

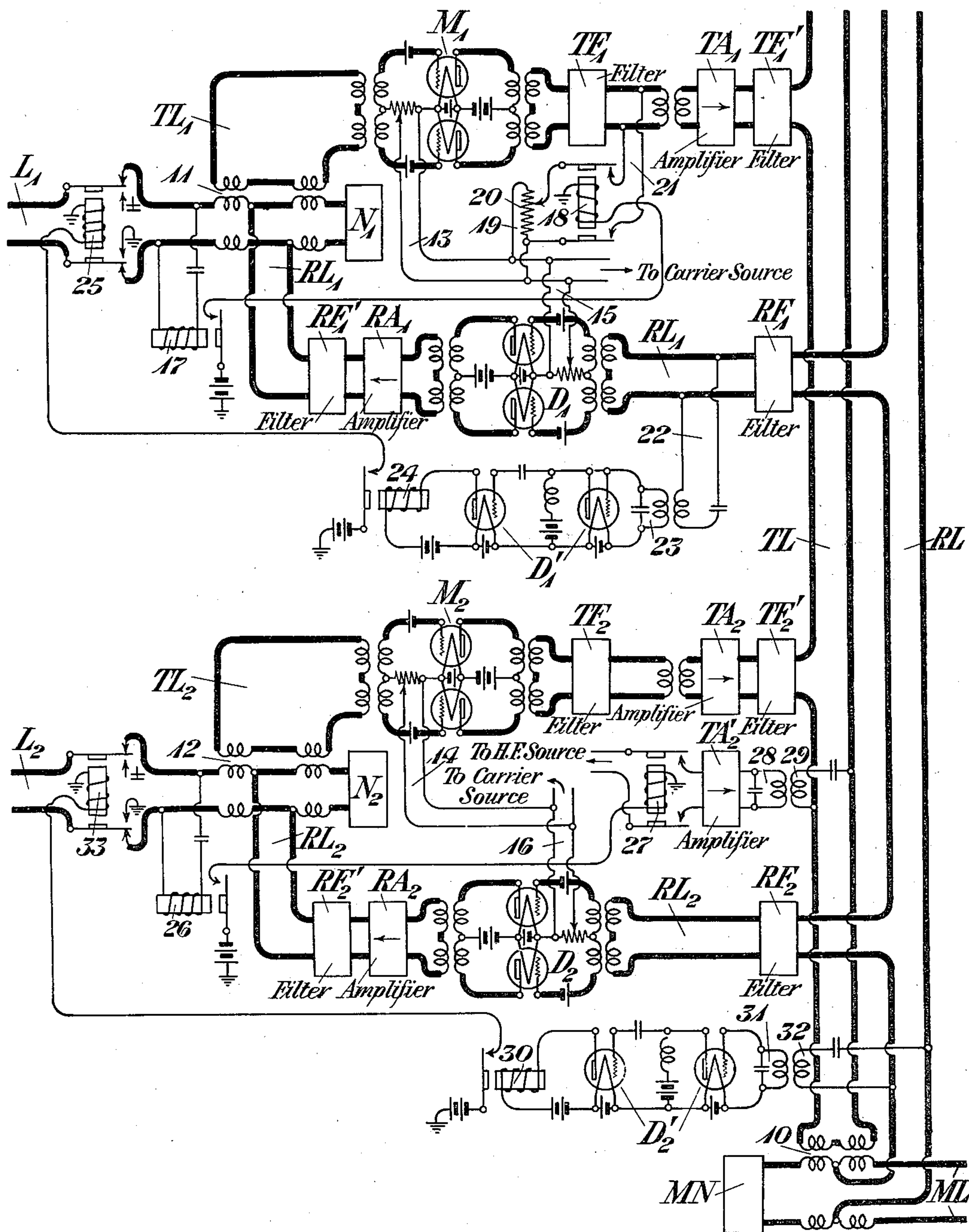
Nov. 6, 1923.

