

[54] **METHOD AND APPARATUS FOR FORMING AN UNSOLDERED SHEATH ABOUT A STRAND**

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[51] Int. Cl. **H01b 13/26, H01b 13/16**

[58] Field of Search **29/624, 203 C, 202 S; 156/50, 51, 52-56; 174/102 D, 105, 106, 107, 110 PM, 116, 113 R; 219/59; 117/102 R, 102 L; 118/56, 58, 63, 7, 211, 244**

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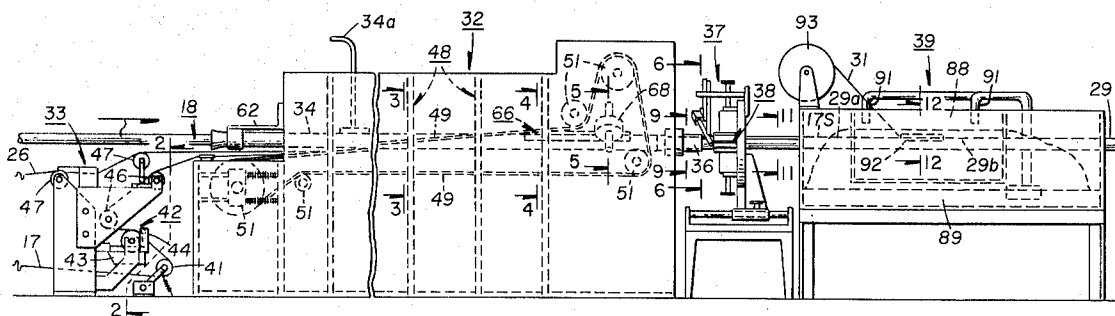
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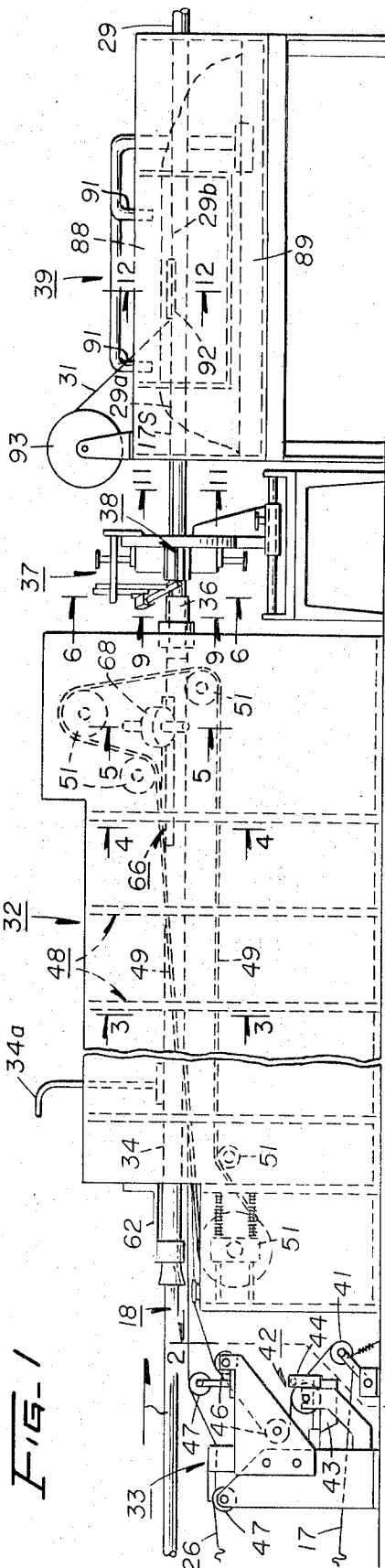
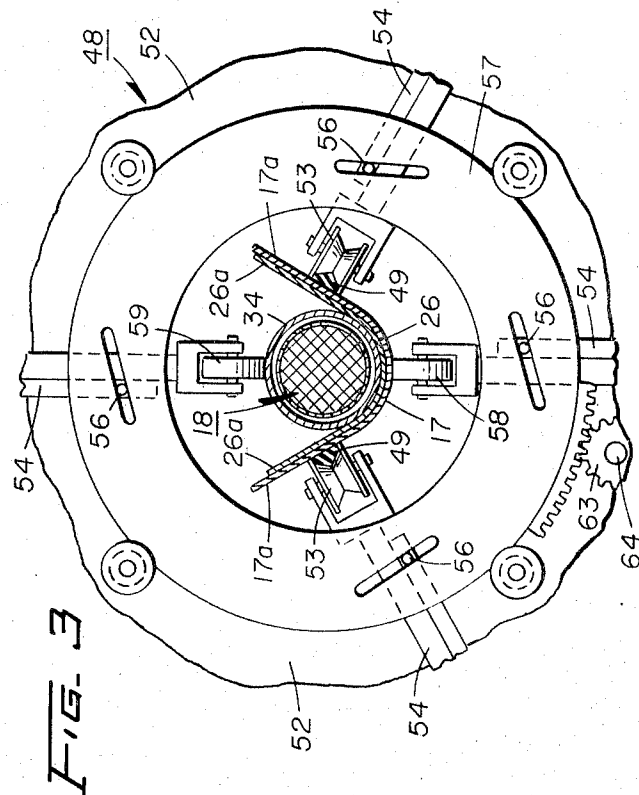
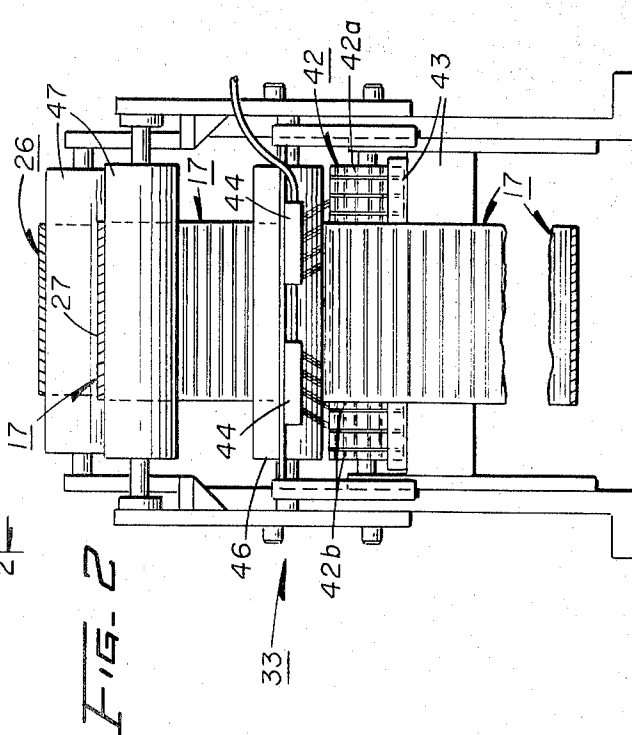
[57] **ABSTRACT**

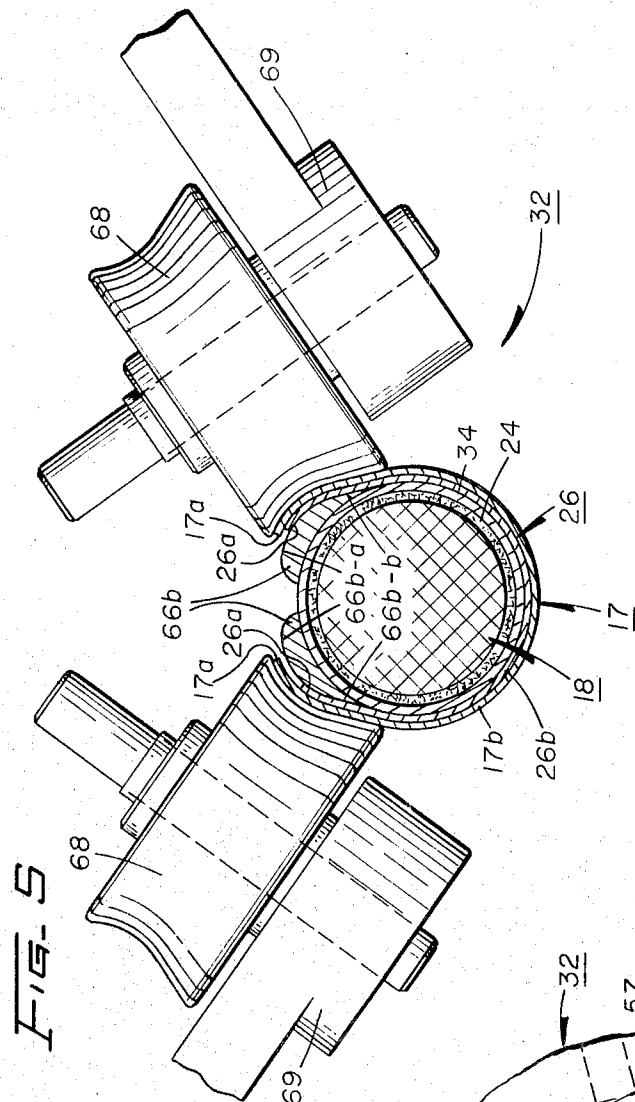
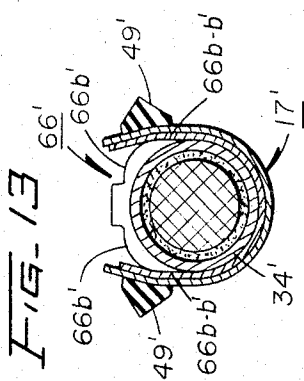
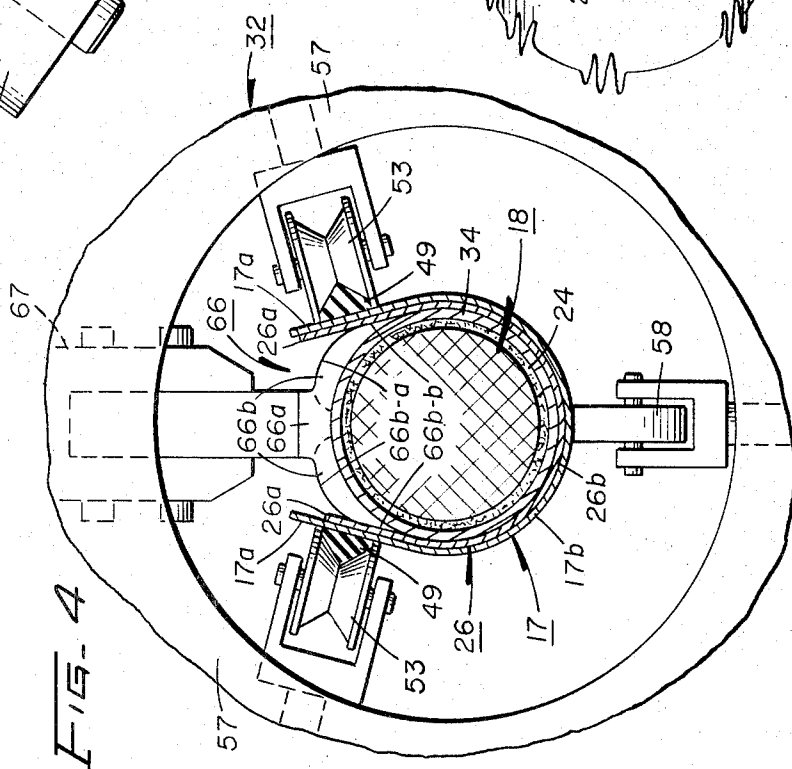
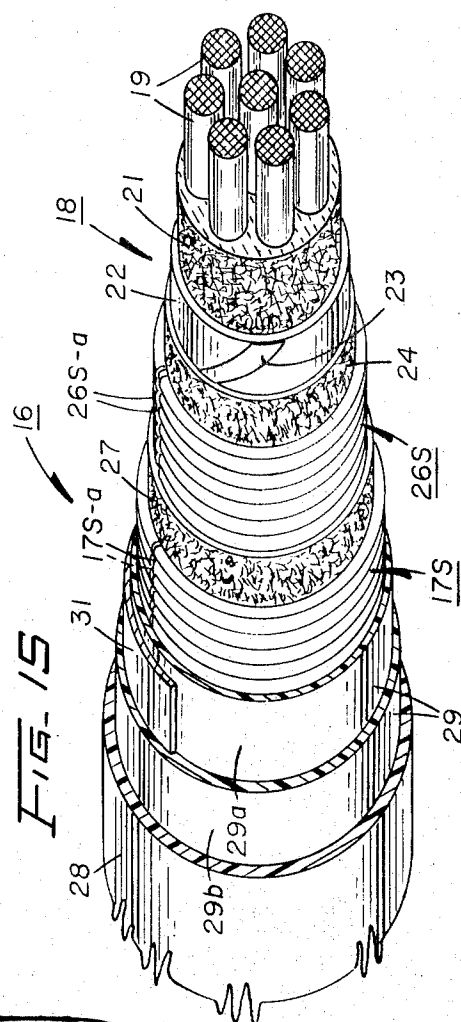
In the forming of an unsoldered sheath about a strand,

