Fig. 4

Input level - db below 1 milliwatt

Fig. 6

Receiving relay current - mill.

Frequency deviation - cycles per second

Fig. 7

Receiving signal level percent

Frequency deviation between H.F. oscillators - cycles per second

Fig. 5

Attenuation - db

Channel filter

Spacing discriminator

Marking discriminator

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The invention relates to carrier wave signaling systems and particularly to carrier telegraph systems.

The invention is particularly applicable to, although not limited to, such a system including, as a unit therein, a multichannel voice-frequency carrier telegraph system utilizing in each channel two tones of voice frequency slightly separated in frequency, respectively, for the transmitted “marking” and “spacing” telegraph signals representing a telegraph message, which are separately detected at the receiving end of the system and applied to the opposing windings of the channel polar receiving relay causing its operation to repeat the marking and spacing signals. Where it is desired to transmit the voice-frequency telegraph signals of such systems between widely separated points efficiently and cheaply, one of the voice-frequency carrier telegraph terminals may be located at each of those points, and a portion of an existing high frequency transmission system extending between those points, for example, a high frequency channel of a single side-band suppressed carrier telephone system, utilized for transmitting the telegraph signals between the voice-frequency terminals. In that case, a group modulator with an associated high frequency carrier source at the transmitting end of the high frequency channel would be utilized for stepping up the fundamental voice-frequency carrier channels to the higher frequencies required for transmission over it, and a group demodulator with an associated high frequency carrier source at the receiving end of the high frequency channel, for stepping down the received carrier telegraph channels to voice frequencies for reception.

In certain of the existing high frequency systems which may be used in such a combination system, the high frequency oscillators associated with the group modulator and demodulator in the high frequency channel for each direction are normally operated unsynchronized. They may, therefore, have instantaneous frequency differences between them at times which may be sufficient, particularly where the telegraph signals are applied to the voice-frequency carriers by frequency modulation, to introduce intolerable signal bias variations in the received telegraph channels.

An object of the invention is to reduce signal distortion in carrier telegraph systems.

A more specific object is to reduce to an objectionable amount signal bias variations in the telegraph channels of a multichannel voice-frequency carrier telegraph system employing frequency modulation, operated over a high frequency channel employing unsynchronized high frequency carrier sources associated with the group modulation and demodulation apparatus at its opposite terminals.

These objects are attained in accordance with the invention by sending out over the high-frequency channel combining a modulator with the received signal-modulated carriers prior to their separation and demodulation, to transform them to desired low frequencies. The final modulation process effectively cancels out from the received signals any variations introduced by deviations between the frequencies of the unsynchronized high frequency carrier sources associated with the group modulator and demodulator in the high frequency link.

The various features and objects of the invention will be better understood from the following detailed description when read in conjunction with the accompanying drawings in which:

Figs. 1 to 3 in combination show schematically a two-way carrier telegraph system employing frequency modulation, embodying the invention; and

Figs. 4 to 7 show curves used to explain the invention.

Figs. 1, 2, 3, when placed side by side in that order with Fig. 1 at the left, show a complete two-way carrier telegraph system providing four message channels in each direction, consisting of a west and east two-way voice frequency carrier telegraph terminal and an intermediate two-way high frequency transmission link HFL, which may be one two-way high frequency channel of a multichannel single side-band carrier telephone system, converted to telegraph use.

The high frequency transmission link HFL of the combination system, as shown in Fig. 1, comprises a west-to-east one-way high frequency repeating path EA and an east-to-west one-way high frequency repeating path WA coupled at their west and east terminals in conjugate relation with each other and in energy transmitting relation with the west two-way line section LE by means of the hybrid repeating coil HCS and the associated line balancing network NW, and the hybrid repeating coil HCS and associated line balancing network NZ, respectively. The path EA includes
and \( F_{o1} \) respectively adapted to pass only a band of frequencies corresponding to the total frequency range of the modulated voice-frequency carriers and pilot wave generated at the west voice-frequency carrier telegraph terminal, and the path \( W_A \) in its input and output the band-pass filters \( F_{a1} \) and \( F_{a2} \) respectively adapted to pass only a band of frequencies corresponding to the total frequency range of the modulated voice frequency carriers and pilot wave generated at the east voice frequency carrier telegraph terminal in the manner to be described. The path \( W_A \) also includes in its input, to the east of filter \( F_{a2} \), a group modulator \( M_1 \) and associated carrier source \( O_{c1} \) generating the high frequency \( f_1 \), and in its output, to the west of band-pass filter \( F_{a1} \), a group demodulator \( D_1 \) with an associated carrier source \( O_{c2} \) of corresponding nominal high frequency \( f_1 \). The path \( W_A \) also includes in its input, to the west of filter \( F_{a1} \), a group modulator \( M_2 \) with an associated carrier source \( O_{c1} \) of the high frequency \( f_2 \); and in its output, to the east of filter \( F_{a2} \), a group demodulator \( D_2 \) with an associated carrier source \( O_{c2} \) of the nominal high frequency \( f_2 \).

