

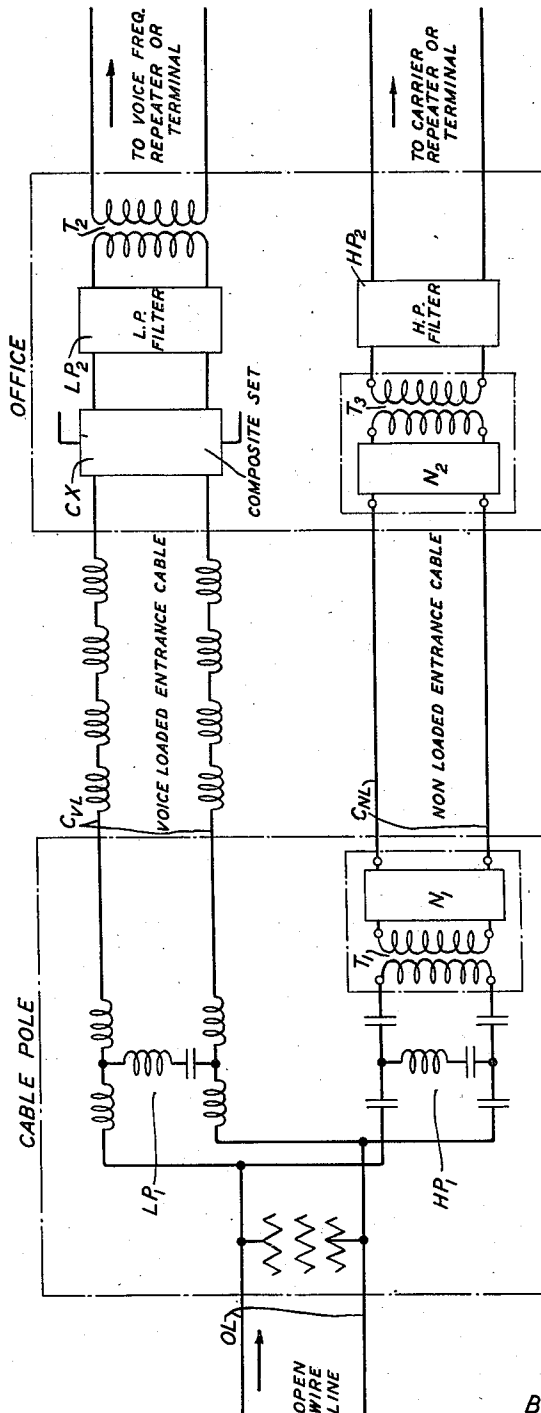
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FILTERING CIRCUITS

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FILTERING CIRCUITS

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The invention relates to open-wire carrier telephone systems and particularly to filtering circuits used in such systems.

An object of the invention is to separate in an economical and efficient manner the carrier frequency, voice frequency and direct current signals received over the open-wire line pairs at a terminal or repeater station of an open-wire carrier telephone system.

Heretofore, it has been the practice in open-wire carrier telephone systems to transmit all telephone signals including carrier frequency and voice signals, and direct current telegraph signals, received over the open-wire line pairs at a repeater station through suitably loaded entrance cable pairs to the repeater office, and there to separate the carrier frequency signals from the other signals by line filter sets comprising high-pass and low-pass filter sections, and associated composite sets. This method requires complicated filter design and increases the loading requirements thus increasing transmission costs.

In some cases the high and low-pass filters have been located at the junction point of the open wire and cable by mounting either on the pole or at some nearby point. The carrier frequency signals are brought into the repeater or terminal office on a non-loaded cable pair while the voice frequency and direct current telegraph circuits are brought in over a loaded cable pair. This method is open to certain transmission objections because the large number of filter sections required in such a low-pass filter resulted in a considerable cross-fire between the direct current telegraph circuits which operate on the two wires of the pair and also because its location at that point makes it more difficult to obtain good return losses on voice frequency repeaters located in the adjacent office. Furthermore, the individual elements comprising both high and low-pass filters must have a high dielectric strength because of their more exposed location.

This invention minimizes these difficulties by placing only a small portion of the separating high and low-pass filters at the junction point. In one embodiment, the voice frequency telephone signals and direct current telegraph signals selected by the low-pass filter are transmitted to the office over voice-loaded entrance cable, and the carrier frequency signals selected by the high-pass filter are transmitted to the office over non-loaded entrance cable. The junction filters need be only large enough to preserve the proper impedances in the working frequency ranges and to prevent mutual bridging losses.

