Nov. 17, 1942. M. A. LOGAN 2,302,039

SWITCHING SYSTEM

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FIG. 1

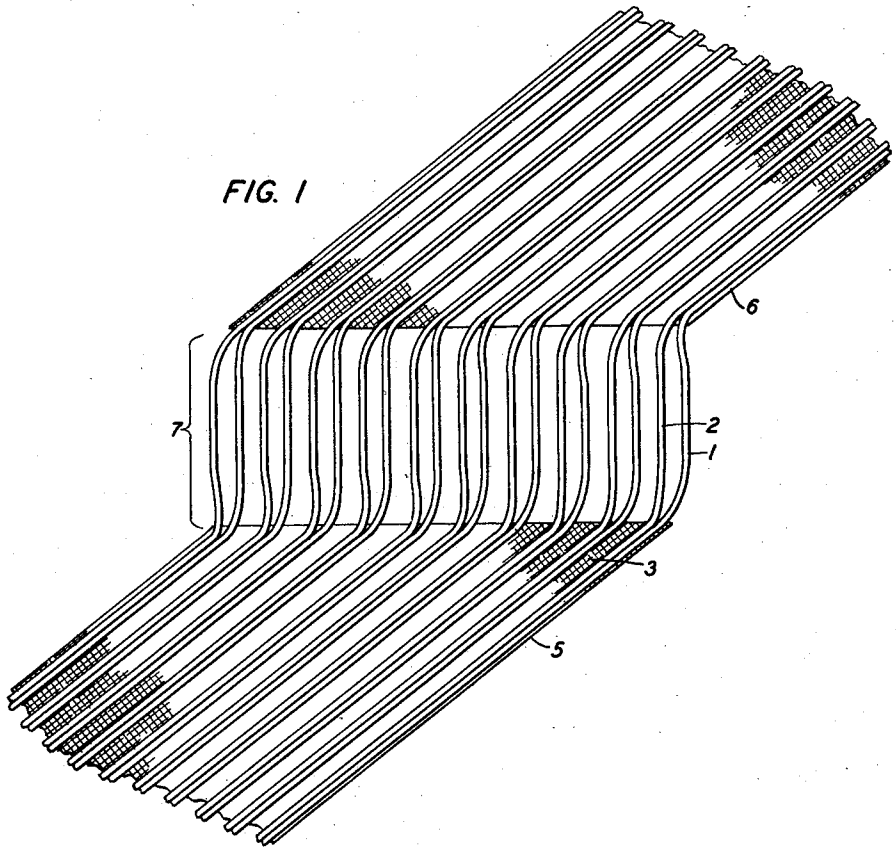

FIG. 2

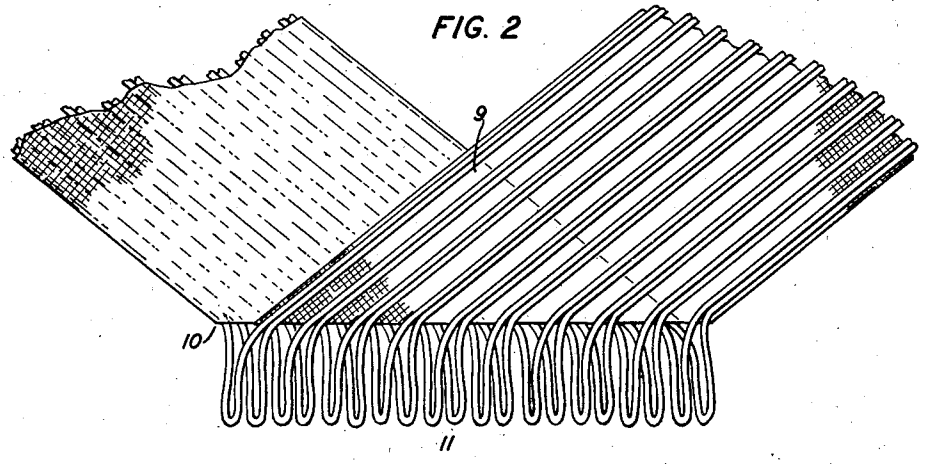

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FIG. 3

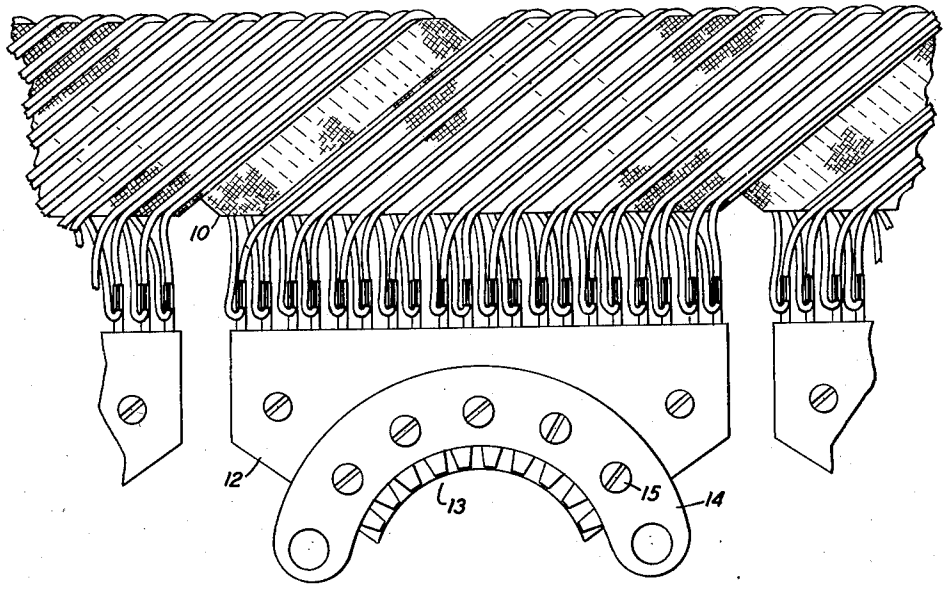


FIG. 4

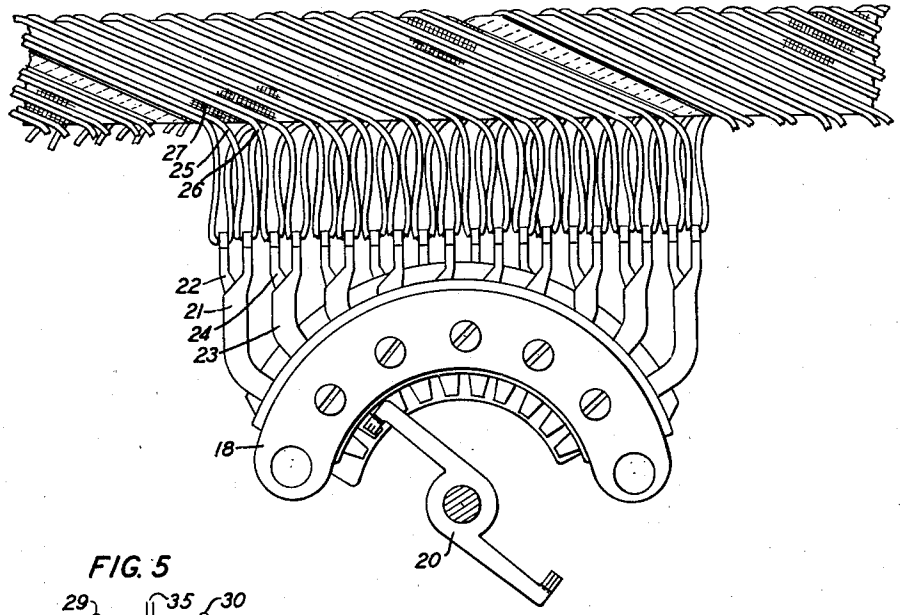
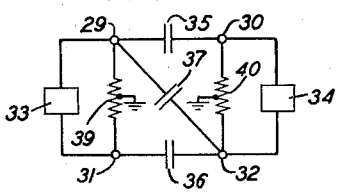


FIG. 5



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SWITCHING SYSTEM

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Application February 15, 1941, Serial No. 379,072

5 Claims. (Cl. 179—174)

This invention relates to switching systems and particularly to improvements in transmission characteristics of such systems.

An object is to prevent cross-talk disturbances between telephone lines engaged in telephonic communication in such systems.

Heretofore in connection with the wiring of terminal banks employed in switching devices for establishing connections between telephone lines, multiple cables have been used in the form of ribbons or flat layers of conductors connected to corresponding terminals arranged in layers in such switching devices. For example, in the case of arcuate terminal banks for rotary switches, the terminals for each line may consist of a tip terminal and a ring terminal with the tip terminal located above the corresponding ring terminal and arranged in groups of horizontal layers, each group consisting of an upper layer of a plurality of tip terminals and a lower layer of a corresponding plurality of ring terminals. A multiple cable is provided for each group of horizontal layers in which each pair of terminals are connected to a corresponding tip conductor and a corresponding ring conductor. Each multiple cable is arranged in a flat ribbon with the tip and ring conductors of each pair lying in parallel relation to adjacent pairs. The conductors in each cable may be secured to a common flat fabric webbing or backing.

