United States Patent

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[73] Assignee **Messrs. R. Melzer OHG**

[54] **KNOTTING DEVICE**
11 Claims, 10 Drawing Figs.

[52] **U.S. Cl.** **289/2**
[51] **Int. Cl.** **B65h 69/04**
[50] **Field of Search** 289/1.2. 1.5, 2, 17, 18

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ABSTRACT: A method and a device for knotting one or multiple yarns, threads or the like in which the yarn end to be knotted is forced to move along a looped path by means of pneumatic forces. The yarn is thereafter liberated from the path defining channel thereby maintaining the loop so that a pulling force exerted upon the free yarn end will tighten the knot provided by the loop.

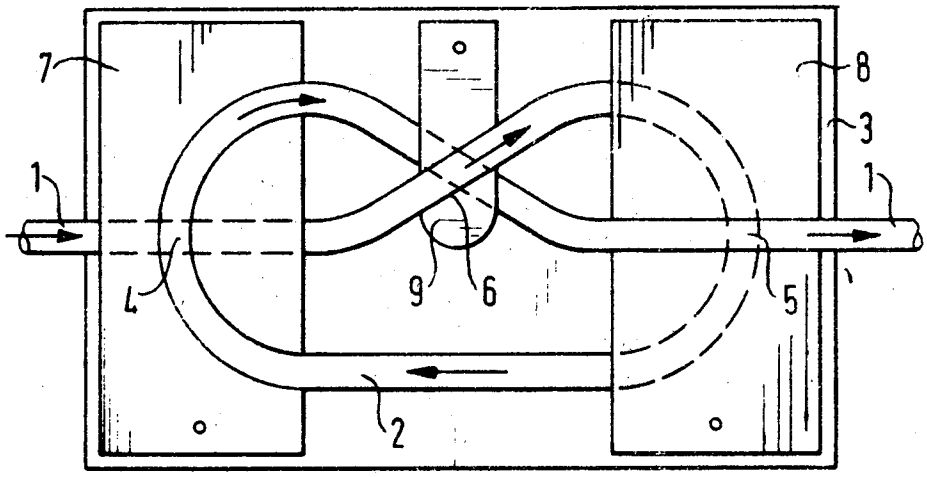


Fig. 1

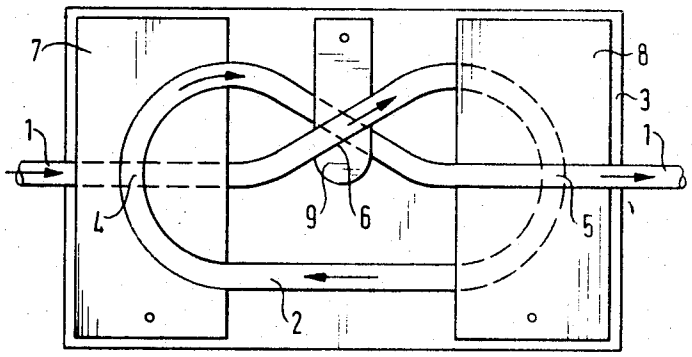


Fig. 2

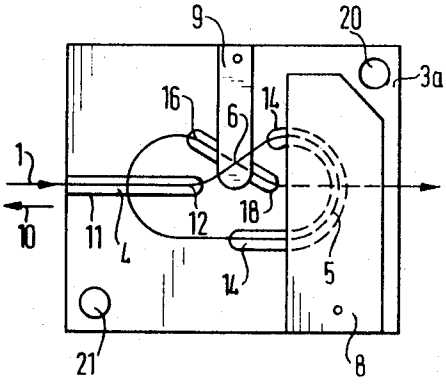


Fig. 3

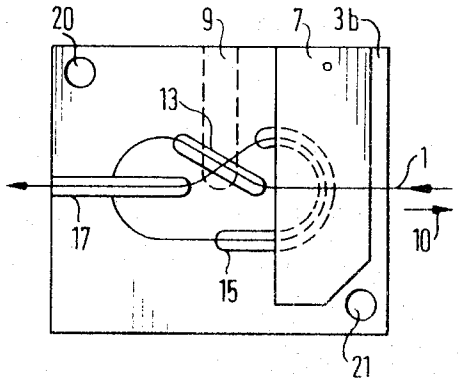




Fig. 4

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Fig.5

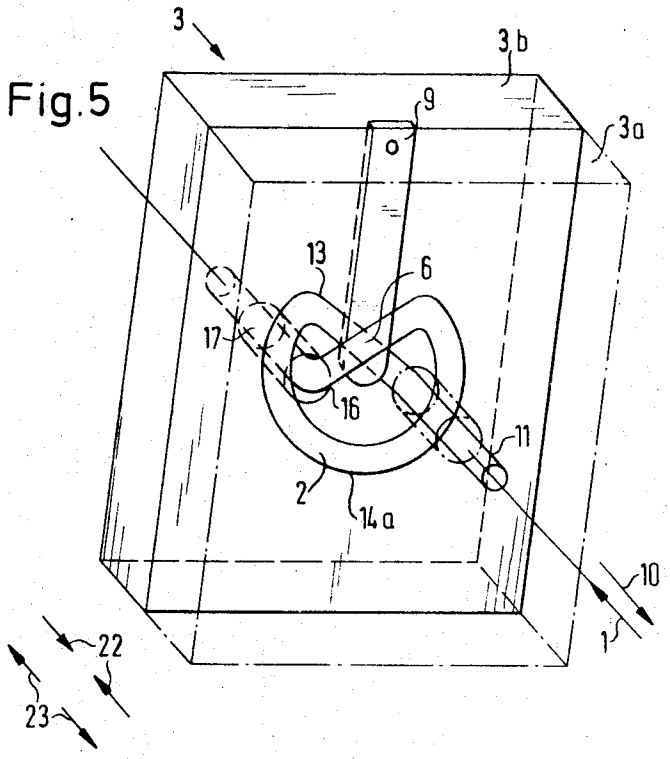


Fig. 6

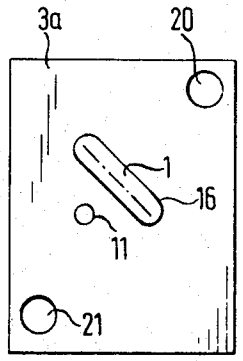
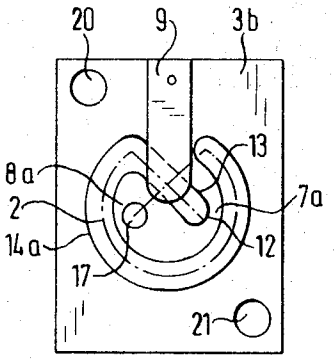
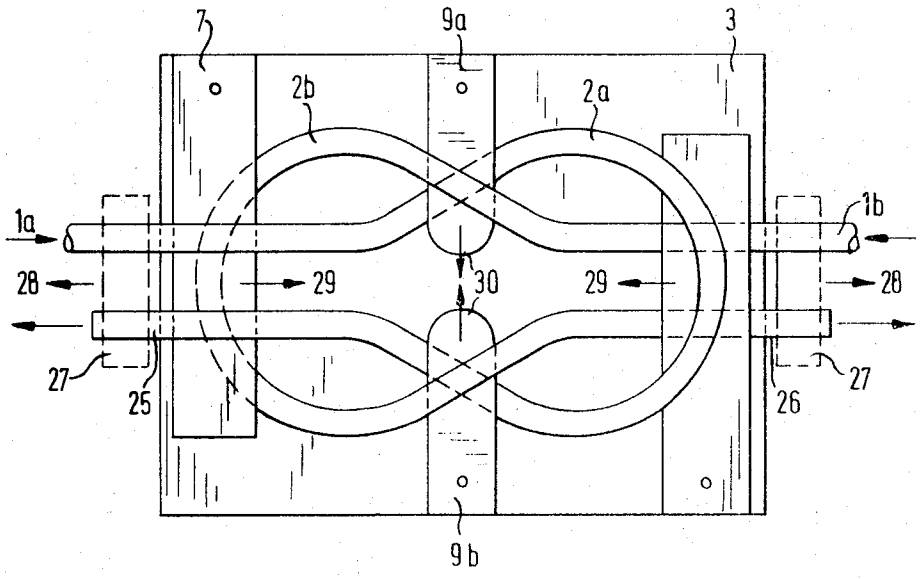


