

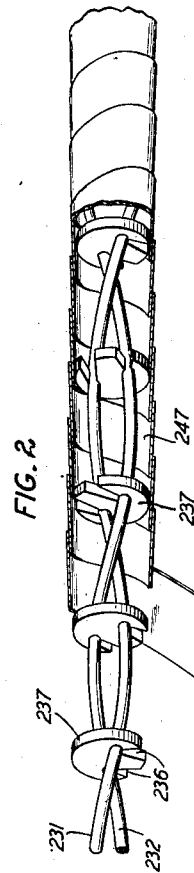
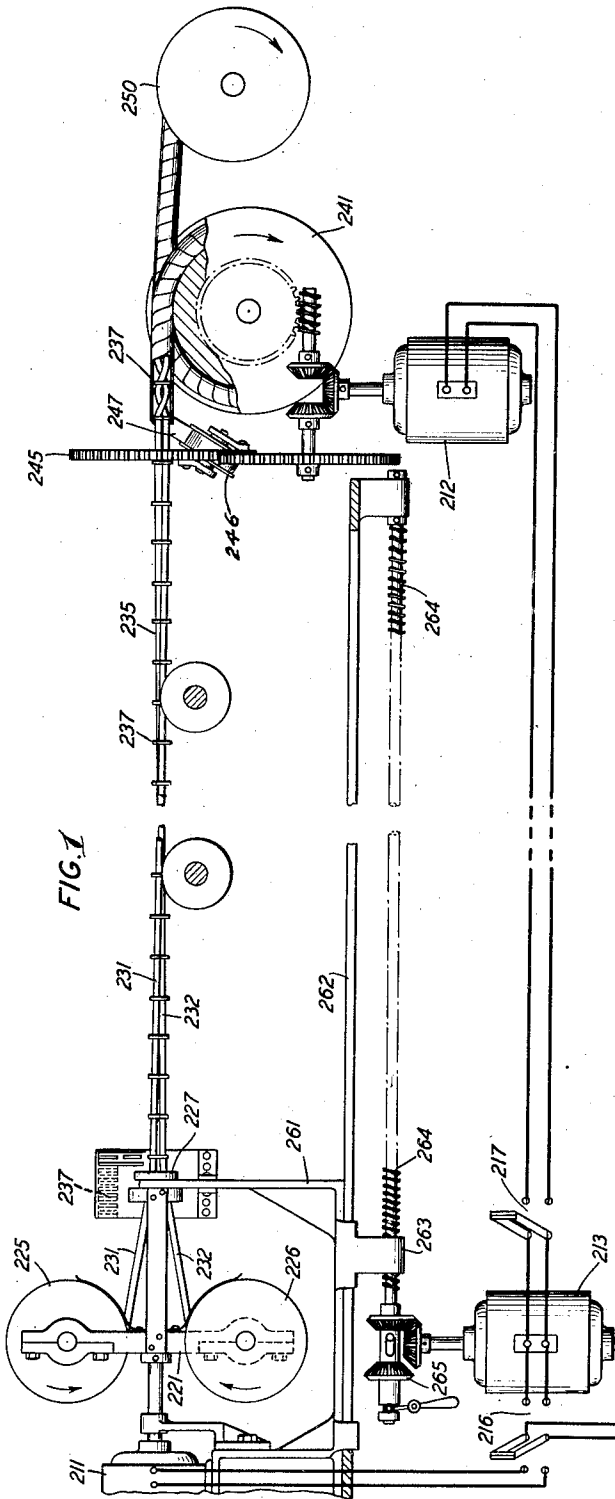
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METHOD OF PRODUCING MULTICONDUCTOR SIGNALING CABLES

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METHOD OF PRODUCING MULTICONDUCTOR SIGNALING CABLES

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This invention relates to multiconductor signaling cables and methods of producing them and particularly to cables of this type in which the conductor units, such as pairs or quads, are twisted or transposed so as to reduce interference from other conductors within the cable or from external sources.

It is an object of the invention to provide a multiconductor cable, such as used for telephone or other signaling purposes, in which the conductor units are designed for high frequency transmission with reduced interference effects.

It is another object of the invention to provide a conductor unit, such as a pair or quad, for inclusion in a multiconductor signaling cable in which the conductors of the unit are transposed with a high degree of uniformity.

It is another object of the invention to provide a twisted conductor unit, such as just referred to, in which periodically recurring irregularities in the twists are substantially reduced.

