

Sept. 5, 1961

O. HAUGWITZ
CABLE TWISTING SYSTEM

2,998,694

Filed Jan. 14, 1958

4 Sheets-Sheet 1

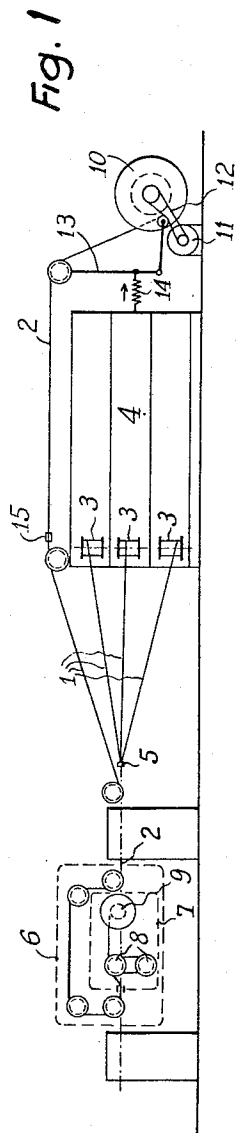


Fig. 2

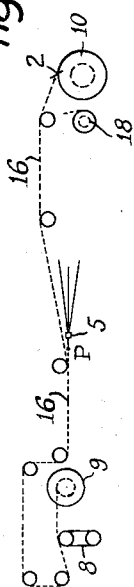


Fig. 3

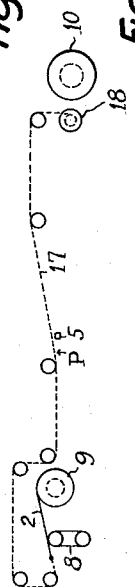


Fig. 4

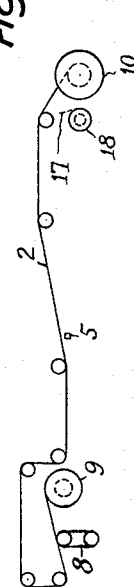
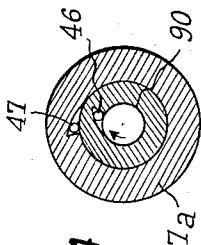


