

July 25, 1939.

H. NITZ

2,167,522

ELECTRIC SEPARATING FILTER

Filed Nov. 2, 1937

2 Sheets-Sheet 1

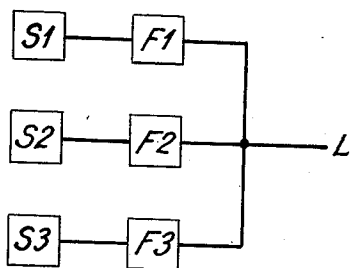


Fig. 1

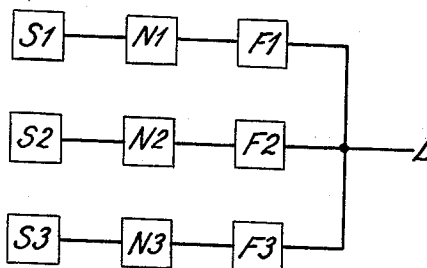


Fig. 4

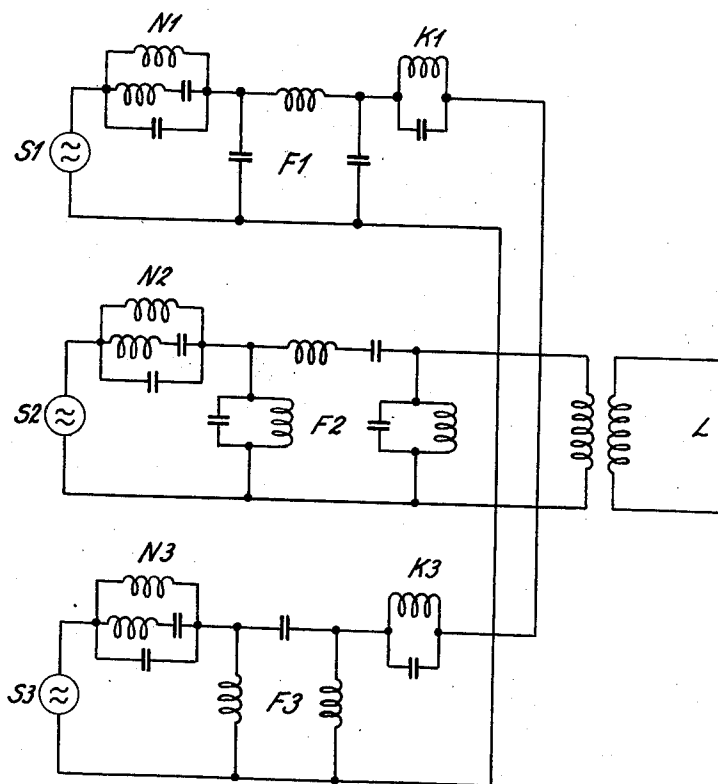


Fig. 5

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2 Sheets-Sheet 2

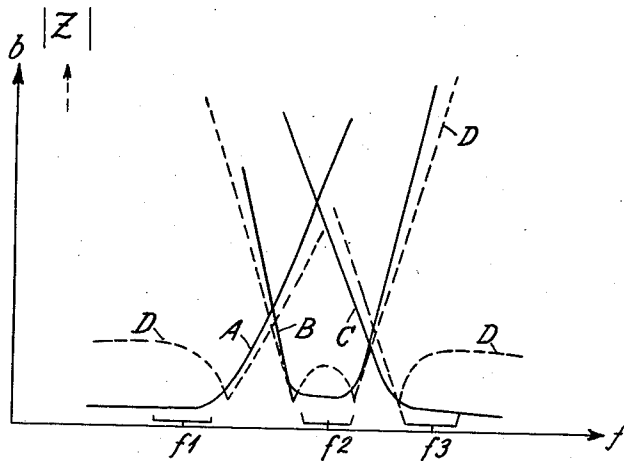


Fig. 2

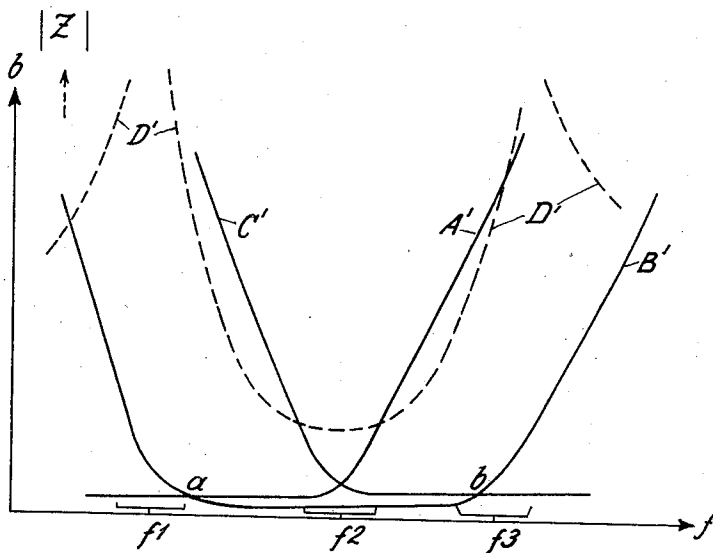


Fig. 3

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UNITED STATES PATENT OFFICE

2,167,522

ELECTRIC SEPARATING FILTER

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2 Claims. (Cl. 178—44)