Fig. 7



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Fig. 8



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Fig.9

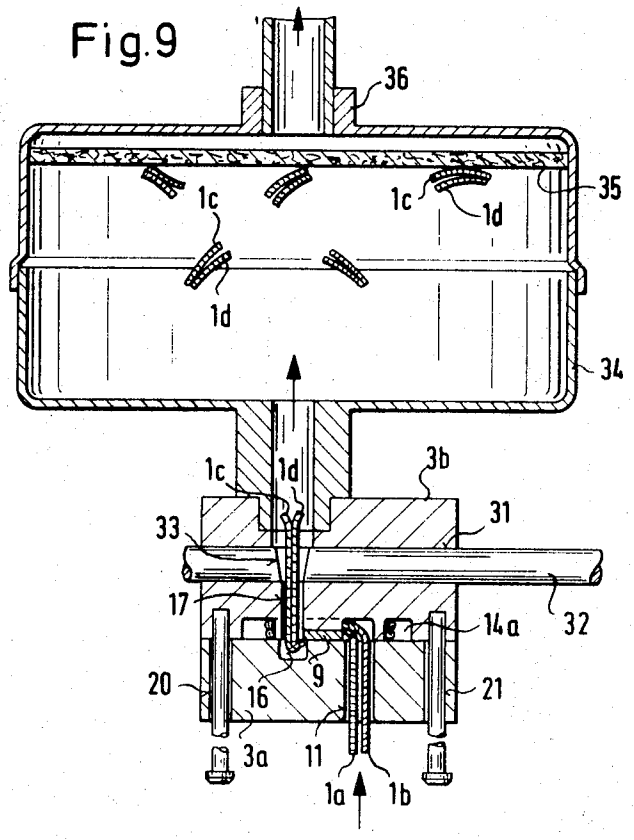
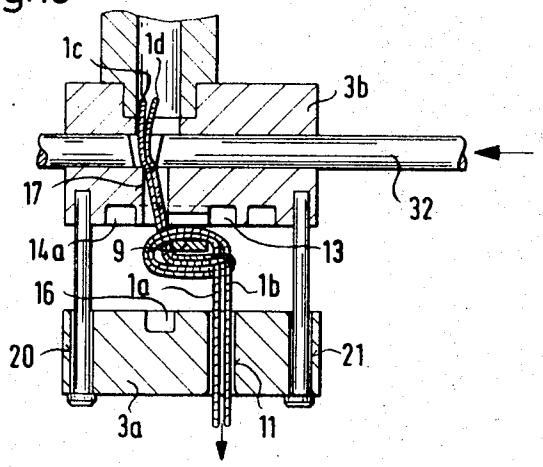


Fig.10



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KNOTTING DEVICE

BRIEF SUMMARY OF THE INVENTION

The invention concerns a method and a device for knotting yarn, thread, wire or any other flexible material which can be knotted manually.

There is a need for knotting devices in particular in the textile industry. For example, spool machines are provided with knotting devices, each one unit being provided at each spool station.

Such known devices all comprise a multiplicity of mechanically driven members subject to wear and tear and being far away from failsafe operation. A further considerable drawback of such known mechanical devices is the fact that the yarn or thread to be knotted will be subjected to a heavy load so that very fine threads cannot be handled. Moreover, very often it will not be possible to form a desired type of knot with a mechanically operating device so that another type must be chosen. Finally, a mechanically operating knotting device will normally be able to knot only a yarn of predetermined thickness but no other yarn.

It is the object of the present invention to provide means for knotting yarn, thread or other flexible material which eliminates the need of mechanically driven yarn guiding and clamping members.

Another object of the invention is to provide a knotting method based on pneumatic forces exerted upon the yarn.

A further object of the invention is the provision of a pneumatically operating knotting device capable of handling different types and thickness of yarn in one and the same unit.

A still further object of the invention is the provision of a pneumatically operating knotting device which can be designed to form even extremely complicated knots.

A still further object of the invention is the provision of a knotting method which permits the construction of extremely simple knotting devices with a minimum of moving parts thereby rendering the device correspondingly reliable.

