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MULTIPLEX SIGNALING SYSTEM

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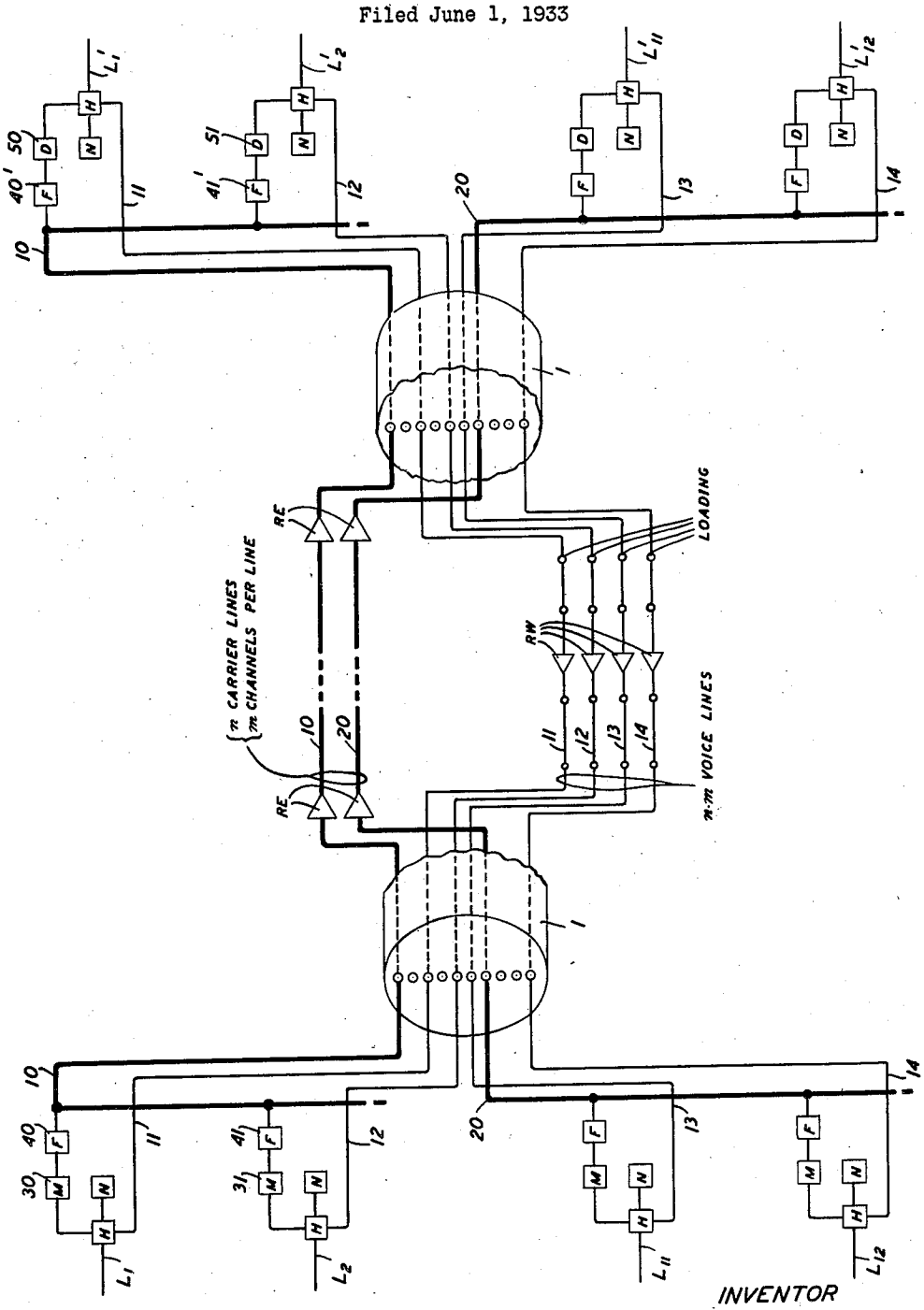

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MULTIPLEX SIGNALING SYSTEM

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2 Claims. (Cl. 179—78)

This invention relates to two-way signaling over a multiplicity of circuits such as those comprised in a telephone cable, although in its broadest aspects the invention is not limited to telephony.

An object of the invention is to increase the message-carrying capacity of a cable or other group of transmission lines or circuits.

This object is accomplished according to the present invention by multiplexing only certain of the lines of the cable for carrier transmission and pairing the message channels thus formed with individual lines that are not multiplexed.

A schematic circuit diagram of a cable system embodying the invention is given in the single figure of the accompanying drawing.

In the figure the cable is indicated by showing its two ends at 1, 1 the central portion through the major extent of its length being broken away in the diagram.

Long cables of the prior art have generally consisted of voice frequency circuits operated on a four-wire basis and loaded. That is, half the circuits transmitted east and the other half transmitted west. Each line contained one-way repeaters. A complete two-way voice circuit was made up by associating as a two-way pair one one-way line with another transmitting in the opposite direction. Subscribers' loops or other two-wire lines were then connected to the pair of one-way lines at each terminal by means of hybrid repeating coils. This gave half as many two-way conversational circuits as there were pairs in the cable.