The present invention relates to electric filter arrangements which are adapted to separate or to combine alternating high-frequency currents, particularly although not exclusively for use in connection with systems for intelligence exchange over wires.

The so-called wire-radio intelligence transmission over lines by means of alternating high-frequency currents is well known. In such wire-radio systems, a plurality of modulated carrier frequencies are simultaneously impressed upon a line common thereto, or upon a number of such lines over filter arrangements. Also in the carrier frequency multiple-telephony, a number of carrier frequencies modulated with different message frequencies are impressed upon a line through filter arrangements. For separating these frequencies into individual communication channels on the receiving side, the corresponding receiving equipment also employs filter arrangements. However, certain difficulties arise on effecting reliable transmission over such systems.

The present invention has for its object to avoid these disadvantages, which hereinafter are more precisely specified.

The invention will be more readily understood from the following description in conjunction with the attached drawings, in which:

Fig. 1 schematically shows a known-wire-radio transmitting arrangement,

Fig. 2 graphically illustrates different curves relating to the known arrangement as shown in Fig. 1,

Fig. 3 shows a graphical illustration of curves obtained as a result of the features according to the invention, as compared with the curves shown in Fig. 2,

Fig. 4 schematically demonstrates one example according to the new arrangement, while

Fig. 5 shows an improved circuit arrangement corresponding to the representation illustrated in Fig. 4.

Referring to Fig. 2 which illustrates a known arrangement, the three transmitters S_1 , S_2 and S_3 each produces a carrier frequency which may be modulated in accordance with the existing requirements. Said carrier frequencies are impressed upon a line L common thereto over the filters F_1 , F_2 and F_3 . The separation of these carrier frequencies on the receiving side is effected in the similar manner.

The above mentioned filters, i. e. the filters F_1 , F_2 and F_3 , for example, are electrical separating means and their attention characteristics are shown in Fig. 2, in which the attenuation v is

illustrated in dependence on frequency. It may for instance be assumed that the three carrier frequencies f_1 , f_2 and f_3 and their side bands are to be transmitted. The attenuation curves of these frequencies are designated A, B and C. For example, the curve A may be the attenuation characteristic of a low-pass filter, the curve B that of a filter which is adapted to pass one particular frequency band only, while the attenuation curve C corresponds to a high-pass filter. The adjustment of the filter belonging to the frequency range of the carrier f_2 involves certain difficulties. For example, a change of the carrier frequency subsequent to the adjustment of the frequency band is impossible without providing a quite new filter or a new filter assembly. Also an accurate adjustment to a particular and relatively narrow frequency band introduces difficulties and can be achieved only by considerable expenditure with respect to switching means.

Each of the filters F_1 , F_2 and F_3 of the arrangement shown in Fig. 1 has for its object to pass the frequency band produced by its allotted transmitter, but to block the frequency bands produced by the other transmitters. In other words by way of an example, only the frequencies produced by the transmitter S_1 are to be impressed upon the line L , while it must be prevented that these frequencies obtain access to the transmitters S_2 and S_3 over the filters F_2 and F_3 . These requirements have been satisfied according to the known arrangements by providing a very high filter attenuation for the entire frequency range to be blocked. The graphical equivalent to this arrangement is shown in Fig. 2. It is thereby necessary to employ electric filter circuits in which the surge impedance Z assumes high values in the blocking range and accordingly presents zero points at the cut-off frequencies. For example, the attenuation characteristic B of the filter F_2 indicates very high values for the frequencies f_1 and f_3 located within the blocking range. The curves D represent the surge impedance curves in relation to their allotted attenuation curves. It will be readily observed from these curves that the filter F_2 comprises a relatively narrow passing range and that the legs of the attenuation curve ascend rather steeply. However, this condition introduces the disadvantage that a relatively high attenuation prevails within the passing range of said filter.

In order to overcome the aforesaid disadvantages, it is proposed according to the present invention to employ filter arrangements, the cut-

off frequencies of which coincide with the adjacent frequencies which are to be blocked, and in which the surge impedance characteristic prevailing at the cut-off frequencies and in the blocking zone is substantially utilized for the blocking action with respect to the frequency bands of the adjacent transmitters.

