Dec. 19, 1922.

L. ESPENSCHIED ET AL.

1,438,987.

HIGH FREQUENCY TRANSLATING CIRCUITS.

FILED SEPT. 30, 1919.

2 SHEETS—SHEET 1.

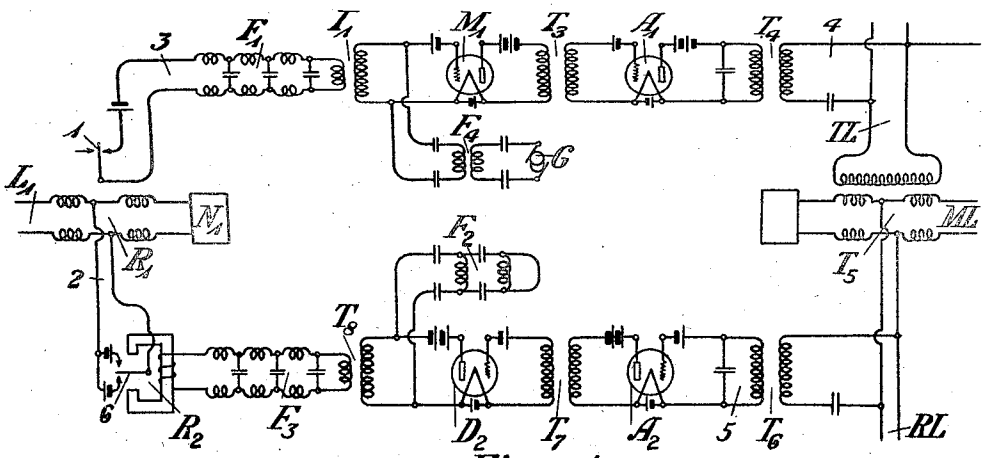


Fig. 1

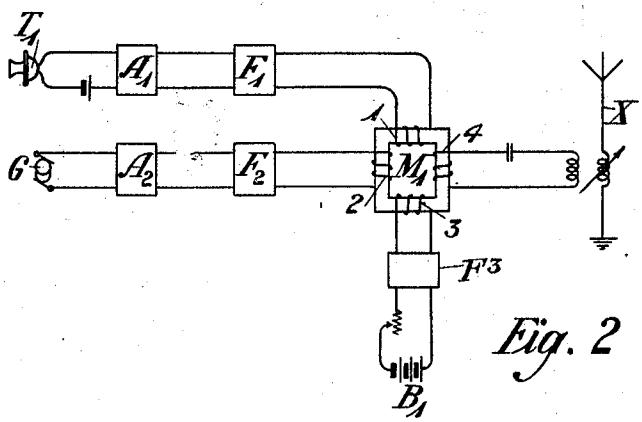


Fig. 2

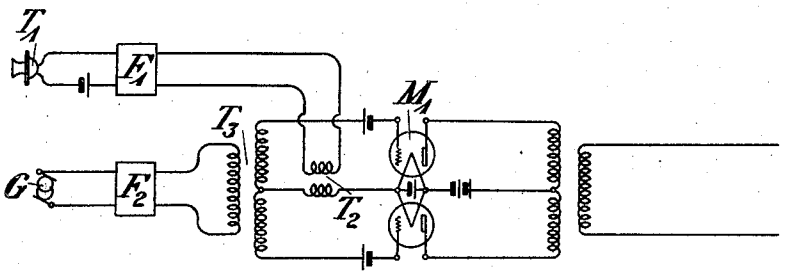


Fig. 3

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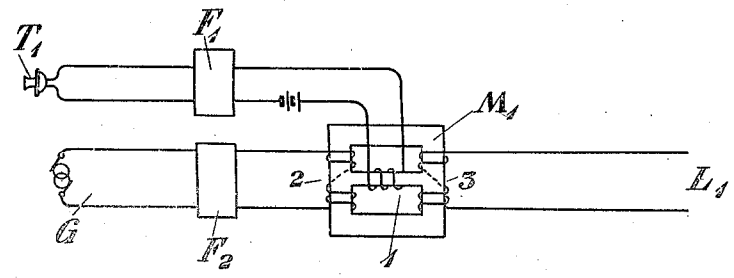


