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Franke, Jr. et al.

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[45] **Nov. 26, 1974**

[54] **APPARATUS FOR MANUFACTURING WATERPROOF CABLE**

[75] Inventors: **Edward L. Franke, Jr.**, Perry Hall; **William J. Hyde; Randy G. Schneider**, both of Baltimore, all of Md.

[73] Assignee: **Western Electric Company**, New York, N.Y.

[22] Filed: **June 13, 1973**

[21] Appl. No.: **369,673**

Related U.S. Application Data

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[52] **U.S. Cl.** **118/50,** 117/61, 117/115, 117/119, 117/213, 117/232, 156/48

[51] **Int. Cl.** **C23c 13/08**

[58] **Field of Search** 118/50; 117/61, 115, 119, 117/213; 156/47, 48

[56] **References Cited**

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Primary Examiner—Mervin Stein
Assistant Examiner—Douglas A. Salser
Attorney, Agent, or Firm—J. B. Hoofnagle, Jr.

[57] **ABSTRACT**

A cable core having stranded twisted pairs of insulated conductors is moved axially through a series of in-line chambers having interconnecting dies to facilitate the evacuation of air from voids of the interstitial structure of the core and the pressure-application of a waterproofing compound of jelly-like consistency into the air-evacuated voids.

The compound-filled cable core is then passed through various stations where core wrap and sheathing materials are placed about the core in combination with additional applications of the waterproofing compound. A plastic jacket is extruded about the sheathing and is cooled prior to take-up of the jacketed cable onto a reel.

3 Claims, 11 Drawing Figures

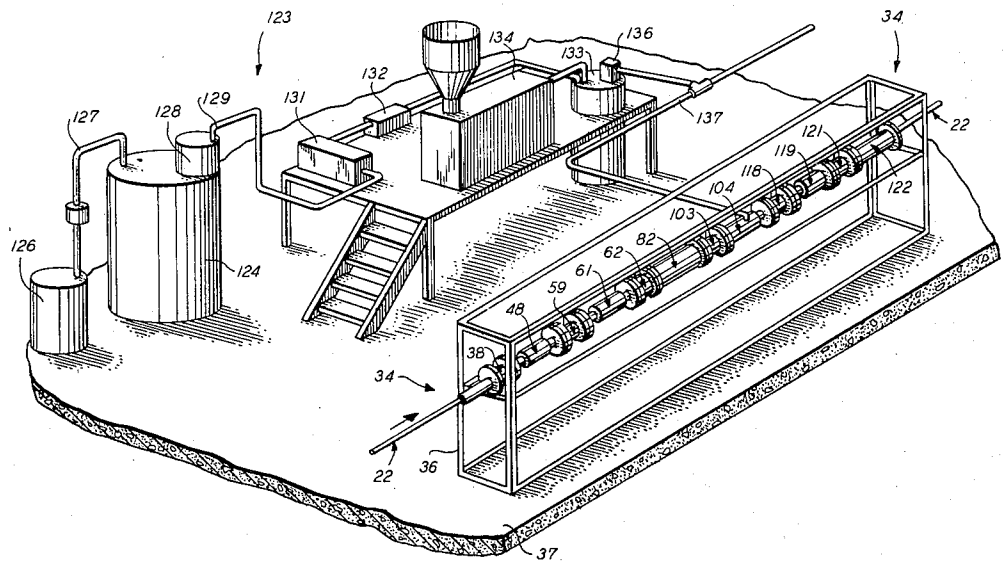
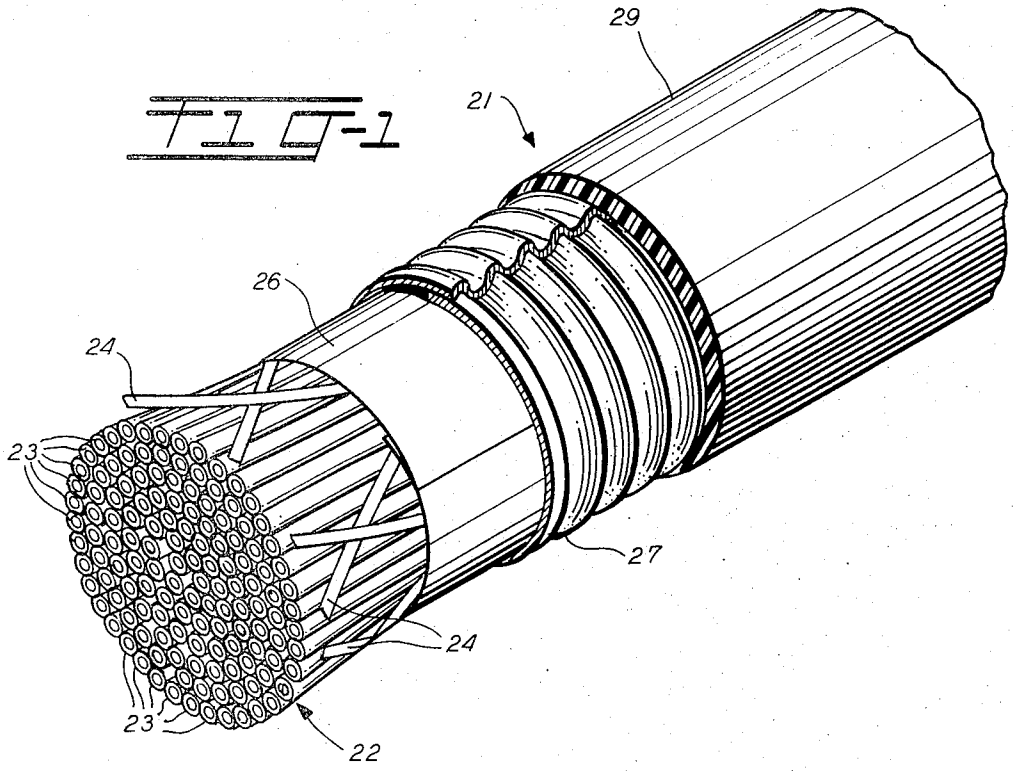