Fig. 7



Sept. 5, 1961

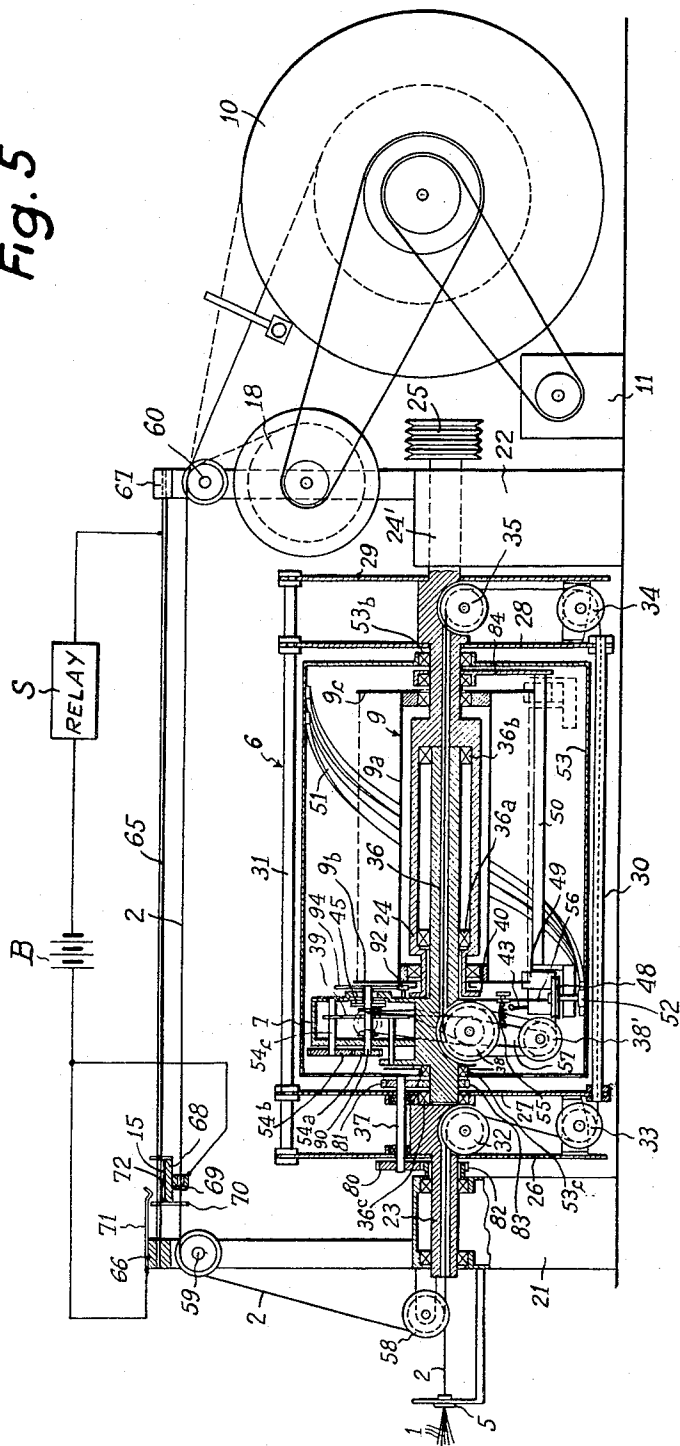
O. HAUGWITZ
CABLE TWISTING SYSTEM

2,998,694

Filed Jan. 14, 1958

4 Sheets-Sheet 2

Fig. 5

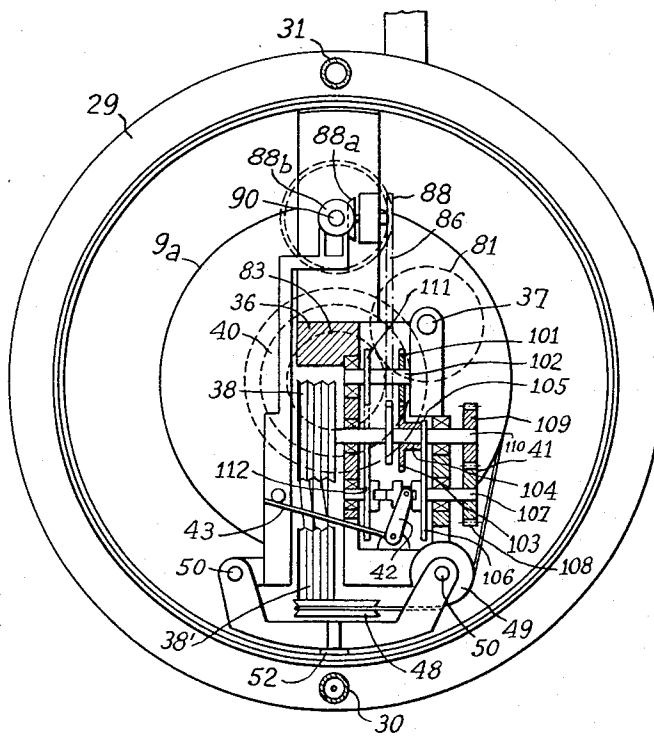


Filed Jan. 14, 1958

CABLE TWISTING SYSTEM

4 Sheets-Sheet 3

Fig. 6



Sept. 5, 1961

O. HAUGWITZ

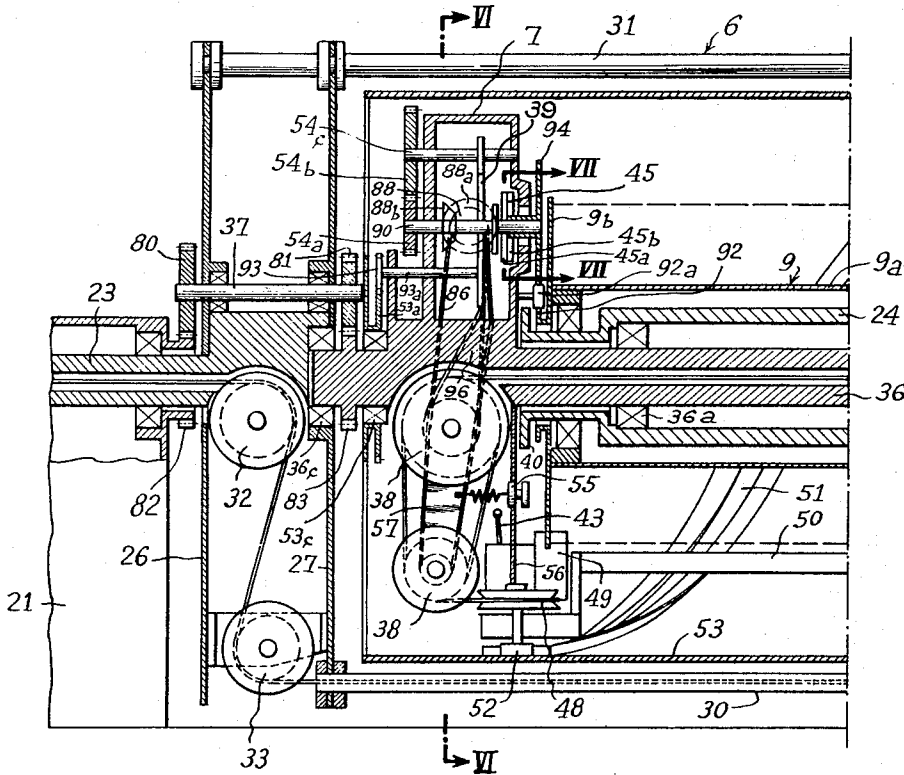
2,998,694

CABLE TWISTING SYSTEM

Filed Jan. 14, 1958

4 Sheets-Sheet 4

Fig. 8



1

2,998,694

CABLE TWISTING SYSTEM

Otto Haugwitz, La Celle Saint Cloud, France, assignor to Societe Anonyme Geoffroy-Delore, Paris, France, a French company

Filed Jan. 14, 1958, Ser. No. 708,802

Claims priority, application France Jan. 17, 1957

12 Claims. (Cl. 57—58.52)

This invention relates to methods and apparatus for producing twisted assemblies comprising two or more flexible elements or strands, of the type in which all the strands are twisted together simultaneously in a common direction and with a common pitch. Systems for performing such operations are herein referred to as throwing systems. One particularly important application of throwing systems and methods is the production of twisted electric cable conductors, and it is in connection with this particular use that the invention will be more specifically described, although it is to be understood that the invention is not limited to that particular use.

Conventional throwing systems usually comprise a feed-out station comprising a stationary frame adapted to carry a number of reels equal in number to that of the strands to be provided in the final twisted assembly and supported in spaced relation on the frame, and a throwing machine comprising a throwing frame rotatable about a horizontal axis and carrying a set of guide pulleys journaled on pivots extending transverse to and radially spaced from the axis of rotation. The individual strands from the feed-out station are led through suitable inlet guide means whereby the strands are gathered together and fed into the throwing frame axially thereof. The gathered strands are then passed over the guide pulleys carried on the rotary throwing frame so as to follow a path which takes them first radially outwards of the frame and then radially inwards again back to the axis of the throwing frame, and are then taken up on a receiver or take-up drum within the throwing frame. On rotation of the throwing frame, the strands are "thrown," i.e. the desired twist is imparted to them simultaneously, and the final twisted assembly is concurrently taken up on the receiver drum rotated at a suitable rate within the machine. The relative rotational velocities are so predetermined with respect to each other as to provide either a single throw or twist of the strands per revolution of the throwing frame, or a double throw or twist per revolution, the latter arrangement obviously achieving a higher production rate than the former.

