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2,913,270

KNOT-TYING APPARATUS

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2 Sheets-Sheet 1

Fig. 1

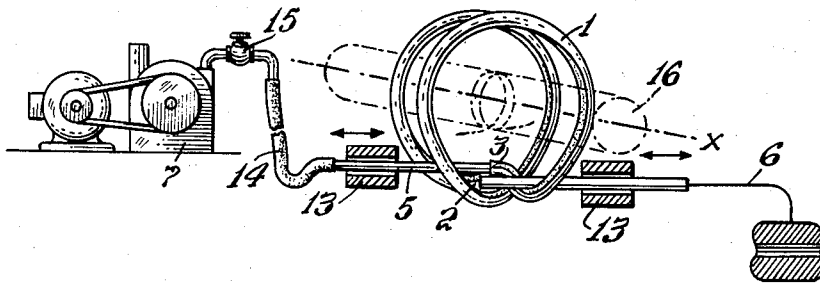


Fig. 2

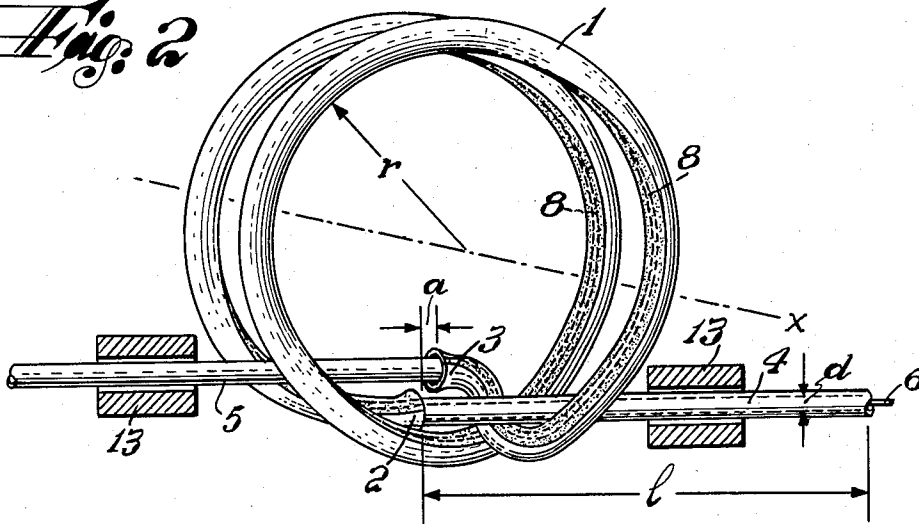


Fig. 3

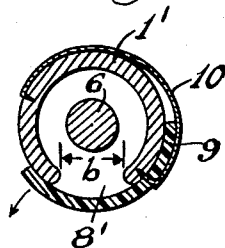
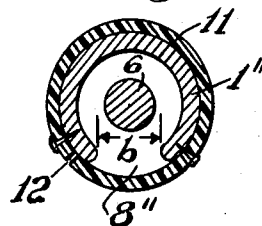


Fig. 4



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Fig. 5

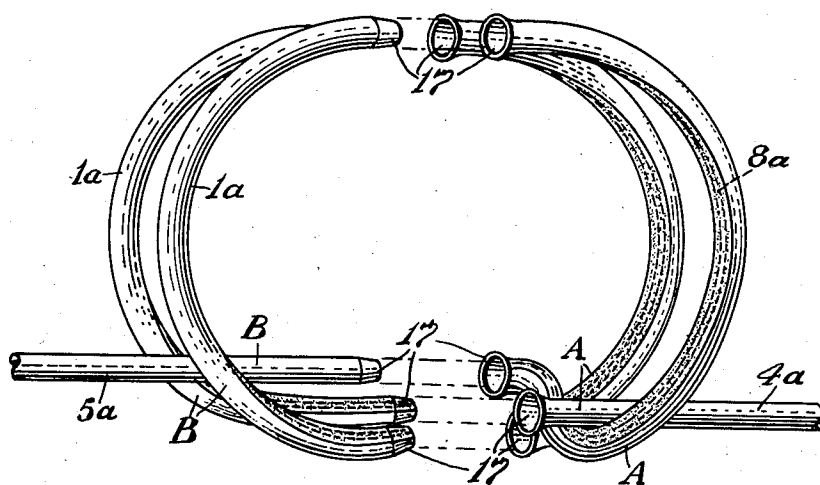
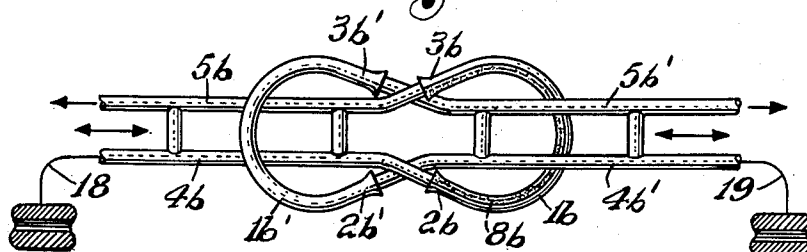