The transmitting circuits of the two-way voice frequency carrier telegraph terminal at the west end of the combined system, as shown in Fig. 1, include four oscillators \( O_{o1} \) to \( O_{o4} \) normally generating carrier currents of the voice frequencies 1445, 1615, 1785 and 1955 cycles for the four transmitting channels 1 to 4. These oscillators may be of the vacuum tube type illustrated for the oscillator \( O_{o1} \) in channel 1 which is shown in more detail. These carrier currents are respectively modulated by separate sending circuits associated with the respective oscillators, to impress telegraph signals constituting a separate message on each carrier. The sending circuit in channel 1 comprises the polar telegraph sending relay \( SR_{o1} \) which is controlled by the telegraph key \( K_{o1} \) or its equivalent in one subscriber's loop. Similarly, the sending circuit in each of the other three channels comprises one of the polar telegraph sending relays \( SR_{o2} \) to \( SR_{o4} \) respectively controlled by one of the operating keys \( K_{o2} \) to \( K_{o4} \), or the equivalent, in other respective subscribers' loops.

When the key \( K_{o1} \) in channel 1 is closed to provide an energizing circuit from the associated battery to the operating winding of sending relay \( SR_{o1} \), that relay is operated to its marking contact \( m \), and when the key \( K_{o1} \) is opened to de-energize the operating winding, that relay is operated to its spacing contact \( s \). The relay connections to oscillator \( O_{o1} \) are such that the capacitance in the tuned circuit of that oscillator is changed by a sufficient amount for the two operating conditions of relay \( SR_{o1} \) to swing the carrier generated by the oscillator 35 cycles to one side of the normal carrier frequency (1445 cycles) for a marking signal and 35 cycles on the other side of the normal carrier frequency for a spacing signal. Thus, by alternatingly closing and opening the key \( K_{o1} \), the carrier wave of voice frequency 1445 cycles in channel 1 may be frequency modulated in accordance with a telegraph message to be transmitted.

Similarly, the frequencies of the carriers generated by the similar oscillators \( O_{o2} \) to \( O_{o4} \), indicated by boxes, in channels 2 to 4, respectively, may be shifted 20 cycles from the nominal values of 1615, 1785 and 1955 cycles, respectively, by operation of the associated sending relay \( SR_{o2} \) to \( SR_{o4} \) alternately to their marking and spacing contacts under control of the telegraph keys \( K_{o2} \) to \( K_{o4} \) in the associated subscriber's loops, to provide frequency-modulated voice-frequency carrier waves representing respectively different telegraph messages to be transmitted. The frequency deviations of the carriers in the output of oscillators \( O_{o1} \) to \( O_{o4} \) in the four channels 1 to 4 pass respectively through the associated sending band filters \( F_{o1} \) to \( F_{o4} \), respectively adapted to pass the frequency bands 1445±35 cycles, 1615±35 cycles, 1785±35 cycles, and 1955±35 cycles. In addition to the four carrier oscillators \( O_{o1} \) to \( O_{o4} \) at the west terminal, there is provided a fifth oscillator \( O_{o5} \) which generates another voice-frequency of 2380 cycles which passes unmodulated through the associated filter \( F_{o5} \) selective to its frequency. The outputs of the five filters \( F_{o1} \) to \( F_{o5} \) are bridge in parallel across the common two-way line section \( LW \) so that the four frequency-modulated carriers and the unmodulated pilot wave of a frequency of 2380 cycles are superposed in that line section and pass therewith to the west terminal of the high frequency transmission link \( HF_{L} \).

