Jan. 16, 1962 C. H. CROSBY ET AL 3,017,450

CABLES

Original Filed July 19, 1957 2 Sheets-Sheet 1

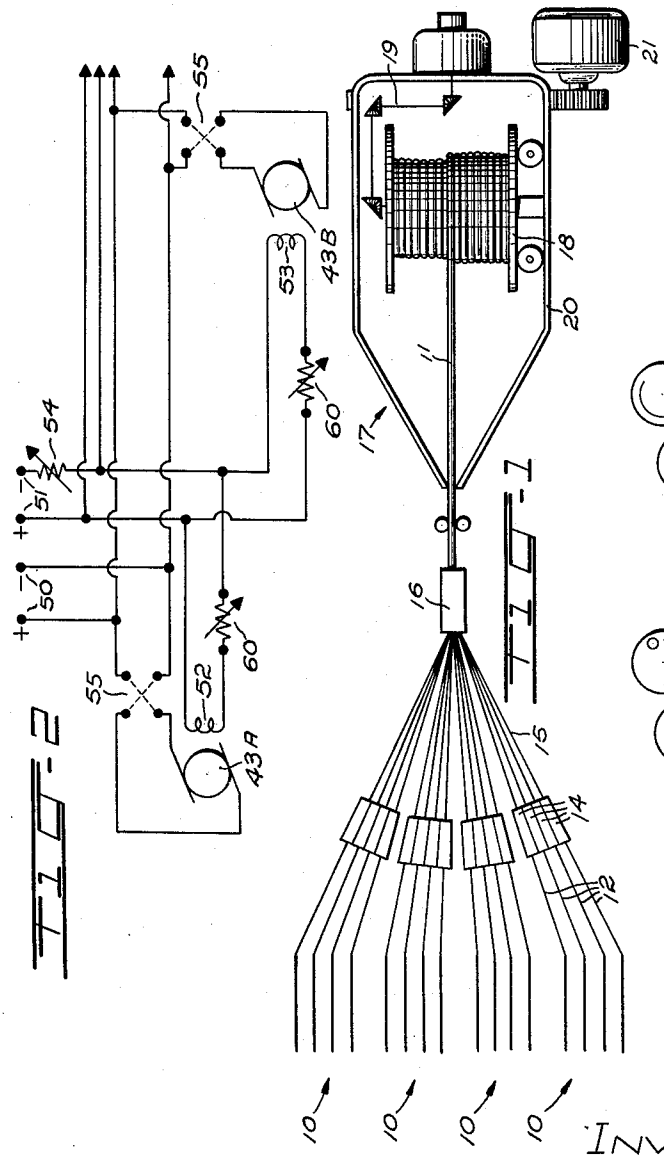


FIG-2

FIG-1

FIG-6

FIG-5

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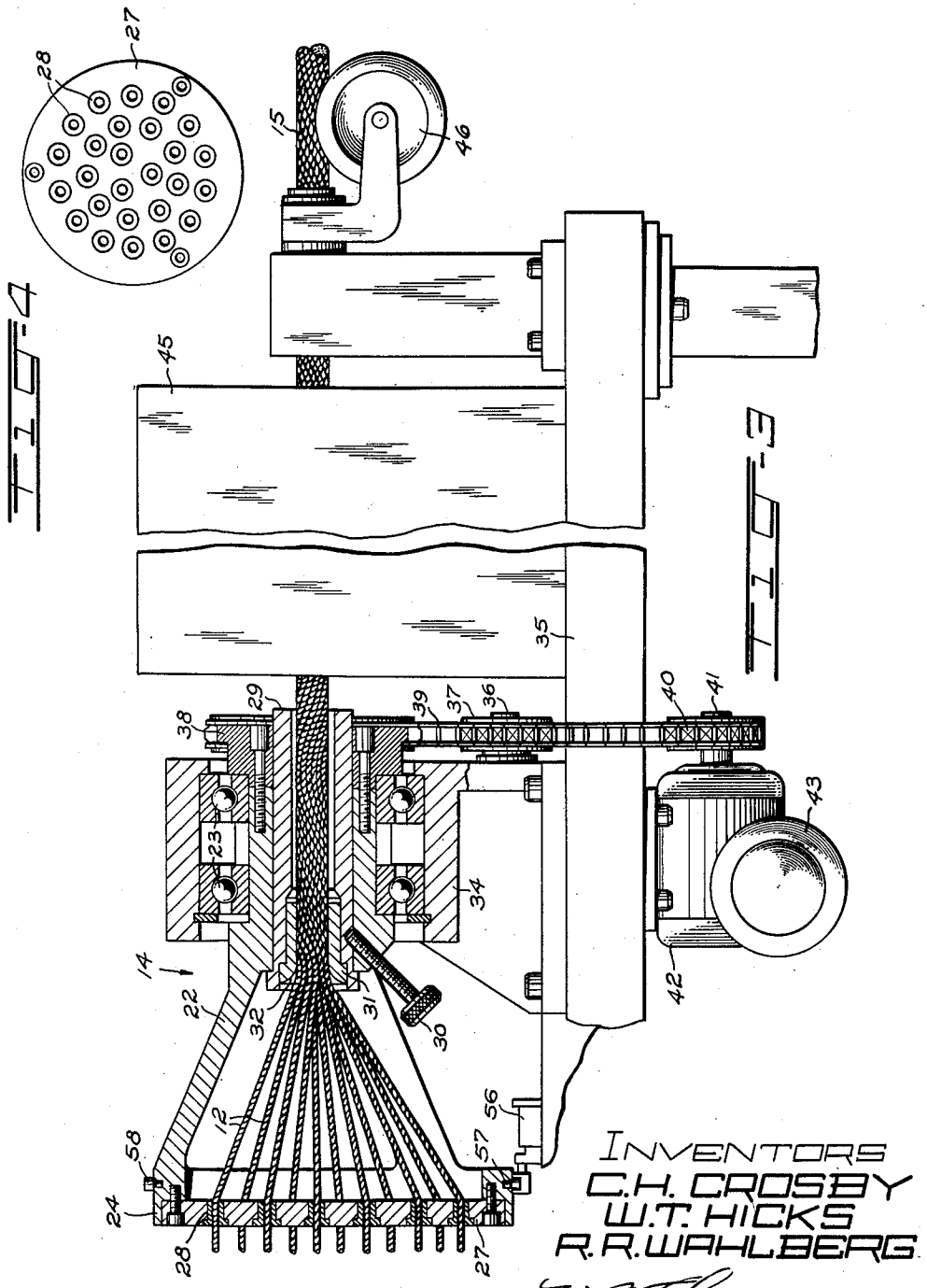


FIG. 4

FIG. 3

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CABLES

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2 Claims. (Cl. 174—34)

This is a division of applicants' co-pending application Serial No. 672,890, filed July 19, 1957, now Patent No. 2,924,930, and the invention herein relates to cables, particularly to telephone cables.

Early in the history of the manufacture of cable for use it became obvious, that for cable of any considerable length special precautions were required to prevent the voice currents in one pair of wires from inducing in adjacent wires similar currents which would give rise to the phenomena generally known as "cross-talk."

It is accordingly common practice as a first step to make twisted pairs of wires having different numbers of twists per unit length. These pairs of different twist lengths are then twisted together in groups to form complete cables or to form so-called unit type cable. In preparing to make the cable, care must be taken to arrange the payoff from the supply reels so that pairs of the same twist length do not occupy adjacent positions in the completed cable.

In the case of unit cables the pairs are selected to insure that those in the outer layers in adjacent units are of different twist lengths since in the cabling operation the units of a conventional unit type cable tend to remain in the same relative orientation throughout the cable length. It therefore has been necessary to make up and keep in stock a number of differently composed types of units in order to be able to make a multi-unit cable which is satisfactory from the cross-talk standpoint.

The general object of this invention is to simplify the construction and reduce the cost of making telephone cables which have a low level cross-talk between the various circuits in the cable.