Fig. 6



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KNOT-TYING APPARATUS

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10 Claims. (Cl. 289—2)

This invention relates to an apparatus for making knots with threads, strings, cords, or the like.

It has already been suggested to use a loop-shaped tubing for knot-tying purposes. The tubing was formed to conform to a position which the flexible object used to tie a knot assumes prior to the actual formation of the knot. This position is assumed by the flexible object previous to being drawn taut in order to joint together the parts of the flexible object, which are involved in the formation of the knot. The tubing receives the flexible object lengthwise and is slitted along its inner periphery. The knot is tied by pulling at both ends of the flexible object within the loop-shaped tubing. In the known devices of this kind, the flexible object, for instance, a thread, is inserted in the loop-shaped tubing by introducing it first in a coil spring and then pushing the coil spring through the tubing. The free end of the thread emerging at the other end of the tubing is held, and the coil spring is removed from the tubing. On pulling the ends of the portion of the thread, that is within the tubing, that portion passes through the slit of the tubing to be laid and tightened around any goods within the loop or loops of the tubing. In practice, the passing and returning of the coil spring through the loops requires considerable time and also causes the sliding parts to wear off quickly, the latter effect being due to mechanical friction. Besides, an inconvenience often occurs inasmuch as the free end of the thread tends to slip into the coil spring, which free end is then difficultly pulled out again. Associated with such inconveniences are interruptions in the operation and losses of time. The shortcomings of the prior devices render it impossible to make packages, to tie sausage casing, to close sacks, bags, or the like in an economical way.

Our present invention aims, therefore, at simplifying the mechanical formation of knots, speeding up the knot-forming actions, avoiding disturbances and breakdowns, and at rendering the mechanical knot-tying more economical. To the accomplishment of the foregoing and other objects which will appear hereinafter, our invention consists in the apparatus elements and their relation one to the other, as are more particularly described in the specification and sought to be defined in the claims.

The specification is accompanied by drawings in which:

Fig. 1 schematically illustrates a knot-forming mechanism proper and associated vacuum pump and guides for the flexible object used to tie knots;

Fig. 2 shows the knot-forming mechanism and guides of Fig. 1 to enlarged scale;

Fig. 3 is a fragmentary cross section through a knot-forming mechanism;

Fig. 4 is a fragmentary cross section through a modified knot-forming mechanism;

Fig. 5 illustrates a modification of a knot-forming mechanism; and

Fig. 6 illustrates still another modification of a knot-forming mechanism.

Referring to the drawings, and initially to Figs. 1 and

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2, the knot-forming mechanism proper consists of a loop-shaped tubing designated 1. The tubing 1 is shaped to conform to the open or embryo position which the flexible object or the thread 6 assumes prior to being drawn taut to actually form the intended knot. The flexible object which may be a thread or any kind of twine, a cord, wire, band, gut, a plastic filament or thread of two or more strands twisted together, etc. passes through the loop-shaped tubing. The thread 6 is fed through a guide tube 4 to enter the tubing 1 at its entrance 2. The free end of the thread leaves the tubing 1 at its exit 3, where the tube 5 receives said free end and acts as a guide. Both tubes are supported in guide sleeves 13 to be axially movable. The tube 5 is connected to a vacuum pump 7 by means of a hose 14.

In the embodiment selected for illustration, as shown in Figs. 1 and 2, the tubing is shaped to deliver a simple knot. The tubing includes an intermediate loop portion, the corresponding thread part of which, upon drawing the thread 6 taut, will press upon the knot formed and prevent unintentional untying.

The object 16 to be tied is shown in phantom and is moved through the tying station in the direction of the line x.