Difficulties have been encountered heretofore in connection with the breakage of a strand in operation. Conventional apparatus generally include electrical break or fault detectors acting to arrest the operation of the machine on occurrence of a break in a strand. Since the action of such detectors cannot be instantaneous, it often happens that the defective strand has already entered the rotary frame of the throwing machine and has thus been made inaccessible before the latter has been brought to a stop. The loose end of the broken strand can thus remain in the twisted cable assembly resulting in wholly or partly defective end products. To avoid this, it may be necessary to untwist the entire length of cable until the break in the defective strand has been located and repaired, and such operation is long, tedious and costly.

It is an object of this invention to provide improved throwing and/or twisting systems, and especially one in which the final receiving or take-up drum or reel can be provided at a fixed station outside the actual throwing machine. It is a related object of the invention to provide an improved throwing system wherein the detection of a faulty strand can be immediately and positively lo-

2

cated and corrected. Other objects of the invention will appear.

According to one aspect of this invention, there is provided a method of throwing twisted assemblies, such as electric cable conductors, which comprises, in a first step, leading a predetermined length of the strands from an exterior feed-out station into a rotating throwing machine having an intermediate take-up station therein, the linear velocity imparted to the strands in a first direction (force exerted on the strands) being so predetermined in relation to the rate of rotation of the throwing frame rotation as to impart to the strands a twist pitch twice the length of the final desired pitch, then, in a second step, leading the intermediate twisted assembly in a reverse direction from said intermediate take-up station by way of the rotary throwing frame to a final take-up station located exteriorly of the machine, the linear velocity imparted to the strands in this second step being so predetermined with respect to the rate of rotation of the throwing frame as again to impart to the strands a pitch twice the length of the desired pitch whereby to produce a final twisted assembly having the desired pitch. It will be understood that the sense of rotation of the throwing frame remains the same in the second step as it was in the first step and that only the direction of the draft force exerted on the twisted assembly is reversed.

The invention in another aspect provides a throwing system comprising in combination a stationary feed-out station for feeding out separate strands of a desired twisted assembly, an inlet guide gathering the individual strands, a throwing machine comprising a rotatable throwing frame receiving the gathered strands from said input guide and a rotatable intermediate take-up drum in said throwing machine adapted to receive a pre-twisted assembly of strands from said throwing frame, a final take-up drum disposed exteriorly of said machine and adapted to receive the finally twisted assembly from said intermediate take-up drum by way of the throwing frame, and selectively reversible draft means for applying to the strands a predetermined draft force from said inlet guide towards said intermediate drum, or from said intermediate drum towards said final take-up drum. It will be understood that while the system is being operated for the preliminary twisting or throwing step, the intermediate take-up drum is positively driven, while in the final throwing step, the outer take-up drum is positively driven whereas the inner take-up drum exerts a restraining force on the strands.

Inasmuch as the final take-up or receiving station is disposed exteriorly of the throwing machine, and preferably a substantial distance from it insofar as the path of travel of the intervening length of twisted assembly is concerned, it is very convenient to dispose suitable fault detectors along said intervening length operative automatically to arrest the operation of the machine every time some fault or defect in the twisted assembly is sensed (as manifested for example by a slight excess thickness of said assembly or a protruding end of a broken strand). The fault is thus immediately located and can be repaired at once, thereby saving costly shut-down in subsequent machinery and other expensive operations as well as waste and rejects.

It will be noted as already indicated that in each of the two stages of the novel throwing process the draft force and the take-up rate are increased twofold over what would be required in order to produce a similar final assembly by means of a conventional, single-stage process with the same rotational speed of the throwing frame. Hence, the total time required to perform the two-stage process remains, in substance, exactly the same as the time required to produce a similar length of twisted conductor with the one-stage process. However, because

the internal receiver drum does not have to be replaced in the novel process as is necessary in the conventional process, but all that is now necessary is to reverse the direction of draft, a nonnegligible amount of time is gained in this manner, since the replacement of the exteriorly disposed final take-up drum can be effected during the first or preliminary twisting stage of every fresh length of strands in the novel process.

A clearer understanding of the invention will be gained from the ensuing exemplary description given with reference to the accompanying drawings wherein:

FIG. 1 schematically illustrates a throwing system according to the invention;

FIGS. 2, 3 and 4 are similar, partial diagrams illustrating different stages of the novel throwing process;

FIG. 5 is an axial cross sectional view of an improved throwing machine for carrying out the method of the invention;

FIG. 6 is an enlarged end view on the line VI—VI of FIG. 8;

FIG. 7 is a fragmentary section on line VII—VII of FIG. 8;

FIG. 8 is an enlargement of a portion of FIG. 5.