Fig-1



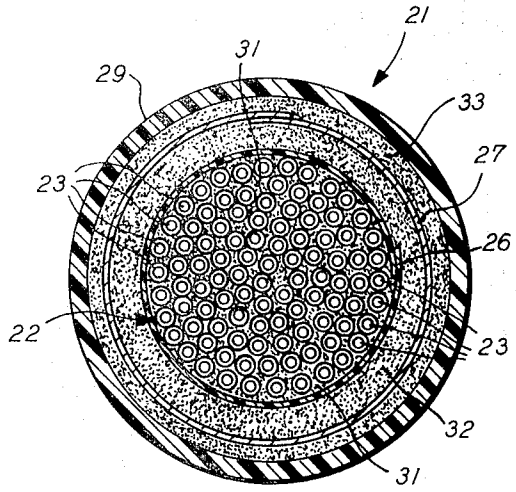


Fig-2

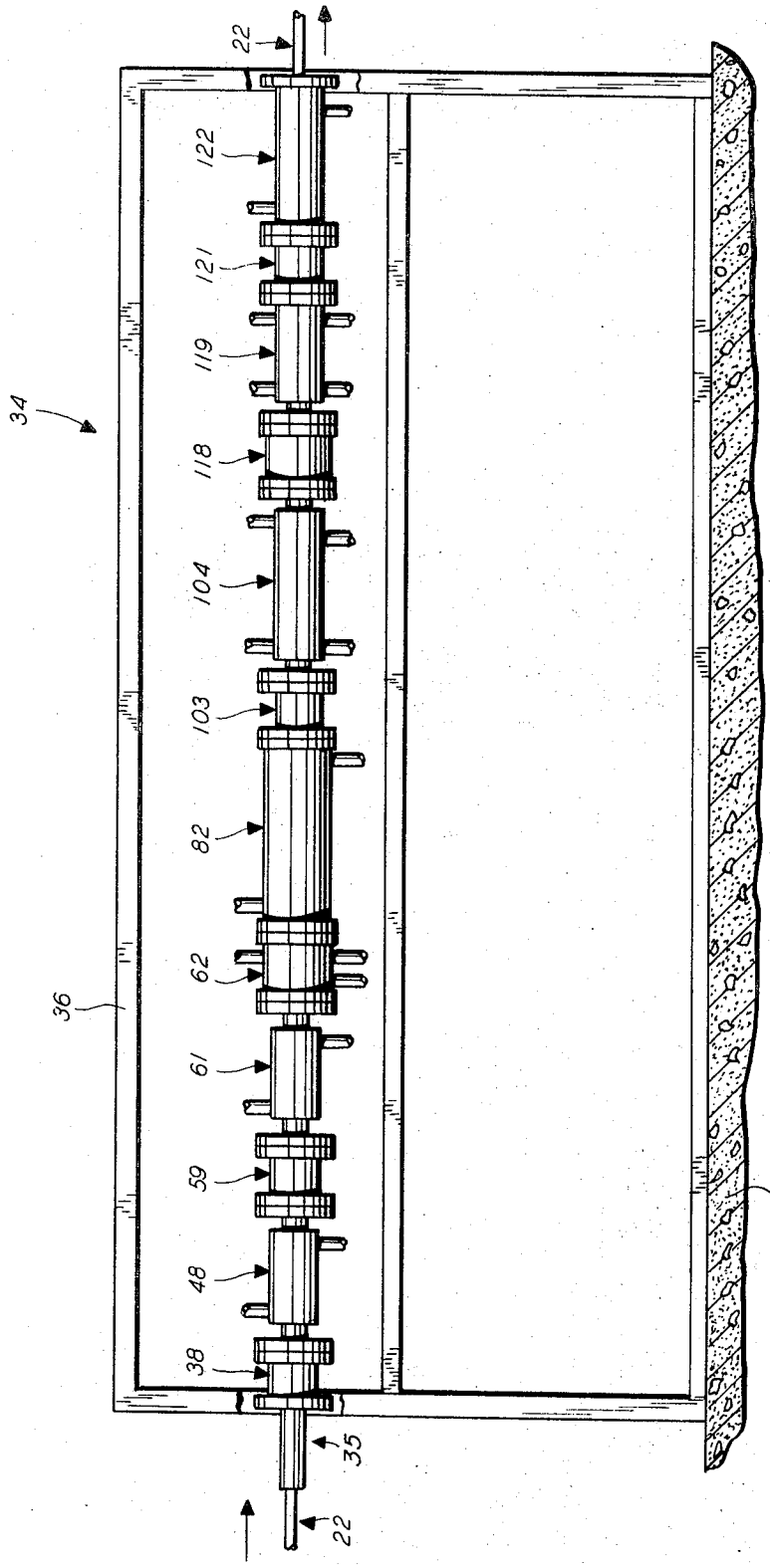


FIG 3

FIG-4

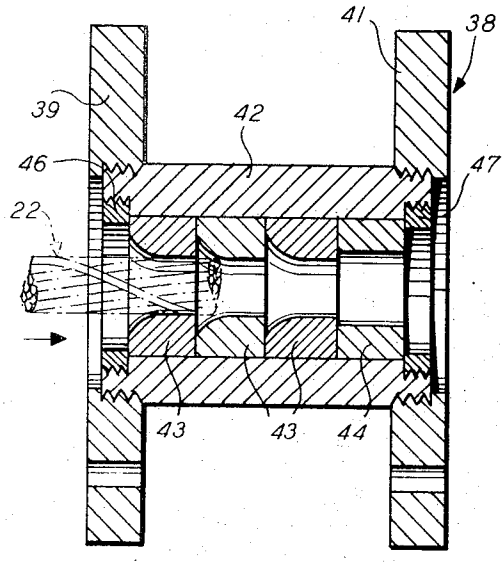
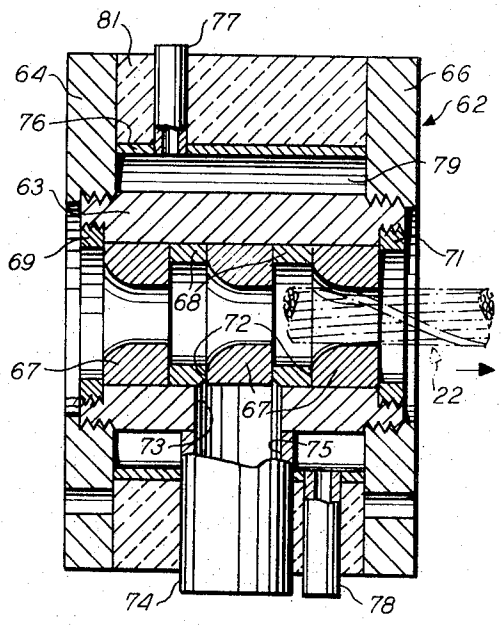


