April 18, 1939. W. E. PAKALA 2,154,694

COMMUNICATION SYSTEM

Filed Sept. 10, 1937

Fig. 1.

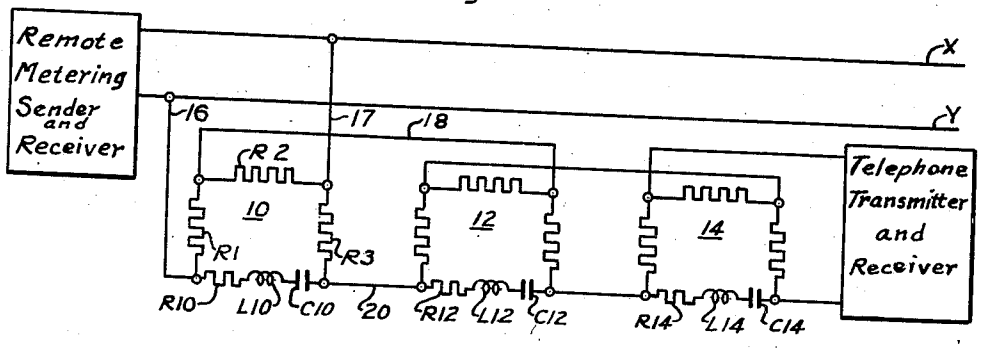


Fig. 2.

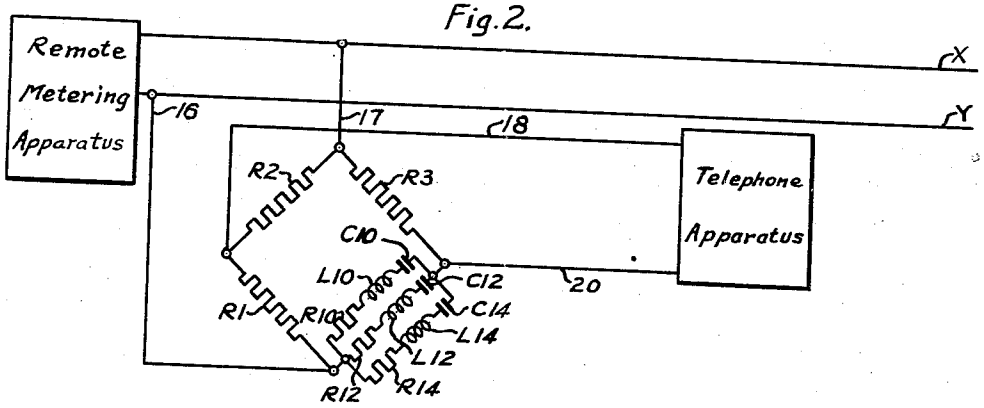


Fig. 3.

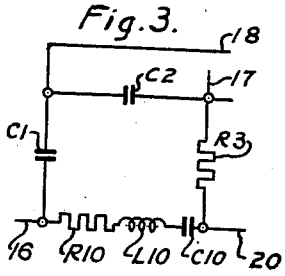
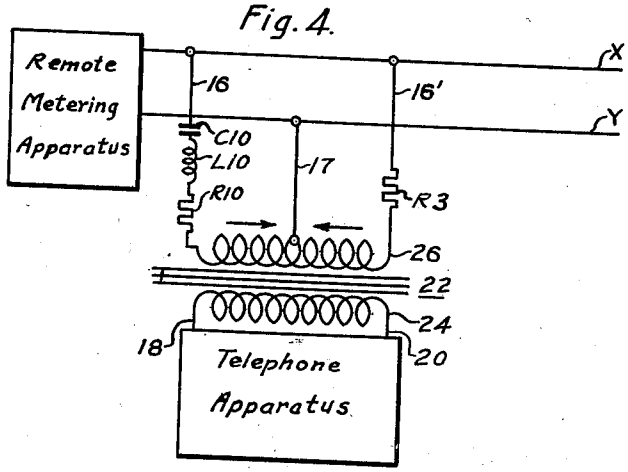


Fig. 4.



