Feb. 22, 1938. H. KADEN ET AL 2,109,334

COMMUNICATION CABLE COMPRISING ONE OR MORE SCREENED CORE GROUPS

Filed July 17, 1935

Fig. 1

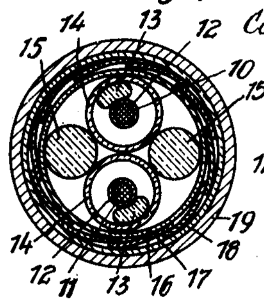


Fig. 2

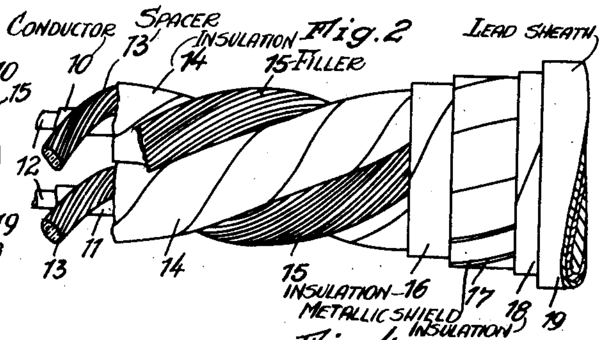


Fig. 3

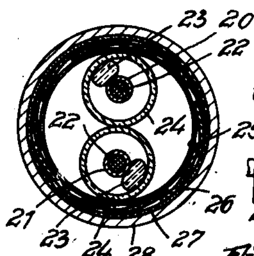


Fig. 4

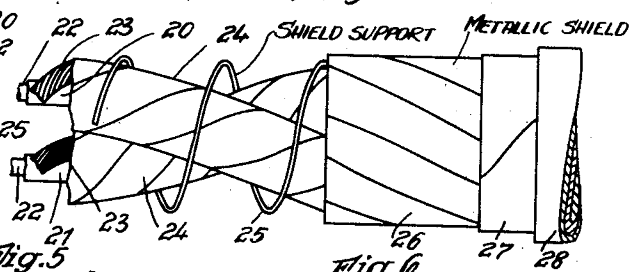


Fig. 5

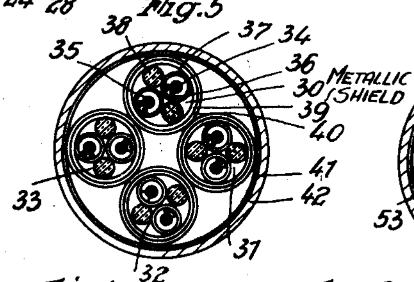


Fig. 6

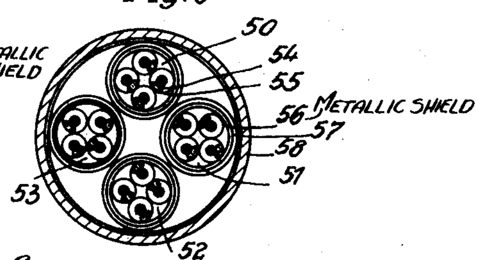


Fig. 7

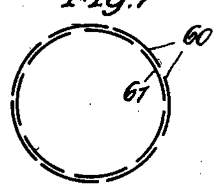


Fig. 8

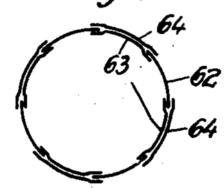


Fig. 9

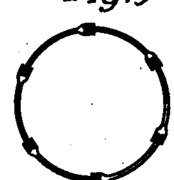


Fig. 10

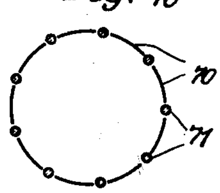
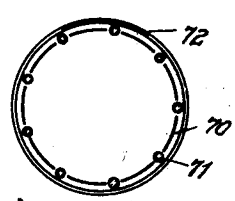


Fig. 11



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COMMUNICATION CABLE COMPRISING ONE OR MORE SCREENED CORE GROUPS

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8 Claims. (Cl. 173—81)

Our invention relates to improvements in communication cables comprising one or more screened core groups.

