May 17, 1938. H. S. BLACK 2,117,835

TELEPHONE SIGNALING SYSTEM

Original Filed June 1, 1936 2 Sheets-Sheet 1

FIG. 1

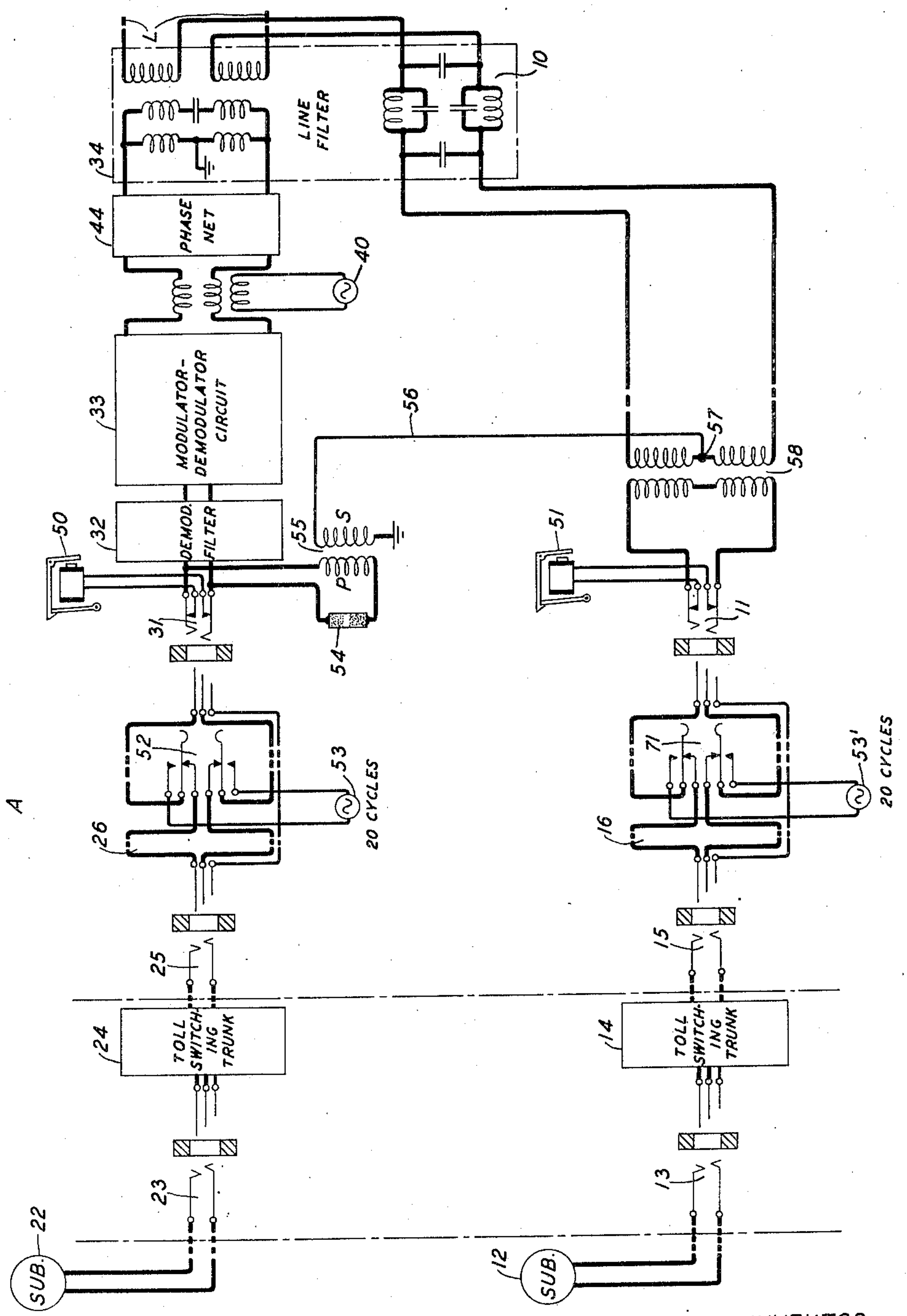

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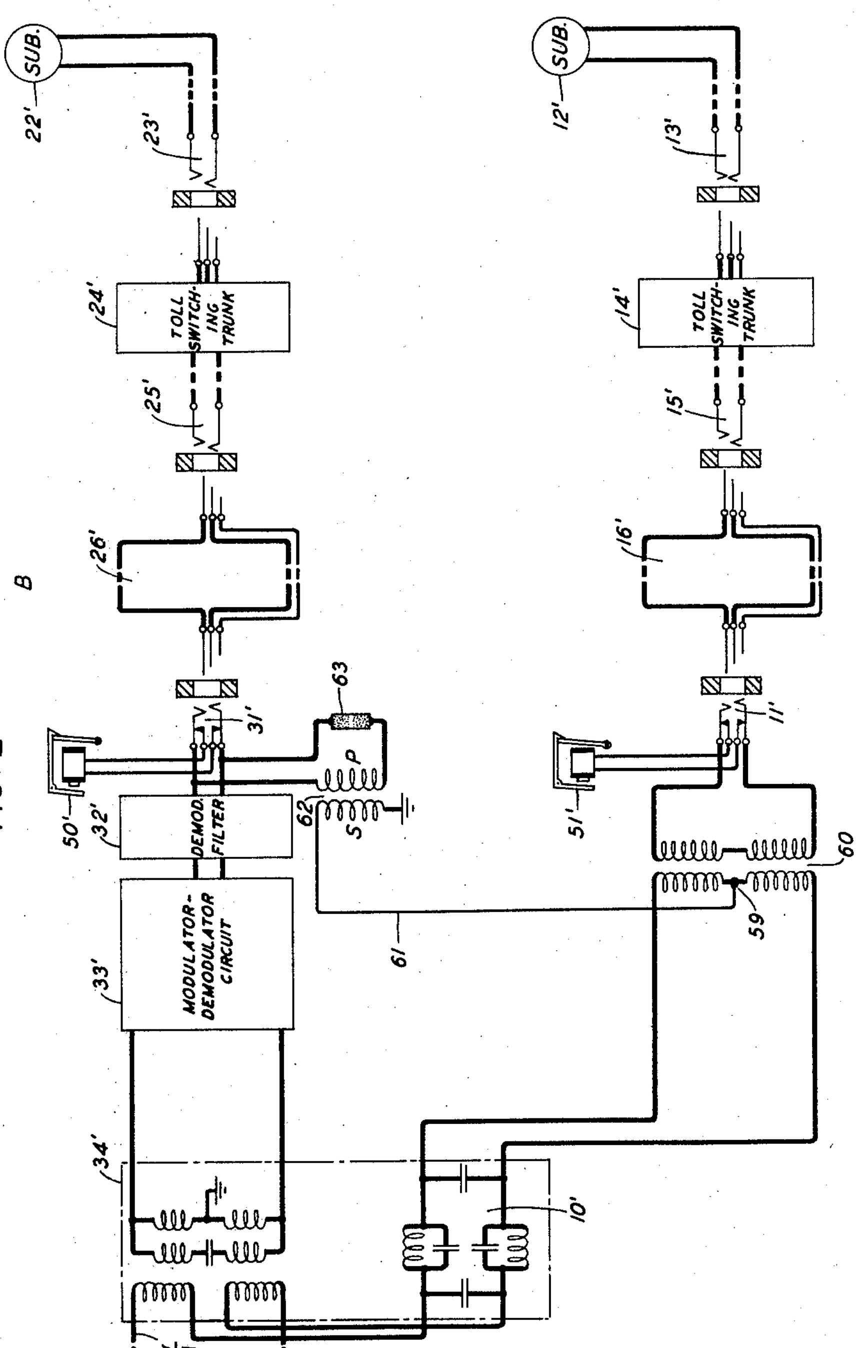
FIG. 2



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Patented May 17, 1938 2,117,835

UNITED STATES PATENT OFFICE

2,117,835

TELEPHONE SIGNALING SYSTEM

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Application June 1, 1936, Serial No. 82,848
Renewed December 31, 1937

10 Claims. (Cl. 179—84)

This invention relates to telephone signaling systems and particularly to the transmission of low frequency signals, such as ringing signals, in carrier telephone systems.