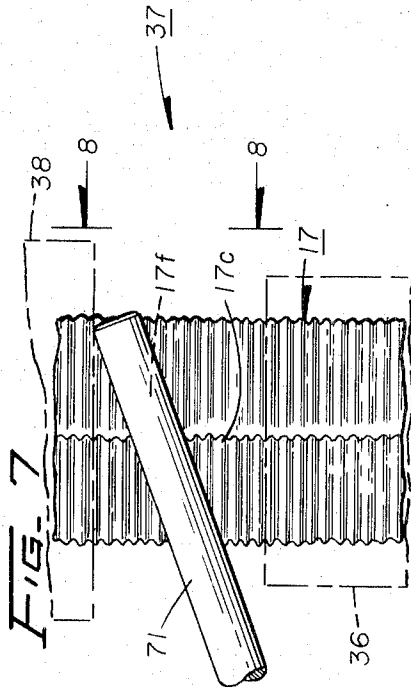
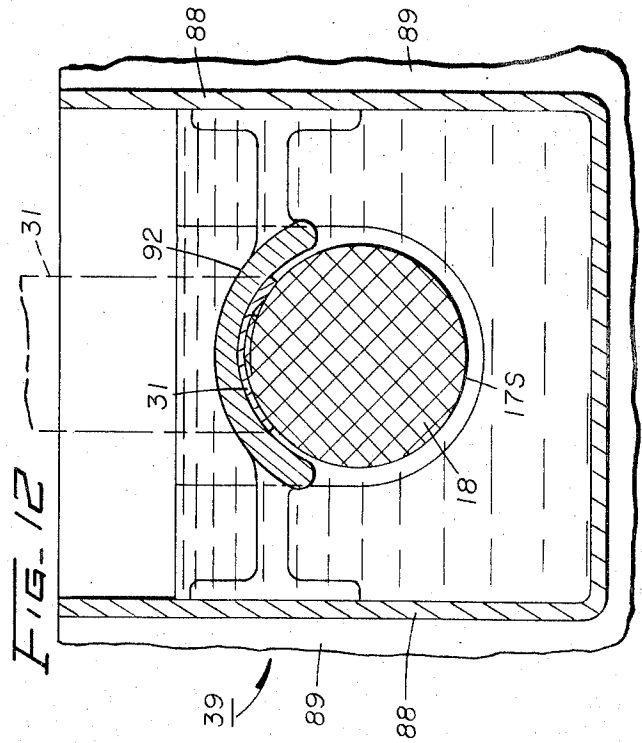
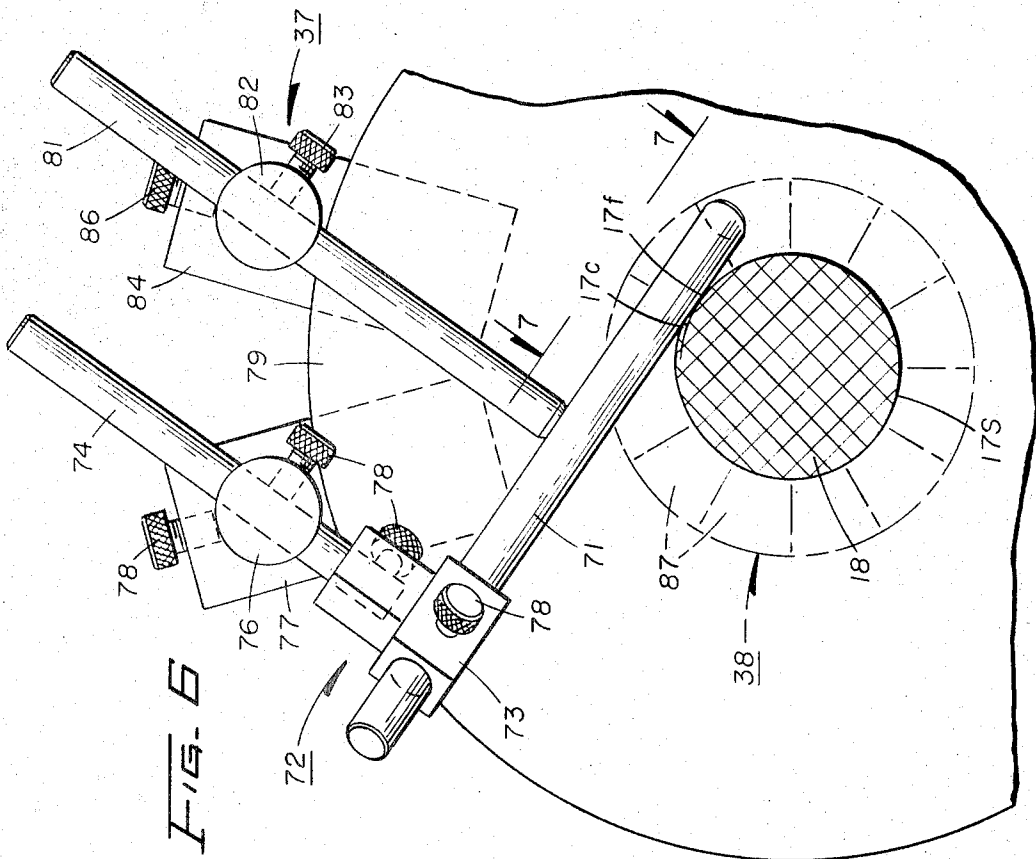
such as a cable core assembly, in which the strand is advanced longitudinally through an elongated tube and in which a corrugated metal tape for sheathing the strand is advanced therewith and folded about the periphery of the tube so as to envelop the strand as the strand exits from the tube, edge portions of the metal tape are overformed into a relatively sharp curved configuration. Subsequently, the edge portions are reverse-formed to a curved configuration similar to that of an intermediate portion of the tape and are overlapped. Radial inward pressure then is applied to an edge section of the advancing tape to form it inward and to cold-work the edge section so that it achieves a permanent set. At the same time, the inner edge portion of the tape is deflected radially inward to facilitate this forming of the edge section, and then is permitted to return into tight-fitting engagement with the edge section whereby the overlapped edge portions form a tight seam. Preferably, the strand is sheathed in two corrugated metal tapes, and a non-adhesive corrosion inhibitor is initially coated on one side of a first tape while air jets preclude flow of the inhibitor onto the opposite side of the tape. The coated side of the first tape then is brought into meshing engagement with a second tape and the two tapes are formed about the strand with the uncoated side of the first tape facing outward. Subsequently, the outer side of the first tape is coated with a corrosion inhibitor having adhesive qualities, to facilitate bonding of an extruded plastic jacket to the tape. An overlay tape also may be embedded in the second corrosion inhibitor over the seam formed by the overlapped edge portions of the tape.