FIG-6



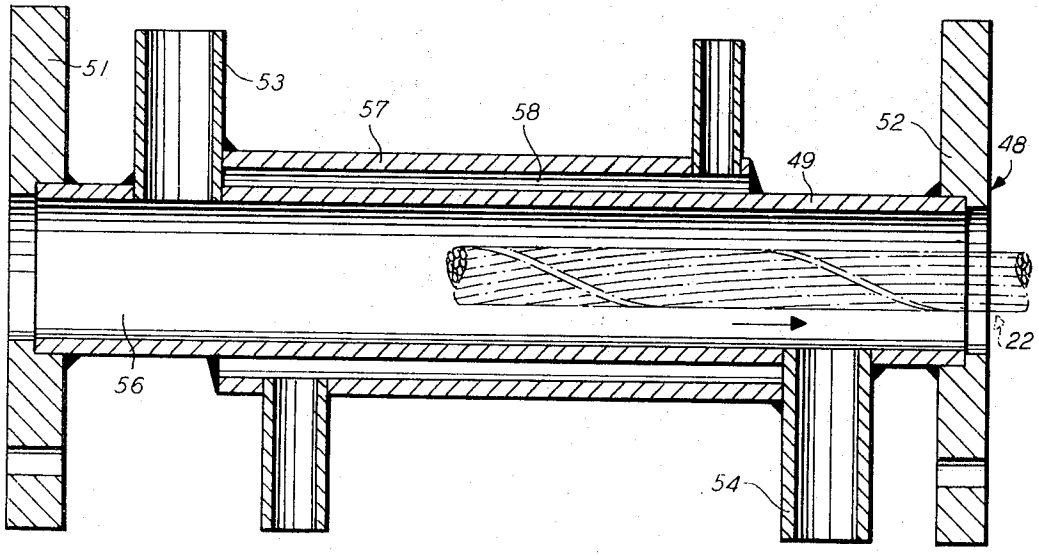


FIG-5

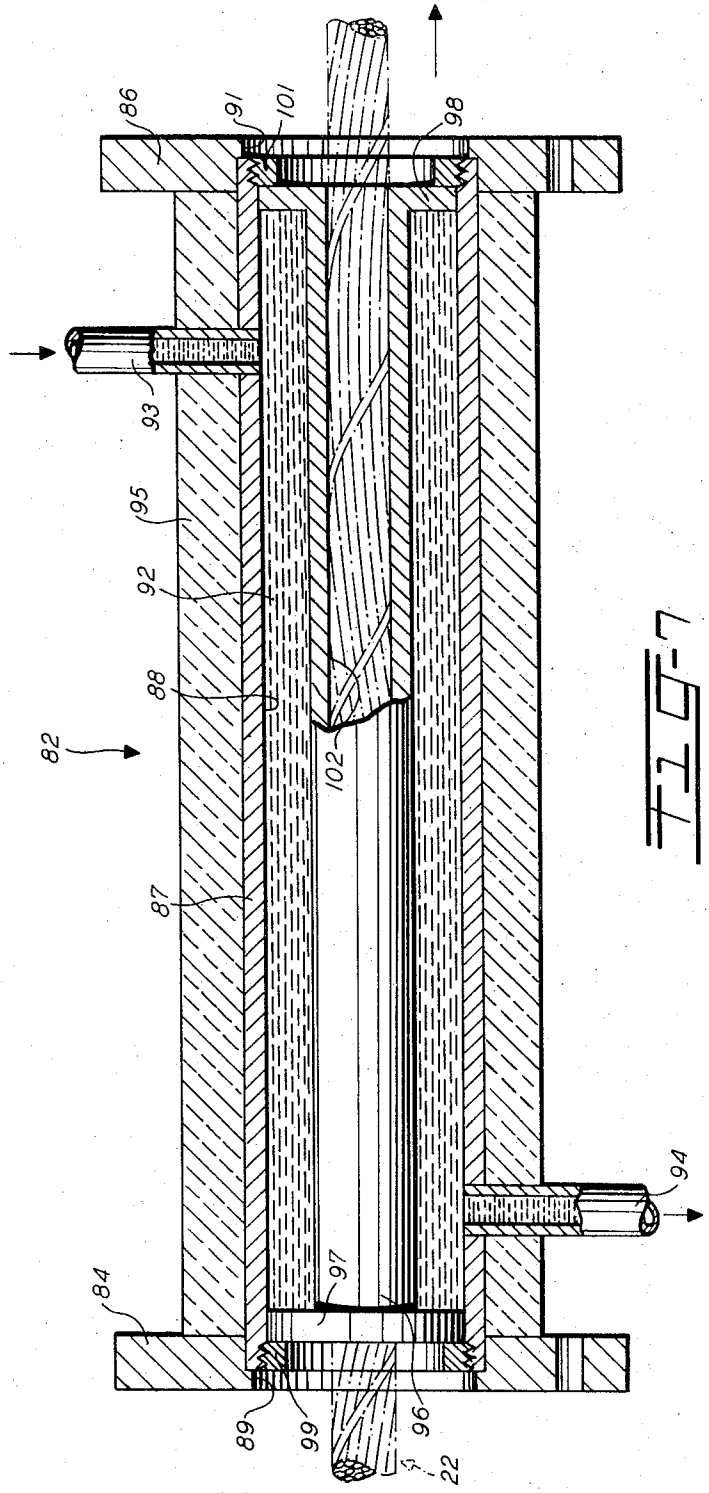


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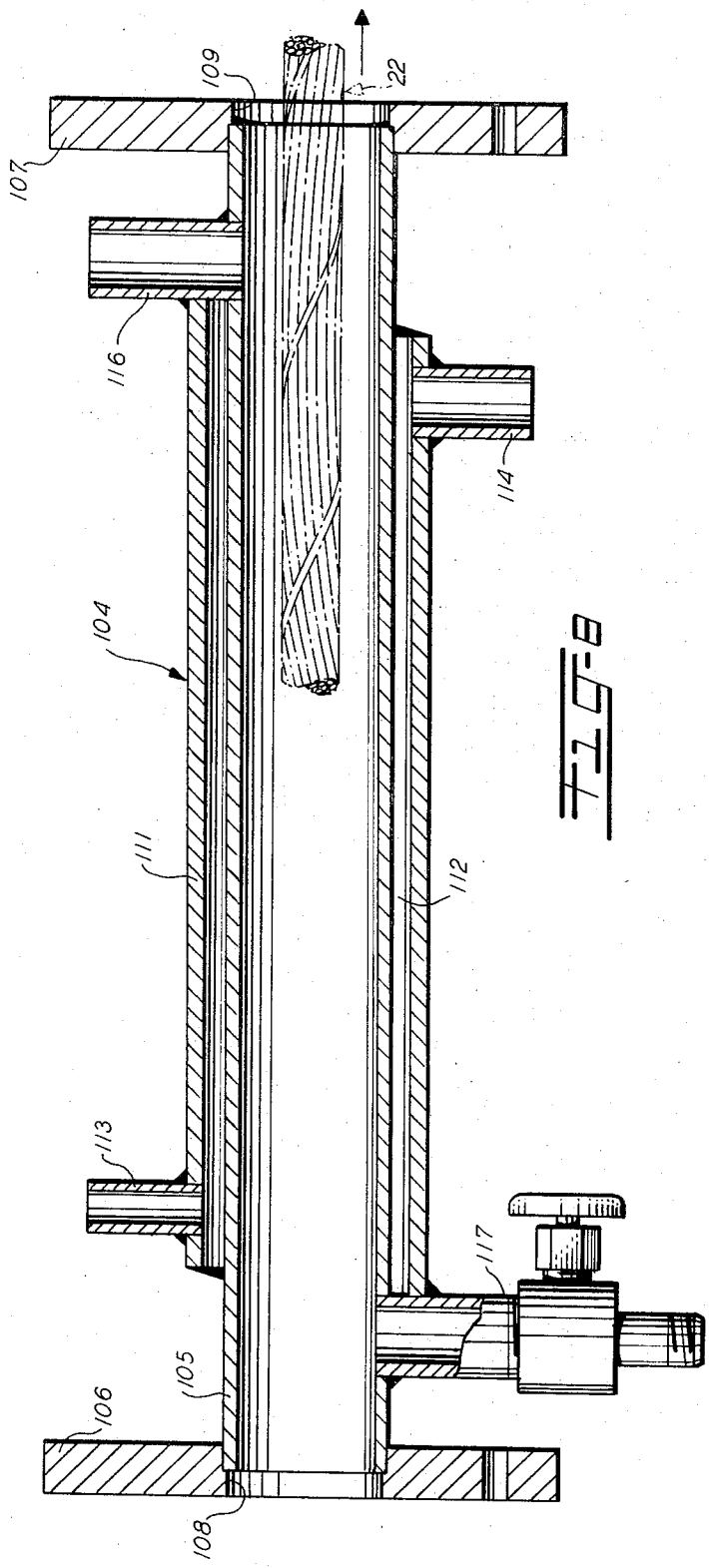


