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(71) **Demandeur/Applicant:**
FCI HOLDINGS DELAWARE, INC., US

(72) **Inventeur/Inventor:**
BRANDON, MARK M., US

(74) **Agent:** DIMOCK STRATTON LLP

(54) **Titre : PROCEDE ET APPAREIL POUR BULBING EN CONTINU DE CABLE DE BRIN**
(54) **Title: METHOD AND APPARATUS FOR CONTINUOUS BULBING OF STRANDED CABLE**

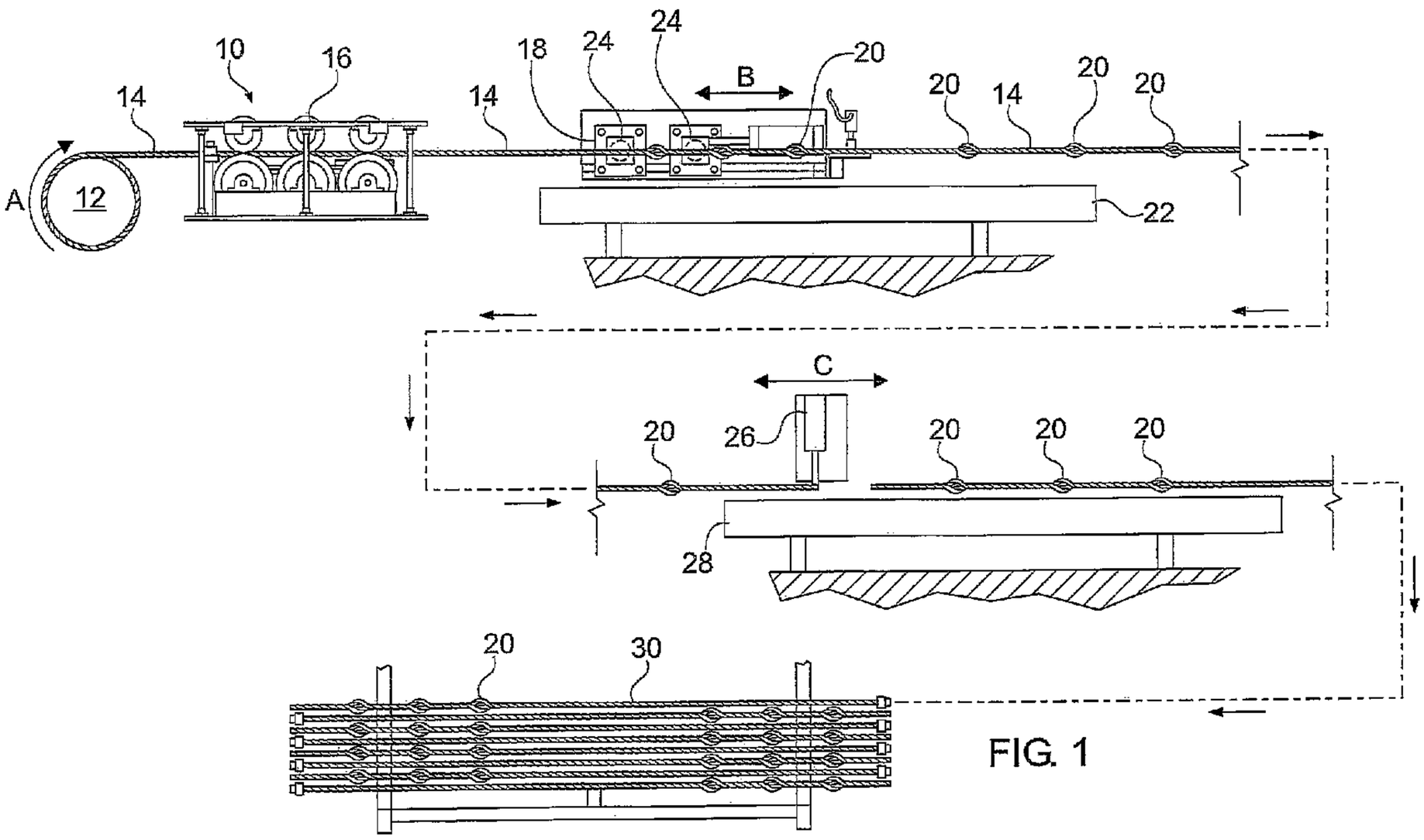

FIG. 1

(57) **Abrégé/Abstract:**
A method of forming a bulb in a cable bolt includes providing cable from a cable source, advancing the cable in a first direction, and forming a bulb in a portion of the cable while the portion of the cable is continuously advanced and while the cable is continuously provided from the cable source.

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(71) Applicant: **FCI HOLDINGS DELAWARE, INC.** [US/US]; Suite 1300, 1105 North Market Street, Wilmington, Delaware 19801 (US).

(72) Inventor: **BRANDON, Mark, M.**; 4084 Willow Creek Drive, Gibsonia, Pennsylvania 15044 (US).

(74) Agents: **MEDER, Julie, W.** et al.; The Webb Law Firm, One Gateway Center, 420 Ft. Duquesne Blvd., Suite 1200, Pittsburgh, Pennsylvania 15222 (US).

