May 17, 1938. C. W. GREEN 2,117,843

FREQUENCY SELECTIVE CIRCUITS

Filed Dec. 2, 1936

FIG. 1

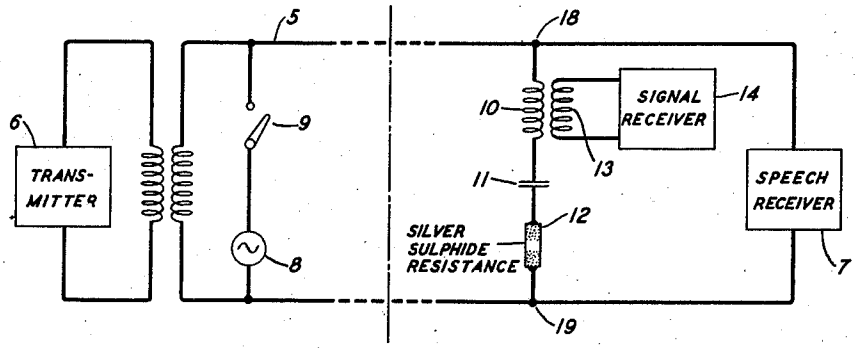
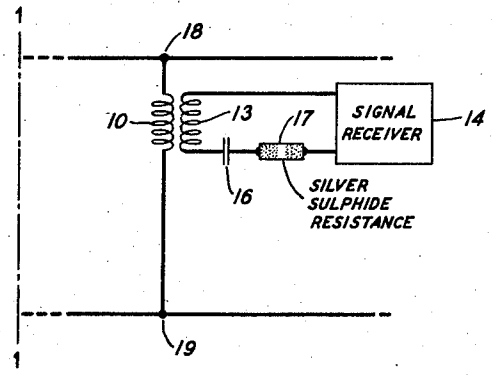


FIG. 2



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FREQUENCY SELECTIVE CIRCUITS

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7 Claims. (Cl. 179—84)

This invention relates to frequency selective circuits such as may be employed in discriminating between signaling currents of different frequencies.

One object of the invention is to increase the impedance of a tuned circuit to frequencies differing materially from the frequency to which the circuit is tuned while offering a substantially reduced impedance to current of the critical frequency.

Another object is to maintain a frequency selective circuit of high impedance to the frequency to which it is resonant, unless the current of said frequency is applied longer than a definite time interval.

A further object is to provide a resonant circuit, the characteristics of which depend upon the amplitude as well as the frequency of the applied voltage.

The invention is principally adapted to the diversion from a transmission line of a current of a single frequency or narrow band of frequencies. For example, in voice frequency ringing over a telephone line, it is desirable to divert the voice frequency signal into its proper receiving circuit without introducing appreciable loss in the other frequency bands transmitted over the line. In one embodiment, the invention may comprise in shunt to a transmission line a condenser, a resistance element such as a silver sulphide resistance having a high negative temperature coefficient of resistance, and the primary winding of a transformer, the transformer and the condenser being resonant at the frequency to be diverted, for example, a ringing current of 1,000 cycles per second. The characteristics of a silver sulphide resistor are such that it presents a high resistance when subjected to voltage below a certain critical value but as the voltage is increased, the temperature of the resistance is increased until a critical point is reached at which the resistance drops to a very low value.

The above described bridge circuit because of the impedance of the tuned circuit and because of the high resistance of the silver sulphide element for the usual low voltages of speech currents near a receiving station introduces a negligible loss at all frequencies at these low voltages. However, when the signaling frequency to which the bridge is tuned is impressed on the line in sufficient amplitude and for sufficient duration of time the resistance of the silver sulphide element will suddenly break down to a very low value to enable the tuned circuit to absorb most of the signaling frequency. The receiving apparatus for the signaling frequency may, of course, be connected to the secondary winding of the transformer.

Referring to the drawing,

Fig. 1 illustrates one embodiment of the invention as applied to a bridged telephone line; and

Fig. 2 is a modification of Fig. 1.

A speech or carrier telephone transmission system is shown somewhat schematically in Fig. 1. Further details of a system of this type may be secured by reference to the H. S. Black United States Patent 1,709,554, issued April 16, 1929, on Voice frequency calling system.

The transmission line 5 may be traversed by speech frequencies or by a carrier wave modulated by the voice from a source such as source 6 to be received at a distant station by suitable receiver 7 which for carrier operation would include a suitable demodulator or detecting device. As is customary in such systems it will also be desirable to transmit over the line a voice frequency wave to actuate calling or signaling apparatus at the distant station. In shunt to line 5 at one station is a source 8 of signaling current and a key 9 for connecting the source to the line. Source 8, for example, may comprise a 1,000 cycle generator interrupted twenty times per second.

At the distant station there is connected in shunt to the line the primary winding 10 of a transformer, a condenser 11, and a silver sulphide resistor 12. Winding 10 and condenser 11 are tuned for series resonance at the frequency of the source 8. The secondary winding 13 of the transformer leads to a suitable signal receiver 14.

For the low voltages of the speech or modulated carrier at the receiving station, the silver sulphide resistor 12 possesses a very high resistance and the shunt circuit 10, 12, therefore, introduces a negligible loss for all frequencies in the speech or carrier bands provided the voltage across the silver sulphide resistor is below its critical value. When, however, the higher voltage from the signaling source 8 is impressed on the line, there is an enormous reduction in the value of resistance 12 so that the line is substantially short-circuited. It follows, therefore, that the bridge circuit 10, 12 receives the signaling frequency from source 8 with full efficiency.