Fig. 4

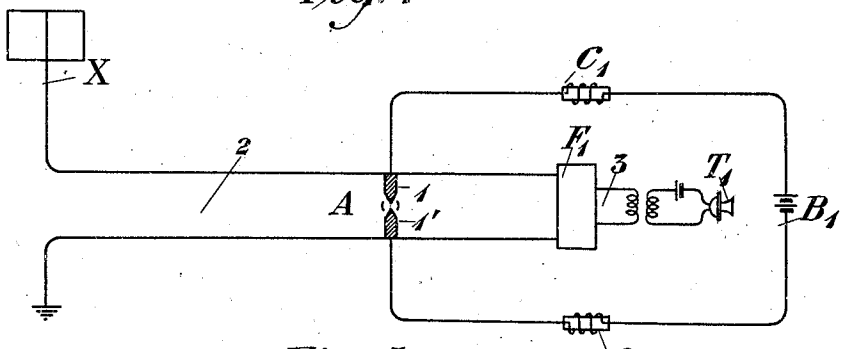


Fig. 5

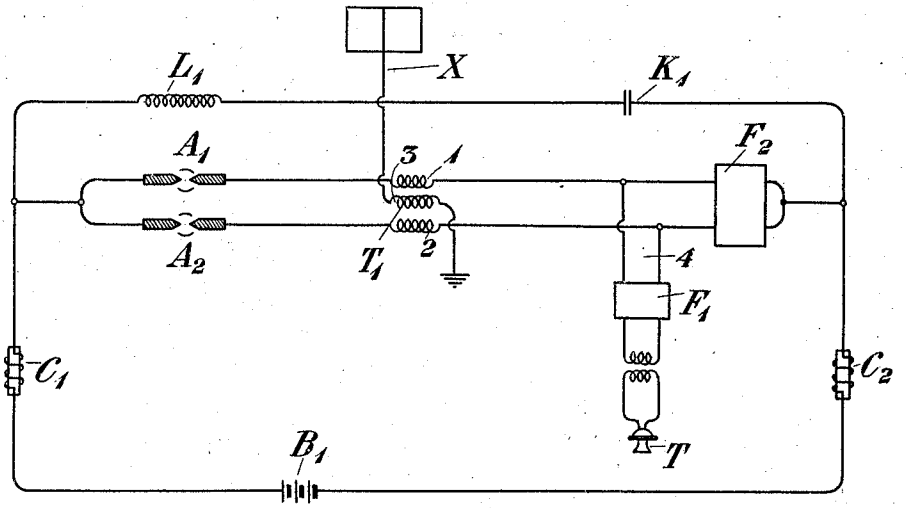


Fig. 6

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Patented Dec. 19, 1922. 1,438,987

UNITED STATES PATENT OFFICE.

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HIGH-FREQUENCY TRANSLATING CIRCUITS.

Application filed September 30, 1919. Serial No. 327,399.

To all whom it may concern:

Be it known that we, LLOYD ESPENSCHIED and HERMAN A. AFFEL, residing at Hollis and Brooklyn, in the counties of Queens and Kings and State of New York, respectively, have invented certain Improvements in High-Frequency Translating Circuits, of which the following is a specification.

This invention relates to high frequency translating circuits, and more particularly to arrangements for modulating currents of various frequencies.

As is well known, modulation of a plurality of frequencies consists in the superposition of the input currents upon each other, either in the modulator element, or at some point in the input side of the said element. By the term "modulator element" is meant any portion of an electrical circuit, the electrical constants of which may be varied in accordance with signal variations; thus, it may be a vacuum tube in which the output resistance is varied in accordance with grid potential, or an electric arc, the resistance of which is a function of the impressed voltage, or, it may be a reactance element such as an inductance, the effective permeability of which is varied by a controlling circuit, or a condenser, the capacity of which may be controlled by variation in the plate separation or in the dielectric constant.