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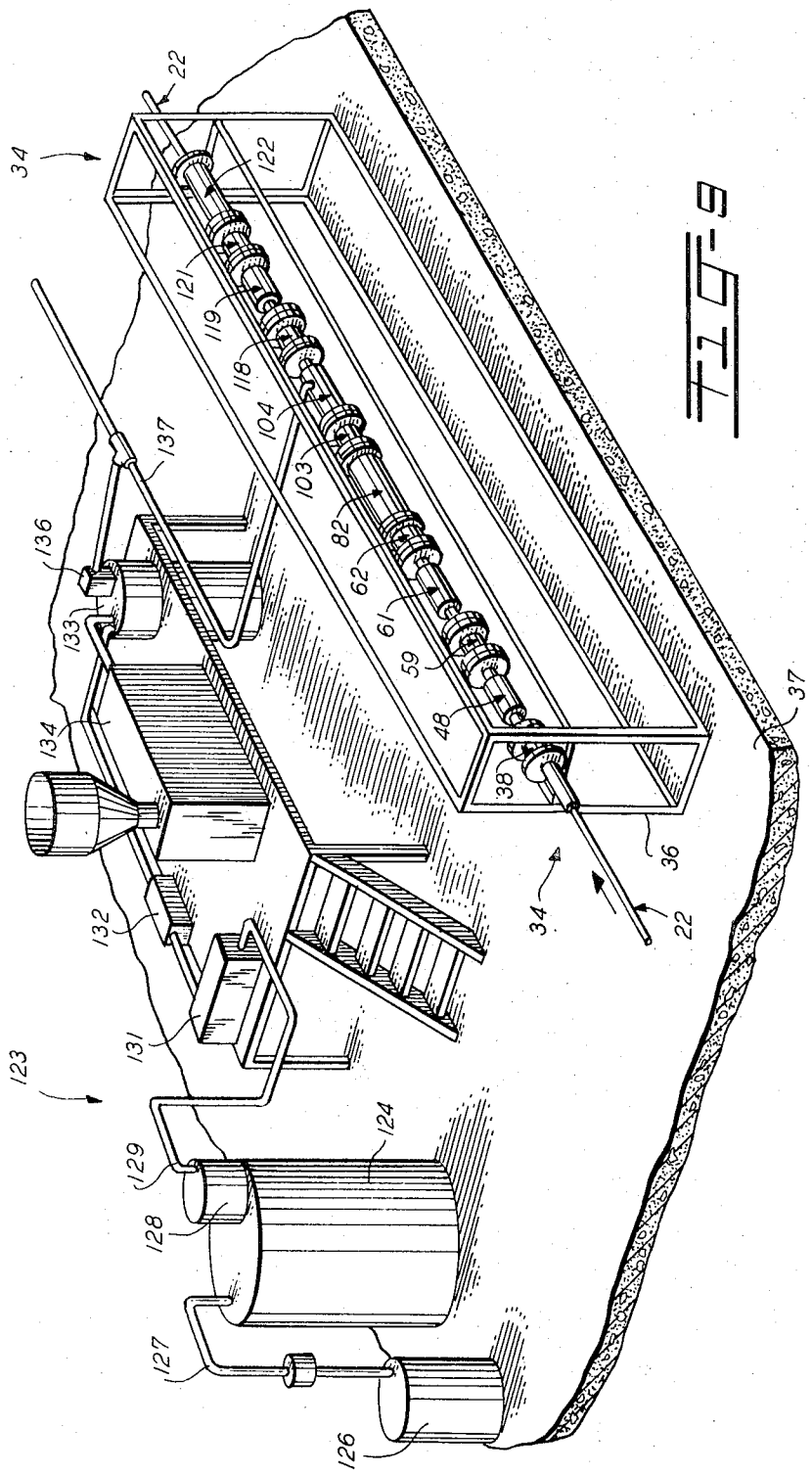
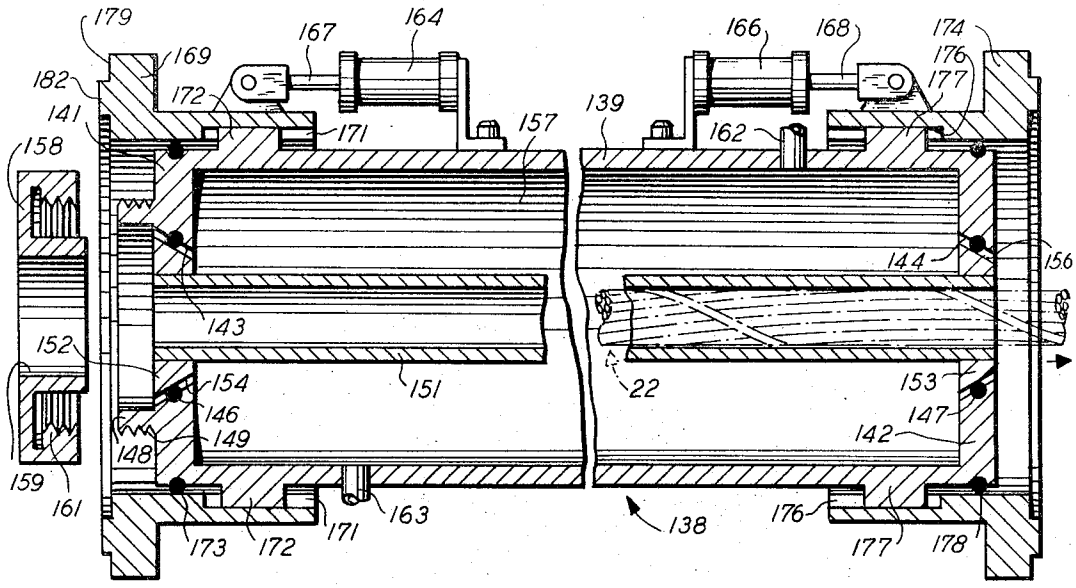

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FIG-9

FIG-10


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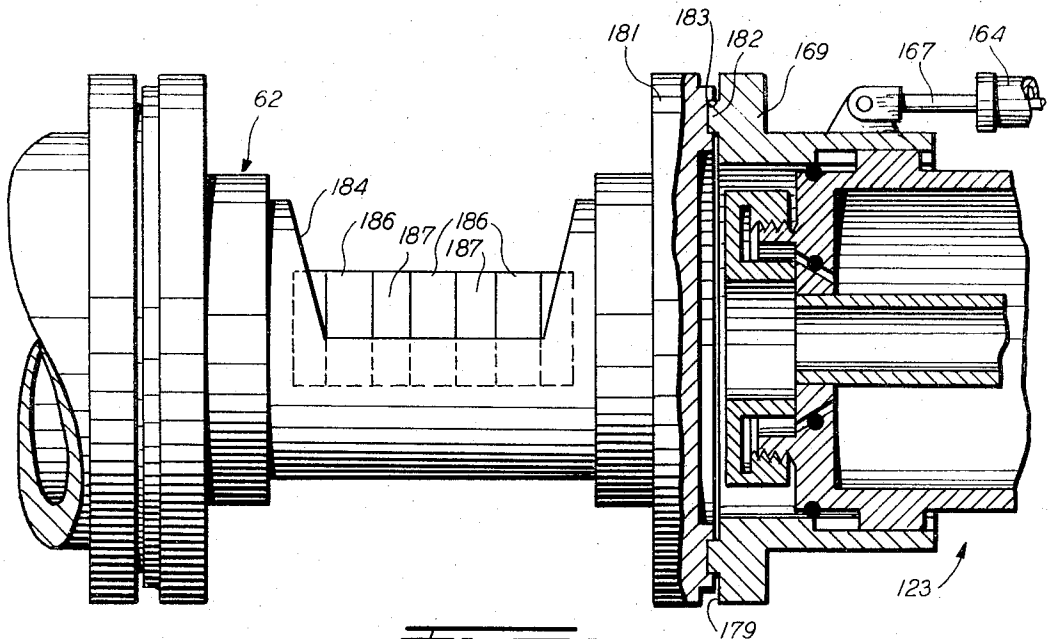

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FIG-11

APPARATUS FOR MANUFACTURING WATERPROOF CABLE

This is a division, of application Ser. No. 155,055 filed June 21, 1971, now U.S. Pat. No. 3,767,454.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to apparatus for manufacturing waterproof cable, and particularly relates to apparatus for filling interstitial voids of a cable core with a waterproofing compound and further to the subsequent application of core wrap, sheathing and jacketing materials in combination with additional applications of the waterproofing compound about the cable core to form an esssentially waterproof cable.

2. Description of the Prior Art

In the manufacture of certain types of communications cable, such as those contemplated for use as underground or buried cable in telephone communications, individual bare conductors are coated by extrusion with an insulating material and each insulated conductor is subsequently twisted with another insulated conductor to form a twisted pair. A plurality of the twisted pairs of insulated conductors are then stranded together to form a cable core. Colored binder ribbons are wound helically about the cable core for coding purposes. A thermal-barrier tape, referred to as a core wrap, and a metal sheathing are wrapped about the cable core and a jacketing layer of plastic insulation extruded over the sheathing.

Since cable of this type is contemplated for underground or buried usage, moisture diffusion into the interior of the core of the cable is likely, thereby resulting in corrosive attack and damage to the conductors and change in capacitance. Further, the presence of moisture within the cable core would result in the inefficient, and in some cases failure of, operation of telephone circuits formed by the conductors. It is also feasible that the jacket and sheathing could be broken open by external forces, such as shifting rock formations in the buried configuration or accidental blows to above-ground portions of the cable, which would immediately expose the cable core to moisture. Therefore, it is more desirable and necessary to protect the insulated conductors of the cable core to minimize the entry of moisture into the cable core.

One of the presently employed techniques for providing a protective shield includes the use of an adhesive-coated metal strip, which is wrapped longitudinally about the core wrap. When a jacket of hot plastic material is extruded about the adhesive coating of the metal, the metal is bonded to the inner wall of the jacket to thereby form a bonded sheath about the cable core. This bonded sheath provides a moisture barrier having characteristics which reduce the penetration of corrosive and damaging moisture into the core of the cable. In addition, the core of the cable may be subsequently pressurized, which also tends to reduce the opportunity for moisture to penetrate into the core.