1,472,821

H. A. AFFEL

RINGING CHANNEL FOR MULTIPLEX TELEPHONE SYSTEMS

Filed July 29, 1919



INVENTOR.
H. A. Affel
BY *ge 402*
ATTORNEY

UNITED STATES PATENT OFFICE.

HERMAN A. AFFEL, OF BROOKLYN, NEW YORK, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

RINGING CHANNEL FOR MULTIPLEX TELEPHONE SYSTEMS.

Application filed July 29, 1919. Serial No. 314,072.

To all whom it may concern:

Be it known that I, HERMAN A. AFFEL, residing at Brooklyn, in the county of Kings and State of New York, have invented certain Improvements in Ringing Channels for Multiplex Telephone Systems, of which the following is a specification.

This invention relates to transmission systems and more particularly to multiplex transmission systems employing carrier currents.

Where multiplex transmission is attained by the use of carrier currents a plurality of carrier frequencies are transmitted over a common transmission line, the carrier frequencies being separated sufficiently to prevent interference and each frequency being assigned for use as a separate channel of communication so that signals, such, for instance, as telephonic variations may be transmitted by impressing them upon the carrier frequencies. Several channels may thus be superposed upon a common transmission line and each channel performs the functions of an ordinary telephone transmission line.

In ordinary telephone transmission it is customary to transmit over the line, in addition to the telephone currents, ringing currents or other signaling currents, for the purpose of signaling between operators in establishing connections. In order to obtain practical telephone service over each carrier communication channel, it is desirable that the channel be utilized for the transmission of such ringing or other signaling currents as well as for the transmission of the ordinary telephone currents.

This invention therefore provides means whereby ringing and other signals may be transmitted for each carrier channel.

The invention also provides a multiplex transmission system in which telephonic and ringing signals may be separately translated into high frequency carrier oscillations and then combined for transmission over a common transmission circuit.

The invention likewise provides a multiplex transmission system in which ringing signals and telephonic signals are transmitted in the form of carrier currents over a common transmission circuit and are sep-

arated at the receiving station in their high frequency condition.

Similarly the invention provides a multiplex transmission system in which telephonic and ringing signals are combined for transmission as high frequency carrier currents after modulation and are separated at the receiving station for transmission as low frequency currents before demodulation.

The invention also provides a multiplex transmission system in which telephonic and ringing signals are translated into high frequency carrier currents for transmission to distant points, taking advantage at the receiving station of the frequency differences existing between the signals in their high frequency condition for separating them.

Another feature of the invention is the provision of a multiplex transmission system in which wholly or at least partially separated channels are provided for the transmission of talking and ringing currents.

Still another feature of the invention is the provision of a multiplex transmission system in which separate high frequency ranges may be used for the transmission of telephonic and ringing signals.

In order to clearly understand the manner in which the above and other objects of the invention are carried out, it is desirable that some consideration should be given to the character of the phenomena which take place when low frequency currents, such as telephone currents, are translated into high frequency carrier currents for multiplex transmission.

The frequencies transmitted over the channels of a carrier telephone system are those of the individual carrier frequencies modified in frequency by the voice frequencies.

Where, for instance, four channels having frequencies of 10,000, 15,000, 20,000 and 25,000 cycles, respectively, are employed, the 20,000 cycle channel is modified by the voice frequency so that it varies from instant to instant in accordance with the voice frequencies from 20,000 cycles minus 2,000 cycles to 20,000 cycles plus 2,000 cycles (2,000 cycles being taken as the extreme of the telephone frequencies employed). Where a system is employed in which the carrier fre-

quency and one side frequency is suppressed only the frequencies above or below 20,000 cycles would be transmitted. For instance, if the frequencies from 20,000 cycles up are suppressed by means of a band filter only frequencies ranging between 18,000 and 20,000 would be transmitted.

