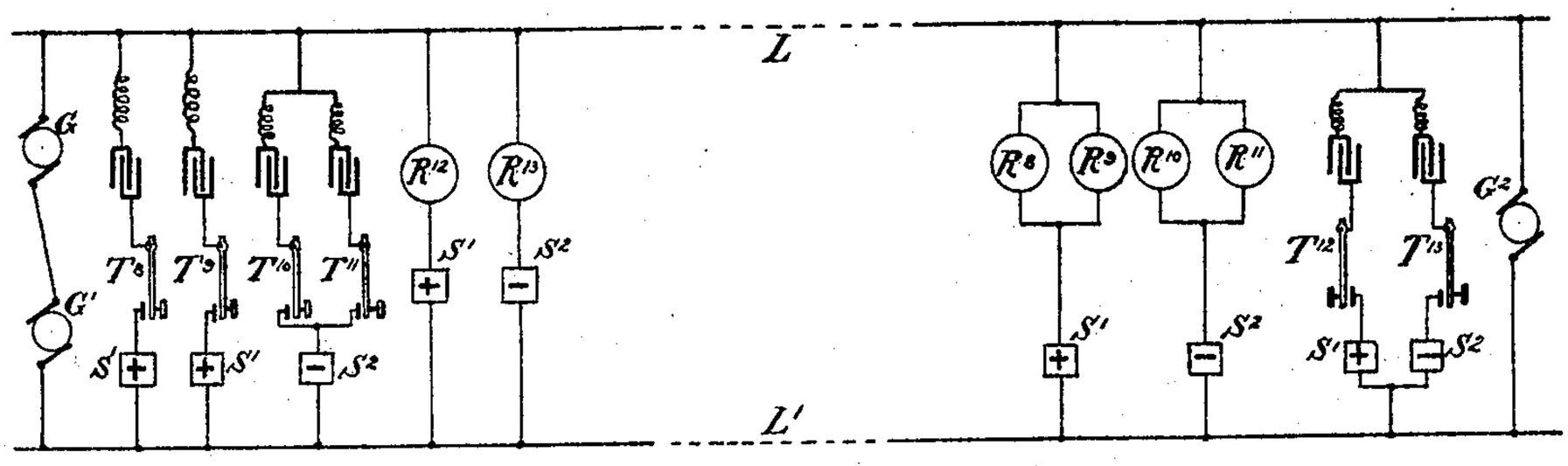
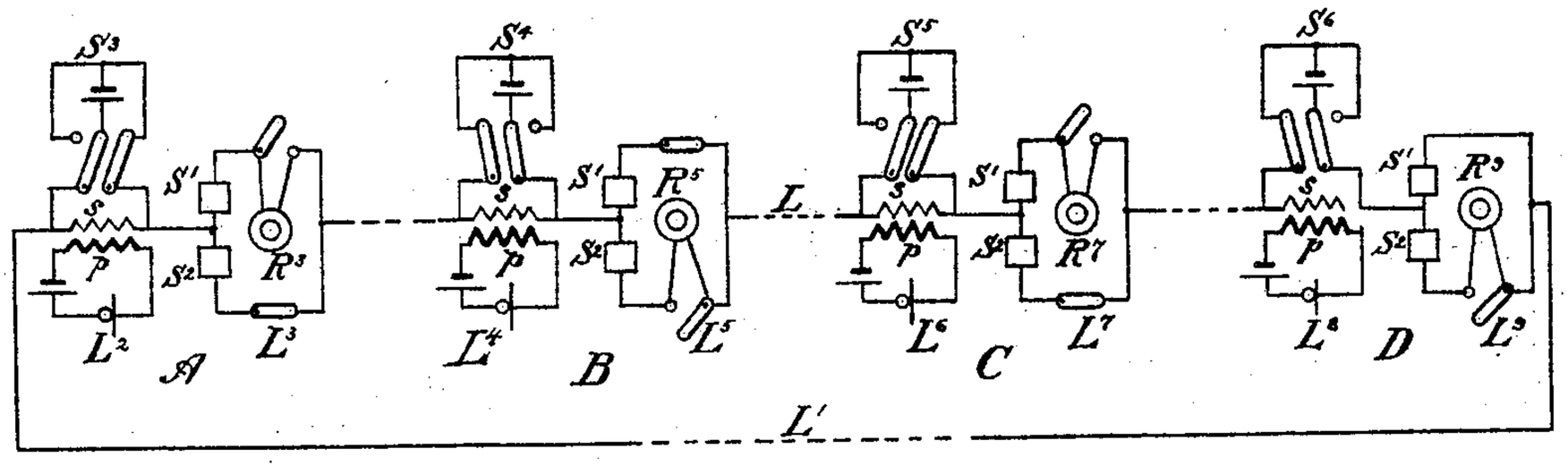


