Aug. 13, 1968 A. A. BIAGINI 3,396,522

STRANDING MACHINE

Filed Jan. 30, 1967 3 Sheets-Sheet 1

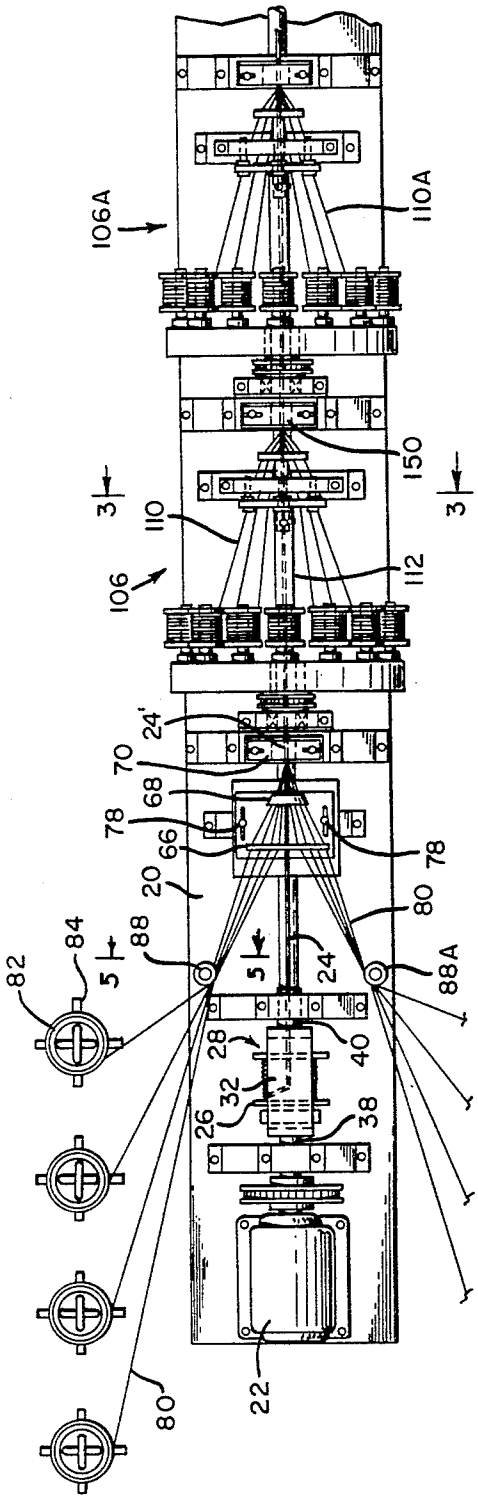


FIG-1-A

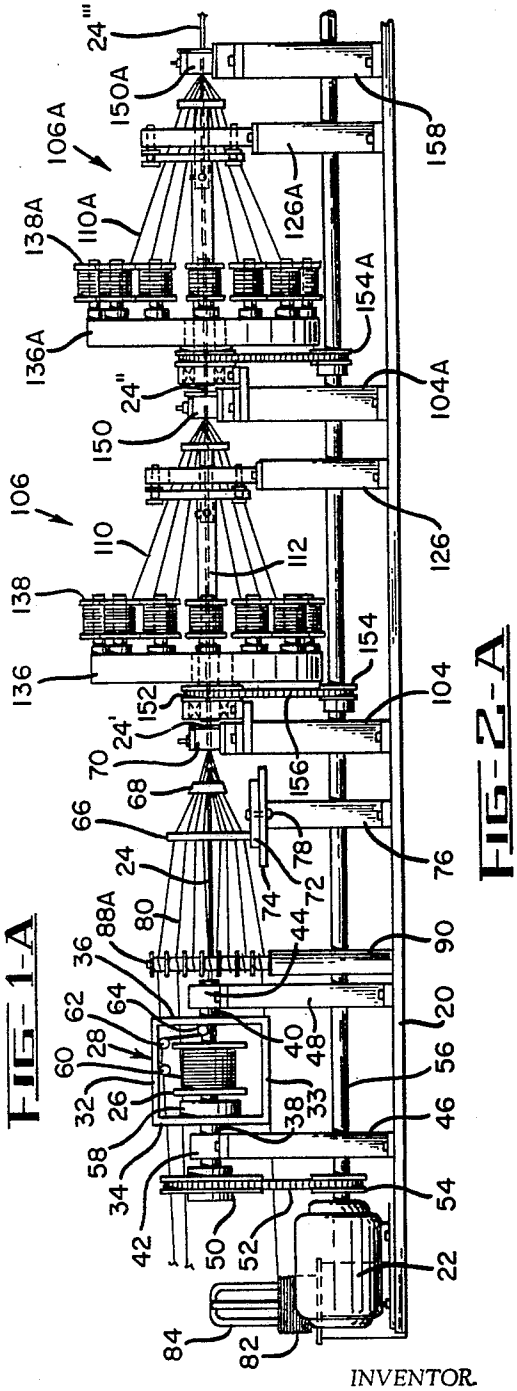


FIG-2-A

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Aug. 13, 1968 A. A. BIAGINI 3,396,522