In addition the low-pass filter may be selected to reduce the carrier current signals to a level which will not produce objectionable intermodulation in the iron core coils of the voice frequency loaded pair. Such supplementary filtering as is needed is added in both high and low-pass branches at the repeater or terminal office. The cost of the supplementary filters may be reduced somewhat in the case of the low-pass branch by taking advantage of the transmission characteristics of the voice frequency loaded pair. Both filters can use individual elements having a dielectric strength considerably lower than is required at the exposed location.

The various objects and features of the invention will be better understood from the following detailed description read in conjunction with the accompanying drawing, the single figure of which shows schematically a portion of a repeater or terminal station and associated circuits, of an open-wire carrier telephone system, embodying the invention.

In the system of the drawing, the incoming open-wire line pair OL carrying carrier and voice frequency telephone signals, as well as superimposed direct current telegraph signals, is connected in parallel to the inputs of the small high-pass filter HP₁ and the small low-pass filter LP₁, which are preferably mounted on or near the entrance cable pole. These small filters are designed to provide only such discrimination against the unwanted frequencies as is required to separate the carrier frequencies from the voice frequencies and direct current telegraph signals, to preserve proper impedance and prevent bridging loss, and to prevent objectionable modulation in the loading coils in the voice circuit.

The voice frequency signals and superimposed direct current telegraph signals in the output of the small low-pass filter LP₁ are transmitted to the office over the voice-loaded entrance cable pair CVL. The carrier frequency signals in the output of the small high-pass filter HP₁ are transmitted through the transformer T₁ and the impedance matching network N₁ to a non-loaded entrance cable pair CNL over which they are transmitted to the office. The impedance matching network N₁ and associated transformer T₁ are provided to give the necessary impedance matching between the drop end of the high-pass filter HP₁ and the non-loaded entrance cable pair to prevent reflection losses at this junction which might introduce cross-talk difficulties.

At the office, the voice signals and direct current telegraph signals received over the voice-

loaded entrance cable pair C_{VL} are separated by the usual composite set CX and the voice frequency signal output of the composite set CX is then transmitted through a low-pass filter LP_2 corresponding to the low-pass filter section of the usual line filter set, the low-pass filter LP_2 in this case, however, being separated from the high-pass filter HP_2 corresponding to the high-pass filter section of such a line filter set. The voice frequency signals in the output of the filter LP_2 are transmitted through the output transformer T_2 to the voice frequency repeater or terminal apparatus (not shown).

The carrier frequency signals received at the repeater office over the non-loaded entrance cable pair C_{NL} are transmitted through the impedance matching network N_2 and associated transformer T_3 to the high-pass filter HP_2 , and the carrier frequency signals in the output of that filter are transmitted to the terminal repeater or terminal apparatus (not shown). The impedance matching network N_2 and associated transformer T_3 are designed to provide the proper impedance matching to translate the impedance of the non-loaded entrance cable pair C_{NL} in the carrier leg to that of the office equipment.

The low-pass filter LP_2 and the high-pass filter HP_2 in the repeater office are designed to provide only the additional discrimination required for maintaining suitable singing and cross-talk margins and preventing interference from voice to carrier and carrier to voice. The arrangement of the invention as described besides improving the filtering operation, realizes material savings by making it possible to omit the carrier loading where it is not required for attenuation reduction.

Various modifications of the circuits which have been illustrated and described which are within the spirit and scope of the invention will occur to persons skilled in the art. For example, band-pass filters which pass all or a part of the carrier frequency range and of the voice frequency range may be substituted for the high-pass and low-pass filters, respectively. The junction filter set of the invention is adapted for use to separate the carrier frequency signals from the voice frequency and other signals at terminal or repeater stations of the type in which only the voice frequency and direct current telegraph signals are transmitted to the repeater or terminal office, and the carrier frequency signals are by-passed around the station between two sections of open-wire line, in which case a suitably designed low-pass or low frequency band-pass filter is inserted at each end of voice-loaded entrance cable connecting each section of open-wire line to the repeater office and a high-pass or high frequency band-pass filter is inserted at each end of a non-loaded cable connecting the two sections of open-wire line. The low frequency filters at the junction of the open-wire line and cable could be designed so that a phantom circuit could go through it, if desired. Also the filter arrangement of the invention may be employed in short intermediate cable, such as submarine cable, connecting two sections of open-wire line transmitting voice frequency and carrier frequency signals, to reduce the cost of loading the cable, the low-pass filters being used in a voice-loaded cable branch and the high-pass filters in a parallel non-loaded cable branch.

