

Dec. 11, 1934.

H. S. BLACK

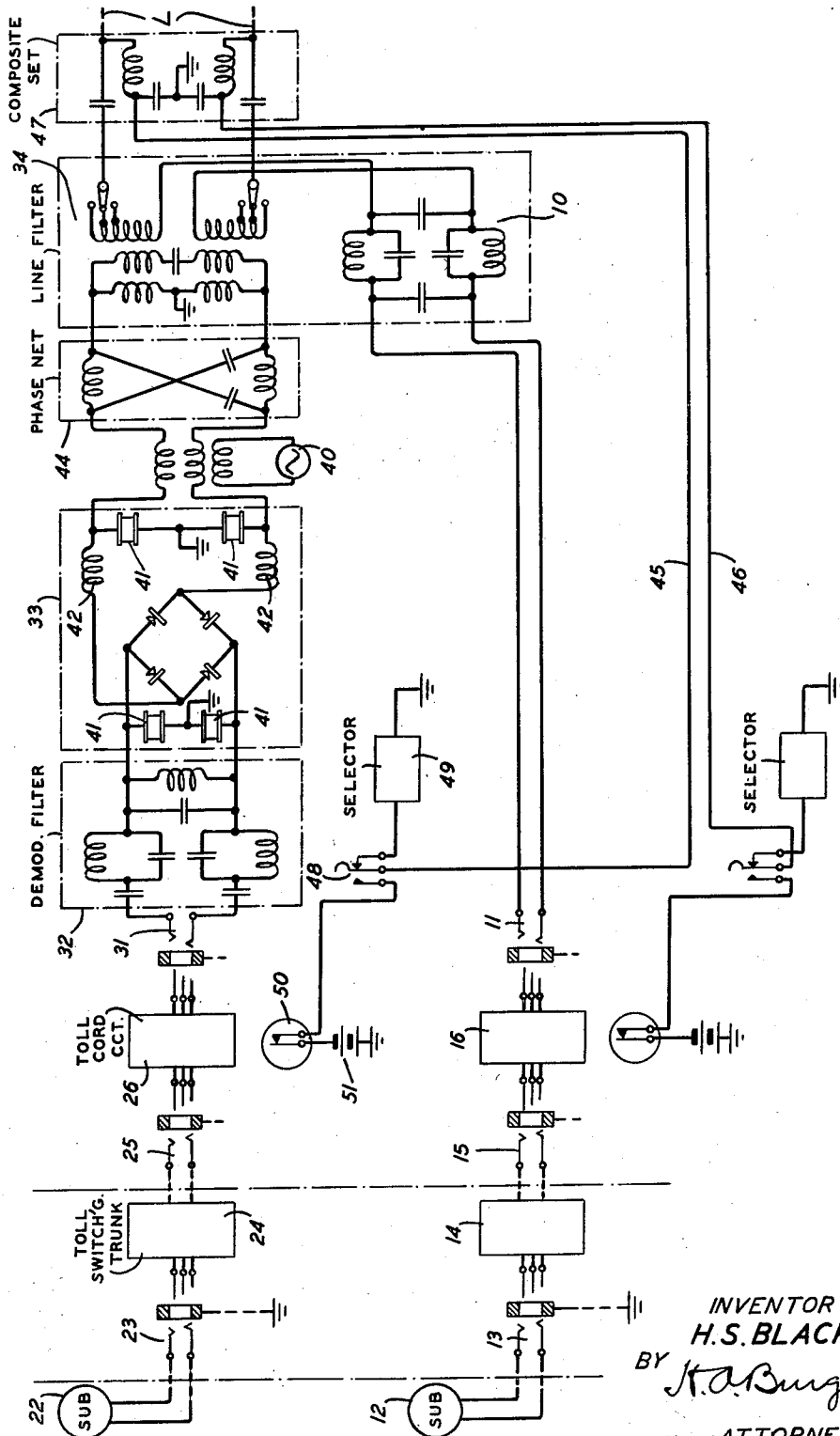
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CARRIER LINE SYSTEM

