

June 27, 1967

A. KRAFT

3,327,469

WIRE ROPE

Filed Sept. 15, 1965

8 Sheets-Sheet 1

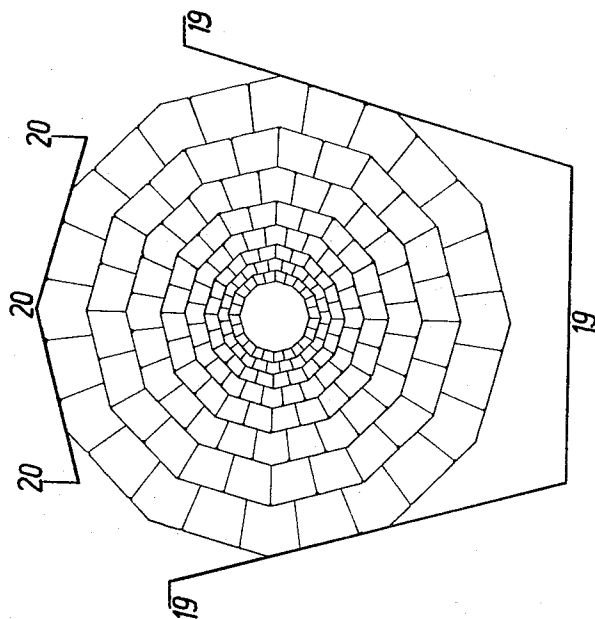


Fig. 2

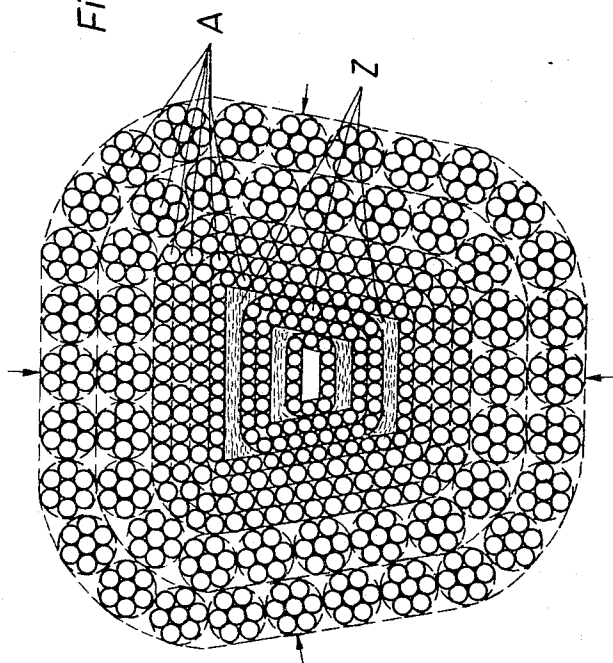


Fig. 1

Inventor:

ANTON KRAFT

By *Young & Thompson*
ATTYS.

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Fig. 8

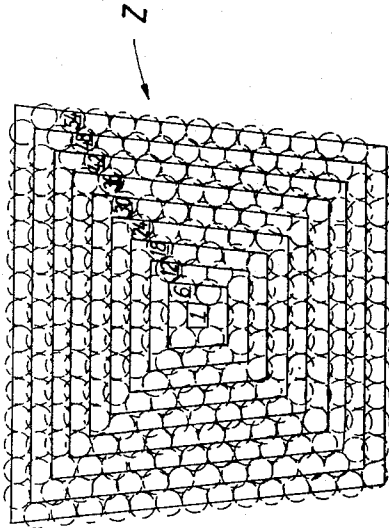


Fig. 9

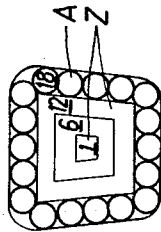


Fig. 12

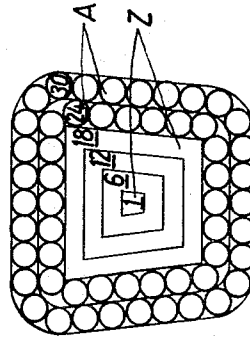


Fig. 11

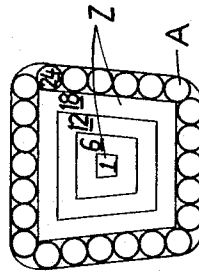
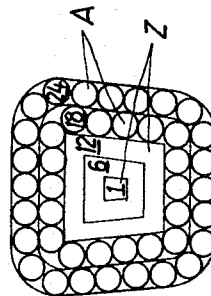


Fig. 10



Inventor
ANTON KRAFT
By *Young & Thompson*
ATTYS.

June 27, 1967

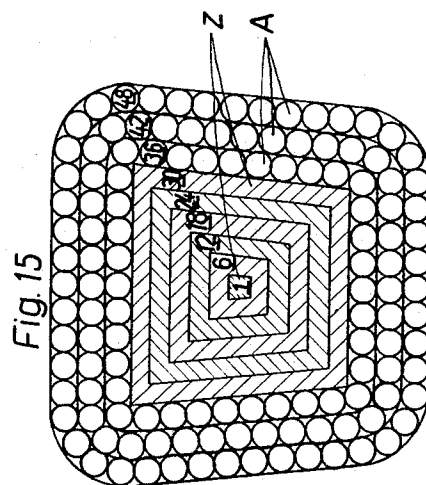
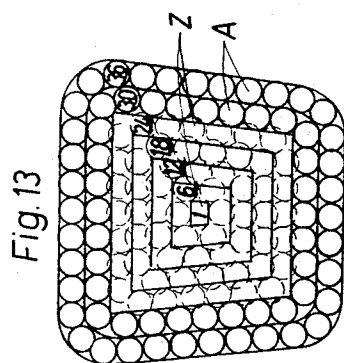
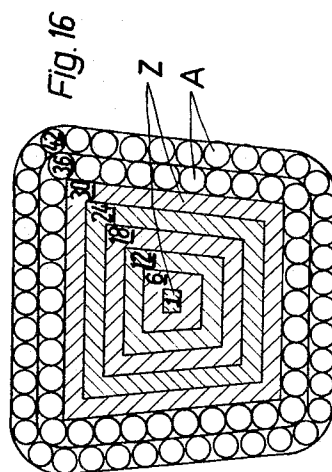
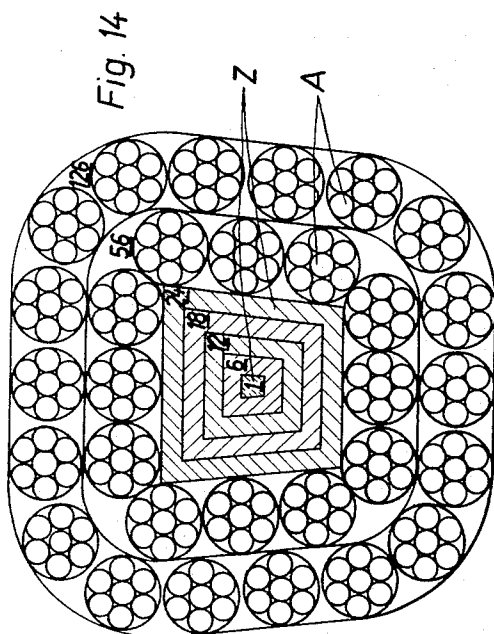
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WIRE ROPE

