Feb. 26, 1935. H. D. L. LLOYD 1,992,707

MANUFACTURE OF ROPES AND THE LIKE

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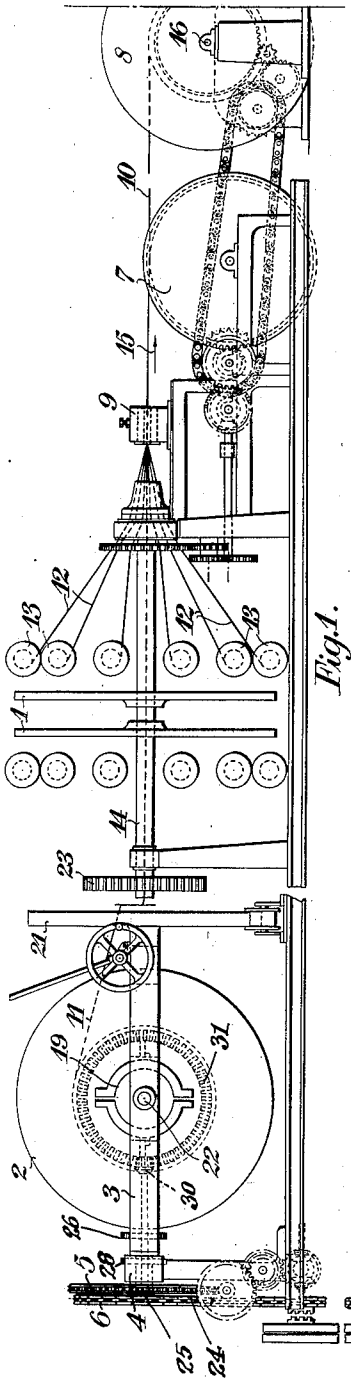

Fig. 1.

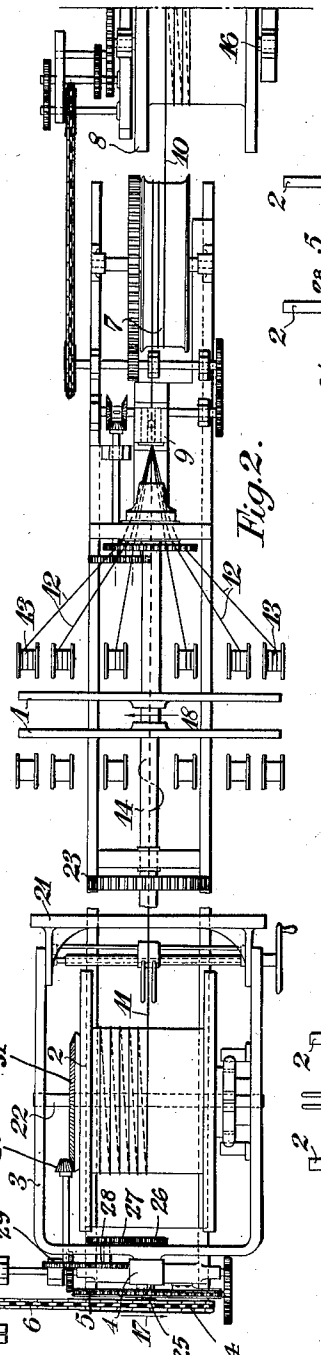

Fig. 2.

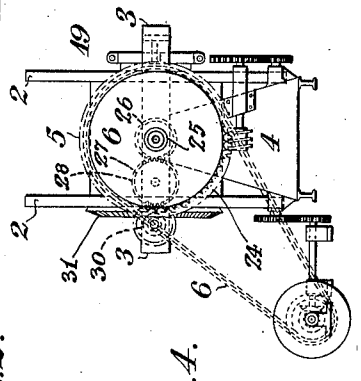

Fig. 4.

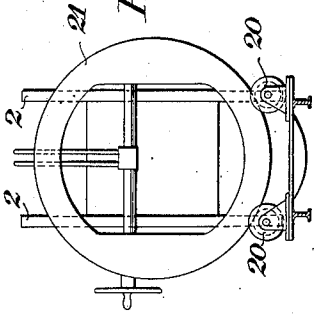

Fig. 3.