As is known, the arrangement of conductive screens in communication cables is an effective means of reducing the crosstalk interferences between the different lines and the interferences arising from external sources of disturbance. To obtain as large a screening effect as possible, the screening sleeves must be as highly conductive as possible and, if possible, form a closed tube, that is, a tube having a continuous unbroken wall. Since, however, a closed tube is, on the one hand, comparatively expensive to produce and, on the other hand, is not very flexible, the screens in communication cables are usually made in the form of tape windings, the tapes consisting for example of tinfoil, metallized paper or of magnetizable material. Such screens in general, are sufficient for low-frequency transmission. In order to obtain with more stringent requirements as to freedom from crosstalk, for example with higher frequency of the communication currents and with high line attenuation, a sufficiently great screening effect, it has been proposed to arrange a number of screens consisting of tape windings, one on the other. Such multiple screens are, however, comparatively expensive and materially increase the diameter of the cable.

The present invention provides a novel construction of the screens and is based on the fact hitherto unknown that the paths of the eddy currents produced by the communication currents, extend in the direction of the cores. According to the invention, there are arranged around the core group to be screened, for example, a pair or quad, a number of good conducting tapes or wires, generically termed in some of the annexed claims as "strand elements", which are laid and twisted in the same direction as that in which the cores of the core group are stranded.

Preferably also, the stranding lay or length of the pitch of the screening strand elements is made to agree with the length of twist or pitch of the core group.

In this way, the eddy currents induced in the screen, which follow the twist of the core group, are caused to flow in a metallic layer of small resistance. In previous constructions of the screens in the form of short pitch tape windings, the eddy currents meet with a large resistance at the abutting edges of the adjacent turns of the tape winding. Consequently, with the screens made in the prior art form of short pitch tape windings, the eddy currents cannot develop to an extent which is necessary for the screening of the magnetic field of the lead jacket of the cable. The consequence is that the magnetic field, as a result of the insufficient screening effect, penetrates into the lead jacket and with high frequencies causes heavy losses therein, since the additional losses caused by the lead jacket in the case of high frequencies increase with the square root of the specific resistance of the material of the sleeve. If, however, in accordance with the invention, a screen is arranged over the core group consisting of longitudinally twisted strand elements having the same direction of stranding as that of the core group, then the resistance of the screen to the eddy currents is small and consequently the screening effect is large.

The screen is, as far as possible, made as a closed stranded layer. A simple form of construction consists of a number of thin tapes stranded so as mutually to overlap one another at the side edges. Furthermore, two layers of tapes may be stranded one over the other in such manner that the tapes of the outer layer cover the gaps between or the abutting edges of the tapes of the inner layer. Further embodiments of the invention consist in making the screen by an alternating arrangement of single and double tape strands in which the lateral edges of the single strands are located between the lateral edges of the double strands, or else all strands may consist of double tape and one lateral edge of each strand may be located between the next adjacent lateral edges of one of the adjoining strands. Thus in each case a closed screening layer is formed.

The screens made in accordance with the invention are suitable for use with particular advantage for high frequency cables, for example, for multiple carrier frequency cables, and for television cables which contain only a single core group, in order to avoid the eddy currents otherwise arising in the lead jacket when high frequency currents are used.

If the screen tapes or wires are stranded with the same length of lay or twist pitch and the same direction of twist as the cores of the core group to be screened, the danger exists of these stranded elements dropping into the interstitial spaces between the cores of the group. To avoid this, according to a feature of the invention, either the gaps are filled up by fillers of insulating material or a supplementary supporting member, for example, an open wire winding is arranged underneath the screen.

In the screen consisting of longitudinally twisted tapes there is also the danger that when the cable is mechanically stressed, especially in bending, the tapes become displaced over each other so that gaps occur which more or less impair the action of the screening sleeve. For example, electric or magnetic internal or external fields can penetrate through the gaps of the metal screens and thus produce interferences and this particularly affects cables for the transmission of very high frequencies. Hitherto, there has been no possibility of securing tapes arranged with long lay or pitch in their positions with respect to each other, so that it has been necessary either to use shorter lengths of lay or pitch for the tapes which is undesirable for electrical reasons and also on account of the increase in the cost of making the cable, or it has been necessary to give the tapes a particular shape in order to secure their position, which, however, is still more expensive than the use of shorter lengths of lay. It would be, for example, possible to use profiled lengths of Z-shape in cross section which while engaging securely in each other, are thick and heavy to an extent out of all comparison with the thickness of the metal sleeve which is actually necessary. Thus, for example copper tapes of a thickness of 0.2–0.3 mm. suffice as electrostatic protection, whereas profiled tapes can only be made in thicknesses of several millimetres. Also the folding of thin bands is not a suitable solution of the difficulty since the folding operation is too complicated and expensive to justify protecting sleeves being made in this way. The use of a number of layers of thin metallized paper tapes and the like, has again the disadvantage that the tapes have too great an electric resistance, so that they do not suffice for screening strong fields, especially magnetic fields and, furthermore, cannot provide any mechanical protection to the cores.