It is a well-known practice to twist or transpose the two sides of pair or phantom circuits in cables, such as those used for telephone or signaling purposes, in order to reduce interference effects from other pair or phantom circuits within the same cable or from exterior sources. There are various forms of coupling or induction occurring between such conductor units which may be the cause of interference effects. One type of coupling, which may be termed the "longitudinal" coupling, is due to irregularities in the twist of a unit throughout the length of the cable. Thus it has been found that, with hitherto practiced methods of twisting, each cycle of twist may be identical with all other cycles of twist throughout the length of the cable, but that the two halves of each cycle may differ consistently by a small amount, the first half cycle always being either longer or shorter than the second half cycle. It is evident that in such an arrangement the conductors are improperly transposed with respect to the disturbing field and also that, though the difference between adjacent half cycles may be slight, the continued repetition of this difference may sum up to permit of serious cross-talk or other disturbance. The present invention has particular reference to this longitudinal type of coupling caused by irregularities in the twist.

Irregularities occurring at random along the length of the cable section have a comparatively small effect, inasmuch as the effect increases only as the square root of the length of the cable. The effect of systematically occurring irregularities, on the other hand, increases directly with the length of the cable, and it has been discovered that in pairs or quads the periodic longitudinal irregularities are a very prominent cause of cross-talk. It has further been found

that this effect is particularly serious at the higher carrier frequencies.

The twisting machines used for transposing or twisting the pairs or quads are usually arranged to form individual twists one at a time in close succession, and this is secured by arranging that the unit be led onto the capstan immediately after a twist, or a fraction thereof, has been formed by the twisting head. Since the twist of the conductor unit will be held fixed practically from the moment the unit engages the capstan, there is little opportunity in such an arrangement for the twists to equalize themselves, and such irregularities as may have been introduced by the machine or otherwise in the formation of the twists will be retained permanently. The general tendency in recent years has been to reduce the distance between the twisting head and the capstan to an absolute minimum, that is, to the length of half a twist or even less in order to, as quickly as possible, transfix the twist produced by the machine. However, this method has been found not to give sufficiently uniform results especially for conductor units used at higher frequencies. With the present day tendency to increase the frequency of carrier signaling, this problem of longitudinal irregularities is becoming more pressing.

In accordance with the invention the twisting or transposition of conductor units, such as pairs or quads, is performed in such a manner that the slight differences between the angle of pitch of one part of a complete twist and that of another part of the same twist may be automatically equalized before the conductor unit becomes transfixed by engagement with the capstan or by binding after the forming of the twist. For this purpose the capstan which serves to pull the conductors through the machine is removed a distance from the twisting head or face-plate far in excess of the length of a twist and, thus, far in excess of distances hitherto used in machines of this type. Dependent upon the uniformity of twist desired, the distance between the capstan and the twisting head may be from five to more than a hundred twist lengths as compared with about one-half to one twist length in prior machines.

In accordance with the invention, the process of transposing the conductors of a conductor unit may be continuous or may be intermittent.

In the intermittent process the conductors composing a conductor unit, such as a pair or quad are pulled through the twisting head by the capstan in substantially parallel relation over the whole distance between the twisting head and the capstan, that is, without relative twisting movement between the twisting head and the capstan. The longitudinal movement is then stopped and the total stretched length of conductors is twisted

a number of times until the desired pitch is attained. The twists in the twisted portion between the twisting head and the capstan may or may not be transfixed as by the application of a binding or a wrapping of paper. The twisted stretch is next pulled over the capstan and advanced to the storing reel and a new stretch of untwisted conductors is pulled through the twisting head, whereupon the process is repeated on the new length of conductors. It has been found that a high degree of uniformity of twist may be attained by this intermittent method and that since means are known for reducing other forms of coupling between the circuits a cable substantially free of cross-talk or other interference effects may be produced in this manner.

It should be understood that the methods of twisting in accordance with the invention referred to above are applicable to conductors of different types. It is thus evident that the methods can be readily applied to the well-known types of telephone conductors insulated either with paper strip or with paper pulp. The methods may also be applied to conductor pairs or quads in which the conductors are held spaced apart by means of insulating washers or discs, placed at regular intervals along the conductors. With this latter type of construction the intermittent method of twisting may be found preferable.

The principles of the invention and their practical application in certain preferred arrangements will now be described more in detail, and reference will be made to the attached drawing in which:

Fig. 1 shows an arrangement whereby conductors may be twisted in accordance with the invention by an intermittent method; and

Fig. 2 shows a twisted strand of two conductors separated by spacers and covered by a wrapping as produced in accordance with the invention.