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MANUFACTURE OF ROPES AND THE LIKE

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6 Claims. (Cl. 117—17)

This invention relates to the manufacture of ropes and the like, and more especially to the construction of the locked coil wire ropes such as used for colliery winding gear, sinking, or other ropes built on the concentric or multiple strand pattern, more particularly of the non-rotating type.

The full lock concentric type of wire rope apparently originated with Messrs. Batchelor and Latch, (see for example, Batchelor and another, British Letters Patent Nos. 5724/84 and 3407/85). It has come into prominent use in modern colliery winding gear, and the ordinary methods of construction practised by manufacturers who now manufacture these ropes in Great Britain have been fairly satisfactory as far as the smaller sizes of ropes were concerned.

The methods of construction have been largely by rule of thumb, and the details of design and actual work of construction largely left to experienced and skilled operators.

In the smaller sizes of locked coil ropes used for winding gears, the stresses are comparatively light and have not led to serious difficulties being experienced in general, and in many cases the full statutory life of three and a half years can be worked. With the more modern colliery gears winding increasingly heavy loads from great depths, larger diameters of rope with greatly increased stresses have been introduced, and in these serious trouble has been experienced very often after only a few months of working, difficulties developing which may be described in terms used in the wire rope trade as:—

Bird caging, spiralling, waviness, slack cover, unlocking of the covering wires and broken wires.

Since the tendency for any layer of steel wires or strands laid up helically in a concentric cable or a rope is to unlay or untwist in the opposite direction to that in which it is laid up, a truly non-rotating cable or rope can only be secured by arranging for the tendency to untwist of layers laid up in one direction to be exactly balanced by the tendency to untwist of layers laid up in the opposite direction.

This is difficult, if not impracticable to secure by the ordinary methods hitherto employed, and I have discovered that practically the whole of the serious troubles thus found to develop in the heavier locked coil winding, or similar non-rotating ropes, are due to this difficulty of securing exact balance.

In the one case where the layers of the core (that is the built-up concentric strand on which the final cover of locked wires, or the like is to be placed) are all laid up in one direction or to one hand, with the outer covering wires laid in the opposite direction, the outer covering wires having a larger individual section area, and greater leverage distance from the central axis of the rope, exert a stronger untwisting moment than the wires of the core when the rope is free from the machine in which it has been made, and cause a revolution of the rope upon its own axis in the direction of untwisting the outer covering wires, with a corresponding twisting up of the core, until the whole rope is in balance, and no further movement takes place.

This can be observed when watching a rope let down a hoisting shaft for the first time, and when fully run out it will be found that up to one or more complete revolutions have taken place in the direction of untwisting the outer covering wires, which process will often continue after the rope is put to work.

Alternatively, if the core is made cross-laid, that is some layers to one hand and other layers to the other hand, either alternately or in pairs or in any other way, the core is already partly balanced before the outer covering wires are laid on, and offers even less resistance than in the previous case to the tendency to untwist of the outer covering wires.

This process of untwisting lengthens the lay of the outer covering wires, leaving them slack upon the core, at the same time twisting up and shortening the lay of the core (which is assumed to be laid up with all layers in one direction as in the first case mentioned opposite to that of the outer covering wires): In the simultaneous shortening of the lay of the core, the diameter of the core is reduced, I have found in practice, by as much as some 2/1,000ths of an inch, leaving the cover slack upon the core by this amount, plus the slackness due to the lengthening of the lay of the outer covering wires.

In ropes working under high stresses, this slackness is the original cause of the difficulties and troubles experienced.

In the case of the smaller ropes not working under high stress, the same process occurs, but the slackness distributes itself fairly evenly as a rule over the whole length of the rope, and is not often a source of serious trouble.

The object of the present invention is to provide a method for making ropes which are free from or substantially free from the difficulties

described in the case of such ropes, whether small or large, and whether working under high or low stresses, and is based on the prevention of the untwisting of the covering wires when the rope is first released off its reel after being manufactured, or after being put to work.

The invention consists in a method for the manufacture of ropes and the like according to which the tendency of the core to untwist is increased by putting extra turns into it by rotation whilst the outer wires or the like are laid around it.

