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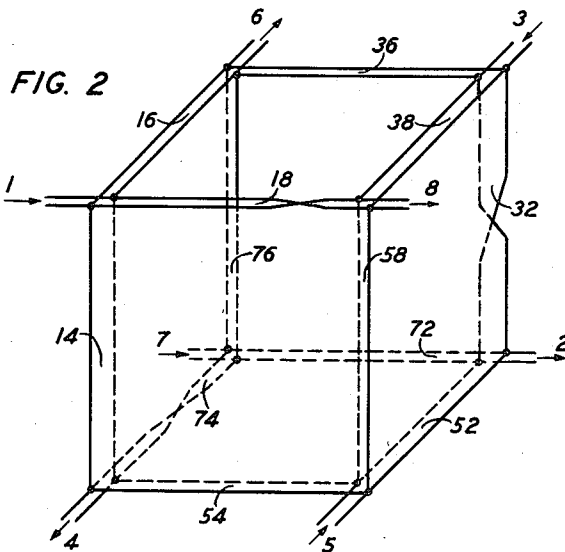
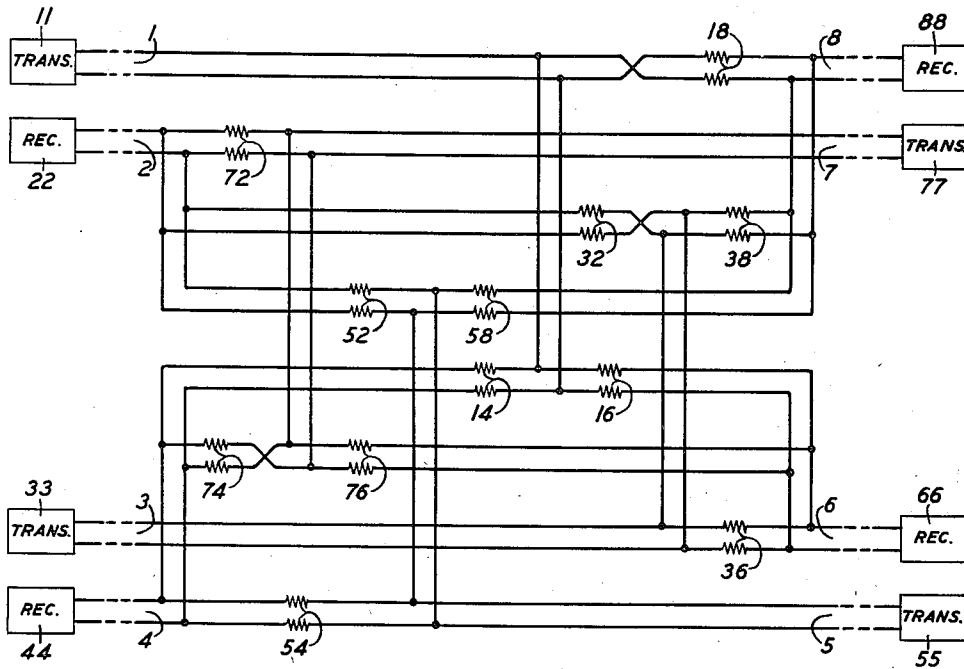
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INTERCONNECTION OF TRANSMISSION LINES

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FIG. 1



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INTERCONNECTION OF TRANSMISSION
LINES

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4 Claims. (Cl. 178-44)

The present invention relates to the interconnection of a plurality of pairs of transmission circuits so that each pair is enabled to transmit to and receive from each other pair of circuits.

An object of the invention is to interconnect a number of pairs of circuits or lines in mutually communicative relation while maintaining a high loss between a given transmitting circuit and the receiving circuit with which it is paired.

The lines so interconnected may carry any type of current or waves such as speech, music or visual image current. The invention has particular application to situations in which it is desired to associate several four-wire circuits so that each transmitting line may transmit into all the other receiving lines except its own receiving line and as to that it is practically conjugate. The invention provides a simple and direct method of accomplishing this result by use of simple attenuators which may be directly connected to the several lines in a manner that will be made clear as the description proceeds.

In the drawing, Figs. 1 and 2 are two different diagrammatic representations of the same circuit except that Fig. 2 has been simplified by the omission of certain of the elements of Fig. 1. The two circuit representations are given in order that the invention may be more readily understood.

The invention will be described and has been illustrated with specific reference to the interconnection of four pairs of lines, that is, four four-wire circuits each comprising a transmitting line and a receiving line. It will be understood, however, that the invention is not limited to any particular number of lines, but that the same scheme of connection may be applied to the interconnection of three lines, four lines, or more than four lines.

In the drawing, one pair of lines is shown at 1, 2, another pair at 3, 4, etc. The lines 1, 3, 5 and 7 are transmitting lines each having associated with it a transmitter 11, 33, 55 or 77, respectively. The lines 2, 4, 6 and 8 are receiving lines each having a respective receiver 22, 44, 66 or 88. It will be observed that the line 1, for example, is connected to the line 4 through an attenuator 14 and to the line 6 through a similar attenuator 16 and to the line 8 through a similar attenuator 18. Similarly, the line 3 is connected to the line 2 through an attenuator 32, to the line 6 through an attenuator 36 and to the line 8 through an attenuator 38. A similar scheme of connection is carried out for all of the

transmitting and receiving lines except for the transpositions which will now be referred to.