It is desirable, therefore, to provide means for superposing the two input currents so as to avoid loss of energy and diminution of modulating efficiency arising from mutual shunting effects. There are, in general, two ways whereby the input currents may be superposed so as to be rendered mutually non-interfering, one known as the method of balance and the other as the method of frequency selection. It is the object of this invention to show means for superposing the input circuits upon each other by the method of frequency selection, and also to show means which combine the method of frequency selection with the method of balance.

This invention will be better understood from the following description when read in connection with the drawing, of which Figures 1, 2 and 5 show the application of the method of frequency selection, and Figures 3, 4 and 6 show the application of the method of frequency selection combined with the method of balance.

In Figure 1, L_1 represents a line adapted for the transmittal of low frequency currents, such as for example, telegraph currents, which is connected with a high frequency terminal circuit by means of a relay R_1 having a network N_1 adapted to balance the line L_1. This relay comprises balanced windings connected with the line and an armature 1, which is under the control of the said windings and adapted to apply impulses to the transmitting circuit. A receiving circuit 2 is bridged across the midpoints of the balanced windings of the relay R_1 so that impulses transmitted over the line L_1 by the receiving circuit 2 will not actuate the receiving relay R_1. The low frequency output circuit 3 has inserted therein a low pass filter F_1 which is adapted to transmit low frequency signaling currents which may be impressed upon the input side of the modulator M_1 by means of a transformer T_1. The generator G may be any type of device adapted to generate high frequency sinusoidal oscillations, which oscillations may be impressed upon the input side of the modulator M_1. The filter F_4 or its equivalent is inserted in the high frequency input circuit, in order to transmit high frequency oscillations, and suppress low frequency currents. The output side of the modulator M_1 is connected with the input side of the amplifier A_1 by the transformer T_3. The output circuit of the amplifier A_1 is tuned and adapted to transmit oscillations of the resonant frequency upon the output circuit 4. This output circuit is connected with a transmitting circuit TL which is in turn connected with the main transmission line ML by a transformer T_5. The filters herein referred to may be of the general type illustrated and described in the U. S. Patents to George A. Campbell No. 1,227,113 and No. 1,227,114, both dated May 22, 1917.

Oscillations received over the line ML and the receiving branch RL are impressed by the transformer T_6 upon the resonant input circuit 5 of the amplifier A_2. The amplified oscillations are impressed by transformer T_7 upon the detector D_2. Bridged across the output side of the said detector is a high pass filter F_2 which is adapted to shunt, the carrier frequency oscillations that pass through

the detector D_2, thereby preventing their passage into the low frequency circuit. Low frequency impulses which result from demodulation are impressed by the transformer T^8 upon an input circuit containing a low pass filter F_3 and the windings of a polarized relay R_2. The low frequency impulses applied to the said relay actuate the armature 6, and send impulses over the low frequency signaling circuit L_1 to the receiving apparatus associated therewith.

In the operation of this circuit, low frequency signals arriving over the line L_1 will actuate the armature 1, and send a low frequency impulse over the circuit 3. The frequency of this impulse is such as will pass through the low pass filter F_1, and the impulse will be impressed upon the input side of the modulator M_1 by the transformer T_1. Since the filter F_4 is adapted to pass only high frequency oscillations, the low frequency impulses impressed upon the input circuit by the transformer T_1 will not be permitted to pass into the high frequency channel. High frequency oscillations set up by generator G will pass through the high frequency filter F_4 and be impressed across the input side of M_1. These oscillations will not also pass into the low frequency circuits 3 on account of the presence therein of the low pass filter F_1. It will be seen that the input circuits are rendered mutually non-interfering by means of the application of this method of frequency selection.