In order to secure metal tapes laid with a long twist in their relative positions, in accordance with the invention, there are inserted in a very advantageous manner, between the thin and wide screening tapes and alternating with them, thicker and narrower shaped lengths of material, such as round wires, with the same twist lay. These thicker, narrower shaped lengths of material suffice in a surprising manner entirely to prevent the thin wide tapes from shifting over each other so that the core groups or the whole cable core protected by screens formed by the tapes can be bent round a curve of any desired small radius, without the tapes shifting over each other or gaps being otherwise produced between them. If the alternating tapes and/or wires are to be secured in position even more firmly, this can be effected by the application of an additional wire or tape with a different lay around the screen, preferably with a lay of like direction but shorter pitch than the screen tapes and in widely spaced helical windings. These additional wires or tapes may consist of the same material as the screen or of a different material and may also be arranged to serve as required as a transverse conductive combining means for the protective tapes.

A number of embodiments of the invention are shown in Figures 1 to 11 of the accompanying drawing, of which Figures 1 and 2 show one form of cable respectively in cross section and in sectional side elevation;

Figures 3 and 4 are views similar respectively to Figures 1 and 2 of another form of cable;

Figures 5 and 6 show respectively cross sections of two further forms of cable; and

Figures 7 to 11 show respectively in diagrammatic form and in cross-section different constructions of screening sleeves built up in accordance with the invention.

Figures 1 and 2 show a high frequency cable which comprises a twisted double line the two conductors of which are indicated at **10** and **11**. The conductors are formed as thin hollow conductors which are each supported upon an internal core **12** of insulating material. To form an air space insulation, each conductor is surrounded with a helically wound cord **13** and a sleeve **14** of insulating material is then applied in the form of a tape winding. The two cores so built up are twisted together in common with filler elements **15** of insulating material.

Over the double line is first arranged a sleeve **16** of insulating material and over this is arranged a screen **17** formed in accordance with the invention. The screen **17** consists of a closed layer formed of thin copper tapes laid with a long length of twist and with overlapping of their edges. Over the conductive screen so formed a sleeve of insulating material **18** is applied in the form of a tape winding and then a lead jacket **19**.

The high-frequency cable shown in Figures 3 and 4, differs from the embodiment shown in Figures 1 and 2 essentially only in that no such additional fillers as the fillers **15** in Figures 1 and 2 are provided for supporting the conductive screen but instead a metal wire wound round the conductor pair in open helical turns is arranged under the conductive screen. In Figures 3 and 4, **20** and **21** indicate the two tubular conductors which are each supported on a core **22** consisting of insulating material. A cord **23** of insulating material is wound in open helical windings around each conductor and is surrounded with a closed sleeve **24** of insulating material in the form of a tape winding. The two cores twisted together are then surrounded by a wire **25** wound in spaced helical turns and then provided with a screen **26** built up of tapes of good conducting material in the same way as the screen **17** in Figures 1 and 2. Over the screen **26** a sleeve **27** of insulating material is arranged in the form of a tape winding, and then a lead jacket **28**.

Figure 5 shows a communication cable comprising four conductor pairs **30**, **31**, **32**, and **33** in which the individual pairs are each surrounded by a screen formed in accordance with the invention. Each conductor pair consists of the two tubular conductors **34** and **35** which are each surrounded by a cord **36** of insulating material and then by a sleeve **37** also of insulating material. The two cores so formed are twisted together in combination with filler elements **38** of insulating material and are surrounded with a conductive screen **39** and a sleeve **40** of insulating material. The conductive screen is built up of a number of good conducting tapes twisted with a long lay or pitch and overlapping one another at their edges. Over the four twisted pairs a sleeve **41** of insulating material is applied and then a lead jacket **42**.

The communication cable shown in Figure 6 differs from that shown in Figure 5 essentially only in that the cable is built up of spiral quads instead of pairs and the individual conductors are solid instead of tubular. The cable comprises four spiral quads **50**, **51**, **52**, and **53**. The individual conductors in each quad are surrounded with a helically wound cord **54** and then surrounded with a sleeve **55** of insulating material. Over each spiral quad a screen **56** is provided which is formed in accordance with the invention and a sleeve **57** of insulating material is applied around the screen. A lead jacket **58** is provided for the cable.