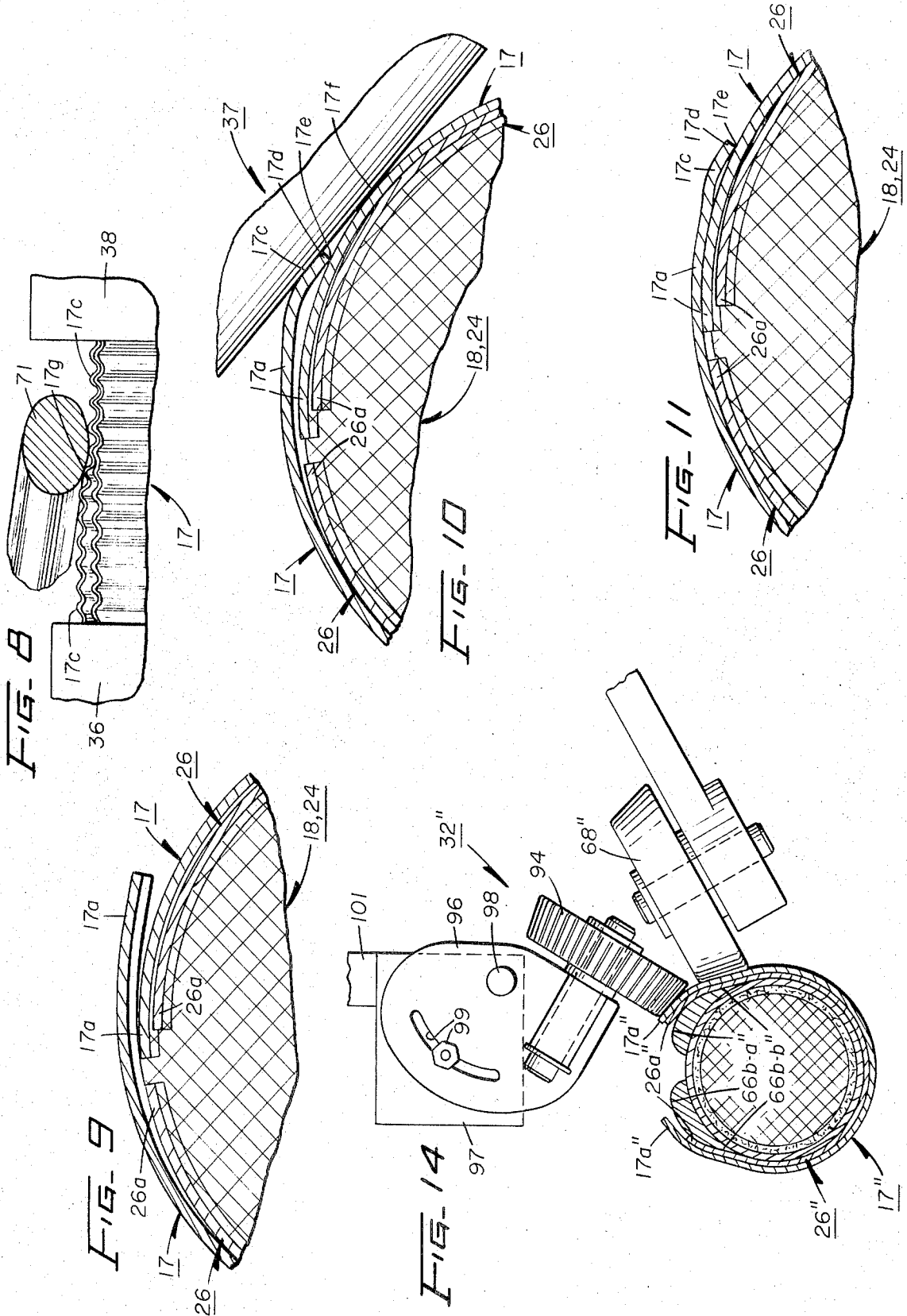
14 Claims, 15 Drawing Figures











METHOD AND APPARATUS FOR FORMING AN UNSOLDERED SHEATH ABOUT A STRAND

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a method and apparatus for forming an unsoldered sheath about a strand, and more particularly to a method and apparatus for forming an unsoldered metal sheath for a cable core assembly of a waterproof communication cable.

2. Description of the Prior Art

In the manufacture of certain communication cables, it has been standard practice to enclose a cable core made up of a plurality of electrical conductor wires, in aluminum and steel sheaths. In this cable construction, the aluminum sheath provides protection against damage by lightning and shielding from electrical disturbances when the cable is installed in the field. The steel sheath provides mechanical and rodent protection for the cable and normally has been soldered or otherwise mechanically joined by a seam to provide a hermetic seal and to prevent deleterious moisture penetration into the cable, in addition to holding the sheaths in position about the cable core.

The step of soldering, bonding or otherwise mechanically joining the steel sheath is usually one of the most expensive steps in the entire cable manufacturing operation. For example, where the seam of the steel sheath is to be soldered, it is normally necessary to provide one or more layers or coatings of conductive metal on the surface of the steel sheath to permit reasonable soldering rates, thus adding considerably to the cost of forming the sheath. Further, because of limitations on soldering rates, even when the conductive coatings are utilized, the cable manufacturing process normally cannot be carried out as a continuous in-line operation and the forming of the cable core, the soldering of the steel sheath and the application of a final outer plastic jacket must be accomplished in separate steps. Additional expense is involved in the necessity of providing a heat barrier in the cable to protect the cable core during the soldering operation and in the cost of solder wire to form the soldered seam.

In the manufacture of a recently developed waterproof communication cable, however, of the type disclosed in the U.S. Pat. No. 3,607,487, issued on Sept. 21, 1971, to M. C. Biskeborne et al., the cable core is surrounded by water-proofing compound whereby it is no longer necessary for the seam of the steel sheath to form a hermetic seal. Accordingly, it has been proposed that the soldering of the seam on the steel sheath be eliminated and that overlapping portions of the steel sheath be formed to produce a tight seam by a system of stretch forming and cold-working of the sheath.

In manufacturing this cable with an unsoldered steel sheath, however, it has been found that the overlapping edge portions of the steel sheath tend to rebound and to project outward relative to the periphery of the sheath, rather than lying in proper mating engagement with one another. Thus, the edge portions of the sheath tend to create a finished cable which has a distorted periphery and which is not substantially circular in configuration, and in which the outer edge of the sheath may actually penetrate and protrude through the final outer plastic jacket, particularly as the cable is being wound upon a reel. This condition occurs even when the outer edge of the sheath has been curled inward, as has been

suggested in the art, and is aggravated when the overlapped edge portions of the steel sheath have not meshed properly, such as on startup of a cable line, before operating conditions have stabilized.

Another problem which has been encountered in forming the steel sheath about the cable core involves the tendency for the inner edge of the sheath to bite into the inner surface of the sheath and become "hung up" thereby, which condition is undesirable because it also contributes to peripheral distortion of the finished cable. More important, however, is the fact that proper closing of the seam of the steel sheath cannot be obtained and in some instances the cable may not even be able to pass through subsequent operations properly, such as the extrusion of the final plastic jacket thereon, without producing detrimental defects in the cable.

SUMMARY OF THE INVENTION

In accordance with certain aspects of this invention, an intermediate portion of a sheathing tape is folded into a curved configuration about a strand. At least one of the edge portions of the sheathing tape then is overformed into a curved configuration having a relatively sharp radius of curvature as compared to the radius of curvature of the folded intermediate portion of the tape. Next, the overformed edge portion is reverse-formed to a curved configuration having a radius of curvature substantially equal to the radius of curvature of the folded intermediate portion of the tape, and is lapped over the other edge portion of the tape. Inward radial pressure then is applied to an edge section of the outer reverse-formed edge portion to cold-work the edge section and to form it into tight-fitting engagement with the adjacent outer surface portions of the tape and so that it achieves a permanent set to produce a tight seam.

In a specific embodiment of the invention, an unsoldered sheath for a strand includes first and second corrugated sheathing tapes in meshed engagement with each other. In this regard, a first compound, which is immiscible with respect to a second compound subsequently to be applied to the sheath, is initially coated on one side of the first sheathing tape while flow of the compound onto the opposite side of the tape is precluded by air streams, after which the coated side of the first tape is brought into mating engagement with one side of the second sheathing tape. Then, as the strand is advanced longitudinally through an elongated tube, the tapes are advanced with the strand and folded about the periphery of the tube adjacent its exit end so as to envelop the strand as the strand exits from the tube.

More specifically, intermediate portions of the tapes are folded about a peripheral portion of the elongated tube, and edge portions of the tapes are formed about first and second anvils adjacent the exit end of the tube, so that the edge portions are overformed into a curved configuration having a relatively sharp radius of curvature as compared to the radius of curvature of the intermediate portions of the tapes. The overformed edge portions of the tapes then are reverse-formed to a curved configuration having a radius of curvature substantially equal to the intermediate portions of the tapes, and one of the edge portions of the outer tape is lapped over the other edge portion of the outer tape, whereby the tapes enclose the strand in sheathed relationship.

