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ELECTRIC RIBBON CABLE

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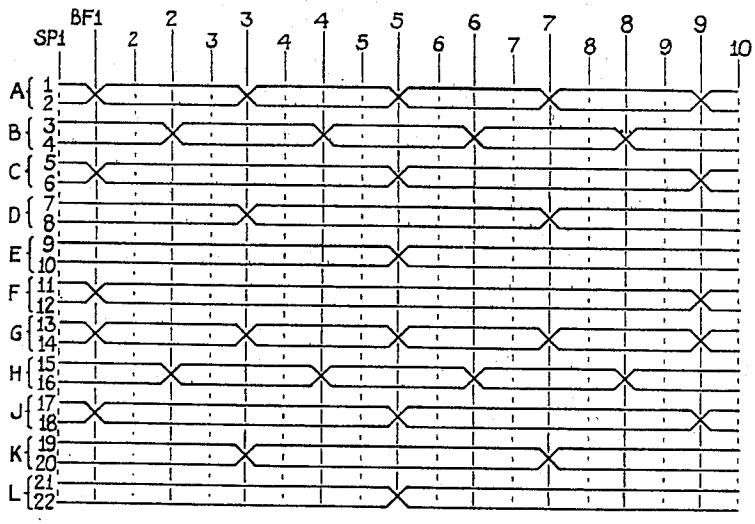


Fig. 1

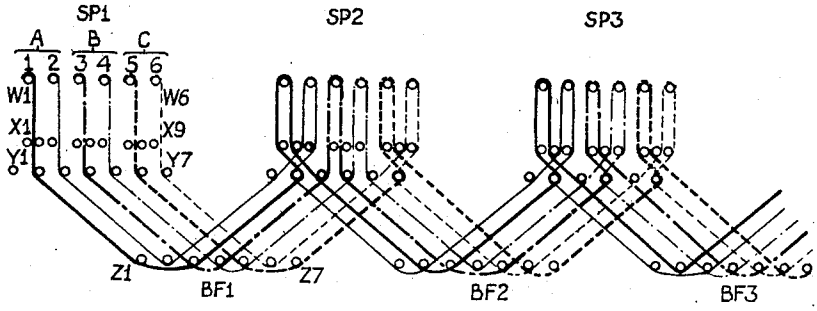


Fig. 2

INVENTORS
Sidney Reynell Smith
and
Cecil Rhodes
By Lippincott & Smith,
ATTORNEYS

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ELECTRIC RIBBON CABLE

Sidney Reynell Smith and Cecil Rhodes, Liverpool, England, assignors to Automatic Telephone & Electric Company Limited, Liverpool, England, a British company

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5 Claims. (Cl. 179—78)

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The present invention relates to electrical wiring arrangements and is more particularly concerned with improvements in so-called ribbon cables which may be used in multiple wiring of selector banks in automatic telephone exchanges.

Selector contact banks of the type described in United States Patent No. 2,149,632 are widely and successfully employed in conjunction with two-motion selectors in telephone systems. In a bank of this type the contact members are arranged in a suitably insulated and clamped arcuate pile-up, the particular bank described being often referred to as a double bank since each of the 10 levels comprises two rows of 11 contacts, i. e. 220 contacts are provided. The contact members in each level are appropriately splayed towards the ends forming the soldering tags so that the 22 tags are spaced at equal intervals in an arc to provide for easy accessibility.

In a telephone exchange, a bank multiple for a so-called shelf of two-motion selectors may comprise say 10 selector positions located side by side, and each position may be equipped, for instance, with three banks of the type mentioned, the banks in each position being mounted one above the other. By way of example to provide for 200 traffic outlets, the first 10 pairs of contacts in each bank level are utilised, one bank in each position being adapted to serve 100 two-wire speech paths, the second bank another 100 speech paths, and the third bank providing access to the 200 private wires associated with the separate speech paths. The 11th position contacts which often cater for overflow or like conditions may be included in the multiple as required.

Now the most widely employed arrangement for multipling the banks involves the use of twisted pairs of separately insulated (usually fabric covered) wires, one wire of a pair being progressively looped over and soldered to similarly located tags in each position, while the other wire of the pair is dealt with in the same manner to connect together the partner tags. The lengths of wire extending between tags in adjacent selector positions are subsequently formed neatly by hand. Bank multiples manufactured according to the foregoing method have proved very satisfactory in service but it will be appreciated that the process of manufacturing is slow and comparatively costly. It may be mentioned that in such multiples the more or less random displacement of the twists in the conductors serves generally to limit cross-talk and inductive pick-up and no doubt the limitation is assisted by the air spacing of the conductors

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which is inherent in the arrangement described.