According to the general features of the invention, a cable having a plurality of units or groups of twisted pairs of wires is made in one operation directly from twisted pairs and with a distribution pattern of the pairs which varies continuously in a non-repetitive manner throughout the length of the cable. All the pairs of wires which are to be cabled together are fed toward a cabling apparatus and those which are to form each unit or group are directed to their proper relative location with respect to the other units. Prior to cabling the units together, the wires of each unit are subjected to a reverse twisting operation about the axis of the unit at a different and varying length to produce a random lay of the wires in the completed cable. This may be accomplished for example by passing the pairs of each group or unit being fed to the cabling apparatus through a separate face plate having a perforation for each pair and oscillating the several face plates independently of each other at rates which vary slightly in a random manner. One very convenient way of attaining the random rate of oscillation is to drive each face plate with a separate direct current motor as explained in more detail below.

Other objects and advantages will be apparent from the following detailed description when considered in conjunction with the accompanying drawings wherein:

FIG. 1 is a schematic top plan view of the apparatus;

FIG. 2 is a fragmentary wiring diagram for the individual motors for the oscillating units;

FIG. 3 is a vertical sectional view of one of the oscillating units and its motor drive;

FIG. 4 is a front elevational view of a face plate of one of the oscillating units; and

FIGS. 5 and 6 are schematic illustrations of certain of the groups of wires which may be employed in forming a cable.

In FIG. 1 the heavy lines **10** represent, schematically, supply stands. In the present instance, 26 reels containing pairs of wires are supported for each heavy line (supply stand) to supply their wires as desired in forming a cable core **11**. Lines **12** represent the groups of 26 pairs of wires being directed to units **14**. The units **14** are similar in structure to that shown in FIG. 3, the only difference being in the inherent differences of the driving motors. Returning to FIG. 1, lines **15** represent the groups of 26 pairs of wires after random lays have been produced therein by the oscillating units **14**. The random lay groups **15** are directed to a stationary unit **16** where they are received in their respective spaced positions through a face plate (not shown) and are twisted together through the action of a take-up unit **17**. The take-up unit **17** supports a reel **18** which is driven by a mechanism **19** to wind the cable core **11** thereon while at the same time the housing **20** for the take-up unit is rotated by a motor drive **21** to produce the desired twist of the random lay groups of wires in the cable core.

The novel feature of the cable is the presence of random group lay therein and the feature of the apparatus for producing this result is the individual driving of the units **14** by direct current motors. In FIG. 3 the unit **14** includes a main member **22** supported by bearings **23** and having its entrance end **24** flared outwardly and recessed to receive a face plate **27**. The face plate **27** has, in the present instance, twenty-six bushing-like guides **28** for the twenty-six pairs of wires **12** received from the supplies **10**. The exit end of the main member **22** has a sleeve **29** mounted therein, removably held in place by a thumb screw **30**. A forming die **31** mounted in the sleeve **29** has an outwardly flared entrance end **32** to receive the pairs of wires **12** and form them into a circular group. The bearings **23** are supported in a housing **34** mounted on a support **35**. The housing **34** carries a spindle **36** for an idler sprocket **37**. A sprocket **38** is secured to the exit end of the main member **22** and is connected by a chain **39** to a sprocket **40** on an output shaft **41** of a speed reducing unit **42**. A direct current motor **43** drives the speed reducing unit **42** to drive, through the intermediate connecting means, the face plate **27**. The box type structure **45** represents a suitable means for binding the group of wires **15** together. This structure is not shown in detail as it per se is not a part of the present invention. A suitable roller **46** is positioned at the exit end of this structure to guide its respective group of wires to the unit **16**.