Other techniques used to minimize the entry of moisture into the core of the cable include the flooding of voids of the interstitial structure of the core of the cable with a compound which has properties sufficient to minimize the entry of moisture into the core. It would be most desirable if the compound could be deposited or placed in all of the air spaces and voids within the core of the cable which make up the interstitial structure of the cable core. Since the twisted pairs of the core of the cable have been stranded, it is difficult to insure that all of the voids of the interstitial structure are filled with the compound, particularly those which occupy the axially central portions of the core.

In addition, the compound which is used to fill the voids of the interstitial structure of the cable core desirably and essentially replaces all of the air in the cable core. Therefore, the compound must have excellent electrical properties so that the compound-filled cable will maintain transmission characteristics which are at least as good as those of acceptable and proven cables having an air-filled core which utilize other techniques of moisture exclusion. In addition, the compound must possess excellent resistance to flow at certain atmospheric temperatures due to the fact that portions of the cable must be brought above ground for terminating purposes. Further, the compound must possess low-temperature properties, such as adhesion and resistance to cracking due to the handling of the cables in cold environments. Also the compound should not possess any toxic effects which would make the compound objectionable to handle by installation personnel who may have to come into intimate contact with the compound.

In an examination of various types of filling compounds which could be used for waterproofing purposes in buried telephone cables, it was discovered that a mixture of petrolatum and low-density polyethylene in a precise blend would satisfy the requirements outlined above. However, the cost of mixing, handling and shipping of the blended compound to the point of use, and the necessity for the addition of an antioxidant to improve product quality due to long blending cycles, increased the cost of the compound significantly and tended to cause some concern as to the economic feasibility for using the precisely blended petrolatum-polyethylene blend as a waterproofing compound for buried telephone cables.

Therefore, suitable means had to be developed to overcome the difficulties and high costs encountered when the petrolatum-polyethylene waterproofing compound was blended at a distant location and transported to a location whereat the compound was to be injected into the core of the cable.

SUMMARY OF THE INVENTION

It is, therefore, an object of this invention to provide new and improved apparatus for manufacturing waterproof cable.

Another object of this invention is to provide new and improved apparatus for blending selected materials to form a waterproofing compound to eliminate the costly transportation of the blended compound from a mixing location to a location whereat the compound is to be applied to a cable core.

Still another object of this invention is the provision of apparatus for injecting and depositing a preblended waterproofing compound into the voids of the interstitial structure of a cable core.

A further object of this invention is to provide new and useful apparatus for blending a waterproofing compound in a workable and flowable state and immediately transferring the flowable compound into the voids of the interstitial structure of a cable core for waterproofing the core.

A still further object of this invention is to provide apparatus for depositing a waterproofing compound into the voids of the interstitial structure of an axially moving cable core and for thereafter applying sheathing and jacketing materials in combination with additional amounts of the waterproofing compound to manufacture a waterproof cable.

An apparatus embodying certain principles of the invention may include means for evacuating air from the voids of the interstitial structure of the core of a cable, means for depositing a waterproofing compound in a workable state into the air-evacuated voids of the cable core, and means for placing the deposited compound which occupies the voids of the cable core in a nonflowable state so that the deposited compound remains in the voids of the core of the cable to exclude substantially the entry of moisture into the core.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects and advantages of the present invention will be apparent from the following detailed description when considered in conjunction with the accompanying drawings, in which:

FIG. **1** is a perspective view showing a portion of a communications cable;

FIG. **2** is a sectional view of a communications cable showing waterproofing compound located within the interstices of the core of the cable as well as other portions of the cable;

FIG. **3** is a plan view showing an apparatus for injecting waterproofing compound into the core of a cable embodying certain principles of the invention;

FIG. **4** is a sectional view showing a constrictor section for facilitating the passage of the cable core through an essentially air-tight passageway;

FIG. **5** is a sectional view of a vacuum section for developing a vacuum in the interstitial structure of a cable core;

FIG. **6** is a sectional view showing an insulated constrictor section;

FIG. **7** is a sectional view showing a cooling section for cooling a cable core moving therethrough;

FIG. **8** is a sectional view showing a compoundapplying section for facilitating the application of a waterproofing compound to a cable core moving therethrough;

FIG. **9** is a perspective view of a compound mixing and blending area and the compound-application apparatus which is illustrated in FIG. **3**;

FIG. **10** is a sectional view showing a removable cooling section, and

FIG. **11** is a sectional view showing the removable cooling section of FIG. **10** in assembly with a constrictor section.

DETAILED DESCRIPTION

Referring to FIG. **1**, there is illustrated a section of a communications cable, designated generally by the numeral **21**. The cable **21** includes a cable core, designated generally by the numeral **22**, composed of a plurality of stranded, insulated conductors **23—23** which form a plurality of twisted pairs. A plurality of colored binder ribbons **24—24** are wrapped about the stranded conductors **23—23** to provide a color code indication of certain aspects of the cable core **22**. A core wrap **26**, which is a plastic, thermal-barrier and dielectric tape, is wrapped longitudinally about the cable core **22**. A corrugated aluminum shielding tape **27** is wrapped longitudinally about the core wrap **26**, and provides a lightning shield for the cable core **22**. A jacket **29** of insulating material is extruded about the corrugated tape **27** to complete the cable **21**.

As illustrated in FIG. **2**, the stranded, insulated conductors **23—23** are arranged in such a manner that air voids are normally formed in interstices **31—31** of the cable core **22**. In order to reduce the opportunity for moisture to diffuse into and collect in the interstices **31—31** of the cable core **22**, the air voids of the interstices are filled with a waterproofing jelly-like compound which is composed of a mixture of petroleum and polyethylene. An example of a range of waterproofing compound which successfully accomplishes the waterproofing of the cable **21** includes a mixture of about 85 percent petrolatum and 15 percent low-density polyethylene to a mixture of 95 percent petrolatum and 5 percent low-density polyethylene.

In order to further provide a waterproof protection for the cable **21**, additional amounts of the waterproofing compound are placed in a space **32** between the core wrap **26** and the corrugated tape **27**, as well as in a space **33** between the corrugated tape and the jacket **29**. The filled cable **21**, as illustrated in FIG. **2**, provides a cable which has proven to be substantially impervious to moisture. It thereby provides sufficient moisture-barrier protection for the conductors **23—23** of the cable **21**, and, consequently essentially eliminates all of the attendant disadvantages experienced when moisture diffuses into the core of cables used in the communications industry.

The stranded structure of the cable core **22** is arranged so that air voids exist throughout the cross sectional configuration of the core. Consequently, it is difficult to insure that the air voids of the centermost interstices **31—31** will be filled with as much waterproofing compound as the air voids of the outermost interstices. Therefore, techniques and apparatus had to be developed which can facilitate the application of the waterproofing compound to the cable core **22** in such a manner that substantially all voids of the interstices **31—31** of the core are filled with the compound.

Referring to FIG. **3**, there is illustrated a compound-applying apparatus, designated generally by the numeral **34**, which facilitates the application of the waterproofing compound into the interstices **31—31** of the cable core **22** in accordance with certain principles of the invention. The apparatus **34** includes a support frame **36** mounted on a stationary floor **37**. The apparatus **34** further includes a lead-in tube **35** which provides a pressure-gradient entry of the core **22** into the apparatus **34**. The apparatus **34** also includes a first constrictor section, designated generally by the numeral **38**, which is connected to the trailing end of the lead-in tube **35**.