In carrier telephony, as practiced in the field today, it is customary to associate with a telephone line interconnecting two widely separated telephone exchanges, carrier equipment which renders it possible to utilize the line circuit for the simultaneous transmission of a plurality of telephone communications. In such systems, the telephone line terminates at the two exchanges in jacks, by virtue of which a connection between calling and called subscribers may be completed by way of the line circuit. Superimposed on the line at each end thereof is a jack-ended carrier channel which comprises carrier terminal apparatus so designed as to transmit and receive speech currents modulated at a particular carrier frequency.

In certain systems of this type it is customary to utilize 20-cycle frequency alternating current for the transmission of signals, other than speech signals, between exchanges. Due to the transmission characteristics of the carrier terminal equipment it is necessary that the low frequency signaling current be excluded from the carrier channel and transmitted over the physical line circuit. Heretofore, the separation of the low frequency signaling currents and the high frequency speech currents was accomplishd by bridging the carrier channel, between the jack terminals thereof and the carrier equipment, with a low frequency tuned circuit including an inductance coil and a tuning condenser, and inductively coupling the bridge circuit with the physical circuit. The bridge circuit presents a high impedance to currents in the range of voice frequencies and a relatively low impedance at frequencies within the range of those used for the transmission of ringing signals. In this manner the signaling currents of low frequencies have been effectively excluded from the carrier channel and the voice frequencies transmitted thereover without interference. Such an arrangement has been found to function satisfactorily in all instances where the frequency of the signaling current source remained constant.

In numerous areas served by the telephone operating companies, the source of low frequency signaling current is known to vary in frequency over relatively wide limits. In some localities, the signaling frequency varies anywhere from less than 15 cycles to more than 20 cycles. In such areas the tuned circuit does not serve to advantage.

It is, accordingly, the object of this invention to simplify and improve low frequency signaling facilities in carrier telephone systems and to render such systems immune to frequency variations of the signaling current source.

This object is attained in accordance with a feature of the invention by substituting, for the frequency discriminating means heretofore employed in the low frequency signaling bridge associated with carrier telephone lines, a voltage discriminating device whose effective functioning depends, not upon the constancy of the frequency of the supply source, but upon the relative voltages of the signaling and speech currents impressed on the line, irrespective of their frequencies. More specifically, a resistor, such as a silver sulphide resistor, having a characteristic such that it presents a high resistance when subjected to voltages below a certain critical value, is included in the signaling bridge associated with carrier telphone lines.

The action of a silver sulphide resistor is such that as the voltage applied is increased, the temperature of the resistor is increased until a critical point is reached. At this point the resistance suddenly drops to a very low value. Since the heating of the resistor is a function of the voltage applied, the resistance will drop to a low value at a critical voltage. For this reason, reference is made, hereinafter, to the silver sulphide resistor as a voltage discriminating device.

The voltage of the low frequency signaling source used in these systems is, generally, in the neighborhood of 95 to 115 volts and since, as is well known, speech currents, when impressed on a line circuit, produce relatively low voltages, usually in the neighborhood of several volts, a resistor having a characteristic such as defined above will serve satisfactorily as a means for separating the speech and signaling currents in a carrier telephone system and will obviate the need for such expensive equipment as the inductance coil and tuning condenser heretofore used for this purpose.

The invention will be readily understood from the following detailed description made with reference to the accompanying drawings in which:

Figs. 1 and 2, when placed side by side, with Fig. 1 at the left, show in schematic form a circuit for superposing on an ordinary telephone line L, a carrier telephone channel of the type disclosed in U. S. Patent 1,983,528, issued December 11, 1934 to H. S. Black, and in which a silver sulphide resistor is included in the alternating current signaling bridge in accordance with the present invention.

The ordinary or physical circuit is connected to the line L at each of the exchanges A and B through a low-pass filter 10 or 10′ leading to a jack 11 or 11′. Thus the subscriber's station 12 may be connected, for a toll call, by suitable local and toll board switching circuits, such as answering jack 13, toll switching trunk 14 leading to jack 15 at the exchange A and toll cord 16 to jack 11 and thence to the line L. At the opposite terminal, or station B (Fig. 2) the call may be extended to the toll switching trunk 14′ by way of the toll cord 16′ and eventually to the called subscriber's station 12′ by way of jack 13′ located at an office at which the called line terminates.