For the sake of convenience the machine is shown as being driven by electric motors 211, 212 and 213 controlled by the switches 216 and 217. The motor 212 drives through an appropriate gearing the capstan 241 and the wrapping head 245. The motor 211 drives the spoolhead or twisting head 221 carrying the necessary number of spools 225 and 226 of conductors 231 and 232 and also carrying the guide or face plate 227 for passing the conductors from the spools into the equalizing space. The motor 211 and the apparatus driven thereby are mounted on a carrier 261 placed on a guide 262 and slidable along the guide by means of the arm 263 and the spindle 264 which is driven through proper reversing gears 265 by the motor 213. The capstan 241 is provided for pulling the twisted strand 235 from the equalizing space at a predetermined substantially constant speed. From the capstan the strand 235 passes on to the storing reel 250 which may be driven in any desired manner. The motor 212, when desired, also drives through suitable gearing a wrapping head 245 which carries a spool 246 of suitable wrapping material 247. Spool 246 is rotated about the twisted conductors and applies the tape 247 at a fixed angle about the moving strand 235.

Whereas the machine shown in Fig. 1 may be used for twisting individually insulated conductors, the production of a modified strand construction will be described. Thus the conductors 231 and 232 will be assumed to be bare conductors which in the twisted strand will be held apart by insulating spacers 237, as shown in Fig. 2. The spacers or washers 237 have two slots 236

for passing the conductors into position; the slots are shaped so that they provide a slight locking action about the conductors, which snap into place.

The distance between the guide 227 and the capstan 241 or the point at which the twist becomes fixed, as by the wrapping 247 may be equal to five to ten twist lengths and should preferably be of the order of fifty or more twist lengths, a greater distance insuring greater uniformity of twisting pitch.

Assuming now that the strand 235 has progressed to the position shown in Fig. 1 and that the suspended portions of the substantially untwisted conductors 231 and 232 have been provided with spacers 237, and further assuming that all the motors are at rest, the switch 216 will first be thrown to the left, operating motor 211 to rotate the spoolhead 221 a number of times equal to the number of twists to be given to the stretched conductors. The switch 217 is then closed and the reversing gear 265 set for sliding the carriage 261 to the right. After the twisting operation has been completed, the switch 216 is thrown to the right for driving the motors 212 and 213 and for stopping the twisting motor 211. The capstan 241 will now pull the twisted conductors 231 and 232 to the right and the spindle 264 will slide the carriage 261 to the right with the same speed, and at the same time the tape 247 will be applied about the advancing conductors. When the carriage 261 has reached its extreme right position, the switch 217 is opened and the gear 265 is reversed. The conductors will now be held stationary by the capstan 241 while the carriage 261 travels to its left-hand position, feeding out a new portion of the conductors 231 and 232.

With the carriage 261 there may be provided an automatic device for snapping spacers 237 onto the parallel conductors immediately in front of the guide plate 227 and while the carriage is feeding the conductors out in its travel to the left, just described. This device may be of the type disclosed in U. S. Patent 2,060,162 issued to H. J. Boe on November 10, 1936. The spacers may, of course, be applied by hand. When the carriage has reached the position shown in the drawing, switch 216 is opened and all the parts are in position for repetition of the steps just described.

Thus in accordance with this arrangement the conductors 231 and 232 are intermittently passed from the spools 225 and 226 through the guide 227 while the carriage 261 is traveling from right to left and will be suspended substantially without twists through the long equalizing space from the wrapping head 245 or the capstan 241, as the case may be, at which the twist is fixed to the guide 227. Due to the subsequent rotation of the twisting head 221 the stretched conductors will be given a number of simultaneous twists.

It is evident that even comparatively large periodic irregularities in the rotation of the spoolhead 221 will, by this arrangement, be practically evenly absorbed by the twists which at any moment, are being formed in the suspended stretch of the strand 235 with the result that the pitch of twisting will be constant throughout the length of the cable.

Whereas the machine, as shown, has been arranged for twisting only two conductors, it is evident that it may be modified to twist any desired number of conductors.

It is contemplated that the various rotating

elements of the machine may be driven through proper gearing from a single source of power and that the various switching operations, or corresponding clutching operations in a full mechanical driving system for the machine may be performed in their proper order and with proper timing by automatic means. Such arrangements are well known to those skilled in this art and therefore are not shown or described herein.