Three points of transposition are shown in the drawing, one being between line 1 and line 8, another being between line 3 and line 2 and the third being between line 7 and line 4. The purpose of these transpositions is to minimize cross-talk, that is, undesired transmission from any transmitting line through the interconnecting circuit and back into the receiving line with which it is paired.

The manner in which these transpositions reduce such cross-talk may be more readily apparent from considering the geometrical diagram of Fig. 2 in which for simplicity the transmitters and receivers as well as the attenuators have been omitted, but the numbering of the attenuators has been retained at the positions where the attenuators would be if present. It will be observed in the "cube" diagram of Fig. 2 that any pair of lines such as 1 and 2 appear at opposite "corners" of the cube. Six cross-talk paths are present between any transmitting line and its associated receiving line, each of which paths comprises no more than three branches in series. These may be traced as follows: 1-4-5-2; 1-4-7-2; 1-6-3-2; 1-6-7-2; 1-8-3-2; and 1-8-5-2. These may be conveniently considered in pairs as regards their tendency towards producing cross-talk. The first pair of paths is ineffectual in producing cross-talk because of the single transposition at 74 which makes the cross-talk current through the first two paths arrive at point 2 in respectively opposite phase. The second pair of paths on account of the transposition at 32 tends to produce zero voltage at the point 2. The paths of the third pair on account of the transposition at point 32 are also opposed in their tendency to produce voltage in line 2.

Such other paths as exist between the lines of one pair contain more than 3 branches in series and are of negligible effect in producing cross-talk.

It will be observed that the scheme of connection is symmetrical and the same result as is indicated above would be obtained from tracing through the various paths for cross-talk current between the lines of any pair.

In one example used by applicant the direct transmission from any line to any line of another pair was about 14.7 decibels. The attenuators comprised 800 ohm resistances in each side of the circuit and the line impedance was 650 ohms. These figures correspond to a transmission loss

through one attenuator of 14 decibels. However, considering the transmission path from line 1 to line 3 in Fig. 2 there are two paths in parallel to the direct transmission path between these two lines, that is, 16, 36 and 38 making up one path and 14, 54 and 58 making up the other path, each having a loss of 42 decibels or the two paths in parallel having a loss of 36 decibels. These two parallel paths contain no transposition so that when their conductivity is combined with that of the direct path from line 1 to line 3 containing transposition 18 a resultant loss of 14.7 decibels is obtained.

There is nothing critical or limiting about the figures that have been given. For example, in another case which applicant has used, each attenuator comprised a resistance of 5,545 ohms in each side of the line and there was a shunt of 850 ohms across each line junction, the line impedance in that case being about 700 ohms. These conditions correspond to a transmission loss of about 30.2 decibels from each transmitting line across to the receiving lines of the other pairs of lines.

The present invention is capable of extension to a greater number of lines than 4, for example in the manner specifically referred to in the application of Cowan and Goetz, Serial No. 729,864, filed June 9, 1934, on which the present invention is an improvement.

One advantage of the present invention is that equal attenuators can be used in all the connections between lines in all cases on account of the use (in the case of four four-wire lines) of the three transpositions disposed as shown. Where only two transpositions are used as disclosed in the Cowan et al. application, in some instances, as where the attenuators between lines have low loss, it is necessary for equal transmission through all paths to use unequal losses in the attenuators.

What is claimed is:

1. In an interconnecting circuit for pairs of lines each pair consisting of a transmitting line and a receiving line, a circuit bridged across from the transmitting line of each pair to each of the receiving lines of other pairs, whereby the possibility exists of undesired cross-talk paths between lines of the same pair through a plurality of said bridged circuits in succession, certain of said bridged circuits having their conductors transposed such that, taking any two cross-talk paths in parallel, each comprising two bridged circuits in succession between the same points, one only of such paths contains a transposition such that said parallel paths are opposed in their tendency to produce cross-talk.

2. In an interconnecting system for four pairs of lines, each pair consisting of a transmitting line and a receiving line, a connection, including an attenuator, from the transmitting line of each pair to the receiving lines of other pairs, three of said connections containing a transposition such that all of the six principal cross-talk paths between lines of any one pair have a substantially zero resultant effect in producing cross-talk.

3. In an interconnecting circuit for pairs of lines, each pair consisting of a transmitting line and a receiving line, circuits bridged across from the transmitting line of each pair to the receiving lines of other pairs, certain bridging circuits being transposed such that, starting from any transmitting line, any two bridging circuits in series are paralleled by two other bridging circuits in series, one only of the two paralleled paths so formed containing a transposition, whereby currents in one such parallel path tend to neutralize currents in the other.

4. A combination according to claim 2, in which said attenuators are all equal and the transmission losses from each transmitting line to the receiving lines of other pairs are all equal.

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