WITNESSES:

H. F. Susser

Joe Weber

INVENTOR

William E. Pakala.

BY

G. M. Crawford

ATTORNEY

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COMMUNICATION SYSTEM

William E. Pakala, Forest Hills, Pa., assignor to Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., a corporation of Pennsylvania

Application September 10, 1937, Serial No. 163,201

16 Claims. (Cl. 179—2)

My invention relates, generally, to communication systems and, more particularly, to a system whereby telephone messages may be sent over circuits which are used for remote metering.

Systems of remote metering have been devised which transmit several different metering indications over a single pair of wires, the different indications being transmitted over the wires at different audio frequencies and being distinguished from each other at the receiving station by means of frequency responsive devices. Such a metering system is described in the patent to R. N. Stoddard, 2,081,684, issued May 25, 1937. Telephone communication between such sending and receiving stations is usually provided.

An object of my invention is to provide a telephone system which shall operate on the circuit of a remote metering system without interference from the metering frequencies.

Another object of the invention is to provide a communication system which shall function to transmit and receive a plurality of fixed frequencies over a circuit without appreciably interfering with the transmission of a comparatively wide band of frequencies being transmitted over the circuit.

A further object of the invention is to provide a communication circuit over which speech frequencies are transmitted with means for transmitting a plurality of fixed frequencies within the speech frequency range over the circuit without appreciably interfering with the reception of speech over the circuit.

These and other objects and advantages of the invention will be apparent from the following detailed description taken in connection with the accompanying drawing, in which:

Figure 1 is a diagrammatic illustration of the cooperative relationships of the elements of the invention showing a plurality of bridge circuits for stopping a plurality of metering frequencies from entering a telephone circuit.

Fig. 2 is a diagrammatic illustration of a modification of the invention in which a single bridge is employed for stopping a plurality of metering frequencies.

Fig. 3 is a diagrammatic illustration of an alternative bridge arrangement which may be used in place of the bridge arrangements of Figs. 1 and 2.

Fig. 4 is a diagrammatic illustration of a transformer bridge arrangement for accomplishing the results of the devices of Figs. 1, 2 and 3.

In practicing the invention, a remote metering system over which one or more distinct frequencies are transmitted is provided with telephone communication equipment and one or more Wheatstone bridge arrangements each having as one of its legs a circuit which is resonant at one of the metering frequencies and which has an impedance such as to balance the bridge at the resonant frequency.

In another modification the several fixed metering frequencies are prevented from entering the telephone circuit by a single bridge having several parallel impedances each of which is resonant at one of the fixed metering frequencies.

In a third modification, a transformer bridge may be used to balance at the metering frequencies and to pass the speech frequencies.

Referring now to Fig. 1 of the drawing, the remote metering equipment shown, which may comprise such equipment as that disclosed in the hereinbefore referred to Stoddard patent, is connected to a single circuit comprising conductors X, Y. This metering equipment may energize the circuit X, Y with several distinct fixed frequencies for the different metering operations in a well-known manner.

The telephone apparatus shown may comprise any standard telephone receiving and transmitting apparatus and is connected to the circuit X—Y through a series of bridge circuits 10, 12 and 14. The bridge circuit 10 comprises three resistances R1, R2, R3 forming the three legs of a Wheatstone bridge circuit and a condenser C10 and inductance L10 and a resistor R10 connected in series to form the fourth leg of the Wheatstone bridge. The bridge 10 is connected to the circuit X—Y by conductors 16 and 17 and is connected to the second bridge 12 by conductors 18 and 20, the bridge 12 comprising elements similar to those of bridge 10 and being connected, in turn, to a similar bridge 14 which is connected to the telephone apparatus.