Similarly, at the east end of the system the transmitting circuits of the east voice-frequency carrier telegraph terminal, as shown in Fig. 2, include four oscillators \( O_{e1} \) to \( O_{e4} \) normally generating carrier currents of the different voice frequencies 955, 705, 935, 1105 cycles for the four carrier telegraph channels in the east-to-west direction. The oscillators \( O_{e1} \) to \( O_{e4} \) are adapted to be respectively controlled by the associated sending circuit comprising sending relay \( SR_{e1} \) and the associated subscriber's key \( K_{e1} \), the sending relay \( SR_{e2} \) and the associated subscriber's key \( K_{e2} \), the sending relay \( SR_{e3} \) and the associated subscriber's key \( K_{e3} \), the sending relay \( SR_{e4} \) and the associated subscriber's key \( K_{e4} \). Each similar subscriber's loop is connected to the associated sending relay \( SR_{e1} \) to \( SR_{e4} \) to \( SR_{e4} \) and the unmodulated output of the 2380-cycle oscillator \( O_{e5} \) are respectively selected by the transmitting band filters \( F_{e1} \) to \( F_{e5} \) and are superposed in the two-way line section \( LE \) over which they pass to the east terminal of the high frequency transmission line \( HF_{L} \).

The voice-frequency carrier telegraph receiving circuits at the east terminal of the system, shown in Figs. 2 and 3, include a balanced modulator \( M_3 \) which may be of the second order type, such as disclosed, for example, in F. A. Cowan Patent 1,959,450. The modulator \( M_3 \) includes four copper-oxide rectifier units connected in a Wheatstone bridge formation; an output transformer \( T \) connected across one diagonal of the bridge, one input circuit, including the band-pass filter \( F_{e1} \), passing the frequency range 1375-2025 cycles corresponding to the frequency range occupied by both the marking and spacing signals of all four voice-frequency carrier telegraph channels generated at the west terminal, connected between the normal terminal of the bridge, and a second input circuit, including the narrow band filter \( F_{o5} \) selective to the frequency 2380 cycles produced by the pilot
wave oscillator O at the west terminal, connected by transformer 3 across the other "conjugate" diagonal of the bridge. The two input circuits of modulator M3 are fed in common through transformer 4 from the two-way line section LE terminating the east end of the high frequency channel HFL with the waves of voice frequency received from that channel, the pass frequency range of filters F1 and F2 being such as to prevent the outgoing signal outputs of the transmitting band filters F6 to F9 bridged across the line section LE from feeding into the input of the modulator M3.

Neglecting for the moment the effect of any variations produced in the transmitted signal-bearing voice frequency carriers because of variations between the frequencies of the unsynchronized high frequency carrier oscillators in the intermediate high frequency carrier link HFL, the operation of the voice frequency carrier telegraph receiving circuits at the east terminal is as follows: The four frequency-modulated carrier waves of the frequencies 1445±55 cycles, 1615±55 cycles, 1785±55 cycles and 1955±55 cycles and the one unmodulated pilot wave of 2360 cycles received in the line section LE over the high frequency carrier link HFL from the west terminal of the system will pass through the transformer 4 to the conjugate input circuits of modulator M5. The four signal bearing waves will be selected by the band filter F1 and will be impressed by transformer 2 on one diagonal of the copper-oxide rectifier bridge of the modulator M5 and will combine with the 2360-cycle unmodulated pilot wave, selected by filter F5 and impressed by transformer 3 on the other conjugate diagonal of the bridge, to produce the desired output frequencies shown in Table 1 to the right of modulator M5. These desired frequencies are respectively selected and passed on by the narrow receiving channel band filters F13, F14, F15, F16 and F17 connected in parallel to the output of modulator M5, the undesired products of modulation in modulator M5 being rejected by these filters. From this point it will be sufficient to trace the path in one channel only as all perform in a similar manner.

Considering receiving channel 1, the current out of the 425-cycle filter F15 swings back and forth between 425±35 cycles and 425±35 cycles for the received marking and spacing signals. This current of varying frequency then passes into the current limiter CL2 comprising the two transformer-coupled-amplifying vacuum tube stages 1 and 8, a portion of the output of the second stage tube being picked off through a third winding 6 on output transformer 10, rectified by the half-wave rectifier 11 and passed through the series resistance 12 in the control grid-cathode circuit of tube 8 to provide a varying direct current bias on its control grid. The circuit constants of the current limiter CL2 and those of the similar current limiters in the other receiving channels at both terminals of the system are selected such as to produce a current-input-output characteristic resembling that of Fig. 4. It will be observed that for a wide range of input levels, the output is nearly constant. The purpose of this limiter circuit is to provide at its output current of closely constant amplitude, regardless of the frequency variation of its current input and regardless of the rather wide swings in amplitude which may be caused by line equivalent variations. There then will be impressed on the marking discriminator D1 and the spacing discriminator D2 having their inputs connected in parallel to the output of the current limiter CL2, a current of constant amplitude and of a frequency which may be steady or variable, depending on whether the channel is standing idle or transmitting signals.