STRANDING MACHINE

Filed Jan. 30, 1967 3 Sheets-Sheet 2

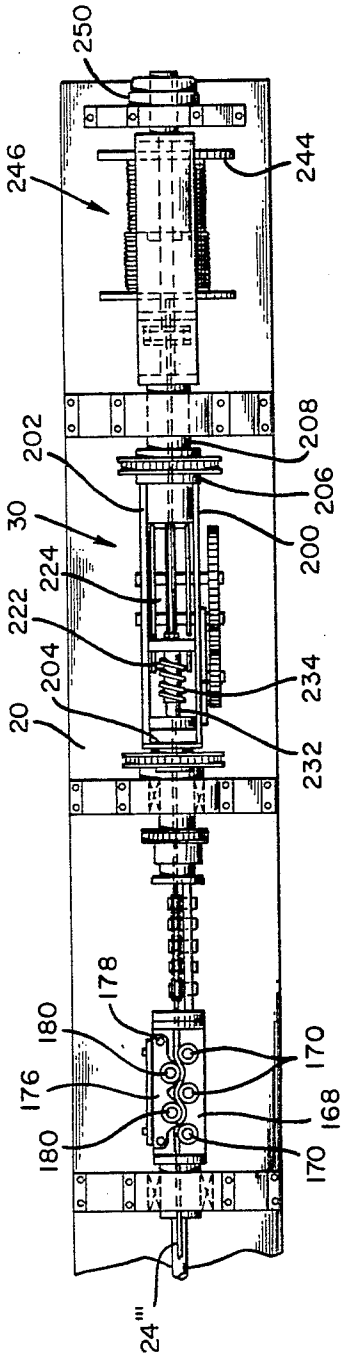


FIG-1-B

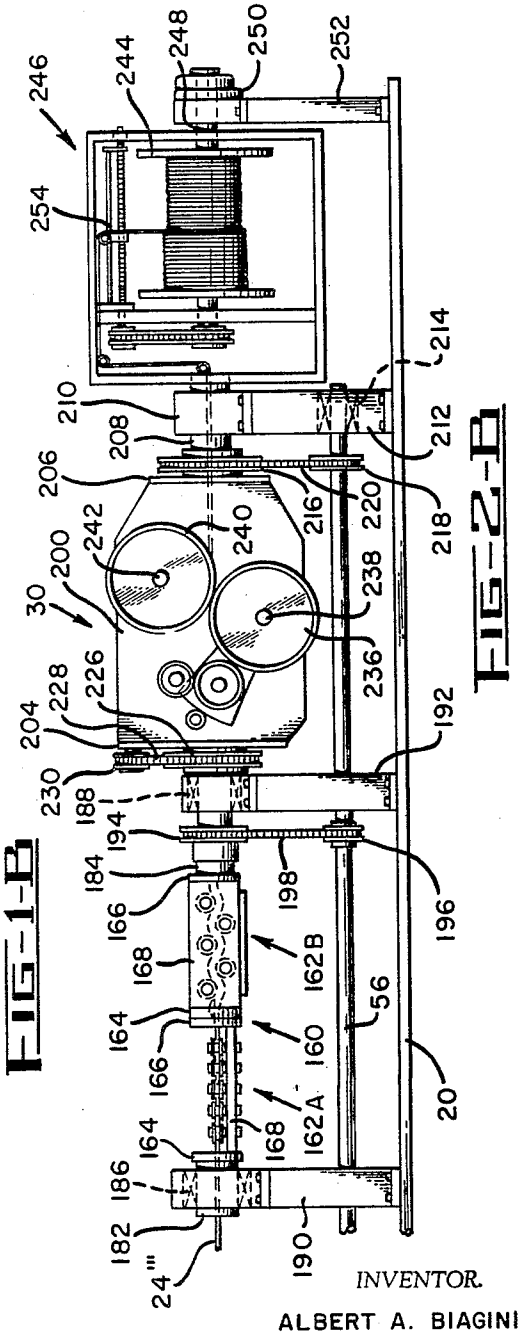


FIG-2-B

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Aug. 13, 1968 A. A. BIAGINI 3,396,522