Referring to the diagram of FIG. 1, the novel throwing system comprises a fixed feed-out station 4 supporting a number of reels 3 thereon, each carrying one of the individual strands of the desired twisted assembly, e.g. a cable conductor. The number of strands and hence reels is three in the illustrated example. The strands 1 from the reels 3 are led through an input guide 5 which gathers the three separate strands together and the gathered strands are then passed into a throwing machine which comprises a rotating throwing frame 6 driven in rotation about a horizontal axis. The throwing frame may comprise as shown four guide pulleys including an input pulley 32 and an output pulley 35 adjacent to the axis of rotation of the frame and a pair of axially spaced intermediate pulleys 33 and 34 displaced radially from said axis. The gathered strands from guide 5 are passed to and trained over said guide pulleys 32, 33, 34 and 35 so as to extend over a path in the throwing frame leading first radially outward then radially inward thereof, as shown. Said strands are then passed into a relatively stationary frame or cradle 7 within the throwing machine, being first trained over a dual pair of multi-groove draft wheels or sheaves 8 and then being fed to a take-up reel or drum 9 supported in the cradle 7, said drum 9 constituting the intermediate or internal receiving station of the system. The reason for providing a dual draft sheave assembly 8 will be made clear later.

When the throwing frame 6 is rotated about its axis and simultaneously the draft sheaves 8 and take-up drum 9 are rotated at a predetermined rate and in the clockwise direction as shown in FIG. 1, the strands are twisted together or "thrown" in the sense previously specified and the resulting twisted assembly is taken up on the drum 9. It will be understood that the drum 9 is rotated through friction means with a certain lead relatively to the draft sheaves 8 as will be later described in detail.

A preliminary twisted assembly is thus obtained which is wound upon the drum 9.

In a second stage of the process, this pre-twisted assembly is led out from drum 9, over draft pulleys 8, over the guide pulleys of the throwing frame in the reverse order from that in the first stage, out of the throwing machine by way of an output guide pulley 58, then over further guide pulleys 59 and 60 shown in FIG. 1 as journaled above the feed-out frame 4, and to a final take-up or receiving reel 10. The throwing frame 6 is again driven in rotation in the same direction about its horizontal axis as in the first stage, and the draft sheaves 8 are rotated in the reverse sense from that in the first stage, i.e. counterclockwise herein. Drum 9 in its rotation now lags behind the rotation of the draft sheaves 8. Final take-up drum 10 is likewise rotated to take-up the

finally twisted cable, its rate of rotation being automatically regulated in response to the draft speed of the twisted assembly 2 as determined by the draft sheaves 8. This automatic regulation may be accomplished, as schematically shown in FIG. 1, by driving the take-up drum 10 from a motor 11 by way of a drive belt 12 and adjusting the tension of said belt by means of a tension roller journaled on a pivoted lever arm 13 which tends to be displaced in a direction to increase the tension on drive belt 12 in response to a slackening of the twisted conductor 2, and which is urged in the opposite direction by a spring 14, so as to decrease the tension on drive belt 12 in case of an increase in the tension of the twisted conductor 2.

A fault detector 15 is schematically shown as being interposed on the path of the final twisted conductor 15 between the throwing machine and the take-up reel 10.

Means will now be described with reference to FIGS. 2 to 4 which are preferably used according to the invention for facilitating the practical performance of the novel two-step throwing process. Starting consideration of the operating cycle at that point where a predetermined length of final twisted cable has been reeled up on the final take-up drum 10, and in readiness for the production of a fresh predetermined length of the same value as the reeled length of twisted cable, one end of a flexible element 16 preferably in the form of a chain having axially interpivoted or swivelled links is attached to the body of the internal or intermediate take-up drum 9. The length of the chain is such that when the chain is led out over the guide pulleys of the throwing frame and over the further guide pulleys above the station 4 the free end 2 of said chain in its fully unwound state will just reach to the outer drum 10, as indicated at M in FIG. 2. The end of the swivel chain attached to drum 9 is then wound around the drum 9 by an amount such that the free end of the chain is retracted and is positioned substantially at the point P just short of the guide 5, as shown in FIG. 2. The separate strands from reels 3 are then passed through the guide 5 and attached to the free end of the swivel chain 16 positioned at the point P and the first step of the throwing process is performed. Due to the character of the swivel chain 16 the axially swivelled links thereof can accommodate the throwing action of frame 6 as applied to the chain without any interference from said links, and the first-step throwing operation is performed until the desired length of strands has been fed out from the feed-out reels 3. At this point the strands are severed at the point P and one end of another similar swivel chain 17, fed out from an auxiliary reel 18 (FIG. 2), is attached to the severed ends of the strands extending out of the throwing machine. The first throwing step is then continued until the full desired length of the strands has been subjected to the first throwing operation and the pre-twisted assembly or cable has been taken up on intermediate drum 9. This condition is illustrated in FIG. 3.

The sense of rotation of the draft wheels 8 and drum 9 is now reversed to start the second throwing step. In an initial phase of this second step, the swivel chain 17 is taken up on its auxiliary drum or reel 18 until the free end of the twisted cable has reached a point adjacent to the drum 10. Said free end of the cable is then unfastened from the chain 17 and fastened to the periphery of the drum 10 (see FIG. 4). The second step of the throwing process is then continued until the full desired length of the twisted cable has been wound up on the reel 10. At this time, the first swivel chain 16 has its end positioned at point M at the periphery of the drum 10 and the condition is the same as that in FIG. 2. The chain 16 is unfastened from the length of cable just completed on drum 10 and the operating cycle can be repeated as described. The initial step of the fresh cycle will consist of winding up again the chain 16 about the inner drum 9 until the free end of the chain has reached the point P and fastening the ends of the strands 1 from reels 3 to the chain.

5

It will be noted that by using the procedure just described the full length of strands is utilized, there being no rejects.

It will be noted as already mentioned that the fault detector 15 is disposed at a fully accessible position and makes it possible readily to check that the full length of twisted cable has been correctly thrown and is free of defects.