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Inventor:

ANTON KRAFT

By Young + Thompson

ATTYS.

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Fig. 18

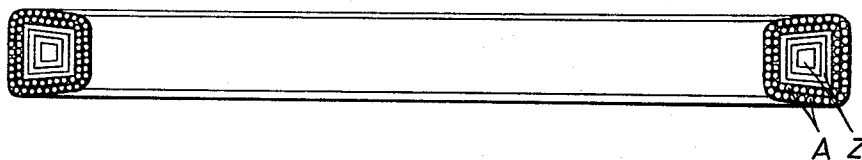
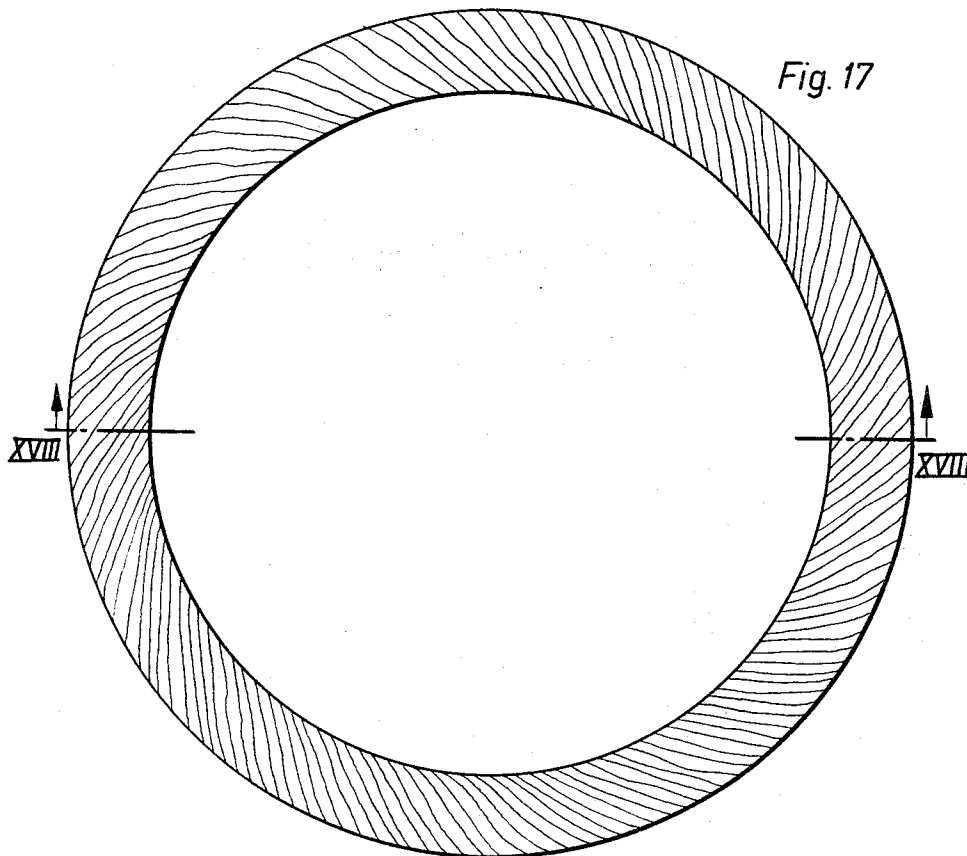


Fig. 17



Inventor:

ANTON KRAFT

By Young & Thompson

ATTYS.

June 27, 1967

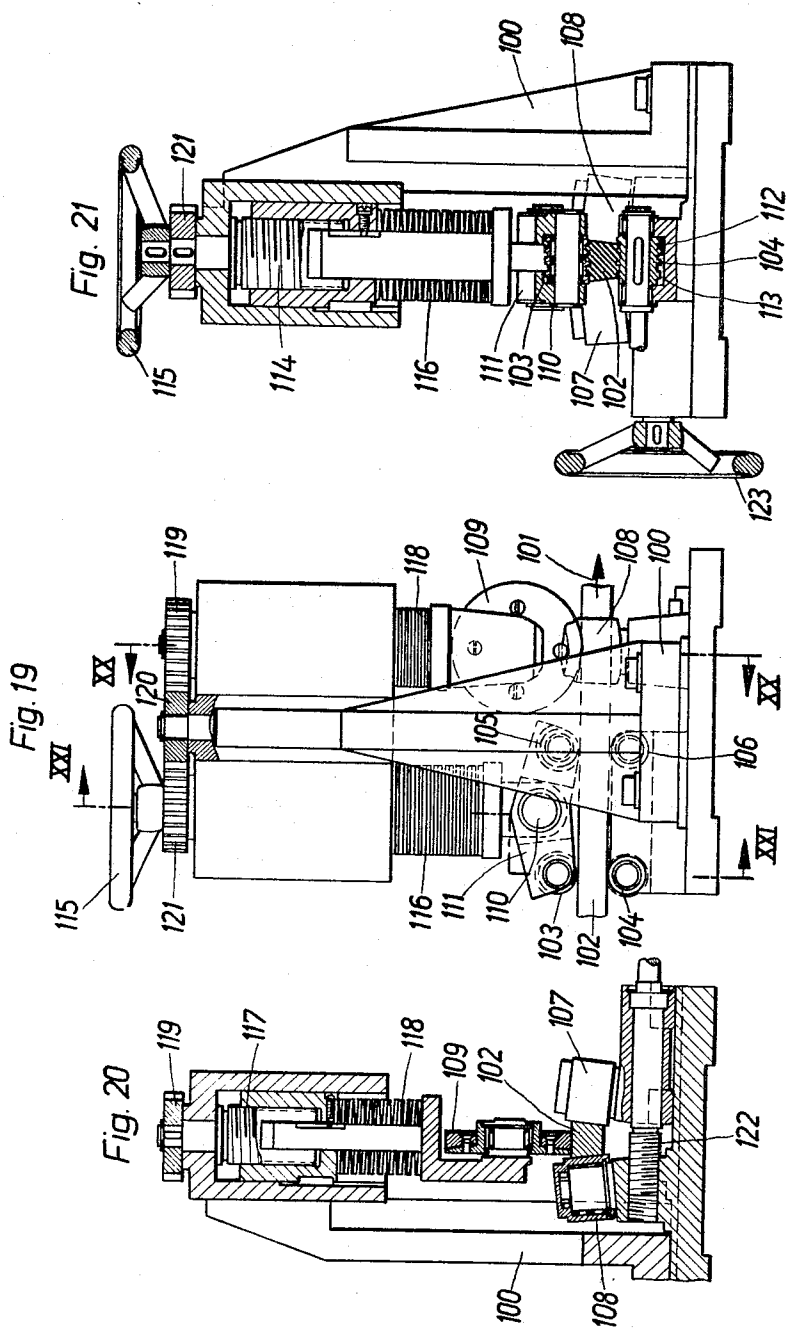
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Inventor:

