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CARRIER REPEATING SYSTEM

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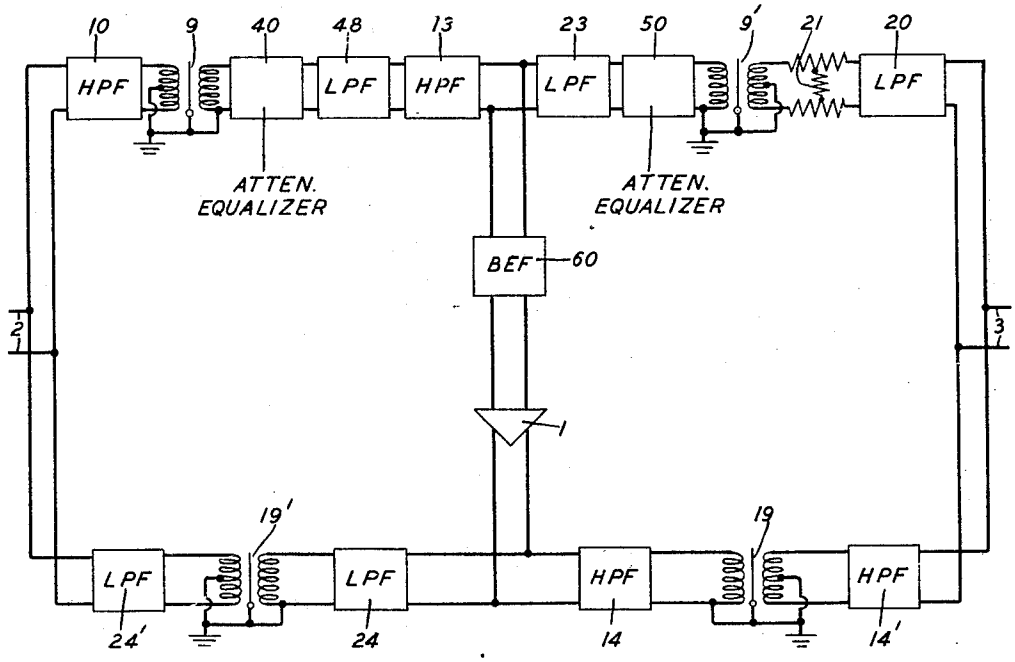

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CARRIER REPEATING SYSTEM

Application filed September 10, 1930. Serial No. 480,836.

This invention relates to wave transmission systems, as for example carrier telephone repeaters.

An object of the invention is to increase the load capacity of such systems.

As an example of applications of the invention, to accomplish this object in a carrier telephone repeater of the type having a common amplifier for oppositely directed transmission of different frequency ranges, a band elimination filter is inserted in the input circuit of the amplifier to provide the major portion of the loop attenuation (required to prevent singing) over the non-transmitting frequency range of the repeater. The band elimination filter thus relieves the direction filters of the burden of attenuating wave in this frequency range forming the gap between the upper frequency group and the lower frequency group of the carrier telephone channels, in the general manner of the tuned circuits of Shea Patent 1,743,691, January 14, 1930. The cut-off frequency of the high frequency direction filters can then be lowered, and the cut-off frequency of the low frequency direction filters be raised, while the transmitting frequency ranges of the repeater remain unaltered, with the result of lower loss in the direction filters at the frequencies limiting the non-transmitting range of the repeater. This lower loss in the output direction filters means lower load (lower transmission output level) for the repeater amplifier, for a given level of transmission output from the repeater, provided that the band elimination filter is located in the input circuit of the amplifier and therefore does not reduce the ratio of the repeater output level to the amplifier output level. Thus by locating the band elimination filter in the input circuit of the amplifier, as for example in Campbell Patent 1,227,114, May 22, 1917, instead of in the output circuit of the amplifier as for instance in Rose Patent 1,642,749, September 20, 1927, and relocating the cut-off frequencies of the direction filters, the load capacity of the carrier repeater is materially increased over that of the type of carrier repeater of the Shea patent mentioned above, for example.

Other objects and aspects of the invention will be apparent from the following description and claims.

The single figure of the drawing shows a carrier telephone repeater embodying the specific form of the invention referred to above.

The repeater of the figure is of the general type shown in Fig. 1 of H. S. Black Patent 1,762,953, July 10, 1930. Elements designated in these two figures by the same reference characters are substantially alike, except as to features described herein.

A unidirectionally transmitting amplifier 1 transmits carrier signaling waves in both directions between sections 2 and 3 of a carrier transmission line.

The carrier signaling waves may be carrier waves modulated by speech or other modulating waves. The carrier signaling waves from line section 2 lie in one carrier frequency range. They pass through a small portion 10 of an input high pass filter (or high frequency transmission band filter), thence through a transformer 9, thence through an attenuation equalizer 40 which equalizes the attenuation of line section 2 (and filters 10, 48, 13, 14 and 14′ and transformers 9 and 19) over the one frequency range, thence through the major portion 13 of the input high pass filter, thence through a band elimination filter 60, thence through the unidirectionally transmitting amplifier 1, thence through the major portion 14 of an output high pass filter thence through a transformer 19, and thence through a small portion 14′ of the high pass output filter, to the line section 3. The carrier signaling waves from the latter line section lie in a second carrier frequency range, below the first carrier frequency range. They pass through a small portion 20 of an input low pass filter (or low frequency transmission band filter), thence through a resistance pad or attenuating network 21, thence through a transformer 9′, thence through an attenuation equalizer 50 which equalizes the attenuation of the line section 3 (and filters 20, 23, 24 and 24′ and

transformers 9′ and 19′) over the second carrier frequency range, thence through the major portion 23 of the input low pass filter, thence through filter 60 and the unidirectionally transmitting amplifier 1, and thence through the major portion 24 of an output low pass direction filter, a transformer 19′ and a small portion 24′ of the low pass output filter, to the line section 2.