The operation of translating an ordinary telephone circuit into a carrier channel may be regarded as being that of merely elevating the frequency band occupied by the telephone circuit to a higher position in the broad frequency scale where it occupies a band of frequencies of the same width as it did at the ordinary telephone frequencies; that is, the several telephone circuits feeding into a carrier system may be regarded as being merely shifted in frequency from their absolute values, the different circuits being displaced by different amounts in frequency so that they do not overlap in the carrier frequency scale. Since the low frequency band of each telephone circuit, which is thus shifted does not ordinarily extend down to zero frequency, but has a lower limit somewhere in the region of 300 cycles, it is apparent that a frequency difference of about 300 cycles will exist between the normal carrier frequency of each channel and the nearest modulated frequency due to voice frequencies. For instance, in the case of the channel having a normal frequency of 20,000 cycles, if the said band above the normal carrier frequency is suppressed and frequencies ranging from 18,000 to 20,000 cycles are transmitted, the transmission of voice frequencies would only occupy that portion of the transmitted range which extends between 18,000 cycles and 19,700 cycles.

If then some arrangement is provided whereby ringing signals are translated into unmodulated currents of the normal carrier frequency of the channel assigned for the corresponding voice currents, a sufficient degree of separation in frequency would exist between the modulated voice currents and the unmodulated oscillations representing ringing signals so that when transmitted to a receiving station the voice and ringing signals may be separated at high frequency by means of proper filtering or tuning arrangements. For instance, in the case of the channel whose normal frequency is 20,000 cycles, by providing a sharply tuned circuit at the receiving station which is resonant at 20,000 cycles, the 20,000 cycle frequencies representing ringing signals may be selected and separately demodulated, while the frequencies between 19,700 and 18,000 cycles representing voice currents may be passed to another demodulator whereby these frequencies are separately translated into low frequency voice currents.

It is not necessary, however, in carrying out the invention to utilize the normal car-

rier frequency of each channel for the transmission of ringing signals, as frequencies may be assigned for the transmission of ringing currents which are located in the broad frequency scale between each corresponding telephone channel and the next adjacent telephone channel. In fact it is not necessary that the frequencies assigned for the transmission of ringing signals be even thus closely associated with the corresponding telephone channels, as the ringing channels corresponding to the several telephone channels may be grouped together in a frequency range either above or below the group of telephone channels in the broad frequency scale. Under any one of the conditions above referred to it is possible to cause separate modulation of the telephone and ringing signals so that they may be combined for high frequency transmission over a common transmission circuit. Likewise, in each case the telephone and ringing signals may be separated at the receiving station in their high frequency condition and then separately be demodulated.

The invention may now be fully understood by reference to the following description when read in connection with the accompanying drawing, the figure of which is a diagram illustrating such features of the apparatus as is necessary to a clear understanding of the invention.

Referring to the drawing, ML designates a main transmission line connected at one end through a transformer 10 with a common transmitting circuit TL and a common receiving circuit RL, whereby the main transmission line may be associated with terminal carrier apparatus. In order to render the transmitting circuit TL and receiving circuit RL conjugate with respect to each other so that electrical variations in the one circuit will not affect the other, the main line ML is balanced by an artificial line or net work MN. In the diagram the carrier apparatus associated with one end of the transmission line ML only is illustrated, it being understood that at a distant station the main line will terminate in similar apparatus.

A low frequency transmission line, such as a telephone line L_1 , is shown associated with the main line ML for carrier transmission by means of a carrier transmitting channel TL_1 and a carrier receiving channel RL_1 , the former being connected to the common transmitting circuit TL and the latter to the common receiving circuit RL. The transmitting channel TL_1 , and receiving channel RL_1 are associated with the terminal line L_1 through a transformer 11 and are rendered conjugate with respect to each other by balancing the transmission line L_1 with an artificial line or net work N_1 . In a similar manner other low frequency trans-

mission lines, such as L_2 , may be associated with the main line ML through carrier transmitting channels, such as TL_2 and carrier receiving channels, such as RL_2 . The channels TL_2 and RL_2 are associated with the terminal line L_2 through a transformer 12 and are rendered conjugate with respect to each other by balancing the line L_2 by means of an artificial line or net work N_2 .