ANTON KRAFT

By *Young + Thompson*

ATTYS

June 27, 1967

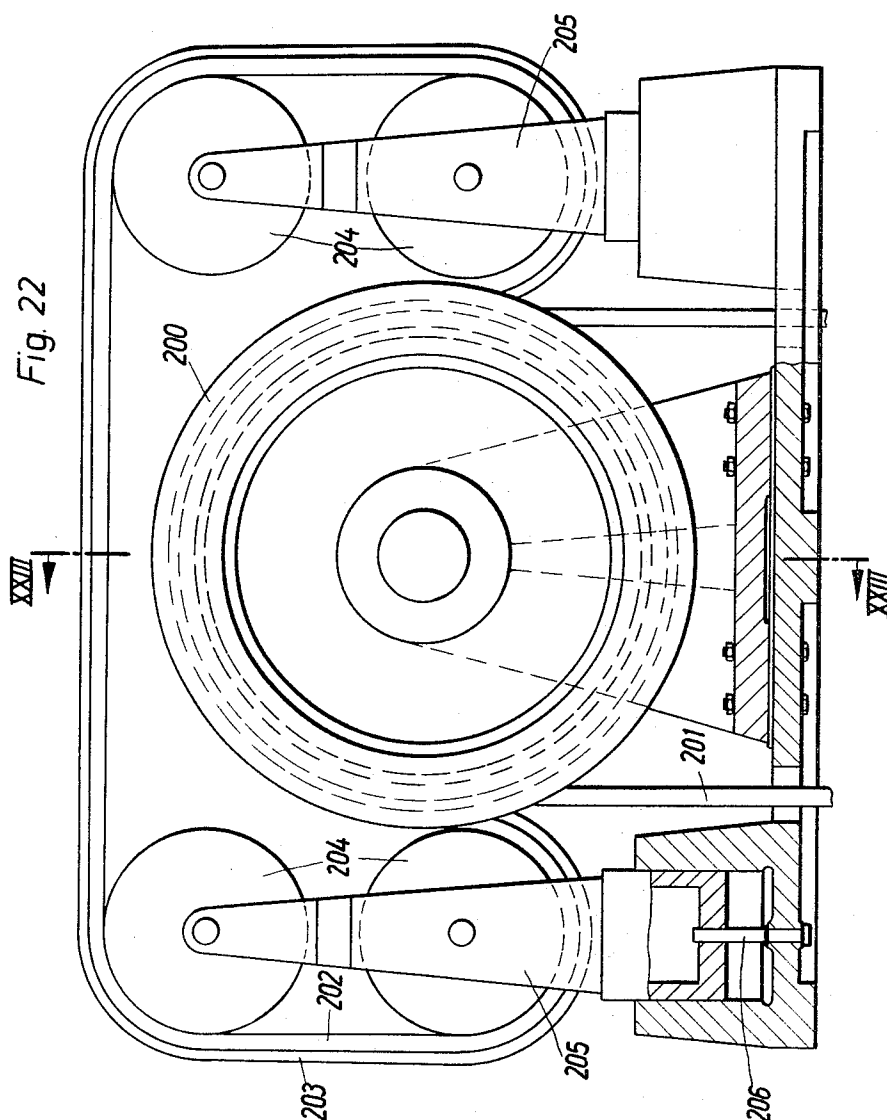
A. KRAFT

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Inventor:

ANTON KRAFT

By *Young & Thompson*
ATTYS.

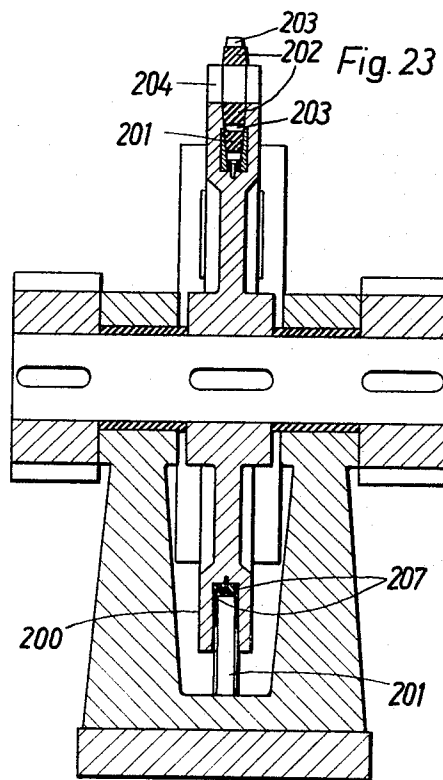
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A. KRAFT
WIRE ROPE

3,327,469

Filed Sept. 15, 1965

8 Sheets-Sheet 8



Inventor:

ANTON KRAFT

By *Young & Thompson*
ATTYS.