The sheathed strand then passes adjacent a forming member extending tangentially and obliquely of the tapes so as to exert inward radial pressure on an outer edge section of the outermost tape, to cold-work the edge section and to form it inward so that it achieves a permanent set. At the same time, the forming member applies inward radial pressure on an adjacent peripheral portion of the outermost tape so that the outward pressure which the inner edge portion of the tape exerts on its outer edge portion is reduced temporarily. Subsequently, the inner edge portion is permitted to return into opposed pressure relationship with the outer edge section to form a tight seam. Finally, the second compound is applied over the outermost sheathing tape, with an overlay tape being applied over the seam of the tape between first and second layers of the compound, if so desired.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an elevational view of a portion of a cable line in accordance with the invention;

FIG. 2 is an elevational view of a tape coating apparatus which forms a part of the cable line shown in FIG. 1, as viewed along the line 2—2 in that figure;

FIG. 3 is a cross-sectional view of a tape forming apparatus which forms a part of the cable line shown in FIG. 1, taken along the line 3—3 in that figure;

FIG. 4 is a cross-sectional view of the tape forming apparatus taken along the line 4—4 in FIG. 1;

FIG. 5 is a cross-sectional view of the tape forming apparatus taken along the line 5—5 in FIG. 1;

FIG. 6 is an elevational view of a device for forming a seam of a metal sheath, as viewed along the line 6—6 in FIG. 1;

FIG. 7 is a partial plan view of the seam forming device shown in FIG. 6;

FIG. 8 is a schematic view as seen along the line 8—8 in FIG. 7, illustrating the mode of operation of the seam forming device;

FIG. 9 is an enlarged cross-sectional view of a portion of a cable prior to its reaching the seam forming device shown in FIG. 6, and taken along the line 9—9 in FIG. 1;

FIG. 10 is an enlarged cross-sectional view of the portion of the cable shown in FIG. 9, as it passes the seam forming device shown in FIG. 6, and further illustrating the mode of operation of the device;

FIG. 11 is an enlarged, cross-sectional view of the portion of the cable shown in FIGS. 9 and 10 after it has passed the seam forming device shown in FIG. 6, and taken along the line 11—11 in FIG. 1;

FIG. 12 is a cross-sectional view of a sheath coating apparatus which forms a part of the cable line shown in FIG. 1, as viewed along the line 12—12 in FIG. 1;

FIG. 13 is a partial cross-sectional view similar to FIG. 4, illustrating an alternate embodiment of the invention;

FIG. 14 is a partial cross-sectional view similar to FIG. 5, illustrating another alternate embodiment of the invention; and

FIG. 15 is an isometric view of a portion of a waterproof communication cable which may be manufactured by the method and apparatus of the invention.

DETAILED DESCRIPTION

Referring to FIG. 15, it is seen that the illustrated embodiment of the invention relates to the manufacture of

a waterproof-type communication cable 16 having an unsoldered, corrugated steel sheath 17S. The communication cable 16 includes a cable core assembly 18 comprising a cable core 19 in the form of a plurality of insulated electrical conductors having the air voids therebetween filled with a waterproofing jelly-like compound 21, such as a mixture of 85 percent petroleum jelly and 15 percent polyethelene. The filled cable core 19 is wrapped in an elongated tape or core wrap 22 which has overlapped edge portions and which is held in place by a helical binder ribber 23. The thus formed cable core assembly 18 is coated with a layer 24 of the waterproofing jelly-like compound and is enclosed in a metal sheath composed of an inner corrugated aluminum sheath 26S having spaced edge portions 26S-a, and the outer steel sheath 17S having overlapped edge portions 17S-a which form a longitudinally extending, continuous unsoldered seam. A thin layer 27 of a corrosion inhibiting material of a non-adhesive nature, such as the above-mentioned waterproofing compound 21, is provided between the steel and aluminum sheaths 17S and 26S. The steel sheath 17S is enclosed in an outer extruded plastic jacket 28, which is bonded to the sheath by an adhesive and corrosion inhibiting coating 29 of thermoplastic material. An overlay tape 31 also may be embedded in the thermoplastic coating 29 over the seam formed by the overlapped edge portions 17S-a of the steel sheath 17S, if so desired.

General Operation

Referring to FIG. 1, in accordance with this invention the cable core assembly 18 and corrugated steel and aluminum tapes 17 and 26 for forming the sheaths 17S and 26S, respectively, are advanced from left to right, as viewed in this figure, through a tape forming apparatus 32, by a suitable advancing mechanism, such as a tractor-type capstan (not shown). Prior to the tape forming apparatus 32, a tape coating apparatus 33 applies the corrosion inhibiting layer 27 to one side of the corrugated steel tape 17. Subsequently, the corrugations on the coated side of the steel tape 17 are brought into matching and meshing engagement with the corrugations on one side of the corrugated aluminum tape 26, at a point beneath an elongated forming tube 34 of the tape forming apparatus 32. When meshed, the tapes 17 and 26 are aligned as shown in FIG. 3, with the left-hand edge of the aluminum tape 26 spaced from the adjacent edge of the steel tape 17 to permit subsequent overlapping of edge portions 17a of the steel tape, to form the overlapped edge portions 17S-a (FIG. 15) of the steel sheath 17S. As the cable core assembly 18 then passes through the forming tube 34 of the tape forming apparatus 32, waterproofing compound is introduced into the tube under relatively high pressure through a pipe 34a to coat the cable core assembly with the waterproof layer 24 (FIG. 15), in a manner disclosed in the copending application of L. D. Moody, Ser. No. 69,837, filed Sept. 4, 1970, and assigned to the same assignee. At the same time the meshed tapes 17 and 26 pass outside of the forming tube 34 and are formed about the tube so as to substantially envelop the coated cable core assembly 18 as it exits therefrom.

The forming of the meshed tapes 17 and 26 includes overforming the edge portions 17a and 26a of the tapes relative to intermediate portions 17b and 26b of the tapes, as shown in FIG. 5, in the tape forming apparatus 32, and then reverse-forming and overlapping the edge

portions of the steel tape, as shown in FIG. 9, in a lapping die 36 of the tape forming apparatus. Next, as is shown in FIGS. 6, 7, 8 and 10, inward radial pressure is applied to the steel tape 17 as it passes a seam forming device 37, to cold-work an outer edge section 17c (FIG. 10) of the steel tape 17 and to form corrugated edge portions 17d of this tape into tight-fitting engagement in adjacent corrugated portions 17e of the tape. After passage through the seam forming device 37, and a final sizing die 38, the edge portions 17a and 26a of the tapes 17 and 26, as a result of their inherent resiliency, assume final relative positions as shown in FIG. 11, to form the steel and aluminum sheaths 17S and 26S.

Subsequently, the sheathed cable core assembly 18 passes through a sheath coating apparatus 39 for applying the coating 29 of adhesive and corrosion inhibiting thermoplastic compound over the steel sheath 17S, and for applying the overlay tape 31 over the seam of the steel sheath. Finally, the sheath 17S is enclosed in the outer extruded plastic jacket 28 by passage through suitable extruding apparatus (not shown), with the plastic jacket becoming bonded to the sheath by the thermoplastic compound 29.

Tape Coating Apparatus

In the illustrated embodiment of the invention, the non-adhesive corrosion inhibiting layer 27 between the steel and aluminum tapes 17 and 26 and the adhesive thermoplastic coating 29 on the steel tape 17 are immiscible in nature. Accordingly, the construction of the tape coating apparatus 33 is such that the layer 27 of the non-adhesive corrosion inhibitor is applied to only the inner side of the steel tape 17, because any of this material on the outside of the tape may preclude the adhesive thermoplastic coating 29 from adhering thereto, and thus the plastic jacket 28 will not become properly bonded to the steel sheath 17S.

Referring to FIGS. 1 and 2, in the tape coating apparatus 33 the steel tape 17 is advanced from a corrugating device (not shown) and about a suitably mounted dancer roller 41 to an applicator roller 42 having corrugations 42a (FIG. 2) in meshed engagement with the corrugations in one side of the tape. As the applicator roller 42 is rotated by the advancing steel tape 17, the lower portion of the roller passes through a bath in a suitable constant level flooding reservoir 43 to be come coated with the non-adhesive corrosion inhibitor, and subsequently applies the coating 27 of the corrosion inhibitor to the steel tape upon coming into engagement therewith. The coating 27 should be such as to fill any voids between the steel tape 17 and the aluminum tape 26 when they are subsequently meshed together, without any substantial amount of material being squeezed out from between the tapes onto the opposite side of the steel tape. In this regard, the corrugated applicator roller 42 also includes a plurality of axially-spaced, circumferentially extending grooves 42b which facilitate the even application of the coating 27 to the corrugations of the steel tape 17, with the amount of the coating applied to the tape being generally proportional to the size and the number of the grooves in the roller.

During the application of the corrosion inhibiting coating 27 to the one side of the corrugated steel tape 17 by the applicator roller 42, the flow of the corrosion inhibitor onto the opposite side of the tape is precluded by first and second banks of air jets 44 mounted above the flooding reservoir 43. Each bank of air jets 44 is ar-

ranged to direct an air stream adjacent a respective edge of the steel tape 17 and parallel to its corrugations to preclude the corrosion inhibitor 27 from flowing onto the opposite side of the tape. After the one side of the steel tape 17 has been coated with the corrosion inhibitor 27, the uncoated side of the tape passes about successive idler rollers 46. The steel tape 17 then travels adjacent and substantially parallel to the aluminum tape 26, which is being advanced over idler rollers 47 on the frame of the tape coating apparatus 33, and the corrugations in the coated side of the steel tape subsequently are meshed with the corrugations in one side of the aluminum tape in the tape forming apparatus 32.

Tape Forming Apparatus

In general, the tape forming apparatus 32, with the exception of various modifications as will subsequently be described, may be of any suitable type and in the illustrated embodiment of the invention includes a plurality of forming stations 48, one of which is shown in detail in FIG. 3, and a pair of horizontally spaced continuous forming belts 49 which pass through each forming station and about suitable sheaves 51 at entrance and exit ends of the apparatus. As the meshed steel and aluminum tapes 17 and 26 pass through the tape forming apparatus 32, the tapes are formed by the belts 49, as illustrated in FIGS. 3 and 4.

In this regard, as is best shown in FIG. 3, at each forming station 48 the forming tube 34 extends through an upstanding vertical frame plate 52 and each forming belt 49 rides over a sheave 53 rotatably mounted adjacent one end of an elongated rod assembly 54 which extends radially with respect to the forming tube and which is adjustable longitudinally. Each rod assembly 54 also is adjustably mounted between suitable guide-ways (not shown) fixed to the frame plate 52 and includes a stud 56 which projects laterally therefrom into a camming slot in a rotatable, ring-shaped cam plate 57. In addition, a tape support roller 58 and a forming tube hold down roller 59 are mounted on respective rod assemblies 54, and suitable forming belt return sheaves (not shown) are mounted on the frame plate 52. As is well known to those skilled in the art, at successive ones of the forming stations 48, the positions of the belt support sheaves 53 progressively change in upward and inward directions with respect to the forming tube 34, to accomplish forming of the meshed steel and aluminum tapes 17 and 26. Further, adjacent the left-hand or entrance end of the tape forming apparatus 32, as viewed in FIG. 1, the forming tube 34 is resiliently mounted on a frame member of the tape forming apparatus by means of a vertically adjustable, flexible hanger assembly 62, while at the forming stations 48 adjacent the righthand or exit end of the forming apparatus, the forming tube is supported by the meshed steel and aluminum tapes 17 and 26 as shown in FIGS. 3 and 4.