As also mentioned above, it will be noted that the outer take-up drum 10 can be replaced without loss of time during performance of the first throwing operation and that the inner take-up drum 9 does not in the novel process require replacement at any time but may be retained permanently in its position within the throwing machine. This not only represents a saving of time as mentioned above but has additional advantages. Owing to the permanent mounting of drum 9, the construction of this drum and its associated equipment can depart substantially from the standard construction of similar take-up assemblies as used heretofore and can advantageously be designed to make more efficient use of the available space within the rotatable throwing frame 6. Thus the useful capacity of the drum can be increased so as to permit the take-up of greater lengths of cable than in a comparable machine of conventional type, or conversely for a given useful capacity, the diameter of the throwing frame 6 can be reduced and at the same time its rotational velocity correspondingly increases. This, as well as other novel features of construction, will be described in greater detail in connection with an embodiment of an improved throwing machine as illustrated in FIGS. 5 to 8.

Referring to FIG. 5, the frame of the machine comprises two spaced posts 21 and 22 having end journals 23 and 24' of the rotatable throwing frame 6 rotatably mounted in suitable bearings in said posts. Secured to the outer end of journal 24' beyond post 22 is a multi-groove drive pulley 25 for rotating the frame 6 through a suitable belt drive, not shown. Journal 24' is extended inwardly from post 22 towards post 21 to provide a tubular shaft portion 24 which has a gear 40 secured on its inner end. Gear 40 serves as a movement take-off for driving various components of the machine later described. Secured to the opposite journal portions 23, 24' between posts 21, 22 are pairs of axially spaced discs or flanges including the flanges 26 and 27 adjacent post 21 and flanges 28 and 29 near post 22. The flanges are interconnected by tubular members such as 30 and 31 to provide a rigid frame. Four guide pulleys are journaled on this frame between the pairs of discs in a generally common axial plane about axes transverse to the rotational axis of shaft 24. The guide pulleys include input pulley 32 and output pulley 35 both of which are so positioned that a bottom circumference of the groove in each pulley is substantially tangent to the center axis of the shaft 24 which for this purpose is suitably recessed and is axially bored, as indicated in the drawing. The guide pulleys further include the intermediate pulleys 33 and 34 which are radially offset from the axis of the frame and are respectively positioned in common transverse planes with the pulleys 32 and 35.

A relatively stationary frame or cradle assembly 7, corresponding to the frame similarly designated in the schematic view of FIG. 1, is provided within the throwing frame 6. For this purpose, the frame 7 is supported from an inner shaft 36 which is received within the tubular shaft 24, the latter being rotatably supported about the inner shaft 36 through spaced bearings 36a and 36b as shown. Inner shaft 36 is axially bored in alignment with the axial bore in the end journal portion 24' of shaft 24. Inner shaft 36 has an end projecting axially beyond the inner end of the tubular shaft 24 and rotatably supported adjacent to the journal portion 23 through a further bearing 36c. In this way it will be seen that the inner shaft 36 is able to retain a relatively stationary condition on rotation of the throwing frame

6

assembly 6. The inner shaft 36 and hence frame 7 is held in this stationary condition through a gearing arrangement including two gears 80, 81 secured on the ends of a lay shaft 37 journaled across the discs 26 and 27 and meshing respectively with a fixed gear 82 secured to post 21 and with a gear 83 secured to the adjacent end of inner shaft 36 whereby the inner shaft 36 is held stationary on rotation of the throwing frame 6. Any other suitable means might be used for restraining the inner shaft 36 against rotation with the throwing frame, e.g. a pendulous weighting arrangement in cases where the twisted assemblies to be produced on the machine are relatively small-diameter.

Journaled in the stationary frame 7 in a diametral plane thereof is a radially inner multi-groove draft sheave or wheel 38 positioned so that its inner groove circumference is substantially tangent to the axis of the inner shaft 36 for which purpose this shaft is suitably recessed as shown. A depending lever arm 57 is pivoted on frame 7 coaxially with the sheave 38 and has a secondary draft sheave or wheel 38' journaled on its lower end. The lever arm 57 is resiliently restrained against rocking motion by an adjustable bias spring device 55 adjustably supported by a piece 56 fixed on the frame 7. The purpose of this arrangement will be later described.

It is convenient to indicate at this point that the strands to be twisted are introduced from the reels of the feed-out frame (not shown in FIG. 5 but positioned to the left of the machine there shown) through inlet guide 5, through the axial bore in journal 23, around guide pulleys 32 and 33, through tube 30, around guide pulleys 34 and 35, through the aligned axial bores in shaft 24 and inner shaft 36 and around the multiple grooves in the draft sheaves 38 and 38' and issue from the radially outer sheave 38' towards a coil distributor arrangement 48, 49 and intermediate drum 9 as later described.

The inner or main draft sheave 38 selectively is driven from take-off pinion 40 in one sense or the other by way of a reversible transmission which includes conventional gearing and belt drives only schematically indicated in FIG. 6. The transmission includes a reversing jaw clutch 42 operable by a manual lever 43 between two positions. When the jaw clutch 42 is in the position shown, the sheave 38 is driven through the following gear train. A pinion 101 fixed on a shaft 102 meshes with and is driven by the main drive pinion 40 on the inner end of the rotating shaft 24. The pinion 101 on shaft 102 also meshes with a pinion 103 on a hollow stub shaft 104 carrying a pulley 105. A belt on pulley 105 drives a pulley 106 fixed to one driving element of clutch 42. The driven element of clutch 42 is non-rotatable but axially slidable on a shaft 107 which extends through, but is not fixed to, the pulley 105 and carries a pinion 108 meshing with a pinion 109 on a shaft 110 which extends rotatably through the hollow shaft 104 and pinion 103 and carries the sheave 38. When the jaw clutch is in the opposite position the drive is through a pulley 111 fixed on the shaft 102 and driving through a belt a pulley 112 fixed to the opposite driving element of the clutch 42, the remainder of the drive being the same. When driven in one direction, the sheave 38 draws cable from the throwing frame and feeds it toward the drum 9. When driven in the opposite direction the sheave 38 draws cable from the drum 9 and feeds it toward the take up reel 10. Gears 108, 109 are readily replaceable for determining the drive ratio from throwing frame 24 to draft sheave 38 and thereby determining the throwing or twisting pitch.