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3,327,469 WIRE ROPE

Anton Kraft, 596 Olpe, Lindenhardt,
Westphalia, Germany

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Claims priority, application Germany, Sept. 16, 1964,
K 54,014

9 Claims. (Cl. 57—145)

This invention relates to stranded wire rope of polygonal cross section.

According to a principal feature of the invention, a shape-determining rope center is produced, in a manner conventional in the rope manufacturing art, from a number of stranded layers comprising, from the inside toward the outside, individual wires which increase in number, for example, 1, 6, 12, 18, 24, 30 and so on, of soft mild steel. At least some of the stranded layers of the shape-determining rope center are compressed by rolling to a quadrilateral cross section, more particularly a cross section having the particular double-wedge angle required; and the rope center thus formed has one or more layers of individual or stranded cast-steel wires disposed around it.

It is an object of the invention to improve the construction, manufacture and use of wire ropes of this kind.

It is also an object of the invention to enable ropes to be constructed by means of a stranded construction in order that ropes of this kind may be used with greater efficiency than previously for endless V-belt drives.

The invention relates more particularly to a wire rope of the kind specified wherein the shape-determining rope center is made, in a manner conventional in the rope manufacturing art, from any number of stranding layers having, for instance, 1, 6, 12, 18, 24, 30 and so on individual wires of mild steel. Each stranding layer of the shape-determining rope center is compressed by rolls into a V-cross section having the required V-angle, and the rope center thus formed has one or more layers of individual or stranded cast-steel wires wound around it. According to the invention, the wire rope can have the shape of an endless V-belt.

The wire rope according to the invention requires a special kind of apparatus for compressing the rope center. In such an apparatus according to the invention, the apparatus has, as considered in the direction in which the rope center passes through, relatively vertically movable first and second pairs of compressing or condensing rolls each comprising a top roll and a bottom roll and a third relatively laterally movable pair of compressing or condensing rolls and a hold-down roll associated with the third pair of rolls. The top rolls of the first and second pairs are rotatably mounted in a common hoop or stirrup or the like adapted to pivot around a pivot pin disposed horizontally and transversely of the direction of movement of the wire rope center, and the rolls of the third pair have their spindles disposed at an inclination to one another in accordance with the required V-angle of the wire rope cross section.

According to another feature of the invention, the top roll and bottom roll of the first pair are formed with annular grooves so that the raised peripheral edges between such grooves compress about half the parallel surface of the wire rope center, and the rolls of the second pair have a smooth cylindrical surface so as to compress the second half of the parallel surfaces of the wire rope center after the first pair of rolls. Preferably, the compression provided by the top rolls of the first and second pairs of rolls and the hold-down pressure of the hold-down roll associated with the third roll pair can be adjusted each via a respective spindle and a respective set

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of cup springs. In this case, the spindles can be operated jointly via pinions through the agency of a hand wheel. Preferably, another spindle can be provided to adjust the distance between the inclinedly disposed rolls of the third roll pair.

As an advantageous example of how the wire ropes according to the invention can be used, the invention provides a novel conveyor for conveying loads wherein a V wire rope is engaged frictionally over half the periphery in a groove in a V-belt conveying pulley. To increase the frictional engagement between the wire rope and the pulley, hold-down or back-up or the like rolls are provided in a known manner, or else an endless V wire rope running over guide rolls—of which one pair each is disposed in the central plane of the pulley on both sides thereof—is guided with adjustable pressure over an arcuate portion, operatively connected to the said pulley, of the conveying wire rope. Preferably, the endless V wire rope used to increase the pressure has, on the side in operative engagement with the conveying wire rope, a rigidly mounted resilient rubber spring.

The invention will now be described in greater detail with reference to the exemplary drawings, wherein

FIG. 1 shows a wire rope according to the invention having a four-sided construction;

FIG. 2 shows a conveyor rope in which each layer of wire has been compressed to form a polygon;

FIG. 3 shows an apparatus for producing wire ropes according to the invention, for example, in association with a high-speed strander;

FIG. 4 is a section looking in the direction of the arrow IV—IV of FIG. 3;

FIG. 5 is a section on the line V—V of FIG. 3;

FIG. 6 is a section on the line VI—VI of FIG. 3;

FIG. 7 is a section on the line VII—VII of FIG. 3;

FIGS. 8—16 are views, all in cross section, of various forms of V wire rope according to the invention;

FIG. 17 is a simplified and foreshortened view of an endless kind of V rope according to the invention;

FIG. 18 is a section on the line XVIII—XVIII of FIG. 17;

FIG. 19 is a view in side elevation of a novel apparatus for compressing the shape-determining center of a V rope according to the invention;

FIG. 20 is a section on the line XX—XX of FIG. 19;

FIG. 21 is a section on the line XXI—XXI of FIG. 19;

FIG. 22 is an example showing how the various embodiments shown in FIGS. 8—16 can be used for a novel kind of load conveyor; and

FIG. 23 is a section on the line XXIII—XXIII of FIG. 22.

FIG. 1 shows a stranded rope corresponding to the basic principles of the invention. The rope has four layers which encompass each other, the outer stranded layer A taking the form of bundles of wires. In external shape the rope is a V belt with a 20° angle, although this value is not limitative. Rope center Z is built up, for instance, from a shape-determining steel strip around which a first stranded layer of 12 wires is disposed. To shift the radius of the second and third stranded layers upwards and downwards, elastomeric inserts are provided between the first and second such layers and these, under the pressure of the pressing jaws known in stranders, serve as a stable filling material. Filling material is provided similarly between the third and fourth layers to shift the radii of the next stranded layer upwards and downwards respectively. Shifting the radii in this way increases the wedge surfaces marked by arrows.

FIG. 2 shows by way of example a dodecagonal conveying rope which is basically a square member. If required, a different number of sides can be provided. The

areas to be compressed become smaller, and less pressure need be applied to the individual surfaces for very high compression of the strands, in proportion as the number of sides are greater. Preferably, therefore, at least five sides are provided, the number increasing in accordance with the thickness of the conveying rope or strand. Framing 19 in FIG. 2 indicates the surfaces to which pressure is applied. The resulting wedge angle is 30° for the dodecagonal shape shown and would therefore be 15° for a 24-sided shape.

