United States Patent [19]

Derich et al.

[11] **3,832,868**

[45] **Sept. 3, 1974**

[54] **WARP KNITTING MACHINE**

[75] Inventors: **Josef Derich**, Monchengladbach; **Heinz Kamp**, Rickelrath; **Gunter Frehn**, Monchengladbach, all of Germany

[73] Assignee: **W. Schlathorst & Co.**, Monchengladbach, Germany

[22] Filed: **Nov. 13, 1972**

[21] Appl. No.: **306,350**

[30] **Foreign Application Priority Data**

Nov. 12, 1971 Germany 2156386
Apr. 28, 1972 Germany 2220942

[52] **U.S. Cl.** ..... **66/84**, 66/86 R, 66/125 R
[51] **Int. Cl.** **D04b 23/06**
[58] **Field of Search** ..... 66/86, 87, 85, 84, 84 A, 66/85 A, 125

[56] **References Cited**

UNITED STATES PATENTS

3,134,248	5/1964	Kubelka et al.	66/85 A
3,523,430	8/1970	Inui	66/84
3,648,459	3/1972	Furst et al.	66/84 A

FOREIGN PATENTS OR APPLICATIONS

2,049,254	3/1971	France	66/84 A

Primary Examiner—Ronald Feldbaum
Attorney, Agent, or Firm—Herbert L. Lerner

[57] **ABSTRACT**

In a warp knitting machine, pneumatically operated means is provided for inserting weft thread in the material being knitted. The pneumatically operated means includes an elongated slotted tube in which a projectile is pneumatically propelled back and forth within the tube. The projectile has an arm passing through the slot in the tube and carrying operable means externally of the tube for pulling weft threads from a stationary supply reel. The weft threads are inserted in the material being knitted and suitable control means are provided for controlling the operation of the pneumatically operated means and the insertion of the weft threads.

