Aug. 2, 1955 L. C. WOLCOTT 2,714,623

NON-METALLIC CONDUCTOR

Filed March 9, 1950 3 Sheets-Sheet 1



Fig. 1

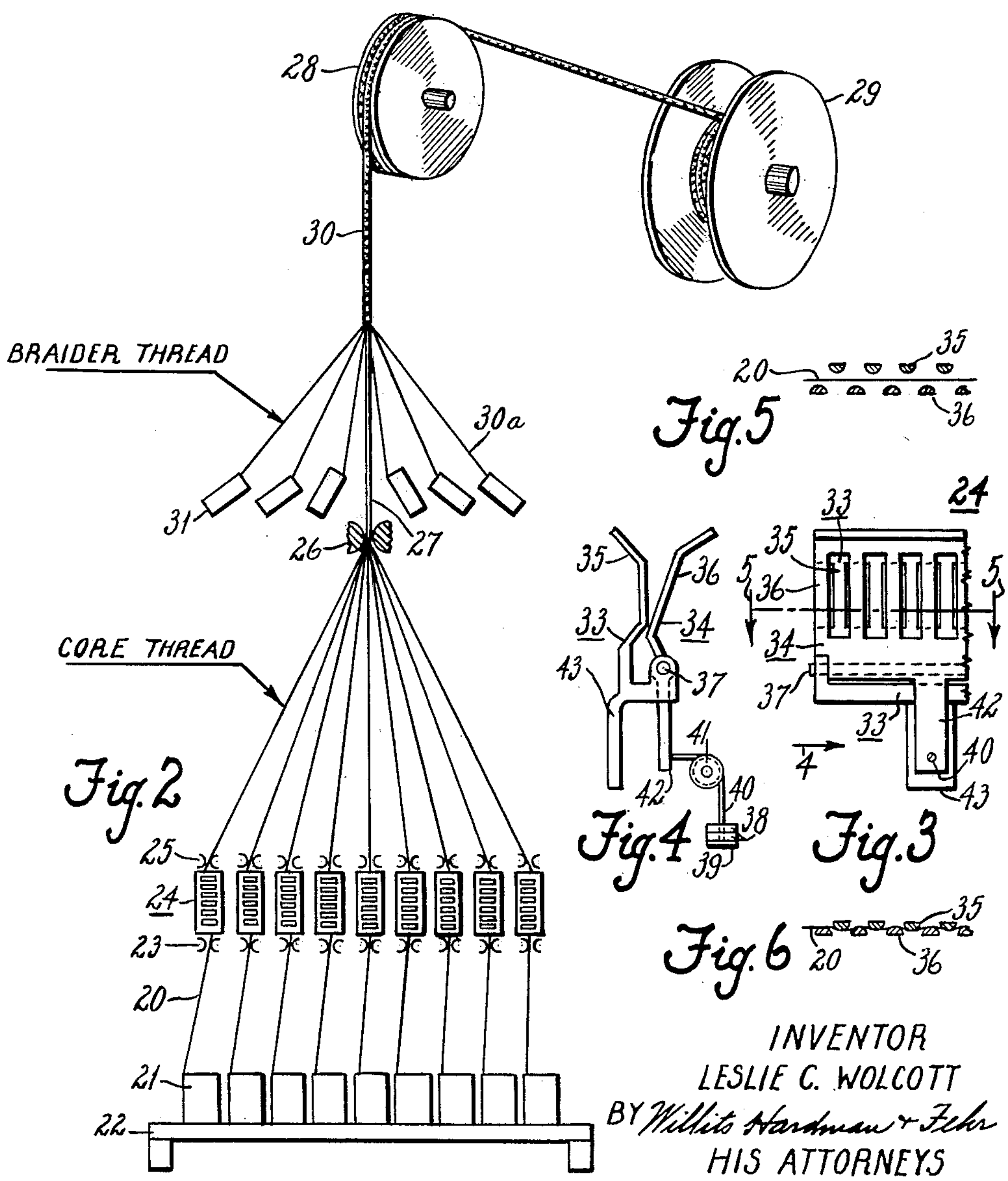


Fig. 2

Fig. 5

Fig. 4

Fig. 3

Fig. 6

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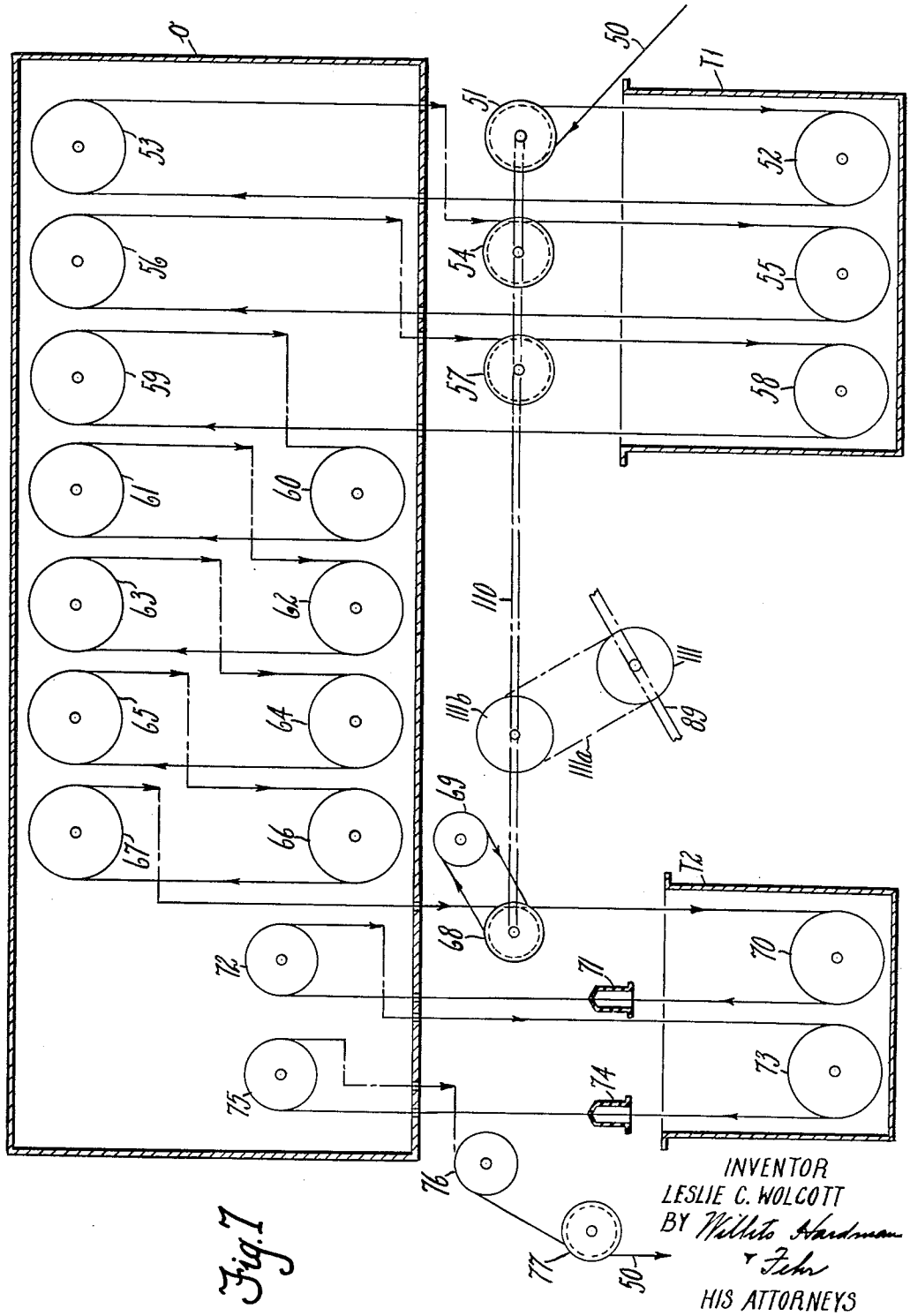


Fig. 1

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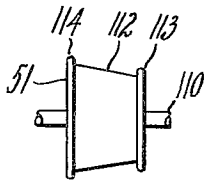


Fig. 9

Fig. 8

Fig. 10



Fig. 11

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NON-METALLIC CONDUCTOR

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Application March 9, 1950, Serial No. 148,595

3 Claims. (Cl. 174—120)

This invention relates to non-metallic conductors and more particularly to spark plug cables having non-metallic cores. A conductor of this type is desirable since it has a uniformity distributed resistance of such value as to suppress interference by operation of the ignition apparatus of an automobile with radio and television apparatuses.