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2 Sheets-Sheet 1

FIG. 1



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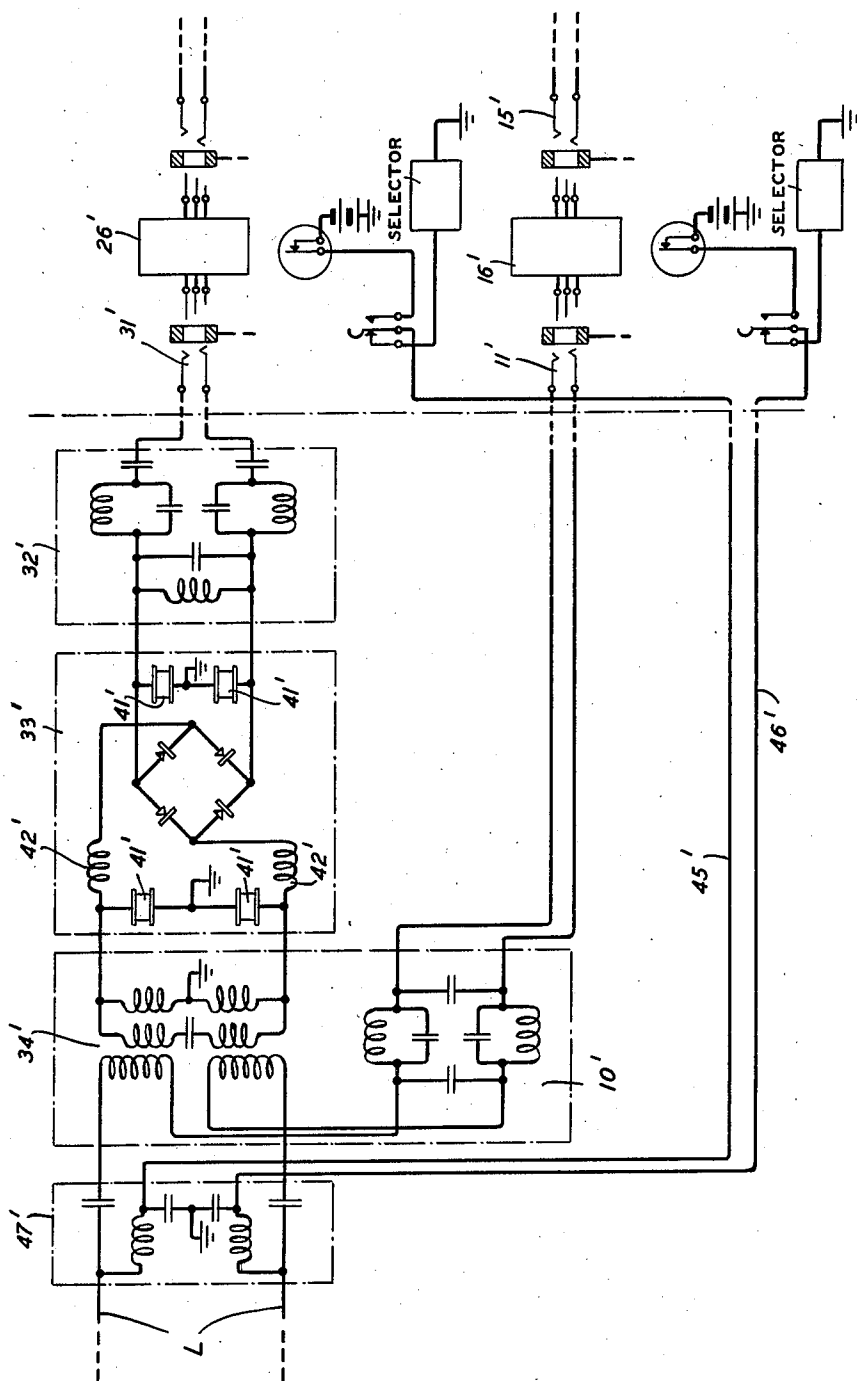
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FIG. 2



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CARRIER LINE SYSTEM

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Application December 7, 1933, Serial No. 701,268

4 Claims. (Cl. 179-43)

This invention relates to carrier line transmission of speech or other signals. It has particular reference to the two-way transmission of signals over a high frequency carrier current line.

5 An object of the invention is to simplify the apparatus required for practicing carrier telephony or other types of carrier transmission.

A related object is to provide a carrier system such that only one terminal need be attended, the
10 other terminal or terminals having only a minimum of apparatus thereat suitable for continued operation without attention.

In carrier telephony as practiced heretofore it has been usual to employ either some form
15 of differential or hybrid balance to separate transmissions in opposite directions over a line or to allocate different frequencies to oppositely directed transmissions and to separate them by grouping filters. Such systems require separate
20 high frequency transmitting and receiving branches at a terminal for respectively transmitting to and receiving from the high frequency line.