The discriminators D1 and D2 consist merely of high- and low-pass filters or tuned circuits, respectively, of simple design. Their characteristics are shown in Fig. 3 with that of the receiving channel band filter F3, drawn in dotted lines to show the band limits. When the received carrier current is at the marking frequency fm, the loss through the marking discriminator D1 is low and the loss through the spacing discriminator D2 is high. Therefore, the marking current out of the discriminator D1 is at a maximum and the spacing current out of the spacing discriminator D2 is at a minimum. As the frequency is shifted from fm to fs, the loss through the discriminator D1 increases and that through the discriminator D2 decreases. When the carrier reaches fs, the current out of the discriminator D2 has reached a maximum and that out of the discriminator D1 has reached a minimum. It will be noted that the modulation process in M5 has turned over the frequency deviation. The marking frequency in channel 1 started out from the west terminal as 1955±35 cycles and became 425±35 cycles in the output of modulator M5.

The currents out of the discriminators D1 and D2 are amplified and rectified in the marking detector MD1 and the spacing detector SD2 respectively, and the result is a push-pull current in the marking and spacing windings of the polar receiving relay RR1, respectively connected to the outputs of those detectors. Typical marking and spacing winding currents in the receiving relay RR1 are shown in the curves of Fig. 6. The push-pull currents in the windings of the relay RR1, produced by the detected marking and spacing currents, cause the armature of that relay to move back and forth between its marking contact m and its spacing contact s, which repeats the telegraph signals to the subscriber. When the receiving loop connected to those contacts causes the operation of the printer, sounder or other receiving or recording device in that loop in accordance with the repeated signals. In receiving channels 2, 3 and 4, the receiving apparatus is similar to the receiving apparatus in channel 1, as indicated by the use of the same identification characters but with suitable subscribers corresponding to the number of the channel, and operates in response to the marking and spacing signals in the output of modulator M5 of the frequencies 983±35 cycles, 785±35 cycles and 938±35 cycles, respectively, in a manner similar to that which has just been described for channel 1 to cause operation of the channel receiving relays RR2 to RR4 to repeat these signals to the subscriber's receiving loops respectively connected to the channels.

Similarly, the voice-frequency telegraph receiving circuits at the west terminal of the system, as shown in Fig. 1, include a balanced second order modulator M2 of the copper-oxide rectifier bridge type, similar to the modulator M5 at the east terminal, having its conjugate input branches respectively including a band-pass filter F4 and the narrow band-pass filter F5 fed in common through transformer 5 from the two-way line section LW terminating the west end
of the high frequency transmission link HFL, and its single output circuit coupled by output transformer 6 in parallel to the inputs of the four receiving band filters $F_{a}$ to $F_{d}$ in the receiving carrier telegraph channels 1 to 4. The four frequency-modulated carrier waves of the frequencies $2050\pm35$ cycles, $2550\pm35$ cycles, $3050\pm35$ cycles, and $3550\pm35$ cycles generated by the sending circuits at the east terminal and the accompanying unmodulated pilot wave of the frequency 2550 cycles generated at that terminal pass from the two-way line section LW through the input transformer 5 to the modulator $M_{s}$. The four signal bearing waves are selected out by the band filter $F_{a}$ passing the frequency range 525 to 1175 cycles in one input branch, and are combined in the modulator $M_{s}$ with the 2550-cycle pilot current selected by the filter $F_{b}$ in the other conjugate input branch, to produce the four desired output frequencies in the output of the modulator, shown in Table 2 to the left of that modulator. These desired frequencies pass through output transformer 6 and are respectively selected by the receiving band filters $F_{a}$ to $F_{d}$ in the four receiving channels, the unmodulated products of modulation in the output of the modulator $M_{s}$ being rejected by these filters.

In receiving channel 1 at the west terminal, the current output of filter $F_{a}$ swings back and forth between 1445-35 and 1445-35 cycles with the marking and spacing signals. This current of varying frequency then passes through the individual current limiter $C_{L}$ for channel 1, which provides an output current of substantially constant amplitude regardless of the frequency variation and regardless of the wide swings in amplitude in the current input caused by line equivalent variations. The output of the current limiter $C_{L}$ is impressed on the parallel-connected inputs of the marking and spacing discriminators $D_{a}$ and $D_{b}$, similar to the corresponding discriminators in each receiving channel at the east terminal just described and operating in similar manner. The currents out of the discriminators $D_{a}$ and $D_{b}$ are respectively amplified and detected in the marking detector $M_{d}$ and the spacing detector $S_{d}$, and the resulting detected currents are applied in push-pull to the marking and spacing windings of the polar receiving relay $R_{a}$ to cause alternate operation of its armature to its marking and spacing contacts to repeat the telegraph signals to the subscriber's receiving loop associated with that channel.