Fig. 8.



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UNITED STATES PATENT OFFICE.

LEO WALTER HILDBURGH, OF NEW YORK, N. Y.

TELEGRAPH.

SPECIFICATION forming part of Letters Patent No. 607,239, dated July 12, 1898.

Application filed June 2, 1897. Serial No. 639,189. (No model.)

To all whom it may concern:

Be it known that I, LEO WALTER HILDBURGH, a citizen of the United States, residing at New York city, in the county and State of New York, have invented a certain new and useful Improvement in Telegraphs, of which the following is a specification.

The object of my invention is to apply the principle of the separation of the positive and negative waves of an alternating current to harmonic telegraph systems.

In my Patent No. 571,948, issued November 24, 1896, I described a system of telegraphy in which alternating currents were employed for the simultaneous transmission of two or more messages in the same or opposite directions by separating the positive and negative waves, and each set of waves being employed for transmitting and receiving messages. My present system depends upon the separate control of the plus and minus waves of various frequencies admitted to the line in order that each set of waves shall affect only its own instruments.

In the accompanying drawings I have illustrated my invention in several forms.

Figure 1 is a diagram illustrating two transmitting-stations A and B and two receiving-stations C and D. In this illustration, for the purpose of avoiding repetition, I have shown the transmitting-stations of different forms. Fig. 2 is a diagram illustrating transmitting and receiving instruments at each end of the line, the generators being arranged in series. Fig. 3 is a diagram similar to Fig. 2, but showing the generators connected in parallel. Fig. 4 is a diagram illustrating a receiving-station at which the instruments are arranged in two groups, one group comprising the instruments affected by positive impulses only and the other group comprising the instruments affected by negative impulses, and a device for each group controlling the passage of the impulses. Thus a single device controls the passage of the impulses to all the receiving instruments of one group instead of employing such a device for each receiving instrument. Fig. 5 illustrates a method of receiving by electrical resonance, the instruments being connected in parallel. Fig. 6 illustrates a modification of the arrangement of Fig. 5 and applied to the receiving system of Fig. 4. Fig. 7 illustrates a system employing resonant transmitters and resonant receivers. Fig. 8 illustrates the application of my invention to a telephone system, and Fig. 9 illustrates a form of commutator which may be employed with the transmitters to control the passage of the positive and negative impulses to the line.

Referring to Fig. 1, A and B indicate two sets of transmitting instruments or stations, and C and D indicate two sets of receiving instruments or stations. At the transmitting-stations G and G′ represent alternating-current generators connected in series in the main line L and whose pulsations are of different frequency. The transmitting instruments are located in branches connected across the terminals of the generators, and these branches contain devices for controlling the passage of the positive and negative impulses to the line. By this arrangement when the transmitting instrument—a key, for instance—in one branch is closed one set of impulses will be short-circuited and the other set will pass to the line. At station A one device is employed for controlling the passage of the positive and negative impulses to the line, while at station B such a device is placed in each branch. These devices may be asymmetrical resistances or equivalent means. The circuit connections at station A are as follows: from line L by wire *a* to key T, contact and wire 1 to device S, wire 3, contacts 5, and wire 7, through resistance X and wire *a′* to the line. This branch will hereinafter be referred to as branch T, and it will be assumed that the closure of key T short-circuits the positive impulses, and the negative impulses pass to the line unaffected by the closure of that key. When key T is opened again, the positive impulses will again pass to the line, and thus in operating that key the positive impulses alternately pass to the line and around the branch T, the effect being equivalent to the opening and closing of a key in a simple telegraph-line. The circuit connections to the other branch at station A are as follows: from line L by wire *a* to key T′, contact and wire 2 to device S, wire 4, contacts 6, and wire 8, through resistance X and