The intermediate take-up drum 9 comprises a cylindrical body 9a and end flanges 9b and 9c rotatably mounted on bearings around axially spaced points of the shaft 24, and is driven from the take-off pinion 40 on said shaft through a friction clutch and overrunning means presently described. First, however, means will be described for uniformly distributing the pre-twisted cable

issuing from the outer draft wheel 38' in even helical coils along the length of the drum 9. It should be noted that the possibility of providing the coil distributor means about to be described in the machine of the invention is a direct consequence of the novel feature according to which the take-up drum 9 within the throwing machine need not be removable and hence can have relatively complex equipment associated with it which obviously is not feasible in the case of conventional throwing machines.

Referring to FIGS. 5, 6 and 8, the relatively stationary frame 7 supports a pair of guide bars 50 extending parallel to shaft 24 at equal radial distances therefrom and having their remote ends supported at the outer ends of a spider member 84 rotatably supported through bearings on a portion of shaft 24. Supported on the guide bars 50 for axial sliding displacement along them is a sliding coil-distributor assembly comprising a pulley 48 and roll 49. The arrangement is such that the twisted cable issuing from the outer draft sheave 38' can be trained around pulley 48 journaled at right angles to it and then around the roll 49 journaled at right angles to the pulley 48, to be guided towards that point of the periphery of drum 9 opposite to which the sliding assembly including pulley 48 and roll 49 happens to be positioned at the time. The entire sliding assembly is reciprocated back and forth along the guide bars 50 at a relatively slow rate correlated with the rate of rotation of the drum 9 in order to achieve the desired even helical coiling of the pre-twisted cable around the drum. Any suitable means may be used to achieve this reciprocatory motion of the coil distributor assembly, e.g. a screw-shaft with crossed threads as known per se. In the illustrated embodiment, however, the arrangement used comprises a cylindrical cage or casing 53 rotatably mounted through bearings 53b and 53c around shaft 24 at one end and shaft 36 at the other end. A helical guide groove 51 is formed in the inner periphery of the cylindrical casing 53 and is engaged by a following roller 52 journaled coaxially with the pulley 48. The casing 53 is driven in rotation from the main draft sheave 38. For this purpose, a belt drive 86 is provided from a pulley coaxial with sheave 38 to a pulley 88 journaled in frame 7 and having a bevel gear 88a secured coaxially with it which meshes with another bevel gear 88b secured on a lay-shaft 90 journaled parallel to the frame axis to rotate the lay-shaft in a sense corresponding to the sense of rotation of sheave 38. As is shown in FIG. 8 lay-shaft 90, by way of a set of gears 54a and 54b which are readily replaceable for changing the pitch of the coils on drum 9, shaft 54c and a belt drive 39, rotates a pinion 93 meshing with a gear annulus 53a secured coaxially on casing 53. It will be understood that on rotation of the sheave 38 the casing 53 is slowly rotated and by way of the helical guide-and-follower device 51, 52 reciprocates the sliding assembly of pulley 48 and roll 49 to and fro along the guide bars 50, said sliding assembly moving rightward during one half of each revolution of the casing 53 and leftward during the other half.

The reversible driving connection between draft wheel 38 and take-up drum 9 will now be described. Formed on the inner end of drum 9 is a gear 92 which, through an intermediate gear 92a mounted on frame 7 meshes with a gear 94 rotatably mounted on the outer end of lay-shaft 90 mentioned previously. Gear 94 is adapted to be driven from shaft 90 by way of a friction clutch assembly 45 supported on said shaft. Assembly 45 includes a slidable friction clutch element 45a having a hub portion engaged by the forked upper end of a lever arm 96 integral with lever arm 57 and extending upwardly from it. Further, a clutch element 45b of the friction assembly 45 is connected with shaft 90 by way of a one-way drive or free wheel element 46 shown in the cross sectional view of FIG. 7, and so disposed that on rotation of shaft 90 in the counterclockwise direction which is the direction in which shaft 90 is rotating when draft wheel 38 is rotated

to draw cable towards the drum 9, said clutch element is driven positively with the shaft 90. The clutch element is further connected with a surrounding boss 7a of frame 7 by way of another one-way or free-wheel element 47 disposed oppositely from element 46. The arrangement described operates as follows:

For performing the first stage of the novel throwing process, lever 43 is operated to throw reverser clutch 42 to the position shown in FIG. 6 whereupon draft wheel 38 is rotated from drive pinion 40 in a counterclockwise sense (as in FIG. 5) to feed cable to the coil distributor pulley 48 and hence to drum 9 as already described. At the same time lay-shaft 90 is rotated and hence coil-distributor casing 53 is slowly rotated as also described above to reciprocate the distributor pulley 48 and roll 49 to feed the cable evenly from draft wheel 38' to the drum 9.

