



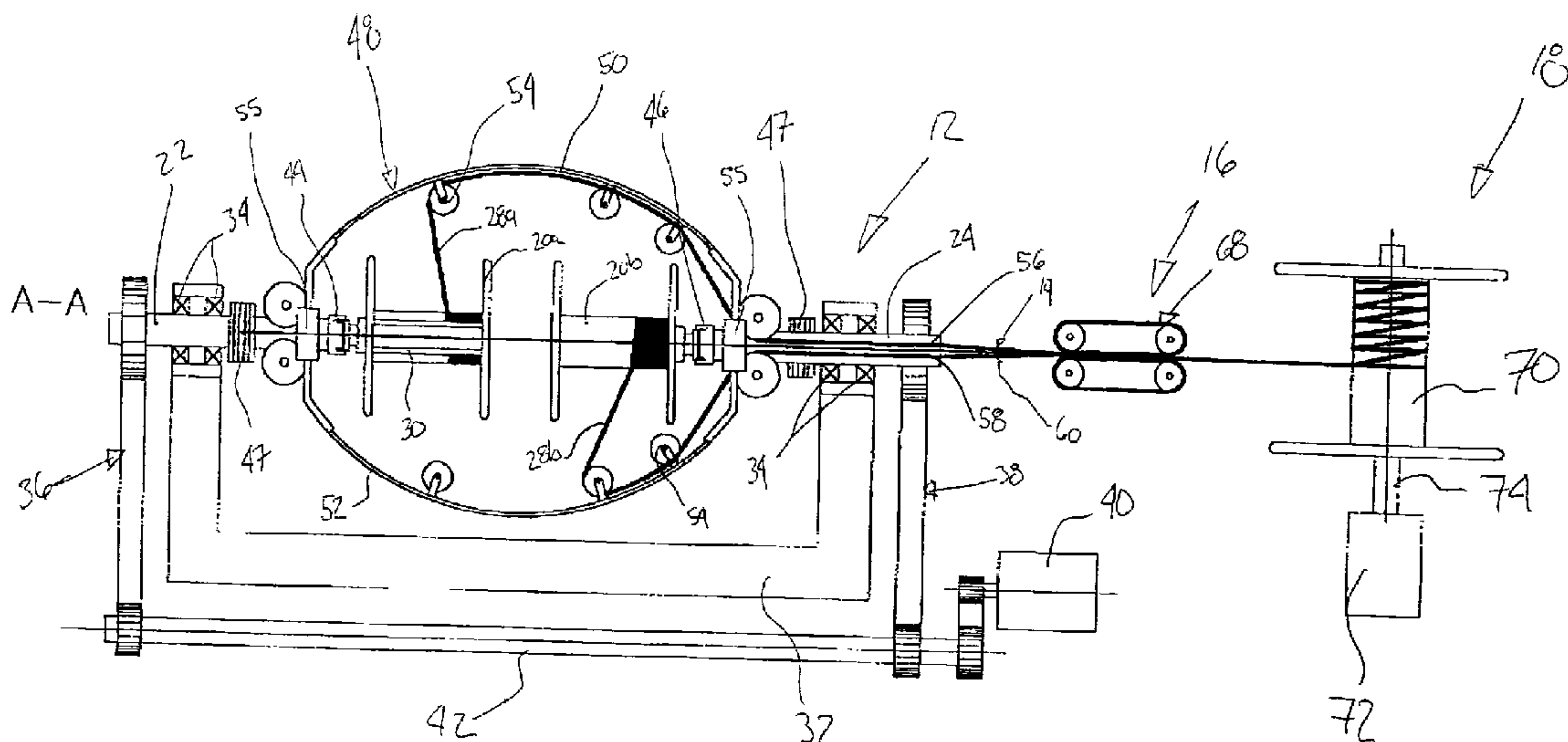
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(54) **APPAREIL POUR ASSEMBLER, EN FORME D'HELICE, AU MOINS DEUX FILAMENTS**

(54) **APPARATUS FOR HELICALLY ASSEMBLING AT LEAST TWO FILAMENTS**



(57) An apparatus for helically assembling filaments on an advancing core or about a common axis comprises a supply spool assembly mounted for rotation about an axis and having filaments wound thereon, and a flyer mounted for rotation about the same axis so that rotational movement thereof encompasses the supply spool assembly. The filaments are directly guided from the supply spool assembly onto the flyer to minimize the backtwist effect. The filaments are wound together as they pass through a closing die. A capstan is provided downstream of the closing die to impart an advancing speed to the filaments. A control system allows for the control of the number of revolutions of the flyer per unit length of filaments advancing through the closing die to obtain a constant helical pitch. The tension in the filaments is controlled by hysteresis brakes acting on the supply spool assembly. The control system is operational to adjust the torque exerted by the brakes as filaments are unwound from the supply spool assembly.

ABSTRACTAPPARATUS FOR HELICALLY ASSEMBLING
AT LEAST TWO FILAMENTS

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APPARATUS FOR HELICALLY ASSEMBLING
AT LEAST TWO FILAMENTS

BACKGROUND OF THE INVENTION

5 1. Field of the invention

The present invention relates to an apparatus of the type used for helically assembling filaments or elongated flexible elements about a common axis or, alternatively, over a central core
10 and, more particularly, the present invention pertains to such an apparatus wherein each individual supply filament is directly guided onto a rotating flyer assembly.

15 2. Description of the Prior Art

In conventional stranding apparatus, supply wires are assembled together by imparting a single, double, or more, twists to them. Indeed, in the conventional stranding apparatuses, the supply wires are not directly conveyed onto a rotating flyer
20 assembly and thus they are submitted to an undesired twisting torque at their entry to the rotating flyer assembly.

According to applicant, there is only one prior apparatus wherein the supply wires are directly
25 guided onto a rotating flyer which is mounted coaxially with the supply spools for rotation therearound. This apparatus is disclosed in United States Patent No. 4,709,542 issued to Krafft on December 1, 1987. However, it is pointed out that
30 the intent of Krafft was to provide a stranding apparatus which was adapted to form stranded cables of infinite lengths and that it does not appear that the Krafft apparatus is effective in suppressing or at least minimizing the backtwist which is normally
35 induced in the supply wires by the above mentioned conventional stranding apparatus.

More specifically, Krafft discloses a cable assembly apparatus having a rotating shaft which is provided with two integral supply reels which are respectively adapted to receive thereon a group of wire elements. The flyer assembly rotates around the supply reels for unwinding the groups of wire elements therefrom. The flyer assembly is rotated in the same direction as the two integral supply reels but at a speed which causes the wire elements to be unwound from the supply reels. A drive motor is directly connected to the rotating shaft for driving the integral supply reels. The flyer assembly is connected to the same drive motor but through a variable diameter pulley assembly so that the rotational speed of the flyer assembly is adjustable with respect to that of the integral supply reels. The apparatus further comprises a gathering assembly which is mounted for rotation with the flyer assembly for gathering and twisting the individual wire elements together or over a core element to form a cable. A take-up reel is disposed downstream from the gathering assembly to receive thereon the finished cable coming out from the center of the rotating shaft. A motor is coupled to the take-up reel to enable the same to be operated to draw the cable from the gathering assembly. The motor of the take-up reel may be adjusted to maintain a desired amount of tension in the cable to enhance the quality of the finished cable. However, it is the rates of rotation of the integral supply reels and of the flyer assembly which control the rate of production of the cable and thus the tension which is applied to the cable does not change the rate at which the cable is produced. Indeed, an increase of the rotational speed of the take-up reel does not change the rotational speed of the integral supply reels as the same are not allowed to freely rotate on the rotating

shaft thereof. Accordingly, in order to obtain a desired length of twist per unit length of cable, the rotational speed of the flyer assembly must be adjusted relative to the rotational speed of the
5 integral supply reels.