The rotatable, ring-shaped cam plate 57 at each of the forming stations 48 encircles the forming tube 34, the forming belts 49, and the steel and aluminum tapes 17 and 26, as is best shown in FIG. 3, and is supported for rotation on a plurality of rollers mounted on the station's vertical frame plate 52 in spaced relationship with respect to the frame plate. The cam plate 57 has an arcuate gear rack secured thereto and engaged with a gear 63 on a horizontally disposed and longitudinally extending shaft 64, which is journaled for rotation in the vertical frame plates 52. The shaft 64 is rotatable

by an adjusting crank (not shown) which has a worm screw meshed with the gear 63 at one of the forming stations so that the cam plates 57 at the forming stations can be rotated in unison to move the belt support sheaves 53 and the rollers 58 and 59 radially outwardly and inward for positioning of the steel and aluminum tapes 17 and 26 in the apparatus at the beginning of a cable run.

As is best shown in FIGS. 4 and 5, the above-described tape forming apparatus 32 is modified in accordance with this invention, to accomplish the overforming of the edge portions 17a and 26a of the steel and aluminum tapes 17 and 26, by supporting a one-piece anvil member 66 above the forming tube 34 adjacent its exit end. The anvil member 66 is in the form of a two tine fork member having a base portion 66a and spaced anvil portions 66b extending forwardly (and rearwardly if so desired) along upper opposite sides of the forming tube 34, and having a concave bottom surface such that it can straddle the upper portion of the forming tube in mating engagement therewith. The base portion 66a of the anvil member 66 includes an upstanding projection by means of which the anvil member is secured to and suspended from a bracket 67 mounted on the frame of the tape forming apparatus 32 in a suitable manner, not shown. A different one of the anvil members 66 is required for different diameters of the forming tube 34, depending on the diameter of the cable core assembly 18 being processed, the diameter of the forming tube generally being chosen so that its internal dimension is only slightly greater than the external diameter of the cable core assembly.

Each anvil portion 66b of the anvil member 66, as viewed in cross-section, includes an arcuate surface 66b-a having a relatively sharp outwardly convex radius as compared to the external radius of the forming tube 34, for overforming the associated edge portions 17a and 26a of the meshed tapes 17 and 26 relative to their intermediate portions 17b and 26b. Each anvil portion 66b also includes a linear surface portion 66b-b which merges into its arcuate surface portion 66b-a and which extends tangentially to the forming tube 34, for forming a straight transition section in the tapes 17 and 26 between the overformed edge portions 17a and 26a and the intermediate portions 17b and 26b.

The exact configuration of each anvil portion 66b varies, depending upon the external radius of the forming tube 34 and the width of the steel tape 17 being applied to the cable core assembly 18. By way of illustration, the radius of each arcuate surface 66b-a may be one-quarter of an inch for a forming tube external radius on the order of seven-sixteenths of an inch and a tape width of 2½ inches, three-eighths of an inch for a forming tube external radius of one-half inch and a steel tape width of 2¾ inches, one-half inch for a forming tube external radius of three-quarters of an inch and a steel tape width of 4½ inches, and five-eighths of an inch for a forming tube external radius of one inch and a steel tape width of 6 inches. Similarly, for a forming tube external radius of thirteen-sixteenths of an inch and a steel tape width on the order of 4½ inches or above, each linear surface 66b-b preferably is inclined to the vertical at an angle on the order of 15°, as shown in FIG. 4. However, for smaller forming tubes 34 and narrower steel tapes 17, each linear surface preferably extends vertically, as shown in the alternate embodiment of FIG. 13.

Referring to FIG. 1, shortly after the steel and aluminum tapes 17 and 26 have entered the tape forming apparatus 32, they are meshed together by the forming belts 49 engaging the tapes between the belts and the elongated forming tube 34. As the meshed steel and aluminum tapes 17 and 26 then advance through the tape forming apparatus 32, the forming belts 49 initially fold the tapes about the bottom and lower side portions of the forming tube 34 in a conventional manner, as shown in FIG. 3. Subsequently, the forming belts 49 begin to fold the tapes 17 and 26 against the linear surfaces 66b-b of the anvil portions 66b, as shown in FIG. 4. The forming belts 49 then diverge outwardly and upwardly from the sheaves 53 at the final belt forming station 48, to the sheaves 51 (FIG. 1) at the exit end of the tape forming apparatus 32.

Subsequently, referring to FIG. 5, adjacent the exit end of the forming tube 34 the edge portions 17a and 26a of the tapes 17 and 26 are overformed about the curved surfaces 66b-a of the anvil portions 66b, by rollers 68 having peripheral surfaces of the same configuration as the curved surfaces. Each overforming roller 68 is journaled adjacent the lower end of an arm member 69 which is adjustably mounted on the frame of the tape forming apparatus 32 for sliding movement toward and away from its respective anvil portion 66b in a manner not shown, to permit threading of the steel and aluminum tapes 17 and 26 between the roller and the anvil portion, and for varying the pressure exerted on the edge portions 17a and 26a of the tapes by the roller.

After the edge portions 17a and 26a of the meshed steel and aluminum tapes 17 and 26 have been overformed by the rollers 68, the cable core assembly 18 and the tapes pass through the lapping die 36 (FIG. 1), which is fixedly mounted on the frame of the tape forming apparatus 32 at its exit end. The lapping die 36 may be of any suitable type capable of reverse-forming the overformed edge portions 17a and 26a of the tapes 17 and 26 to a radius substantially equal to the external radius of the forming tube 34 and thus the radius of the intermediate portions 17b and 26b of the tapes, prior to lapping one of the edge portions 17a of the steel tape 17 over the other edge portion of the tape, as shown in FIG. 9. For example, the lapping die 36 may include first and second guide slots for receiving respective ones of the overformed edge portions 17a and 26a, the configuration of the slots being such that as the edge portions pass therethrough they are first reverse-formed, after which the edge portions 17a of the steel tape 17 are overlapped in a conventional manner.

The overforming and reverse-forming of the edge portions 17a and 26a of the tapes 17 and 26, as above described, tends to reduce their resiliency and thus reduces the tendency for the edge portions to rebound and project outwardly after the tapes have been formed about the cable core assembly 18. As a result, the edge portions 17a and 26a also tend to retain a more arcuate configuration, whereby the tendency for the inner edge of the steel tape 17 to bite into the inner periphery of the tape and become "hung up" thereby during subsequent passage through the final sizing die 38, is substantially reduced. Generally, however, to attain a proper tight-fitting seam in the steel tape 17 it also is necessary to subject the outer edge section 17c of the tape to a cold-working operation in the seam forming device 37, next to be described.

Seam Forming Device

Referring to FIGS. 6 and 7, the seam forming device 37 for cold-working the outer edge section 17c of the steel tape 17 includes an elongated circular bar 71 which can be positioned to extend tangentially and obliquely of the tape, and in engagement with the outer edge section and an adjacent peripheral portion 17f of the tape, so as to exert inward radial pressure on the tape at these two points simultaneously. Preferably, the forming bar 71 is positioned at an angle (such as 20°) to the direction of travel of the tape 17, as illustrated in FIG. 7, to help preclude excessive stretching of the corrugations of the tape adjacent its outer edge.

Referring to FIG. 10, the forming bar 71 is positioned against the steel tape's outer edge portion 17c, which preferably has a width on the order of one-eighth to three-sixteenths of an inch, so that as the steel tape 17 is advanced the forming bar continuously deforms the outer edge section radially inward. Subsequently, after the outer edge section 17c has passed beyond the forming bar 71, it will retain a certain degree of permanent set or deformation as shown in FIG. 11. Preferably, the pressure exerted on the outer edge section 17c by the forming bar 71 is such that a slight "back wave" 17g in the edge section is produced behind the forming bar during the cold-working process, as is illustrated schematically in FIG. 8.

For best results, the forming bar 71 also is positioned so that it applies inward radial pressure on the peripheral pressure point 17f of the steel tape 17, as illustrated in FIG. 10. The superior results attained are attributed to the force which is exerted on the peripheral pressure point 17f by the forming bar 71, causing an inward bowing or deflection of the steel tape inner edge portion 17a and its underlying aluminum tape edge portion 26a, as shown in FIG. 10. This relieves the outward pressure which the inner edge portion 17a of the steel tape 17 would normally exert on its outer edge portion 17a, to permit the deforming of the tape's outer edge section 17c to be more readily accomplished. The inward deflection of the inner edge portion 16a also moves the inner edge of the steel tape 17 into spaced relationship with the inner periphery of the tape, or at least out of tight pressure engagement therewith, to reduce the possibility of the inner edge biting into the inner periphery of the tape and becoming "hung up" thereby, so as to prevent proper closing of the tape's seam as the tape subsequently passes through the closely adjacent final sizing die 38. The tendency of the inner edge of the steel tape 17 to become "hung up" inside the tape also can be reduced by forming a slight inward curl (not shown) in the edge, such as in the lapping die 36, if so desired.

After the meshed steel and aluminum tapes 17 and 26 have passed the forming bar 71 and through the final sizing die 38, the inner and outer edge portions 17a of the steel tape 17 assume relative positions as shown in FIG. 11. More specifically, the inner edge portion 17a of the steel tape 17 and the underlying edge portion 26a of the aluminum tape 26, as a result of their inherent resiliency, tend to return toward their initial positions as shown in FIG. 9. The outer edge section 17c of the steel tape 17, however, having achieved a certain degree of permanent set as a result of its having been cold-worked and deformed by the forming bar 71, tends to remain in deformed condition. As a result, the outer edge section 17c of the steel tape 17 opposes

this outward movement of the tape edge portions 17a and 26a, with the corrugated edge portions 17d of the steel tape bearing against the adjacent corrugated peripheral portions 17e of the tape to form a tight seam.