From time to time efforts have been made to simplify and speed up the fabrication of bank multiples and in this respect pre-formed ribbon cables, for use with suitably arranged bank contact soldering tags have been proposed.

It is already known to modify banks of the general type hereinbefore described so that the tags are extended and formed to terminate in a vertical plane. Moreover it has been proposed that ribbon cables for use in multiples employing such modified banks shall be provided on the basis of one ribbon cable to serve each of the corresponding bank levels of the selector positions in a shelf. In such ribbon cables, connecting means such as wire loops are arranged to branch from one edge of the insulated body of the ribbon in positions appropriate to the soldering tags of the banks. Each ribbon is laid across the contact members of the corresponding levels of the banks, between the clamped portion and the soldering tags, so that the bodies of the ribbons lie within the bounds of the soldering tags. The connecting means branching from the ribbon are directed rearwardly, i. e. in the same direction as the soldering tags, and are then appropriately interlocked with the tags, whereupon soldering may be effected with great rapidity by immersing the tags of the whole shelf in a solder bath.

A ribbon cable for multipling selector banks in the foregoing manner must fulfill certain requirements dimensionally and in its physical and electrical properties. In addition to the need for its constituent insulated conductors to retain their positions, the ribbon must be compact and, particularly, thin enough to be accommodated in the very limited space between the tags of two adjacent levels in a bank. The conductors must be strong, flexible and adequately insulated so that there is no likelihood of breakdowns or short-circuits developing during the manufacture or normal handling of the ribbon, or when the ribbon is used under severe climatic conditions such as high humidity and extremes of temperature.

In the applicants' application Serial No. 214,823, filed March 9, 1951 various methods of manufacturing ribbon cables, which are intended to meet all the foregoing requirements, are described. Briefly, each of those methods is concerned with the manufacture of ribbon cable for multipling purposes by forming an initially flat ribbon cable into what has been termed a flat helix having connecting loops along one edge, the initial ribbon comprising a plurality of conduc-

tors which are arranged in spaced parallel relationship in one plane within a homogenous mass of thermoplastic insulating material, such as plasticised polyvinyl chloride. Although such a ribbon multipling cable will find many useful applications, it may well be that, if it is employed particularly in the speech path bank multiples of large telephone exchanges, the level of cross-talk will be unacceptable.

The suggestion has been made heretofore, with a view to minimising induced currents in a pair of conductors due to the presence of varying currents in other nearby conductors, that a ribbon cable should incorporate the previously described practice of twisting or transposing the conductors forming a pair with respect to each other. According to this arrangement a twisted pair is formed by transposing the relative positions of two adjacent conductors twice between successive connecting loops, and it therefore follows that the thickness of the ribbon will not be uniform, indeed the body of the ribbon will be three and even four wires thick in places. Moreover there is difficulty in arranging the transpositions formed in the various pairs of conductors to reduce interference due to unbalanced capacitative coupling between them.

The chief object of the present invention therefore is to provide an improved ribbon cable for multipling purposes in which transposing of the conductors is effected to reduce cross-talk and pick-up without increasing the thickness of the cable.

According to one feature of the invention in a ribbon cable suitable for the multipling of contact banks of automatic telephone switches having the conductors arranged in zig-zag formation transposition is effected without increasing the thickness of the cable by arranging that at a transposition point the conductors of a pair do not cross at one edge of the cable and at the other edge of the cable the connecting loops for the contacts cross outside the thickness of the cable so as to bring them in the proper place.

According to another feature of the invention in a transposition arrangement for ribbon cable as used for the multipling of contact banks of automatic telephone switches the transposition plans for the various pairs of conductors in a ribbon cable involve transpositions which are all symmetrical about the middle of the bank multiple run along the switch shelf and are different for adjacent pairs of conductors.

In a preferred embodiment of the invention the cable is fabricated from conductors individually covered with thermoplastic material, such as polyvinyl chloride, and during the manufacture of the cable the body of the cable or some part thereof is subjected to pressure across the thickness while heat is also applied so as to effect welding of the insulation on abutting conductors whereby the conductors are subsequently retained in correct relationship.

The invention will be better understood from the following description of one method of carrying it into effect which should be read in conjunction with the accompanying drawings comprising Figs. 1 and 2.