The inductances and condensers of each of the bridge circuits 10, 12 and 14 are such as to make the branch of their respective bridges in which they are connected resonant at a different one of the metering frequencies which is being applied to the circuit X—Y by the remote metering apparatus. It will be seen that the bridge circuit 10 will pass all frequencies except that to which the branch of the bridge which contains inductance and capacity is resonant. This will follow from the fact that at the resonant frequency, the impedance of the lower branch of the bridge will be merely the resistance R10, and since the resistances R1, R2, R3 and R10 are so chosen as to make the product of resistances R1

and R3 equal to the product of the resistances R2 and R10, the bridge will balance when this condition obtains.

In like manner the bridge circuit 12 will fail to pass the frequency to which its lower branch is resonant and bridge 14 will fail to pass the frequency to which its lower branch is resonant. In this manner all frequencies except the metering frequencies are permitted to enter the circuit to the telephone apparatus.

It is understood that the resistance R10 may be the resistance of whatever inductance apparatus is employed to provide the inductance L10 and the resistances R1, R2 and R3 may be made equal to the resistance R10 to produce the best results. This condition is true also of bridge circuits 12 and 14. It is also understood that there are a number of bridge circuits equal to the number of metering frequencies applied to the conductors X—Y, so that each of these frequencies will be prevented from entering the telephone apparatus.

Since each of the bridge circuits consumes considerable energy, the modification shown in Fig. 2 of the drawing may be employed for preventing the metering frequencies from entering the telephone circuits. In this embodiment the usual remote metering apparatus and telephone apparatus is shown, and a single bridge is employed with three of its legs made up of resistances R1, R2 and R3 as was explained in connection with the description of the modification of Fig. 1, and its fourth leg is made up of parallel circuits of capacity, inductance and resistance, each of the parallel circuits being resonant to a different one of the metering frequencies. The resistances of the inductance coils in each of these parallel circuits is so chosen as to make the product of the resistance and R2 equal the product of R1 and R3 at the frequency to which the parallel circuit is resonant. In this way it will be seen that the bridge will be unbalanced when any frequencies are applied thereto other than the frequencies to which the three parallel circuits are resonant, and that the bridge will pass all frequencies, except the metering frequencies, to the telephone apparatus. It will be seen that since this circuit of Fig. 2 has fewer resistances in series than that of Fig. 1, less of the energy will be consumed before reaching the telephone apparatus.

An alternative method of constructing the bridge circuits for this system is shown in Fig. 3. This bridge circuit is the same as those shown in Fig. 1 except that the condensers C1 and C2 are substituted for resistances R1 and R2, and are so chosen as to make the product of the resistance of the lower branch at the frequency at which it is desired to balance the bridge and the capacity of condenser C2 equal to the product of the resistance R3 and the capacity of the condenser C1. Such a circuit has the advantage that there is less power loss in this bridge than in those of the circuits of Figs. 1 and 2. It is understood that a series of parallel circuits may be used in the lower branch of the bridge of Fig. 3 in the manner described in connection with the bridge of Fig. 2.

In Fig. 4 there is shown a transformer bridge arrangement for preventing the metering frequencies from entering the telephone apparatus. In this arrangement a transformer 22 has a secondary winding 24 to which the telephone apparatus is connected and a split primary winding 26 with its two windings connected in parallel and in opposition to the circuit X—Y by the conductors 16 and 16' and the common conductor 17. One coil of the primary winding 26 is connected in series with the resistance R3 and the other coil is connected in series with a condenser C10, an inductance L10 and a resistance R10, the inductance and condenser being so chosen as to be resonant at the metering frequency which it is desired to prevent from entering the telephone apparatus. The resistance R10 which may be the equivalent resistance of the inductance coil L10 at the resonant frequency is so chosen as to be equal to resistance R3 at the resonant frequency. Thus it will be seen that the inductances in circuit with the two parts of the primary winding will be equal at the resonant frequency, and since these windings are so connected as to oppose each other, the resonant frequency will not affect the secondary 24 of the transformer and none of this frequency will be transmitted to the telephone apparatus.