STRANDING MACHINE

Filed Jan. 30, 1967 3 Sheets-Sheet 3

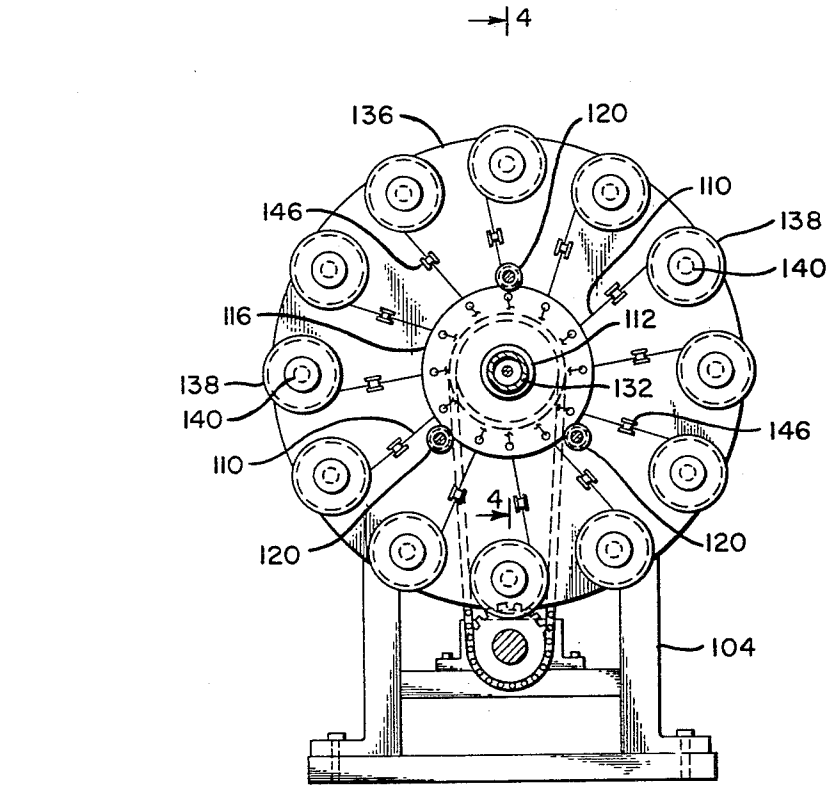


FIG-3

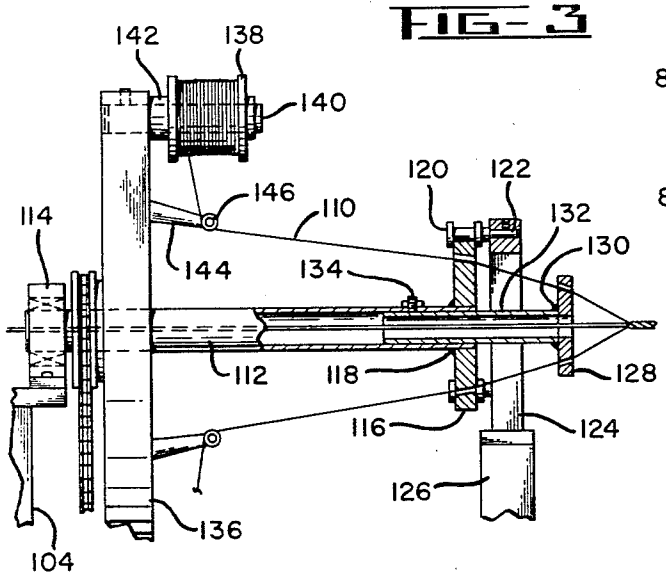


FIG-4

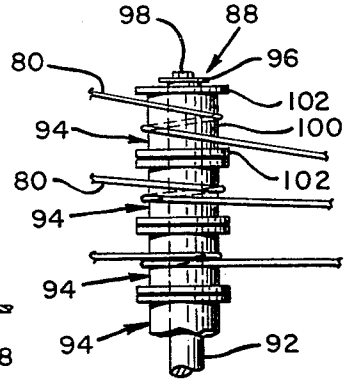


FIG-5

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United States Patent Office 3,396,522 Patented Aug. 13, 1968

3,396,522

STRANDING MACHINE

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Continuation-in-part of application Ser. No. 531,693, Mar. 4, 1966. This application Jan. 30, 1967, Ser. No. 612,722

21 Claims. (Cl. 57—15)

ABSTRACT OF THE DISCLOSURE

A stranding machine having at least first and second dies and at least first and second relatively rotatable wire supply means for supplying outer wires to the respective first and second dies, with the wires from the first and second wire supply means being applied with different lay distances. A strand setter and preformer having means for guiding a strand along curved paths in substantially quadrature space relation. A twist limiting means comprising one or more sheaves over which a wire or wires from a wire supply means are fed to a wire utilization means to limit twisting of wires by the wire utilization means to that portion between the wire utilization means and twist limiting means.

This is a continuation-in-part of my application Ser. No. 531,693 filed Mar. 4, 1966 entitled "Method and Apparatus for Stranding Wires, or the Like."

With prior art apparatus, a strand is produced by twisting outer wires about a core or heart wire, and winding the strand upon a take-up reel. Then, in a second independent operation, the strand is fed through another stranding, wrapping or laying step or apparatus wherein a desired layer of wires, armor coating, insulating material, or the like, is applied to the strand.

An object of this invention is the provision of a stranding machine which does not require separate passes through separate machines, or through the same machine a plurality of times, to form a plurality of layers with different lay distances.

An object of this invention is the provision of a stranding machine for forming a plurality of layers, all of which layers may be formed to the right, or all to the left, or with lays in opposite directions, as desired, and which layers may be formed with the same or different lay distances, as desired, and all of which layers are formed in a single pass through the machine.

An object of this invention is the provision of a stranding apparatus whereby stranding operations for application of a plurality of layers of outer wires are accomplished simultaneously during a single pass through the apparatus.

The machine of this invention may include therein a stranding apparatus of any well known type or of the type illustrated in my above-mentioned copending patent application Ser. No. 531,693. Also included in the machine, in accordance with this invention, is a second stranding mechanism for wrapping the strand with the desired material, which mechanism is located between the die through which the core and outer strand wires of the strand from the first-mentioned stranding apparatus are drawn and the pulling means for drawing the strand through the die. The second stranding mechanism comprises a rotatable member or members, such as plates or discs, formed with an axial opening through which the strand passes. One or more spools of wire, insulation or the like are rotatably mounted on the rotatable member. The strand from the die in the first stranding apparatus, together with the wire, or the like, from the spools on the second mechanism or apparatus, are fed through a second die for laying the spooled material onto the strand. The lay distance and direction

of rotation of the second layer of material is dependent upon the relative rate of rotation of the spool holding member and the center strand being covered or wrapped. With a non-rotating center strand, a lay in one direction is obtained by rotating the spool holder plate in said one direction, and a lay in the opposite direction is obtained by rotating the spool holder plate in the opposite direction.