In one embodiment of the invention, as illustrated schematically in FIG. 1, there are 16 of the units **14**, shown in detail in FIG. 3. These units may be identical in structure, with the exception of the motors **43**, furthermore, the motors may be commercially identical units made to the same specifications and nearly alike as possible. As is well known, however, a group of such motors driven from the same power source will not operate at exactly the same speeds nor will they respond in exactly the same way to variations in load. The power required to drive the various face plates will not be exactly the same and will vary slightly from time to time. Hence, for these and other reasons the several face plates will be oscillated at slightly different rates. The relative orientation of the several face plates will therefore be changing constantly and due to the many factors determining their oscillation rates the distribution of the wire pairs in the cable will vary in a random manner.

The wiring diagram shown in FIG. 2 is a fragmentary portion of the entire wiring arrangement for the 16

motors in that only a portion for two of the motors is shown. Lines **50** and **51** supply the direct current energy for motors **43**–A and **43**–B and their respective field windings **52** and **53**. The field windings of all of the motors are connected to lines **51** through a variable resistance **54**. The armatures of all of the motors are connected to the supply lines **50** through reversing contactors **55** operated by a single switch **56** on each unit **14**. In FIG. 3 the switch **56** is mounted for engagement with and actuation by removable screws **57** and **58**, mounted in the main member **22** of the oscillating unit. Their functions, as a result of their spaced positions from each other are to determine the degree of oscillation of the unit **14**. In the present illustration they are disposed 180° apart assuring 180° oscillation of each unit. Other adjustments may be made by varying the relative positions of the screws **57** and **58**.

Considering the operation of the apparatus to produce the cable with the random group lay, let it be assumed that all of the operating units of the apparatus have been rendered effective, including the take-up **17**, to advance the completed cable core **11** on to the take-up reel **18** and that the motors **43** have been energized. Regardless of the positions of the switch actuating screws **57** and **58** with respect to the switches **56** at the time the motors **43** are energized, the differences inherent in the operating characteristics of the direct current motors **43** will produce oscillation of the units **14** at slightly different speeds to produce a continuous change in the formation of the lays of the groups of wires. If, for example, the units **14** were all in the position shown in FIG. 3 where the screw **57** is ready to reverse the switch **56** to cause reversal in the switches **55** for all of the motors **46** at the beginning of the cable forming operation, before the screw **58** of any one of the units operates its switch **56** there will be a variation in the positions of these screws **58** with respect to their switches **56** due to the differences in the speeds of their motors **43**. These differences need be only very slight since they are cumulative and the initial cross-sectional arrangement of pairs begins to change immediately in a non-repetitive manner so that no two successive cross-sections of the cable are identical.

A typical cross-section of the cable is shown in FIG. 5. One pair of wires is shown in each unit to indicate the orientation of the unit and the instantaneous direction of oscillation of each unit is indicated. If another section is taken along the cable even at a point where all the face plates are rotating in the same directions as before the orientation of the various units will be different as indicated in FIG. 6, and the pairs in adjacent units which formerly were close together in inductive relation will be relatively remote from each other. With this constant shifting in the relative positions of the various pairs in different units the inductive difficulties between pairs of different units are substantially balanced out.

If wider variations in the random lays in the groups of wires are required variable resistance unit **69** may be disposed in the motor circuits and set at different values to increase the inherent differences in the motor speeds as required.

One of the important advantages of the present invention is that by making it possible to form a complete cable in one operation, all of the former expense incident to the use of a number of the different types of units is entirely eliminated.

It is to be understood that the above described arrangements are simply illustrative of the application of the principles of the invention. Numerous other arrangements may be readily devised by those skilled in the art which will embody the principles of the invention and fall within the spirit and scope thereof.

What is claimed is:

1. A multi-unit cable formed of a plurality of cable units bound together, the cable units having groups of twisted pairs of wires and the groups of pairs of wires in each unit being twisted together in a relative orientation which varies in a non-repetitive manner between the units throughout the length of the cable.

2. A multi-unit cable formed of a plurality of cable units bound together, the cable units having groups of twisted pairs of wires and the groups of pairs of wires in each unit having back-and-forth random twists causing relative orientation of the pairs of wires of the groups in the units to vary in a non-repetitive manner between the units throughout the length of the cable, and individual bindings for the cable units to retain the random twists of their groups of pairs of wires.

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