17 Claims, 21 Drawing Figures

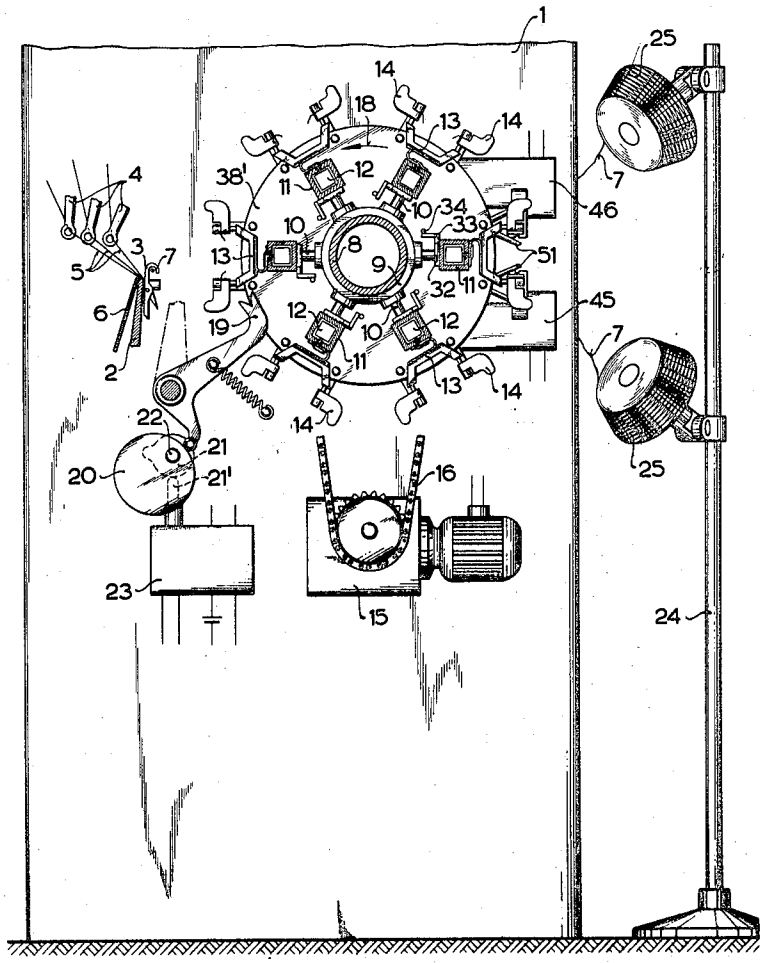


FIG.1

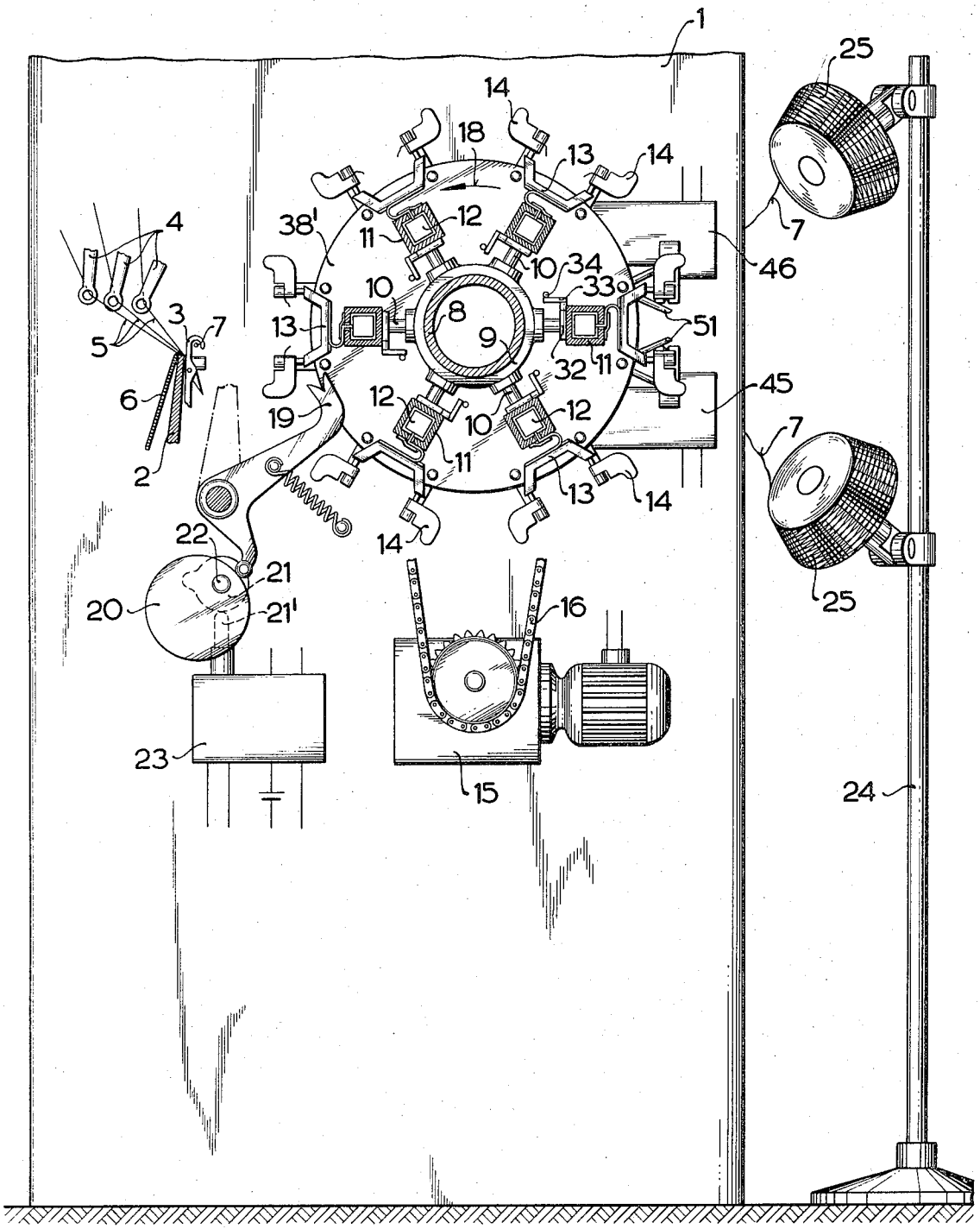

1
25
14
18
13
14
38'
12
11
4
7
46
10
34
33
3
7
8
51
5
13
9
32
11
45
6
19
12
12
10
7
2
11
13
14
14
22
21
16
20
21'
25
23
15
24