wire a' to the line. This branch, hereinafter referred to as branch T', it will be assumed, controls the passage of the negative impulses to the line, and the action will be the same as with branch T. The resistance X is provided for the purpose of preventing injury to the generators upon closing the branches T or T'. If, for instance, the device S at station A is an asymmetric resistance, which permits positive impulses to pass through it in one direction and negative impulses in the opposite direction, it will be seen that the closure of key T will permit the positive impulses from the generator G to pass through the branch T and the device S to the other terminal of the generator, hence short-circuiting the positive impulses from the line, while the negative impulses pass to the line unaffected. If the key T' be closed, it will be seen that the negative impulses will pass through the loop T' and the device S and be short-circuited from the line, and the positive impulses will be unaffected and pass to the line. At station B the same effect is produced. At this station, however, two independent branches are connected across the terminals of the generator G'. One branch contains a resistance X, device S', and transmitter T^2. The other branch contains a resistance X, device S^2, and transmitter T^3. The devices S' and S^2 may be similar to the device S—that is, assymmetrical resistances or equivalent means—and the device S' is designed to permit the positive impulses to pass around the branch T^2, while the device S^2 is designed to permit the negative impulses to pass through the branch T^3. Thus the closing and opening of the branches T^2 and T^3 short-circuit, respectively, the positive and negative impulses from the line, the effect being, as before stated, the same as at station A. With either of the arrangements just described it will be seen that four messages may be transmitted over the line simultaneously and without interference, since the two sets of positive impulses will be of different frequency and the two sets of negative impulses will be of different frequency.

The receiving instruments in Fig. 1 are placed at two stations C D, and the instruments at each station are placed in two branches of the main line, (marked $c\,c'$ at station C and $d\,d'$ at station D.) The branches c and d contain devices S' for permitting the passage of the positive impulses from the transmitting-stations, and branches c' and d' contain devices S^2 for permitting the passage of the negative impulses only. The receiving instruments are indicated at R. It will be noticed that I have shown three receiving instruments at the station C and but one receiving instrument at station D. This is done simply to show the flexibility of the system, since it will be understood that one of the receivers in the branch c may be placed in the branch d or there may be a greater number of receivers, and it will be understood that the location and grouping of the receivers, as well as the transmitters, will of course be such as will meet the demands of the system.

In Fig. 2 I have illustrated two sets of transmitters at each end of the line and a set of receivers at each end. The generators G, G', G^2, and G^3 are in series, and the eight transmitting instruments T to T^7 are placed in branches around the terminals of the generators, as at station B of Fig. 1. The receiving instruments are connected in parallel, four at each end of the line, and each receiver is provided with a device S' or S^2 to control the passage of the proper impulses to the receivers R.

In Fig. 3 the generators G, G', G^2, and G^3 are connected in parallel across the line L L, and with each generator are connected two branches containing devices S' and S^2 and transmitting instruments T to T^7, inclusive. The receiving instruments R are connected in parallel across the line, each receiver being in series with a device S' or S^2, as in Fig. 2. In this illustration each branch from the generator is normally open, and the respective generators are thus disconnected from the line, so that the operation of the transmitter does not short-circuit any set of impulses, as in the arrangements of Figs. 1 and 2. The devices S' permit the passage of the positive impulses through their respective branches, and the devices S^2 control the passage of the negative impulses through their respective branches. With this arrangement it may be necessary to provide each transmitting-circuit with a device at x, which will permit only a current of a certain frequency to flow on that circuit, whereby the passage of the impulses from one generator through either of the other generator or transmitter circuits will be prevented.