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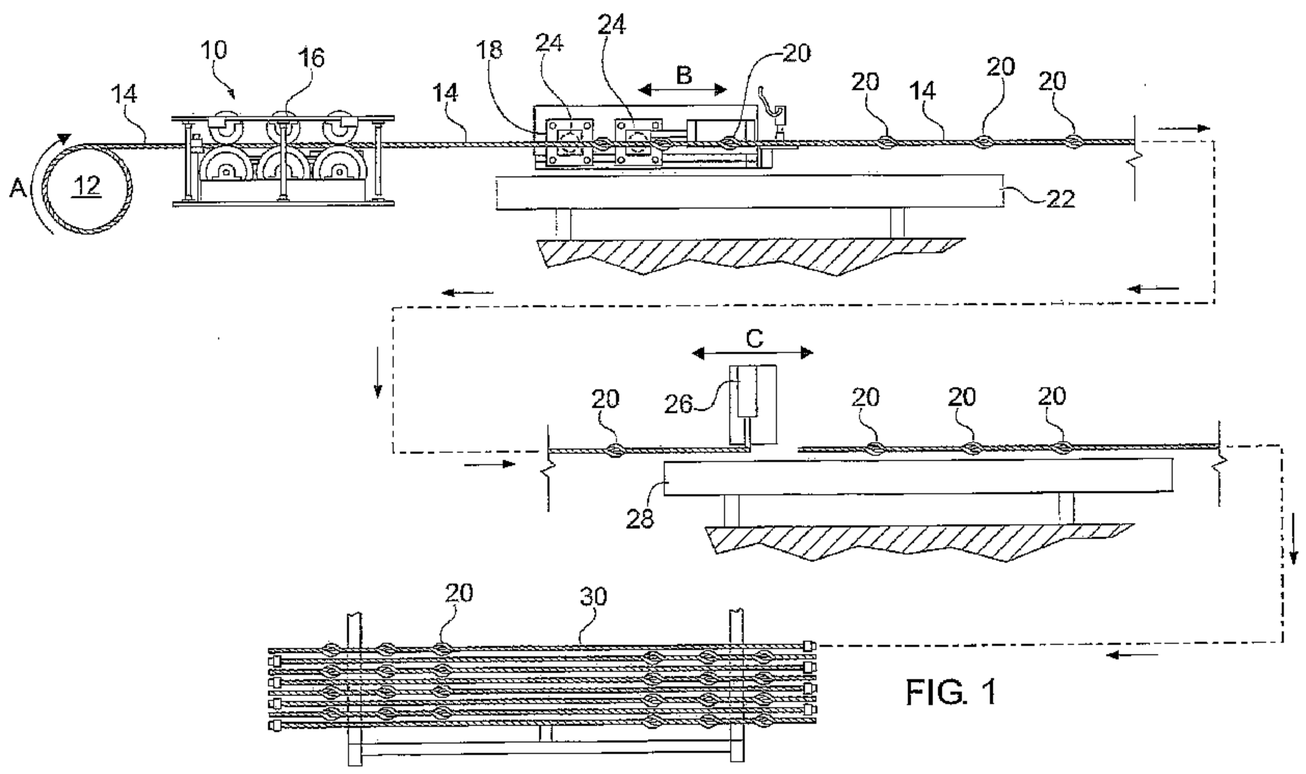

FIG. 1

(57) Abstract: A method of forming a bulb in a cable bolt includes providing cable from a cable source, advancing the cable in a first direction, and forming a bulb in a portion of the cable while the portion of the cable is continuously advanced and while the cable is continuously provided from the cable source.

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METHOD AND APPARATUS FOR CONTINUOUS BULBING OF STRANDED CABLE

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Application No. 61/590,010, filed January 24, 2012, the entire content of which is hereby incorporated by reference.

BACKGROUND OF THE INVENTION

Field of the Invention

[0002] The present invention relates to cable bolts, in particular, to a method and apparatus for forming a bulb in a stranded cable bolt.

Description of Related Art

[0003] Cable bolts are used in the mining industry for their ease of handling and installation. Cable bolts are generally easier to fit into a borehole than the elongated rods of conventional rod bolt systems. Regardless of the height limitations in a mine, cable bolts may be adapted to boreholes of any length due to their flexibility. The strength capacity of cables exceeds that of conventional rod bolts and, therefore, cable is the preferred reinforcement for certain roof conditions.

[0004] Cable bolts are typically installed by placing a resin cartridge including catalyst and adhesive material into the blind end of a borehole, inserting the cable bolt into the borehole so that the upper end of the cable bolt rips open the resin cartridge and the resin flows in the annulus between the borehole and the cable bolt, rotating the cable bolt to mix the resin catalyst and adhesive, and allowing the resin to set about the cable bolt. In such cable bolts, the resin is typically set at an upper portion of the cable bolt at the blind end of the borehole. The cable bolts are typically formed with one or more bulbs to increase the bonding between the bolts and the resin.

SUMMARY OF THE INVENTION

[0005] In one embodiment, a method of forming a bulb in a cable bolt includes providing cable from a cable source, advancing the cable in a first direction, and forming a bulb in a portion of the cable while the portion of the cable is continuously advanced and while the cable is continuously provided from the cable source.