As can be gathered from FIG. 2, the central wire of each stranding layer has 24 wires around it. Since in external shape the rope has 12 surfaces or corners, the complement of each of the subtended angles is 30°. Since the 24-wire stranding leads to a complement of 15°, an angle at which the first layers stranded around the center wire must be thin wires, the first layers need only be 12-wire, corresponding to the number of sides.

If as is shown in FIG. 2 each layer is compressed in dodecagonal form, the compression can be performed by six pairs of rolls. The surface compressed by the top roll is indicated by a line 20 in FIG. 2 and applies pressure to the pressure surfaces of the bottom roll. The angular relationships are such that the pressure applied by the top pressing surface 20 acts as an amplified pressure on the pressure surfaces 19 of the bottom roll. Since two surfaces of the polygonal strand are compressed in this way, six identical pairs of rolls are provided for finishing. The surface pressure required for compression is less when correspondingly thin polygonal strands are manufactured. This reduced surface pressure can be distributed between three pairs of rolls; in this case, the roll pair pressing surfaces must be devised in accordance with the line 20 for the top roll.

As the description of manufacture in accordance with the invention of polygonal strands with surface formation shows, the pressure required for compression is provided by a number of roll pairs. As the description of all stranded ropes or ropes whose surfaces are formed shows, they are manufactured as stranded layers for which a large number of wires are illustrated.

As FIG. 1 shows, the final stranded layers can take the form of bundles of wires. For rational manufacture of these novel wire ropes, the invention proposes a new stranding procedure and associated apparatus not requiring stranders having from 40 to 60 bobbins.

In this new stranding procedure, for example, a 24-bundle stranding layer is produced on a six-bobbin high speed machine. Two strandings are necessary for this process. In the first stranding, six bundles each of four wires are stranded by the length of lay coinciding with the haul-off length required as length of lay in the stranding of the 24-bundle layer. To produce a 24-bundle layer, these 6 pre-stranded bundles of four wires each are placed in a conventional six-bobbin strander and stranded, in the same direction as the preliminarily stranded bundles, to form a 24-bundle layer. This novel restranding according to the invention is effected by allotting the six prestranded 4-wire bundles to a common 24-element guide as far as the stranding point of the 24-bundle layer, at which the back-twist required for stranding is the same as the back-twist of the prestranded bundles.

This novel stranding procedure for restranding, for which a new kind of apparatus is necessary, will now be described with reference to FIG. 3.

FIG. 3 shows a high speed strander whose general construction is known, a stranding member 21 being rotatably mounted on running rollers 22. Bobbins 23, 24 are disposed in known manner in freely rocking stirrups 25, 26 in the member 21 and do not rotate therewith. The material for stranding, in the form of four-wire prestranded bundles 27, 28, is present on the bobbins 23, 24 and on the other bobbins (not shown).

The prestranded bundle 27 on the bobbin 23 passes, in a novel laid-up form, through a preliminary zone preced-

ing the stirrup 25. The prestranded four-wire bundles are laid up in the latter zone because the four wires are divided as they pass through the guiding apertures in the stranding member 21 when the same rotates in the laying-up direction. After such zone, the various wires of the laid-up bundles 27 are guided through the apertures in the member 21, at 90° intervals, to the stranding place inside a pressing jaw 43. For continuous laying-up of this kind, the haul-off length of the laying up must be exactly the same as the length of lay of the prestranding. To ensure this, the preliminary zone comprises contact means providing the required control of haul-off of the required covering layer by a regulating operation of the haul-off speed of a haul-off disc 30. It is assumed for this purpose that all six prestranded bundles 27, 28, 32, 33 and so on have the same lengths of lay. The prestranded bundles which still remain then pass in distributed form through guide apertures 36-40 disposed outside the inner bobbin circle of the member 21, to the front end thereof, whence they are supplied in laid-up form through preliminary distribution plates 41, 44 to the stranding place inside the jaw 43.

The first bobbin zone comprising a bobbin 44 is for a core 55 and, through the agency of a stirrup 45, is adapted to receive three bobbins required to receive a core 55 and the filling material for the novel ropes.

As the drawing shows, guidance of the prestranded bundles 27 in laid-up form leads to a laying-up angle 46, 47 respectively whose value changes only in the event of the haul-off length of the laying-up failing to coincide with the length of lay of the preliminary stranding. When the haul-off length or the speed of the haul-off disc 30 is too little, the laying-up angle changes after a few rotations of the machine until the individual wires forming such an angle cause contacts to operate. When the speed of the haul-off disc 30 is too great, the latter angle changes until the contacts operate at the stranding angle 47. Too small an angle 46 leads to contact with a contact ring 48 mounted in insulated manner in the member 21. Too large a laying-up angle leads to contact with an insulated contact member 50 disposed on a holder.

Current is supplied to the corresponding contacts 48, 50 via supply wiring from outside the member 21, by way of slip rings 52, which are mounted in insulated manner on the distribution disc 41, and slip rings 53, 54 cooperating with the rings 51, 52. This known slip ring and brush supply system is conductively connected to the actuating lever of the steplessly variable transmission of the haul-off disc 40. Consequently, a bundle which it is required to lay up in accordance with the process, the haul-off length of the stranded bundle being required to coincide with its length of lay, is produced by electrical commands on the basis of alteration of the laying-up angle.

In this novel stranding process, which is shown by way of example in the drawings and in which six prestranded bundles each of four wires are laid up around the core 55 to form, for instance, a 24-wire layer corresponding to the number of bundles, the other prestranded bundles are laid up similarly but before the plate 41. The resulting laying-up angles are determined by the 24-part guiding of the plate 41 by which they are guided through the 24-part distributing plate 42 until being restranded at the stranding station of the jaw 43.

Preferably, since the system for controlling haul-off speed is very important for satisfactory performance of the novel stranding procedure, the prestrander and the main strander for producing the layers also have measuring means enabling the exact wire length required for production of the lengths of lay to be correctly adjusted for the two stranding events—i.e., prestranding and the production of the layers. These measuring means have been provided in the two devices each performing one stranding operation, in each case in a stationary stirrup of the pay-off bobbins, and have adjustable limit values for a contact system providing direct adjustment (without

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contact ring and contact element) in steplessly variable manner of the haul-off speed of the plate 30 to the value corresponding to the limit value.