It will be understood that the knot-tying action of the flexible object may start from different open positions. Accordingly, the loop or loops of the knot-forming mechanism proper may have different radii. The loops are given a radius r (see Fig. 2) which will correspond to the measurements of the goods to be passed through the loop for tying.

For the tubing 1, a slitted tube is used. The tubing is shaped to form two complete convolutions, and so that the slit 8 will appear along the inner peripheries of the loops. Thus, it is possible for the thread 6, when a pull is exerted on both ends thereof, to be drawn together and to emerge from the tubing through the slit 8. The slit is provided in a width which will ensure that the flexible object used may pass therethrough without obstruction.

The tubing may be given any suitable shape which corresponds to the open or embryo position of the intended knot, provided that the knot is simply formed by pulling the ends of the flexible object relatively apart.

The vacuum pump 7, according to our invention, sucks air through the tubing 1 and thus pulls the free end of the thread 6 in the sucking direction. It is obvious that any gas may be used instead of air and that the fluid current may be produced by drawing the transporting medium as well as by blowing same through the tubing.

To obtain a strong fluid current and to keep vacuum or pressure losses at a minimum, and in order to ensure that the flexible object be quickly and reliably transported through the loops of the tubing, we provide a cover for the slit in the tubing. Having reference to Fig. 3, 1' is a loop of a knot-forming mechanism, along the inner periphery of which loop a slit 8' is incised to allow the flexible object 6, for instance, a string, to slip therethrough. The slit is of a width b . A band 9 of rubber or similar resilient material is secured along, and on one side of, the slit. The band 9 acts in the manner of a flap valve. It may be cemented to the outer surface of the loop 1' or fastened thereto by means of clasps 10. In Fig. 4, a sleeve 11 of rubber or similar resilient material is shown which is longitudinally slitted at 12 and which surrounds the loop 1' to cover the slit 8''. It will be seen that the slits 8' and 12 are not aligned. As materials suitable for the band 9 and the sleeve 11, leather and plastics, for instance, may be used. Any material is suitable, the resilience of which is such as to ensure a tight closure of the longitudinal slit 8' and 8'', respectively, and to permit at the same time the

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flexible object to pass through the slit when the flexible object is tightened to form the knot.

Reverting to Fig. 2, the ends 2 and 3 of the tubing 1 are a distance a from each other so that the part of the thread 6, that emerges from the portion of the tubing, running obliquely with respect to the guide tubes 4 and 5, can actually continue without being caught by the ends 2 and 3. It is advantageous to provide sliding and guide means (not shown) at or near the ends of the loop-shaped tubing in order to assist the flexible object in its movement through the slit. Preferably, the end portions of the tubing are parallel, and the very ends of these end portions are funnel-shaped. Coaxially with the end portions at the ends 2 and 3, and joined thereto, extends the tapered end portion of the tubes 4 and 5, respectively. Each of the tapered end portions fits accurately into a funnel-shaped end of the tubing 1 so that the tubes 4 and 5 are coupled with the tubing in an airtight although loose fashion. The tubes 4 and 5 are longitudinally or axially movable. They are shown to be supported in guide sleeves 13 but may be supported in slides, circular guides as well.

The length l and the bore d of the guide-in tube are adjusted one to the other. We have found that the shorter the tube 4 is the tighter has its bore to surround the flexible object. It is, therefore, advisable not to provide a guide-in tube which is too short since threads and cords are frequently nonuniform in cross section and thickened portions in flexible objects must be reckoned with. Such nonuniformity, however, is insignificant if, with a sufficient length l of the guide-in tube 4, the latter can be given a diameter which will ensure a greater play for the flexible object so that thickened portions and the irregularities may readily be sucked through the bore.

The guide-out tube 5 which is joined to the exit end 3 of the tubing 1 is likewise coaxially arranged with respect to the end portion of the tubing 1 at 3. The tube 5 makes it possible to provide a long enough end of the flexible object, and to conveniently tie the knot. In the case of the tube 5, there is no interdependence as far as bore of the tube, thickness of the flexible object, and length of the tube are concerned. Like the guide-in tube, the guide-out or guide-off tube is longitudinally movable. It may be connected over a flexible hose 14 to the inlet side of the vacuum pump 7.

