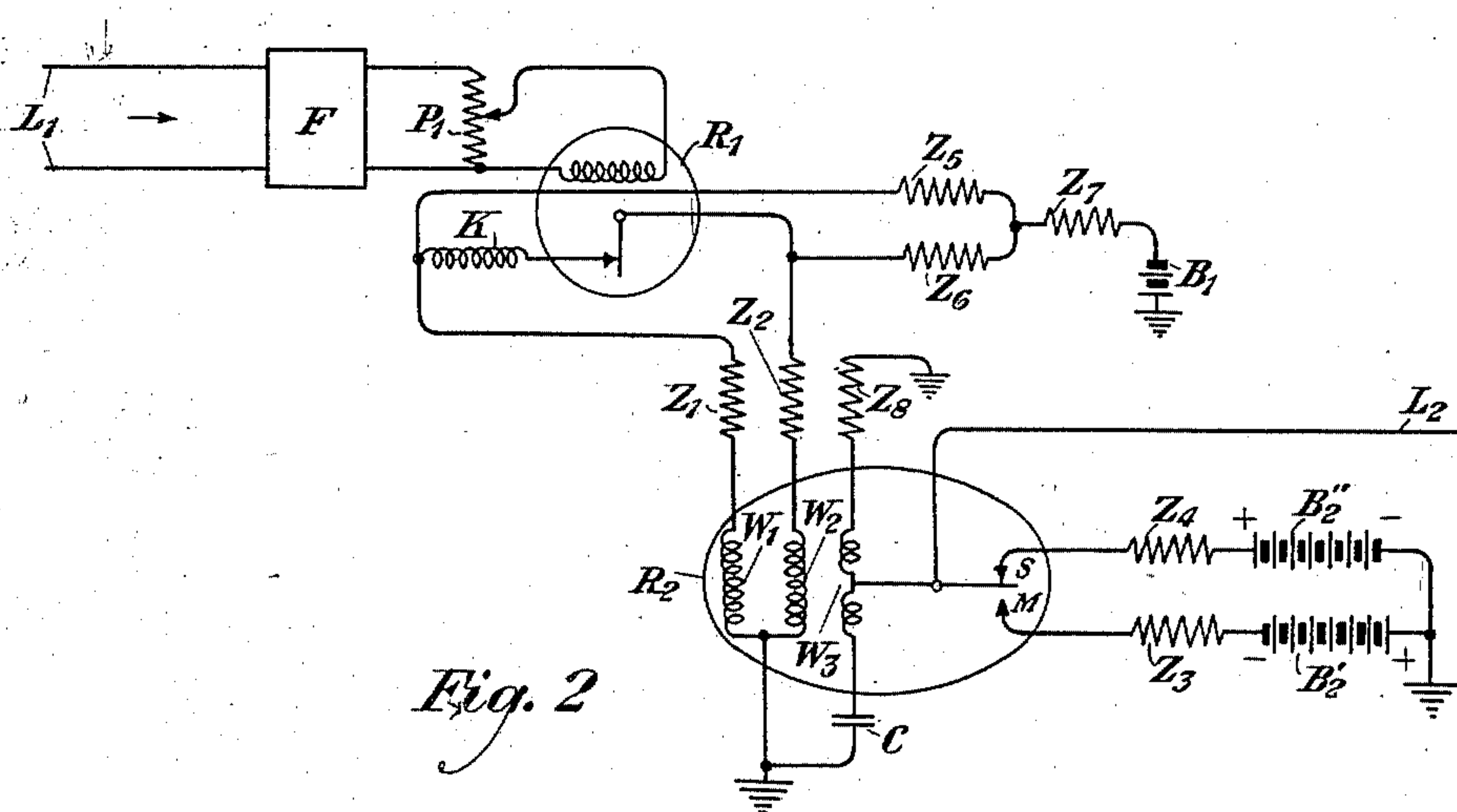