The transmitting channel TL_1 includes a modulator M_1 , broad band filters TF_1 and TF_1' and an amplifier TA_1 . The broad band filters TF_1 and TF_1' are preferably of the type illustrated and described in U. S. patents to George A. Campbell, Nos. 1,227,113 and 1,227,114 dated May 22, 1917. These filters are so designed as to transmit a range of frequencies extending either above or below the normal carrier frequency assigned to the channel by a frequency range equal to a band of frequencies for low frequency transmission extending from zero up to the upper frequency employed in ordinary telephonic transmission.

The modulator M_1 may be of any well-known type, but is preferably a duplex vacuum tube modulator of the general type illustrated and described in the U. S. patent to B. W. Kendall, No. 1,459,709, issued June 19, 1923, or in the U. S. patent to John R. Carson, No. 1,343,307 issued June 15, 1920. Carrier oscillations of the proper frequency are transmitted from a suitable source to the common branch of the input circuits of the modulator M_1 through a circuit 13, and as set forth in the above patents to B. W. Kendall and John R. Carson, the modulator M_1 is normally balanced so that in the absence of modulating low frequency currents no carrier oscillations are transmitted.

The amplifier TA_1 is included in the transmitting channel TL_1 between the filter TF_1 and the filter TF_1' . This is preferably an amplifier of the well-known vacuum tube type.

Similarly, the transmitting channel TL_2 includes a modulator M_2 , filters TF_2 and TF_2' and an amplifier TA_2 . These elements are similar to the corresponding elements of the transmitting channel TL_1 , the modulator M_2 being supplied with carrier oscillations of the frequency assigned to this channel over a circuit 14. The filters TF_2 and TF_2' differ from the filters TF_1 and TF_1' only in that the range of frequencies transmitted thereby is located on the broad frequency scale sufficiently far distant from the band of frequencies transmitted by the filters TF_1 and TF_1' to avoid interference.

The receiving channel RL_1 includes broad band filters RF_1 and RF_1' , a demodulator or detector D_1 and an amplifier RA_1 . The filters RF_1 and RF_1' are likewise of the general type disclosed in the patents to

Campbell above referred to, the filter RF_1 being substantially identical in structure and characteristics with the filters TF_1 and TF_1' . The filter RF_1 , however, is a low frequency filter and is designed to transmit a band of frequencies extending over the range employed in ordinary telephonic transmission.

The demodulator D_1 may be of any well known character, but is preferably of the duplex vacuum tube type disclosed in the U. S. patent to John R. Carson, No. 1,343,308 issued June 15, 1920. As set forth in the said application of John R. Carson the duplex modulator operates upon the so-called homodyne method of receiving and is therefore supplied with carrier oscillations of the same frequency as those supplied to the modulator M_1 , said oscillations being supplied to the common branch of the input circuit of the demodulator D_1 over a branch circuit 15. The amplifier RA_1 is in general similar to the amplifier TA_1 and is used for the transmission of low frequency currents.

The receiving channel RL_2 includes filters RF_2 and RF_2' , a demodulator or detector D_2 and an amplifier RA_2 , these elements being in general similar to the corresponding elements of the receiving channel RL_1 . The filter RF_2 , however, is arranged to transmit a band of frequencies similar to that transmitted by the filters TF_2 and TF_2' .