In general, according to the invention, the yarn movement sequence is imitated which takes place when a knot is formed manually. Thus, the invention provides a two-cycle operation. At first, a loose loop is established with the yarn and in a second step the loop is tightened thereby forming the knot.

For this purpose, a channel system corresponding to the loop shape which, by the way, may be even very complicated, is provided at the inlet of which the yarn is introduced. Introduction of the yarn is accomplished by sucking at the other end of the channel system so that the yarn end will follow the looped path established by the channel system. As soon as the yarn end appears at the suction or outlet end of the channel, the negative pressure is relieved and the channel system is opened so that the loop may come clear thereby still maintaining the loop. Pulling at the introductory yarn end will then tighten the loop so that a corresponding knot will be formed.

A very important feature of the invention is the design of the channel system in particular at the cross points of the loop. During the loop forming operation cycle, the channel portions adjacent the cross points must be positively separated from each other by a physical wall. During the second cycle, however, the yarn must be able to "break through said walls in order to pull the knotted yarn ends out of the channel without destroying the loop. Thus, the intermediate walls must be movable to some extent and these are in fact mechanically movable members of the device; the knotting device may be designed in such a manner that all other parts are stationary.

Further objects, features and advantages of the invention will be explained in detail hereunder with reference to the accompanying drawings which show preferred embodiments of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a simple knot, diagrammatically intermediate walls being indicated at cross points of the knot loop formed by movable flat springs.

FIG. 2 and

FIG. 3 are front elevations respectively of two complementary suction channels of a suction channel system provided to produce the simple knot as shown in FIG. 1, the channels being provided each in one-half of a suction channel block.

FIG. 4 is a perspective view of a simple knot formed by knotting two yarn ends disposed in side-by-side relation within the knotting device as shown in FIGS. 1—3.

FIG. 5 shows another embodiment in accordance with the invention to produce a simple knot as shown in FIG. 4.

FIG. 6 and

FIG. 7 are front elevation views of the front faces of the suction channel block as shown in FIG. 5, the two block halves being illustrated in side-by-side relation while, in operation, being oppositely arranged.

FIG. 8 is a diagrammatic illustration of a device in accordance with the invention provided to produce a so-called loom-knot formed by knotting of two yarn ends introduced into the device from opposite directions, the movable intermediate walls at the knot cross points being schematically indicated.

FIG. 9 and

FIG. 10 illustrate diagrammatically the function of a knotting device in accordance with the invention, illustrating successive stages of operation of the device, the Figure showing sections through the embodiment of FIG. 5 at the level of the input channels 11, 17.

DESCRIPTION OF THE SHOWN EMBODIMENTS

Referring to FIG. 1, serving the purpose of illustration only, a yarn end 1 is shown which is to be knotted. The yarn end 1 forms a loop 2 which, when tightly pulled, will form the knot. A suction channel block 3 is schematically illustrated and comprises a suction channel system in accordance with the loop form. In FIG. 1, only one-half of the block 3 is shown which, in fact, comprises two halves apt to be separated in the plane of the drawing during the knotting operation.

In FIG. 1, the suction channels themselves are not illustrated but it is to be noted that they must be separated from each other at the loop cross points 4, 5 and 6. For this purpose, movable intermediate walls 7, 8 and 9 are provided. Intermediate wall 7 is connected to that half of the block 3 which is not shown in FIG. 1 so that after separation of the two block halves from each other, the loop may be drawn out of the suction channel portion covered by intermediate wall 7. The intermediate wall 8 is accordingly connected to the block half shown in FIG. 1 while intermediate wall 9 is provided at cross point 6 either at the one or at the other half of the block 3, the yarn portions moving along a straight path at this point.