An object of the invention is to provide a cable having a non-metallic conductor of small and uniform diameter and which has good tensile strength. In the disclosed embodiment of this invention this object is accomplished by bunching together parallel threads and braiding thereon a covering of other threads while the parallel threads are maintained under uniform tension. The braided core is impregnated with suitable carbonaceous material, such as graphite and is dried, and a coating is applied thereto in order to stiffen the core to facilitate threading it through an extruder head and to provide a bond between the braided core and the insulation which is extruded around it.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein a preferred embodiment of the present invention is clearly shown.

In the drawings:

Fig. 1 is a view of a piece of the braided core;

Fig. 2 is a diagram of the apparatus forming the braided core shown in Fig. 1;

Fig. 3 is a view showing on a large scale a fragment of a thread-tensioning device;

Fig. 4 is a view in the direction of arrow 4 of Fig. 3;

Fig. 5 is a sectional view on line 5—5 of Fig. 3, showing the relation of the teeth of the tensioning combs before tension is applied;

Fig. 6 is a view similar to Fig. 5 showing the relation of the tensioning combs after tension is applied to a thread;

Fig. 7 is a diagram of the apparatus for impregnating the braided core and for applying latex thereto;

Fig. 8 is a diagram of the take-up apparatus used in connection with the apparatus shown in Fig. 7;

Fig. 9 is a side view of a capstan included in the apparatus shown in Fig. 7;

Fig. 10 is a longitudinal sectional view of one of the nipples 90 drawn to a larger scale than Fig. 7;

Fig. 11 is a fragmentary perspective view of a portion of the finished cable.

Referring to Fig. 2, a plurality of threads 20 are pulled from spools 21 supported by a table 22 and are passed through eyes 23, tensioning devices 24, eyes 25 and are bunched together by passing them through an eye 26 to provide a core 27. The core 27 is passed around a power driven capstan 28 and then secured to a power driven take-up reel 29. While the core 27 passes upwardly, a covering of braided thread 30 is applied thereto by a braider which is represented diagrammatically by a plurality of spools 31 from each of which a thread 30*a* is drawn while the spools are moved around the core and

are used to intertwine in a manner well known to the art of braiding.

The threads 20 should be of material which is tough and resilient and has sufficient tensile strength and which, comprises small individual fibers so as to present a relatively large area for coating by the core impregnating material. Linen threads are preferred since they provide the required strength for a small diameter of core. For example, nine linen threads each 30 lea, will make a core approximately .053" in diameter. Various materials, such as cotton, linen, rayon, glass or combinations of these materials, could be used, depending upon the tensile strength required and the temperature to which the material is exposed during the curing process.

The braid threads 30*a* can be of any of the materials usable as the core threads 20. The braid threads should be small in diameter so as not to increase substantially the diameter of the core. Rayon threads of 300 denier size are satisfactory.

Each of the tensioning devices 24 is a conventional form of thread tensioning device. As shown diagrammatically in Figs. 3 and 4, the fixed comb member 33 having tines 35 cooperates with a movable comb member 34 having tines 36 and pivotally supported by rod 37 fixed to the comb 33. Eyes 23 and 25 direct each linen strand 20 between the comb tines and substantially at right angles thereto. To apply tension to the thread the comb 34 is adjusted to the comb 33 in order to bring the tines 36 closer to the tines 35 as shown in Fig. 6, so that the thread 20 intertwines the tines. Each of the tensioning devices 24 is adjusted so that the tension on each of the threads between the tensioning devices and the capstan will be substantially uniform. As shown diagrammatically in Fig. 4, the tension is adjusted by adding or removing weights 38 supported by a plate 39 attached to a cord 40 passing around a pulley 41 and attached to an arm 42 connected with comb 34. Comb 33 is integral with a fixed supporting bracket 43. The tension on each thread can be determined by attaching thereto a scale which, on being pulled to draw the thread through the tensioning device, will indicate the amount of tension. The uniformity of thread tension is desirable so that, when the tension is relieved during a subsequent step, the threads will contract equally and no threads will form a bulge or loop.

The braided core is impregnated with carbonaceous material by passing it through a solution comprising preferably, by weight, four parts water, one part aquadag and one-tenths of one percent of a wetting agent, preferably dioctyl sodium sulfosuccinate known to the trade as "Aerosol O. T."

Aquadag is understood to be a suspension of graphite with a binder comprising starchy material and protein material which makes it adhere.