It is believed that the apparatus of the above described patent never gained commercial acceptance as the helical pitch of the final product and the amount of tension in each supply wire were
10 overly difficult to control.

SUMMARY OF THE INVENTION

It is therefore an aim of the present invention to provide an apparatus for helically assembling filaments about a common axis or,
15 alternatively, over a core element to produce a cable.

It is a further aim of the present invention to provide such an apparatus wherein supply filaments are directly guided from their supply
20 spools onto a flyer assembly.

It is a further aim of the present invention to provide such an apparatus wherein supply filaments do not travel centrally of a supply spool and flyer assembly.

25 It is a still further aim of the present invention to provide such an apparatus which is adapted to produce cables or the like having substantially uniform helical pitches throughout the length thereof.

30 It is a still further aim of the present invention to provide such an apparatus which is capable of adjusting and controlling the amount of tension in each individual filament passing through the apparatus.

35 It is a still further aim of the present invention to provide such an apparatus which is provided with removable supply spools.

Therefore, in accordance with the present invention, there is provided an apparatus for helically assembling individual elongated flexible elements about a common axis to form a product, comprising at least two independent supply spooling means mounted for rotation about an axis, each said supply spooling means having a single elongated flexible element wound thereon, flyer means mounted for rotation about said axis and around said supply spooling means, means for rotating said flyer means about said axis, said elongated flexible elements being directed from said supply spooling means to said flyer means and then to a gathering means wherein said elongated flexible elements are helically assembled about said axis according to a rotational movement of said flyer means, advancing means for advancing said elongated flexible elements through said apparatus, and a tension adjusting means adapted to independently act on said supply spooling means to maintain a desired amount of tension in each said elongated flexible element.

Also in accordance with the present invention, there is provided an apparatus for assembling at least one individual elongated flexible element on an advancing core to form a product, comprising at least one independent supply spooling means mounted for rotation about an axis, said supply spooling means having a single elongated flexible element wound thereon, flyer means mounted for rotation about said axis and around said supply spooling means, means for rotating said flyer means about said axis, said elongated flexible element being directed from said supply spooling means to said flyer means and then to a gathering means wherein said elongated flexible element is helically assembled around said core passing axially through said gathering means, advancing means for advancing

said elongated flexible element and said core through
said apparatus, and a tension adjusting means adapted
to independently act on said supply spooling means to
maintain a desired amount of tension in said
5 elongated flexible element thereof.

Further in accordance with the present
invention, there is provided an apparatus for
helically assembling individual filament means about
a common axis to form a product, comprising at least
10 two supply spooling means mounted for rotation about
an axis, each said supply spooling means having
filament means wound thereon, flyer means mounted for
rotation about said axis and outwardly of said supply
spooling means, means for rotating said flyer means
15 about said axis, said filament means being directed
from said supply spooling means to said flyer means
and then to a gathering means wherein said filament
means are helically assembled about said axis
according to the rotational movement of said flyer
20 means, advancing means for pulling said filament
means off said supply spooling means and for
imparting an advancing speed to said filaments means
through said apparatus, and means for controlling and
adjusting the speed ratio between the advancing speed
25 of said filament means and a rotational speed of said
flyer means to achieve a substantially uniform number
of rotations of said flyer means per unit of length
of said product.

Still further in accordance with the
30 present invention, there is provided an apparatus for
helically assembling at least one filament means on
an advancing core to form a product, comprising at
least one supply spooling means mounted for rotation
about an axis, said supply spooling means having
35 filament means wound thereon, flyer means mounted for
rotation about said axis and outwardly of said supply

spooling means, means for rotating said flyer means about said axis, said filament means being directed from said supply spooling means to said flyer means and then to a gathering means wherein said filament
5 means is helically assembled around said advancing core passing axially through said gathering means, advancing means for pulling said filament means off said supply spooling means and for imparting an advancing speed to said filament means and to said
10 advancing core through said apparatus, and means for controlling and adjusting the speed ratio between the advancing speed of said filament means and a rotational speed of said flyer means to achieve a substantially uniform number of rotations of said
15 flyer means per unit of length of said product.

Still further in accordance with the present invention, there is provided an apparatus for assembling filament means about a common axis, comprising a plurality of supply spool and flyer
20 assemblies disposed in series, each said supply spool and flyer assembly including at least one supply spooling means mounted for rotation about an axis and a flyer means also mounted for rotation about said axis and outwardly of said supply spooling means,
25 said at least one spooling means having filament means wound thereon, said filament means being directed from said supply spooling means to said flyer means, said flyer means of said plurality of supply spool and flyer assemblies being rotated
30 substantially at a same speed and in a same direction, gathering means for receiving said filament means from a downstream end of said plurality of supply spool and flyer assemblies, said filament means being assembled about said axis in
35 said gathering means according to a rotational movement of said flyer means, advancing means for displacing forward said filament means through said

plurality of supply spool and flyer assemblies and through said gathering means.

Still further in accordance with the present invention, there is provided an apparatus for assembling filaments means on an advancing core comprising a plurality of supply spool and flyer assemblies disposed in series, each said supply spool and flyer assembly including at least one supply spooling means mounted for rotation about an axis and a flyer means also mounted for rotation about said axis and outwardly of said supply spooling means, said spooling means having filament means wound thereon, said filament means being directed from said supply spooling means to said flyer means, said flyer means of said plurality of supply spool and flyer assemblies being rotated substantially at a same speed and in a same direction, gathering means for receiving said filament means and said advancing core from a downstream end of said plurality of supply spool and flyer assemblies, said filament means being assembled around said advancing core in said gathering means according to a rotational movement of said flyer means, advancing means for displacing forward said filament means and said advancing core through said plurality of supply spool and flyer assemblies and through said gathering means.

BRIEF DESCRIPTION OF THE DRAWINGS

Having thus generally described the nature of the present invention, reference will now be made to the accompanying drawings, showing by way of illustration a preferred embodiment thereof and in which:

Fig. 1 is a schematic side elevational view of a cable assembly apparatus according to the present invention;

Fig. 2 is an enlarged cross-sectional view of a gathering assembly of the cable assembly apparatus of Fig. 1; and

Fig. 3 is a schematic side elevational view of a wire assembly apparatus, wherein a plurality of supply spools and flyer assemblies are disposed in series.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Now referring to the drawings, and in particular to Fig. 1, an apparatus for helically assembling elongated flexible elements, such as individuals wires or the like, embodying the elements of the present invention and generally designated by numeral 10 will be described.

The apparatus 10 is suitable for a variety of industrial applications such as the manufacture of products such as electrical cables, conductor steel line cords, steel ropes, steel cables, LAN cables and the like. As shown in Fig. 1, the apparatus 10 comprises a supply spool and flyer assembly generally indicated at 12, a gathering assembly 14, a filament advancing assembly 16 for pulling a product out of the gathering assembly 14 and, a take-up spool assembly 18 for receiving the product.