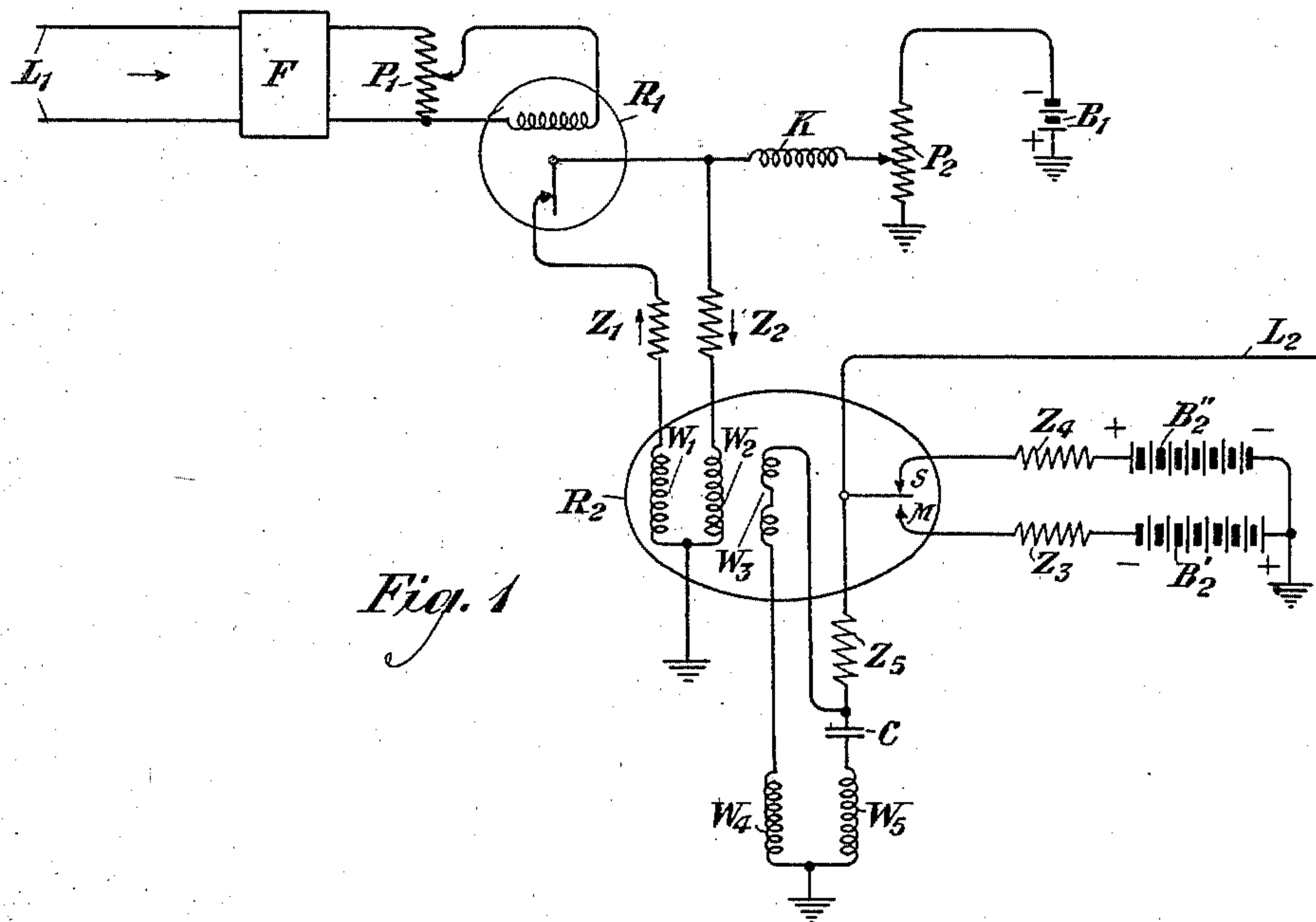