FIG. 2

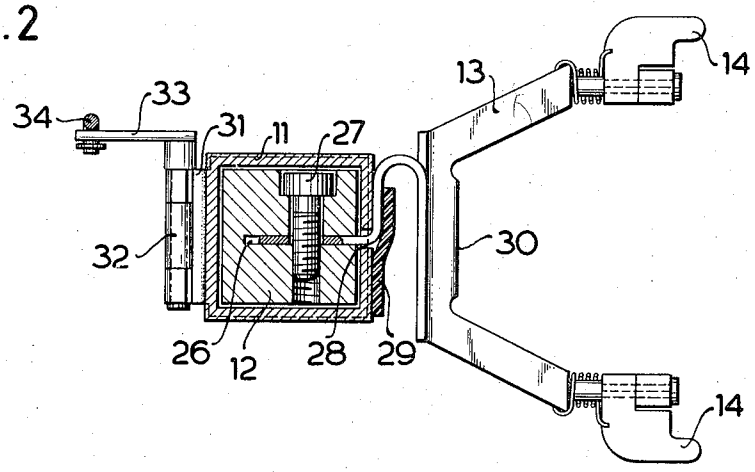


FIG. 3

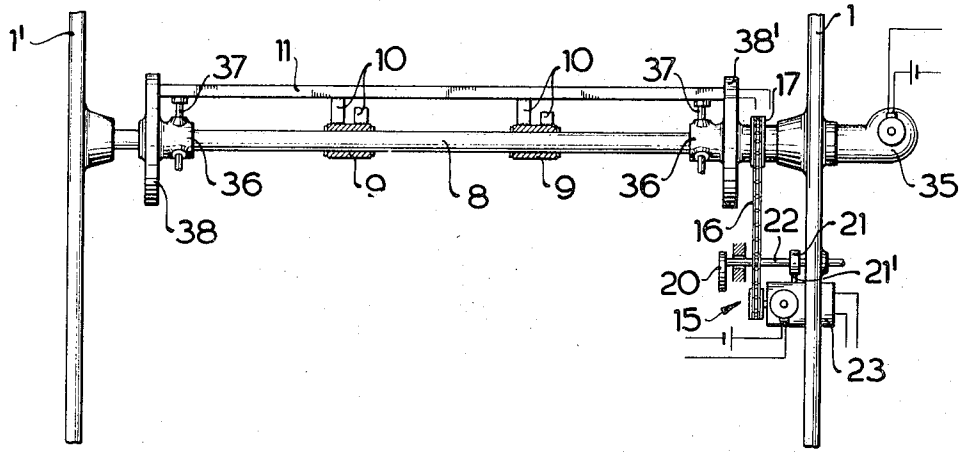


FIG. 4

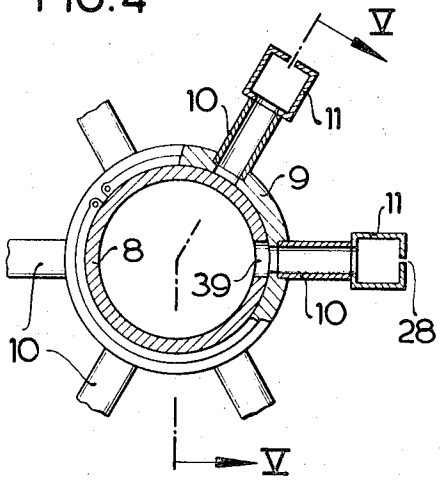


FIG. 5

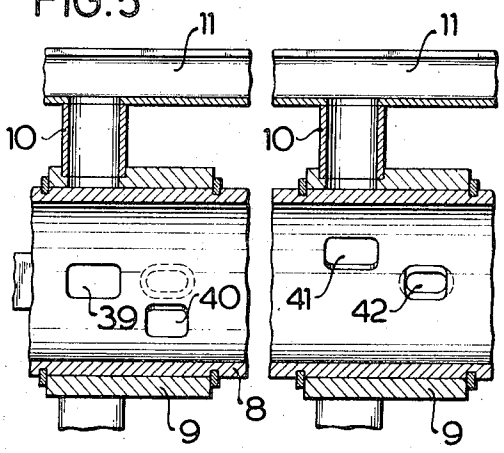


FIG.6