At frequencies other than the metering frequency which it is desired to prevent from entering the telephone apparatus, the circuit of that part of the primary winding of the transformer containing the inductance and the capacity will have a higher impedance than the circuit of the other part of the primary winding and unequal currents will flow through the two windings of the primary of the transformer producing a resultant flux which will affect the secondary winding 24 and transmit these frequencies to the telephone apparatus.

Several circuits, each of them resonant to a separate fixed metering frequency, may be connected in parallel in the circuit of one part of the primary winding to prevent a plurality of metering frequencies from entering the telephone apparatus circuit. It is understood that inductances could be used in place of the condenser C1 and C2 in the bridge circuit of Fig. 3 and that either inductances or condensers could be used in a like manner in the bridge circuit of Fig. 2.

It will be seen that I have provided simple and inexpensive apparatus for preventing a plurality of fixed metering frequencies from entering telephone apparatus which is connected to the same circuit as the metering apparatus, thus permitting a single circuit to be employed as a telephone communication circuit and a remote metering circuit carrying several frequencies simultaneously.

In compliance with the requirements of the patent statutes, I have shown and described herein the preferred embodiments of my invention. It is understood, however, that the invention is not limited to the precise constructions shown and described, but is capable of modification by one skilled in the art, the embodiments herein shown being merely illustrative of the principles of my invention.

I claim as my invention:

1. In a communication system in which a band of frequencies and a fixed frequency are superposed upon a single circuit, means for preventing said fixed frequency from interfering with the reception of said band of frequencies comprising a Wheatstone bridge arrangement connected to said circuit, three legs of the bridge having equal impedances at all frequencies and the fourth leg having an impedance equal to that of the others only at said fixed frequency.

2. In a device for preventing the flow of current of one of two different frequencies from one circuit having both of said frequencies imposed thereon to another circuit, a Wheatstone bridge

arrangement connected between the two circuits, said bridge having the impedances of its legs such as to balance the bridge at the one frequency and to unbalance the bridge at the other frequency.

3. In a communication system in which a band of frequencies and a fixed frequency are superposed upon a single circuit, means for preventing said fixed frequency from interfering with the reception of said band of frequencies comprising a Wheatstone bridge arrangement connected to said circuit, said bridge having the impedances of its legs such as to balance the bridge at said fixed frequency only.

4. In a communication system in which a band of frequencies and a plurality of different fixed frequencies are superposed upon a single circuit, means for preventing said fixed frequencies from interfering with the reception of said band of frequencies comprising a plurality of Wheatstone bridge arrangements in cascade connection connected to said circuit, each of said bridges having the impedances of its legs such as to balance the bridge only at a different one of said fixed frequencies.

5. In a device for preventing the flow of current of a plurality of fixed frequencies from one circuit having said frequencies imposed thereon to another circuit, a plurality of Wheatstone bridge arrangements in cascade connection between said circuits, each of said bridges having the impedances of its legs such as to balance the bridge only at a different one of said fixed frequencies.

6. In a communication system in which a band of frequencies and a plurality of fixed frequencies are superposed upon a single circuit, means for preventing said fixed frequencies from interfering with the reception of said band of frequencies comprising a plurality of Wheatstone bridge arrangements connected in cascade to said circuit, three of the legs of each bridge having equal impedances at all frequencies and the fourth leg of each bridge having an impedance equal to that of the other legs only at different ones of said fixed frequencies.

7. In a communication system in which a band of frequencies and a plurality of different fixed frequencies are superposed upon a single circuit, means for preventing said fixed frequencies from interfering with the reception of said band of frequencies comprising a Wheatstone bridge arrangement connected to said circuit, said bridge having the impedance of its legs such as to balance the bridge only at said fixed frequencies.