By the simultaneous impression of the signaling current and the carrier current upon the modulating element, the carrier current will be modulated thereby and the modulated oscillations will be amplified by the amplifier A_1, and be impressed upon the output circuit 4, and transmitted over the transmission lines TL and ML. The received high frequency oscillations will be impressed by the transformer T_6 upon the amplifier A_2 and the resulting amplified oscillations will in turn be impressed upon the detector D_2. Oscillations of the carrier frequency which may pass through the detector D_2 together with the detected currents will pass into the filter F_2 and be suppressed thereby. The low frequency signaling impulses resulting from demodulation will pass through the low frequency filter F_3 and actuate the polarized relay R_2. High frequency oscillations will not pass into the circuit containing the relay R_2 due to the presence of the low pass filter therein, which prevents the transmission of the high frequency oscillations. It will be seen from the foregoing that the input circuits are rendered non-interfering by means of suitable filtering devices inserted therein.

Figure 2 shows a way in which the method of frequency selection may be applied to a magnetic translating circuit. T_1 represents a source of low frequency signaling currents connected with an amplifier A_1 whereby the amplified currents will pass through the low pass filter F_1 and be impressed upon the iron core modulating device M_1 by means of the winding 1. High frequency oscillations from the source G, which may be of any well-known type of generating device may be impressed upon the amplifier A_2 and the amplified currents passing through the high pass filter F_2 will be impressed upon the modulator M_1 by means of the winding 2. The third winding 3 of the modulator is connected with a source of current B_1 by means of which the proper degree of saturation of the iron core of the modulator M_1 may be maintained and a filter F_5 is inserted between the source and the winding 3 to prevent shunting the low frequency voice currents and also the high frequency carrier current. A fourth winding 4 is connected with a tuned output circuit coupled with the antenna X. In the operation of this circuit, low frequency signaling currents set up by T_1 are amplified by the amplifier A_1 and pass through the low frequency filter F_1 to the modulator M_1. Simultaneously high frequency carrier currents produced by G and amplified by A_2 pass through the high frequency filter F_2 and are likewise impressed upon the modulator M_1. It will be seen that high frequency oscillations cannot pass through the low pass filter F_1 to the low frequency circuit, and similarly low frequency currents cannot pass through the high pass filter F_2 to the high frequency generating circuit. In this manner interference between the input circuits is avoided, and the modulated oscillations are transmitted by the winding 4 to the antenna circuit X.

Figure 3 shows a means for combining the method of frequency selection with the method of balance in order to avoid interference between the input circuits. A transmitter T_1 is adapted to impress low frequency signals upon the common conductor of the modulator M_1 by means of a transformer T_2, the said low frequency signals passing through the low pass filter F_1. Simultaneously, high frequency oscillations from the source G passing through the high pass filter F_2 are impressed by the transformer T_3 upon the input side of the modulator M_1. This modulating device may be of any well-known balanced type such as, for example, the balanced duplex modulator described in the patent to John R. Carson, 1,343,308, dated June 15, 1920. It will be seen that the low frequency currents set up by the transformer T_2 in the common conductor of the modulator M_1 will flow in opposite directions in the winding of the transformer T_3, and therefore, will produce substantially no effect in the generating circuit G, and similarly high frequency oscillations

impressed across the input side of the modulator will produce substantially no effect in the windings of the transformer T_2. Since the filter F_1 is adapted to pass only low frequency oscillations, the high frequency oscillations arising from the generator G will not be transmitted into the low frequency transmitting circuit.

Figure 4 shows another means of combining both methods of preventing interference between input circuits of a demodulating element. The low frequency circuit has therein a transmitter T_1 and a low pass filter F_1. The low frequency signals set up in this circuit are impressed across the winding 1 upon the central arm of the core of the modulator M_1. High frequency oscillations from the generator G pass through the high pass filter F_2 and are impressed upon the winding 2 upon one of the side arms of the core of the modulator M_1. Symmetrically arranged upon the same core is a winding 3 which is connected with the output circuit L_1. Low frequency currents impressed upon winding 1 set up therein a flux which divides in the arm of the core upon which the winding 2 is placed, half of the flux passing upward and half downward, which creates a neutral condition preventing induction of currents in the winding 2 upon this core. In a similar manner the flux set up by the high frequency winding 2 will not induce high frequency oscillations in the low frequency circuit. Filters F_1 and F_2 interposed in the low frequency and high frequency input circuits respectively prevent the passage of high frequency and low frequency currents through filters F_1 and F_2, respectively. If low frequency signaling currents are impressed upon the winding 1 upon the central arm of the core, the resulting flux will change the permeability of the core with respect to the winding 2. The high frequency current set up in the winding 2 by means of the source G will be modulated accordingly, and the modulated high frequency current will be impressed upon the winding 3 of the output circuit L_1. This arrangement shows means for combining frequency selective devices with a balanced iron core modulator, thereby assuring a higher degree of freedom from interference of the oscillations in one of the input circuits by those in the other input circuit.