Rotation of lay-shaft 90 is at this time effected in such a sense (counterclockwise in FIG. 7) that free-wheel element 46 acts to drive the associated element of friction clutch 45 positively with shaft 90, so that gear 94 and hence drum 9 are driven from shaft 90 through friction clutch 45. The movable element of this clutch is adjusted in axial position through lever arm 95 in accordance with the angular position of the lever 57, 96. Noting that in the stage of the process now being described where the draft wheels or sheaves 38—38' are drawing cable towards the drum 9 the tension of said cable tends to rock the lever arm 57 clockwise (as in FIG. 5). It will be appreciated that the combined action of cable tension and of biasing spring 55 acts continually to regulate the engagement pressure of clutch 45 and hence the speed of rotation of the drum 9 in such a manner as to maintain a substantially constant tension on the pre-twisted cable being reeled up around the drum.

When the reverser clutch 42 is thrown to its reverse position by manual action of lever 43 for the second stage of the process of the invention, rotation of draft wheel 38 and hence that of lay-shaft 90 is reversed. Free-wheel element 46 is now disabled so that the associated friction clutch element is not driven from shaft 90 and therefore gear 94 and drum 9 are not power-driven. Draft wheel 38 is now rotated in a sense to draw cable from drum 9 (by way of distributor device 48—49) and the pull of the cable as it is drawn off rotates the drum 9 in the reverse direction from the direction it was driven during the first stage and in lagging relation with respect to the draft wheel 38. This rotation of drum 9 by cable action rotates gear 94 and the related element of friction assembly 45, but the outer freewheel element 47 is now operative to block the other friction element relatively to the stationary frame 7, so that the friction assembly 45 now acts as a brake rather than a drive and serves to restrain the rotation of the drum 9. At this time, it will be noted that the cable tension on the draft wheels is tending to rock the lever 57, 96 counterclockwise, i.e. in the proper sense to reduce the brake pressure in friction assembly 45. In this manner, the correct lead-lag relationship is at all times obtained as between the draft wheel or sheave 38 and the drum 9, and a uniform tension is at all times maintained in the cable, both during the first and the second stages of the process, without requiring any setting adjustment or other manual operation in transferring from one stage to the other stage, other than operating the lever 43.

In the second stage of the process, the twisted cable is led out of the throwing machine by way of the axial bore in journal 23 as will be understood from the foregoing disclosure and is passed by way of guide pulleys 58, 59 and 60 to the final take-up drum 10 provided externally of the machine and driven through a belt drive from electric slip motor 11. The cable tension regulating means described above with reference to FIG. 1 is not illustrated in FIG. 5. FIG. 5 does illustrate how-
ever the auxiliary pulley 18 also driven from motor 11

and serving to operate the swivel-chain 17 as previously described with reference to FIGS. 2 to 4.

Fault detecting means are associated with the horizontal portion of the path of outgoing cable 2 between the guide pulleys 59 and 60. As shown, the fault detector 15 comprises an apertured guide 69 and an apertured plate 70 of conductive material through which the cable 2 is threaded. Guide 69 and plate 70 are secured in depending relation from an insulating support member 68 which is slidably mounted upon a horizontally extending conducting rod 65 supported at its ends through insulator members 66, 67 from frame posts of the system. Support 68 is normally restrained in a predetermined position on guide rod 65 by means of a spring 72. In case a loose end of a broken strand is present at any point of the outgoing cable 2, such a loose end will make electric contact with plate 70 and complete a circuit through conductive guide rod 65 with a source of voltage B, e.g. 24 volts D.-C., connected with said rod, thereby operating a relay S to arrest operation of the throwing machine. Similarly, in case of an increase in the diameter of the outgoing cable 2 indicative of faulty twisting operation, the entire assembly including guide 69 and plate 70 will be carried toward the right with the cable and plate 70 will engage a contact 71 thereby completing the emergency shut-down circuit. It will be noted that due to the considerable length of the guide rod 65 there is ample time for the emergency system to bring the machine to a stationary condition before the fault-detector unit has reached the end of its travel, thus avoiding breakage of the cable. Guide 69 and plate 70 are each preferably provided in two separable, e.g. inter pivoted, parts to enable the swivel chain and connecting portions to be passed without operating the shut-down means.

It will be understood that a similar fault-detecting arrangement may if desired be associated with the ingoing path of the strands between inlet guide 5 and the throwing machine.

It will be understood that various modifications may be provided in the embodiment illustrated and described without exceeding the scope of the invention. Thus the draft sheave assembly 38 may be provided outside the throwing machine rather than inside as shown. For example, the draft sheave assembly may take the place of the guide pulley 58 in FIG. 5. The final receiver system for the finished twisted assembly may comprise coiling means for taking up the cable within stationary cylindrical drums rather than on rotatable reels or drums as shown herein. While the novel process is herein shown as applied to a double-twist throwing machine, its applicability to single-twist and to multiple-twist systems is evident.

What I claim is:

1. In a system for producing a cable-like twisted assembly from a plurality of strands, means for feeding out said strands from stores thereof, a throwing frame rotatable about an axis, guide means on said frame defining a path for said twisted assembly including a portion extending radially away from said axis followed by a portion extending radially toward said axis, intermediate take-up means in said frame, input guide means for leading said strands in a first sense from the feed-out means to said frame along said axis thereof to be passed over said path on the frame to said intermediate take-up means, final take-up means exteriorly of said frame, output guide means for leading said twisted assembly in a second sense from said frame along said axis thereof to said final take-up means, and a draft unit reversibly operable to a selected one of two conditions for selectively applying a draft force to said twisted assembly to pass said assembly in said first sense to produce an intermediate twisted assembly on said intermediate take-up means, and in said second sense to produce a final twisted assembly on said final take-up means.