The impregnating and drying apparatus is shown diagrammatically in Fig. 7 in which the braided core is indicated by a single line 50. Therefore, numeral 50 in Fig. 1 indicates the assembly of core and braid. The braided core 50 is unwound from the reel 29 (Figs. 2 and 8) and passes a few turns around a capstan 51, down into a tank T1 containing the aquadag solution, around a pulley 52, up into an oven O, around a pulley 53, down through the bottom of the oven, around a capstan 54 a few turns, down into tank T1 around a pulley 55, up into the oven, around a pulley 56, down through the bottom of the oven, around a capstan 57 a few turns, down into tank T1, around a pulley 58, up into the oven, around a pulley 59, around pulleys 60–67 all in the oven, down through the bottom of the oven, around a capstan 68 around an insulated brass pulley 69, again around the capstan 68, down into a tank T2 containing the coating solution, around a pulley

70, up through a wiper 71, up into the oven, around a pulley 72, down through the bottom of the oven and into tank T2, around a pulley 73, up through a wiper 74, up into the oven, around a pulley 75, down through the bottom of the oven, around an insulated pulley 76, around a dual capstan 77 a few turns and then to a take-up reel 78 (Fig. 8). Capstan 77 comprises two grooved pulleys, one being driven and the other idling.

A motor 79 (Fig. 8) drives, through speed reducing V-belt drives (comprising pulley 80, belt 80*a* and pulley 81), a shaft 82 connected by speed reducing gears 83, 84 with a shaft 85 connected by sprocket 86, chain 87 and sprocket 88 with a shaft 89 connected with the dual capstan 77. Sprocket 90, chain 91, sprocket 92 and a friction, slipping clutch 94 connects the shaft 89 with a shaft 95. Sprocket 93 takes up slack in chain 91. Shaft 95 drives a disc 96 carrying pins 97 which are received by holes in the hub of reel 78 when it is mounted upon shaft 95. A traverse mechanism (not shown) driven by shaft 95 guides core 50 in even layers upon reel 78.

A brake drum 98 journaled on shaft 95 carries pins 99 which are received by holes in the hub of reel 29 when mounted on shaft 95. Drum 98 is engaged by a leather strap 100 anchored at 101 to apply a light friction to the drum 98. Strap 101 is attached to a rod 102 which passes through a fixed bar 103 and receives a nut 105 which confines a spring 104 under compression. By turning the nut 105, the friction applied by the strap 101 to the drum 98 is so adjusted as to obtain the frictional drag sufficient to take up slack in core 50 between the reel 29 and the capstan 51 and also to make the capstans pull evenly and give a uniform low tension.

Capstans 51, 54, 57 and 68 are connected with a shaft 110 (Fig. 7) driven from shaft 89 by a chain drive comprising sprocket 111, chain 111*a* and sprocket 111*b*. Capstans 68 and 77 (driven by motor 79) have the same peripheral speed. Capstans 51, 54 and 57 are larger in diameter than capstans 68 and 77, and are alike. Referring to Fig. 9, which shows capstan 51, each of these capstans 51, 54 and 57 have a conical periphery 112 at 10 degree taper between flanges 113 and 114. The periphery 112 is chrome-plated and polished. The turns of the core 50 received by the periphery 112 tend to move toward flange 113 and lie in an even layer. Since the diameter of these peripheries is greater than the diameter of the core-engaging surfaces of capstans 68 and 77 there is slippage between the core 50 and these peripheries. The capstans 51, 54 and 57 cooperate in a manner such that there is no appreciable stretch in the core 50 as it passes down into the tank T1 and up into the oven O. These capstans impart to the core 50 only the amount of traction required to take up the slack in the core. Since the core 50 is not being stretched while passing through the tank T1 and the oven, it will absorb the maximum amount of aquadag.

Pulley 69 is insulated electrically from pulley 68, and a resistance measuring instrument is connected in a circuit which includes these pulleys and a current source so that amount of resistance in a portion of the core 50 can be measured in order to determine whether the desired resistance is being obtained.

A satisfactory coating solution in the tank T2 consists of:

	Parts
Neoprene latex	740
Acetylene black	100
Marasperse C. B	60
Igepal C	2

Marasperse C. B. is used as a dispersing agent for carbon blacks and its chemical composition is about 91% sodium lignosulfonate and about 9% inorganic matter.