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F. J. SINGER
TRANSMISSION SYSTEM

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TRANSMISSION SYSTEM

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This invention relates to telegraph transmission, receiving and signaling systems. More particularly, this invention relates to arrangements for converting pulses or pulsations of alternating current into corresponding direct current pulses or pulsations. Still more particularly, this invention relates to arrangements interconnecting an alternating current relay, the winding of which is energized with pulses or pulsations of alternating current, and a direct current relay, the armature of which is to control the operation of a telegraph line or other signaling circuit so that pulses or pulsations of direct current may be transmitted over the telegraph line or other signaling circuit in accordance with the pulses or pulsations of alternating current energizing the winding of the alternating current relay.

Heretofore, pulses or pulsations of alternating current, which may be characteristic of telegraphy, or of other signals, were transmitted over an electrical circuit, one of these pulses or pulsations representing, for example, a marking signal, and the absence of that pulse or pulsation, a spacing signal. At the distant or receiving terminal of the system, an amplifier, frequently of the vacuum tube type, was employed for the purpose of amplifying these alternating current pulsations. Coupled to the amplifier there was a detector, frequently also of the vacuum tube type, this detector being employed to rectify the received and amplified pulsations and to transform these pulsations into corresponding direct current pulsations. It was also the practice to so relate a direct current relay to the output of the detector or rectifier that the armature of this relay might move back and forth between its contacts and thereby control and operate another electrical circuit, which may, for example, be a telegraph loop. Such an arrangement is well known to be quite expensive in its first cost as well as in its operating charges. It is proposed to substitute for the amplifier, detector or rectifier, etc., a relay system which may include an alternating current relay upon the winding of which may be impressed high frequency signals which may

be merely alternating current pulsations, and a direct current relay properly related and connected to the alternating current relay, so that the armature of the direct current relay may control the operation of another circuit which may be the above mentioned telegraph loop.

Thus, it is one of the objects of this invention to provide a receiving circuit for receiving and/or detecting modulated high frequency signals substantially without distortion and not necessarily including vacuum tube circuits.

Another of the objects of this invention is to properly interconnect a tuned, sensitive alternating current relay which may be energized by alternating current pulses, and a direct current relay controlling a receiving circuit, so that the direct current relay may control the transmission of pulses of direct current to the receiving circuit corresponding to the impressed alternating current pulses.

A further object of this invention is to provide a receiving circuit which may include a direct current relay, the windings of which may become energized by low voltage currents, which may be signaling currents, and the armature of which may control the transmission of higher voltage currents to the receiving circuit, or conversely, a similar arrangement may be employed in which the voltages of the respective currents are inverted in their relative magnitudes.

And it is a still further object of this invention to combine an alternating current relay, the armature of which may vibrate at a definite periodicity when alternating current of corresponding frequency is impressed upon the winding of that relay, and the armature of which is to remain fixed against one of its contacts when no current is impressed upon the winding of the relay, with means to prevent the armature of that relay from remaining connected with one of its contacts for a prolonged period of time when alternating current of the desired frequency is energizing that relay. Thus, a receiving relay may be so related to the system that its armature may faithfully repro-

duce any signals which may be modulated upon carrier current sent from the distant station.

While this invention will be pointed out with particularity in the appended claims, the invention itself, both as to its further objects and features, may be better understood from the detailed description hereinafter following, when read in connection with the accompanying drawing, in which Figure 1 represents one embodiment of the invention, including an alternating current relay upon the winding of which pulsations of alternating current may be impressed, and a direct current relay the armature of which vibrates in accordance with the signals represented by the alternating current pulsations; and Fig. 2 represents a modification of the arrangement shown in Fig. 1.