In forming a strand, a core wire, together with a plurality of outer strand wires, is fed through a die wherein the outer strands are twisted about the core. When the outer wires are twisted or layed about the core at the die they are also twisted about their own longitudinal axes, and when the twist is permitted to extend back to the wire supply from the die, difficulty is sometimes encountered in wrapping the outer strands around the core because of kinking and knotting of the wires.

An object of this invention is the provision of a twist limiting means for use with travelling wires which are twisted about their longitudinal axes for terminating the twist at said twist limiting means.

An object of this invention is the provision of a twist limiting means for confining the twist in wires to that portion between the die and said twist limiting means.

The twist limiting means of this invention comprises one or more rotatably mounted spools or sheaves around which the outer wires pass in travelling from the supply coils to the die. A sufficient wrap of the wires about the spools or sheaves to terminate twisting at the spools is employed. A wrap of at least 360 degrees has been found to be satisfactory.

Strands, cables, wire rope, and the like, from stranding, wrapping, rope-making machines, and the like, often include wires or layers which are in a stressed condition due to the manufacturing process. When such strands, cables, ropes, etc. are broken or cut they generally fly apart rather than remaining in the tightly twisted or wrapped condition.

An object of this invention is the provision of a strand setting apparatus for eliminating the stress of wires included in a strand, rope, or the like, after the same has been formed.

The stress relieving apparatus of this invention involves passing the completed strand along a zig-zag path in a first plane of the strand and then along a zig-zag path in a second plane which is substantially at right angles to the first plane. This is simply accomplished by use of first and second preforming heads of the type mentioned above, in which the axes of the guide rollers of one head are at substantially right angles to the axes of the guide rollers of the second head. Upon passing through the guide rollers the stresses are relieved to place the strand in a substantially unstressed preformed condition.

The above and other objects and advantages of the invention will become apparent from the following description taken in connection with the accompanying drawings. In the drawings, wherein like reference characters refer to the same parts in the several views:

FIGURES 1A and 1B, when taken together, show a plan view of a novel stranding machine embodying this invention;

FIGURES 2A and 2B, when taken together, show a side elevational view of the machine shown in FIGURE 1;

FIGURE 3 is an enlarged cross-sectional view taken on line 3—3 of FIGURE 1A;

FIGURE 4 is a fragmentary sectional view taken along line 4—4 of FIGURE 3; and

FIGURE 5 is an enlarged fragmentary view taken on line 5—5 of FIGURE 1A.

Reference is first made to FIGURES 1A, 1B, 2A and 2B wherein there is shown a stranding machine comprising a base **20** which carries a drive motor **22** for driving various rotatable elements of the machine.

A core, or heart wire **24** (which may comprise a wire, strand, rope or the like) is shown wound on a supply reel **26**, which reel is rotatably supported by a reel holder **28**. The rotatable reel holder **28**, together with a rotatable twisting and drawing unit **30**, provide means for rotating the core heater wire while it is being fed through various dies in wrapping the outer layers thereon. In my above-mentioned copending patent application, a stranding machine is shown which includes a rotatable supply reel holder and twisting and pulling unit of the type shown in the present application. It will here be noted that the present invention is not limited to an arrangement wherein the core wire is rotated while being pulled from a supply reel by a twisting and pulling unit, i.e., the core wire may be pulled through the machine without being rotated or spooled.

Continuing the description of the apparatus, the reel holder **28** is shown comprising an open rectangular-shaped frame formed with a pair of longitudinal plates **32** and **33** interconnected by end plates **34** and **36**. Shafts **38** and **40** are fixed to and project from opposite ends of the plates **34** and **36**, which shafts are rotatably supported in bearings **42** and **44** on upright supports **46** and **48** carried on the base **20**. The reel holder frame is rotated by the motor **22** through a sprocket **50** fixed to the end of the shaft **38**, a chain **52**, and a sprocket **54** secured to a drive shaft **56** coupled to the motor shaft by means not shown.

The core wire supply reel is attached to the inside wall of plate **34** of the frame through a slip coupling **58** of any suitable type. Slip couplings which operate electrically, mechanically or hydraulically are well known and need not be described in detail herein. When the core wire **24** is being withdrawn from the reel **26** by the pulling and twisting unit **30**, the slip coupling provides a drag force on the reel to create a tension in the core **24** as it unwinds from the reel. Means, not shown, are provided for releasably securing the supply reel **26** to the coupling for loading and unloading the same in the machine.

From the supply reel **26** the core wire **24** is directed over guides **60**, **62** and **64** and out through an axial bore in the shaft **40**. The guides may comprise rollers, eyes or other suitable means, not shown in detail. The core wire then passes through center apertures in guide plates **66** and **68** and thence to a die **70**. The guide plate **66** is fixedly secured to a mounting plate **72** which, in turn, is attached to the top of a platform **74** carried on a stationary support **76**. Fastening bolts **78** which fasten the plate **72** to the platform extend through elongated slots at opposite sides of the plate. When the bolts are loosened, the guide plate **66** may be adjusted in a longitudinal direction toward or away from the die **70**, as desired, to accommodate outer wires or strands of different size, elasticity and stiffness. The guide plate **68** is supported by any suitable means, not shown.

Outer wires or strands, designated **80**, are fed through the stationary guide plates **66** and **68** to the die **70** where they are wrapped about the core wire **24**. The guide plates **66** and **68** may simply comprise plates with a central aperture for the core wire **24**, as mentioned above, and a plurality of apertures at a radial distance from the central aperture through which the outer wires **80** extend. If desired, the guide plate **66** may be provided with preforming means for preforming the outer wires as they pass therethrough; a suitable preforming means being shown and described in my above-mentioned copending patent application.