The novel process which is of use for producing multi-wire layers and the novel feature of which is that it is not necessary to provide pay-off bobbins to a number corresponding to wire speed can be performed in simplified manner by cage-type stranders. In the known cage-type stranders having an adjustable back twist, contact devices identical to those hereinbefore described can precede the back-twist stirrups of the pay-off bobbins rigidly connected to the cage. Switching orders can be transmitted to the adjustable back twist by the laying-up angle 46 or 47 arising from the identical stranding. Since the haul-off of a cage-type strander is always the same, laying up can be adapted to the length of lay of the pre-stranded bundles by variation of the back twist, with the advantage that, for instance, a six-bobbin heavy duty machine which is operated only intermittently for special purposes can be arranged to produce 48-course-wired stranded layers.

Conventionally, ropes have been manufactured on stranders which strand up to about 60 wires for a Seale's-type rope. The overall length of these machines is about 60 meters and, since the bobbins pay off dissimilarly and the overall length is so great, they must stop for long dead times. To avoid these dead times and more particularly because stranded layers comprising 60 or more wires are desirable for the stranded ropes according to the invention with surface formations, it is suggested that the novel stranding procedure be used to strand multi-wire layers with the apparatus described. This ensures that all kinds of wire rope can be manufactured very rationally. Although the prestranding required must be counted as an extra stranding step, the great advantage of the prestranding step is that, for example, an 18-bobbin machine can with only 4-wire prestranding produce a stranded layer of the order of 72 wires. 36- to 60-bobbin stranders with their great overall length cease to be necessary.

The 18 prestranded 4-wire bundles required to produce a stranded 72-wire layer are prestranded with the same length of lay as is required for the 72-wire layer. This gives a length of lay corresponding to about 330 times the wire diameter. In a 24-wire layer, 6 prestranded bundles having a length of lay which should correspond to 110 times the wire diameter would be necessary.

Also, a 12-bobbin or two interconnected 6-bobbin stranders can produce, for instance, known Seale's-type stranded bundles, two layers each of 24 wires being stranded in one step. For a clearer explanation of the possible ways in which the novel process can be used to manufacture multibundle layers, the basis chosen for explanation is the manufacture of 24-wire layers.

As already mentioned, the length of lay of a stranded layer of this kind corresponds to 110 times the wire diameter. Consequently, the preliminary stranding of the 4 wires, which stranding must agree in length of lay exactly with the length of lay associated with the stranding of the 24-wire layer, corresponds to 110 times the diameter of the wires to be stranded. These 4-wire pre-stranded bundles can comprise six to eight or even more wires. As described, however, the lengths of lay must be exactly the same as the stranding lengths of the prestranding and as the stranding of the 24-wire layer. Clearly, the novel process can be used to prestrand for example 8 wires. Since 8-wire prestranded bundles produce hollow or tubular cores, the 8-bobbin strander must have special provision to ensure that the 8 wires are stranded to identical lengths.

This kind of manufacture requires only a three-bobbin strander to produce a 24-wire stranded layer. Three-wire or four-wire prestranded bundles do not produce tubular vanes and can be prestranded to identical lengths in known manner, without special means, by passing through

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an appropriate pressing jaw. This produces, with this new stranding procedure, the technically desired equal length stranding of the wires.

As will be apparent from the embodiments hereinbefore described on the basis of a 24-wire layer, the lengths of lay required for stranding are very large, and so the haul-off speed becomes excessive, corresponding to wire thicknesses, and requires limiting. Instead of the conventional high-speed stranders, therefore, short low-speed stranders are used having, for instance, 3 bobbins, to produce a normal 24-wire stranded layer. Because of the advantages of this step, it is suggested that the pay-off bobbins of the stranders be so large that the wires or pre-stranded bundles wound on the bobbins have very long pay-off lengths. Since all the wires involved in the pre-stranding step are complete and soldered together, for instance, 24-wire layers in which the prestranded bundles are of equal length can be produced without interruption until the bobbins are empty.

When the process according to the invention is used to strand stranded layers, a superficial estimate shows that the same output can be achieved in premises half as large as the conventional large premises and with less labor than conventionally, since the overall lengths associated with the novel process are one-third or less of the 60 meters of the conventional systems.

FIGS. 8-16 give some idea of various forms of the novel wire rope, the shape resembling a V-belt, the rope for example being used advantageously as an endless V-belt. In this V-rope, cast steel wires are stranded around a shaping rope center or core consisting of soft mild steel wires of the same thickness. The wires of the core, having been stranded by a novel system to be described herein-after, are rolled to form the required core or to the required core shape, to give a finished product in the form of a steel conveying element and a novel V-belt.

The known V-belts depend for their strength and performance upon the strength of the known silk and textile cord yarns placed as tension yarns in the zero stress layer. A recent trend, more particularly with narrow V-belts, is to use tension yarns made of high strength polyester or polyamide. Since the thickness and quantity of the inserted yarns are determined by considerations of space, the only way of increasing the performance of the known V-belts is to provide a completely new form of construction and nature for them, more particularly because, when the endless V-belt runs over pulleys, compressive stresses are produced below the strengthening neutral layer insert of yarns and tensile stresses are simultaneously produced above the neutral layer so that the belts are heavily stressed. The reason for this is that the compression tends to increase volume and, depending upon the extent of bending in this zone of the belt, leads to corresponding pressures between the sides of the pulley groove and the sides of the belt. The tensile stresses, on the other hand, tend to reduce volume and cause the belt flanks to disengage from the groove flanks.

All this impairs the performance of the belts and so, in accordance with the invention, V-belts are manufactured from very strong steel wire in stranded form so that all the wires share in the tensile stressing and, because of the stranding of the wires, there can be no change in the belt flanks which engage with the flanks of the pulley grooves.