In order to transmit ringing signals incoming from the line L_1 over the main line M_1 to a distant station a relay 17 is bridged across the line L_1 , its circuit being so arranged as to be readily responsive to currents of ringing frequency but to offer a high impedance to currents of telephone frequency. This relay controls a relay 18 whereby unmodulated oscillations of the normal frequency assigned to the transmitting and receiving channels TL_1 and RL_1 may be applied to some point of the outgoing circuit beyond the modulator M_1 . As herein illustrated these oscillations are taken from the source of carrier frequencies assigned to the transmitting and receiving channels TL_1 and RL_1 over a branch circuit 19 through a potentiometer 20 and over a circuit 21 which is connected to the transmitting channel TL_1 between the filter TF_1 and the amplifier TA_1 . By applying the oscillations corresponding to the ringing signal at this point the amplifier TA_1 used for amplifying the high frequency oscillations modulated in accordance with telephonic signals may be also used for amplifying the unmodulated oscillations representing the ringing signal.

In order to separate, before detection the received high frequency oscillations representing a ringing signal from received modulated high frequency oscillations corresponding to telephonic signals, a tuned bridge 22 may be included at some point in the receive-

ing circuit, said bridge being tuned as sharply as possible to the frequency of the normal carrier oscillations assigned to the transmitting and receiving channels TL_1 and RL_1 . As illustrated the tuned circuit 22 is bridged across the receiving channel RL_1 between the filter RF_1 and the demodulator or detector D_1 employed for detecting telephonic currents. The circuit 22 is inductively associated with a resonant circuit 23 associated with the input of an amplifying and detecting arrangement D_1' , comprising two vacuum tubes arranged in tandem with a direct current relay 24 in the output circuit in the last tube of the series. By means of this arrangement the received oscillations of carrier frequency and constant amplitude corresponding to the ringing signal are translated into a direct current signal where- by the relay 24 is energized to control the application of a local source of ringing current to the line L_1 through the medium of the relay 25.

The means employed for translating the ringing signal into high frequency oscillations and for translating high frequency oscillations into a ringing signal above described in connection with the line L_1 involve the employment of high frequency oscillations for the transmission of the ringing signal having a frequency at or in the neighborhood of the normal carrier frequency assigned to the telephone channel, although any frequency between the normal carrier frequency of the channel and the nearest adjacent high frequency employed in the transmission of telephonic currents over the channel may be used, provided selecting circuits are available having a sufficiently sharp frequency discrimination. In some instances it may be desirable to employ for the transmission of ringing signals high frequency oscillations of constant amplitude and having a frequency lying without the frequency range above described. For instance, it may be desirable to utilize a frequency for the ringing channel which lies between the frequency range of the corresponding telephone channel and the frequency range employed for the nearest adjacent telephone channel either above or below the first mentioned channel in the broad frequency scale. Under other conditions it may be preferable to employ for the transmission of ringing signals carrier frequencies remote from the corresponding frequency ranges employed for telephonic transmission, so that the frequencies employed for the transmission of ringing signals may be grouped either above or below the group of channels employed for telephonic transmission. In order to provide for the several conditions just mentioned, the modified circuit arrangement illustrated in connection with the line L_2 may be employed.

In accordance with the modified arrangement the ringing responsive relay 26 bridged across the line L_2 to respond to ringing signals transmitted thereover controls a relay 27 whereby oscillations of constant amplitude from some source having the desired frequency may be applied to the common transmitting circuit TL . In order to amplify these oscillations an amplifier TA_1' of the same general character as the amplifier TA_2 may be employed, the oscillations being impressed upon the common transmitting circuit TL through suitable tuned circuits 28 and 29. In order to translate received high frequency oscillations representing ringing signals into the corresponding signals a detecting and amplifying arrangement D_2' comprising a pair of vacuum tubes arranged in tandem and having a direct current relay 30 in the output circuit of the last tube of the series is associated with the common receiving circuit RL_1 through tuned circuits 31 and 32. The circuits 31 and 32 are tuned to the frequency of the oscillations assigned to the ringing channel associated with the line L_2 .