More particularly, the supply spool and flyer assembly 12 includes two supply spools 20a and 20b mounted on respective shafts 22 and 24 for rotation about a common axis 26. The supply spool 20a has a single elongated flexible element or filament 28a wound thereon. Similarly, supply spool 20b has a single filament 28b wound thereon. Cylindrical tubular members 30 are mounted on bearings at free ends of the shafts 22 and 24 for receiving thereon respective supply spools 20a and 20b. A locking mechanism (not shown) is provided to ensure that the spools 20a and 20b remain in position on their respective cylindrical tubular members 30

when the shafts 22 and 24 are rotated. Each shaft 22 and 24 is mounted at an opposed end portion thereof to a frame 32 by means of a pair of bearings 34 for rotation about the common axis 26. The shafts 22 and 24 are respectively rotatably driven by conventional belt and pulley assemblies 36 and 38 which are both connected to a single motor 40 through a connecting shaft 42. It is pointed out that the belt and pulley assemblies 36 and 38 are configured so as to ensure that the rotating shafts 22 and 24 rotate in unison, although they are not directly connected to each other.

An electro-mechanical brake, such as hysteresis brake 44, is mounted on rotating shaft 22 adjacent the supply spool 20a and is operational to apply a magnetizing torque on the cylindrical tubular member 30 of the supply spool 20a. Similarly, a hysteresis brake 46 is mounted on rotating shaft 24 adjacent supply spool 20b and is operational to apply a magnetizing torque on the cylindrical tubular member 30 of the supply spool 20b. Accordingly, the hysteresis brakes 44 and 46 may be activated to respectively couple the supply spools 20a and 20b to the rotating shafts 22 and 24 so that the supply spools 20a and 20b may rotate jointly with their respective rotating shafts 22 and 24 when no exterior force, such as a pulling force exerted on the filaments 28a and 28b, acts thereon. However, it is pointed out that the rotational speed of the supply spools 20a and 20b may be different, i.e. greater or less than the rotational speed of the rotating shafts 22 and 24, as bearings are disposed within each cylindrical tubular member 30. As will be explained in more details hereinafter, the hysteresis brakes 44 and 46 permit to properly and efficiently control the amount of tension in each individual filaments 28a and 28b to thus enhance the overall quality of the

cable produced by the apparatus 10. A conductive element, such as a brush 47, is provided on each rotating shaft 22 and 24 for conducting current to the hysteresis brakes 44 and 46 and/or to any other
5 electrical component, such as sensors, which are located in the surroundings of the rotating shafts 22 and 24.

The supply spools 20a and 20b are removably mounted to their respective rotating shafts 22 and 24
10 so that when desired or required they may be easily removed from the apparatus 10 and replaced by other supply spools having similar or different sizes and configurations. As shown in Fig. 1, the rotating shafts 22 and 24 are mounted to the frame 32 so as to
15 define a free space between the end portions thereof which respectively supports the supply spools 20a and 20b, thereby enabling the manipulation and removal of the supply spools 20a and 20b.

The filaments 28a and 28b wound onto the
20 supply spools 20a and 20b are directly guided to a flyer 48 which is mounted for rotation about the common axis 26. The flyer 48 includes two diametrically opposite arcuate members 50 and 52 which are provided on inner facing surfaces thereof
25 with a plurality of guides 54, such as pulleys or eyelets, for receiving the filaments 28a and 28b. As seen in Fig. 1, the filament 28a is directed to the arcuate member 50, whereas filament 28b is directed to the arcuate member 52. Each arcuate member 50 and
30 52 is fixedly mounted at opposed ends thereof to the rotating shafts 22 and 24 for rotation therewith. As schematically illustrated in Fig. 1, end bells 55 may be provided to secure the arcuate members 50 and 52 to the rotating shafts 22 and 24. The arcuate
35 members 50 and 52 extend in substantially opposite radial positions with respect to the common axis 26 and are operational to rotate around the supply

spools 20a and 20b. As shown in Fig. 1, the supply
spools 20a and 20b are disposed and configured to be
within the arc or envelope defined by the rotational
movement of the flyer 48. By mounting the flyer 48
5 and the supply spools 20a and 20b for rotation about
the same axis and by directly guiding the filaments
28a and 28b onto the flyer 48, the backtwist which is
normally induced in each individual filament during
operation of conventional cable assembly apparatuses
10 can be minimized. Indeed, in most of the
conventional cable assembly apparatuses, the supply
filaments are not directly guided onto the rotating
flyer and thus they are submitted to a twisting
torque at their point of entry in the rotating flyer.

15 Two parallel off-centre axial passages 56
and 58 are defined in the rotating shaft 24 for
respectively allowing filaments 28a and 28b to exit
the supply spool and flyer assembly 12. However, it
is understood that any other suitable passage or
20 guide may be used to permit the filaments 28a and 28b
to be pulled out of the supply spool and flyer
assembly 12.

The gathering assembly 14 is located
downstream of the supply spool and flyer assembly 12
25 and is positioned so as to assemble the filaments 28a
and 28b together about the common axis 26. As shown
in Fig. 2, the gathering assembly 14 is independent
of the supply spool and flyer assembly 12 and
includes a closing die 60 having a diamantane insert
30 62 defining an axial passage 64 in which the
filaments 28a and 28b are helically assembled as they
pass therethrough. It is pointed out that for
applications which do not necessitate a high
rotational speed of the flyer 48 and a high
35 advancement speed of the filaments 28a and 28b
through the closing die 60, the gathering assembly 14
may be non-rotatably secured in position, as the

friction exerted by the filaments 28a and 28b on the inner surface of diamantane insert 62 is not sufficient to cause damage thereto. However, it is understood that when the apparatus 10 operates at relatively high speeds, the closing die 60 may be rotated at the same speed as the flyer 48 to thus eliminate the relative rotational movement existing between the filaments 28a and 28b and the closing die 60, whereby the friction between the diamantane insert 62 and the filaments 28a and 28b will be only generated by the axial displacement of the filaments 28a and 28b through the closing die 60. Some pulleys 66 may be provided at the exit end of the shaft 24 to convey the filaments 28a and 28b into the gathering assembly 14 and to collect information, as will be described in more details hereinafter.

The filament advancing assembly 16 is disposed downstream of the gathering assembly 14 and is operational for advancing the filaments 28a and 28b through the supply spool and flyer assembly 12 and through the gathering assembly 14. The filament advancing assembly 16 includes a capstan 68 which may be driven by an independent motor (not shown) or, alternatively, through a variable transmission (not shown) which in turn may be coupled to the motor 40 or to any other appropriate motor. Hence, it is the capstan 68 which dictates the advancement speed of the filaments 28a and 28b. Accordingly, by adjusting the rotational speed of the capstan 68 relative to the rotational speed of the flyer 48, the filaments 28a and 28b may be assembled in the gathering assembly 14 with a constant helical pitch. In other words, to produce a cable having a constant helical pitch, the speed ratio between the flyer 48 and the capstan 68 must be constant during all of the assembly operation. Indeed, different speed ratios

between the flyer 48 and the capstan 68 will result in different helical pitches in the final product.