The outer wires **80**, which provide the first layer of wires on the core, are supplied to the machine from any desired and conveniently located supply source. They may be supplied from coils or from rotatable spools or reels. In the illustrated arrangement coils **82** carried on upright coil supporting stands **84** adjacent the machine supply the outer wires thereto. A strand tensioning device, not shown, of any well known design, may be included at the coil stands to maintain a constant tension of the wires or strands drawn from the coils. As with the core **24**, wires, strands, ropes or the like may be used for the first outer layer members **80**.

As the wires **80** are wrapped about the core **24** at the die **70** they are also twisted about their longitudinal axes. The twist in the outer wires will extend from the die **70** to the coils **82** unless terminated at some intermediate point therebetween. If the twist is not terminated at some intermediate position near the die **70** the wires **80** may become knotted or kinked in the process.

To terminate the twist in the outer wires **80**, the wires are fed through novel twist limiting means **88** and **88A** in travelling from the coils **82** to the die **70**. The twist limiting means **88** and **88A** are mounted on supports **90** at opposite sides of the machine platform, and are of the same construction so that a description of one applies to both. Referring also to FIGURE 5, the guide means **88** is shown comprising a post **92** fixed to and extending vertically from the support **90**. A plurality of spools or sheaves **94** are rotatably supported on the post **92**, and are held thereon by a washer **96** and nut **98** at the upper threaded end of the post.

In the illustrated arrangement the sheaves or spools **94** each comprise a cylindrical member **100** with radial flanges **102** at opposite ends thereof. The outer wires **80** pass around the sheaves or spools **94** in traveling from the coils to the die. The amount of wrap of the wires on the sheaves or spools must be sufficient to substantially prevent the twist in the wires **80** at the die **70** from extending back to the supply source **82**. At least one complete wrap of the wires on the spools or sheaves is sufficient. The amount of wrap, in the illustrated arrangement, depends upon the position of the coils **82** and the apertures in the guide plate **66**, relative to the posts and, as seen from FIGURE 1A, may range from less than a complete turn to greater than a complete turn. With this arrangement, the twist in the wires **80** is confined to the runs between the twist limiting means **88** and **88A** and the die **70**. The run between the twist limiting means **88** and **88A** and the supply source **82** remains substantially untwisted. By limiting the length of the twisted portion from die **70** to twist limiting means **88** and **88A**, kinking and knotting are eliminated.

In a modification of the twist limiting means, not shown, spools or sheaves with end and intermediate radial flanges, i.e., multiple grooved sheaves or spools, may be employed. The intermediate flanges provide separate sections about which separate outer wires are wrapped. Since all of the outer wires **80** are drawn to the die **70** at substantially the same speed there is substantially no relative slipping of the wires on the multiple-grooved sheaves or spools.

The die **70** to which the core wire **24** and first layer of outer wires **80** are fed is carried on an upright support **104**. The die is removable for replacement with dies having different diameter bores to accommodate different size strands. It will be understood that the drawing and twisting mechanism **30** (FIGURES 1B and 2B) is rotated at the same, or substantially the same, rate of rotation as the supply reel holder **28**. The non-rotating outer wires **80** are thereby twisted about the core wire **24** at the die **70**, the lay distance of the outer wires **80** depending upon the rate of rotation of the supply reel **28** and twisting and pulling unit **30** relative to the speed with which the wires are drawn through the die. The core **24** with the first layer of outer wires **80** thereon comprises a strand designated **24'**, which is fed to the following wrapping or laying unit **106**. If desired, the strand **24'** may be provided with an additional layer or layers before being fed to the unit **106**, which layers may be applied at an additional station, or stations, similar to that disclosed and in the manner described above.

The laying unit **106** functions to wrap a second layer

of wires **110** onto the strand **24'** with a lay distance which differs from the lay distance of the first layer of wires **80**. The unit **106**, as best shown in FIGURES 3 and 4, comprises a tubular shaft **112** rotatably supported at the forward end in a bearing **114** on the upright support **104**. A guide plate **116** which may be in the form of a disc is attached as by welding **118** to the downstream end of the shaft **112**. The disc **116** is rotatably supported by rollers **120** rotatably carried on pins **122** extending from the face of an inverted U-shaped bracket **124** attached to an upright support **126**. The unit **106** is provided with a second guide plate **128** suitably secured as by welding **130** to a tubular shaft section **132** telescopically mounted in the shaft **112**. Axial adjustment of the guide plate **128** is permitted when the set screw **134** for locking the telescopic guide section **132** to the shaft **112** is loosened.

A supporting member **136** in the form of a plate, disc, or the like, with a central aperture therein is affixed to the shaft **112** adjacent the upstream end of the shaft, upon which member reels or bobbins **138** are supported from which the wires **110** are withdrawn. The member may be provided with pins **140** at equal radial distances from the center thereof for rotatable support of the reels. A tension device **142** which includes a compression spring, or the like, not shown, is provided at each reel supporting means to provide tension on the wires **110** as they are withdrawn from the reels. Tensioning devices are well known and require no detailed showing. Arms **144** with guide means **146**, such as rollers, eyes, or guides at the free ends thereof are mounted on the member **136** radially inwardly of the spools **138**. The wires **110** from the spools **138** pass over the guide means **146**, through apertures in the guide plates **116** and **128**, and thence to a second die **150**, shown in FIGURES 1A and 2A.