The patent to E. V. Griggs No. 1,559,867 dated
25 November 3, 1925 is an exception to this usual practice in that a single modulating circuit suffices at a channel terminal and both the incoming and outgoing transmissions pass through this modulating circuit either in opposite directions
30 through the circuit or at least without having first to be separated into a receiving and transmitting branch respectively. The present invention is a further exception to the usual practice and in its specific aspects it differs from the system disclosed in the Griggs patent in (among
35 other things) supplying the carrier waves that are to be modulated directly to the line and adapting the modulating circuit at the different terminals to derive their unmodulated carrier
40 supply from the line circuit. This enables the carrier oscillator to be located at or near one terminal and to serve as the source of supply not only to the local modulator but to those at distant terminals as well. By employing suitable
45 modulator elements, such as elements of the contact resistance or variable conductivity type maintenance may be restricted mainly to that terminal at which the carrier source is located. This results in simplification and economy in
50 operation, control and maintenance of the system.

The various aspects and objects of the invention, together with its mode of operation, will be
55 more fully understood from the following detailed description taken in conjunction with 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
60 for superposing on an ordinary telephone line L,

a carrier telephone channel according to the invention.

The ordinary telephone or "physical" circuit is connected to the line L at each station 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, and toll card 16, to jack 11 and thence to line L. At the opposite terminal (Fig. 2) the corresponding jack 11', toll cord 16' and jack 15' serve to extend the call to the wanted local or other exchange, and eventually to the wanted subscriber.

In an analogous manner, the same subscriber's station, 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 jack 31 and line L (to be described more fully hereinafter). At the opposite terminal (Fig. 2) corresponding carrier terminal equipment intervenes between line L and jack 31', from which the call is extended by toll cord 24', jack 25', etc. to the wanted exchange and eventually to the wanted subscriber.

The carrier equipment, beginning at the jack 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 and side-band currents in the carrier branch, respectively.

In addition to the elements above mentioned, the station shown in Fig. 1 has a source of carrier waves 40 and in some cases preferably would have a phase compensating network 44. The latter is described more fully and is claimed in an application of Roy W. Chesnut Serial No. 701,267, filed of even date. It will be noted that carrier source 40 is present at only the one station.

The modulator-demodulators 33, 33', are shown as comprising solid elements preferably copper oxide rectifier units in bridge circuit configuration. The carrier wave from source 40 is applied across one diagonal while the speech is applied across the opposite diagonal. As the result carrier and side-band components appear across the diagonal to which the carrier wave is applied. When demodulating, the side-bands and carrier

are both applied across the same diagonal and the detected speech appears across the other. Thus, one pair of apices of the bridge are low frequency terminals for both applied and detected speech and the other pair are high frequency terminals for the carrier and for both applied and produced side-bands. The modulator-demodulator unit is, therefore, a two-way frequency translating circuit.

Lightning protection is shown provided comprising shunt thyrite protector elements 41 and series retard coils 42.

As a means of signaling between toll operators, a composited circuit for each speech channel is shown by way of example. These circuits are shown at 45, 45' and 46, 46', each connected between one side of the line and ground, by way of composite sets 47 and 47' which may be of the usual type employed in superposing Morse telegraph circuits on a telephone line. Circuits 45 and 46 may terminate in any suitable signaling apparatus. For example, circuit 45 connects through normal contact of key 48 to a selector 49 responsive to dial impulses for actually selecting a trunk or line and making connection thereto or for operating an appropriate signal to apprise the operator of a call. The alternate contact of key 48 leads to a dial 50 and battery 51 to ground. The arrangement is the same for circuits 45', 46 and 46'.

In the operation of the system, the subscriber is put through from station 12 or 22 to the toll station in the usual manner and assuming that both connections are to be used at the same time, one cord 26 is plugged into jack 31 and the other cord 16 is plugged into jack 11. By actuating the key 48 and dial 50 associated with either channel the operator transmits impulses to the distant terminal and, as explained above, these impulses may be used to give an indication of an incoming call or designate an outgoing trunk or circuit or operate a selector to actually extend a connection. By use of the ordinary talking key in the cord, the operators at opposite ends of the line L may converse with each other.