To start operation, that is, to produce a knot with the aid of the apparatus of our invention, a flexible object, such as the thread 6, is introduced into the bore of the guide-in tube. The tube is moved longitudinally until its tapered end comes to lie within the funnel-shaped end 2 of the tubing 1. Here as well as in the case of the tube 5 or guide-out tube, as has already been pointed out, an airtight connection is achieved. Next, the vacuum pump 7 which is connected to the guide-out tube over the hose 14 is started to operate briefly or permanently. If the vacuum pump operates uninterruptedly, a stop valve which may be provided at any place between the guide-off tube and the vacuum pump is opened for a brief period of action. In whatever way the vacuum pump is made to become effective, during that brief period of time, a predetermined length of the flexible object used is sucked through the tube 4 as far as the tube 5.

In the construction shown, for instance, in Fig. 3, due to the vacuum produced in the line, the resilient band 9 is tightly pressed against the edges of the slit 8' in the tubing 1', making it impossible for the air to enter in any way other than through the guide-in tube holding the flexible object or thread 6. The thread 6 is similarly pushed forward as a piston in a cylinder.

Prior or during the movement of the flexible object, the goods to be tied, identified by the numeral 16 in Fig. 1, are fed into the space within the tubing 1. To tie the knot, all that is still needed is a pull to be applied to the thread 6 at both ends. This may, for instance,

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be accomplished by fastening one end to the tube 4 and one end to the tube 5, and axially moving the tubes in opposite direction. In this manner, the embryo knot of the thread will be tied tautly around the piece of the goods involved. Then the thread is cut off, the tied piece 16 removed, and the apparatus is ready for a new knot-tying action.

In the construction shown in Fig. 5, the tubes 4a and 5a are rigidly connected to the tubing 1a. However, the whole knot-forming mechanism is split into two sections A and B in a plane shown in the construction selected for illustration to be perpendicular to the tubes 4a and 5a. The two sections A and B are made to be movable toward and from each other. At the connecting points 17, the ends of the tubes 4a and 5a are tapered, and the ends of the tubing 1a are funnel-shaped, similar to the formations shown in Figs. 1 and 2. The operation of the form of apparatus, shown in Fig. 5, and the knot-formation are similar to what has been described heretofore. In view of the provision of the knot-forming mechanism in two sections, and the movability of the sections, it is possible to design the two sections so as to serve as means to grab the goods to be tied, for instance, sheaves.

According to another feature of the invention, two or more flexible objects, such as threads, are used instead of a single flexible object. In Fig. 6, a construction is shown in which two equally thick threads 18 and 19 are to be tied to form a kind of reef knot. Equal thickness of the flexible objects, however, is not required since the two devices 1b and 1b' and the respective associated guide tubes may as well be designed to suit different thicknesses. The guide-in tube 4b and guide-off tube 5b are parallel and arranged to be movable relative to the ends of the tubing 1b. The tubes 4b' and 5b' are similarly arranged with respect to the tubing 1b'. Each of the tubings 1b and 1b', shown in plan view, is formed by a single semi-circular or horseshoelike lengthwise slitted loop, the open ends of which are located so as to make sure that the flexible object is carried therethrough by an angle of at least 180°. The loops of the two tubings, with their slitted sides, are so interlaid that upon pulling the ends of each of the threads 18 and 19, the threads will leave the slits and finally be tied together to form the referred to type of reef knot. The mode of operation, as far as each of the two tubings 1b and 1b' is concerned, and the occurrences during the tying of the knot correspond to the actions described with respect to Figs. 1 and 2.

The apparatus of our invention can be equipped with means to carry out all the steps involved automatically, such as, the introduction of the flexible object, its passage through the apparatus, the clamping, tightening, and cutting-off of the flexible object, and the feeding of the goods to be tied. Provision is made to perform all these steps in proper and continuous succession.

Our apparatus can be designed for intermittent as well as continuous feed of the goods to be tied. Goods to be tied in our apparatus are, for instance, sacks, bags, bales, parcels, bundles, natural and synthetic casings enclosing sausage meats, etc. In addition to tying a hose, the apparatus according to our invention can also be used to wind a cord or the like around a hose.

As media to transport flexible objects through the knot-tying apparatus, air or any other gas may be used. To prevent a gaseous medium from entering through the slit in the loop-shaped tubing, when working under vacuum, or to prevent a transporting pressure medium from escaping through the slit, it is also possible to provide a sleeve-like valve and to arrange for same to be moved in the direction of the axis x (Fig. 2) to close the slit, and to be withdrawn upon the introduction of the package to be tied and prior to tying, thus making it possible for the flexible object to leave the loop-shaped tubing through the slit.