The attenuation network 21 compensates for the lower attenuation of line section 3 over the frequency range of the carrier signaling waves transmitted to the repeater from line section 3 than over the frequency range of the carrier signaling waves transmitted from the repeater to line section 3.

The cut-off frequency of filter 48 is preferably just above the upper limit of the frequency range of the signals transmitted over the circuit. Thus since the usual grouping filters (not shown) in lines 2 and 3 preferably have a cut-off frequency just below the lower limit of the carrier signals transmitted over the circuit, the repeater amplifies only waves of frequency within the frequency range of the carrier signaling waves transmitted over the circuit. As explained in the Black patent referred to above, filter 48 prevents overloading of the repeater by interference from power line carrier waves, which ordinarily are of high power relative to the power of carrier signaling waves in carrier telephone transmission lines and lie in a frequency range somewhat above the frequency range of the latter waves.

The filters 10, 13, 14, 14′, 20, 23, 24 and 24′ are direction filters, for separating the oppositely directed signals in the repeater; but over the non-transmitting frequency range of the repeater their action in preventing waves from the output circuit of the repeater amplifier from reaching the input circuit of the amplifier is supplemented by the band elimination filter 60, which offers sufficient attenuation over that range to assure that the loss between the output circuit of amplifier 1 and the input circuit of the amplifier will be great enough to guard against singing in the repeater. Filter 60, by thus sustaining the loop attenuation or providing the major portion of the loop attenuation (required to prevent singing) over the non-transmitting frequency range of the repeater, relieves the direction filters of the burden of attenuating waves of this frequency range forming the gap between the upper frequency group and the lower frequency group of the carrier telephone channels. Filter 60 thereby renders it practicable to lower the cut-off frequency of the filters 10, 13, 14 and 14′ and raise the cut-off frequency of the filters 20, 23, 24 and 24′, so that they need not operate so close to their cut-off frequencies, or in other words, so that the transmitting frequency ranges of the repeater, or the operating ranges of the direction filters, do not approach so nearly the cut-off frequencies of the direction filters. Thus, filter 60 without introducing attenuation in the output circuit of the amplifier, makes it possible to meet a given commercially desirable low attenuation requirement for the repeater output filters (including the transformers 19′ and 19) at the frequencies limiting the non-transmitting range of the repeater and at the same time maintain this range desirably narrow.

The relocation of the direction filter cut-off frequencies referred to above improves the impedances of the repeater facing the lines 2 and 3, so that in some cases it becomes unnecessary to provide impedance correcting networks which would otherwise be required at the line ends of the filters in order to obtain a sufficiently low reflection coefficient at these points.

Any loss caused by dissipation which the band elimination filter 60 introduces over the transmitting ranges of the repeater need not affect the overall gain of the repeater since this loss can be subtracted from the resistance pad 21 in the lower group of channels and from the equalizer 40 in the upper group.

Since filter 60 operates to insert loss in both of the repeater loops, in some cases its use enables a reduction to be made in the number of elements otherwise required in the band pass direction filters to sustain the loop attenuation.

Instead of providing transformers to terminate the line ends of the repeater as shown at 9 and 19 in the Black patent mentioned above, the transformers 9 and 19′, and 9′ and 19 mentioned above are provided, these transformers being grounded at the mid-points of their windings nearest the lines 2 and 3, transformer 9 being located between the direction filters 10 and 13, transformer 19′ between the direction filters 24′ and 24, transformer 9′ between the direction filters 20 and 23, and transformer 19 between the direction filters 14′ and 14. This feature is claimed in the application of A. G. Ganz, Serial No. 489,578 filed October 18, 1930, assigned to the assignee of this application. As explained in the Ganz application, the portions of the direction filters between the transformers and the lines 2 and 3 (i. e., the portions 10, 24′, 20 and 14′) are of the balanced type, so that they do not cause unbalance of line 2 or line 3 with respect to ground, whereas the remaining portions of the direction filters can be of the unbalanced type, so as to economize with regard to the number of elements in the filter; and placing the repeating coils after a filter such as 10, 24′, 20 or 14′ (of one filter section, for example) instead of immediately next to the line 2 or 3, greatly reduces deleterious effects of modulation products generated in the magnetic core material of the transformer.

What is claimed is:

1. A two-way transmission system comprising a unidirectionally transmitting path, a band elimination filter and an amplifying device included in said path, said filter being in the input circuit of said device, and frequency selective means for transmitting transmissions of mutually exclusive frequency ranges oppositely directed over said system in the same direction through said path, said filter having low attenuation for waves of said ranges but high attenuation for waves of frequencies between said ranges.

2. A carrier wave repeating system comprising a two-way two-wire circuit, a one-way path feeding said circuit, a second one-way path fed from said circuit, a unidirectionally transmitting amplifying device common to said two paths, two band pass filters in said first path passing a given frequency range, one of said filters being in the input circuit of said device and the other in the output circuit of said device, two band pass filters in said second path passing a frequency range exclusive, of said first range, one of the latter filters being in the input circuit of said device and the other in the output circuit of said device, and a band elimination filter in the input circuit of said amplifier between two of said band pass filters and said amplifier, said band elimination filter having low attenuation in said ranges and high attenuation between said ranges.

In witness whereof, I hereunto subscribe my name this 8th day of September, 1930.

WILLIAM E. KAHL.