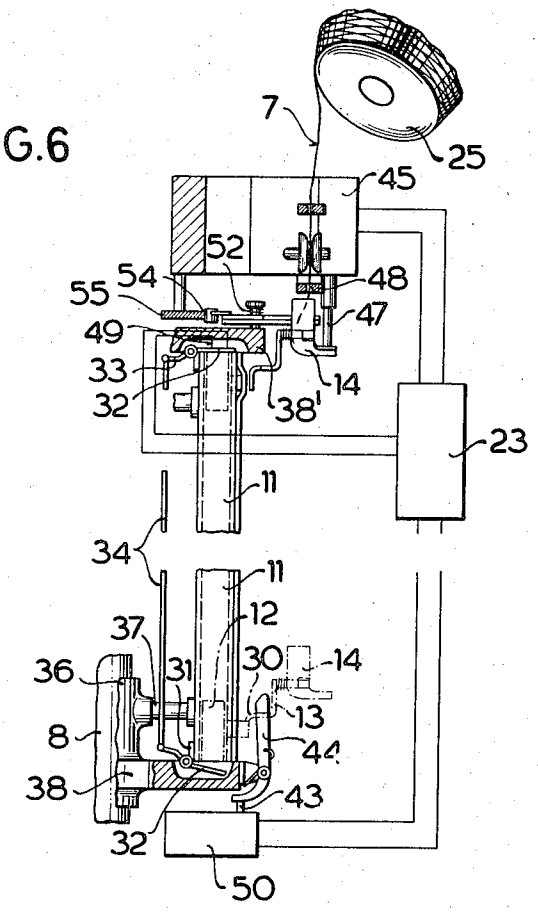


FIG.7

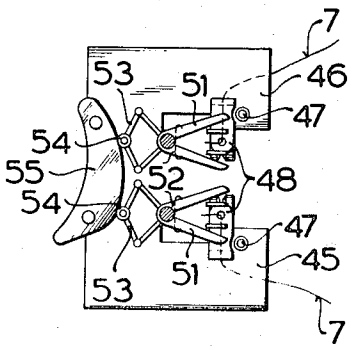


FIG.8

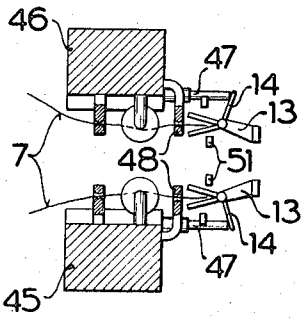


FIG.9

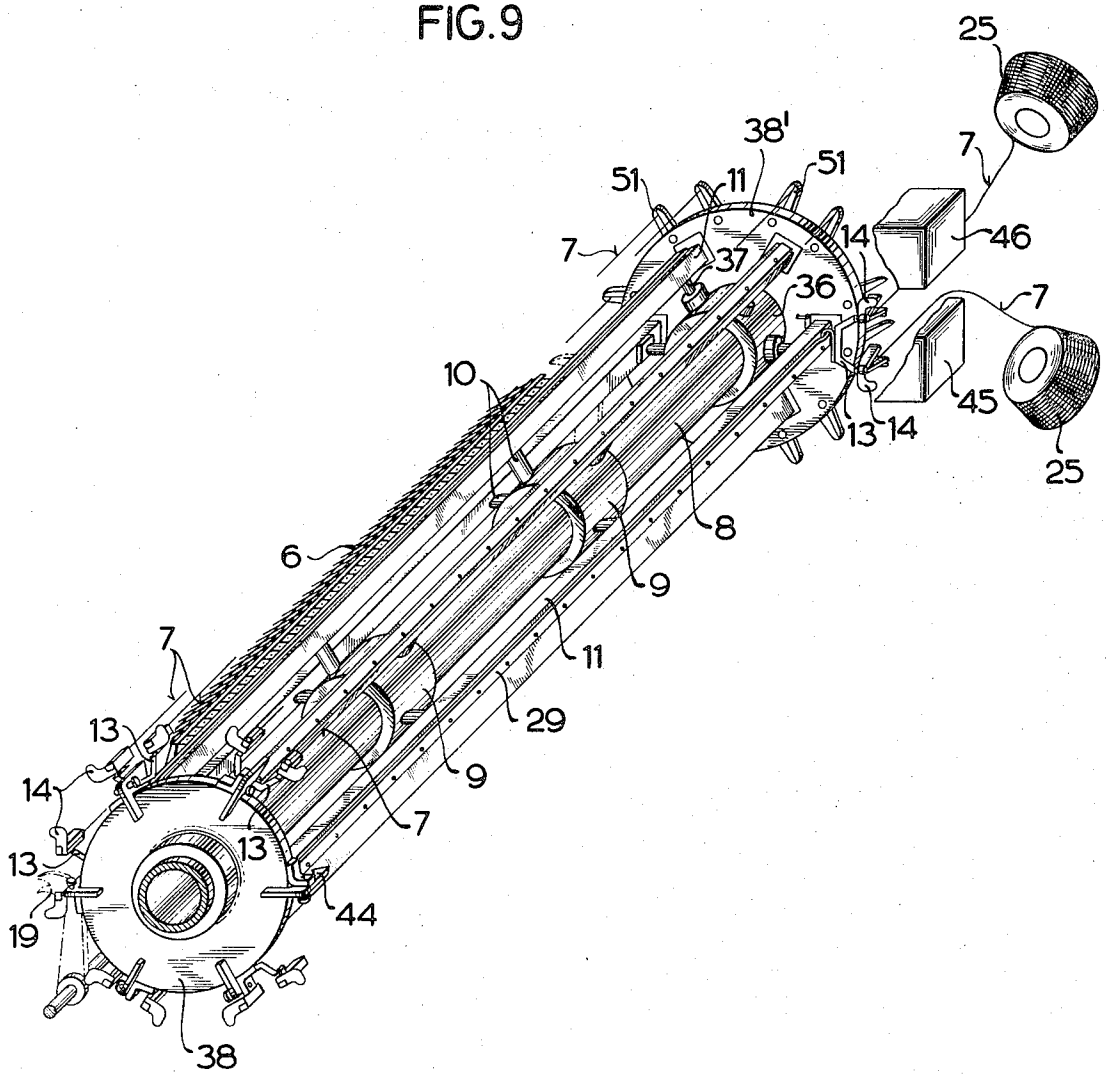

25
38'
7
51
11
51
7
14
46
37
36
7
10
45
13