The talking circuit, for operators or subscribers, will now be described. In the physical branch the speech circuits from subscriber or operator pass through the low filter 10 and through the line windings of the repeating coil associated with and forming part of line filter 34, through the series condensers of the composite set 47, over line L and through the corresponding elements at the opposite station to jack 11' from whence they pass through appropriate connecting circuits, such as cord 16', etc., to the wanted party.

From jack 31 the speech currents pass through the filter 32 to the modulator 33 where side-bands are produced by action of the modulator supplied by carrier current from source 40. Both side-bands and unmodulated carrier are transmitted through phase compensating network 44, line filter 34 including the repeating coil shown, through the series condensers of composite set 47 and are thus impressed on line L. At the opposite station the side-bands and carrier are received from line L through composite set 47', line filter 34' and modulator-demodulator 33' where speech currents result from the demodulation and pass through low filter 32' to jack 31' and appropriate connecting apparatus to the wanted subscriber.

Speech currents applied to jack 31' for transmission over line L pass through speech filter

32' to modulator-demodulator 33' where they modulate carrier current supplied over the line L from source 40 at the distant terminal. The resulting side-bands traverse the line to the terminal in Fig. 1 and are demodulated in circuit 33 by combination with carrier current from source 40. The output of demodulated speech will be the maximum if, other things being equal, the carrier wave is supplied to both modulator-demodulators 33, 33' in such phase that if the unmodulated carrier component be considered as transmitted from 33' to 33 it arrives exactly in phase with that supplied to 33 from source 40. The effect will then be the same as though a separate source of carrier had been used at 33' and the unmodulated carrier component from that source arrived at demodulator 33 exactly in phase with the wave from source 40. In the case of some lines it will be advantageous to use a phase compensating network 44 to build out the line to a desired total phase shift, as explained more fully in the copending Chesnut application referred to above.

In one case the thyrite protectors 41 and inductances 42 were effective against power surges induced from neighboring power lines to reduce a voltage of 800 volts appearing across the copper oxide unit to a voltage of 30 volts. In place of the thyrite protectors 41, neon tubes can be used as arresters. Such tubes have been found to introduce a transmission loss of as low an order as 0.05 decibel.

It will be noted that the carrier apparatus in Fig. 2 is or may be located at a distance from the exchange in Fig. 2 as is indicated by the broken line extending across the various circuits and the dotted line showing of the conductors. For instance, the apparatus shown in the broken line enclosures at 10', 32', 33', 34' and 47' may all be mounted in a casing on a pole or in a man-hole and the lines extending across the broken line at the right of Fig. 2 may be in the form of toll entrance cable leading to the toll office of Fig. 2. This is practicable because of the lack of necessity for maintenance of the carrier apparatus at this terminal. In one case all of the apparatus mentioned above as adapted for mounting on a pole was included in a casing 9 inches by 3½ inches by 3½ inches.

What is claimed is:

1. A duplex signaling system comprising a high frequency transmission line connecting stations adapted for connection to subscribers' lines, a bi-directionally conducting modulator-detector device at each station connected between said transmission line and a subscribers' line, each of said devices serving as a modulator for signals passing from the respective subscriber's line to said high frequency transmission line and as a detector for signals passing in the other direction through the device, and a source of carrier current connected to the modulator-detector device at one only of said stations, said source supplying carrier current to said one device and over said transmission line to said device at the distant station.

2. In a carrier wave system, a high frequency line having terminal stations, low frequency circuits at each station, a two-way frequency translating device at each station connected between said high frequency line and one of said low frequency lines, a source of carrier waves applied to said high frequency line, waves from said source being impressed at each station on said translating device, each of said devices operating

to modulate said waves by low frequency signals received over the respective low frequency circuit and to demodulate carrier wave signals received over said high frequency line.

5 3. A system according to claim 2 in which said frequency translating devices comprise variable impedance elements in bridge configuration, with the high frequency line and low frequency circuit effectively connected across opposite diagonals.

10 4. In a carrier wave signaling system, a line extending between terminal stations, a carrier terminal at one of said stations, a carrier terminal adjacent the other station and connected

by line conductors to said other station, each carrier terminal including a bi-lateral modulator-demodulator unit adapted to modulate carrier waves by signals and to demodulate modulated carrier waves to reproduce signals, and a single source of carrier waves for said system connected to the line at the first station and supplying unmodulated carrier current to both carrier terminals, whereby said second-mentioned carrier terminal is adapted for mounting at a distance 10 from all attended points of the system.

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