[0006] The bulb may be formed by moving a bulb forming mechanism along with the cable. The method may further include cutting the cable to a preset length while the cable is continuously advanced by moving a cutting device along with the cable. The cutting device

may have a first position and a second position spaced from the first position, with the cutting device moving between the first and second positions while cutting the cable to the preset length. The cable source may include a spool having a length of cable, and the cable may be provided from an inner portion of the spool. The bulb forming mechanism may be movable between a first position and a second position spaced from the first position, with the bulb forming mechanism moving from the first position to the second position while forming the bulb. The method may further include spooling the cable after being cut to a preset length onto a spooler. The bulb forming mechanism may move from the second position to the first position after forming the bulb. The method may further include forming a plurality of bulbs in spaced apart portions of the cable. The bulb forming mechanism may include first and second clamps, with the first clamp engaging the cable as the bulb forming mechanism moves along with the cable and the second clamp moving relative to the first clamp to form the bulb. The cable may be advanced via a drive mechanism. An entire portion of the cable extending from the cable source may be continuously advanced until the cable is cut to the preset length.

[0007] In a further embodiment, an apparatus for forming a bulb in a cable bolt includes a drive mechanism configured to continuously advance a length of cable, and a bulb forming mechanism movable along a longitudinal axis defined by the length of the cable between a first position and a second position spaced from the first position. The bulb forming apparatus is configured to form a bulb on a cable while moving along with the advancing cable.

[0008] The apparatus may further include a cable source configured to provide a length of cable. The length of cable extends to the drive mechanism and from the drive mechanism to the bulb forming mechanism. The apparatus may further include a cutting device configured to cut a length of cable to a preset length. The cutting device may be movable between a first position and a second position spaced from the first position. The bulb forming mechanism may include first and second clamps, with the first clamp configured to engage a cable as the bulb forming mechanism moves along with the cable and with the second clamp being movable relative to the first clamp to form a bulb on the cable. The bulb forming mechanism may include a motor to move the bulb forming mechanism between the first and second positions.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] Fig. 1 is a schematic view of an apparatus for forming a bulb in a cable bolt according to one embodiment of the present invention, showing a first position of a bulb forming mechanism and cutting mechanism.

[0010] Fig. 2A is a schematic view of a spool of cable according to another embodiment of the present invention.

[0011] Fig. 2B is a schematic view of a spool mechanism according to a further embodiment of the present invention.

[0012] Fig. 3 is a schematic view of the apparatus shown in Fig. 1, showing a second position of the bulb forming mechanism and cutting mechanism.

[0013] Fig. 4 is a plan view of a bulb forming mechanism according to one embodiment of the present invention, showing a cable bolt prior to bulbing.

[0014] Fig. 5 is a plan view of the bulb forming mechanism of Fig. 4, showing the cable bolt after a bulb has been formed.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0015] For purposes of the description hereinafter, the terms "upper", "lower", "right", "left", "vertical", "horizontal", "top", "bottom", and derivatives thereof, shall relate to the invention as it is oriented in the drawing figures. However, it is to be understood that the invention may assume various alternative variations and step sequences, except where expressly specified to the contrary. It is also to be understood that the specific devices and processes illustrated in the attached drawings, and described in the following specification, are simply exemplary embodiments of the invention. Hence, specific dimensions and other physical characteristics related to the embodiments disclosed herein are not to be considered as limiting.

[0016] Referring to Figs. 1-3, an apparatus 10 for forming a bulb in a cable bolt includes a spool 12 having a length of stranded cable 14 wound around to the spool 12 and configured to pay off cable from the spool 12 as indicated by direction A by rotating the spool 12. Although the cable 14 is shown being advanced from an outer portion of the spool 12, the cable 14 may also be spooled such that the cable 14 is advanced from a center or eye of a coil of cable as shown in Fig. 2A. A drive mechanism 16 receives the cable 14 and is configured to advance the cable 14 in a direction corresponding to a longitudinal axis of the cable 14. The drive mechanism 16 includes a measuring device (not shown), such as a set of measuring

wheels, which allows the formation of bulbs at preset and varying intervals along the length of the cable 14. In particular, the measuring device may include an encoder wheel driven by the moving cable that includes an optical sensor that provides pulses of light with each revolution of the encoder wheel. The length of cable 14 advanced is determined by the quantity of revolutions experienced by the encoder wheel. A programmable logic controller (PLC) (not shown) detects when a certain length of cable 14 has been advanced and controls the apparatus to form bulbs 20 at preset and varying intervals along the length of the cable 14.

[0017] Referring again to Figs. 1-3, a bulb forming mechanism 18 receives the cable 14 from the drive mechanism 16 and forms one or more bulbs 20 along the length of the cable 14 as controlled by the PLC or other suitable arrangement. The bulb forming mechanism 18 is mounted on a sliding frame shown schematically at 22 such that the bulb forming mechanism 18 is movable as indicated at B along a direction corresponding to the longitudinal axis of the advancing cable 14 to allow the bulb forming mechanism 18 to travel with the cable 14. In particular, the bulb forming mechanism 18 is configured to form a bulb 20 on the cable 14 while the cable 14 is continuously advanced by moving with the cable 14 while forming the bulb 20. In one embodiment, the bulb forming mechanism 18 includes a pair of clamps generally indicated at 24 that releasably engage the cable 14. One of the clamps 24 is movable relative to the other clamp to buckle the strands of the cable 14 thereby forming the bulb 20 in the cable 14. When the PLC initiates the bulbing sequence, the bulb forming mechanism 18 will clamp onto the cable 14 and travel along with the cable 14 while forming a bulb 20 at a specified location as determined by the measuring device and PLC.