The ringing arrangements above described in connection with the line L_2 are of such a character that by suitable adjustment of the tuned circuits 28—29 and 31—32 frequencies at any point in the broad frequency scale may be utilized for ringing purposes, the only limitation being that the frequencies be so chosen as not to interfere with channels for the transmission of telephone currents. Thus for the line L_2 the frequency supplied over the contacts of the relay 27 may be equal to the normal carrier frequency of the channel as in the case of the line L_1 , or it may be a frequency intermediate between the frequency bands employed for telephonic transmission, or it may be a frequency lying either above or below the group of frequency bands employed for the transmission of telephone currents. In short, the several frequencies employed for the transmission of ringing signals may be interspersed between the various telephone channels or may be grouped together either above or below the group of telephone channels upon the broad frequency scale.

It will be understood of course that while channels are illustrated for only two lines, the system may include channels for as many additional lines as desired, all being adapted for transmission over the main line ML . Furthermore, while the carrier arrangements associated with the two lines illustrated are shown as being specifically different in order that more than one modification may be illustrated without unnecessary duplication of diagrams, it will be understood that the arrangements of all of the lines in the system may be of the same character.

Further details of the apparatus may now be understood from a description of the operation which is as follows:

Telephone currents incoming from the line L_1 are transmitted over the back contacts of relay 25 and through the transformer 11 to the input circuit of the modulator M_1 . As has already been stated the modulator M_1 is so arranged that normally no high frequency oscillations are transmitted, due to the balanced arrangement of the circuit. Upon the application of telephonic variations to the input circuit of the modulator, however, the modulator is unbalanced so that high frequency carrier oscillations are transmitted and modulated in accordance with the telephonic signals. These oscillations are transmitted through the filter TF_1 so that on the output side thereof a band of frequencies appear equal in width to the range of frequencies employed in low frequency telephone transmission, said band of frequencies being either above or below the frequency of the oscillations supplied from the circuit 13 with a frequency difference of say 300 cycles between the normal frequencies applied to the circuit 13 and the nearest modulated frequency. This band of frequencies is then amplified by the amplifier TA_1 and transmitted through the filter TF_1' to the common transmission circuit TL where it is combined with modulated frequencies from other transmitting channels and then transmitted through the transformer 10 and over the main line ML to the distant station.

In a similar manner modulated high frequency oscillations transmitted from the distant station over the main line ML pass into the receiving circuit RL and are selected through the filters RF_1 , RF_2 , etc. The modulated band of frequencies corresponding to the telephone signal which is to be transmitted to the line L_1 passes through the filter RF_1 and as the bridge circuit 22 is tuned to the normal carrier frequency of the channel while the nearest adjacent frequency in the telephone band will have a frequency difference in respect thereto in the neighborhood of 300 cycles, the band of telephone frequencies passing through the filter will not be diverted into the circuit 22, but will be impressed upon the output circuit of the demodulator D_1 . In the demodulator this band of frequencies reacts with unmodulated oscillations of the basic carrier frequency supplied over the circuit 15 so that in the output of the detector D_1 low frequency telephone currents appear corresponding to the telephone signal in accordance with which the carrier oscillations were modulated at the distant station. The low frequency telephone currents are then amplified by the amplifier RA_1 and are passed through the low frequency filter RF_1' to the

mid points of the line windings of the transformer 11 where the energy divides, part being transmitted to the artificial line N_1 and part being transmitted over the back contacts of the relay 25 to the line L_1 .

70 Ringing current incoming from the line L_1 actuates the relay 17, the circuit of which is tuned to ringing frequency. Relay 17 causes the energization of relay 18 whereby oscillations of the carrier frequency assigned to the channel under consideration are transmitted through the potentiometer 20 and over the front contacts of the relay 18 and over the circuit 21 to the input side of the amplifier TA_1 . The oscillations are now amplified by the amplifier TA_1 and transmitted through the filter TF_1' to the common transmitting circuit TL. From this point the oscillations corresponding to the ringing signal are transmitted through the transformer 10 and over the line ML to the distant station. A ringing signal translated into carrier oscillations of the same frequency and constant amplitude transmitted over the line ML from a distant station passes into the common receiving circuit RL and through the filter RF_1 . As the circuit 22 is tuned to the frequency of these oscillations the major portion of the energy thereof passes into the bridge 22 and through the transmitting circuit 23 to the combined detector and amplifier D_1' . As a result an increased direct current flows through the relay 24 in the output circuit of the last tube of the apparatus D_1' so that said relay is energized and closes the circuit of the relay 25. The relay 25 disconnects the line L_1 from the high frequency apparatus and applies ringing current from a local source thereto.