The invention also consists in a process for the manufacture of ropes and the like in which extra turns or twists are given to the core whilst it is in the process of having the final outer covering of locked coil wires or the like placed upon it.

The invention also consists in a process according to either of the preceding two paragraphs in which the core, that is, the built-up concentric strand on which the final covering of locked wires is to be placed is laid up in one direction or to one hand, and not what is called cross-laid, that is, some layers to one hand and other layers to the other hand either alternately or in pairs or in any other way.

The invention also consists in a modification of the process according to the preceding paragraph in which the layers of wire or the like near the centre of the core are laid the opposite way to the rest.

The invention also consists in a process according to any of the preceding four paragraphs in which the core is wound back after each layer is applied so that the starting end for each concentric layer is the same.

The invention also consists in a process according to any of the preceding five paragraphs in which extra turns are applied to the core after it is made, to remove the natural spring of the core wires and reduce the outside diameter of the core by an appreciable amount of several thousandths of an inch, so as to form a solid bed for the outer covering wires to lie upon.

The invention also consists in apparatus for carrying into effect processes according to any of the preceding six paragraphs comprising a covering machine and a core rotating machine.

The invention also consists in an apparatus according to the preceding paragraph provided with an additional appliance for winding or rewinding the core on to the core twisting gear for the purpose of applying each layer of the core in the same direction from end to end.

The invention also consists in processes for the manufacture of ropes and the like substantially as herein described.

The invention also consists in apparatus for the manufacture of ropes and the like substantially as herein described.

The invention also consists in ropes or the like such as may be made by the processes or with apparatus substantially as herein described, including ropes or the like which do not substantially revolve or tend to revolve when first released from the reel after being made or subsequently in a direction which untwists or tends to untwist the covering wires, but may even revolve in a direction to twist up the covering wires and so shorten the lay and tighten the outer covering wires on the core.

Referring to the accompanying diagrammatic drawing:—

Figure 1 is an elevation of an arrangement according to one form of the present invention, the core entering the hollow shaft of the covering machine and the rope leaving the draw-off drum of the covering machine being shown broken in two places to avoid unnecessary length in the illustration.

Figure 2 is a plan of Figure 1.

Figure 3 is an end view of Figure 1, looking from right to left, the parts in front of the part 21 (referred to below) having been removed; and

Figure 4 is an end view of Figure 1 looking from left to right of part 21, the part 21 and the rest of the machine to the right of it in Figure 1 having been removed.

In carrying the invention into effect in the form illustrated by way of example, there are provided a covering machine 1 of the usual disc or other type, a core carrying drum 2 mounted in a rotatable carriage 3, carried in a bearing 4 at the rear end, and on trunnion bearings at the front end, as shown.

The core carrying machine is provided with suitable gear 5 for revolving the carriage, and the core carrying drum in either direction, and also provided with another set of gears 6 for rotating the core carrying drum in the carriage when in-winding the core.

The core drum rotating gear is driven independently of the frame rotating gear by means of a shaft which passes through the shaft carrying the latter. This is effected as follows:—Wheel 5 is attached to the end of the shaft forming part of the core drum carrying frame, and serves to rotate the whole frame through the worm and worm wheel illustrated. Wheel 6 is attached to a shaft which passes through the main frame shaft just referred to, using the latter as a bearing, and driving through a train of wheels to the core drum rotating gear.

The covering machine 1 has the usual draw-off drum 7 and a drum 8 for winding on the finished ropes, with means for rotating the various elements.

There are also provided suitable die boxes such as 9 for the rope 10. The core drum 2 carries the complete core 11, that is the whole of the inner body of the rope ready to be covered by outer wires 12, carried by the bobbins 13 of the covering machine 1 to form the complete rope. The core 11 is drawn off from the core drum 2 by the draw-off drum 7, and passes through the hollow centre shaft 14 of the covering machine 1. From this hollow shaft 14 the core 11 with wires 12 as a covering passes through the closing die box 9, where the formation of the rope 10 is completed.