In Fig. 4 I have illustrated two groups of receivers R and R', one group—those designed to be affected by the positive impulses—being connected between the branch conductor E and the return-circuit L' of the main line, and the other group—those designed to be affected by the negative impulses—being connected between the branch conductor E' and the return-conductor L'. The branch conductor E contains a device S' for permitting the passage of the positive impulses only to the group of receivers R, and the branch conductor E' contains the device S^2 for permitting the passage of the negative impulses only to the group of receivers R'. If additional receiving instruments are required, they may be connected between the branch conductors E E' and the conductor L' or they may be connected directly across the main line L L', as indicated in dotted lines. The arrangement of receivers illustrated in this figure may be applied to the systems of Figs. 1, 2, and 3, the receivers being all connected as indicated in Fig. 4 or partly connected as in the other figures and partly connected as in Fig. 4.

In Fig. 5 I have illustrated the receiving instruments arranged to operate by electrical resonance. S′ and S^2 indicate the devices for controlling the passage of the positive and negative impulses, respectively. R^2 indicate the receiving instruments. In series with these instruments are connected the condensers F and any suitable form of inductance F′, the functions of which are well understood.

In Fig. 6 I have shown a modified arrangement of the receivers operating by electrical resonance applied to the receiving systems of Fig. 4. In this illustration E and E′ are the two branch conductors, as in Fig. 4, and S′ and S^2 are the devices for controlling the passage of the positive and negative impulses, respectively. R indicates the receivers connected between the branch conductor E and the main-line conductor L′, and R′ indicates the receivers connected between the branch conductor E′ and the main conductor L′. The condensers are shown at F and the inductance at F′.

In Fig. 7 is shown a system employing both resonant transmitting and receiving instruments. Three generators G, G′, and G^2 are shown connected in series and each of different frequency. Six transmitter-circuits are shown, and each is provided with means for adjusting for inductance and capacity. The transmitting instruments are illustrated as keys T^8 to T^{13}. The transmitter-circuits T^8 and T^9 are provided with devices S′ for permitting the flow of positive impulses from the generators G and G′, respectively, and the closure of those keys short-circuits from the main line the two sets of positive impulses from the generators G and G′. Transmitter-circuits T^{10} and T^{11} are provided with a single device S^2 for permitting the flow of negative impulses from generators G and G′, and the closure of those keys short-circuits from the main line the two sets of negative impulses from the generators G and G′. Separate devices S^2 may be employed for the circuits T^{10} and T^{11}, if desired, a single device being shown in this instance merely to illustrate another way of connecting the instruments. Another way of connecting the transmitters is shown at transmitter-circuits T^{12} and T^{13}, where separate devices S′ and S^2 are employed for controlling the passage of the impulses, circuit T^{12} receiving the positive impulses and circuit T^{13} receiving the negative impulses. Transmitters T^{12} and T^{13} control, respectively, the flow to the main line of the positive and negative impulses from generator G^2. R^8 to R^{13} represent resonant receiving instruments. Instruments R^{12} and R^{13} are shown connected in separate receiving-circuits and provided, respectively, with devices S′ and S^2 for permitting the flow of positive and negative impulses from generator G^2, and which impulses are controlled, respectively, by transmitters T^{12} and T^{13}. Receiving instruments R^8 and R^9 receive the positive impulses of different frequency from the two generators G and G′, controlled by transmitters T^8 and T^9. A single device S′ is shown for controlling the flow of the positive impulses to receivers R^8 and R^9, although one of these devices may be employed for each receiver. Receivers R^{10} and R^{11} are connected in the same manner as receivers R^8 and R^9, and a single device S^2 is shown for controlling the flow of the negative impulses of different frequency from the generators G and G′, controlled by transmitters T^{10} and T^{11}.