The wrapping unit **106** is rotated by a sprocket and chain arrangement which includes sprockets **152** and **154** on the shafts **112** and **56**, respectively, and a chain **156** between the sprockets. Obviously, any other suitable connecting means between the motor **22** and wrapping unit **106** may be employed for rotating the same. To wrap the wires **110** on strand **24'** the member **136** and strand **24'** must be relatively rotated. If the plate member **136** is rotated in the same rotary direction but at a slower rate than the strand **24'**, the wires **110** are wrapped in the same rotary direction as the wires **80** but have a longer lay distance than the wires **80**. If, on the other hand, the plate **136** is rotated in the same rotary direction as the strand **24'** but at a greater rate of rotation than the strand **24'**, the wires **110** are wrapped on the strand **24'** in the opposite rotary direction from the wires **80**. The rate at which the wrapping unit **106** is rotated is determined by the relative diameters of the sprockets **152** and **154** used in driving the same, and the sprockets may be removable for replacement by sprockets of different size.

In use, the apparatus may be provided with one or more wrapping or laying units of the type designated **106** for application of the desired number of layers to the strand with the desired lay distances and lay directions for each layer. For purposes of illustration, a second unit **106A** is shown which is of the same construction as the unit **106**. Corresponding parts in the two units are supplied with the same reference numerals, with the numerals for the components in the second unit **106A** being provided with the suffix A to distinguish the same from the first unit components. The strand **24''** which is fed to the unit **106A** comprises the core wire **24** with the first and second outer layer wires **80** and **110** applied thereto. The outer layer wires **110A** are wrapped on the strand by the unit **106A** at the die **150A** carried on an upright support **158**. The above described conditions for wrapping the wires **110** with a different lay distance and/or lay direction than the wires **80** apply also to the unit **106A** for wrapping the wires **110A** with a different lay distance and/or lay direction than the wires **80** and will not be repeated. As a further condition, the unit **106A** must be rotated at a different rate of rotation from that of the unit **106** if the wires **110A** are to be applied with a lay distance which differs from the wires **110**. In practice, when forming a strand with three outer layers of wires, the first two-applied layers are generally layed in the same direction, and the third layer wires are layed in the opposite direction. The relative size of the sprockets **152A** and **154A** control the rate of rotation of the unit **106A** and may be selected to provide the desired lay distance and/or direction of wrap of the wires **110A**.

From the die **150A** the strand **24'''** travels to a novel strand setting and preforming unit **160** embodying this invention, the function of which unit is to relieve the internal stress of the wires comprising the strand **24'''**. The strand setting and preforming unit **160** comprises a pair of rotating series-connected preforming devices **162A** and **162B** of identical construction but which are provided with different reference characters for purposes of identification. As shown in the drawings, each preforming device **162A** and **162B** comprises a pair of end plates **164** and **166** interconnected by a longitudinally extending base member **168**. A series of guide rollers **170** are carried by the base member **168**, which rollers are arranged along a straight line with adjacent rollers at spaced distances apart. An adjustable plate **176** is attached to the base member **168** by bolts **178** which extend through elongated holes in the plate **176** and threadedly engage tapped holes in the member **168**. The plate **176** is provided with a pair of rollers **180** substantially intermediately positioned with respect to adjacent rollers **170**.

The end plates **164** and **166** are provided with central apertures through which the strand **24'''** extends. The adjacent end plates **164** and **166** of the devices **162A** and **162B** are secured together by any suitable means, not shown. The devices **162A** and **162B** are interconnected such that the base members **168** of the devices **162A** and **162B** lie in planes at substantially right angles to each other whereby the strand **24'''** is curved in first and second planes in passing therethrough.

Tubular shafts **182** and **184** are secured by welding or other suitable means, not shown, to the opposite end plates **164** and **166** of the devices **162A** and **162B** and are rotatably supported in bearings **186** and **188** carried on upright supports **190** and **192**, respectively. Sprockets **194** and **196** on the shafts **184** and **56**, respectively, and an interconnecting chain **198** are provided for drive rotation of the unit **160** by the drive motor **22** at the same rate as the supply reel holder **28** and drawing and twisting unit **30**. In passing through the preforming devices **162A** and **162B**, the completed strand **24'''** first travels in a generally zig-zag path in a first plane extending along the longitudinal axis of the strand, and then travels in another generally zig-zag path in a second plane along the longitudinal axis of the strand but at substantially right angles to the plane of the first path. Where the strand is rotated, as in the illustrated arrangement, the above-mentioned first and second planes rotate therewith. Of course, the novel strand setting and preforming unit is useable on non-rotatable strands, in which case the planes of the zig-zag paths would be non-rotatable. In passing through the strand setter and preforming unit the stress in the wires produced during the stranding operation are relieved and the strand emerges therefrom in a substantially unstressed preformed condition.

The twisting and drawing unit **30** for simultaneously drawing the wires through the dies and rotating the same may be of the same construction as that employed in my above-mentioned copending application Ser. No. 531,693. Briefly, the unit comprises a pair of spaced, longitudinally extending plates **200** and **202** interconnected by forward and rear end plates **204** and **206**, respectively. The tubular shaft **184** extends through the forward end plate **204** and is secured thereto as by welding or other suitable means, not shown. Another shaft

208 extends through the end plate 206 and is secured thereto as by welding. The shaft 208 is rotatably supported in a bearing 210 on an upright support 212. (Also, the outer free end of the shaft 56 is supported in a bearing 214 carried by the support 212.) Sprockets 216 and 218 on the shafts 208 and 56, respectively, and a chain 220 between the sprockets serve to connect the drawing and twisting unit to the shaft 56 for drive rotation thereof. Since the strand setter and preformer unit 160 and twisting and drawing unit 30 are interconnected by the shaft 184, they are driven at the same rotary rate.