In an analogous manner, the same subscriber's station 12, or for simplicity of description, another subscriber's station 22 may be connected, for a toll call, by jack 23, toll switching trunk 24, jack 25, toll cord 26 and jack 31 to the carrier terminal apparatus shown located between the jack 31 and the line L. At the opposite terminal (Fig. 2), corresponding carrier terminal equipment intervenes between the line L and jack 31′, from whence the call may be extended to a calling subscriber's station 22′ by way of the jack 31′, toll cord 26′, jack 25′, toll switching trunk 24′ and line jack 23′.

The carrier equipment, beginning at the jack 31 or low frequency terminals, comprises at each station, a speech filter 32 or 32′ designed to pass speech currents, but suppress currents of higher frequencies, a modulator-demodulator circuit 33 or 33′ and a high-pass filter 34 or 34′ adapted to pass currents of frequencies employed by the carrier channel but excluding speech frequency currents. Thus filters 10 and 34 serve to impress separately on line L, or to receive from line L and separate into their respective terminal branches, the low frequency speech currents in the physical branch and the high frequency carrier side-band currents in the carrier branch, respectively.

In addition to the elements mentioned, the station A has a source of carrier waves 40 and in some cases preferably would have a phase compensating network 44. It will be noted that the carrier source is present at only one of the stations.

It is believed unnecessary to disclose in detail the carrier terminal equipment since it is fully shown and described in the above-identified patent. Only that much of the equipment necessary for a complete understanding of the invention is shown in the drawings in detail.

In order for the operator at station A to signal an operator at station B on a call to be extended over the physical branch of line L, the former would actuate ringing key 71 associated with the toll cord 16 whereupon 20-cycle signaling current from the source 53′ would be impressed on the tip and ring conductors of the physical branch, assuming of course, that the calling jack of the cord 16 is inserted in the jack 11, which causes the drop signal 51 to be disconnected from the line. Signaling current would therefore traverse the left-hand winding of repeating coil 58 and would be induced in the right-hand winding thereof, from whence it would travel transversely over the physical branch including the low-pass filter 10, line L, low-pass filter 10′ and through the left-hand winding of repeating coil 60. Signaling current induced in the right-hand winding of repeating coil 60 thereupon traverses the winding of drop signal 51′ which is connected across the line at the terminals of jack 11′. In answering this signal, the operator at station B would proceed in the usual manner by inserting the answering plug of a cord 16′ into jack 11′ to open the circuit to the drop signal 51′ which is restored to normal. A signal originating at station B is transmitted to the station A in a similar manner to cause the actuation of drop signal 51.

On a call that is to be extended from station A to station B by way of the line L and the carrier channel associated therewith, the operator at station A inserts the calling plug of her cord 26 into the jack 31 to remove the drop signal 50 from the line and then actuates the ringing key 52. Ringing current from the 20-cycle source 53 is thereupon impressed on the terminals of the carrier channel and on the bridge circuit connected thereacross which comprises the silver sulphide resistance 54 and the primary of transformer 55. Since the voltage of the signaling current source is in the neighborhood of 90 to 116 volts, well above the critical value at which the resistor breaks down, the resistance of the bridge circuit is reduced materially with the result that the carrier channel is, in effect, short-circuited, and the signaling current traverses the primary winding of transformer 55. The current induced in the secondary of 55 travels from ground through the secondary of 55, simplex leg 56 to the mid-point 57 of the right-hand winding of repeating coil 58 and thence longitudinally over the physical branch, line L, the other physical branch to the mid-point 59 of the left-hand winding of repeating coil 60 and thence to ground by way of the simplex leg 61 and secondary of transformer 62. Current is induced in the primary of 62 and travels through drop signal 50′ by way of the silver sulphide resistor 63 and the normally closed contacts of jack 31′. The operation of drop signal 50′ indicates to the operator at station B that there is a call awaiting on the line identified by the signal 50′. The operator answers the call in the well known manner. Signaling current from station B may be transmitted over the line in a similar manner to actuate the drop signal 50 at station A.

The bridge circuit including the resistors 54 or 63 presents a very high resistance to speech currents since the voltages set up across this circuit by these currents are very small and well below the critical breakdown value. The speech currents are accordingly impressed on the carrier equipment unimpeded in any manner by the bridge circuit. When the high voltage signaling current, however, is impressed on the line at the jack 31, the silver sulphide breaks down and becomes a low resistance causing the signaling current to be excluded from the carrier channel and transmitted over the physical branch of line L.