105 Telephonic transmission between the line L_2 and the main line ML takes place in both directions in a manner similar to that already described in connection with the line L_1 and need not be further considered. Ringing current incoming from the line L_2 , however, passes over the back contacts of relay 33 and into the bridge including the relay 26 which is thereby energized and completes the circuit of the relay 27. The relay 27 upon being energized applies oscillations having a frequency assigned to the ringing channel associated with the line L_2 over the front contacts of said relay to the amplifier TA_2' whereby the oscillations corresponding to the ringing signal are amplified. The oscillations are then transmitted through the tuned circuits 28 and 29 to the common transmitting circuit TL and through the transformer 10 over the main line ML to the distant station. High frequency oscillations of the frequency assigned to the receiving ringing channel associated with the line L_2 are transmitted over the line ML in response to a ringing 130

signal arising at the distant station and then pass into the common receiving circuit RL. Owing to the fact that circuits 31 and 32 are tuned to this frequency, these oscillations pass to the input circuit of the combined demodulating and amplifying arrangement D_2' , thereby operating the direct current relay 30 to close the circuit of relay 33. The relay 33 disconnects the line L_2 from the carrier apparatus and applies the source of ringing current thereto so that the ringing signal is transmitted to the distant terminal station.

By means of the arrangements above described telephone and ringing signals may be translated into high frequency oscillations and combined in their high frequency state for transmission over a common circuit, being again separated at the distant station while still in their high frequency condition so that they may be separately detected, thus permitting a wide choice in the frequencies assigned for the transmission of ringing signals. It will further be understood that while the invention has been illustrated as embodied in certain organizations which are deemed desirable from a practical standpoint, the general principles herein disclosed may be embodied in many other organizations widely different from those illustrated without departing from the spirit of the invention as defined in the following claims.

What is claimed is:

1. In a signaling system, a transmission line, means to transmit over said line modulated high frequency currents corresponding to speech signals, means responsive to ringing signals to transmit over said line high frequency currents corresponding to said ringing signals, means to separate high frequency currents of the latter character from currents of the former character, separate means to detect from the two sets of currents speech and ringing signals and means for impressing said speech and ringing signals upon a common circuit.

2. In a signaling system, a transmission line for the transmission of telephone and ringing signals, means at a sending station for transmitting to said line high frequency oscillations modulated in accordance with speech and means responsive to ringing signals to transmit over said line high frequency oscillations corresponding to said ringing signals, and means at a receiving station for detecting speech and ringing signals from said oscillations, means at said receiving stations for separating said speech and ringing signals before detection and means for impressing said speech and ringing signals upon a common circuit after detection.

3. In a signaling system, means to translate voice signals into high frequency oscillations,

means responsive to ringing signals to translate said ringing signals into high frequency oscillations, means to transmit said high frequency oscillations to a distant station, means at said station to separate the high frequency oscillations corresponding to ringing signals from the high frequency oscillations corresponding to voice signals, means to thereafter translate said high frequency oscillations into ringing and voice signals and means for impressing said ringing and voice signals upon a common circuit.

4. In a signaling system, a circuit over which voice and ringing signals may be transmitted, a transmission line, a modulator for transmitting to said line high frequency oscillations modulated in accordance with voice signals from said circuit, and means responsive to ringing signals from said circuit to transmit to said line independently of said modulator high frequency oscillations corresponding to said ringing signals.