It is believed that the construction and operation of

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the apparatus, and the many advantages thereof, will be fully understood from the foregoing detailed description. In reviewing some of the features of the invention, it is pointed out that a gaseous medium is used to transport the flexible object through the loop-shaped tubing. The loop-shaped tubing may comprise one or more loops and is slitted along its inner periphery. In order to decrease flow losses and to increase the efficiency of the apparatus, a cover is provided to close the slit in an airtight manner while a vacuum is applied or during the flow of a pressure medium. In doing away with parts to convey the flexible object through the apparatus, the construction of the latter is very simple. Our apparatus ensures a simple, fast, and fool-proof operation. It does not require the attendance by skilled labor, nor does it require careful handling. It is well suited to be handled in a rough manner, as is necessary in the case of tying grain sheaves, cement sacks, or similarly heavy goods. The passage of the flexible object through the loop-shaped tubing, just as the passage of the goods to be tied through the coils of the tubing, requires practically no time. There is no longer any wear since such parts as have been used heretofore to move the flexible object are eliminated. Our apparatus is suited for use in high-speed packing machines and can also be used for the tying together of two ends of single or two flexible objects.

It will be apparent that while we have shown and described our invention in a few forms only, many changes and modifications may be made without departing from the spirit of the invention defined in the appended claims.

We claim:

1. Apparatus for tying knots with threads, strings, cords, or the like flexible objects, including a tubing of loop shape to conform to an open embryo form of the knot to be tied and serving to lengthwise receive the flexible object, the open embryo form being assumed by the flexible object before the latter is tautened to actually form the knot, the loop-shaped tubing being provided with a single continuous slit along its inner periphery, sealing means provided on the outside of the tubing to normally keep said slit closed in a gastight manner, and an air pump communicating with the tubing to deliver an air stream to transport the flexible object through the tubing.

2. The apparatus according to claim 1, wherein the loop-shaped tubing consists of two detachable sections, one section having an entrance end to receive the flexible object, the other section having an exit end to discharge the flexible object, and wherein a tube is joined to the entrance end, and another tube is joined to the exit end.

3. Apparatus for tying square knots with threads, strings, cords, or the like flexible objects, including two tubings of loop shape to conform to an open embryo form of the knot to be tied, each tubing serving to lengthwise

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receive one of two flexible objects used to form the knot, the open embryo form being assumed by the two flexible objects before the latter are tautened to actually form the knot, each of the loop-shaped tubings being provided with a single continuous slit along its inner periphery, sealing means provided on the outside of the tubings to normally keep the two slits closed in a gastight manner, and an air pump communicating with the tubing to deliver an air stream to transport the flexible objects through the tubings.

4. In the apparatus according to claim 1, a band of resilient material, provided on the outer surface of the loop-shaped tubing to cover the slit in the manner of a flap valve and to serve as said sealing means.

5. In the apparatus according to claim 1, a slitted sleeve of resilient material, surrounding the loop-shaped tubing and serving as said sealing means.

6. In the apparatus according to claim 1, the loop-shaped tubing having an entrance end to receive the flexible object, and an exit end to discharge the flexible object, a vacuum pump serving as said air pump and being connected to said exit end.

7. In the apparatus according to claim 6, a tube arranged to be movable along its axis and to be loosely joined to said exit end, the tube serving to receive the free end of the flexible object upon the passage of the latter through the tubing, and being interposed between the exit end of the tubing and the vacuum pump.

8. In the apparatus according to claim 1, the loop-shaped tubing having an entrance end to receive the flexible object, and an exit end to discharge the flexible object, a tube arranged to be movable along its axis and to be loosely joined to said entrance end, the tube serving to guide the flexible object into the loop-shaped tubing.

9. In the apparatus according to claim 8, said guide-in tube having a bore to surround the flexible object tighter in proportion as the tube is shorter.

10. In the apparatus according to claim 1, the loop-shaped tubing having an entrance end and an exit end and comprising more than one convolution, the entrance and exit end being a distance apart from each other, a loop portion obliquely traversing the space between the tubing ends, said distance being such as to allow the part of the flexible object emerging from said loop portion to continue unobstructedly.

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