It is apparent, from the foregoing, that the frequency of the signaling source, such as 53, may vary without, in any way, affecting the operation of the system due to the inclusion, in the signaling bridge, of a resistor which functions independently of frequency and which relies solely upon the relative voltages of the signaling and speech currents in producing the desired results. Silver sulphide, not only has the desired characteristics, but is considerably cheaper than the tuned circuits heretofore employed.

What is claimed is:

1. In a telephone system, a line circuit including a physical branch and a carrier channel, and means including a signaling bridge circuit coupling the terminals of the carrier channel with

the physical branch of said line circuit, said bridge including a non-linear resistance.

2. In a telephone system, a line circuit including a physical branch and a carrier channel, and means including a signaling bridge circuit coupling the terminals of the carrier channel with the physical branch of said line circuit, said bridge including a silver sulphide resistor.

3. In a telephone system, a line circuit including a physical branch and a carrier channel, said carrier channel adapted for the transmission of speech frequency currents, and means including a bridge circuit coupling the terminals of the carrier channel with the physical branch of said line circuit, said bridge including a resistor which presents a high resistance to the speech frequencies impressed on said carrier channel.

4. In a telephone system, a line circuit including a physical branch and a carrier channel adapted for the transmission of speech frequencies, a source of signaling current of higher voltage than those of the speech frequencies transmitted over the carrier channel, and means including a bridge circuit coupling the terminals of the carrier channel with the physical branch of said line circuit, said bridge including means which presents a high resistance at the voltage of the speech currents and becomes a low resistance at the voltage of said signaling current source.

5. In a telephone system, a line circuit including a physical branch, a carrier channel associated with said line circuit, a source of signaling current, switching means for connecting said source to said carrier channel, and a bridge circuit connected across said carrier channel and inductively associated with the physical branch of said line, said bridge including a non-linear resistance which becomes effective upon the operation of said switching means in excluding current from said source from the carrier channels and causing it to be transmitted over the physical branch of said line.

6. In a telephone system, a line circuit including a physical branch, a carrier channel associated with said line circuit, a source of signaling current, switching means for connecting said source to said carrier channel, and a bridge circuit connected across said carrier channel and inductively associated with the physical branch, said bridge including a silver sulphide resistor which becomes effective, upon the operation of said switching means, in excluding current from said source from said carrier channel and transmitting it over the physical branch of said line circuit.

7. In a telephone system, a line circuit including a physical branch, a carrier channel associated with said line circuit, means for impressing low voltage speech currents on said carrier channel, means for impressing high voltage signaling current on said carrier channel, and voltage discriminating means connected across said carrier channel and inductively associated with the physical branch of said line which serves to exclude the high voltage signaling current from said carrier channel and cause it to be transmitted over the physical branch, said discriminating means effecting a high resistance shunt across said channel when subjected to the low voltage speech currents.

8. In a telephone system, a line circuit including a physical branch, a carrier channel associated with said line circuit, means for impressing low voltage speech current on said carrier channel means for impressing high voltage signaling current on said carrier channel, and a bridge circuit connected across said carrier channel and inductively associated with the physical branch of said line, said bridge circuit including a silver sulphide resistor which presents a high resistance to the low voltage speech currents and becomes a low resistance when subjected to the high voltage signaling currents whereby said signaling currents are excluded from said carrier channel and transmitted over the physical branch of said line and the speech currents are transmitted over said carrier channel.

9. In a telephone system, a carrier channel adapted to be subjected to high voltage signaling and low voltage speech currents, and voltage discriminating means connected across said carrier channel for excluding the high voltage signaling current from said channel while permitting the transmission of the low voltage speech currents thereover, said means including a silver sulphide resistor.

10. In a telephone system, a carrier channel adapted to be subjected to high voltage signaling and low voltage speech currents, and means for effectively short-circuiting said channel when subjected to high voltage signaling current, said means comprising a circuit in bridge of said channel and including a resistor having a characteristic such that it presents a high resistance when subjected to voltages produced by the speech currents and a low resistance when subjected to voltages produced by the signaling currents.

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