8. In a device for preventing the flow of current of a plurality of fixed frequencies from one circuit having said frequencies imposed thereon to another circuit, a Wheatstone bridge arrangement connected between said circuits, the impedance of the legs of said bridge being such as to balance the bridge only at said fixed frequencies.

9. In a communication system in which a band of frequencies and a plurality of fixed frequencies are superposed upon a single circuit, means for preventing said fixed frequencies from interfering with the reception of said band of frequencies comprising a Wheatstone bridge arrangement connected to said circuit, three of the legs of said bridge having equal impedances at all frequencies and the fourth leg having an impedance equal to that of the other legs only at said fixed frequencies.

10. In a combined telephone and remote metering system, a single circuit upon which a fixed remote metering frequency and telephone frequencies in the speech frequency band are superposed for transmission, means for preventing said metering frequency from entering the telephone receiver circuit comprising a Wheatstone bridge one set of diagonally opposite junctions of which are connected to said single circuit, the other diagonally opposite junctions of which may be connected to the telephone receiver, all of the legs of the bridge having equal resistances and one of said legs being resonant at said fixed metering frequency only.

11. In a combined remote metering and telephone system, a single circuit upon which telephone frequencies in the speech frequency band and a plurality of different fixed remote-metering frequencies are superposed, means for preventing said metering frequencies from entering the telephone receiver circuit comprising a Wheatstone bridge one set of diagonally opposite junctions of which are connected to said single circuit, the other diagonally opposite junctions of which may be connected to the telephone receiver, all of the legs of the bridge having equal resistance and one of said legs being resonant at said fixed metering frequencies only.

12. In a combined remote metering system and telephone system, a single circuit upon which telephone frequencies in the speech frequency range and a plurality of different remote-metering frequencies are superposed, means for preventing said metering frequencies from entering the telephone receiver circuit comprising a plurality of Wheatstone bridge arrangements in tandem connection, diagonally opposite junctions of the first of said bridges being connected to said single circuit and diagonally opposite junctions of the last of said bridges being connectible to a telephone receiver, all of the legs of each of said bridges having equal resistances, and one of the legs of each of said bridges being resonant to a different one of said metering frequencies only.

13. In a combined telephone and remote metering system, a single circuit upon which a remote-metering frequency and telephone frequencies in the speech frequency band are superposed for transmission, means for preventing said metering frequency from entering the telephone receiver circuit comprising a Wheatstone bridge arrangement one set of diagonally opposite junctions of which are connected to said single circuit, the other diagonally opposite junctions of which may be connected to the telephone receiver, the two legs of the bridge adjacent one of the telephone receiver connections being of equal impedance, the other two legs of the bridge being of equal resistance and one of said other legs being resonant at said metering frequency only.

14. In a device for preventing the flow of current of certain of a plurality of frequencies from one circuit having all of said frequencies imposed thereon to another circuit, a Wheatstone bridge arrangement having two diagonally opposite junctions connected to said one circuit and its other junctions connected to said other circuit, the legs of the bridge adjacent one of said connections to said other circuit having equal impedances, the other legs having equal resistances and one of said other legs being resonant to said certain frequencies only.

15. A device for preventing the flow of current of one of two different frequencies from one circuit having both of said frequencies imposed thereon to another circuit comprising a bridge

arrangement having the impedances of its legs such as to balance the bridge at the one frequency only.

16. In a combined telephone and remote metering system, a single circuit upon which a remote-metering frequency and telephone frequencies in the speech frequency band are superposed for transmission, means for preventing said metering frequency from entering the telephone receiver circuit comprising a Wheatstone bridge arrangement one set of diagonally opposite junctions of which are connected to said single circuit, the other set of diagonally opposite junctions of which may be connected to the telephone receiver, the two legs of the bridge adjacent one of the telephone receivers being condensers of equal capacity, the other two legs of the bridge being of equal resistance and one of said other legs being resonant at said metering frequency only.

WILLIAM E. PAKALA.