The forming bar 71, which is made of a long wearing material, such as tool hardened steel, is adjustably mounted for universal movement by a mechanism 72 which includes a T-shaped connector member 73, a circular rod 74, a circular shaft 76, a bracket 77, and a plurality of set screws 78. The bracket 77 is fixed, as by welding, to a circular support plate 79 for the final sizing die 38. Further, the pressure which the forming bar 71 exerts on the steel tape 17 is adjustable by means of an elongated circular rod 81 having its lower end engaged with the forming bar, and having an upper portion thereof adjustably secured in an apertured circular shaft 82 by a set screw 83. The shaft 82 is adjustably mounted in a second bracket 84 by a set screw 86, this bracket also being fixed to the circular support plate 79 for the final sizing die 38. Thus, the forming bar 72 is readily movable into any desired position relative to the outer edge section 17c of the steel tape 17, and is readily movable to an inoperative position (not shown).

Final Sizing Die

The final sizing die 38, through which the cable core assembly 18 and the tapes 17 and 26 pass from the forming bar 71, may be of any suitable type and therefore is illustrated only schematically, in FIGS. 6 and 7. For example, the die 38 may include a plurality of circumferentially spaced die segments 87 which are radially adjustable on the support plate 79 thereof in a suitable manner, not shown, which die construction is well known to those skilled in the art.

Sheath Coating Apparatus

Referring to FIGS. 1 and 12, the apparatus 39 for applying the coating 29 of the adhesive, corrosion inhibiting thermoplastic compound to the steel sheath 17S includes an elongated trough 88 through which the sheathed cable core assembly 18 is advanced, the trough having U-shaped entrance and exit openings of such dimensions as to preclude the sheath-ed cable core assembly from engaging the sides of the openings. As the sheathed cable core assembly 18 passes through the trough 88, the thermoplastic compound is continuously pumped from a suitably heated supply reservoir 89 therebeneath, to a pair of spaced discharge heads 91 located above the trough adjacent its entrance and exit ends and from which the compound is discharged over the steel sheath 17S. At the same time, compound in the trough 88 continuously flows out of its entrance and exit openings and back into the reservoir 89, with the amount of compound pumped from the reservoir to the discharge heads 91 being sufficient to maintain the steel sheath 17S substantially immersed in the compound as it passes through the trough.

In certain instances, such as during startup and before operating conditions have stabilized, and particularly on larger size cables 16, the corrugations in the overlapped edge portions 17S-a of the steel sheath 17S may not always mesh properly. Accordingly, it may be desirable to apply the overlap tape 31 over the seam of the steel sheath 17S, so as to press the thermoplastic compound into any voids in the seam and to reduce the possibility of the outer edge portions 17S-a distorting or protruding through the final outer plastic jacket 28. For this purpose, the flooding apparatus 39 includes a saddle-shaped squeegee 92 mounted between the sides

of the flooding trough 88 so the squeegee rides on the top of the steel sheath 17S, as shown in FIG. 12. Thus, as the steel sheath 17S passes between the entrance end of the flooding trough 88 and the squeegee 92, a first coating or layer 29a of thermoplastic compound is applied over the seam of the sheath by the first discharge head 91. The squeegee 92 then presses the overlay tape 31, which is pulled from a supply reel 93 and between the discharge heads 91 by the advancing sheathed cable core assembly 18, into the first layer 29a to force the thermoplastic compound into the seam of the steel sheath 17S. Subsequently, as the steel sheath 17S passes from the squeegee 92 to the exit end of the flooding trough 88, a second layer 29b of the thermoplastic compound is applied over the overlay tape 31 and the first layer 29a of the compound by the second discharge head 91. When the overlap tape 31 is no longer required, its use readily can be discontinued merely by severing it between the squeegee 92 and the supply reel 93.

Alternate Embodiments

As noted hereinabove in the discussion of FIG. 4, the alternate embodiment of the invention shown in FIG. 13 is particularly useful with a forming tube 34' having an external diameter less than thirteen-sixteenths of an inch and a steel tape 17' having a width less than 4½ inches. This embodiment of the invention is identical in configuration and function to that as shown in FIG. 4 except that an anvil portion 66b' of an anvil member 66' is provided with a linear surface 66b-b' which extends vertically, rather than at an angle to the vertical, as does the linear anvil surface 66b-b in FIG. 4.

FIG. 14 which is similar to FIG. 5, discloses an alternate embodiment of the invention in which a forming roller 68'' on each side of the apparatus has a conically tapered surface for forming steel and aluminum tapes 17'' and 26'' against a linear anvil surface 66b-b'', and in which edge portions 17a'' and 26a'' of the tapes are formed over a curved anvil surface 66b-a'' by a forming roller 94 having a conically tapered, serrated periphery. The forming roller 94 is journaled on a plate member 96 which is pivotally supported on a mounting plate 97 for movement about a pivot pin 98, and which is adjustable about the pivot pin by means of a pin and slot connection 99. The mounting plate 97 is fixed to the lower end of a vertical rod 101 which is adjustably mounted on the frame of a tape forming apparatus 32'' for vertical movement in a suitable manner.

While the disclosed embodiment of the invention, in which both the inner and outer edge portions 17a and 26a of the steel and aluminum tapes 17 and 26 are overformed and then reverse-formed, is preferred, in certain instances it may be possible to eliminate the overforming and reverse-forming of the edge portions and rely solely on the deformation of the edge section 17c of the steel tape 17 by the forming bar 71, to provide a tight seam on the steel sheath 17S. In other instances, it may be possible to overform and reverse-form only the outer edge portion 17a of the steel tape 17, and the adjacent edge portion 26a of the aluminum tape 26. If the edge portions 17a and 26a of the tapes 17 and 26 are not overformed and reverse-formed, however, they have a greater tendency to expand radially outward so as to cause the seam of the steel sheath 17S to open up before or after the sheath has been enclosed in the final outer plastic jacket 28. Further, during the travel of the tapes 17 and 26 along the forming

tube 34, if an anvil portion 66b for overforming the tape inner edge portions 17a and 26a is not utilized, it still is necessary to equalize drag on the tapes at each side of the forming tube in some manner, so that the tapes will not twist circumferentially about the forming tube and out of the tape forming apparatus 32.

Summary

During a cable run, the cable core assembly 18 and the corrugated steel and aluminum tapes 17 and 26 for forming the sheaths 17S and 26S, respectively, are advanced from left to right in FIG. 1 in a suitable manner, not shown, through the tape forming apparatus 32, the seam forming device 37, the final sizing die 38 and the sheath coating apparatus 39, in succession. Subsequently, the final outer plastic jacket 28 (FIG. 15) is applied about the coated steel sheath 17S by suitable extrusion apparatus, also not shown.

Prior to the steel and aluminum tapes 17 and 26 reaching the tape forming apparatus 32, however, the tape coating apparatus 33 (FIGS. 1 and 2) applies the non-adhesive corrosion inhibiting coating 27 (FIG. 15) to the inner side of the corrugated steel tape 17. More specifically, in the tape coating apparatus 33 the steel tape 17 is advanced about the dancer roller 41 and the corrugated applicator roller 42 which has its corrugations 42a in meshed engagement with the corrugations in the inner side of the tape. As the applicator roller 42 is rotated by the advancing steel tape 17, the lower portion of the roller passes through the constant level flooding reservoir 43 to become coated with the non-adhesive corrosion inhibitor, and subsequently applies the coating 27 of the corrosion inhibitor to the steel tape upon coming into engagement therewith. Uniform application of the coating 27 of corrosion inhibitor to the corrugations of the steel tape 17 is facilitated by the axially spaced, circumferentially extending grooves 42b in the corrugated applicator roller 42, with the amount of the inhibitor applied to the tape being generally proportional to the size and the number of the grooves in the roller.

During the application of the coating 27 of the non-adhesive corrosion inhibitor to the inner side of the steel tape 17 by the applicator roller 42, flow of the non-adhesive corrosion inhibitor onto the opposite side of the tape, which could preclude the adhesive, corrosion inhibiting thermoplastic compound 29 from subsequently adhering thereto, whereby the plastic jacket 28 may not become properly bonded to the steel sheath 17S, is precluded by the banks of air jets 44. In this regard, each bank of air jets 44 directs an air stream adjacent a respective edge of the steel tape 17 and parallel to its corrugations to preclude the non-adhesive corrosion inhibitor from flowing onto the opposite side of the tape. The uncoated side of the steel tape 17 then passes about the idler rollers 46 and into opposed, substantially parallel relationship with the aluminum tape 26. Subsequently, the coated side of the steel tape 17 is meshed with the opposed side of the aluminum tape in the tape forming apparatus 32 by the tapes becoming engaged between the forming tube 34 and the forming belts 49 thereof.

As the cable core assembly 18 passes through the forming tube 34 of the tape forming apparatus 32, waterproofing compound is introduced into the tube under relatively high pressure through the pipe 34a to coat the cable core assembly with the waterproofing layer 24. At the same time, as the meshed steel and alu-

minum tapes 17 and 26 advance through the tape forming apparatus 32, the forming belts 49 initially fold the tapes about the bottom and lower side portions of the forming tube 34 in a conventional manner, as shown in FIG. 3. Subsequently, the forming belts 49 begin to fold the tapes 17 and 26 against the linear surfaces 66b-b of the anvil portions 66b, as shown in FIG. 4.