Figure 5 shows the application of this invention to a circuit in which an arc constitutes the modulator element. A represents an arc between the electrodes 1 and 1', across which a direct current from the battery B_1 is applied through the reactance coils C_1 and C_2. Oscillations are set up in the output circuit 2 which embraces the antenna X. Low frequency signaling current in the transmitter T_1 may be impressed upon the circuit 3 which is bridged across the electrodes 1 and 1'. A filter F_1 is inserted in the low frequency circuit 3 adapted to transmit the low frequency signals of, for example, 10 to 2500 cycles, and will prevent the transmission therethrough of frequencies below 10 and above 2500 cycles. High frequency oscillations will be set up in the circuit 2 in a manner that is well known, and these high frequency oscillations may be modulated by the low frequency current impressed upon the circuit 3 by the transmitter T_1. These low frequency signals will pass through the filter to the modulator device, namely the arc, but high frequency oscillations of the circuit 2 may not be transmitted through the filter F_1 into the low frequency signaling circuit. This circuit arrangement shows the means whereby the low frequency input circuit may be protected from interference by the high frequency oscillations of the oscillating circuit, which the low frequencies are adapted to modulate.

Figure 6 shows an arrangement for a balanced arc modulating system, in which the method of frequency selection is also applied in order to assure a higher degree of protection of the frequencies in one input circuit from interference by currents in the other input circuits of the modulating device. In the circuit arrangement A_1 and A_2 represent two arcs which may be of any well-known type connected with a common source of direct current B_1, and having reactance coils C_1 and C_2 associated in the direct current circuit. The output circuit is represented by the antenna X, which has connected therein one of the windings 3 of the triple-winding transformer T_1. The other two windings of the said transformer are connected in series with the arcs, each winding being individual to an arc circuit. These windings of the transformer are so arranged and designed that equal currents in the same direction in each arc conductor will cause no resultant action in the winding 3 which is connected with the antenna X. Under these conditions, the action of the two arcs in parallel is equivalent to that of a single arc connected across the source of direct current B_1 and its frequency of oscillation will be determined by the inductance L_1 and the capacity K_1. Bridged across the arc conductors is a low frequency circuit 4 upon which signaling currents from the transmitter T may be impressed. Inserted in the low frequeny circuit is a filter F_1 or its equivalent, which is adapted to transmit frequencies within the range of 10 to 2500 cycles. Inserted in the two arc conductors, between the point where the low frequency signaling circuit is connected across the two arc conductors and the point of connection of the two arc conductors with one side of the battery and the oscillation circuit, is a suppression filter F_2 which is adapted to suppress oscil-

lations having a frequency between 10 and 2500 cycles and to transmit frequencies below 10 and above 2500 cycles.