Fig. 1 is a typical transposition diagram for a 22-wire ribbon cable suitable for use in conjunction with a 10-position selector shelf having the before-mentioned modified type of double banks, while Fig. 2 shows a stage in the manufacture of a portion of a ribbon cable.

Referring to Fig. 1, the 22 conductors are designated 1 to 22 and are arranged in pairs A, B, C, and so on. The connecting loops would of course be arranged ultimately to branch from the edge of the cable at the selector positions which are referred to as SP1 and SP10. It will be understood that the conductors are arranged in a zig-zag formation across the width of the cable and for convenience the various appearances of the conductors along the other (or back) edge will be referred to as the back folds and are accordingly designated BF1 to BF9.

Starting at selector position SP1, the 22 conductors traverse the width of the cable diagonally, and in parallel relationship, to the back fold BF1. At this position, transpositions are effected upon pairs A, C, F, G and J. At the next back fold, BF2, the conductors in pairs B and H are transposed. A perusal of the diagram shows that transpositions are made as required in accordance with a pre-arranged pattern at intervals along the back edge of the ribbon. Considering particularly the first two pairs of conductors A and B, it will be apparent that the equally spaced transpositions occur at the odd and even numbered back folds respectively. It can be seen from the diagram that in the aggregate the individual wires of pair B lie alongside wire 1 for equal distances, and likewise the wires of the same pair lie alongside wire 2 for an equal distance. Conversely similar considerations apply to the relationship of pair A with regard to wires 3 and 4. Thus in the ideal state, capacity unbalance between these adjoining pairs of conductors, which may of course be employed in separate talking circuits, is substantially eliminated with a consequent reduction in cross-talk. It will be appreciated that by an extension of the foregoing considerations, the six pairs of conductors A, B, C, D, E and F will be substantially non-interfering with respect to each other. Now the transpositions in each of the remaining pairs of conductors G, H, J, K, and L correspond respectively with those of the before-mentioned pairs A, B, C, D and E. Hence although the pairs of conductors in the former group, like those of the latter, are substantially non-interfering with respect to each other, it might be expected that some coupling would occur due to capacity unbalance between corresponding pairs in each group. However the distance between said pairs is sufficient to render this coupling negligible.

Reference will now be made to Fig. 2 which pertains to the layout and manufacture of a ribbon cable in accordance with Fig. 1. However, only six conductors, 1 to 6, and three selector positions, SP1 to SP3, are shown, in order to simplify the description and drawing, and it will be appreciated that a degree of distortion has been introduced insofar as the distances between corresponding connecting loops in the various selector positions are reduced and this results in the spacing of the conductors in their edge to edge runs being exaggerated.

Preferably the cable involves the use of, say, .018" diameter conductors which have been previously insulated with thermoplastic material such as polyvinyl chloride, applied by an extrusion process to give an overall diameter of about .040". Moreover the insulating coverings of the odd and even numbered wires may be distinctively coloured to assist in the subsequent identification of the conductors.

In the manufacture of the ribbon by hand, three groups of pins such as W1 to W6, X1 to X9

and Y1 to Y7 for each selector position of the ribbon, and a group of pins Z1 to Z7 for each back fold position, are fixed in a flat metal base plate. Now considering the A pair of conductors, and conductor 1 in particular, this is anchored to pin W1, passed between pins X1 and X2, then to the left of pin Y2, and below pins Z1 and Z3, and so on, as indicated by the continuous thick line. Afterwards the partner conductor, A2, which is shown as a continuous thin line is anchored to pin W2, threaded between pins X3 and Y3, and then formed round a single pin Z2 and so on. In considering conductors 1 and 2 together, it is interesting to note that the transposition required at back fold BF1 (vide Fig. 1) is obtained without crossing the conductors. The correct appearance of connecting loops 1 and 2 at position SP2 is obtained by crossing over the loops outside the body of the ribbon, the cross over serving also to maintain the transposition introduced at BF1. Since no transposition is required at BF2, the conductors are formed below two pins each i. e. wire 2 below pins Z1 and Z2 and wire 1 below pins Z2 and Z3. Thus at back folds BF2 a transposition does not occur although the wires cross. Again at position SP3 the correct location of the loops is obtained and the relative positions of the conductors in the body of the ribbon is maintained by crossing the loops. The next transposition of the A pair occurs at fold BF3 and this is effected due to conductor 2 passing below pins Z1 to Z3, while conductor 1 passes below pin Z2 only.