[0018] Once the bulb 20 is formed, the cable 14 will be released by the bulb forming mechanism 18 and the bulb forming mechanism 18 will move to its original position. Thus, the bulb forming mechanism 18 has a first position (shown in Fig. 1) at the start of the bulb forming sequence and a second position (shown in Fig. 3) spaced from the first position at the end of the bulb forming sequence. The bulb forming mechanism 18 will return to the first position after forming a bulb 20. Because the bulb forming mechanism 18 is movable, the spool 12 and drive mechanism 16 can be continuously operated such that the cable 14 is continuously advanced without stopping any portion of the cable 14 to form the bulbs 20. Such a continuous operation improves efficiency of the bulb forming operation by not having to start and stop the drive motors (not shown) powering the spool 12 and drive mechanism 16 and by not having stoppage time while the bulbs 20 are being formed.

[0019] Referring again to Figs. 1 and 3, in one embodiment, after forming one or more bulbs 20, the cable 14 will continue passing through a cutting device 26, such as a cut off

saw, although other suitable cutting devices may be utilized. The cutting device 26 is mounted on a sliding table arrangement 28 in a similar manner as described above in connection with the bulb forming mechanism 18 such that the cutting device 26 is movable as indicated at C along a direction corresponding to the longitudinal axis of the advancing cable 14. The cutting device 26 is configured to automatically cut the bulbed cable 14 to preset lengths, which are then bundled and packaged as shown at 30. In another embodiment, as shown in Fig. 2B, the cable 14 may also be passed through the cutting device 26 to a rewind spooler 32 to allow for spooling of longer bulbed cable bolts as indicated by direction D of the spooler 32. The cutting device 26 has a first position (shown in Fig. 1) at the start of the cutting process and a second position (shown in Fig. 3) spaced from the first position at the end of the cutting process. The cutting device 26 will return to the first position after performing the cutting process. The movement of the cutting device 26 allows the cable 14 to be continuously advanced thereby allowing the cable 14 to have a positive velocity throughout the process.

[0020] Referring to Figs. 4 and 5, one embodiment of the bulb forming mechanism 18 is shown in more detail. The bulb forming mechanism 18 is supported by a frame 40 having a pair of parallel racks 42. The bulb forming mechanism 18 includes a first clamp set 44 fixedly mounted to a base 46 and a second clamp set 48 movably mounted to the base 46. The second clamp set 48 is supported by a sliding bush and shaft arrangement 50, 52. Each clamp set 44, 48 includes a pair of hydraulically operated mutually opposed jaws 54, 56 which are releasably engagable with the cable 14. However, other suitable clamping arrangements may be utilized to grip the cable 14. Double acting hydraulic cylinders 58, 60 are used to activate the first and second clamp sets 44, 48 to clamp the cable 14 therebetween. However, the double acting hydraulic cylinders 58, 60 may be substituted by single acting cylinders which activate the first and second clamp sets 44, 48 to clamp the cable 14 therebetween.

[0021] The bulb forming mechanism 18 includes an actuator 62 in the form of a hydraulic piston with one end fixedly mounted to the base 46 and the other end movably mounted to the second clamp set 48. The piston 62 provides movement of the second clamp set 48 towards the first clamp set 44 during the bulbing process. Alternatively, the single actuator 62 may be substituted by two actuators located on either side of the cable 14 with each actuator having one end fixedly mounted to the base 46 and the other end movably mounted to the second clamp set 48. Other power sources, such as electricity, may be utilized to power the actuators.

[0022] The bulb forming mechanism 18 includes a set of driven front pinions 64 and a complementary pair of rear idler pinions 66 in gearing engagement with the parallel racks 42 for enabling the clamp sets 44, 48 to move along with the cable 14 during the bulb forming process as described above. The front pinions 64 are preferably driven by a reversible, variable speed, hydraulic motor 68 with a built-in brake. A reversible, variable speed, electric motor with a brake could also be used for this purpose. Although the bulb forming mechanism 18 is movably mounted to the frame 40, the bulb forming mechanism 18 may also be movably mounted to a ceiling rail, or other suitable arrangement, which runs parallel to the cable 14. The bulb forming mechanism 18 includes one or more proximity sensors (not shown) for measuring the radial displacement of the bulb formed in the cable. The bulb forming mechanism 18 also includes an encoder 70 for controlling the movement of the pinions 64, 66 along the racks 42.

[0023] In use, the cable 14 is advanced across the length of the frame 40 with a portion of the cable 14 extending through the jaws 54, 56 of the first and second clamp sets 44, 48. Oil pressure is then applied to the double acting hydraulic cylinders 58, 60 to respectively clamp the cable 14 between the jaws 54, 56 of the first and second clamp sets 44, 48, as shown in Fig. 4. The hydraulic piston 62 is then activated to move the second clamp set 48 towards the first clamp set 44 forming a bulb 20 in the cable 14, as shown in Fig. 5. As the cable 14 is clamped by the first and second clamp sets 44, 48, the hydraulic motor 68 drives the pinions 64 to move the bulb forming mechanism 18 along with the cable 14 in a direction corresponding to the longitudinal axis of the cable 14. Thus, the portion of the cable 14 where the bulb 20 is formed is continuously advanced. Radial displacement of the cable 14 may be controlled by the PLC using one or more proximity sensors (not shown) to limit the radial displacement of the bulb 20. Once the first bulb is formed, oil pressure is applied to the hydraulic cylinders 58, 60 to release the cable 14 from the jaws 54, 56 of the first and second clamp sets 44, 48. Oil pressure is then applied to the topside of the hydraulic piston 62 which in turn moves the second clamp set 48 back to its starting position, as shown in Fig. 4. After the bulbing process, the bulb forming mechanism 18 is in the second position as shown in Fig. 3 and described above. The motor 68 then drives the pinions 64 along the racks 42 to move the bulb forming mechanism 18 to the first position, as shown in Fig. 1 and described above, for performing further bulb forming processes. Although the first and second positions are generally mentioned, the bulb forming mechanism 18 may be moved as necessary to form one or more bulbs 20 on the cable 14 at predetermined positions while the cable 14 is continuously advanced.