As illustrated in FIG. **4**, the constrictor section **38** includes a pair of spaced flange rings **39** and **41** which are threadedly secured to opposite ends of an interconnecting sleeve **42**. A plurality of constricting members **43—43** and a spacer **44** are positioned within the sleeve **42**. A pair of locking rings **46** and **47** are threadedly secured to opposite ends of the sleeve **42** to lock the constricting members **43—43** and the spacer **44** in the aligned orientation as illustrated in FIG. **4**. Each of the constricting members **43—43** is formed with a central opening having portions which have an internal diame-

ter substantially equal to the external diameter of the cable core **22.** Consequently, as the cable core **22** passes through the openings of the constricting members **43—43,** an essentially air-tight seal is formed at the entry of the core into the compound-applying apparatus **34.**

Referring again to FIG. **3,** a first vacuum section, designated generally by the numeral **48,** forms a portion of the apparatus **34** and is connected at one end thereof to the constrictor section **38.** A vacuum pump (not shown) is connected to the first vacuum section **48** for developing a suction within the section to extract air from the interstices **31—31** (FIG. **2**) of the cable core **22.**

As illustrated in FIG. **5,** the vacuum section **48** includes a sleeve **49** having a pair of flange members **51** and **52** secured to opposite ends thereof. A pair of tubes **53** and **54** form passageways which communicate with an inner chamber **56** formed by the internal wall of the sleeve **49.** The tubes **53** and **54** are connected to the associated vacuum pump to create the suction within the vacuum section **48** to facilitate the extraction of air from the interstices **31—31** of the cable core **22.**

An outer sleeve **57** is concentrically mounted about an intermediate portion of the sleeve **49** and forms an inner chamber **58** which can be utilized to permit the passage of a heating medium about the sleeve **49** if required.

As further illustrated in FIG. **3,** a second constrictor section, designated generally by the numeral **59,** which is identical to the first constrictor section **38,** is connected at one end thereof to the opposite end of the first vacuum section **48.** The second constrictor section **59** provides for an essentially air-tight passageway for the cable core **22** from the vacuum section **48** into a second vacuum section, designated generally by the numeral **61.** The second vacuum section **61** is identical to the first vacuum section **48** and is also connected to a vacuum pump (not shown) for developing a suction within the section to assist in extracting air from the interstices **31—31** of the cable core **22.** The first vacuum section **48** extracts essentially 85 percent of the air from the interstices **31—31** of the cable core **22.** The second vacuum section **61** extracts essentially an additional 5 percent of the volume of air apparent in the interstices of the cable core prior to the entry of the core into the first constrictor section **38.**

The second vacuum section **61** is attached at the opposite end thereof to one end of an insulated constrictor section, designated generally by the numeral **62.**

As illustrated in FIG. **6,** the constrictor section **62** includes an inner sleeve **63** and a pair of flange members **64** and **66** threadedly secured to opposite ends thereof. Three constricting members **67—67** are positioned within the central opening of the sleeve **63** and are separated by a pair of spacers **68—68.** A pair of locking rings **69** and **71** are threadedly secured to opposite ends of the sleeve **63** to retain the constricting members **67—67** and the spacers **68—68** in the orientation as illustrated in FIG. **6.**

Each of the spacers **68—68** is formed with an opening **72** which forms a passageway communicating with an opening **73** formed in an intermediate portion of the sleeve **63.** An outlet tube **74** is attached to the inner sleeve **63** and is formed with a central opening **75** which communicates with the opening **73** of the sleeve.

An outer sleeve **76** is positioned concentrically about the sleeve **63** and is held in the orientation as illustrated in FIG. **6** between the flange members **64** and **66.** A pair of tubes **77** and **78** are attached to the sleeve **76** and provide passageways which communicate with a chamber **79** formed between the outer wall of the inner sleeve **63** and the inner wall of the outer sleeve **76.** A composition of insulating material **81** is placed over the outer surface of the sleeve **76** to facilitate the retention of heat within the constrictor section **62** where the heat emanates from a medium, such as steam, being circulated through the chamber **79.**

The smaller inner diameter portions of the constricting members **67—67** are substantially the same size as the outer diameter of the cable core **22.** This feature provides a seal between subsequent compound-applying facilities and the vacuum sections **48** and **61** which essentially precludes any of the waterproofing compound from being drawn into the vacuum sections and, subsequently, into the vacuum pump.

Referring again to FIG. **3,** the opposite end of the constrictor section **62** is connected to one end of an insulated cooling section, designated generally by the numeral **82.**

As illustrated in FIG. **7,** the insulated cooling section **82** includes a sleeve **87** extending between and attached at opposite ends thereof to flange members **84** and **86.** The axis of a central passage **88** of the sleeve **87** is aligned with the axis of central openings **89** and **91** formed in the flange members **84** and **86,** respectively. A chamber **92** is formed within the sleeve **87** to permit the circulation of a cooling medium such as water therein. An inlet pipe **93** and an outlet pipe **94** are attached to the sleeve **87** to permit the continuous circulation of the cooling medium through the chamber **92.** A composition insulation **95** is placed over the sleeve **87** to retain the temperature of the cooling medium at a consistent level.

A removable sleeve **96** is formed with flanges **97** and **98** at opposite ends thereof and is insertable within the central passage **88** of the sleeve **87.** The removable sleeve **96** is retained within the central passage **88** of the sleeve **87** by a pair of locking rings **99** and **101** which are threadedly securable to opposite ends of the inner sleeve as illustrated in FIG. **7.**

The flanges **97** and **98** and the locking rings **99** and **101** seal the sleeve **96** within the chamber **92.** Thus the cooling medium can be circulated about the sleeve **96** to cool a central passageway **102** of the sleeve and any cable core **22** which may be passing therethrough.

The removable sleeve **96** is formed with the central opening **102** which is of sufficient size to provide movement axially therethrough by the cable core **22.** Since different size cable cores **22—22** will require the application of a waterproofing compound thereto, the removable sleeve **96** will have to be exchanged at selected periods to accommodate the different sizes of cable cores. For example, the cable core **22** could include 25, 50, 100 or 200 twisted pairs of conductors **23—23** (FIG. **1**); however, the diameter of the flanges **97** and **98** of each of the removable sleeves **96—96** will be the same so that any removable sleeve will fit within the central passage **88** of the sleeve **83.**

Referring again to FIG. **3,** the cooling section **82** is connected at the opposite end thereof to one end of a

constrictor section, designated generally by the numeral **103**, which is identical in structure to the constrictor section **38**. The constrictor section **103** is connected at the opposite end thereof to one end of a compound-applying section, designated generally by the numeral **104**.

As illustrated in FIG. **8**, the compound-applying section **104** includes an inner sleeve **105** attached at opposite ends thereof to end plates **106** and **107**. The central opening of the sleeve **105** is axially aligned with openings **108** and **109** formed in the end plates **106** and **107**, respectively. An outer sleeve **111** is positioned concentrically about an intermediate portion of the inner sleeve **105** and is spacely displaced from the inner sleeve **105** to form a chamber **112** therebetween. The ends of the outer sleeve **111** are closed to seal the chamber **112** excpet for an inlet pipe **113** and an outlet pipe **114** which permit the circulation of steam through the chamber and around the intermediate portion of the inner sleeve **105**. An inlet pipe **116** is connected to the inner sleeve **105** to permit the low-pressure movement of the waterproofing compound into the sleeve **105**. An outlet pipe **117** having a valve is provided for cleaning the compound from within the sleeve **105** when the compound-applying section **104** is not being used. Otherwise the valve of the pipe **117** is closed to keep the compound within the sleeve **105** under a low pressure.

The end plate **107** of the compound-applying section **104** is connected to one end of a constrictor section, designated generally by the numeral **118**, as illustrated in FIG. **3**. The constrictor section **118** is identical in structure to the constrictor section **38**. The constrictor section **118** is connected at the opposite end thereof to one end of a temperature-gradient section, designated generally by the numeral **119**, which is similar to the compound-applying section **104**, but does not include the entry and exit pipes **116** and **117**. The purpose of the temperature-gradient section **119** is to permit successive sections of the cable core **22**, with the recently applied hot waterproofing compound, to pass through an area which is not heated. This procedure assists in gradually reducing the temperature of the hot waterproofing compound of the successive sections of the cable core **22**. During the passage of the cable core **22** through the temperature-gradient section **119**, the waterproofing compound becomes less fluid and tends to solidify by approaching a jelly-like consistency.