Igepal C., which possesses good wetting, emulsifying and detergency properties, in an alkyl aryl polyethylene glycol made from the condensation of alkyl phenol with ethylene-oxide. The kind of neoprene latex which is desirable to use as a coating is one which does not coagulate when unusual amounts of acetylene black are mixed with it in order to increase the electrical conductivity of the coating. Neoprene latex is desirable because it is not affected by lubricating oil which may be present at the guider tip of the extruder head which is used to extrude a jacket of insulation about the coated core. The neoprene latex is compounded with known vulcanizing agents so that curing will take place in the oven O. Each of the wipers 71 and 74 comprises, as shown in Fig. 10, a wiper nipple 120 which a clamping band 121 attaches to a pipe 122 supported by a fixed plate 123. The function of the nipple 120 is to wipe off the excess coating before baking the coating which remains.

The material wound on the spool 78 is unwound therefrom, passed through an extruder which places a first sheath of insulation 125 (Fig. 11) around the coated core. The sheathed core passes from the extruder through cold water in order to set up the insulating sheath so that the uncured sheath will not be deformed when the sheathed core is wound on a take-up reel. From the take-up reel the sheathed core is passed through a second extruder which applies sheath 126 (Fig. 11); and the cable is laid in a pan and both sheaths 125 and 126 are vulcanized simultaneously by the batch method in a steam vulcanizer.

The insulation material may be any suitable elastomer. For the sheath 125, rubber is satisfactory; and for the sheath 126, neoprene is preferred because it resists attack by lubricating oil and gasoline.

The core coating of material such as neoprene latex has the following functions: (1) It stiffens the core to facilitate threading it through the guider tube of the extruder head used in applying the first sheath 125. (2) It binds the braid threads together and thereby practically eliminates the tendency of the braid to "sleeve back" on the parallel threads and bind in the guider tube of the first extruder head. Because "sleeving back" is avoided, the diameter of the guider tube can be smaller than otherwise whereby it fits the core more closely to provide for centering it more accurately with the extruder die and thus with the sheath extruded around it. (3) It promotes adhesion of the first sheath 125 to the core so that the first sheath does not slip on the core when passing through the second extruder which applies the sheath 126. If the adhesion were not sufficient, the first sheath 125 might slip back on the core and bind in the guider tube of the second extruder. (4) By promoting adhesion the presence of air pockets and consequently corona is minimized. (5) It does not cause "leaching out" of the impregnating graphite; but, on the contrary, materially improves conductivity by reason of the amount of acetylene black it can carry without coagulating.

The oven O is heated with direct fired gas. Since the same oven is used for drying the aquadag and for curing the latex, the passes of the core for drying the aquadag are longer than the passes for curing the latex. After each of the first and second passes through the aquadag there is a single up and down pass in the oven for partially drying the aquadag before a subsequent pass through the aquadag. After the third pass through the aquadag, there are a plurality of passes up and down in the oven to cause the aquadag to be thoroughly dried before applying the latex. For satisfactory results the top temperature of the oven can be in the range of 250° to 275° F. For a particular oven, the satisfactory core speed is 18 feet per minute when top temperature is 250° F. and is 20 feet per minute, when top temperature is 275° F. At speeds faster than those specified for those temperatures, the aquadag is not dried properly. At tem-

peratures above 275° F., the binders tend to burn out of the aquadag and it flakes off so much that the required resistivity is not obtained.

In the claims which follow the term "rubber latex" means any latex of a rubber-like elastomer, such as neoprene latex; and the term "rubber sheath" includes a sheath of any rubber-like elastomer.

While the embodiment of the present invention as herein disclosed, constitutes a preferred form, it is to be understood that other forms might be adopted.

What is claimed is as follows:

1. An electrically conducting cable comprising a nonmetallic fibrous core formed of a plurality of straight parallel threads covered by a sheath of braided threads, said core being impregnated with comminuted nonmetallic conducting material and coated with rubber latex, the coated core being encased in a rubber sheath which surrounds the coated surface, the latex providing a bond between the core and sheath.

2. An electrically conducting cable comprising a nonmetallic fibrous core which includes substantially parallel threads encased in a sheath of braided threads, said core being impregnated with comminuted conducting material and encased by an insulating sheath and having, intermediate the core and sheath, an intermediate layer of bonding material.

3. An electrically conducting cable comprising a nonmetallic fibrous core which includes substantially parallel linen threads encased in a sheath of braided rayon threads and impregnated with comminuted graphite and coated with rubber latex and encased in a rubber sheath bonded to the core by virtue of the latex coating.

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