[0024] The bulb forming mechanism 18 described above and shown in the figures may take other forms as long as the mechanism for forming the bulbs is movable to allow the portion of the cable where the bulb is formed to be continuously advanced. In particular, the bulb forming mechanism 18 may be embodied as the bulb forming mechanism shown and described in U.S. Patent Application Publication No. 2011/0259072 to Evans et al. and U.S. Patent Nos. 5,344,256 to Hedrick and 6,820,657 to Hedrick, which are each incorporated by reference in their entirety.

[0025] Although the invention has been described in detail for the purpose of illustration based on what is currently considered to be the most practical and preferred embodiments, it is to be understood that such detail is solely for that purpose and that the invention is not limited to the disclosed embodiments but, on the contrary, is intended to cover modifications and equivalent arrangements that are within the spirit and scope of the description. For example, it is to be understood that the present invention contemplates that, to the extent possible, one or more features of any embodiment can be combined with one or more features of any other embodiment.

THE INVENTION CLAIMED IS:

1. A method of forming a bulb in a cable bolt, the method comprising:

providing cable from a cable source;

advancing the cable in a first direction;

forming a bulb in a portion of the cable while the portion of the cable is continuously advanced and while the cable is continuously provided from the cable source.

2. The method of claim 1, wherein the bulb is formed by moving a bulb forming mechanism along with the cable.

3. The method of claim 1, further comprising cutting the cable to a preset length while the cable is continuously advanced by moving a cutting device along with the cable.

4. The method of claim 3, wherein the cutting device has a first position and a second position spaced from the first position, the cutting device moving between the first and second positions while cutting the cable to the preset length.

5. The method of claim 1, wherein the cable source comprises a spool having a length of cable, and wherein the cable is provided from an inner portion of the spool.

6. The method of claim 2, wherein the bulb forming mechanism is movable between a first position and a second position spaced from the first position, the bulb forming mechanism moving from the first position to the second position while forming the bulb.

7. The method of claim 3, further comprising spooling the cable after being cut to a preset length onto a spooler.

8. The method of claim 6, wherein the bulb forming mechanism moves from the second position to the first position after forming the bulb.

9. The method of claim 1, further comprising forming a plurality of bulbs in spaced apart portions of the cable.

10. The method of claim 2, wherein the bulb forming mechanism comprises first and second clamps, the first clamp engaging the cable as the bulb forming mechanism moves along with the cable, the second clamp moving relative to the first clamp to form the bulb.

11. The method of claim 1, wherein the cable is advanced via a drive mechanism.

12. The method of claim 3, wherein an entire portion of the cable extending from the cable source is continuously advanced until the cable is cut to the preset length.

13. An apparatus for forming a bulb in a cable bolt, the apparatus comprising:

a drive mechanism configured to continuously advance a length of cable; and

a bulb forming mechanism movable along a longitudinal axis defined by the length of the cable between a first position and a second position spaced from the first position, wherein the bulb forming apparatus is configured to form a bulb on a cable while moving along with the advancing cable.

14. The apparatus of claim 13, further comprising a cable source configured to provide a length of cable.

15. The apparatus of claim 14, wherein the length of cable extends to the drive mechanism and from the drive mechanism to the bulb forming mechanism.

16. The apparatus of claim 13, further comprising a cutting device configured to cut a length of cable to a preset length.

17. The apparatus of claim 16, wherein the cutting device is movable between a first position and a second position spaced from the first position.

18. The apparatus of claim 13, wherein the bulb forming mechanism comprises first and second clamps, the first clamp configured to engage a cable as the bulb forming mechanism moves along with the cable, the second clamp being movable relative to the first clamp to form a bulb on the cable.

19. The apparatus of claim 18, wherein the bulb forming mechanism comprises a motor to move the bulb forming mechanism between the first and second positions.

20. The apparatus of claim 19, further comprising a cable source configured to provide a length of cable, wherein the length of cable extends to the drive mechanism and from the drive mechanism to the bulb forming mechanism.