In operation, the filaments 28a and 28b are unwound from their respective supply spools 20a and 20b and are directly guided to the flyer 48 which rotates at a predetermined speed relative to the speed of the capstan 68 which pulls the filaments 28a and 28b outside of the supply spool and flyer assembly 12, thereby, simultaneously causing the supply spools 20a and 20b to rotate at a different speed than the rotational speed of the rotating shafts 22 and 24 and thus than that of the flyer 48. As the filaments 28a and 28b are unwound from the supply spools 20a and 20b, they are directed to the closing die 60 where they are helically wound about the common axis 26 according to the rotary motion of the flyer 48. It is pointed out that as both the supply spools 20a and 20b and the flyer 48 rotate, each individual filament 28a, 28b is not twisted onto itself while being helically wound to the other filament 28a, 28b in the closing die 60, thereby enabling the production of a high-quality product. Again, it is the speed ratio between the flyer 48 and the capstan 68 which defines the helical pitch and thus it must be constant from the beginning to the end of the operations to obtain a final product, such as a cable, which has a substantially uniform helical pitch throughout the length thereof. This manner of controlling the helical pitch is simpler and more efficient than Krafft's method in aforementioned U.S. Patent No. 4,709,542 which consists of controlling the rotational speed of the flyer relative to the rotational speed of the supply spools.

It will be appreciated that as the filaments 28a and 28b are advanced through the supply spool and flyer assembly 12 by the capstan 68, the winding diameters of the supply spools 20a and 20b

are gradually reduced and thus their rotational speeds are increased such as to preserve a constant advancement speed. Accordingly, to apply a constant tension in each individual filament 28a and 28b, the magnetizing torques exerted by the hysteresis brakes 44 and 46 on the supply spools 20a and 20b, respectively, are adjusted so as to provide an appropriate opposition to the rotational movement of the supply spools 20a and 20b. Generally, as the torques applied on the supply spools 20a and 20b through the tension forces in the filaments 28a and 28b are proportional to the winding diameters of the supply spools 20a and 20b and as these winding diameters become reduced during the operation of the apparatus 10, the magnetizing torques exerted by the hysteresis brakes 44 and 46 must be adjusted, i.e. reduced, so as to preserve a constant tension in individual filaments 28a and 28b throughout the assembly operations.

By having separate and independent supply spools 20a and 20b which are respectively provided with single filaments 28a and 28b and by having distinct hysteresis brakes 44 and 46 acting on each of the supply spools 20a and 20b, it is possible to control the amount of tension in each individual filament 28a and 28b to prevent one of the filaments 28a and 28b from being wound with less tightness than the other in the final product, thereby contributing to enhance the overall quality of the final product.

Furthermore, the supply spools 20a and 20b may have different diameters, as they are separated and independently controlled.

At its exit of the capstan 68, the final product may be directed to the take-up spool assembly 18 or, alternatively, to any other subsequent handling steps for the treatment or the modification of the assembled product. For instance, the

assembled product may be directed to an extrusion unit. As illustrated in Fig. 1, the take-up spool assembly 18 includes a take-up spool 70 rotatably driven by a motor 72 through a rotating shaft 74 or a clutch. An electro-mechanical brake (not shown) may be mounted on the rotating shaft 74 to control the rotational movement of the take-up spool 70, thereby eliminating the utilization of a dancer. Accordingly, the electro-mechanical brake (not shown) may be adjusted at different tensions depending on the speed of the capstan 68 and the amount of final product loaded onto the take-up spool 70 so as to wind the final product at an appropriate tension on the take-up spool 70. It is pointed out that the take-up spool assembly 18 is only used to receive the final product and thus it does not have any influence on the rate at which the final product is produced. Indeed, as described hereinbefore, it is the capstan 68 which dictates the advancement speed of the filaments 28a and 28b. The take-up spool assembly 18 is not suited to control the advancement speed of the filaments 28a and 28b, as the inertia of the take-up spool 70 changes as the filaments 28a and 28b are wound thereon, thereby making the control of the advancement speed of the filaments more complicated. Once the take-up spool 70 has been completely loaded with the final product, the production is stopped and the take-up spool 70 is replaced by an empty take-up spool which is not necessarily identical to the completely loaded take-up spool.

Speed sensors (not shown) are provided for measuring the rotational speeds of the flyer 48 and of the capstan 68. The sensed data are sent to a control system (not shown) which is adapted to control and adjust the rotational speeds of the flyer 48 and of the capstan 68 so that a constant speed ratio between the flyer 48 and the capstan 68 is

maintained at all times to thus obtain a final product having a constant helical pitch throughout the length thereof.

Each pulley 66, illustrated in Fig. 2, may
5 be mounted on a load cell (not shown) for measuring the tension in the filaments 28a and 28b. The control system receives signals from the load cell, and it is operative for determining the voltage to send to each hysteresis brake controller so that the
10 amount of tension in each filament 28a and 28b remains constant and equal to one another as they are unwound from their respective supply spools 20a and 20b.

Alternatively, speed sensors (not shown)
15 may be provided for sensing the rotational speed of each supply spool 20a, 20b and for measuring the rotational speed at the exit of the capstan 68, thereby allowing to determine the diameter of filaments 28a and 28b wound on the supply spools 20a
20 and 20b, respectively. The voltage to send to each hysteresis brake controller can then be determined by the control system (not shown) to thus ensure that a constant tension is maintained in the filaments 28a and 28b as they are unwound from their respective
25 supply spools 20a and 20b.

The control system also permits to detect the rupture of the filaments 28a and 28b. In the event that one of the filaments 28a and 28b breaks, the rotational speed of the supply spool associated
30 therewith becomes equal to the rotational speed of the flyer 48. Accordingly, the control system (not shown) has been instrumented so as to compare the data received from the speed sensors of the flyer 48 and of the supply spools 20a and 20b and to emit a
35 warning signal when the rotational speed of one of the supply spools 20a and 20b is equal to that of the flyer 48. It is pointed out that this is possible

because the supply spools 20a and 20b are each provided with a single filament 28a and 28b, respectively. Indeed, if there were more than one filament per supply spool, the rotational speed
5 thereof would not be affected by the breaking of only one of the filaments, thereby resulting in the production of a low-quality final product.

While the apparatus 10 is normally operated for helically assembling filaments 28a and 28b about
10 a common axis, it may also be operated for winding filaments 28a and 28b around an advancing core filament or wire which is axially displaced through the apparatus 10 along the common axis 26 by the pulling action of the capstan 68. Hence, the
15 advancing core filament and the filaments 28a and 28b would have the same advancement speed. It is understood that when it is desired to obtain a final product having a core element and a single filament wound thereon, the apparatus may comprise only one
20 supply spool instead of two as described hereinbefore.

It is noted that the motors 40 and 72 may be electronically controlled or, alternatively, a variable transmission may be used to provide a large
25 flexibility of utilization.