In the telegraph system the device for controlling the passage of the positive and negative impulses to the main line may be a mechanical device—such, for instance, as the commutator illustrated in Fig. 9. In this illustration L and L′ indicate the main line. H and H′ may be the collecting-rings of a generator, and I represents the generator-winding. The collecting-rings may be carried by the armature-shaft or by a separate shaft geared to the armature-shaft, and in either case the ring H will be made adjustable on the shaft, in order to adjust for changes in the phase of the current from generator I. Ring H′ has a continuous contact-surface, while ring H is notched at both ends, a section of insulation being inserted at the notches, so that metal surfaces *h* and insulating-surface *h′* will alternate, as shown. The generator-winding is connected to the rings H and H′. A brush I′ makes contact with ring H′, from which extends the main line L. A brush I^2 makes contact with the continuous metal surface of ring H, to which brush the other main conductor L′ is connected through a resistance Y. The transmitting instruments or keys are shown at T^{14} and T^{15}, which are connected to the main line L by wires 14 and 15, respectively. The main circuit is always closed from the main line L through brush I′, ring H′, generator-coils I, ring H, brush I^2, to main L′, through resistance Y. The operation of the transmitters T^{14} and T^{15} produces the same results as the operation of transmitters T and T′ of Fig. 1. The path of the current when both keys are open is from line L to brush I′, ring H′, generator-coils I, commutator II, and from commutator II the current passes to line L′ through two parallel circuits, one including brush I^2 and resistance Y and the other including brush I^4, wire 16, contacts 18, and wire 20 at one instant and at the next instant brush I^3, wire 17, contacts 19, and wire 21, due to the alternate makes and breaks at brushes I^3 and I^4. Contacts 18 and 19 are spring-contacts, which are held closed by the insulated rear ends of the keys and which contacts will open when the keys are closed. If key T^{14} affects the positive impulses and T^{15} the negative impulses, the path of the impulses when the keys are closed will be as follows: When key T^{14} is closed, the path of the line-current at one instant will be line L, brush I′, ring H′, generator-coils I, ring H, and in parallel through brush I^2 and resist-

ance Y, and brush I^3, wire 17, contacts 19, wire 21, line L'. The next instant the path of the line-current will be line L, wire 14, key T^{14}, resistance Z, wire 16, brush I^4, ring II, brush I^2, resistance Y, line L'. The positive impulses will be short-circuited by key T^{14}, and at those instants the line-current will divide between the generator-coils and the circuit, including wire 14, key T^{14}, resistance Z, wire 16, brush I^4; but the line-resistance will not change, because the resistance of Y will make the total resistance from line L to L' when Z and I are in parallel and Y in series the same as the resistance of coils I alone. When key T^{15} is closed, the path of the line-current at one instant will be main line, brush I', ring II', generator-coils I, ring II, and in parallel through brush I^2 and resistance Y, and brush I^4, wire 16, contacts 18, wire 20, line L'. The next instant the path of the line-current will be line L, wire 15, key T^{15}, resistance Z', wire 17, brush I^3, ring II, brush I^2, resistance Y, line L'. The negative impulses will be short-circuited by key T^{15}, and the effect will be similar to that produced by the operation of key T^{14}. When both keys are closed, the generator-waves will be continuously shut out from the circuit. Thus by the arrangement of Fig. 9 the main line is never opened, the resistance is maintained constant, and the positive and negative impulses from the generator may be short-circuited from the line at will.

In the telephone system illustrated in Fig. 8 I have shown four telephone sets or stations A, B, C, and D. These sets comprise, respectively, local transmitter-circuits L^2, L^4, L^6, and L^8, local receiver-circuits L^3, L^5, L^7, and L^9, and local circuits containing asymmetrical resistances or equivalent devices S^3, S^4, S^5, and S^6 for short-circuiting either the positive or the negative waves of the alternating current produced by induction-coils p s, and each of the last-named local circuits is provided with a reversing-switch, so that the connections of the devices S^3, &c., may be reversed and control the passage of either the positive or the negative waves over the main line. The local receiver-circuits are arranged in two branches, in either of which branches the receivers R^3, R^5, R^7, and R^9 may be connected. The receiver branches are provided with devices S' and S^2 for controlling, respectively, the passage of the positive and negative waves.