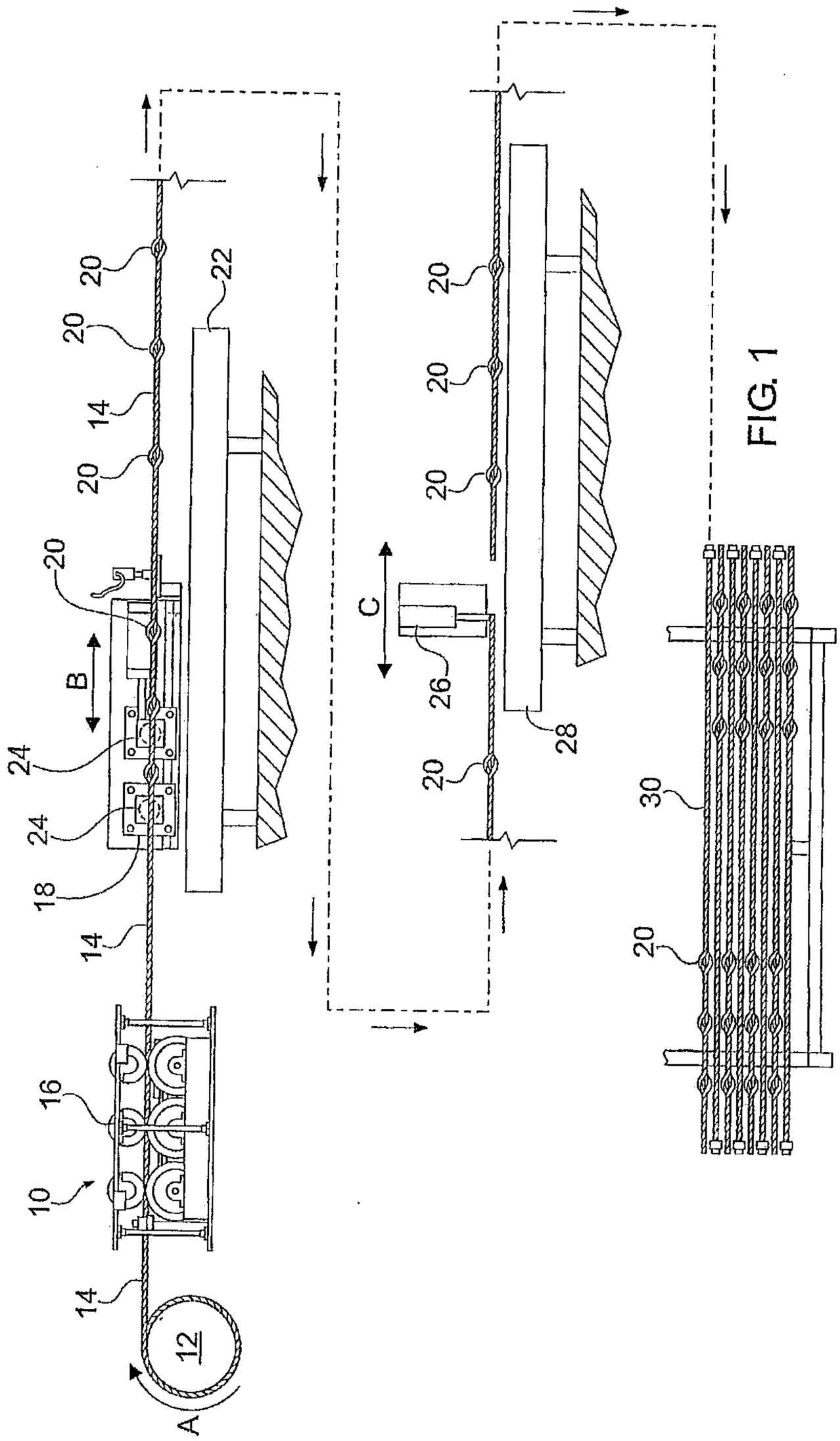

FIG. 1

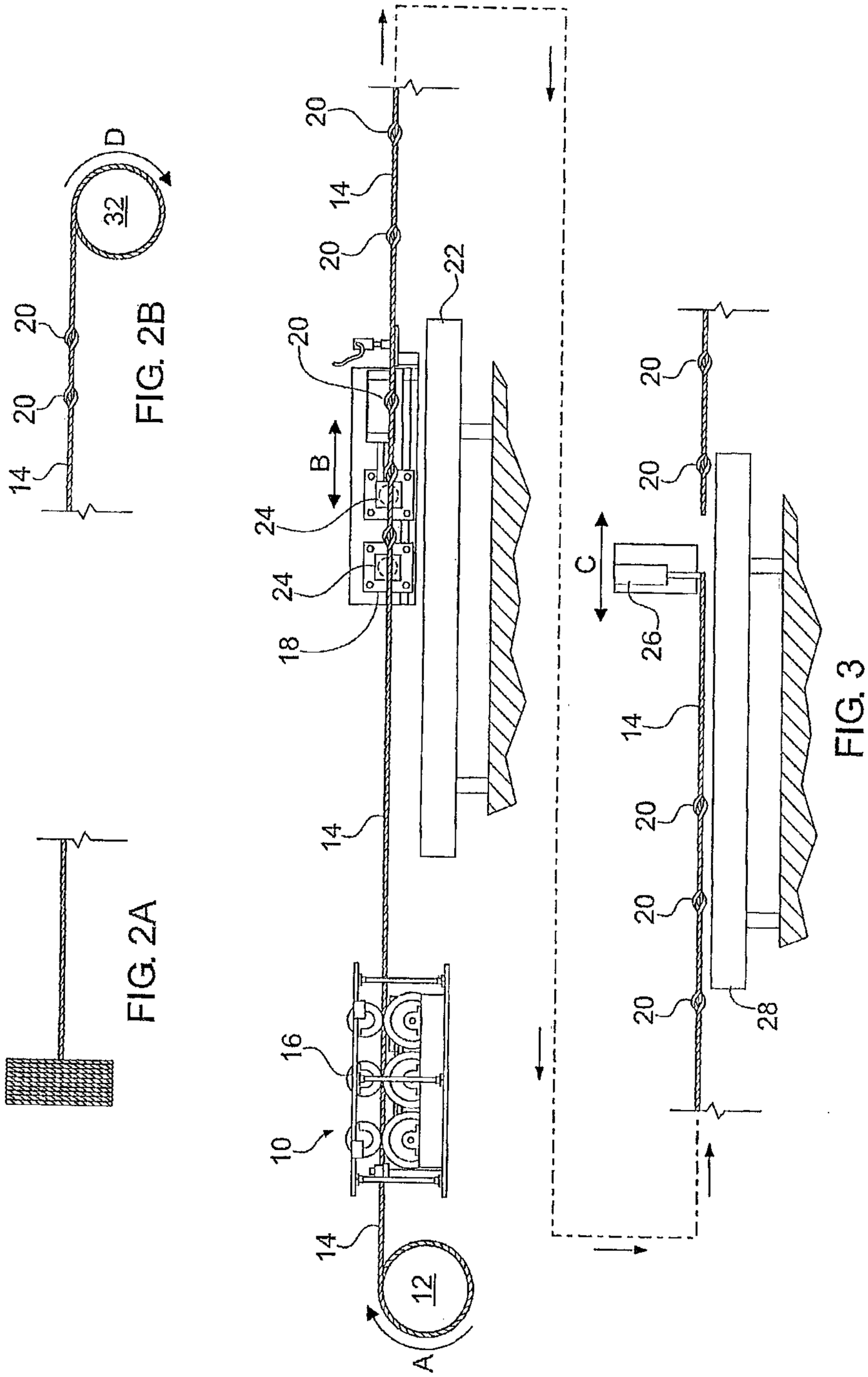

FIG. 2A

FIG. 2B