The Fig. 3 represents the graphical equivalent according to the inventive idea. The curve B' represents the attenuation of the middle filter F2 in dependence upon frequency, and the curves A' and C' represent the attenuation of the filters assigned to the other transmitters. For instance, the passing range of the filter F2 pertaining to the frequency f_2 , and consequently also to the transmitter S2, is not so narrowly elected as indicated by the curve B of the Fig. 2, but is made wider so that the cut-off frequencies of the filter coincide with the frequencies f_1 and f_3 . In addition, this filter presents an essentially wider frequency range in which the attenuation is very low, said range extending e. g. between the points a and b at which an attenuation increase takes place. Furthermore, the filters are so dimensioned according to the invention that the surge impedance represented by the curve D' of Fig. 3 theoretically presents points of infinity with respect to the frequencies of the other transmitters to be blocked. It may be assumed by way of an example that the frequency f_3 and its side bands are to be applied to the line L from the transmitter S3 through the filter F3, and that this line has a surge impedance equal to 150 ohms. In this case the surge impedance of the filter F2 which corresponds to the surge impedance curve D' is very high for these frequencies, say, several thousands of ohms. This condition also relates with respect to the filter F1, the attenuation of which is shown by the curve A'. Consequently, the largest portion of the energy is impressed upon the line without permitting this frequency to obtain access to the remaining filter or transmitter means. The shape of the attenuation characteristic within the blocking range is of sub-ordinated importance only. The considerations now made with reference to three frequencies, may also be applied in connection with a larger number of frequencies, however, with the result that the attenuation and surge impedance curves will be more complicated. In this case the cut-off frequencies of the filters are selected so as to coincide with the adjacent frequencies to be blocked, while their passing ranges are made wider as compared with the known arrangements according to which the passing ranges closely encompass the frequency bands to be transmitted. The result obtained by these measures is not only a reduced attenuation within the passing range, but also the significant advantage that the carrier frequencies pertaining to the filters may be easily altered.

Furthermore, in order to secure matching of the frequency dependent input or output impedance of the filter arrangement in an operating circuit with respect to the shape of the filter surge impedance characteristic being utilized according to the invention for creating the blocking effect, terminating networks N1, N2 and N3 are provided in front of or behind the filters F1, F2 and F3 of the arrangement according to Fig. 4. These terminating networks are adapted to influence the shape of the filter impedance char-

acteristic within the blocking range, contradictory to the terminating networks employed in the known devices, which create impedance smoothing in the passing range without varying the attenuation of this range of the filter. Any kind of known π —, T— or differential circuit arrangements thereby serve as filters, in which the surge impedance of their fundamental members present points of infinity with respect to the cut-off frequencies which are provided so as to coincide with the frequencies of the adjacent transmitters which are to be blocked, instead of being located at the boundaries of the frequency band to be transmitted, as was usual in the past. The passing range is thereby made considerably wider with the result that an attenuation decrease is obtained in the range practically utilized. The value of the attenuation with reference to the curve B for the frequency f_2 , for instance, is higher than the attenuation shown by the curve B'.

The actual blocking effect with respect to the adjacent frequencies as looked upon from the line, is attained by virtue of maximum points of the input impedance of the filter as above described. The input impedance in the blocking range is influenced in the desired manner by adding terminating networks or corrector means to the filters as such.

The circuit arrangement according to the new filter device shown in Fig. 5 comprises the members F1, F2 and F3 of the fundamental filter arrangement, and terminating networks N1, N2 and N3, as well as correctors K1 and K3. This arrangement of the inductances and the capacities permit, e. g. impedance and attenuation curves to be obtained which are adapted according to the invention to combine the carrier alternating currents produced in the transmitters S1, S2 and S3 in order to impress these currents upon the line L.

In cases of an intended frequency separation in carrier frequency multiple-telephony, receivers must be believed to substitute the transmitters S1, S2 and S3. The terminating networks and the corrector means may be of different shape, that is to say, simpler or more complicated, dependent on the space between the frequencies of the transmitters.

What is claimed is:

1. An electric filter arrangement for separating and combining alternating carrier frequency voltages comprising a plurality of filters connected in parallel on one side thereof to a common circuit, said filters being so dimensioned that their characteristic impedances approach infinity at the cut-off frequencies, and that said cut-off frequencies of each filter coincide with the passed frequencies of the adjacent channel filter.

2. An arrangement according to claim 1, wherein said filters are so dimensioned that the blocking effect with respect to the adjacent frequencies which results from the variations in characteristic impedances of said filters predominates over the corresponding blocking effect which results from the variations in attenuation of said filters, further comprising, terminating networks adapted to influence the impedance characteristic prevailing within the blocking range.

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