It is a feature of the present invention to arrange the distance between the tip conductor of one pair and the ring conductor of the adjacent pair in such ribbon multiple cables to correspond with the distance between the corresponding pair of tip terminals or between the corresponding pair of ring terminals of said two pairs so that the capacity between said tip and ring conductors in the length between two adjacent terminal banks is equal to the combined capacity between said tip terminals and between said ring terminals in one bank. This is for the purpose of eliminating cross-talk between said adjacent pair of conductors and terminals when talking current on said two pairs is present due to said pairs being engaged for telephone conversation.

The invention has been illustrated in the accompanying drawings in which

Figs. 1 and 2 show a method of forming ribbon cables that may be arranged in accordance with the present invention.

Figs. 3 and 4 show two different forms of ribbon cables attached to corresponding terminal banks arranged in accordance with this invention; while,

Fig. 5 is a diagrammatic representation of the capacity existing when two adjacent pair of telephone conductors are engaged in telephone conversation to illustrate the principles of this invention.

Referring now to the drawings and particularly to Figs. 1 and 2, a ribbon cable may be manufactured by arranging the tip and ring conductors 1 and 2 of a plurality of pairs in a layer with a certain predetermined distance 3 between adjacent pairs. This layer of pairs of conductors may be secured to rhomboidally shaped fabric sections 5 and 6, for example, leaving the conductors without any fabric sections connected thereto at the portion marked 7 in Fig. 1. This intermediate section 7 between the fabric sections 5 and 6 may be bent in the shape shown in Fig. 1 and then again bent to form loops as shown in Fig. 2 so that the two adjacent fabric sections 5 and 6 partially overlap each other. These fabric sections 5 and 6 may then again be turned or folded over themselves at their middles in line with the lower edge 10 and the folding of the ribbon cable may then be continued in either or both directions so as to produce corresponding loops such as shown at 11 and for connection to succeeding switch terminal bank.

In Fig. 3 such a ribbon cable has been shown connected to the corresponding tip and ring terminals of a switchbank 12. The terminals are bent and shaped to form an arc 13 and different layers of said ribbons and rows of bank terminals may be piled on top of each other to form individual banks. The various layers of terminals are separated by insulation plates and held together by clamping plates 14 by means of bolts 15 in a manner well known in the art.

In Fig. 4 a similar ribbon cable has been illustrated except that it is somewhat narrower or more closely folded. The terminal bank 18 is also shaped in a somewhat different manner. In this figure a brush 20 is illustrated to show how it may be rotated to sweep over the terminals in a layer.

If reference is now made to Fig. 4 and the left-hand first and second pairs of terminals comprising the tip terminal 21 and ring terminal 22 of the first pair and the tip terminal 23 and the ring terminal 24 of the second pair and their associated connecting conductors, it will be noted that the distance between the tip conductor 25 connected to the tip terminal 21 and the ring conductor 26 connected to the ring terminal 22 of the adjacent pair is of a certain dimension marked 27. This dimension will bear a certain

relation to the distance between the tip terminals 21 and 23 and the same distance between the ring terminals 22 and 24 and to the length of wire in the ribbon cable between two adjacent terminal banks to obtain the desired balance of capacities to prevent cross-talk.

This relationship may be described in connection with Fig. 5 in which the point 29 represents the tip terminal 21 and the associated tip conductor 25, the point 30 representing the tip terminal 23 and the associated tip conductor, while the point 31 represents the ring terminal 22 and the associated ring conductor and the point 32 represents the ring terminal 24 and the associated ring conductor 26. The tip and ring points 29 and 31 are connected to a telephone station 33 and the points 30 and 32 are connected to a telephone station 34. The capacity between the tip points 29 and 30, as determined by the distance between the tip terminals 21 and 23 is represented by the capacity 35 and the capacity between the ring points 31 and 32 as determined by the distance between the ring terminals 22 and 23 is represented by the capacity 36 while the capacity 37 may represent the capacity between tip conductor 25 of the first pair and the ring conductor 26 of the second pair as determined by the distance 27 between these two conductors and the length of the conductors 25 and 26 between two adjacent terminal banks. Said distance may be arranged so that the capacity 37 is equal to the capacity 35 plus the capacity 36. If the telephone station 33 is connected for conversation through the tip and ring points 29 and 31 to another station, the resistance to ground between these points may be represented as shown at 39 and if at the same time station 34 is connected for conversation to another station through the tip and ring points 30 and 32, the resistance to ground between these two points may be represented as shown at 40. Hence speech current passing through the telephone circuits 29, 39, 31 and 33 will, due to the values of the capacities 35, 36 and 37, not create any cross-talk in the telephone circuits 30, 40, 32 and 34 and on the other hand, speech current passing through this latter telephone circuit will not produce any cross-talk in the first-mentioned telephone circuit as the effect of the capacity 37 neutralizes the effect of the capacities 35 and 36. Consequently with a ribbon cable and terminal banks arranged in this manner, there will be no cross-talk disturbances when telephone conversations are carried on over both of said two circuits simultaneously when said two circuits have their tip and ring conductors and terminals located next to each other in a ribbon cable and terminal banks.