10 It will be seen from Fig. 2 that if it should be desired to apply the tape 247 to the edges of the washers 237 the washers would be locked in position and the twist of conductors 231 and 232 would be fixed.

15 The distance between the spoolhead 221 and the taping head 245 may be made quite considerable, for example as much as 100 to 150 feet. The conductors are stretched between the capstan 241 and the spools 245, which may be provided with brakes in any desirable manner. To prevent undue sagging between the two points of stretching, the conductors may be supported by rollers which may be automatically withdrawn as the carriage 261 advances to the right.

20 It is evident that with the machine or process of twisting, described above, the two half cycles of a twist length cannot be consistently different on account, for example, of an irregularity in the speed of the twisting head, as there is no means by which the twisting could consistently affect one half cycle of each or any twist length in a different manner from the other half cycle.

What is claimed is:

1. A method of twisting a plurality of continuous conductors into a strand with a highly uniform pitch angle which comprises removing equal lengths of a plurality of conductors from their individual supply spools, stretching successive portions of said conductors between two points separated by at least five twist lengths to equalize the pitch angle of the twists, twisting the conductors together between said points by revolving them at one of said points and fixing the pitch angle by applying a binder to the strand at the other of said points.

2. A method of producing a continuous, twisted strand of insulated conductors which comprises feeding equal lengths of a plurality of conductors from their individual supply spools, stretching successive portions of said conductors with substantial freedom of rotation over a distance of at least five twist lengths, holding the conductors at close mutual spacing throughout said portion, revolving one end of said portion to form a series of highly uniform twists in said portion and fixing the pitch angle by applying a binder to the strand at the other end of said portion.

3. A method of producing a continuous, twisted strand of mutually insulated conductors which comprises feeding equal lengths of a plurality of conductors from individual supply spools, stretching a length of said conductors with substantial freedom of rotation between two points separated by at least five twist lengths and holding them at substantially the same mutual spacing between said points as in the twisted strand, revolving the fed conductors at one of said points to form a series of highly uniform twists between said points and fixing the twist by applying a binder to the strand shortly before it passes the other of said points.

4. A method of producing a continuous, twisted strand of mutually insulated conductors which

comprises feeding the conductors with equal speed through a twisting machine with individual conductor supplies, stretching successive portions of the conductors with substantial freedom of rotation between two points in the machine separated by at least five twist lengths, twisting the conductors between said points to form highly uniform twists in the distance between said points and fixing the twist by applying a binder to the twisted strand before it leaves the space between said two points.

5. A method of twisting a plurality of continuous conductors into a strand which comprises feeding said conductors with equal speed from individual supplies, stretching a portion of the fed conductors at close mutual spacing between two separated points in a twisting machine, rotating the conductors at one of said points to form and equalize at least five complete twists in said portion, advancing the twisted portion through the twisting machine, applying an external binder to the twisted strand at the other of said points, and continuing the said operations on successive portions of the conductors.

6. A method of producing a continuous, twisted strand of conductors which comprises first passing equal lengths of the conductors into a twisting machine, suspending the conductors between two separated points in the machine and then rotating one end of the suspended portion of the conductors to build up a series of at least five uniform twists in said suspended portion, and repeating the said steps on successive portions of the conductors.

7. A method of twisting a plurality of continuous conductors into a strand which comprises passing the conductors through a twisting machine by an intermittent motion, stretching the conductors during said intermittent passage between two separated points in the machine, and between said intermittent motions rotating the conductors at one of said points to build up simultaneously a plurality of at least five twists between said points.

8. A method of forming a twisted strand from a plurality of bare conductors which comprises passing a portion of the conductors into a twisting machine, holding the conductors stretched between two separated points in the machine, insulating the conductors between said two points to fix their separation, forming a plurality of at least ten simultaneous twists of said insulated conductors between said two points, advancing the conductors out of the machine and fixing the twists by applying a binder to the twisted strand at the point of leaving the machine and repeating the steps on the next succeeding portion of the conductors.

9. A method of forming a twisted strand from a plurality of bare conductors which comprises passing a portion of the conductors through a twisting machine, holding the conductors stretched between two separated points in the machine, inserting spacers between said conductors in said portion to fix their spacing apart, forming simultaneously at least ten twists of said conductors between said two points, applying an external binding to the spacers in the twisted portion of the strand to fix the twists, advancing the strand through the machine and repeating the steps on each succeeding portion of the conductors.

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