The twisting and drawing unit 30 includes a pair of capstans 22 and 224 (FIGURE 1B) about which the strand 24''' is wrapped and by means of which it is drawn from the strand setter and preformer unit 160. The capstans are driven by a mechanism which includes a stationary sprocket 226 fixed to the upright support 192, and a chain 228 which connects the sprocket 226 to a sprocket 230 attached to a shaft 232. A worm 234 on the shaft 232 connects throught a gear train, not shown in detail, to a gear 236 attached to a shaft 238 to which the capstan 222 is secured. The gear 236 engages a second gear 240 attached to a shaft 242 to which the capstan 224 is secured. From the strand setting and preforming unit 160 the strand 24''' is first wrapped about the capstan 222 and then is wrapped around the capstan 224. The strand is drawn from the strand setter and preformer unit by rotation of the capstan about the axes of the shafts 238 and 242 and is twisted by rotation of the unit about its longitudinal axis.

The strand 24''' passes through the tubular shaft 208 from the twisting and drawing unit 30 and is wound upon a takeup reel 244 included in a reel holder mechanism 246. The reel holder mechanism 246 may be of the same type as that shown in my above-mentiontd co-pending patent application Ser. No. 531,693 and need not be described in detail herein. In brief, the reel 244 is detachably secured to a shaft 248 which, in turn, is connected through a slip clutch mechanism 250 to a stationary upright support 252 on which the shaft is rotatably supported. The forward end of the reel holder mechanism 246 is attached to the tubular shaft 208 for rotatable support thereof. The strand 24''' from the tubular shaft 208 is guided by a traverse mechanism 254 for neatly laying the strand on the take-up reel. The rate at which the take-up reel mechanism 246 attempts to wind the strand on the reel 244 exceeds the rate at which the strand is drawn through the twisting and drawing unit whereby the strand is placed in tension between the capstan 224 and take-up reel.

A brief summary of the operation of the stranding apparatus will now be given. When the motor 22 is energized, the supply reel holder 28, wrapping units 106 and 106A, strand setting and preforming means 160, drawing and twisting unit 30, and the take-up reel holder 246 are rotated. The strand setting and preforming unit 160, twisting and drawing unit 30, and take-up reel holder 246 are rotated at the same rate since they are interconnected by the shafts 184 and 208, and, preferably, the supply reel holder 28 is rotated in synchronism therewith. The wrapping units 106 and 106A preferably are rotated in the same direction as the units 28 and 30 but at different rates to provide the wires 110 and 110A with different lay distances and with right or left lays, if desired.

The outer wires 80 are twisted about the core wire 24 and about their longitudinal axes at the die 70. The twist limiting devices 88 and 88A limit the axial twist of the wires 80 to relatively short length portions between the die 70 and the devices 88 and 88A whereby kinking and knotting thereat is prevented. The twisting of the outer wires about the core and about their own longitudinal axes results in internal stresses within the wires of the completed strand. This stress is relieved by the novel strand setter and preformer unit 160 wherein the completed strand 24''' is made to travel zig-zag paths in quadrature space relation.

The invention having been described in detail in accordance with the requirements of the patent statutes, various changes and modifications may suggest themselves to those skilled in this art. For example, the wires 80 could be wound upon rotatable spools or bobbins for removal from the ends thereof. If the twist created by removal from the spools or bobbins is in the same direction and at the same rate as the axial twist at the die 70, the wires 80 would be rotatably fed to the die without twisting, in which case the twist limiting means 88 and 88A would not be required. Such a supply means for the wires is shown in my above-mentioned co-pending patent application. Also, as suggested above, the machine could be used with a single wrapping mechanism 106, or with more than two such wrapping mechanisms, if desired. Also, if suitable preformers are employed in feeding the outer wires 80, 110 and 110A to the respective dies 70, 150 and 150A, the strand setting and preforming mechanism may be deleted from the construction. In addition, the wrapping units 106 and 106A and the strand setting and preforming unit 160 are readily adaptable for use with a conventional strander mechanism in which outer wires are carried on bobbins which are rotated about a nonrotatable core wire. For example, the units could be employed between the die (or downstream die if more than one die is used) and the drawing capstan included in the conventional strander.

It will be apparent that the apparatus is not limited to use with the number of outer wires illustrated in the drawings since a fewer or greater number of such outer wires could be employed, as desired. Additional spools could be accommodated on the rotatable plates 136 and 136A, if desired, for application of additional outer wires. Instead of increasing the diameter of the plates to accommodate additional spools, another set of spools could be mounted on the forward facing side of the plates (by spacing the plates from the sprockets 152 and 152A) and the wires from such additional spools passed through suitable apertures and guide means on the plates to the dies 150 and 150A. The momentum of the revolving mass is minimized by mounting the spools as close to the center of the plates as possible. Also, it will be apparent that the machine may be operated without a core wire 24, whereupon the resultant strand would simply comprise a plurality of layers of twisted wires. In addition, although non-rotatable dies 70, 150 and 150A are shown, the dies could be rotated if desired. It is intended that the above and other such changes and modifications shall fall within the spirit and scope of the invention as defined in the appended claims.