Fig. 3 illustrates a second preferred embodiment of the present invention, wherein the apparatus 10' comprises two supply spool and flyer assemblies 12 and 12' mounted in series upstream of
30 the gathering assembly 14, the filament advancing assembly 16 and the take-up spool assembly 18. The apparatus 10' is operational for helically assembling four filaments 28a, 28b, 28a' and 28b' in the gathering assembly 14 about a common axis 26 or,
35 alternatively, around a core filament (not shown) advancing axially through the apparatus 10' along the common axis 26. The supply spool and flyer

assemblies 12 and 12' are driven by the same motor 40 through connecting shaft 76. However, it is understood that different motors may be used to respectively drive the supply spool and flyer assemblies 12 and 12'. The supply spool and flyer assembly 12' is provided with an upstream shaft 78 which defines two parallel axial passages 80 and 82 for respectively guiding the filaments 28a and 28b emanating from the supply spool and flyer assembly 12 onto the flyer 48' of the supply spool and flyer assembly 12'. The remaining feature of the supply spool and flyer assembly 12' are similar to those of the supply spool and flyer assembly 12 and thus their duplicate description will be omitted.

15 In operation, the flyers 48 and 48' rotate at the same speed in a predetermined ratio to the rotational speed of the capstan assembly 68 which pulls on the filaments 28a, 28b, 28a' and 28b' so as to impart to them a same advancement speed. The
20 filaments 28a and 28b are directly guided onto their respective arcuate members 50 and 52 and then they pass through the axial passages 56 and 58, respectively. Thereafter, the filaments 28a and 28b are respectively received in the axial passages 78
25 and 80 defined in the upstream shaft 78 of the supply spool and flyer assembly 12'. Accordingly, the filaments 28a and 28b enter in the supply spool and flyer assembly 12' without being helically assembled, as the same are conveyed in separate passages. The
30 filament 28a is then directly guided onto the arcuate member 50' with the filament 28a', while the filament 28b is directly guided onto the arcuate member 52' with the filament 28b'. The filaments 28a and 28a' leave the supply spool and flyer assembly 12' through
35 the axial passage 56', whereas the filaments 28b and 28b' leave the supply spool and flyer assembly 12' through the axial passage 58'. The four filaments

28a, 28b, 28a' and 28b' are then helically wound together about the common axis 26 as they pass through the gathering assembly 14. The final product is then received by the take-up spool assembly 18.

5 Again, when the apparatus 10' is used for obtaining a final product having a central core, a core filament is advanced through the apparatus 10', along the common axis 26, by the capstan 68. As the core filament passes through the gathering assembly
10 14, the filaments are helically wound thereon to form a final product.

 Although the supply spool and flyer assemblies 12 and 12' have been described as respectively including two supply spools 20a, 20b,
15 20a' and 20b', it is noted that only one supply spool per supply spool and flyer assembly 12 and 12' may be provided depending on the number of filaments required to form the final product.

 It is because the gathering assembly 14 is
20 independent of the supply spool and flyer assembly 12 that it is possible to have a plurality of supply spool and flyer assemblies connected in series. Indeed, although the apparatus 10' has been described as having two supply spool and flyer assemblies 12
25 and 12', it is understood that a plurality of supply spool and flyer assemblies may be mounted in series upstream of the gathering assembly 14 and of the filament advancing assembly 16 in order to obtain a final product which is formed of a plurality of
30 individual filaments.

 According to further embodiments of the present invention, hydraulic brakes may be used to control the tension in each filament instead of the above described electro-mechanical brakes.
35 Alternatively, motors or any other appropriate braking mechanism may also be used to control the amount of tension in the filaments.

Furthermore, the filaments advancing assembly 16 may comprise a caterpillar extractor having two parallel driven tracks which are symmetrically disposed to the common axis 26 for
5 engaging therebetween the final product so as to cause the advancement of the filaments 28a and 28b through the apparatus 10. Any other pulling mechanism adapted to uniformly pull on the filaments to displace the filaments forward, at a same speed,
10 through the apparatus may be provided.

Finally, when only one supply spool is disposed within the flyer, the latter may include only one arcuate member.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

- 5 1. An apparatus for helically assembling individual elongated flexible elements about a common axis to form a product, comprising at least two independent supply spooling means mounted for rotation about an axis, each said supply spooling means having a single
10 elongated flexible element wound thereon, flyer means mounted for rotation about said axis and around said supply spooling means, means for rotating said flyer means about said axis, said elongated flexible elements being directed from said supply spooling
15 means to said flyer means and then to a gathering means wherein said elongated flexible elements are helically assembled about said axis according to a rotational movement of said flyer means, advancing means for advancing said elongated flexible elements
20 through said apparatus, and a tension adjusting means adapted to independently act on said supply spooling means to maintain a desired amount of tension in each said elongated flexible element.
- 25 2. An apparatus as defined in Claim 1, wherein said tension adjusting means includes at least two braking means which are respectively operational to apply a tensioning torque to one of said supply spooling means, each said braking means being connected to a
30 control means adapted to automatically adjust the tensioning torques applied to said supply spooling means as said elongated flexible elements are unwound therefrom so as to maintain a substantially constant amount of tension in each said elongated flexible
35 element.

3. An apparatus as defined in Claim 2, wherein each said braking means include an electro-mechanical brake.

5 4. An apparatus as defined in claim 3, wherein each said electro-mechanical brake includes a hysteresis brake.

10 5. An apparatus as defined in claim 2, wherein said control means comprises a control system and two load cells for determining the amount of tension in each said elongated flexible element at an entry thereof into said gathering means.

15 6. An apparatus as defined in claim 2, wherein each said supply spooling means have a rotational speed and a winding diameter, wherein said advancing means are driven at a speed, and wherein said control means comprise a control system sensing means connected
20 thereto for determining the rotational speed of each said supply spooling means and the speed of said advancing means which directly correspond to an advancing speed of said elongated flexible elements, whereby the winding diameter of each said supply
25 spooling means can be determined by said control system in order to adjust the tensioning torques applied on said supply spooling means by said brake means as said elongated flexible elements are unwound from said supply spooling means.

30

7. An apparatus as defined in claim 1, wherein said advancing means impart an advancing speed to said elongated flexible elements, and wherein means are provided for controlling and adjusting the speed
35 ratio between the advancing speed of said elongated flexible elements and the rotational speed of said flyer means to achieve a substantially uniform number

of rotations of said flyer means per unit of length of said product.

8. An apparatus as defined in claim 1, wherein said
5 advancing means include a capstan means disposed downstream of said gathering means for pulling said elongated flexible elements off said supply spooling means.

10 9. An apparatus as defined in claim 7, wherein said advancing means are driven at a speed, and wherein said means for controlling and adjusting the speed ratio between the advancing speed of said elongated flexible elements and said rotational speed of said
15 flyer means include a control system and sensing means connected thereto for determining the speeds of said flyer means and said advancing means.

10. An apparatus as defined in claim 1, wherein said
20 gathering means include a closing die.

11. An apparatus as defined in claim 1, wherein said flyer means include two arcuate members mounted for rotation about said axis, each said arcuate member
25 being adapted to engage a respective one of said elongated flexible elements.

12. An apparatus as defined in claim 1, wherein each said supply spooling means are respectively mounted
30 to a first end of a shaft means which is in turn rotatably mounted at a second end thereof to a frame means, said supply spooling means being adapted to rotate independently of said shaft means, said flyer means being secured to said shaft means for rotation
35 therewith about said axis so that the rotational movement thereof encompasses said supply spooling means.

13. An apparatus as defined in claim 12, wherein said supply spooling means are removably mounted to said shaft means.

5

14. An apparatus as defined in claim 1, wherein a take-up spool assembly is disposed downstream of said advancing means for receiving said product.