Referring to the drawing, L_1 designates an electrical circuit over which may flow alternating current pulsations. These alternating current pulsations may, for example, be produced by an alternating current generator, the output of which is interrupted at more or less regular intervals so that these pulsations may be characteristic of signals such as are employed in telegraph signaling systems. These pulsations may become impressed upon a filter F , which may be of any well-known type, preferably a band pass filter of the type disclosed in Campbell Patent 1,227,113, dated May 7, 1917. Thus, this band pass filter may freely transmit alternating current, or currents, of frequencies which are quite close to the frequency of the generator employed at the transmitting terminal of the system. It will be understood, however, that in practice the employment of the filter may not be deemed necessary, and this is especially so if the alternating current relay receiving the alternating current pulsations is tuned to the particular frequency of the generator.

The filter F is connected to a potentiometer P_1 so that the voltage of the current transmitted thereby may be controlled as found necessary. These pulsations are then impressed upon the winding of an alternating current relay R_1 , the armature of which may vibrate substantially in accordance with the frequency of the current of each pulsation, this current being frequently designated carrier current. Relay R_1 is preferably a highly tuned polar relay. Its armature may preferably be biased against its contact. Thus, this armature may be made to normally close its contact by attaching a spring, for example, thereto, or it may be biased magnetically or electromagnetically, or gravitationally due to its weight, or in any other well-known manner.

The reference character R_2 designates the direct current relay having two operating windings W_1 and W_2 , and a third winding

W_3 , which may form part of a so-called vibrating circuit. It will be apparent that the windings of the direct current relay may be coupled to one another so that the magnetic field established by the current flowing through these windings may tend to move the armature of the direct current relay back and forth between its contacts S and M . A battery B_1 may be employed to energize the operating windings of the direct current relay. In series with battery B_1 there is the resistance element of a potentiometer P_2 so arranged that the entire battery potential is impressed upon the terminals of the potentiometer. The slidable contact of potentiometer P_2 may be manipulated so as to make any portion of the potential of battery B_1 available. Accordingly, the magnitude of the potential to be impressed upon the operating windings of the direct current relay and upon the armature and contact of the alternating current relay may be decreased to any desired value. A choke coil K is interposed between the slidable contact of the potentiometer P_2 and the contact of the armature of the alternating current relay r_1 . The operating winding W_1 of the relay R_2 is connected in series with the armature of relay R_1 and its contact as well as with a resistance Z_1 . The other of the operating windings W_2 of relay R_2 , is connected in series with another resistance Z_2 . Thus, the current derived from battery B_1 also flows through the choke coil K and through parallel paths, one of which includes winding W_1 , resistance Z_1 and the armature of relay R_1 and its contact, and the other of which includes the winding W_2 and resistance Z_2 .

It will thus be apparent that as the armature of relay R_1 vibrates in accordance with the frequency of an impressed carrier current, pulses will be received by the operating windings W_1 and W_2 of the direct current relay R_2 , these pulses corresponding to the number of times the armature of relay R_1 closes its contact and not necessarily corresponding to the frequency of vibration of the armature. It will also be apparent that windings W_1 and W_2 are preferably oppositely poled so that the magnetic field established by one of these windings may cause the armature of relay R_2 to move towards one of its contacts, while the magnetic field established by the other of these windings may cause that armature to move to the other of its contacts. Moreover, the resistances Z_1 and Z_2 may be so proportioned that the magnetic field established by one of the windings is considerably greater than the magnetic field established by the other of the windings, so that when current flows through both windings, the armature of relay R_2 will be held in position against a particular one of its contacts. For example, resistances Z_1 and Z_2 may be so proportioned that the current

flowing through the winding W_1 , and, consequently, the magnetic field established thereby, may be twice as great as the current flowing through the winding W_2 and the magnetic field established thereby, and, since the effect of winding W_1 is, therefore, greater than that of W_2 , the armature will be caused to close contact S. Obviously, when the armature of relay R_1 does not close its contact, no current will flow through winding W_1 , and therefore winding W_2 will effectively cause the armature of relay R_2 to close contact M.