Turning now to FIGS. 2 and 3, both the two halves 3*a* and 3*b* are illustrated to show the actual form of the suction channels in detail. In operation, the block halves 3*a* and 3*b* engage each other in the plane respectively shown in FIGS. 2 and 3 such that the suction channel grooves in each of the halves complete a closed suction channel system having the form of the loop as shown in FIG. 1. It may be assumed that the yarn 1 is introduced into the suction channel system from the left-hand side, negative pressure being applied to the right-hand side of the system thereby sucking the yarn end along a channel system in form of a loop until the yarn end appears at the channel opening at the right side face of the block. The yarn 1, at first, follows a straight channel portion 11 provided in the block half 3*a* and will cross over about at 12 to the channel portion 13 which is provided in the block half 3*b* and will be seen in FIG. 3. Channel portion 13 connects the straight channel portion 11 with a curved channel portion 14 in block half 3*a*, terminating in a straight end. The yarn will then again cross over into the block half 3*b* which for this purpose is pro-

vided with a channel portion 15 quite similar to portion 14 in block half 3*a*. The channel cross point 11—15 (4 in FIG. 1) requires separation of the two crossing channels for which purpose intermediate wall 7 is movably connected to block half 3*b*. Having passed channel portion 15, the yarn must be sucked at the center cross point 6 bypassing with respect to the yarn portion which is already present at this point, for which purpose channel portion 15 is followed by a channel portion 16 in block half 3*a* connecting portion 15 with the outlet channel portion 17 in block half 3*b*. Again, movable intermediate walls are provided to separate the channel crossings 13–16 (6 in FIG. 1) and 14—17 (5 in FIG. 1), the intermediate walls being designated with 9 and 8, respectively. Intermediate walls 7, 8, 9 have preferably the form of flat springs made of resilient sheet metal. They are fastened to the respective block halves 3*a*, 3*b*—as shown in FIGS. 2 and 3—in such a manner that the y may be slightly lifted from the suction channel portions which are covered by the intermediate walls, the lifting occuring upon separation of the block halves and tightening of the yarn loop, the loop thereby getting clear of the walls 7, 8 and 9. This will be easily accomplished by simply pulling at the yarn end in direction of arrow 10 in FIGS. 2 and 3, i.e., in opposite direction with respect to the suction direction.

Intermediate walls need not necessarily be flat springs, flat slides being as well suited for this purpose but requiring complicated drive means.

For sake of simplicity, in FIGS. 2 and 3 but one yarn end is shown, however, with a suitable section of the suction channel system two or even a multiplicity of yarn ends may be processed in the device, in the case of two yarn ends a knot resulting as shown in FIG. 4.

The embodiment of FIG. 2 and 3 comprises almost identical halves of the block 3, the channel portions in the two halves 3*a* and 3*b* being even completely identical. They differ, however, with respect to the intermediate walls and they may further be provided with different means for guiding the block halves during the separation movement. Such guide means may be pins on which the block halves may ride with enough clearance to permit an easy movement. Other constructions for the guiding purpose will be within the knowledge of persons skilled in the art. The operation of the device may have been understood by reading of the foregoing description. In summary, the device operates as follows:

The two block halves are moved together so that the channels face each other. Negative pressure is applied at one outlet channel orifice, e.g., at 17, and the yarn end or yarn ends sucked into the channel system due to said negative pressure, thereby following the loop defined the channel system. As soon as the yarn end or ends appear at the suction orifice, the negative pressure is removed and the block is separated or opened in the plane of the channels. Pulling at the yarn will result in sliding of the loop over the intermediate walls thereby lifting the latter from the respective block half and simultaneously tightening the loop so that finally a knot will be produced.

FIGS. 5—7 show another embodiment of the knotting device according to the teachings of the invention. Again, the block 3 consists of two halves 3*a* and 3*b* having, however, different channels as shown in FIGS. 6 and 7. The yarn inlet 11 and the yarn outlet (or suction orifice) 17 are not provided in the separating plane of the block but intersect the channel system at points corresponding to the yarn displacing points 12, 18 in FIG. 2. Thus, yarn inlet channel 11 passes through the body of the block half 3*a* from its outer face and perpendicularly with respect to the separating plane of the block where it terminates at the inlet point 12 of channel 12 provided in the other block half 3*b*. Suction channel portion 13 opens into the outlet 17 via a curved channel portion 14*a*—provided in block half 3*b* in continuation of straight channel portion 13—and a straight channel portion 16, provided in block half 3*a*, into which the yarn crosses during its being sucked into the channel system. Straight channel portion 16 bridges the straight channel portion 13 in block half 3*b*. Inlet and outlet channel 11 and 17, respectively, are not aligned but define a plane perpendicular with respect to the separation plane of the block. At cross point 6 of suction channel portions 13, 16 again a movable intermediate wall 9 is provided having the shape of a flat tongue made of resilient material, as steel, plastic, or others. The two other cross points are eliminated in this embodiment due to the fact that inlet channel 11 and outlet channel 17 each intersect one of the block halves entirely from their respective outer face. The function of intermediate walls 7, 8 in FIGS. 1—3, will, in the embodiment shown in FIGS. 5—7, be accomplished by solid intermediate walls 7*a*, 8*a* separating respectively from the inlet and outlet channel the ring channel 14*a* extending thereabout: of course, walls 7*a*, 8*a* are integral with the block half 3*b*.