Similarly, the frequency-modulated carrier outputs of the filters $F_{a}$ to $F_{d}$ in the telegraph receiving channels 2 to 4 at the west terminal, of the frequencies $1615\pm35$ cycles, $1785\pm35$ cycles, and $1955\pm35$ cycles, are respectively operated on by the current limiter, marking and spacing discriminators, and the marking and spacing detectors of the corresponding channels in a manner similar to that which has been described for the similar elements in channel 1, to provide respective alternate operation of the channel receiving relays $R_{b}$ to $R_{c}$ to their marking and spacing contacts, to repeat the marking and spacing telegraph signals for those channels to the connected subscriber's receiving loop to operate a printer, sounder or other receiving or recording device.

In the above description of the passage of the frequency-modulated carrier waves and of the unmodulated pilot wave from the transmitting telegraph apparatus at the west voice frequency carrier telegraph terminal to the voice frequency telegraph receiving apparatus at the east terminal, and vice versa, the action of the high frequency apparatus in the intermediate high frequency transmission link HFL, not previously described in detail, is as follows.

The directly directed voice-frequency carrier channels and the accompanying unmodulated pilot wave generated by the voice-frequency carrier telegraph transmitting apparatus at the west terminal passing into the two-way line section LW at that terminal, will be impressed by the hybrid coil $H_{a}$ on the input of the west-to-east repeating path EA in the link HFL in which they will be selected by the band-pass filter $F_{a}$ having a pass range which includes all of those frequencies but excludes those of the westerly directed voice-frequency channels and pilot wave. The selected voice frequency-modulated carrier output of the filter $F_{a}$ in the path EA will be impressed on the modulator $M_{s}$ in which it will be combined with the high frequency carrier of nominal value $f_{s}$ supplied from the associated oscillator $O_{a}$ of the voice frequency carrier channels and the pilot wave, to frequencies suitable for transmission over that path. At the east terminal of the high frequency path EA, the received carrier channels of stepped-up frequencies are combined in the demodulator $D_{a}$ with a high frequency carrier wave of the same nominal frequency $f_{s}$ supplied to the demodulator from the associated oscillator $O_{a'}$ to step the carrier channels down again to their original frequencies which are selected by the band-pass filter $F_{a}$ in the output of the path EA, having the same pass range as the filter $F_{a}$, and are impressed by the hybrid coil $H_{c}$ on the two-way line section LE. The received voice-frequency channels and pilot wave will pass from the line section LE to the voice-frequency carrier telegraph receiving circuits of the east terminal described above.

Similarly, the westerly directed voice-frequency carrier channels and the unmodulated pilot wave generated in the voice-frequency carrier telegraph transmitting apparatus at the east terminal of the system of Fig. 1, passing into the two-way line section LE will be impressed by the hybrid coil $H_{a'}$ on the east-to-west repeating path WA of the intermediate high frequency link HFL and will be selected by the band-pass filter $F_{a}$ having a suitable frequency pass range. The selected frequencies in the output of the filter $F_{a}$ will be combined in modulator $M_{s}$ in the input of the path WA with the high frequency carrier of nominal frequency $f_{s}$ supplied from the associated carrier oscillator $O_{a}$, to step up all of the voice-frequency channels and the pilot wave to high frequencies suitable for transmission over that path, and at the west terminal of the high frequency link HFL, the received waves will be combined in the demodulator $D_{a}$ with the high frequency carrier of nominal frequency $f_{s}$ supplied from the associated carrier oscillator $O_{a'}$ to step them down again to their original voice frequencies. These frequencies will be selected by the band-pass filter $F_{a}$ of suitable transmission frequency range, and impressed by the hybrid coil $H_{c}$ on the two-way line section LW from which they will pass to the voice-frequency carrier telegraph receiving circuits of the west terminal described above.