With the connections as in Fig. 8 station A may communicate with station C and station B may communicate with station D. When the transmitting-diaphragm at station A is vibrated, the negative waves of the alternating current from the induction-coil will flow around the local circuit containing asymmetrical resistance S^3 and the positive waves will flow through the branch of the local circuit L^3 containing the device S', which device allows the positive waves from transmitter L^2 to pass through receiver R^3 and along the line and through the branch of the local circuit L^5 containing device S', and then along the line to receiver R^7 at station C. The same action takes place at station B when the diaphragm in local circuit L^4 is vibrated, except that the switch in the local circuit containing device S^4 is reversed and the positive waves will flow around that local circuit and the negative waves pass over the line to receiver R^9, the path being through the branches of the local receiver-circuits L^5, L^7, and L^9 containing devices S^2, which permit only negative waves to flow in those circuits. The switches in the local circuits containing devices S^5 and S^6 at stations C and D are adjusted so that the positive and negative waves from the transmitter-circuits L^6 and L^8, respectively, will pass over the line, and those waves will affect the distant receivers R^3 and R^5, respectively. If station A desires to communicate with station B, receiver R^3 is connected in the other branch of the local receiver-circuit L^3 and the reversing-switch for device S^3 is shifted so that the positive waves from station A will be short-circuited from the line. The connections at other stations will be similarly changed to communicate with different stations, and thus it will be seen that any pair of stations may communicate with each other without interference.

The telephone system may be extended to include a greater number of stations by applying arrangements similar to those employed in connection with the herein-described telegraph systems employing resonant circuits.

The devices employed for controlling the flow of the positive and negative waves to the line may be arranged to short-circuit all the waves of one set from the line when the transmitting instruments are operated, or such devices may be arranged to only partially short-circuit the waves of one set from the line, without departing from the spirit of my invention.

What I claim is—

1. In a system of electrical communication, the combination with a main line and a source of alternating current therefor, of means for controlling the flow of the positive and negative impulses from the generator by short-circuiting one set of impulses at the time of generation of either set of waves, the other set being unaffected, substantially as set forth.

2. In a system of electrical communication, the combination with a main line and a source of alternating current therefor, of means for controlling the flow of the positive and negative impulses from the generator, said means being located at or near the generator, and means for maintaining the line resistance, substantially as set forth.

3. In a system of electrical communication, the combination with a main line, of two or more generators generating alternating currents of different frequencies, two branch circuits connected across the terminals of each

generator, transmitting instruments located in each branch, and means for separately controlling the flow of the positive and negative impulses from each generator over the line to receiving instruments, substantially as set forth.

4. In a system of electrical communication, the combination with a main line, of two or more generators generating alternating currents of different frequencies, two branch circuits connected across the terminals of each generator, transmitting instruments located in each branch, and a device in each branch for causing a set of impulses of one sign to pass over the branch in which such device is located when the transmitting instrument is closed, thereby short-circuiting that set of impulses from the line, substantially as set forth.

5. In a system of electrical communication, the combination with a main line and a source of alternating current therefor, of a device combined with transmitting instruments for controlling the flow of the positive and negative impulses from the generator over the main line by causing one set of impulses to flow through a branch circuit, the other set being unaffected and allowed to pass over the main line, substantially as set forth.

6. In a system of harmonic telegraphy, the combination with a main line, of two or more generators generating alternating currents of different frequencies, transmitting instruments for controlling the flow of the positive and negative impulses over the line, each transmitting instrument being arranged to short-circuit the impulses of a given sign and frequency, substantially as set forth.

7. In a system of harmonic telegraphy, the combination with a main line, of two or more generators generating alternating currents of different frequencies, transmitting instruments for controlling the flow of the positive and negative impulses over the line, each transmitting instrument being arranged to short-circuit the impulses of a given sign and frequency, and a series of receiving instruments each adapted to receive impulses of a given sign and frequency, substantially as set forth.

8. In a system of electrical communication, the combination with a main line, of two or more generators connected in series and generating alternating currents of different frequencies, means for controlling the passage of the positive and negative impulses from each generator over the line, a transmitting instrument for each set of impulses of a given sign and frequency, and a series of receiving instruments connected in parallel and each arranged to receive impulses of a given sign and frequency, substantially as set forth.

9. In a system of electrical communication, the combination with a main line, of two or more generators connected in series and generating alternating currents of different frequencies, branch circuits connected across the terminals of each generator, means located in each branch for controlling the passage of the positive and negative impulses from each generator over the line, transmitting instruments in each branch, and a series of receiving instruments connected in parallel and each arranged to receive impulses of a given sign and frequency, substantially as set forth.

This specification signed and witnessed this 17th day of May, 1897.

LEO WALTER HILDBURGH.

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