10 15. An apparatus as defined in claim 14, wherein said take-up spool assembly includes a rotationally driven take-up spooling means and a clutch means acting on said take-up spooling means to ensure that the product is wound at an appropriate tension on
15 said take-up spooling means.

16. An apparatus for assembling at least one individual elongated flexible element on an advancing core to form a product, comprising at least one
20 independent supply spooling means mounted for rotation about an axis, said supply spooling means having a single elongated flexible element wound thereon, flyer means mounted for rotation about said axis and around said supply spooling means, means for
25 rotating said flyer means about said axis, said elongated flexible element being directed from said supply spooling means to said flyer means and then to a gathering means wherein said elongated flexible element is helically assembled around said core
30 passing axially through said gathering means, advancing means for advancing said elongated flexible element and said core through said apparatus, and a tension adjusting means adapted to independently act on said supply spooling means to maintain a desired
35 amount of tension in said elongated flexible element thereof.

17. An apparatus as defined in Claim 16, wherein
said tension adjusting means include at least one
braking means which is operational to apply a
5 tensioning torque to said supply spooling means, said
braking means being connected to a control means
adapted to automatically adjust the tensioning torque
applied to said supply spooling means as said
elongated flexible element is unwound therefrom so as
10 to maintain a substantially constant amount of
tension in said elongated flexible element.

18. An apparatus as defined in Claim 17, wherein
said at least one braking means include an electro-
15 mechanical brake.

19. An apparatus as defined in claim 18, wherein
said electro-mechanical brake include an hysteresis
brake.

20

20. An apparatus as defined in claim 17, wherein
said control means comprise a control system and at
least one load cell for determining the amount of
tension in said elongated flexible element at an
25 entry thereof into said gathering means.

21. An apparatus as defined in claim 17, wherein
said at least one supply spooling means have a
rotational speed and a winding diameter, wherein said
30 advancing means are driven at a speed, and wherein
said control assembly include a control system and
sensing means connected thereto for determining the
rotational speed of said supply spooling means and
the speed of said advancing means which directly
35 correspond to an advancing speed of said elongated
flexible element, whereby the winding diameter of
said supply spooling means can be determined by said

control system in order to adjust the tensioning torque applied on said supply spooling means by said brake means as said elongated flexible element is unwound from said supply spooling means.

5

22. An apparatus as defined in claim 16, wherein said advancing means impart an advancing speed to said elongated flexible element, and wherein means are provided for controlling and adjusting the speed ratio between the advancing speed of said elongated flexible element and the rotational speed of said flyer means to achieve a substantially uniform number of rotations of said flyer means per unit of length of said product.

15

23. An apparatus as defined in claim 16, wherein said advancing means include a capstan means disposed downstream of said gathering means for pulling said elongated flexible element off said supply spooling means.

20

24. An apparatus as defined in claim 22, wherein said advancing means is driven at a speed, and wherein said means for controlling and adjusting the speed ratio between the advancing speed of said elongated flexible element and the rotational speed of said flyer means include a control system and sensing means connected thereto for determining the speeds of said flyer means and said advancing means.

30

25. An apparatus as defined in claim 16, wherein said gathering means include a closing die.

26. An apparatus as defined in claim 16, wherein said flyer means include at least one arcuate member mounted for rotation about said axis, said at least

35

one arcuate member being adapted to engage said elongated flexible element .

27. An apparatus as defined in claim 16, wherein at
5 least two supply spooling means are provided, and
wherein said flyer means includes two arcuate members
mounted for rotation about said axis, said two
arcuate members being adapted to engage respective
elongated flexible elements of said supply spooling
10 means.

28. An apparatus as defined in claim 16, wherein
said supply spooling means is mounted to a first end
of a shaft means which is in turn rotatably mounted
15 at a second end thereof to a frame means, said supply
spooling means being adapted to rotate independently
of said shaft means, said flyer means being secured
to said shaft means for rotation therewith about said
axis so that the rotational movement thereof
20 encompasses said supply spooling means.

29. An apparatus as defined in claim 28, wherein
said supply spooling means is removably mounted to
said shaft means.
25

30. An apparatus as defined in claim 16, wherein a
take-up spool assembly is disposed downstream of said
advancing means for receiving said product.

30 31. An apparatus as defined in claim 30, wherein
said take-up spool assembly includes a rotationally
driven take-up spooling means and a braking means
acting on said take-up spooling means to ensure that
the product is wound at an appropriate tension on
35 said take-up spooling means.

32. An apparatus for helically assembling individual filament means about a common axis to form a product, comprising at least two supply spooling means mounted for rotation about an axis, each said supply spooling
5 means having filament means wound thereon, flyer means mounted for rotation about said axis and outwardly of said supply spooling means, means for rotating said flyer means about said axis, said filament means being directed from said supply
10 spooling means to said flyer means and then to a gathering means wherein said filament means are helically assembled about said axis according to the rotational movement of said flyer means, advancing means for pulling said filament means off said supply
15 spooling means and for imparting an advancing speed to said filaments means through said apparatus, and means for controlling and adjusting the speed ratio between the advancing speed of said filament means and a rotational speed of said flyer means to achieve
20 a substantially uniform number of rotations of said flyer means per unit of length of said product.

33. An apparatus as defined in claim 32, wherein said advancing means include a capstan means disposed
25 downstream of said gathering means.

34. An apparatus as defined in claim 33, wherein said capstan means are rotationally driven by a motor
30 means.

35. An apparatus as defined in claim 32, wherein said advancing means are driven at a speed, and wherein said means for controlling and adjusting the speed ratio between the advancing speed of said
35 filament means and said rotational speed of said flyer means include a control system and sensing

means connected thereto for determining the speeds of said flyer means and said advancing means.

36. An apparatus as defined in Claim 32, wherein
5 said apparatus further includes a tension adjusting means adapted to independently act on said supply spooling means to maintain a desired amount of tension in each said filament means.

10 37. An apparatus as defined in Claim 36, wherein said tension adjusting means includes at least two braking means which are each operational to apply a tensioning torque to a respective one of said supply spooling means, each said braking means being
15 connected to a control means adapted to automatically adjust the tensioning torques applied to said supply spooling means as said elongated flexible elements are unwound therefrom so as to maintain a substantially constant amount of tension in each said
20 filament means.

38. An apparatus as defined in Claim 36, wherein said braking means each include an electro-mechanical
25 brake.

39. An apparatus as defined in claim 37, wherein said control means include a control system and two load cells for determining the tension in said filament means at an entry thereof into said
30 gathering means.

40. An apparatus as defined in claim 37, wherein each said supply spooling means has a rotational speed and a winding diameter, wherein said advancing
35 means are driven at a speed, and wherein said control means include a control system and sensing means connected thereto for determining the rotational

speed of each said supply spooling means and the speed of said advancing means which directly correspond to the advancing speed of said filament means, whereby the winding diameter of each said supply spooling means can be determined by said control system in order to adjust the tensioning torques applied on said supply spooling means by said brake means as said filament means are unwound from said supply spooling means.

10

41. An apparatus as defined in claim 32, wherein said gathering means include a closing die.

42. An apparatus as defined in claim 32, wherein said flyer means include two arcuate members mounted for rotation about said axis, each said arcuate members being adapted to engage one of said filament means.