Referring to FIG. 5, adjacent the exit end of the forming tube 34 the edge portions 17a and 26a of the tapes 17 and 26 next are overformed about the outwardly convex curved surfaces 66b-a of the anvil portions 66b by the overforming rollers 68. The cable core assembly 18 and the meshed tapes 17 and 26 then pass through the lapping die 36 which reverse-forms the overformed edge portions 17a and 26a of the tapes, and laps one of the edge portions 17a of the steel tape 17 over the other edge portion of the tape, as shown in FIG. 9. This overforming and reverse-forming of the tape edge portions 17a and 26a tends to reduce their resiliency, whereby their tendency to rebound radially outward and to cause subsequent opening of the seam of the steel sheath 17S is reduced. Further, the tape edge portions 17a and 26a tend to retain a more arcuate configuration so as to reduce the tendency for the inner edge of the steel tape 17 to bite into the inner periphery of the tape and to become "hung up" thereby, so as to prevent proper closing of the steel sheath 17S in the final sizing die 38.

The cable core assembly 18, and the steel and aluminum tapes 17 and 26, next pass beneath the forming bar 71 of the seam forming device 37, which has been positioned tangentially and obliquely of the steel tape in engagement with the outer edge section 17c and the pressure point 17f thereof, as shown in FIGS. 6, 7 and 10. As the steel tape 17 advances the forming bar 71 continuously deforms and cold-works the outer edge section 17c radially inward to form a permanent set or deformation therein, with the pressure exerted on the outer edge section being such that the "back wave" 17g in the edge section is produced behind the forming bar during the cold-working process, as illustrated in FIG. 8.

At the same time, the forming bar 71 applies radial inward pressure on the pressure point 17f of the steel tape 17, which pressure tends to cause an inward bowing or deflection of the innermost edge portion 17a of the tape, and of the underlying aluminum tape edge portion 26a, as illustrated in FIG. 10. This inward deflection relieves the outward pressure which the inner edge portion 17a of the steel tape 17 normally would exert on the outer edge portion 17a, to permit the deforming of the edge section 17c to be more readily accomplished. This inward deflection of the inner edge portion 17a also causes the inner edge of the steel tape 17 to move into spaced relationship with the inner periphery of the tape, or at least out of tight pressure engagement therewith, to reduce the possibility of the inner edge biting into the inner periphery of the tape and becoming "hung up" thereby, so as to prevent proper closing of the tape seam in the closely adjacent final sizing die 38.

After the meshed steel and aluminum tapes 17 and 26 have passed under the forming bar 71 and through the final sizing die 38, the inner and outer edge portions 17a of the steel tape 17 will assume relative positions as shown in FIG. 11. More specifically, the innermost edge portion 17a of the steel tape and the underlying

aluminum tape edge portion 26a, as a result of their resiliency, tend to return toward their initial positions as shown in FIG. 9. The outer edge section 17c of the steel tape 17, however, having achieved a certain degree of permanent set as a result of its having been cold-worked and deformed by the forming bar 71, tends to remain in a deformed condition. As a result, the outer edge section 17c of the steel tape 17 opposes this outward movement of the tape edge portions 17a and 26a, whereby the corrugated edge portions 17d of the steel tape bear against the adjacent corrugated peripheral portions 17e of the tape to form a tight seam.

After passing through the final sizing die 38, the cable core assembly 18 and the formed tapes 17 and 26 travel through the sheath coating apparatus 39 for applying the coating 29 of adhesive, corrosion inhibiting thermoplastic compound to the steel tape 17, which now forms the steel sheath 17S. In this regard, as the sheathed cable core assembly 18 passes through the flowing trough 88 of the sheath coating apparatus 39, the thermoplastic compound is continuously pumped from the heated supply reservoir 89 to the discharge heads 91 above the trough, and is discharged over the steel sheath 17S. At the same time, compound in the trough 88 continuously flows out of its entrance and exit openings and back to the reservoir 89, with the amount of compound being pumped from the reservoir and discharged into the trough being sufficient to maintain the steel sheath 17S substantially immersed in the compound as it passes through the trough.

In certain instances, such as during start up and before operating conditions have stabilized, and particularly on the larger size cables 16, since the corrugations in the overlapped edge portions 17S-a of the steel sheath 17S may not always mesh properly, it may be desirable to apply the overlay tape 31 over the seam of the steel sheath. When the sheath coating apparatus 39 is being operated in this manner, as the steel sheath 17S passes between the entrance end of the flooding trough 88 and the squeegee 92, the first layer 29a of the thermoplastic compound is applied over the seam of the sheath by the first discharge head 91. As is best shown in FIG. 12, the squeegee 92 then presses the overlay tape 31, which is being pulled from the supply reel 93 and between the discharge heads 91 by the advancing sheathed cable core assembly 18, into the first layer 29a of the thermoplastic compound to force the compound into the seam of the steel sheath 17S. Subsequently, the second layer 29b of the thermoplastic compound is applied over the overlay tape 31 and the first layer 29a of the compound by the second discharge head 91. When the overlay tape 31 is no longer required, its use readily can be discontinued merely by severing it between the squeegee 92 and the supply reel 93.

The function of the alternate embodiment of the invention shown in FIG. 13 is identical to that of the apparatus as shown in FIG. 4, the only difference being that the linear anvil surfaces 66b-b' in FIG. 13 extend vertically, while the linear anvil surfaces 66b-b in FIG. 4 intersect the vertical at an angle. Similarly, the function of the alternate embodiment of the invention in FIG. 14 is substantially the same as that of the apparatus as shown in FIG. 5, except that the tape edge portions 17a'' and 26a'' are formed over the anvil surfaces 66b-a'' and 66b-b'' by the separate forming rollers

68" and 94, instead of by the unitary overforming rollers 68.

What is claimed is:

1. The method of forming an unsoldered sheath about a strand as the strand and an elongated tape for sheathing the strand are being advanced longitudinally, which comprises:

engaging and overforming at least one edge portion of the sheathing tape into a curved configuration having a relatively sharp outwardly convex radius of curvature as compared to the radius of curvature of a folded intermediate portion of the tape;

then reverse-forming the overformed edge portion of the sheathing tape to a curved configuration having a radius of curvature substantially equal to the radius of curvature of the folded intermediate portion of the tape;

lapping the reverse-formed edge portion of the sheathing tape over a second edge portion of the tape to cause the tape to enclose the strand in sheathed relationship;

then engaging and applying inward radial pressure on an outer edge section of the overlapped reverse-formed edge portion of the sheathing tape to form the edge section inward and to cause the edge section to achieve a permanent inward set;

simultaneously engaging and applying inward radial pressure on a peripheral portion of the sheathing tape adjacent the outer edge section of the overlapped reverse-formed edge portion of the tape at the same time that inward radial pressure is being applied to the outer edge section, to deflect the inner second edge portion of the tape inward and temporarily reduce the outward pressure which the inner second edge portion exerts on the overlapped reverse-formed edge portion during the inward forming of the outer edge section thereof; and

releasing the inward radial pressure on the inwardly formed outer edge section of the overlapped reverse-formed edge portion of the sheathing tape and the adjacent peripheral portion of the tape to permit the inner second edge portion of the tape to move radially outward into opposed pressure engagement with the inwardly formed outer edge section to form a tight seam.

2. The method of forming an unsoldered sheath about a strand as the strand and first and second elongated tapes for sheathing the strand are being advanced longitudinally, in which the space between the tapes is to be filled with a material which is immiscible with respect to a material which is to be coated on the outside of the unsoldered sheath, and which comprises:

coating the first immiscible material on one side of the first longitudinally advancing sheathing tape;

directing air streams adjacent the edges of the first sheathing tape and outwardly of the tape on the opposite side of the tape to preclude flow of the first immiscible material onto the opposite side of the tape;

bringing the coated side of the first sheathing tape into substantially mating engagement with one side of the second longitudinally advancing sheathing tape;

forming portions of the engaged first and second sheathing tapes which are intermediate edge portions of the tapes into a curved configuration about

the strand with the uncoated side of the first tape facing outwardly of the strand;

engaging and overforming first and second edge portions of the first and second sheathing tapes into a curved configuration having a relatively sharp outwardly convex radius of curvature as compared to the radius of curvature of the intermediate portions of the tapes;

reverse-forming the overformed edge portions of the first and second sheathing tapes to a curved configuration having a radius of curvature substantially equal to the radius of curvature of the intermediate portions of the tapes;

lapping the first reverse-formed edge portion of the first sheathing tape over the second reverse-formed edge portion of the first sheathing tape to cause the first sheathing tape to enclose the strand in sheathed relationship;

then engaging and applying inward radial pressure on an uncoated outer edge section of the overlapped first edge portion of the first sheathing tape to form the edge section inward and to cause the edge section to achieve a permanent inward set;

simultaneously engaging and applying inward radial pressure on a peripheral portion of the first sheathing tape adjacent the outer edge section of the overlapped first edge portion of the tape at the same time that inward radial pressure is being applied to the outer edge section, to deflect the inner second edge portion of the tape inward and temporarily reduce the outward pressure which the inner second edge portion exerts on the overlapped first edge portion during the inward forming of the outer edge section thereof;

releasing the inward radial pressure on the inwardly formed outer edge section of the overlapped first edge portion of the first sheathing tape and the adjacent peripheral portion of the tape to permit the inner second edge portion of the tape to move radially outward into opposed pressure engagement with the inwardly formed outer edge section to form a tight seam; and

coating the outer uncoated side of the first sheathing tape with the second immiscible material.

3. The method of forming an unsoldered sheath about a strand as recited in claim 1, in which the opposite sides of the sheathing tape are to be covered with first and second immiscible coatings, and which further comprises:

applying the first immiscible coating to one side of the sheathing tape prior to forming the tape about the strand;

directing air streams adjacent the edges of the sheathing tape and outwardly of the tape on the opposite side of the tape to preclude flow of the first immiscible coating onto the opposite side of the tape; and

applying the second immiscible coating to the opposite side of the tape after the tape has been formed about the strand.

4. The method of forming an unsoldered sheath about a strand as recited in claim 1, which further comprises:

applying a first layer of a sealing material over the seam formed by the inwardly formed outer edge section of the tape;

applying an overlay tape over the first layer of sealing material and the seam so as to force the sealing material into the seam; and

applying a second layer of the sealing material over the first layer of sealing material and the overlay tape.