The operation of the embodiment as shown in FIGS. 5—7 is quite similar to that of FIGS. 1—3. A suction or negative pressure source is connected to outlet 17 to suck the yarn 1 into inlet channel 11 in direction of the arrows carried by the yarn line. The sucked-in yarn end will, or course, follow the channel loop. A pulling action at the free yarn end in direction of the arrows 10 will result in a force acting on the tongue 9 which, in turn, will lift block half 3*a* from block half 3*b* which may be assumed stationary. The loop may then slide over tongue 9 and further pulling at the yarn will result in the knot being tightened. The separating movement of the block halves is indicated with arrows 23, the block halves being moved together after completion of the knot in direction of arrows 22.

The embodiment shown in FIGS. 5—7 is very compact so that even extremely short yarn ends may be knotted. The yarn ends—for example, two or even more—are introduced in parallel relationship into the inlet 11. It is to be noted that the movable intermediate wall is to be provided at the block half opposite the inlet opening in order to permit the loop to get free of the lifting wall upon a pulling force being exercised at the yarn end, the knot otherwise being stuck with the tongue which cannot be lifted by the action of the pulling force if exerted at the end of the yarn at outlet 17.

The symmetrical embodiment shown in FIGS. 1—3 on the contrary permits to interchange inlet and outlet or suction opening, the operation being identical. Based on the design of FIGS. 1—3, a further modification is possible which permits the knotting of two yarn ends introduced along different paths. This embodiment is schematically shown in FIG. 8.

In FIG. 8, the device is designed for knotting a first yarn end 1*a* and a second yarn end 1*b*, each forming a loop 2*a* or 2*b* respectively, by means of corresponding channels in the block 3. The intermediate wall 9 is duplicated so that intermediate walls 9*a*, 9*b* are provided for loops 2*a*, 2*b*, respectively, while intermediate walls 7 and 8 need be just extended in length. Negative pressure is applied at 25 and 26 so that the yarn ends move along the paths defined by the channel system and leave the block at 25 and 26, respectively. Clamping means 27 are provided to maintain the loops 2*a*, 2*b* so that the block 3 may be opened or separated. The right-hand clamping means 27 being assumed stationary, a pulling action exerted on left-hand clamping means 27 will result in the loops getting closely engaged by following paths indicated with arrows 29, 30, thereby sliding free of the intermediate walls 7, 8, 9*a* and 9*b*.

The device according to the invention is able to knot in one and the same unit yarn or thread of quite different thickness, the upper limit being given by the channel cross section area and the lower limit by the force exerted on the yarn during the lifting operation of the intermediate walls which must, of course, not exceed the strength of the yarn. It has been found, moreover, that knotting of two yarns of quite different thickness and quality is possible with the device.

It will be noted that the embodiment shown in FIGS. 5—7, need not be designed as comprising two block halves. In fact, if the tongue 9 and stationary walls 7*a*, 8*a* are replaced with a slider movable into and out of the position actually taken the block halves 3*a* and 3*b* may be tightly connected to each

other. It will, however, be preferred to manufacture the block in two halves in order to facilitate the milling of the channel system.

Replacing the tongue **9** with a slider, on the other hand, would result in an item in which the slider in fact is the only movable part; the slider, of course, would necessitate an individual drive means to accomplish the knotting operation's second cycle.

A separate drive means, however, would not be necessary in case of cutting means being provided for the ends of the yarn beyond the knot which could be designed in such a manner that one and the same reciprocating drive shaft could operate the cutting knife and the slider, the latter all being disposed in parallel.