When an attempt is made to increase the message carrying capacity of cable circuits by multiplexing the lines for carrier transmission, it is found that cross-talk is a limitation and especially so if special shielding or frequency allocation is not resorted to.

The invention provides an economical way of applying multiplex carrier to a cable of ordinary construction to increase the message-carrying capacity. This is done by multiplexing certain of the lines, shown at 10, 20 in the drawing, so that they all transmit in the same direction, assumed eastward in the figure. Since all of the channels on these lines transmit in the same direction, the cross-talk requirements may be brought within practicable limits without resorting to the use of separate cables or shields within the cable as might be necessary where oppositely directed lines were included within the cable and used the same frequency ranges. In the arrangement illustrated the same frequency ranges may be used on carrier lines 10, 20 etc., so that the full economical operating range of each line can be utilized. Let it be supposed that a number, n, of such lines 10, 20 etc. be multiplexed to provide m channels per line, or a total of $n.m$ channels, all eastward. An equal number of westward channels is provided in the form of $n.m$ separate voice circuits 11, 12, 13, 14, etc.

At the west terminal, the carrier line 10 is associated with m subscribers' lines L_1, L_2 to L_m by means of suitable carrier terminal apparatus such as modulators, 30, 31 etc. and band filters 40, 41 etc. in accordance with standard practice for carrier transmission. Each line L_1, L_2 etc. has a hybrid coil H and line balancing network N for associating the line with the carrier modulating circuit for transmitting and with the return voice line 11 or 12 etc. for receiving. A similar arrangement is illustrated for associating the m lines L_{11}, L_{12} to L_{1m} with the carrier line 20 for transmitting eastward and with the m individual voice lines 13, 14 etc. for receiving in the westward direction.

At the opposite cable terminal an entirely similar arrangement is used. This is indicated for the group of lines L_1', L_2' to L_m' which are associated with the multiplex line 10 at that terminal for eastward transmission and with the m individual lines of the cable 11, 12 etc. for a westward transmission. Suitable carrier receiving apparatus comprising filters 40, 41' etc. and demodulators 50, 51 etc. are shown in the carrier receiving circuits that are branched from line 10. A similar arrangement is used for line 20.

Mid-line repeaters are shown in the carrier lines at RE and in the voice lines at RW. On account of the higher attenuation in the carrier range it may be necessary to use closer repeater spacing in the carrier lines than in the voice lines and this is indicated in the drawing by the two carrier repeater points RE, RE for the one repeater point RW in the voice lines.

The invention has application to many different situations in practice. Two such situations will be described.

In the first situation, it is assumed that a cable is to be laid, that present requirements are for 40 voice circuits and that the expected demand will eventually increase to 90 voice circuits. (These figures are of course purely illustrative and an actual case might well involve figures several times larger than these.) In

accordance with the invention, 100-pair cable might suffice. It would contain 90 one-way loaded voice lines for four-wire operation and 10 non-loaded lines which for the present would not be used. These non-loaded lines would represent relatively small capital outlay. The 90 one-way voice lines would provide the 40 two-way circuits immediately required and a margin for growth. After the voice circuits are all in use, multiplex carrier transmission is applied to the non-loaded circuits and some of the voice circuits have their repeaters reversed so that the voice lines may serve for opposite direction of transmission and be paired with the carrier channels. Eventually all 10 non-loaded lines will be multiplexed to provide 9 channels each or a total of 90 eastward channels to go with the 90 westward voice lines. The carrier lines may use the range of 4 to 40 KC or any other suitable range for the 9 channels assumed.

In the second situation, let it be assumed that a 100-pair cable is already in existence and consists only of loaded voice circuits, but that a demand has arisen for 40 additional conversational circuits. Instead of going to the expense of laying an additional cable, 10 of the voice lines are equipped for carrier operation by removal of their loading and installing suitable terminal and repeater apparatus. On a 9 channel basis these ten lines provide 90 one-way channels. The voice lines are all directed one way as in the other case above described and provide the 90 return circuits.

The carrier repeaters may be of the type disclosed in an application of H. S. Black, Serial No. 606,871, filed April 22, 1932.

The carrier lines are preferably spaced apart within the cable so that a number of low frequency pairs intervene between carrier lines and provide some shielding against cross-talk between the carrier lines.

What is claimed is:

1. A two-way signaling system comprising a cable consisting of a plurality of lines multiplexed for carrier transmission in the same direction to provide a plurality of channels per line, and a number of low frequency simplex one-way lines equal in number to the total number of the carrier channels, and all transmitting in the opposite direction with respect to said carrier channels, and two-way terminal circuits cooperating with said carrier and low frequency lines, each such two-way terminal circuit being connected for eastward transmission over a respective carrier channel and for westward transmission over a respective low frequency line.

2. A two-way telephone system comprising a cable consisting of n non-loaded lines multiplexed for carrier operation to provide m carrier telephone channels per line all directed the same way and utilizing the same over-all carrier frequency range, and $n.m$ one-way loaded voice circuits for transmission in the opposite direction, and terminal circuit connections for utilizing each carrier channel as one side of a four-wire conversational circuit and one of said voice lines for the opposite side of the respective four-wire circuit.

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