FIG. 3

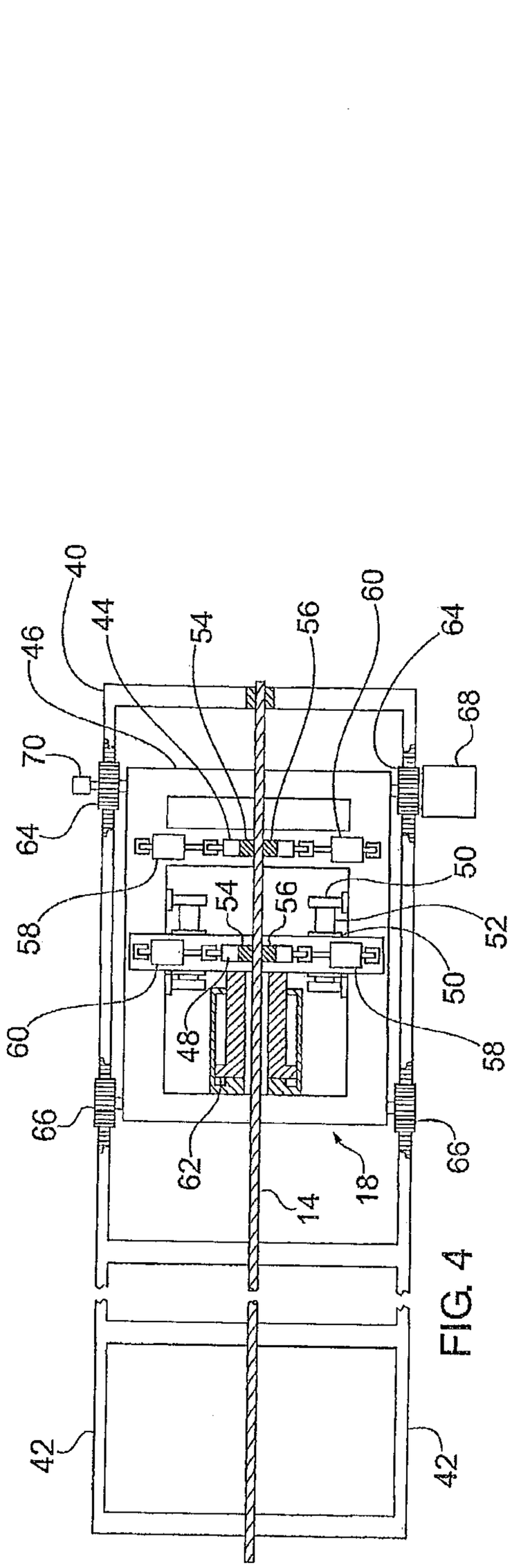
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FIG. 4