I claim:

1. Apparatus for twisting advancing wires, strands, ropes or the like comprising:
first and second dies with bores therethrough,
means supplying first outer wires from fixed locations to the first die and twisting the same at said die to form a strand with a first lay distance, and
means supplying second outer wires and the strand from the first die to the second die and twisting the second outer wires with a second lay distance different from the lay distance of the first outer wires about the strand at said second die, said first and second outer wires being supplied simultaneously for forming a strand having wires with different lay distances during a single pass of the wires through the apparatus.

2. The apparatus as defined in claim 1 including means feeding a core to said first die, said first outer wires being twisted about said core to form said strand.

3. The apparatus as defined in claim 1 including:
a third die with a bore therethrough,
means supplying third outer wires and the strand from the second die to said third die and twisting the

third outer wires with a third lay distance different from the lay distances of the first and second outer wires.

4. The apparatus as defined in claim 3 wherein the second and third outer wires are wrapped in opposite directions.

5. Apparatus for twisting advancing wires, strands, ropes or the like about a core comprising:

means for rotating a straight portion of an advancing core about the longitudinal axis of the straight core portion,

first and second dies with axial bores therethrough,

a stationary supply of first outer wires,

means for feeding the rotating core and first outer wires to said first die for relative twisting of the first outer wires about the core to form a strand,

a rotatable supply of second outer wires,

means for rotating the rotatable supply about the longitudinal axis of the straight core portion, and

means for feeding the strand from the first die as the strand is produced and said second outer wires to said second die for relative twisting of the second wires about the strand with a lay distance different from the lay distance of the first wires.

6. The apparatus as defined in claim 5 wherein said first outer wires are supplied from coils, and

said means for feeding said first outer wires to said first die comprise rotatable sheave members about which the first wires are wrapped in passing from the coils to the first die to limit twisting of the first outer wires about their longitudinal axes to portions between the rotatable sheave members and said first die.

7. A device for relieving stresses in a strand, wire, rope or the like comprising:

first means for guiding a strand along a curved path in a first plane extending through the longitudinal center of the strand,

second means for guiding the strand along a curved path in a second plane extending through the longitudinal center of the strand and at an angle with said first plane, and

means for rotating the stress relieving device and the strand about the strand axis in the same rotary direction and at the same rate of rotation as the strand travels through the stress relieving device.

8. The device as defined in claim 7 wherein said first and second means comprise rollers over which said strand passes along a generally zig-zag path.

9. The device as defined in claim 7 wherein the first and second planes are in substantially quadrature space relation.

10. Apparatus for limiting twist in a wire, strand, rope and the like fed from a supply means to a wire utilization apparatus which creates a twist in the wire, comprising:

a rotatable sheave,

means passing the wire over the sheave in travelling from the supply means to the utilization apparatus with sufficient wrap of the wire about the sheave to limit twisting to the length between the utilization apparatus and sheave, whereby the wire entering the utilization apparatus is twisted without kinking or knotting.

11. The apparatus as defined in claim 10 wherein said sheave is provided with a plurality of spaced annular grooves, and

a plurality of wire supply means with a single wire in each groove on the sheave.

12. The apparatus as defined in claim 10 wherein said supply means comprise a coil of wire.

13. The apparatus as defined in claim 10 including a plurality of adjacent rotatable sheaves to accommodate a plurality of wires.

14. Apparatus for twisting advancing wires, strands, ropes or the like, comprising

a die with a bore therethrough,

means upstream of said die for supplying wires to be twisted to the die,

means downstream of said die for pulling said wires through the die,

means downstream of said die for twisting the wires together at the die as the wires are pulled therethrough, and

twist limiting means for terminating twisting of the wires at a point intermediate the die and supply means to prevent kinking of the wires fed to the die.

15. The apparatus as defined in claim 14 wherein said twist limiting means is rotatable, said wires extending about the rotatable twist limiting means with sufficient wrap to terminate the twist at said twist limiting means and prevent the twist from extending back to the wire supply means in travelling from the supply means to the die.

16. The apparatus as defined in claim 15 wherein the rotatable twist limiting means comprises a sheave having a plurality of spaced annular grooves with a single wire in each groove.

17. The apparatus as defined in claim 15 wherein said rotatable twist limiting means includes a plurality of adjacent rotatable sheaves to accommodate a plurality of wires.

18. The apparatus as defined in claim 14 wherein said wire supply means includes a coil of wire at a fixed location.

19. Apparatus for twisting advancing wires, strands, ropes or the like, into a strand comprising,

a die with a bore therethrough,

means upstream of said die for supplying wires to be twisted to the die,

means downstream of said die for pulling the wires through the die,

means downstream of the die for twisting the wires together into a strand at the die as the wires are pulled through the die,

rotatable stress relieving means intermediate the die and twisting means for relieving stress in the strand as the wires are pulled through the die, and

means for rotating the stress relieving means in the same direction and at the same rate as the strand pulled from the die.

20. The apparatus as defined in claim 19 wherein said stress relieving means comprises means for guiding the strand from the die along first and second generally zig-zag paths which are in substantially quadrature space relation.

21. The apparatus as defined in claim 19 including twist limiting means to terminate twisting of the wires at a point intermediate the die and wire supply means to prevent kinking of the wires fed to the die.

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