A circuit, which may be a local circuit, a telegraph loop, or any other circuit, is designated by the reference character L_2 . This circuit is shown under the control of the armature of relay R_2 . Contact M may be connected in series with a battery B'_2 through a resistance Z_3 , while contact S may be connected through a resistance Z_4 to a battery B''_2 which may be of the same potential as battery B'_2 but of opposite polarity. Thus, as the armature of relay R_2 moves back and forth between its contacts, current may flow over line L_2 from either of the batteries B'_2 or B''_2 .

Winding W_3 of relay R_2 may be connected in a so-called "vibrating circuit," the operation of which will be described later. This circuit is shown in Fig. 1 to include windings W_4 and W_5 which may be inductively coupled to each other, and which may form the primary and secondary windings of a transformer, a condenser C and winding W_3 of relay R_2 . Line L_2 is connected to ground through a resistance Z_5 , condenser C and winding W_5 .

It will also be apparent that the potential of battery B_1 may be substantially different from the potential, or potentials, of batteries B'_2 and B''_2 and that the potential of battery B_1 may, if desired, be substantially lower than the potential, or potentials, of batteries B'_2 and B''_2 . Accordingly, current of substantially low voltage may flow through the operating windings W_1 and W_2 of relay R_2 and through the armature and contact of relay R_1 , while current of substantially higher voltage may be supplied to the line L_2 . It will be understood, however, that the relative magnitudes of these voltages may be reversed so that the voltage of the current flowing through the operating windings of relay R_2 may be higher than the voltage of the current with which line L_2 is supplied.

When a distant station may be sending a specific signal, such, for example, as a telegraph spacing signal, no alternating current will flow through the winding of the relay R_1 , so that its armature may close the associated contact. Current will then flow through the windings W_1 and W_2 of relay R_2 , this current being derived from battery B_1 , the magnitude of the effective voltage of this current

being controlled by the slidable contact of potentiometer P_2 . As has already been stated, the current through winding W_1 , which is poled in opposition to winding W_2 , will cause the armature of relay R_2 to close its spacing contact S. It will be clear that the resistances Z_1 and Z_2 , as well as the resistance of the potentiometer P_2 , may be so proportioned that the voltage across the armature of relay R_1 and its contact is less than a predetermined value. Accordingly, sparking at its contact may be practically eliminated. And when the armature of relay R_1 remains fixed against its contact, the armature of relay R_2 will be similarly fixed against contact S.

When the distant station may be transmitting a telegraph marking signal, alternating current will flow over line L_1 through filter F, potentiometer P_1 and the winding of relay R_1 , causing its armature to vibrate thereby. As the armature of relay R_1 vibrates, the circuit through winding W_1 may become opened and closed periodically, while the circuit through winding W_2 remains closed. Relay R_1 may be so designed that when current of a particular frequency is impressed upon its winding, its armature may close its associated contact substantially fewer times than the frequency of vibration of the armature. Thus, during the transmission of a marking signal there may be several cycles of carrier current transmitted and the armature of the relay R_1 will vibrate a corresponding number of times. The contact of relay R_1 , however, may be closed only during a small percentage of the time, as stated hereinabove, and, therefore, the average current through winding W_1 may be quite small. Incidentally, the average current through winding W_2 becomes increased because the average potential across its terminals is increased, for it is a fact that more current may flow through winding W_2 when the contact of the armature of relay R_1 is open than when this armature contact is closed.

The action of windings W_1 and W_2 , and the action of the so-called "vibrating circuit" to be subsequently described, cause the armature of relay R_2 to move back and forth between its contacts M and S as suitable alternating current is or is not impressed upon the winding of relay R_1 . If a telegraph key were employed at the distant station to control the transmission of alternating current therefrom, the armature of relay R_2 would close the marking contact M when the distant key were closed, and it would close the spacing contact S when that distant key were opened.

It will be clear that when the armature of relay R_2 closes the marking contact M, this contact remains closed throughout the time that suitable current is impressed upon the winding of relay R_1 . At all other times, this

armature may close its spacing contact S. The choke coil K is so related to the circuits interconnecting the relays R_1 and R_2 as to damp out any sudden impulse which may be caused by the brief closure of the contact of relay R_1 during its vibrations. Accordingly, the current through winding W_1 is effectively prevented from momentarily becoming large enough to cause the armature of relay R_2 to close its marking contact M.