Unless the high frequency carrier sources associated with the group modulator and the group demodulator in the repeating path for each di-
carrier communication channels and a separate pilot channel, means at a transmitting point for combining each of said channels with a high frequency carrier for transmission, means at a receiving point for combining the received high frequency waves with a carrier of nominally the same high frequency as the high frequency carrier at the transmitting point, to demodulate the received communication channels and the received pilot channel, and modulating means for combining each of the demodulated carrier channels with the demodulated pilot channel to compensate for any frequency differences between the high frequency carriers at the transmitting and receiving points tending to distort the transmitted carrier communication channels.

2. In combination in a carrier signaling system, a high frequency transmission line, a plurality of sources respectively generating carrier waves of different low frequencies, another source generating a pilot wave of predetermined frequency, means to modulate each of said carrier waves with a different message, means to impress the modulated carrier waves and the unmodulated pilot wave on the input of said line, a group modulator with an associated high frequency carrier source in the input of said line for stepping up the frequencies of all of the impressed waves to those suitable for transmission over that line, a group demodulator with an associated high frequency carrier source of the same nominal frequency as the first high frequency carrier source, in the output of said line for stepping down the received waves to their original frequency values, a second modulator fed from the output of said line, for combining each of the applied low frequency carrier waves with the received unmodulated pilot wave to transform the former to desired lower frequencies, and to eliminate therefrom any variations therein caused by any frequency differences between the high frequency carrier sources associated with the group modulator and group demodulator of the high frequency line, and means to separate the resulting modulated carrier waves and to separately detect the message components therein.

3. In a carrier wave signaling system including low frequency carrier signal transmitting and receiving circuits at each terminal thereof and an intermediate two-way high frequency transmission link including group modulating and demodulating devices with associated high frequency carrier sources for respectively stepping up the low frequency carrier signals received by said link from the low frequency carrier signal transmitting circuits at each terminal to high frequencies suitable for transmission over that link, and for stepping down the high frequency carrier signals received at each terminal over said link to their original frequency values before supplying them to the low frequency carrier signal receiving circuits at that terminal, the low frequency carrier signal receiving circuits at each terminal including other modulating means for combining each of the received high frequency carrier signals with a carrier wave of suitable frequency to transform the former to desired low frequency values before they are separated and the signal components detected therefrom, and means to reduce distortion of the detected signal components due to relative instantaneous frequency differences between the high frequency carrier sources in the intermediate high frequency transmission link comprising means for supplying
said carrier waves of said suitable frequency combined with each received low frequency carrier signals in the low frequency carrier signal receiving circuit at each terminal, over said high frequency transmission link from the other terminal so that they are subjected to the same frequency variations in that link as the transmitted carrier signals.

4. In combination in a multiplex carrier telegraph system, means for producing a plurality of different voice-frequency carriers respectively frequency modulated with a different telegraph message, a high frequency transmission line supplied with said modulated carriers and including in its input modulating means with an associated high frequency carrier source, for stepping up the supplied waves as a group to the high frequencies suitable for transmission thereover, and in its output demodulating means with an associated high frequency carrier source for stepping down the waves received over the line as a group to their original frequencies, another modulating means for combining the modulated carriers of low frequencies received over said line with a carrier wave of suitable frequency to transform the former to suitable frequency values, means for separating the resulting modulated carriers and separately detecting the telegraph message components therefrom, and means to reduce distortion in the detected message components resulting from fortuitous frequency differences between the high frequency carrier sources associated with the group modulating and demodulating means in said high frequency line, comprising means for supplying said carrier wave of suitable frequency combined with the modulated carriers in said other modulating means, over said high frequency line so that it is subjected to the same frequency variations as the modulated carriers transmitted thereover.

5. The combination of claim 4 in which each of said plurality of different voice-frequency carriers frequency modulated with a different message is obtained by changing the tuning of a different voice-frequency carrier oscillator under control of associated keying means so that the generated carrier is swung a given number of cycles to one side of the normal carrier frequency to produce a marking signal and the same amount to the other side of the normal carrier frequency to produce a spacing signal, the receiving circuit of said system comprising separate filters for respectively selecting both the marking signal component and the spacing signal component in each modulated carrier wave in the output of said other modulation means at the receiving terminal, separate current limiters for respectively producing from the current output of each of said filters a current of substantially constant amplitude, regardless of frequency and amplitude variations therein, other filtering means for separating the marking and spacing signal impulses in the resulting wave, detectors for separately detecting said marking and spacing signal impulses and a receiving telegraph relay having opposing windings to which the detected marking and spacing impulses are respectively applied to cause the operation of said relay to repeat the marking and spacing signals of the message.

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