What is claimed is:

1. A switching system comprising a switchbank having pairs of tip and ring terminals, a cable having pairs of tip and ring conductors, the pairs of tip and ring conductors being connected to corresponding pairs of tip and ring terminals, said terminals and said conductors being so arranged that when any two pairs of adjacent terminals and associated connected conductors are engaged in telephone conversations, cross-talk between said two pairs is eliminated, said arrangement being such that the capacity between the tip conductor of one pair and the ring conductor of the other pair is equal to the capacity between the tip terminals of said two pairs plus the capacity between the ring terminals of said two pairs.

2. A switching system comprising a switchbank having pairs of tip and ring terminals, a cable having pairs of tip and ring conductors, each pair of tip and ring conductors being connected to corresponding tip and ring terminals, said terminals and said conductors being so arranged that when any two pairs of adjacent terminals and associated connected conductors are engaged in telephone conversations, cross-talk between said two pairs is eliminated, said arrangement being such that the spacing between the tip conductor of one pair and the ring conductor of the other pair in the cable is related to the spacing in the switchbank between the tip terminals of both pairs and the spacing in the switchbank between the ring terminals of both pairs so that the capacity between said tip and ring conductors is equal to the capacity between the two tip terminals plus the capacity between the two ring terminals.

3. A switching system comprising a switchbank having terminals, and a ribbon cable having individual conductors connected with individual terminals in said bank, the terminals in said bank comprising pairs of tip and ring terminals arranged with the tip terminals of a plurality of pairs in one layer and with the ring terminals of said pairs arranged in a second layer with the tip terminal of each pair above the corresponding ring terminal and with said ribbon cable arranged with the tip conductor of each pair separated a predetermined distance from the ring conductor of the adjacent pair so that the capacity between said adjacent tip and ring conductors in the cable matches the capacity between the adjacent tip terminals of the corresponding pairs of terminals plus the capacity between the adjacent ring terminals of said corresponding pairs to eliminate cross-talk between said two pairs when both of said pairs are engaged in telephone conversations.

4. A switching system comprising a switchbank having tip and ring terminals in pairs, a cable having tip and ring conductors in pairs, each pair of tip and ring conductors being connected to a corresponding pair of terminals, the terminals in the switchbank being arranged so that the tip terminals are arranged in one row and the ring terminals in another row with the tip terminal of each pair adjacent to the corresponding ring terminal and the tip and ring terminals in the corresponding rows arranged a certain fixed distance from each other and the cable is so arranged that the tip and ring conductors of each pair are located close to each other and the conductors of the adjacent pairs arranged in a row with a certain fixed distance between the tip conductor of one pair and the ring conductor of the adjacent pair, the distance being such that when two adjacent pair of terminals and the associated connected conductors are each engaged in a telephone conversation, cross-talk from one pair to the other is eliminated due to the capacity between the tip conductor of one of said pairs and the ring conductor of the other of said pairs being equal to the capacity between the tip terminals of said pairs plus the capacity between the ring terminals of said pairs as determined by said distances.

5. A switching system comprising a series of switch banks, each switch bank having pairs of tip and ring terminals, a cable having pairs of tip and ring conductors, each pair of tip and ring conductors being connected to corresponding pairs of tip and ring terminals in all of said

banks with the pairs of conductors located in parallel relation to each other between the banks, and with the spacing between the pairs of conductors greater than the spacing between the individual conductors in each pair and with the spacing between the tip terminals of adjacent pairs in each bank located a fixed distance apart and with the spacing between the ring terminals of adjacent pairs in each bank located the same distance apart as the associated tip terminals so that the capacity between the tip and ring conductors of any adjacent pairs for the full length of the cable is equal to the capacity between the tip terminals of the associated adjacent pairs in all banks plus the capacity between the ring terminals of the associated adjacent pairs in all banks when two of said adjacent pairs of terminals are engaged in telephone connections at any banks so as to prevent cross-talk disturbances between the lines connected to said two pairs of terminals and associated conductors.

MASON A. LOGAN.