The arrangement of Fig. 2 of this invention shows a Wheatstone bridge circuit interconnecting the armature of relay R_1 and the operating windings W_1 and W_2 of relay R_2 . The windings W_1 and W_2 and the series resistances Z_1 and Z_2 , respectively, form two of the arms of the Wheatstone bridge. The other two arms are formed by resistances Z_5 and Z_6 . One diagonal of the bridge includes battery B_1 , a resistance Z_7 , and ground. The other diagonal of the bridge includes the armature of relay R_1 , its contact and choke coil K. It will be apparent that resistances Z_1 , Z_2 , Z_5 and Z_6 may be so proportioned that when the armature of relay R_1 definitely closes its contact, the windings W_1 and W_2 will establish proper magnetic fields to move the armature of relay R_2 to its spacing contact S. And when the armature of relay R_1 vibrates, due, for example, to the presence of a suitable pulsation in line L_1 , the armature of relay R_2 may be caused to close its marking contact M. Thus, the magnetic field established by one of these windings may be stronger than that established by the other when a suitable pulsation is impressed, and, conversely, the magnetic field of the latter winding may be greater than that of the former when no such pulsation is impressed. It will be understood that while this Wheatstone bridge arrangement may be balanced so that no current may flow through the diagonal including the armature of relay R_1 when the armature of that relay is fixed against its contact, this bridge is preferably unbalanced so that an appreciable current may normally flow through the diagonal including the armature of relay R_1 . Another feature of this Wheatstone bridge arrangement is that it is designed to limit to a definite value the magnitude of the voltage across the armature and contact of relay R_1 .

Winding W_3 of relay R_2 is connected in what is known as a "vibrating circuit". The purpose of this circuit is to render the relay more sensitive to currents flowing through windings W_1 and W_2 and to prevent "chattering" or "rebound" of the armature when it strikes contacts M or S. In the form of vibrating circuit shown in Fig. 2, winding W_3 is connected in a series circuit including a resistance Z_8 , condenser C and ground. The midpoint of winding W_3 is connected to the fixed terminal of the armature of this relay.

When the armature of relay R_2 is acted

upon as a result of the flow of currents through windings W_1 and W_2 , causing it to strike contact S, current will flow from battery B'_2 through resistance Z_4 , armature of relay R_2 , this current then dividing so that part of it flows through the upper half of winding W_3 and resistance Z_8 and so that the rest of the current flows through the lower half of winding W_3 and condenser C. That current which flows through the upper half of winding W_3 and resistance Z_8 will be in such a direction as to set up a magnetic field tending to cause the armature to leave contact S. The initial current flowing through the lower half of winding W_3 and condenser C, however, will be considerably larger than the former current and will be in such a direction as to establish a magnetic field about the lower half of winding W_3 opposing that field set up by the current through the upper half of the winding W_3 and aiding the effect produced by windings W_1 and W_2 . The relay armature will therefore have less tendency to "chatter" than would be the case if this so-called "vibrating circuit" were not connected.

It is not long before the condenser C becomes fully charged, whereupon the current flow through the lower half of winding W_3 becomes reduced to zero; while the current through the upper half of winding W_3 and resistance Z_8 remains steady and tends to cause the armature to leave contact S. This armature cannot leave contact S, however, as long as the stronger magnetic effect of the currents through windings W_1 and W_2 is maintained, whereby the armature is held against contact S. When the magnetic field caused by the flow of currents through windings W_1 and W_2 is reversed, however, due to the action of relay R_1 , the armature of relay R_2 will leave contact S more easily than would be the case if the current through the upper half of the winding W_3 and resistance Z_8 were not present. By virtue of the presence of the vibrating circuit, and of the action of its winding W_3 , relay R_2 is made quite sensitive in its action.