Referring now to the forms of screens shown in Figures 7, 8, and 9, that shown in Figure 7 consists of two layers of stranded tapes of which the tapes **60** of the outer layer cover the joints between the tapes **61** of the inner layer. The screen shown in Figure 8 consists of an alternating arrangement of single metal tapes **62** and two superposed metal tapes **63**, **64**, the edges of each single metal tape **62** being located between the edges of the adjacent double tapes **63** and **64**. The screen shown in Figure 9 is built up entirely of superposed double tapes, the edges of which are slightly spread apart on one side to form a fork-like arrangement into which the lateral edges of the adjacent pair of tapes extend, so that a double closed metal screening sleeve is formed.

Figures 10 and 11 show two forms of screening sleeves in which between the adjacent wide screening tapes thicker, narrower lengths of material are inserted to prevent the tapes from becoming displaced one over the other. In the arrangement shown in Figure 10, comparatively thin but wide tapes **70** are laid on the cable core to form a screen, the core being of any desired form. Between adjacent tapes **70** and alternating therewith thicker, narrower lengths of material are inserted, these lengths consisting of round wires of greater thickness than the tapes. The different thicknesses as of the wires and tapes do not produce any adverse effect as regards the screen but are even, in certain circumstances, desirable. For example, the thicker wires can easily penetrate slightly into the paper cable core and thus engage securely therewith.

The screen shown in Figure 11 differs from Figure 10 only in that a tape **72** or a wire, as mentioned in the introduction is applied in open helical winding over the screen with a shorter lay or pitch than that of the tapes **70** and the wires **71**. Practical experience has shown that great security against displacement of the thin tapes **70** over one another is afforded by this arrangement and the amount of material used for the screen, in comparison to the amount contained in profiled wires, is very small. The tapes **70** may be relatively wider than those shown in the drawing.

We claim as our invention:

1. In a long distance communication cable for low and high frequencies, having at least one group of cores twisted together about a common axis, a screen surrounding said group, said screen consisting of a plurality of good conducting strand elements laid side by side helically around said group and following individually the direction of the cores in said group.

2. In a long distance communication cable for low and high frequencies, having at least one group of cores twisted together about a common axis, a screen surrounding said group, said screen consisting of a plurality of good conducting strand elements laid side by side helically around said group, and having the same twist direction and the same pitch as the core twist.

3. In a long distance communication cable for low and high frequencies, having at least one group of cores twisted together about a common axis, a screen surrounding said group, said screen consisting of a plurality of good conducting tapes, laid edge to edge helically around said group and having the same twist direction and the same pitch as the core twist, said tapes being laid in two superposed layers, the tapes in one layer bridging the joints between the tapes in the other layer.

4. In a long distance commu ıication cable for low and high frequencies, having at least one group of cores twisted together about a common axis, a screen surrounding said group, said screen consisting of a plurality of good conducting tapes, laid edge to edge helically around said group and having the same twist direction and the same pitch as the core twist, at least every other tape of said screen consisting of double tape layers, the adjacent edge of an adjacent tape engaging between the two layers of the double tape.

5. In a long distance communication cable for low and high frequencies, having at least one group of cores twisted together about a common axis, a screen surrounding said group, said screen consisting of a plurality of good conducting tapes, laid edge to edge helically around said group and having the same twist direction and the same pitch as the core twist, each tape consisting of two superposed layers, one edge of each tape having both of its layers interposed between the two layers of the adjacent tape edge.

6. In a long distance communication cable for low and high frequencies, having at least one group of cores twisted together about a common axis, a screen surrounding said group, said screen consisting of a plurality of good conducting strand elements laid side by side helically around said group, and having the same twist direction and the same pitch as the core twist, said strand elements consisting alternately of conducting tapes and of wires.

7. In a long distance communication cable for low and high frequencies, having at least one group of cores twisted together about a common axis, a screen surrounding said group, said screen consisting of a plurality of good conducting strand elements laid side by side helically around said group, and having the same twist direction and the same pitch as the core twist, and supporting means disposed on said twisted cores underneath said screen, for supporting the strand portions circumferentially suspended between the cores.

8. In a long distance communication cable for low and high frequencies, having at least one group of cores twisted together about a common axis, a screen surrounding said group, said screen consisting of a plurality of good conducting strand elements laid side by side helically around said group, and having the same twist direction and the same pitch as the core twist, and a supporting helical open wire winding of much smaller pitch than that of the core twist, wound around said twisted cores for supporting the screen strand portions circumferentially suspended between the cores.

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