FIGS. **9** and **10** show a further modification of the device in order to permit the automatic operation thereof. FIGS. **9** and **10** illustrate a unit which is shown in FIGS. **5—7** in section.

Very often it will be desired to cut the ends of the yarn after its being knotted. For this purpose, a yarn cutting knife is provided in block half *3b*.

FIG. **9** illustrates the operational position of the device, during the suction cycle. Block half *3b* is provided with an opening **31** extending therethrough perpendicular with respect to outlet channel **17** and intersecting the latter. The opening **31** receives a yarn cutting knife **32** which is a steel rod **32** movably engaging the opening **31** and being provided with a transverse bore **33**. In the suction cycle of the operation, the bore **32** is aligned with outlet channel **17** permitting the negative pressure to act on the yarn ends *1c*, *1d*. The negative pressure is applied via a filter housing **34** which houses a filter **35** and is provided with a suction socket **36** to be connected to a source of negative pressure (not shown). The filter chamber **34** will collect the yarn ends **35** cut by the yarn-cutting knife **32**. The latter simultaneously acts as a switch means for the negative pressure since—as shown in FIG. **10**—it is movable along the bore **31**. During the movement of knife **32**, it cuts the yarn ends and closes thereafter the communication between the source of negative pressure and the outlet channel **17**. Only in case a knotting operation is to be effected, the knife **32** will be moved in the operational position as shown in FIG. **9**, permitting communication between the chamber **34** and outlet channel **17** thereby permitting yarn ends to be sucked into inlet channel **11**. Thus, it will be possible to connect a multiplicity of blocks **3** to one and the same chamber **34** thereby drastically reducing the overall negative pressure consumption This will be interesting for certain industrial applications, for example, in spool machines having many spool stations each being provided with a knotting device. Control of the knife **32** may be accomplished by the yarn-detecting lever present at each spooling station. The free yarn ends to be knotted may be introduced into channel **11** by means of suction guides or by means of yarn-finding elements known per se.

The embodiments shown and described are to be considered as examples only, the scope of the invention to be defined by the attached claims because any person skilled in the art may be able to provide modifications when making use of the spirit of the invention.

I claim:

1. A device for knotting yarn ends comprising a block with a yarn inlet opening into a looped channel which extends through said block, cross point separating means in the path of said channel, a yarn outlet connecting said looped channel to a source of negative pressure, and means to liberate the yarn sucked into said channel upon a pulling force being exerted on the yarn end for tightening the yarn loop thereby forming the knot.

2. A device as claimed in claim **1** in which said yarn-liberating means comprises movable cross point separating walls.

3. A device as claimed in claim **2** in which the block comprises two block halves provided with suction channel grooves in their interface surfaces.

4. A device as claimed in claim **3** in which the inlet and outlet are provided in the interface plane of the block.

5. A device as claimed in claim **3** in which the inlet and outlet extend through the block perpendicularly with respect to the interface.

6. A device as claimed in claim **2** in which said movable walls are tongues made of resilient material.

7. A device as claimed in claim **1** comprising a separate block whose halves engage each other during a first cycle of the knotting operation, the yarn-intercrossing channels being provided in the separating plane of the block halves, the cross point separating means being provided in the separating plane and being movable to liberate the yarn in the channel into said plane, and guiding means to guide the block halves during their separation and reengagement, means being provided to separate the block by moving them a predetermined distance during a second cycle of the knotting operation in which the knot is tightened.

8. A device as claimed in claim **7** in which yarn-cutting means are provided which are with negative pressure passage means communicating the source within the outlet during the first cycle, said cutting means being further provided with negative pressure-blocking means to block the communication between the source and they yarn outlet after cutting of the free yarn ends beyond the knot.

9. A device as claimed in claim **1** in which yarn-cutting means are provided.

10. A device as claimed in claim **9** in which filter means are provided between the negative pressure source and the outlet.

11. A device as claimed in claim **1** in which a further yarn inlet with an allotted channel and allotted outlet connected to a source of negative pressure are provided, the looped channels of the two yarn paths intercrossing each other so that a knot will be formed upon a pulling force being exerted upon the yarn ends extending at the two inlets relative with respect to each other.