The draw-off drum 7 causes the core 11 with the covering wires 12 to be drawn in the direction of the arrow 15 through the die box 9, whilst discs 1 of the covering machine carrying the fixed bobbins 13 revolve around the core 11 so as to lay the wires 12 as a covering on to the core 11 in the die box 9 forming the rope. From the draw-off drum 7 the rope passes into the take-up reel 8 mounted on shaft 16 driven by any suitable means such as gearing or chain drive with appropriate slipping clutch.

Whilst the wires 12 are being thus laid on to the core 11 at this point, the frame 3 carrying the core drum 2 is revolved on its axis by means of the gears 5 so as to rotate the free part of core 11 between the drum 2, and the die box 9 upon its own axis.

The direction of rotation of the frame 3 is opposite to that of the rotation of the machine 1, that is to say, looking from the core drum 2

towards the covering machine 1 the core drum may be revolving in a clockwise direction and the machine 1 revolving in a counter-clockwise direction, as diagrammatically illustrated by the arrows 17 and 18 respectively.

Owing to the layers of the core 11 being all laid up to one hand and the outer covering wires to the opposite hand, the method of revolving the core on its axis in the opposite direction to that in which the covering bobbins are revolving in the machine will twist the core more intensely in the direction in which it has already been laid up in stranding the several layers. The revolving of the core drum 2 by way of the frame 3 need not be and is preferably not at the same speed as the revolving of the machine 1 carrying the covering bobbins 13, the difference between the speeds being modified as desired according to the construction and type of rope being made.

In order to prevent rotation of the frame 3 and its associated parts about its axis when in-winding the core 11, a suitable catch or stop device may be employed.

In order to provide the necessary tension in the core as it is being drawn off the core drum 2 by the take-up drum 7, a brake drum is introduced as shown at 19, with adjustable brake-shoes to enable the tension to be regulated according to the size of rope being made. While this brake 19 is in operation, the pull due to the draw-off drum 7 is substantially resisted by flanged rollers 20 co-operating with disc 21, which is associated with the frame 3.

The brake-drum is attached to the side of drum 2 with the outer contracting members attached to the side of the frame, with suitable regulating gear for giving definite tensions as the drum 2 revolves upon its shaft 22.

As indicated above, the effect of rotating the core by rotating the frame 3 is to impart to the core 11 a twist which is in counter direction or in opposition to the wires 12 which are being placed on the core in the opposite angle or hand of lay.

The rotation of the main covering machine 1 is provided by main driving wheel 23 keyed to the hollow central shaft and driven through suitable trains of gearing from motor or line shaft by belt, clutch or other suitable means.

This rotation of the core upon its own axis has the effect of reducing slightly the diameter of the core by a few thousandths of an inch, this resulting or tending to result in a more solid contact between the separate layers of wires in the core and between the surface of the core and the outer covering wires. In brief, therefore, I mount the core in a special carrier at the back of the final covering machine, and as close thereto as possible, this carrier being arranged with its central axis coincident with the centre line of the closing machine, and with an arrangement for revolving the carrier on its axis at the same time as the core is paying off from the drum placed in the centre of the carrier; means being also provided to put tension upon the core as it is being drawn off and covered by the covering machine.

I put, by means of this carrier, (mechanically or manually rotated with suitable gear) extra turns into the core, whilst it is in the process of having the final outer covering of locked coil wires placed upon it.

I find in practice that varying with the size and construction of the rope turns may be beneficially put into the core by the machinery described, of the order of one complete turn for each 50 to 100 feet. It would be possible to put even more turns in, but this I have found unnecessary to get good results in practice.

I also find that the core should be under tension and definitely revolved in order to force the extra turns right through the core up to the point at which the covering wires are applied at the front of the machine.

Further, I find that putting extra turns into the core after it is made in the manner described removes or tends to remove the natural spring of the core wires and reduces the outside diameter of the core by as much as 2/1,000ths or even 3/1,000ths of an inch, forming by that means a more solid bed for the covering wires to lie upon, and to this part of the invention I attach very great importance.