FIG. 8 is a view in cross section of a V-rope in which all the wires are made of mild steel wire stranded, as shown by straight boundary lines, in various layers consisting for example in known manner of 1, 6, 12, 18, 24, 30, 36, 42, 48 and 54 wires, to give a total of 271 wires. As FIG. 8 shows, these 271 wires provide, as the boundary lines indicate, a V-rope which is in cross section trapezoidal and which, due to the stranding of the wires, resembles a flexible rod and which serves as a shaping insert or core, either of mild steel wire or of very high strength and very hard cast steel wire. The first such stranding begins, in accordance with FIG. 8, with the

production of a core of 1+6 wires. After conventional stranding of these 7 wires, the core thus produced goes through an apparatus which will be described in greater detail hereinafter and which produces by rolling the required surface formation for the desired insert shape—that is, the 7-wire core is compressed to the required shape. Once this insert has been produced, twelve wires are in known manner stranded over the 7-wire shaping insert whereafter the finished 19-wire core is compressed to the correct shape and standards by rolling. This procedure continues until the 54-wire stranded layer has been produced. Consequently, as the boundary line shows, a V-shaped flexible wire rope is produced in every layer. To use the novel rolling process for the manufacture of cores, the wires must be of a soft consistency, and this requirement is met in known manner in rolling by pressure to the yield point, giving a hardness and strength increased by up to 45%.

FIG. 9 shows the technical construction of a V-rope in which an insert of 19 mild steel wires has had a covering layer of 18 cast steel wires stranded over it.

In the embodiment shown in FIG. 10, the same shaping insert has been stranded over with two layers, that is, 18+24 wires of cast steel wire. Reference should be made more particularly to FIGS. 4 and 5 in order to have a clear realization that in this standard construction of wire rope, a corresponding wire thickness and wire number can be achieved because of the required bending limit and because of the total strength of the V-rope, due allowance also being made for the widths of the flanks of the V.

Referring now to FIGS. 11 and 12, a shaping insert has had 24 cast steel wires stranded over it in one case and 24+30 cast steel wires stranded over it in the other case. Since the insert consists of 37 mild steel wires, the height of the V flanks has been increased so that an increased number of wires produces this surface formation. This raising of the V flanks is very important so far as the ability of V-ropes to deal with compression is concerned. In FIG. 6 the same feature is provided by increasing the shaping insert from 61 to 91 mild steel wires. The wire ropes shown in FIGS. 6 and 7 have an insert of this kind consisting of 61 mild steel wires.

The two rope constructions shown in FIGS. 13 and 14 differ from one another. In the construction shown in FIG. 13, a shaping core comprising 61 mild steel wires has two layers of cast steel wire stranded around it, whereas in FIG. 14 the same insert has two layers of bundles stranded around it. Consequently, these novel V-ropes can comprise either stranded bundles or individual wires. Also to be gathered from FIGS. 13–16 is the fact that stronger ropes can readily be built up with far more wires, and the shaping inserts can be made, for instance, of plastics or some other bendable material, since the main function of the shaping inserts is to provide shaping with very good strength as an amplification of the total strength of the V-rope.

V-ropes or belts are usually required in endless form, that is, closed on themselves. V-ropes of the kind in accordance with the invention can be produced in this way, and one endless V-rope according to the invention is shown in FIGS. 17 and 18. The inner ring of the rope or belt—that is, the shaping insert or rope core of mild steel wires or of some other flexible material—is produced first; for instance, the ends of a required peripheral length are joined together by welding or soldering. The endless ring which has thus been produced and which has the required V-shape in cross section is then surrounded over its entire peripheral length by a single cast steel wire, to correspond to the stranding of a number of wires corresponding to the periphery of the V cross section. For instance, if an 18-wire overstranding corresponds to the peripheral length of the V cross section, the first convolutions stranded must have a pitch length corresponding to the 18-wire overstranding. This kind of manufacture is known in the rope-making art for the production of end-

less wire rope loops, except that the single wire or single core wire rope loops have a circular cross section, in contrast to the V-wire ropes according to the invention with surface formation.

FIG. 18 shows the stranded layers of the shaping insert produced, for instance, from soft mild steel wire, the insert being emphasized by the straight boundary lines.

The bending capacity of these novel V-belts depends upon the wire thickness used and, because of the many possible constructions as shown in FIGS. 8 to 16, can be made at least equivalent to every known form of V-belt of the prior art.

To compress the shaping center of V-shaped wire ropes of the kind described by rolling, an apparatus previously referred to is suggested and is shown in FIGS. 19–21. The angular relationships of the required rope center of V- or trapezoidal cross section are used in this apparatus to provide some of the pressure for compression. The compressing or condensing apparatus has a machine frame 100 having, in the direction which is indicated by an arrow 101 and in which a wire rope center 102 passes through the apparatus for compression, a vertically acting first pair of compressing rolls 103, 104, a second pair of compressing rolls 105, 106, a third and laterally operative pair of compressing rolls 107, 108, and a hold-down roll 109 associated with the rolls 107, 108, the various roll pairs being disposed consecutively in the order mentioned. The top rolls 103, 105 of the first and second pairs are rotatably mounted in a common stirrup or the like 111 adapted to pivot horizontally and transversely of the direction 101, and the transversely acting rolls 107, 108 of the third pair have their axes at an inclination to one another to suit the required V-angle of the rope cross section.

As FIG. 21 shows, the top roll 103 and bottom roll 104 of the first pair are formed with ring grooves 112 so devised that raised peripheral portions 113 left between the grooves 112 compress substantially half the parallel surfaces of the rope center 102. The rolls 105, 106 of the second pair have a smooth cylindrical surface and therefore compress, subsequent to the action of the first rolls 103, 104, the second half of the said parallel surfaces.

A hand wheel 115 coupled with a spindle 114 (FIG. 21) is provided to adjust the compression provided by the top rolls 103, 105 of the first and second pairs. The force of the compressing pressure is adjusted via an intermediate set of cup springs 116. Similarly, the hold-down pressure of the hold-down roll 109, which is disposed at the same level as the third pair of rolls 107, 108, can be controlled via a spindle 117 and set of cup springs 118. The spindle 117 is connected via pinions 119–121 to the hand wheel 115 so that the two spindles 114, 117 can be operated together. As can be gathered more particularly from FIG. 19, the springs 118 for the hold-down roll 109 are weaker than the springs 116 for the top rolls 103, 105 of the first and second pairs, for the reason that only a relatively small pressure is required to hold down the roll 109, much of the hold-down action being provided on the basis of the angular relationships in the cross section of the rope center 102. As can be gathered from FIG. 20, the width of the roll 109 is less than that surface of the rope center 102 which is urged by the roll 109, so that the same roll 109 can be used for a number of rope centers 102 of different cross-sectional sizes.