When the armature of relay R_2 opens contact S in its travel to contact M, neither of the batteries B'_2 nor B''_2 will be connected to winding W_3 , yet due to the charged condition of the condenser C, current will flow through both portions of winding W_3 in the circuit including that winding, resistance Z_8 and ground. A magnetic field will therefore be established by winding W_3 tending to sharply kick the armature of relay R_2 toward its marking contact M.

When the armature of relay R_2 finally reaches the marking contact M, as will be the case when the relay R_1 is properly energized, current will flow from battery B'_2 through resistance Z_3 , the armature of relay R_2 and contact M and this current will then divide

so that part of it flows through the upper half of winding W_3 and resistance Z_3 , the remainder flowing through the lower half of winding W_3 and condenser C . The current through the upper half of W_3 and resistance Z_3 will continue to flow as long as the armature of relay R_2 is on contact M . But the current through the lower half of winding W_3 and through condenser C will flow at a diminishing rate until condenser C becomes charged to the potential of battery B'_2 , condenser C being now charged to a polarity opposite to that which it had when the armature closed contact S . This charging current through condenser C will produce a magnetic field about the lower half of winding W_3 which will aid that established by windings W_1 and W_2 in holding the armature of relay R_2 against contact M , thereby preventing "chatter".

The current flowing through the upper half of winding W_3 and resistance Z_3 will set up a magnetic field opposing that set up around windings W_1 and W_2 and that set up by the lower half of winding W_3 . Immediately after the armature closes contact M , however, the current through the lower half of winding W_3 and condenser C will be much larger than that through the upper half of winding W_3 and resistance Z_3 so that at first the effective magnetic field due to winding W_3 will aid the effective magnetic field established by the currents through windings W_1 and W_2 , thereby holding the armature against contact M .

After the current charging condenser C has decreased to a value less than that flowing through the upper half of winding W_3 and through resistance Z_3 , the effective magnetic field about winding W_3 will be reversed and will oppose that field established by windings W_1 and W_2 . Then the field of winding W_3 will aid that produced by windings W_1 and W_2 upon a reversal of the magnetic field due to the action of relay R_1 . When the armature of relay R_1 again closes its contact, the armature of relay R_2 will promptly close its contact S in the manner already described hereinabove.

It is to be noted when the armature of relay R_2 begins to leave contact M , current will flow through both portions of winding W_3 , due to the charged condition of condenser C , the magnetic field established by winding W_3 tending to sharply kick the armature of relay R_2 against the spacing contact S . When the armature of relay R_2 finally reaches contact S , the cycle of events already described hereinabove will be renewed.

The vibrating circuit of Fig. 1 operates upon substantially the same principles as those described in connection with the circuit of Fig. 2; yet, the one shown in Fig. 1 is even more effective due to the presence of the coupled windings W_4 and W_5 . These

windings may be employed to boost the effective voltages so that the movement of the armature between its contacts may be even more rapid.

It will be understood that the relay R_1 of this invention is one having an armature which remains fixed against its contact for its spacing condition and vibrates at a high periodicity for its marking condition.

It will be also apparent that the combination of the two relays R_1 and R_2 , and the associated equipment, may take the place of present vacuum tube amplifier, detectors and direct current relays now employed in telegraph receiving systems for receiving pulsations of alternating current corresponding to telegraph signals. Relay R_1 may be considered to perform the function of an amplifier and a detector, and relay R_2 may be considered to act in somewhat the same manner as the present direct current relay. The principles of this invention may be employed in the reception of telegraph signals substantially free from distortion.

While this invention has been shown in certain particular embodiments merely for the purpose of illustration, it will be understood that the general principles of this invention may be applied to other and widely varied organizations, without departing from the spirit of the invention or the scope of the appended claims.

What is claimed is:

1. The combination of an alternating current relay, a direct current relay, means for causing the armature of the direct current relay to close one of its contacts when energy is being supplied to the alternating current relay, means for causing the armature of the direct current relay to close the other of its contacts when no energy is being supplied to the alternating current relay, and means for maintaining the potential difference between the armature of the alternating current relay and its contact below a predetermined value.