43. An apparatus as defined in claim 32, wherein each said supply spooling means are respectively mounted to a first end of a shaft means which is in turn rotatably mounted at a second end thereof to a frame means, said supply spooling means being adapted to rotate independently of said shaft means, said flyer means being secured to said shaft means for rotation therewith about said axis so that the rotational movement thereof encompasses said supply spooling means.

30

44. An apparatus as defined in claim 43, wherein said supply spooling means are removably mounted to said shaft means.

45. An apparatus for helically assembling at least one filament means on an advancing core to form a

product, comprising at least one supply spooling means mounted for rotation about an axis, said supply spooling means having filament means wound thereon, flyer means mounted for rotation about said axis and outwardly of said supply spooling means, means for rotating said flyer means about said axis, said filament means being directed from said supply spooling means to said flyer means and then to a gathering means wherein said filament means is helically assembled around said advancing core passing axially through said gathering means, advancing means for pulling said filament means off said supply spooling means and for imparting an advancing speed to said filament means and to said advancing core through said apparatus, and means for controlling and adjusting the speed ratio between the advancing speed of said filament means and a rotational speed of said flyer means to achieve a substantially uniform number of rotations of said flyer means per unit of length of said product.

46. An apparatus for assembling filament means about a common axis, comprising a plurality of supply spool and flyer assemblies disposed in series, each said supply spool and flyer assembly including at least one supply spooling means mounted for rotation about an axis and a flyer means also mounted for rotation about said axis and outwardly of said supply spooling means, said at least one spooling means having filament means wound thereon, said filament means being directed from said supply spooling means to said flyer means, said flyer means of said plurality of supply spool and flyer assemblies being rotated substantially at a same speed and in a same direction, gathering means for receiving said filament means from a downstream end of said plurality of supply spool and flyer assemblies, said

filament means being assembled about said axis in said gathering means according to a rotational movement of said flyer means, advancing means for displacing forward said filament means through said plurality of supply spool and flyer assemblies and through said gathering means.

47. An apparatus as defined in claim 46, wherein said gathering means are independent of said plurality of supply spool and flyer assemblies.

48. An apparatus as defined in claim 46, wherein said gathering means include a closing die.

49. An apparatus as defined in claim 46, wherein said closing die are non-rotatably secured in position.

50. An apparatus for assembling filaments means on an advancing core comprising a plurality of supply spool and flyer assemblies disposed in series, each said supply spool and flyer assembly including at least one supply spooling means mounted for rotation about an axis and a flyer means also mounted for rotation about said axis and outwardly of said supply spooling means, said spooling means having filament means wound thereon, said filament means being directed from said supply spooling means to said flyer means, said flyer means of said plurality of supply spool and flyer assemblies being rotated substantially at a same speed and in a same direction, gathering means for receiving said filament means and said advancing core from a downstream end of said plurality of supply spool and flyer assemblies, said filament means being assembled around said advancing core in said gathering means according to a rotational movement of said flyer

means, advancing means for displacing forward said filament means and said advancing core through said plurality of supply spool and flyer assemblies and through said gathering means.

5

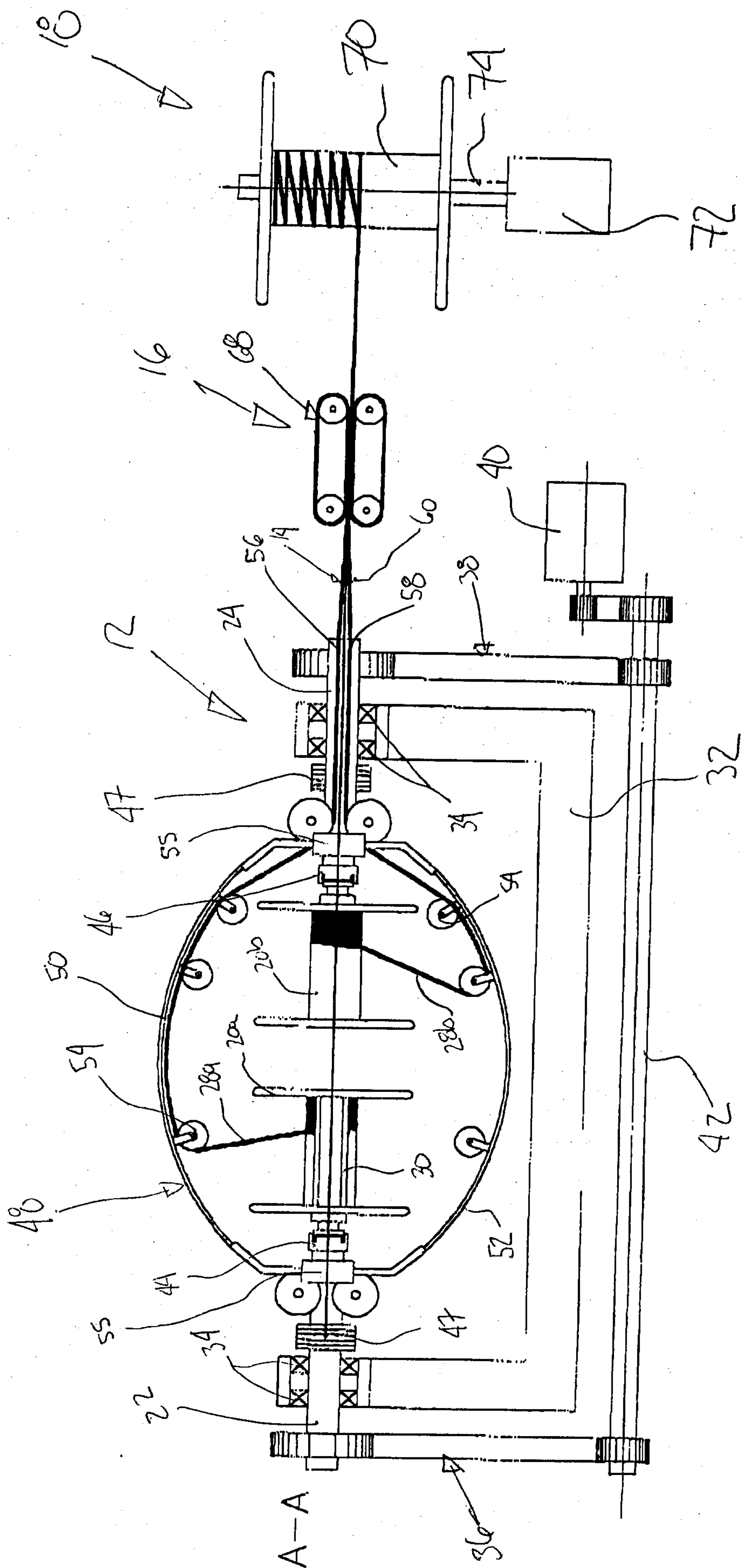
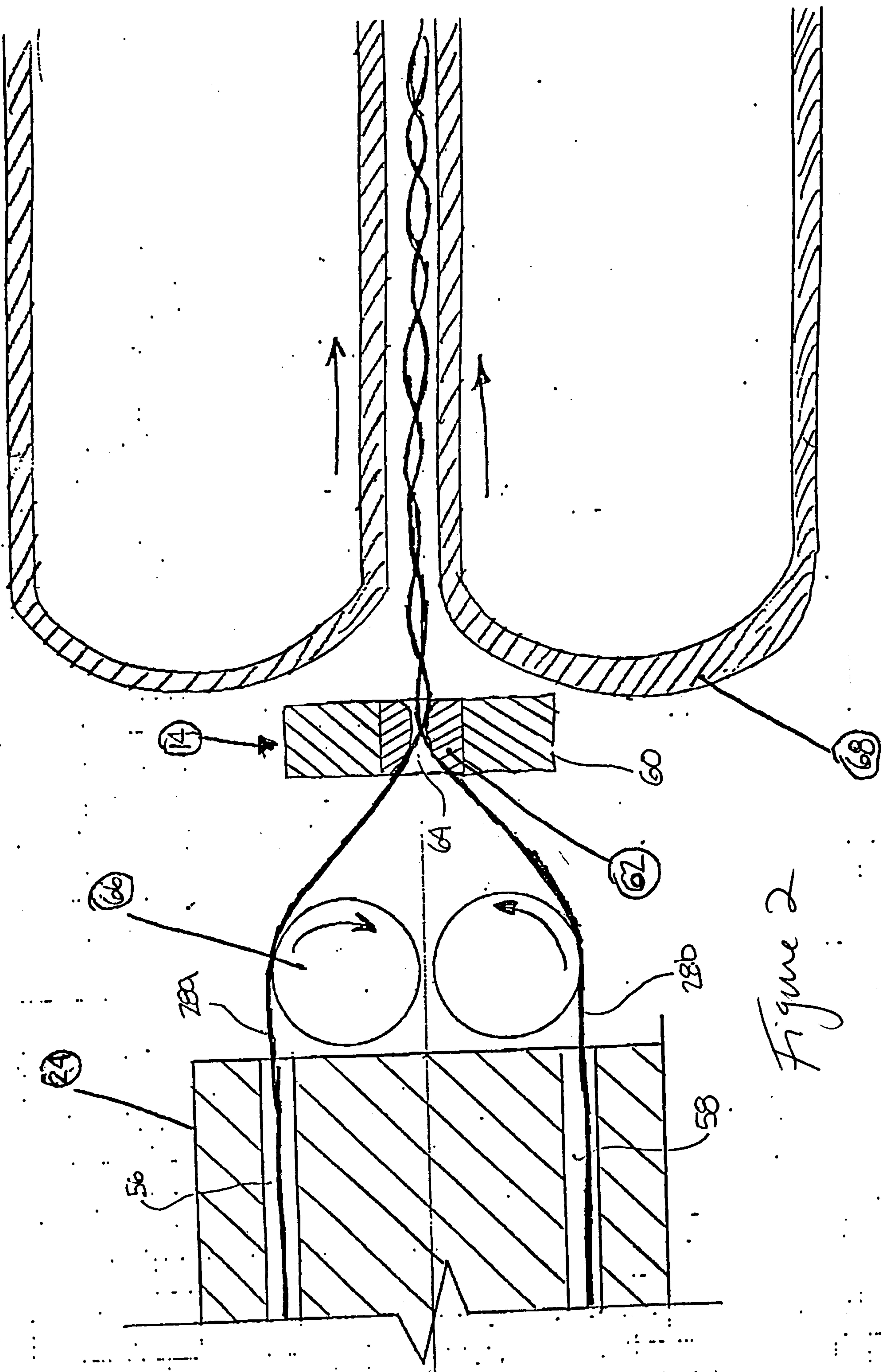