If the silver sulphide resistor 12 were absent from the bridge circuit 18, 19 the tuned circuit 10, 11 would be required to put in a loss as high as 18 decibels to the signal frequency of source 8 in order that the bridge would have a negligible loss at speech frequencies of 0.2 decibel or less.

This high loss in such a bridge circuit would require amplification of the signaling frequency from source 8 before the actuation of the signal receiver 14. However, when the silver sulphide resistor is present, the bridge circuit not only has a negligible loss for speech frequencies but also has a very low loss at the frequency of the signaling source 8.

The silver sulphide unit employed in the above described tuned circuit should preferably be of such size and thermal design that its temperature due to the received voltage from frequency source 8 does not reach the critical value unless this voltage persists for an appreciable time such as 0.5 second. This will aid the signal receiver 14 in discriminating against momentarily impressed voltages having a 1,000 cycle component. The size of the silver sulphide resistor chosen may, for example, be such that for an applied voltage of a few volts such as less than 7 volts, its resistance is several thousand ohms, but for a voltage substantially greater than 7 volts, its resistance will be something like 1/120,000 of its resistance for the low voltage.

Without changing the fundamental principles of the operation, the silver sulphide resistance and the tuning condenser may be placed in series with the secondary winding 13 instead of in series with the primary winding 10. This modification is shown in Fig. 2 where a tuning condenser 16 and a silver sulphide resistance 17 are connected in series with the secondary winding 13. The transmission characteristics of the bridge circuit 18, 19 of Fig. 2 are the same as those described above for Fig. 1.

For various methods which may be employed in making a suitable silver sulphide resistor, reference may be made to the following copending applications: J. R. Fisher application Serial No. 30,780, filed July 11, 1935; J. R. Fisher application Serial No. 18,217, filed April 25, 1935; and R. O. Grisdale application Serial No. 57,180, filed January 2, 1936.

This inclusion in a resonant circuit of a resistance element having a high negative temperature coefficient of resistance may be advantageously employed in widely different types of frequency selective circuits to obtain a selectivity which depends not only upon the frequency but the voltage as well.

It is also to be understood that other substances having a high negative temperature coefficient of resistance may be employed in place of the silver sulphide element.

What is claimed is:

1. In a signal transmission system, a source of signaling current of a wide band of frequencies, a second source of signaling current of a narrow band of frequencies, a line, means for impressing on said line signaling currents from both of said sources and a path bridged across said line comprising a condenser, the primary winding of a transformer and a resistance element having a high negative temperature coefficient of resistance, said path being tuned to a frequency of said second source, said path being of high impedance to the signaling current from said first source.

2. In a transmission system, a line, a source of speech currents, a source of ringing current of a definite frequency, means for impressing currents from said sources upon said line, a receiving station where the current received over said line from said second source is of higher voltage than the current received from said first source, and means at said receiving station for receiving current from said second source, said means comprising in shunt to said line the primary winding of a transformer and a resistance element having a high negative temperature coefficient of resistance.

3. In a signal transmission system, a line, a source of signaling currents of a wide band of frequencies, a source of ringing current of a definite frequency, means for impressing currents from said sources upon said line, a receiving station where the current received from said second source is of higher voltage than the current received from said first source and means at said receiving station for separating said ringing current from the current from said first source, said means comprising a connection to said line including an inductance and a silver sulphide resistance.

4. In a telephone system, a telephone circuit adapted to be subjected to high voltage ringing and low voltage speech currents, and voltage discriminating means connected across said telephone circuit for excluding the high voltage ringing current from said circuit while permitting the transmission of the low voltage speech currents thereover, said means including a non-linear resistance, an inductance connected across said circuit in series with said resistance, and means responsive to the ringing current potential developed across the terminals of said inductance.

5. In a telephone system, a telephone circuit designed for the transmission of low voltage speech currents, and a ringing circuit associated therewith comprising a high voltage ringing current generator, a silver sulphide resistor which presents a high impedance to the low voltage speech currents and a relatively low impedance at the higher voltage of said generator, an inductance in series with said resistor, and means responsive to the ringing current potential developed across the terminals of said inductance.

6. In a signaling system, a source of signaling current of a wide band of frequencies, a second source of signaling current of a narrow band of frequencies, a line, means for impressing on said line signaling currents from both of said sources, a receiving station where current received over said line from said second source is of higher voltage than the current received from said first source, and means at said station for providing in shunt to said line a path of high impedance for the low voltage current from said first source while providing a path of low impedance for high voltage current from said second source, said means comprising an inductance, a condenser and a resistance element having a high negative temperature coefficient of resistance.

7. In a signal transmission system, a source of signaling current of a wide band of frequencies, a second source of signaling current of a narrow band of frequencies, a line, means for impressing on said line signaling currents from both of said sources, a transformer having its primary winding bridged across said line, and a series connection comprising the secondary winding of said transformer, a condenser, a resistance element having a high negative temperature coefficient of resistance, and a signal receiver for the currents from said second source, said series connection being tuned to a frequency of said second source.

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