What is claimed is:

1. In an open-wire carrier telephone system

including entrance cable for connecting the open-wire lines to terminal and repeater offices, signal receiving means at a terminal or repeating point comprising small filters at the junction of the entrance cable and the open-wire line, for respectively selecting the carrier frequency and voice frequency signals received over the open-wire line, a non-loaded entrance cable pair and a voice-loaded entrance cable pair, for respectively transmitting the selected carrier frequency signals and the selected voice frequency signals to the office, and other filtering means at the office end of the non-loaded cable and the voice-loaded cable, respectively, for providing additional frequency discrimination against unwanted frequencies in the carrier and voice frequency channels.

2. In an open-wire carrier telephone system including open-wire lines transmitting signals including carrier frequency and voice frequency signals between separated terminal and repeater offices connected to the open-wire line by entrance cable, signal receiving means at a terminal or repeater point comprising a small high-pass and a small low-pass filter at the junction of the open-wire line and entrance cable, for respectively selecting the received carrier frequency and voice frequency signals, a non-loaded entrance cable pair and a voice-loaded entrance cable pair, for respectively transmitting the selected carrier frequency and voice frequency signals to the office, and separated high-pass and low-pass filters in the office respectively connected to said non-loaded cable pair and said voice-loaded cable pair, for giving further discrimination against unwanted frequencies in the carrier frequency and voice frequency channels.

3. The system of claim 2, in which said small low-pass and high-pass filters are selected to provide only sufficient discrimination against unwanted frequencies as to separate the carrier and voice frequencies, and said high-pass and low-pass filters in the office are selected to provide only sufficient additional frequency discrimination required for maintaining suitable singing margin and for preventing interference between the voice and carrier receiving channels.

4. The system of claim 2, in which said open-wire line also transmits direct current telegraph signals, said small low-pass filter selects both the voice and direct current telegraph signals, and a composite set is included in the voice frequency channel at the office to separate the telegraph and voice frequency signals.

5. A junction filter circuit for use at repeater points of an open-wire carrier telephone system, comprising parallel small low-pass and high-pass filters at the junction of the open-wire line and repeater entrance cable, a line filter set having separated low-pass and high-pass filtering branches in the repeater office, a voice-loaded entrance cable pair connecting the junction low-pass filter to the low-pass filter branch of said line filter set and a non-loaded entrance cable pair connecting said junction high-pass filter to the high-pass filter branch of said line filter set.

6. In an open-wire carrier signaling system including open-wire line transmitting carrier frequency and voice frequency signals and repeater stations at separated points along said line, means for separating and utilizing the carrier frequency and voice frequency signals at one or more of said repeater points, comprising at said one or more points a voice frequency signal repeating office, carrier transmission apparatus, a filter selective

to voice frequencies and a filter selective to said carrier frequencies connected in parallel to the open-wire line, voice-loaded entrance cable for transmitting the voice frequency signals selected by the first filter to said signal repeating office, a non-loaded cable for transmitting the carrier frequencies selected by the carrier frequency filter to said carrier transmission apparatus, and a second filter selective to voice frequencies at the office end of said voice-loaded cable and a second filter selective to said carrier frequencies at the other end of said non-loaded cable, for providing additional discrimination against unwanted frequencies.

7. A signal separating circuit for use at an intermediate point in an open-wire line transmitting voice frequency and carrier frequency sig-

nals, comprising at said intermediate point two filters connected in parallel to the open-wire line, respectively, selective to the voice and carrier signal frequencies, voice frequency signal transmission apparatus, carrier frequency signal transmission apparatus, voice-loaded cable connecting said filter selective to the voice signal frequencies to said voice signal transmission apparatus, non-loaded cable connecting said filter selective to the carrier signal frequencies to said carrier transmission apparatus, and other filtering means respectively selective to said voice frequency signals and to said carrier frequency signals, in said voice-loaded cable and said non-loaded cable, respectively.

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