Figure 1



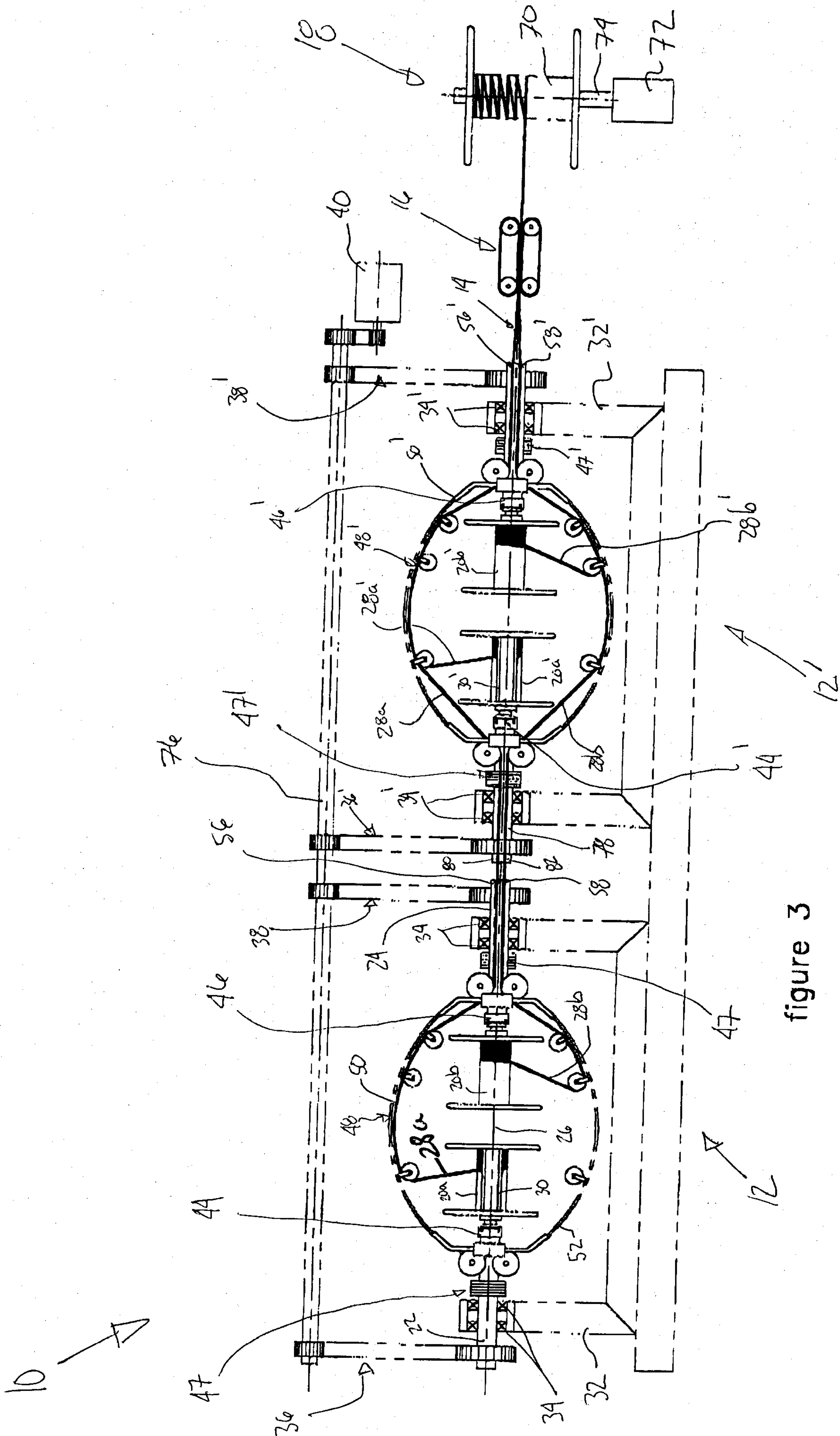


figure 3