The temperature-gradient section **119** is connected at the opposite end thereof to a constrictor section, designated generally by the numeral **121**, which is identical in structure to the constrictor section **38**. The constrictor section **121** is connected at the opposite end thereof to one end of a cooling section **122**. The cooling section **122** is similar to the insulated cooling section **82** except that the cooling section **122** does not include the removable sleeve **96** and does not have the composition insulation **95** surrounding the sleeve **87**. As successive sections of the cable core **22** pass through the cooling section **122**, the waterproofing compound contained within the interstices **31—31** of the successive sections are cooled and become somewhat solidified to the extent that the compound is no longer in a freely flowable condition but has now assumed the jelly-like consistency. The cooling procedure will permit the compound to be retained within the interstices **31—31** of the cable core **22** as the core exists from the opposite end of the cooling section **122** and into the atmosphere.

The cable core **22** containing the waterproofing compound is then passed through a series of operations whereat the core wrap **26** (FIG. **2**) is wrapped longitudinally about the cable core. Additional amounts of the waterproofing compound are injected onto the cable core **22** and aligned coincidental with a subsequently formed longitudinal seam of the core wrap **26**. A band or ribbon is then wrapped helically about the core wrap **26**. Thereafter the corrugated aluminum shielding tape **27** (FIG. **2**) is wrapped longitudinally about the core wrap **26**.

As the corrugated aluminum shielding tape **27** is being formed for subsequent longitudinal wrapping about the cable core **22** and the core wrap **26**, the cable core and the core wrap are passed through a mandrel into which is injected additional amounts of the waterproofing compound immediately prior to the longitudinal forming of the aluminum shielding tape about the core wrap. This aspect of the operation is covered in a co-pending application, Ser. No. 69,837, filed in the name of L. D. Moody on Sept. 4, 1970.

Thereafter the cable core **22**, having the core wrap **26** and the corrugated aluminum shielding tape **27**, is passed through a bath (not shown) of the waterproofing compound so that the compound fills essentially the valleys of the corrugations of the aluminum shielding tape **27**. The cable core **22** with the core wrap **26** and the aluminum shielding tape **27** is then passed through an extruder head where the polyethylene jacket **28** (FIG. **2**) is applied over the corrugated aluminum shielding tape. The jacketed product is then passed through a cooling trough (not shown) and onto a take-up reel (not shown).

Referring now to FIG. **9**, there is illustrated a compound preparation area, designated generally by the numeral **123**, which includes a heating tank **124** positioned on the stationary floor **37**. Commercially available petrolatum is pumped from a drum **126** through a conduit **127** and into the heating tank **124**. The petrolatum is heated to a temperature of about 150°F. in the tank **124** and is circulated through a header tank **128**. Selected amounts of the heated petrolatum are passed through a conduit **129** from the header tank **128** to a metering pump **131** and then through a heat exchanger **132** where the temperature of the petrolatum is raised to approximately 265°F. The heated petrolatum is then pumped from the heat exchanger **132** into a mixing vessel **133**.

An extruder **134** heats low-density polyethylene to a temperature of approximately 265°F and discharges the heated polyethylene into the mixing vessel **133** where the low-density polyethylene is mixed with the petrolatum to form the waterproofing compound. The metering pump **131** facilitates the essentially precise mixture of petrolatum with the polyethylene in the mixing vessel **133**. In this manner, a blend of waterproofing compound within the aforementioned range of mixture is obtained from the mixing vessel **133**. For example, an acceptable mixture could contain 94 percent petrolatum and 6 percent low-density polyethylene.

A pump **136** facilitates the pumping of the prepared waterproofing compound from the mixing vessel **133** to the various points of compound application along the manufacturing line. For example, as illustrated in FIG. **9**, a conduit **137** facilitates the transfer of the water-

proofing compound from the mixing vessel **133** to the compound-applying section **104.**

OPERATION

Referring to FIGS. **3** and **9,** the cable core **22** is moved axially from a supply stand (not shown) and through the in-line elements of the compound-applying apparatus **34.** Successive sections of the cable core **22** pass through the pressure-gradient lead-in tube **35** and into and through the constrictor section **38.** Because of the essentially close openings of the constricting members **43—43** (FIG. **4**), the constrictor section **38** forms an essentially air-tight entry point for the cable core **22** into the compound-applying apparatus **34.** Thereafter the successive sections of the cable core **22** pass through successive vacuum sections **48** and **61** whereat substantially all of the air, which exists within the interstices **31—31** (FIG. **2**) of the successive sections of the cable core, is extracted therefrom. It is noted that, although two vacuum sections **48** and **61** are shown in the compound applying apparatus **34,** sufficient air can be extracted from the interstices **31—31** of the cable core **22** by using a single vacuum section.

The successive, air-evacuated sections of the cable core **22** are then passed through the heated constrictor section **62** and the insulated cooling section **82** and subsequently through the compound-applying section **104.** the waterproofing compound is fed into the section **104** through the entry pipe **116** and is maintained in the section under a low pressure. In this manner, the waterproofing compound is drawn into the air-evacuated interstices **31—31** whereby the compound occupies substantially the entire volume of the interstitial structure of the cable core **22.**

Even though the constrictor sections **62** and **103** are located between the compound-applying section **104** and the vacuum sections **48** and **61,** it is feasible that the waterproofing compound could be drawn undesirably from the compound-applying section and into the vacuum sections under the suction generated by the vacuum pumps. However, as the waterproofing compound is drawn into the insulated cooling section **82,** the compound tends to solidify into a jelly-like consistency and become less flowable. As the cooled compound enters the heated constrictor section **62,** the compound is reheated and flows through the openings **72—72** and the tube **74** which are illustrated in FIG **6.** In this manner, essentially all of the waterproofing compound which tends to approach the vacuum sections **48** and **61** is diverted at the heated constrictor section **62** and is thereby prevented from entering the vacuum sections and the vacuum-generating system.

As previously explained, the successive sections of the cable core **22** which exit from the compound-applying section **104** are passed through the temperature-gradient section **119** which permits the controlled reduction of the temperature of the waterproofing compound contained within the interstices **31—31** of the cable core. Further, the successive sections of the cable core **22** are then passed through the cooling section **122** to prepare finally the compound for the exiting of the cable core into the atmosphere. The cooled compound assumes the jelly-like consistency, will not flow and will remain within the interstices of the cable core **22** to provide a cable core wherein essentially the entire interstitial structure of the core is filled with the waterproofing compound.

It is particularly significant to note that the compound of jelly-like consistency within the interstices **31—31** of the cable core **22** has been cooled rapidly prior to exiting from the cooling section **122** and into the atmosphere. This action provides a compound within the interstices **31—31** which is self-supporting within the core **22** and does not require any external covering.