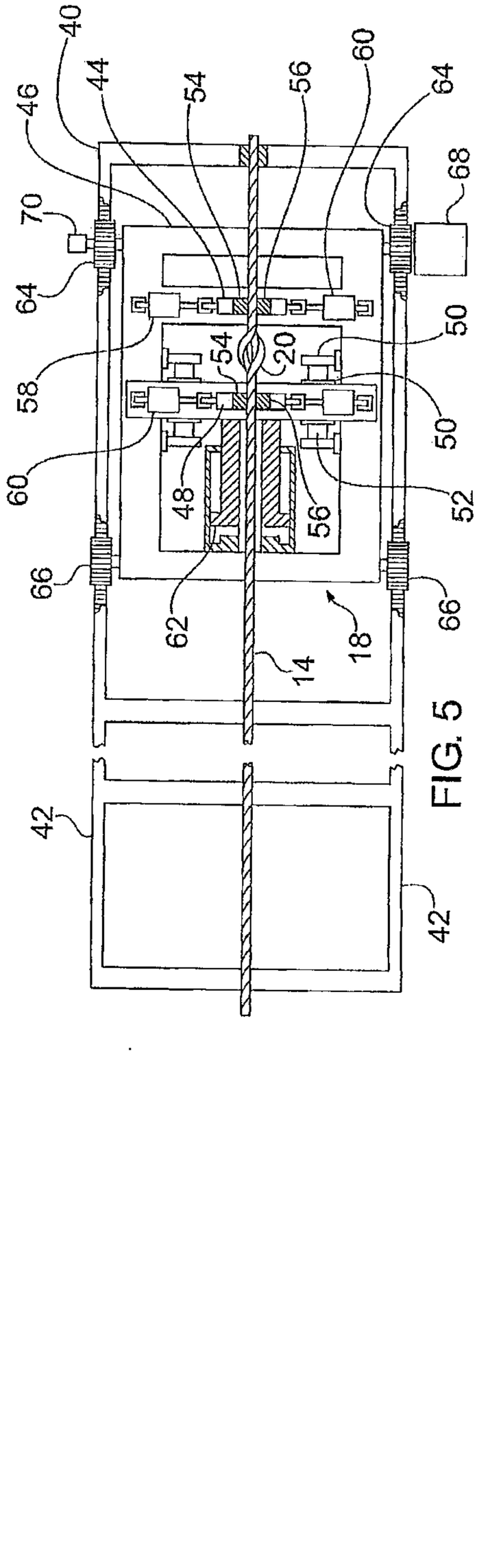
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FIG. 5

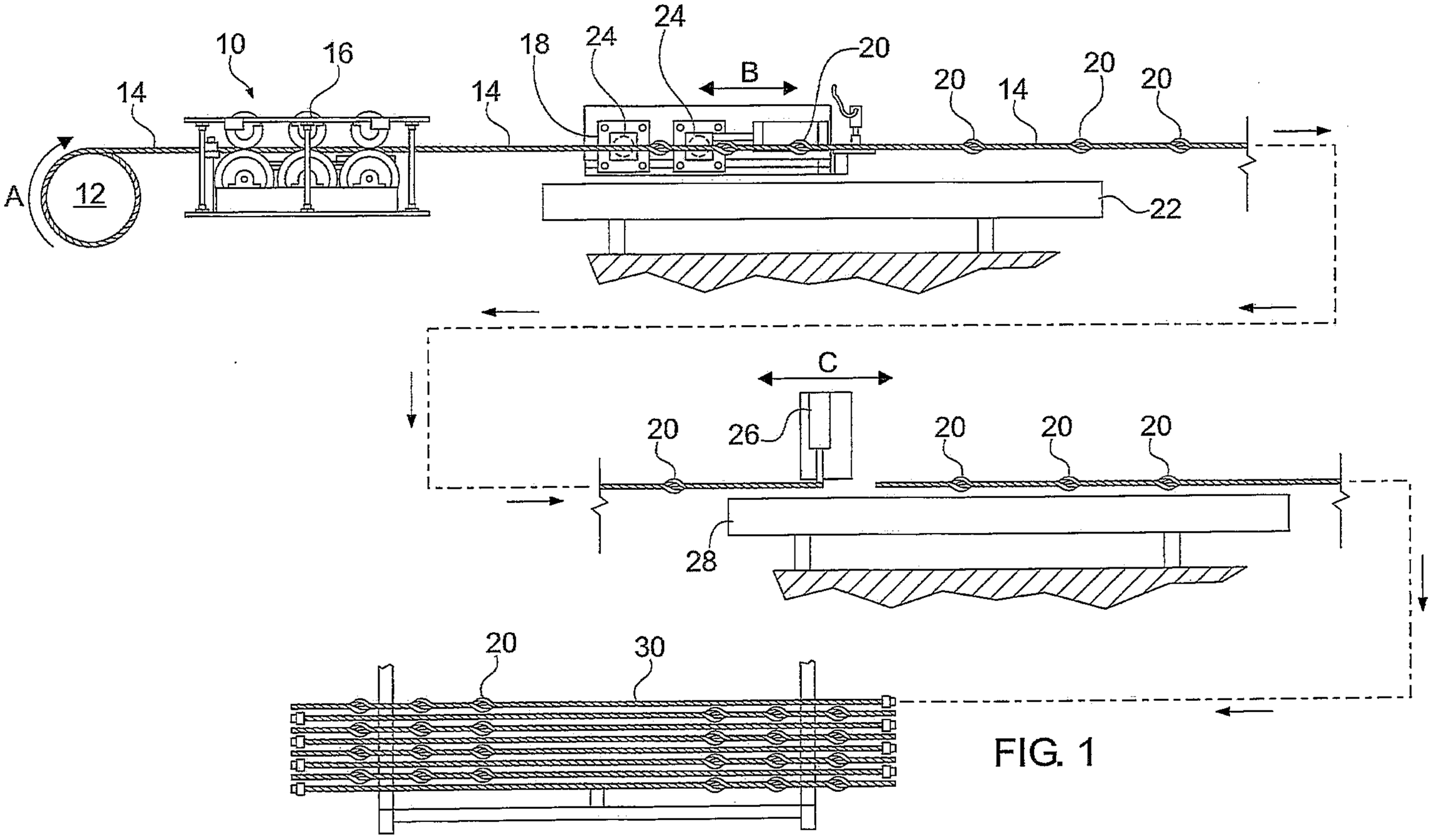

FIG. 1