5. In a signaling system, a transmission line, a modulator for transmitting to said line high frequency oscillations modulated in accordance with voice signals, means responsive to ringing signals to transmit to said line independently of said modulator high frequency oscillations corresponding to said ringing signals, means at a receiving station to separate said two kinds of oscillations, means to thereafter translate said oscillations into talking and ringing currents and means for impressing said talking and ringing currents upon a common circuit.

6. In a signaling system, a common circuit over which speech signals and other signals may be transmitted, a transmission line, means to transmit over said line high frequency oscillations modulated in accordance with speech signals from said common circuit, means responsive to other signals from said common circuit to transmit to said line unmodulated high frequency oscillations, means to separate said unmodulated oscillations from said modulated oscillations, and means to translate said unmodulated oscillations into a ringing signal.

7. In a signaling system, a high frequency transmission line, a plurality of low frequency lines associated with one end thereof, means individual to each low frequency line to translate voice currents incoming from said low frequency lines into modulated high frequency oscillations for simultaneous transmission over said high frequency line, means individual to each low frequency line and responsive to signals other than voice signals transmitted over said low frequency lines, said means operating to transmit unmodulated high frequency oscillations over said high frequency

line in order to transmit said signals other than voice signals, and means associating the other end of said high frequency line with other low frequency lines, said means operating to discriminate between said modulated and unmodulated oscillations.

8. In a signaling system, a high frequency transmission line, a plurality of low frequency lines associated with one end thereof, means to translate voice signals incoming from said low frequency lines into modulated high frequency oscillations for transmission over said high frequency line, means responsive to signals other than voice signals incoming from said lines to transmit unmodulated high frequency oscillations over said high frequency line, and means at the other end of said high frequency line to discriminate between said modulated and unmodulated oscillations.

9. In a signaling system, a high frequency transmission line, a plurality of low frequency lines associated with one end thereof, means to translate voice signals incoming from said low frequency lines into modulated high frequency oscillations for transmission over said high frequency line, means responsive to signals other than voice signals incoming from said lines to transmit unmodulated high frequency oscillations over said high frequency line, means at the other end of said high frequency line to discriminate between said modulated and unmodulated oscillations and means to detect from the separated modulated and unmodulated oscillations voice signals and other signals.

10. In a signaling system, a high frequency transmission line, means to simultaneously transmit over said line a plurality of modulated high frequency oscillations in order to transmit a plurality of voice signals, means responsive to signals other than voice signals to transmit over said line a plurality of unmodulated high frequency oscillations in correspondence to a plurality of signals other than voice signals, means associated with said line for

discriminating between modulated and unmodulated oscillations, a plurality of detectors for detecting a plurality of voice signals from said modulated oscillations, a plurality of additional detectors, one corresponding to each of said first mentioned detectors, for translating said unmodulated oscillations into a plurality of signals other than voice signals, and a plurality of terminal lines over each of which currents may be transmitted under the control of a particular one of said first mentioned detectors, and also under the control of a corresponding detector of the last mentioned group.

11. In a signalling system, a high frequency transmission line, a plurality of low frequency lines associated with one end thereof, means to translate voice signals incoming from said low frequency lines into modulated high frequency oscillations for transmission over said high frequency line, means responsive to signals other than voice signals incoming from said lines for controlling the transmission of unmodulated high frequency oscillations over said high frequency line, and means at the other end of said high frequency line to discriminate between said modulated and unmodulated oscillations.

12. In a signalling system, a high frequency transmission line, a plurality of low frequency lines associated with one end thereof, means to translate voice signals incoming from said low frequency lines into modulated high frequency oscillations for transmission over said high frequency line, means responsive to ringing signals incoming from said low frequency lines to control the transmission of unmodulated high frequency oscillations over said high frequency line, and means at the other end of said high frequency line to discriminate between said modulated and unmodulated oscillations.

In testimony whereof, I have signed my name to this specification this 23rd day of July 1919.

HERMAN A. AFFEL.