5. The method of forming a seam in a sheath for a strand wherein the strand has overlapped inner and outer edge portions, as the strand and the sheath are being advanced longitudinally, which comprises:

engaging and applying inward radial pressure on an outer edge section of the overlapped outer edge portion of the sheath to form a permanent inward deformation in the edge section;

simultaneously engaging and applying inward radial pressure on a peripheral portion of the sheath adjacent the outer edge section of the sheath at the same time that inward radial pressure is being applied to the outer edge section, to deflect the inner edge portion of the sheath inward and temporarily reduce the outward pressure which the inner edge portion exerts on the outer edge portion of the sheath during the inward deforming of the outer edge section; and

releasing the inward radial pressure on the overlapped outer edge section of the sheath and the adjacent peripheral portion of the sheath to permit the inner edge portion of the sheath to move radially outward into pressure engagement with the permanently inwardly deformed edge section of the sheath to form a tight seam.

6. The method of forming an unsoldered sheath about a strand, as recited in claim 2, which further comprises:

applying a first layer of the second immiscible material over the seam formed by the inwardly formed outer edge section of the first sheathing tape;

applying an overlay tape over the first layer of the second immiscible material so as to force the material into the seam; and

applying a second layer of the second immiscible material over the first layer of the material and the overlay tape.

7. Apparatus for forming an unsoldered sheath about a strand, in which the strand is advanced longitudinally through an elongated tube and in which an elongated tape for sheathing the strand is advanced longitudinally with the strand and folded about the periphery of the elongated tube adjacent an exit end of the tube so as to envelop the strand as the strand exits from the tube, which comprises;

means for engaging and overforming at least one edge portion of the advancing sheathing tape into a curved configuration having a relatively sharp outwardly convex radius of curvature as compared to the radius of curvature of an intermediate portion of the tape which is being folded about the elongated tube;

means for reverse-forming the overformed edge portion of the sheathing tape to a curved configuration having a radius of curvature substantially equal to the radius of curvature of the intermediate portion of the tape;

means for lapping the reverse-formed edge portion of the sheathing tape over a second edge portion of the tape to cause the tape to enclose the strand in sheathed relationship;

first means for engaging and applying inward radial pressure on an outer edge section of the overlapped reverse-formed edge portion of the sheathing tape to form the edge section inward and to cause the edge section to achieve a permanent inward set; and

second means for engaging and applying inward radial pressure on a peripheral portion of the sheathing tape adjacent the outer edge section of the overlapped reverse-formed edge portion of the sheathing tape at the same time that said first means is forming the outer edge section inward, to deflect the inner second edge portion of the tape inward and temporarily reduce the outward pressure which the inner edge portion of the tape exerts on the overlapped reverse-formed portion of the tape during the inward forming of the outer edge section thereof, with the inner edge portion of the tape subsequently moving radially outward into opposed pressure engagement with the inwardly formed outer edge section to form a tight seam.

8. Apparatus for forming an unsoldered sheath about a strand, in which the strand is advanced longitudinally through an elongated tube and in which an elongated tape for sheathing the strand is advanced longitudinally with the strand and folded about the periphery of the elongated tube adjacent an exit end of the tube so as to envelop the strand as the strand exits from the tube, which comprises:

means for folding a portion of the sheathing tape which is intermediate edge portions of the tape, about a peripheral portion of the elongated tube;

means for overforming at least one of the edge portions of the advancing sheathing tape into a curved configuration having a relatively sharp radius of curvature as compared to the radius of curvature of the intermediate portion of the tape which is being folded about the elongated tube;

means for reverse-forming the overformed edge portion of the sheathing tape to a curved configuration having a radius of curvature substantially equal to the radius of curvature of the intermediate portion of the tape;

means for lapping the reverse-formed edge portion of the sheathing tape over the other second edge portion of the tape to cause the tape to enclose the strand in sheathed relationship; and

an elongated integral bar member extending tangentially of the sheathing tape and having a curved surface portion which engages and applies inward radial pressure on an outer overlapped edge section of the sheathing tape to cold-work the edge section and to form the edge section inward to cause the edge section to achieve a permanent inward set, said bar member also including a curved surface portion which simultaneously engages and applies inward radial pressure on a peripheral portion of the sheathing tape adjacent the outer edge section of the sheathing tape to temporarily reduce the outward pressure which the inner second edge portion of the tape exerts on the outer reverse-formed edge portion of the tape during the forming of the outer edge section inward, with the inner edge portion of the tape subsequently moving radially outward into opposed pressure engagement with the inwardly formed outer edge section of the tape to form a tight seam.

9. Apparatus for forming an unsoldered sheath about a strand, as recited in claim 8, in which the sheathing tape is transversely corrugated and in which:

said bar member also extends obliquely to the direction of travel of the strand and the sheathing tape.

10. Apparatus for forming an unsoldered sheath about a strand, in which the strand is advanced longitudinally through an elongated tube and in which an elongated tape for sheathing the strand is advanced longitudinally with the strand and folded about the periphery of the elongated tube adjacent an exit end of the tube so as to envelop the strand as the strand exits from the tube, which comprises:

anvil means on the periphery of the elongated tube adjacent the exit end of the tube, said anvil means having surface portions engageable by at least one edge portion of the sheathing tape and defined by a relatively sharp outwardly convex radius of curvature as compared to the radius of curvature of the tube;

rotatable means for forming the one edge portion of the advancing sheathing tape about said anvil means so as to overform the edge portion into a curved configuration having a relatively sharp outwardly convex radius of curvature as compared to the radius of curvature of an intermediate portion of the tape which is being folded about the elongated tube;

means for reverse-forming the overformed edge portion of the sheathing tape to a curved configuration having a radius of curvature substantially equal to the radius of curvature of the intermediate portion of the tape; and

means for lapping the reverse-formed edge portion of the sheathing tape over a second edge portion of the tape to cause the tape to enclose the strand in sheathed relationship.

11. Apparatus for forming an unsoldered sheath about a strand, as recited in claim 10, in which:

said anvil means includes separate surface portions each engageable by a respective one of the edge portions of the sheathing tape and each defined by a relatively sharp outwardly convex radius of curvature as compared to the radius of curvature of the tube.

12. A device for forming a seam in a sheath for a strand wherein the sheath has overlapped inner and outer edge portions, as the strand and the sheath are being advanced longitudinally, which comprises:

an elongated integral bar member extending tangentially of the sheath and having a curved surface portion engageable with an outer edge section of the sheath to deform the edge section radially inward and to cold-work the edge section to form a permanent inward deformation in the edge section; said elongated integral bar member also including a curved surface portion for simultaneously engaging and applying inward radial pressure on a peripheral portion of the sheath adjacent the outer edge section of the sheath to temporarily reduce the outward pressure which the inner edge portion of the sheath exerts on the outer edge portion of the sheath during the deforming of the outer edge section inward, the inner edge portion of the sheath subsequently moving radially outward into opposed pressure engagement with the permanently deformed edge section to form a tight seam.

13. A device for forming a seam in a sheath for a strand, as recited in claim 12, in which the sheath is corrugated circumferentially and in which:

said bar member also extends obliquely to the direction of travel of the strand and the sheath.

14. Apparatus for forming an unsoldered sheath about a strand, in which the strand is advanced longitudinally through an elongated tube, in which first and second elongated tapes for sheathing the strand are advanced longitudinally with the strand and folded about the periphery of the elongated tube adjacent an exit end of the tube so as to envelop the strand as the strand exits from the tube, and in which the space between the tapes is to be filled with a material which is immiscible with respect to a material which is to be coated on the outside of the unsoldered sheath, which comprises:

means for applying a coating of the first immiscible material on one side of the first longitudinally advancing sheathing tape;

a system of air jets on the opposite side of the first sheathing tape directed toward the edges of the tape and outwardly of the tape to preclude flow of the first immiscible material onto the opposite side of the first sheathing tape;

means for bringing the coated side of the first sheathing tape into substantially mating engagement with one side of the second longitudinally advancing sheathing tape;

means for folding portions of the engaged first and second sheathing tapes which are intermediate edge portions of the tapes, about a peripheral portion of the elongated tube, with the uncoated side of the first sheathing tape facing outward of the tube;

first and second anvil means on the periphery of the elongated tube adjacent the exit end of the tube, each of said anvil means having a surface portion defined by a relatively sharp outwardly convex radius of curvature as compared to the radius of curvature of the tube;

rotatable means for engaging and forming the edge portions of the advancing first and second sheathing tapes about respective ones of said first and second anvil means so as to overform the edge portions into a curved configuration having a relatively sharp outwardly convex radius of curvature as compared to the radius of curvature of the intermediate portions of the tapes which are being folded about the elongated tube;

means for reverse-forming the overformed edge portions of the first and second sheathing tapes to a curved configuration having a radius of curvature substantially identical to the intermediate portions of the tapes;

means for lapping one of the reverse-formed edge portions of the first sheathing tape over the other reverse-formed edge portion of the first sheathing tape to cause the first sheathing tape to enclose the strand in sheathed relationship;

fixed means for engaging and applying inward radial pressure on an uncoated outer edge section of the overlapped reverse-formed edge portion of the first sheathing tape to cold-work the edge section and to form the edge section inward to cause the edge section to achieve a permanent inward set;

fixed means for engaging and applying inward radial pressure on an uncoated peripheral portion of the

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first sheathing tape adjacent the outer edge section of the overlapped reverse-formed edge portion of the tape at the same time that inward radial pressure is being applied to the outer edge section, to deflect the inner reverse-formed edge portion of the tape inward and temporarily reduce the outward pressure which the inner edge portion exerts on the outer edge portion during the inward form-

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ing of the outer edge section thereof, the inner edge portion subsequently moving radially outward into opposed pressure engagement with the inwardly formed outer edge section to form a tight seam; and means for applying the second immiscible coating to the outside of the first sheathing tape.

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