As FIG. 20 shows, another spindle 122 is provided to adjust the distance between the laterally acting rolls 107, 108 of the third roll pair and is connected to another hand wheel 123 visible in FIG. 21.

The rope center 102 moves through between the compressing rollers 103–108. Since the rolls 103, 104 of the first pair compress one half of the said parallel surfaces and the rolls 105, 106 of the second pair compress the other half, the pressure required for correct compression is shared half each by the first two pairs of rolls.

As the foregoing description shows, the novel V-ropes can be used as a conveying element and as V-beltting. De-

pending upon their sensitivity to compression, the known V-belts have trapezoidal angles of from 34 to 38°. Their efficiency is therefore limited, for if this angle is less than, for instance, 15°, efficiency goes up by from 4 to 10 times. Also, the tensile strength of the known V-belts is too slight to permit of any great increase in efficiency.

Steel V-ropes according to the invention as hereinbefore described have a trapezoidal angle, for example of 12°, and their efficiency is therefore about four times as high as for the known V-belts. Since the tensile strength of steel wire is such that a V-belt made from it gives an at least tenfold increase in efficiency, the novel suggestion of greatly reducing the trapezoidal angle of V-ropes to increase efficiency is completely justified.

This increased efficiency provided by steel V-belts greatly increases the pressures acting on the flanks of the V as compared with the known system. The pressure conditions, more particularly because of the coefficient of friction of steel in relation to the material used for the pulley grooves, are in a relationship which affects the efficiency of the V-belt drive. It is therefore suggested that for very high efficiency V-belt drives, the pulley grooves be made of a material, such as ceramic, which has a very high coefficient of friction in association with steel.

To explain this feature more clearly, a description will be given, as one possible use of the novel V-belts, of a novel conveyor developed by way of example.

The conveyor of this kind is shown in FIGS. 22 and 23 and has a load-conveying disc 200. The operation of a V-rope as a conveyor element and as V-beltting can be gathered from these figures. A V-rope 201 is in frictional engagement with a groove in the pulley or disc 200. The angular relationships of the trapezoidally angled rope 201 engaging in a matching V-groove are such that the operative engagement between the pulley 200 and the rope 201 increases in proportion as the inclination of the wedge flanks is greater and as the ends of the rope 201 are more loaded. When the loading at each end of the rope 201 is the same, the flanks of the rope 201 engage over half the surface of the pulley 200 with a specific pressure depending, in accordance with the load, upon the particular trapezoidal angle used. Consequently, the rope 201 shown as a conveying element can be so operatively connected to the pulley 200 in accordance with the self-loading by its own weight, including the load to be conveyed, with an appropriate choice of trapezoidal angle of between 4 and 30°, that the mere act of placing the rope 201 in the pulley groove substantially precludes any slipping of the rope 201. To preclude all risk of slipping and to provide much greater reliability than can be provided in known conveying systems, it is suggested for this novel conveying system that, in its arcuate passage around the pulley 200, the rope 201 not only be placed under pressure by its own weight (including its load) but also be positively pressed into the pulley groove like a wedge.

One known way of doing this is for presser rolls to force the rope 201 into the grooves at the places where the rope enters and leaves the same, the arcuate portion of the rope around the cable being under pressure over the entire length of the arc because of the self-jamming action provided by the wedge angle of 30°. Alternatively, and as shown in FIGS. 22 and 23, an endless V-belt 202 in the form of a V-rope so engages with the arcuate portion of the rope 201 that an endless rubber spring 203 connected to the endless V-belt 202 forces the rope 201 into the pulley grooves at the required pressure. The endless belt 202 runs around guide rolls 204, and the endless rubber spring 203 is rigidly connected to that side of the belt 202 which is next to the rope 201. The rolls 204 are rotatably mounted in brackets 205. An adjusting screw 206 is provided for pressing on the rope 201 through the agency of the belt 202 and associated rubber spring 203 so that despite minor unevennesses the disc

or pulley 200 operates satisfactorily with the rope 201 under pressure.

This novel conveying system has advantages in economy, safety of conveyance and rational working, since the windings and guides which were previously essential can be omitted, so that all the risks associated with them are obviated, and the number of loops previously necessary in conveying ropes can be reduced by half, so that the working life of the ropes is at least doubled.

Also, the effect of the angular relationships of the rope 201 and the pressure on the arcuate part of the rope extending around the pulley 200 and the coefficient of friction provide an operative connection between the rope and the pulley such that load conveyance by wire ropes reaches a level of safety never achieved previously. A V-belt of known kind would not have the rupture strength essential for such a performance.

To increase the friction between the pulley 200 and the rope 201, the groove in the pulley 200 has ceramic flange inserts 207.

The invention also relates to modifications of the forms set forth in the annexed claims and relates more particularly to all the features of the invention disclosed individually or in combination throughout the description and drawings.

Having described my invention, I claim:

1. A wire rope of polygonal cross section, comprising a center of individual longitudinally extending wires compressed to quadrilateral cross section, and uncompressed wire on the outside of and extending lengthwise of said center.
2. A wire rope as claimed in claim 1, in which said uncompressed wire is parallel to said center.
3. A wire rope as claimed in claim 1, in which said uncompressed wire is wound about said center.
4. A wire rope as claimed in claim 1, in which said quadrilateral cross section has four straight sides.
5. A method of making wire rope, comprising compressing to polygonal cross section a plurality of longitudinally extending steel wires, and disposing on the outside of said compressed wires at least one layer of uncompressed longitudinally extending steel wire.
6. A method as claimed in claim 5, said polygonal cross section having a plurality of contiguous straight sides.
7. A method as claimed in claim 5, in which said polygonal cross section consists of four straight sides.
8. A wire rope of trapezoidal cross section, comprising a center of individual longitudinally extending wires compressed to quadrilateral cross section and having two sides disposed at an angle to each other of about 4-30°, and uncompressed wire on the outside of and extending lengthwise of said center.
9. A method of making wire rope, comprising compressing to polygonal cross section a plurality of longitudinally extending steel wires in a plurality of layers with compression upon the addition of each layer, and disposing on the outside of said compressed wires at least one layer of uncompressed longitudinally extending steel wire.

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FRANK J. COHEN, *Primary Examiner*.

D. E. WATKINS, *Assistant Examiner*.