2. In a system for producing a cable-like twisted assembly from a plurality of strands, means for feeding out said strands from stores thereof, a throwing frame rotatable about an axis, guide means on said frame defining a path for said twisted assembly including a radially outward portion and a radially inward portion, a first take-up reel rotatable within said frame coaxially therewith, input guide means for leading said strands in a first sense from the feed-out means to said frame along said axis and over said path to be pre-twisted by said frame, second take-up means exteriorly of said frame, output guide means for leading the twisted assembly in a second sense from said frame to said second take-up means, a draft unit engageable with said twisted assembly reversibly operable to a selected one of two positions for applying a draft force to said assembly for passing said assembly in said first sense and in said second sense respectively, and means for rotating said frame.

3. In a system of the type described, a rotatable twisting frame, means feeding out a plurality of strands to be twisted, first reeling means within said frame, second reeling means outside said frame, means leading the strands in an incoming path from said feeding means over said frame to said first reeling means, means leading twisted strands in an outgoing path from said first reeling means over said frame to said second reeling means, and a draft unit engageable with said strands and operable to either one of two conditions for applying a draft force to said strands to draw them selectively over said incoming and said outgoing paths respectively.

4. In a system of the type described, a rotatable twisting frame, means feeding out a plurality of strands to be twisted, first reeling means within said frame, second reeling means outside said frame, means leading the strands in an incoming path from said feed-out means over said frame to said first reeling means, means leading twisted strands in an outgoing path from said first reeling means over said frame to said second reeling means, a draft unit engageable with said strands and operable selectively to a first and a second condition for drawing said strands selectively over said incoming path and said outgoing path, power means for rotating said frame in a predetermined sense, and means connected with said draft unit and said first reel means and operative in said first condition of said drafting unit to rotate said first reeling means from said power means and operative in said second condition of said draft unit to release said first reeling means for free rotation.

5. In a system of the type described, a rotatable twisting frame, means feeding out strands to be twisted, first reeling means within the frame, second reeling means outside the frame, means leading said strands in an incoming path from the feed-out means to the frame, means for leading twisted strands in an outgoing path from the frame to the second reeling means, power means for rotating said frame, a draft sheave engageable with said strands for applying a pulling force thereto and rotatable in one sense to pull said strands over said incoming path and in the opposite sense to pull the twisted strands over said outgoing path, and a drive transmission from said power means to said draft sheave including a reversing gear means.

6. In a system of the type described, a rotatable twisting frame, means feeding out strands to be twisted, a first reel within the frame, a second reel outside the frame, means for leading the strands in an incoming path from the feed-out means to the frame, means for leading twisted strands in an outgoing path from the frame to the second reel, power means for rotating the frame, a draft sheave engageable with the strands and rotatable in one sense to draw the strands over said incoming path and in the opposite sense to draw the twisted strands over said outgoing path, a drive transmission from said power means to said draft sheave including a reverser gear therein operable to a first and a second position for rotating said draft sheave in said one sense and said opposite

11

sense respectively, a driving connection from said power means to said first reel, and means operable on operation of said reverser gear to said second position for disabling said driving connection.

7. In the system claimed in claim 5, distributor means reciprocating adjacent to the first reeling means longitudinally thereof for distributing said strands from said draft sheave in helical coils over said first reeling means, and means for reciprocating the distributor means on rotation of said draft sheave in a direction corresponding to the direction of rotation of said draft sheave.

8. A system as claimed in claim 4, wherein said draft unit comprises a first sheave, a rocker arm pivoted coaxially with said first sheave, a second sheave journaled on said rocker arm and spaced from said first sheave, grooves on said sheaves adapted to have said strands trained therearound whereby rotation of said first sheave will apply a draft force to said strands and the resulting draft tension will tend to rock said arm angularly about its pivot, spring means restraining the rocking movement of said arm, a driving connection from said power means to said first reeling means, said driving connection including a friction clutch therein, and said rocker arm being connected with said friction clutch for controlling the friction of said friction clutch in accordance with the angular position of the arm.

9. In the system claimed in claim 8, first free-wheel means for enabling said friction clutch on rotation of said first and second sheaves in said first condition to drive said first reeling means therefrom and for disabling said friction clutch on rotation of said first and second sheaves in the second condition, and second free-wheel means for blocking an element of said friction clutch on rotation of said first and second sheaves in said second condition whereby frictionally to restrain the rotation of said first reeling means.

10. In the system claimed in claim 3, fault detecting

12

means engaging said twisted strands in said outgoing path thereof between said frame and said second reeling means.

11. In the system claimed in claim 3, an electrically-conductive apertured plate receiving the twisted strands therethrough in said outgoing path of the strands between said frame and said second reeling means, an electric circuit means connected with said plate and responsive to contact between a laterally protruding portion of said twisted strands and said apertured plate for arresting operation of the system.

12. In the system claimed in claim 3, an apertured member receiving the twisted strands therethrough in said outgoing path of the strands between said frame and said second reeling means, means normally restraining said apertured member against displacement with said twisted strands, said apertured member being adapted for displacement by said twisted strands against said restraining means on occurrence of an excess thickness in said twisted strands, and means actuated on displacement of said apertured member for arresting the operation of the system.

References Cited in the file of this patent

UNITED STATES PATENTS

723,806	Avis	Mar. 31, 1903
986,600	Sloper	Mar. 14, 1911
1,031,367	Norman	July 2, 1912
1,907,551	Kraft	May 9, 1933
1,956,730	Reichelt	May 1, 1934
2,364,984	Larsen et al.	Dec. 12, 1944
2,464,860	Green	Mar. 22, 1949
2,763,979	Swanson	Sept. 25, 1956
2,830,431	Klein	Apr. 15, 1958

FOREIGN PATENTS

381,807	Germany	Sept. 25, 1923
---------	---------	----------------