Having in mind the foregoing description, the invention will be made clear from the following description of its mode of operation:

Direct current will flow from the battery B_1 through each of the arcs A_1 and A_2 and through the windings 1 and 2, which are respectively connected with the arcs A_1 and A_2. High frequency oscillations resulting in a manner that is well-known will be set up in the high frequency oscillating circuit which embraces the inductance L_1, the capacity K_1 and the parallel conducting paths containing the arc A_1, the coil 1 and the arc A_2 and the coil 2 respectively. These oscillations will pass through the filter F_2, since it is designed to transmit high frequency oscillations. Since these currents are in the same direction in each of the coils 1 and 2, and of the same magnitude, no oscillations will be set out in the output circuit X. If, however, low frequency signaling currents are impressed across the arc conductors by means of the circuit 4, the high frequency oscillations in the coils 1 and 2 will be varied accordingly, and the modulated oscillations will be set up in the transmitting circuit X, since the transformer T_1 is no longer balanced. In view of the presence of the filter F_2 which suppresses frequencies between 10 and 2500 cycles, the low frequency current applied across the arc conductors will not be short circuited through the junction of the two arc conductors with one side of the direct current circuit and the oscillating circuit. Furthermore, it will be seen that the filter F_1 which is the type adapted to transmit frequencies between 10 and 2500 cycles will prevent high frequency oscillations from being impressed upon the low frequency transmitting circuit. This circuit shows means whereby each input circuit of a balanced arc modulator may be protected from interference by frequencies which are foreign to that circuit.

It will be noticed that certain of the circuit arrangements shown in the drawings are connected with an output circuit consisting of a metallic transmission circuit, and other circuit arrangements shown in the drawings have their output side connected with a radio antenna. It is to be understood that the various circuit arrangements are not limited to the particular type of output circuit shown, but that the output side of any circuit arrangement may be connected either with a metallic transmission line or with a radio antenna without departing from the scope of the invention.

Although this invention has been shown as embodied in particular forms and organizations of parts, it is to be understood that it is not limited to such forms and organizations, but may be embodied in other and different forms within the scope of the appended claims.

What is claimed is:

1. In a high frequency signaling system, the combination of a translating device, an input circuit adapted to impress carrier current upon said translating device, a second input circuit adapted to impress signaling current upon said translating device and means associated with each input circuit for protecting the currents in each input circuit against interference by current of the other input circuits.

2. In a high frequency signaling system, the combination of a balanced translating circuit, a plurality of input circuits adapted to impress a plurality of frequencies upon said translating circuit, and means associated with each input circuit adapted to protect the frequencies of each input circuit from interference by the frequencies of the other output circuits.

3. In a high frequency signaling system, the combination of a balanced duplex translating circuit having thermionic translating devices associated therewith, input circuits adapted to impress a carrier current and a signaling current upon said translating circuit, and frequency selecting means associated with each input circuit to exclude from each respective circuit frequencies foreign to it.

4. In a high frequency signaling system, the combination of a translating device, a plurality of circuits constituting respectively sources of carrier current and of signaling current, each of the said circuits having a filter associated therewith to prevent mutual reaction between the respective input circuits.

5. In a high frequency signaling system, the combination of a modulation circuit, a source of low frequency current, a source of carrier frequency current and means interposed between the said modulation circuit and each of said sources to prevent current from one source interfering with current from said other source.

6. In a high frequency signaling system, the combination of a modulation circuit, a source of low frequency current, a source of carrier current and frequency selecting means inserted between said circuit and each of said sources adapted to transmit readily frequency produced by the source with which the said selecting means is connected.

7. In a high frequency signaling system, the combination of a translating circuit, a circuit having a source of current of one frequency, a circuit having a source of carrier of current, each of said latter circuits having selecting networks adapted to transmit frequency of its particular source, and

each of said latter circuits being so connected with said translating circuit as to prevent current in one of said sources inducing current in the circuit of the other of said sources.

8. In a high frequency signaling system, the combination of a balanced duplex translating circuit, a source of signaling current, a source of carrier current and a filter connected between said translating circuit and each of said sources.

9. In a high frequency signaling system, the combination of a radio frequency transmitting circuit, a translating circuit having a plurality of input circuits, one of said input circuits having connected therewith a source of signaling frequency and another of said input circuits a source of carrier frequency, and a filter individual to and connected with each input circuit to transmit current only of the frequency which characterizes that particular circuit.

In testimony whereof, we have signed our names to this specification this 29th day of September, 1919.

LLOYD ESPENSCHIED.
HERMAN A. AFFEL.