The subsequent applications of the waterproofing compound as the core wrap **26** is being applied and prior to the forming of the aluminum shielding tape **27** about the core wrap, as described in the aforementioned L. D. Moody application, further facilitates the waterproofing of the subsequent cables **21.** In addition, the application of the waterproofing compound about the corrugated aluminum shielding tape **27** prior to the application of the polyethylene jacket **29** further enhances the waterproofing quality of the ultimate cable **21.**

Although not illustrated in the Figures, wiper dies could be utilized at various locations within the compoundapplying apparatus **34** subsequent to the application of the waterproofing compound to the cable core **22** with an accommodating drain to remove any excess compound wiped from the moving cable core **22** by the dies. In addition, splash shields could be utilized along the path of movement of the cable core **22** and prior to the entry of the core into the compound-applying section **104.**

Referring now to FIG. **10,** there is illustrated a representation of a cooling section, designated generally by the numeral **138,** which is an alternate embodiment of and can be used as a replacement for the cooling section **82.** The cooling section **138** includes a sleeve **139** extending between and attached to end plates **141** and **142.** The end plates **141** and **142** are formed with central openings having bevelled surfaces **143** and **144,** respectively. Rubber rings **146** and **147** are positioned within grooves formed in the bevelled surfaces **143** and **144,** respectively. The end plate **141** is formed with a circular extension **148** having a threaded periphery **149.**

A removable sleeve **151** is secured to circular flange members **152** and **153** at opposite ends thereof. Peripheries **154** and **156** of the flange members **152** and **153,** respectively, are bevelled as illustrated in FIG. **10** to complement the bevel of the surfaces **143** and **144** of the end plates **141** and **142,** respectively. The removable sleeve **151** can be inserted into the sleeve **139,** as illustrated in FIG. **10** to a position whereat the bevelled periphery **156** engages the rubber ring **147** to form a seal in the right end of the cooling section **138.** The bevelled periphery **154** of the flange member **152** engages the rubber ring **146** to form a seal in the left end of the cooling section **138** whereby a chamber **157,** formed between the sleeve **139** and **151,** is sealed. the removability of the sleeve **151** permits the interchangeability of sleeves of different diameters to receive cable cores **22—22** of correspondingly different diameters. In addition, the flange members **152** and **153** of all sleeves **151—151** are the same size.

A cap **158,** having a central passageway **159** formed axially therethrough and further formed with an internally threaded portion **161,** is threadedly attached to the extension **148** and abuts the outer surface of the flange member **152** to lock the removable sleeve **151** within the sleeve **139.** Conduits **162** and **163** are at-

tached to the sleeve **139** to facilitate the continuous circulation of a cooling medium, such as chilled water, through the chamber **157** and about the removable sleeve **151.**

A pair of air cylinders **164** and **166** are attached to the outer surface of the sleeve **139** and are provided with piston rods **167** and **168,** respectively. Movement of the piston rod **167** controls a circular slide **169** which is formed with a plurality of keyways **171—171** for guiding movement of the slide over a plurality of keys **172—172** which extend radially from the outer surface of the sleeve **139.** The slide **169** also moves over a rubber ring **173** mounted in a groove formed in the periphery of the end plate **141.**

Movement of the piston rod **168** controls a circular slide **174** at the opposite end of the cooling section **138** by permitting sliding movement of keyways **176—176,** formed in the slide, over keys **177—177** formed radially on the outer surface of the sleeve **139.** A rubber ring **178** is positioned within a groove formed in the periphery of the end plate **142** to further provide a rolling surface for the slide **174.**

While not illustrated in FIG. **10,** the cooling section **138** could include a composition insulation positioned about the outer surface of the sleeve **139** to insulate the section so that the cooling properties of the section are maintained at a desired level.

The cooling section **138** can be attached to a pivotal support (not shown) extending perpendicular to the axis of the cooling section and supported for pivoting movement some distances from the axis of the section. For example, the cooling section **138** could replace the cooling section **82** which is illustrated in FIG. **3.** The pivotal support for the cooling section **138** would extend downwardly and would be attached to a fixed member (not shown) having an axis which is parallel to the axis of the in-line components of the compound-applying apparatus **34.**

When it is desired to change the removable sleeve **151** for a sleeve having a central passageway of a different diameter to facilitate the passage of the cable core **22** of a different size, the cooling section **138** is pivoted from its in-line position in the apparatus **34.** The cap **158** is removed and the removable sleeves **151—151** are exchanged. Since the size of the flange members **152** and **153** of all of the removable sleeves **151—151** are the same, the newly inserted removable sleeve will again form a seal with the rubber rings **146** and **147.** The cap **158** is then reapplied threadedly to the extension **148** to lock the newly inserted sleeve **151** within the sleeve **139.** The cooling section **138** is then pivoted back to a position which aligns the axis of the section with the in-line axis of the other components of the apparatus **34.**

Referring now to FIG. **11,** after the cooling section **138** has been returned to the axially aligned position with the in-line components of the apparatus **34,** the air cylinder **164** is controlled to move the piston rod **167** to the left so that a face **179** of the slide **169** is moved toward an adjacent flange ring **181** of the insulated constrictor section **62.** The face **179** of the slide **169** is formed with a circular projection **182** which is moved into a circular groove **183** formed in the adjacent face of the flange ring **179.**

Referring again to FIG. **10,** the air cylinder **166** is controlled to move the slide **174** into similar engagement with the adjacent flange ring of the constrictor section **103** (FIG. **3**) whereby the cooling section **138** is locked in axial alignment with the remaining components of the compoundapplying apparatus **34.**

Utilization of the cooling section **138** in the manner just described permits the exchange of removable sleeves **151—151** without disturbing any insulation which is mounted about the sleeve **139** and permits a relatively fast and expedient exchange of the removable sleeves.

Referring again to FIG. **11,** the constrictor section **62** is illustrated as having an open top **184.** The representation of the open top **184** illustrates another embodiment for the constrictor sections **38, 59, 62, 103, 118** and **121** wherein a hinged top (not shown) is moveable relative to the remaining portion of the constrictor section to expose the constricting members and spacers therein. For example, constricting members **186—186** and spacers **187—187** are illustrated in FIG. **11.** By providing a hingeable top for the constrictor sections of the apparatus **34,** the constricting members can be quickly changed to facilitate different sizes of cable cores **22—22.**

Thus the methods of and apparatus for applying a waterproofing compound to the cable core **22** provides a relatively air-tight assembly of axially aligned components for extracting air from the interstices **31—31** of the core, applying the compound into the air-evacuated interstices and conditioning the compound to a jelly-like state so that the compound remains within the interstitial structure of the core without the necessity for an external covering to retain the compound therein. In addition, the cooling features of the apparatus **34** provide a relatively clean vacuum operation whereby essentially no portions of the compound are drawn into the vacuum sections of the apparatus. Further, the interchangeable features of the cooling section **138** further enhance the rapid exchange of different sizes of facilities within the apparatus when a cable core of a size different from the previous cable core is to be passed through the apparatus.

What is claimed is:

1. Apparatus for applying a compound to a stranded article, which comprises:

means for evacuating air from interstices of successive portions of the stranded article;

a compound-applying section;

means for moving the air-evacuated successive portions of the stranded article through the compound-applying section;

means for moving amounts of the compound in a semifluid state into the compound-applying section and into contact with the successive portions of the stranded article to facilitate the drawing of portions of the semifluid compound into the air-evacuated interstices of the successive portions of the stranded article;

a compound-conditioning section whereat the compound is placed in a jelly-like state;

means for moving the compound-filled stranded article through the compound in conditioning section whereat the semifluid compound is conditioned to place the compound in a jelly-like state so that the compound is nonflowable and is retained within the interstices of the stranded article independently of any other supporting structure;

means for cooling the air-evacuated successive portions of the stranded article after the portions have

been moved through the means for evacuating air and prior to the entry of the portions into the compound-applying section to place in a jelly-like state any portions of the compound which are drawn from the compound-applying section toward the means for evacuating air to preclude entry of the compound into the means for evacuating air;

means for preheating petrolatum to a selected temperature to place the petrolatum in a semifluid state;

a mixing tank;

means for pumping selected amounts of the preheated petrolatum into the mixing tank;

means for extruding selected amounts of low-density polyethylene into the mixing tank at a temperature consistent with the preheated temperature of the petrolatum;

means for controlling the mixing tank to mix selected preheated amounts of the petrolatum and the low-density polyethylene within the mixing tank to prepare a blended compound, and

means for pumping the blended compound directly from the mixing tank to the compound-applying section.

2. The apparatus as set forth in claim **1** wherein the means for preheating and the means for extruding heat the petrolatum and low-density polyethylene to a temperature of about 265°F.

3. The apparatus as set forth in claim **1** which further comprises:

means for controlling the petrolatum-pumping means and the extruder means to controllably feed the mixture of the petrolatum and polyethylene so that the mixture is within a range of from 85 percent petrolatum and 15 percent polyethylene to 95 percent petrolatum and 5 percent polyethylene.

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