2. The combination of an alternating current relay, means whereby pulses of high frequency current corresponding to the telegraph signals may be impressed upon the winding of the alternating current relay, a direct current relay having an armature which may move between two contacts, means whereby the armature of the direct current relay may close one of its contacts when a pulse of high frequency current is being impressed upon the winding of the alternating current relay, means whereby the armature of the direct current relay may close the other of its contacts when no pulse of high frequency current is being impressed upon the winding of the alternating current relay, and means for controlling the potential difference impressed between the armature of the alternating current relay and its contact.

3. The combination of an alternating current relay, a direct current relay, a line operated by the armature of the direct current relay, means for impressing pulses of alternating current upon the winding of the alternating current relay in accordance with marking and spacing signals characteristic of telegraphy, means for moving the armature of the direct current relay to one of its contacts and to remain on that contact when a pulse of alternating current is impressed on the winding of the alternating current relay, means for moving the armature of the direct current relay to the other of its contacts when no alternating current pulse is impressed on the winding of the alternating current relay, and means for maintaining the potential difference between the armature of the alternating current relay and its contact below a predetermined value.

4. The combination of an alternating current relay, a direct current relay, means for impressing telegraph signals upon the winding of the alternating current relay, means for operating the armature of the direct current relay in accordance with the marking and spacing signals characteristic of said impressed telegraph signals, and means for maintaining the potential difference between the armature of the alternating current relay and its contact below a predetermined value.

5. The combination of an alternating current relay, a direct current relay having two operating windings, one of the operating windings of the direct current relay being in series with the armature of the alternating current relay and its contact, a source of low voltage direct current connected in parallel to the other operating winding of the direct current relay and in parallel to the first operating winding of the direct current relay and the armature of the alternating current relay and its contact, a line controlled by the armature of the direct current relay, and means including a pair of sources of high voltage direct current for impressing currents of opposite polarities upon said line through the armature of the direct current relay.

6. The combination of an alternating current relay having coupled windings, a direct current relay, an input circuit coupled to the winding of the alternating current relay, signaling currents flowing through said input circuit, an output circuit controlled by the armature of the direct current relay, and means interconnecting the armature of the alternating current relay and the two coupled windings of the direct current relay to cause the output circuit to become energized in accordance with those signaling currents flowing in said input circuit.

7. The combination of a tuned, sensitive alternating current relay the winding of which is connected to a circuit over which may flow pulses of alternating current, the armature

of the alternating current relay vibrating with each pulse and at a periodicity corresponding to the frequency of the alternating current and being at rest between pulses, a polar direct current relay having two coupled, operating windings, circuit arrangements interconnecting the armature of the alternating current relay and its contact and one of the operating windings of the direct current relay whereby pulses of direct current may become impressed upon both of the operating windings of the direct current relay corresponding to those alternating current pulses flowing in the winding of the alternating current relay, and a local circuit controlled by the armature of the direct current relay and receiving direct current pulses corresponding to the pulses of alternating current flowing in the circuit connected to the winding of the alternating current relay.

8. The combination of a polar alternating current relay the winding of which is supplied with alternating current pulses corresponding to signals, means for maintaining the potential difference between the armature of the polar alternating current relay and its contact below a predetermined value, a line circuit suitable for the transmission of direct currents representative of the alternating current pulses supplied to the winding of the polar alternating current relay, a pair of oppositely poled batteries, and means interconnecting said line circuit and the polar alternating current relay to cause said line circuit to be supplied with direct current from one of said batteries when no alternating current pulse is flowing through the winding of the alternating current relay and to cause said line circuit to be supplied with direct current of opposite polarity from the other of said batteries when an alternating current pulse is flowing through the winding of the alternating current relay.

In testimony whereof, I have signed my name to this specification this 3rd day of May, 1928.

FRED J. SINGER.