It is the usual practice to allow a small clearance between the neighbouring wires in the individual layers of a concentric cable, calculated in a circumferential direction, for the purpose of allowing the rope to bend freely over the necessary working pulleys and drums, and clearances of 2/3,000ths of an inch between wires are usual, and I find that no increase in this allowance is needed to provide clearance for the extra turns which I put in the core, under my invention, the usual allowance referred to being sufficient to prevent the wires becoming unduly crowded or overstressed in my process.

Having had extra turns put in after it is originally completed, the core has a very much greater tendency to untwist, and therefore a much greater resistance to the tendency of the covering wires to untwist in the opposite direction. In practice the tendency of the core to untwist may be sufficiently increased in this way against the action of the covering wires in their tendency to untwist to create even an opposite effect, i. e., to make the rope revolve when first released from its reel after being made in a direction which twists up the covering wires, and so shortens the lay and makes the cover solid and resistant to the high stresses encountered in working.

The layers of the core may be made of wires of any suitable section, for example, round, flat, segmental, half lock or full lock. Suitable half lock layers may be formed from wires of round and of rail sections alternating.

I find in practice that so long as sufficient extra turns are put into the core during the final process of its being covered by the final locked wires to prevent the rope revolving when released from its reel in a direction tending to untwist the outer covering wires, all the difficulties usually encountered as already described are substantially removed. Extra turns may be put in as a separate process after or during the stranding of the core.

Whilst my method serves to produce a truly balanced rope, and obviates the difficulties usually encountered as already described, I have discovered that by extending the process of putting extra turns into the core so as to make the rope tend to revolve when free from the machine in which it is made in a direction which definitely twists up the outer covering wires tighter upon the core, I secure a means to take up the wear which occurs between the outer covering wires and the core, and even between the different layers of the core in working.

In practice the best results would appear to be secured by giving the rope a pronounced overbalance, that is to say, giving it a tendency to revolve when free from the machine in which it is made in a direction which twists up the outer

covering wires, making them tighten upon the core until the whole rope is in balance.

The invention is applicable to all kinds of non-spinning or non-rotating ropes such as round strand ropes with two or more layers, usually termed multiple strand construction, and for example the flat strand non-rotating steel wire ropes in which there is a core with one or more outer layers of flat strands forming the outside of the core and placed in position before the process of putting extra turns in the core whilst the latter is being covered by a final single outer layer of flat strands.

It is preferred as indicated above that the core shall be wound back on to the carrier bobbin after each layer is applied so that the starting end for each concentric covering layer may be the same.

The object of this operation is to smooth out any slackness that may occur in any layer through any cause such as may occur in the closing dies, slipping, insufficient tension in the bobbins, inequalities in the diameters of the wires, so that such slackness is transferred to the end of the rope and thus removed in the final operation.

Cores for the purposes of the present invention are preferably all laid in one direction or to one hand as distinct from what is called "cross-laid," that is, some layers to one hand and other layers to another hand, either alternatively or in pairs, or in any other way, although, if desired, the layers of wire near the centre of the core may be laid in an opposite direction to the rest.

For the purpose of correlating the balancing of the respective untwisting tendencies of the outer cover and the core the ends of the cable or rope must be securely clamped or seized with servings very tightly laid on, so that there is no actual relative movement between the respective layers during manufacture or after completion.

Having now described my invention what I claim as new and desire to secure by Letters Patent is:—

1. A method for the manufacture of ropes and the like comprising the step of positively holding and positively rotating the core of the rope to effect over-twisting and laying covering wires around it when in such condition in a direction opposite to and with less twist than that of the layers of the core for preventing untwisting of the outer covering layer of the rope due to the untwisting reaction of the core.

2. A method as claimed in claim 1, which consists in laying all the wires constituting the core to one hand and the wires constituting the cover to the opposite hand.

3. A method as claimed in claim 1, which consists in laying all the strands constituting the core to one hand and the strands constituting the cover to the opposite hand.

4. A method as claimed in claim 1, where the number of layers in the core is large, which consists in laying the center wires in an opposite direction to those covering them and forming the remainder of the core.

5. A method as claimed in claim 1, which consists in winding back the core after each layer is applied so that the starting end for each concentric layer is the same.

6. A method as claimed in claim 1, which consists in putting in the extra turns as a separate process from but prior to the process of laying the outer wires round the core.

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