Conductors 3 and 4, forming pair B, which are conveniently shown respectively as thick and thin lines broken into alternately long and short dashes, are anchored at pins W3 and W4 and, since no transposition is required at BF1, both conductors pass below two pins each and are crossed over. The conductors then run parallel to position SP2 where the loops are formed but do not cross over since a transposition has not to be catered for. Conductors 3 and 4 are transposed at back fold BF2 by the previously described method of passing the former below three pins and the latter below the middle pin of the three, the correct order of appearance of the relevant loops at position SP3 being obtained by crossing the loops. The conductors then traverse the ribbon again diagonally to back fold BF3 where no transposition is effected, and accordingly they pass below two pins each. In further applying the layout prescribed by Fig. 1, conductors 5 and 6 of pair C, shown as thick and thin lines respectively broken into short dashes, are anchored at pins W5 and W6 and it will be noted that transposing of the conductors along the lower edge of the ribbon, together with the arranging of the correct locations of the loops is effected as required after the manner of the methods already described.

It can now readily be seen that by employing the principles described with reference to Fig. 2, a 22-conductor (11 pairs) cable, for use with a ten-position selector shelf, and having transpositions according to Fig. 1 may be formed, and it will be noted that such an arrangement has the advantage that at no point in the cable are more than two conductors encountered in its thickness. By a judicious arrangement of the pins, the conductors may be formed so as to be in abutting relationship in their edge to edge runs across the cable, or to be spaced singly or in groups.

After completion of the weaving or forming of the conductors, as described, the body of the cable, or parts thereof as may be required, is subjected to pressure across its thickness while heat is also applied. Under these circumstances the abutting heated portions of the thermoplastic (polyvinyl chloride) coverings flow and weld together so that, when the ribbon cable is later removed from the base plate, the conductors retain their positions.

Those portions of the conductors which form the connecting means may be stripped by a cutting or scraping or like operation with or without the application of heat.

Now, if in the formation of a selector multiple, a plurality of ribbons conforming to Fig. 1 are mounted directly one above the other it will be apparent that an appreciable amount of coupling may occur between corresponding pairs in adjoining ribbons. In order to reduce this coupling it will be of advantage to use two types of ribbon in the pile-up alternately, one type being, say that precisely described, and the other having the pair A transposed like pair D of Fig. 1, pair B like pair E and so on. By this means interfering pairs in adjoining ribbons are so remote as to considerably reduce the possibility of cross-talk.

It will be understood that the method of manufacture of a ribbon cable according to the invention is in no way limited to the precise arrangements described. For instance, instead of the manual methods of forming the ribbon, a weaving or forming machine adapted to deal with each of the wires of the cable either singly or collectively may be employed. Further it is not necessary that the ribbon cable be fabricated from thermoplastic covered wires and subjected to heat and pressure as described. Indeed the conductors might well be of the fabric covered type and the conductors could be retained in position in the body of the ribbon by the application of thin adhesive tape to the faces.

We claim:

1. A ribbon cable suitable for the multipling of contact banks of automatic telephone switches having the conductors arranged in zig-zag formation in which transposition is effected without increasing the thickness of the cable by arranging that at a transposition point the conductors of a pair do not cross at one edge of the cable and at the other edge of the cable the connecting loops for the contacts cross outside the thickness of the cable so as to bring them in the proper place.

2. A ribbon cable suitable for the multipling of contact banks of automatic switches having the conductors arranged in zig-zag formation from edge to edge of the cable and having connecting loops formed in all the conductors at each successive appearance along one edge in which transposing of the conductors of any pair is effected at an appearance of the conductors at the edge remote from that providing the connecting loops and in such manner that not more than two conductors are included in the thickness of the cable at any point.

3. A ribbon cable as claimed in claim 1 in which transpositions of different conductors are effected according to different plans all of which involve transpositions at points which are symmetrical about the middle of the bank multiple run along the switch shelf and are different for adjacent pairs of conductors.

4. A ribbon cable as claimed in claim 1 in which the conductors are individually covered with thermoplastic insulating material and are maintained in correct position due to the welding of the insulation by the application of heat and pressure after the forming of the cable.

5. A ribbon cable as claimed in claim 1 in which the conductors are provided with textile insulation and are maintained in proper position by the application of adhesive tape or the like on one or both sides.

SIDNEY REYNELL SMITH.
CECIL RHODES.

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