14
25
8
6
9
7
11
29
13
14
9
13
7
13
44
19
38

FIG.10

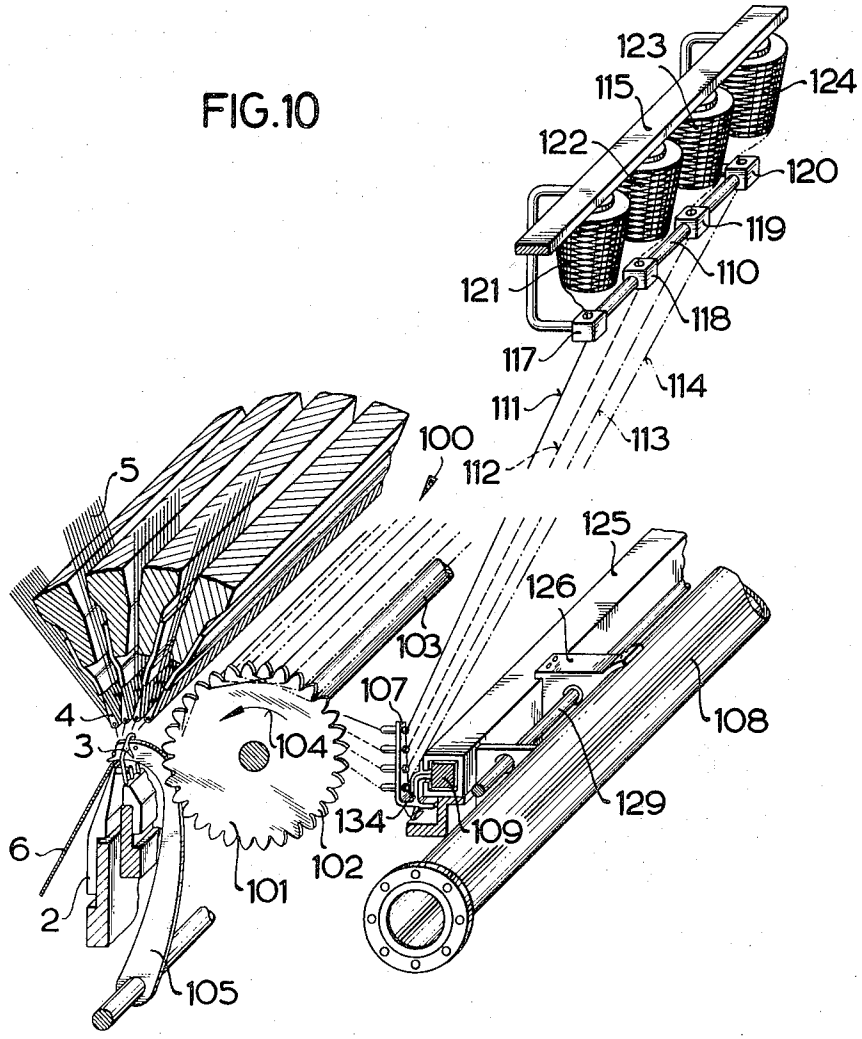

123
115
124
122
120
119
110
121
118
117
114
111
113
100
112
5
125
126
103
107
108
4
3
104
129
134
109
6
102
101
2
105

FIG.11

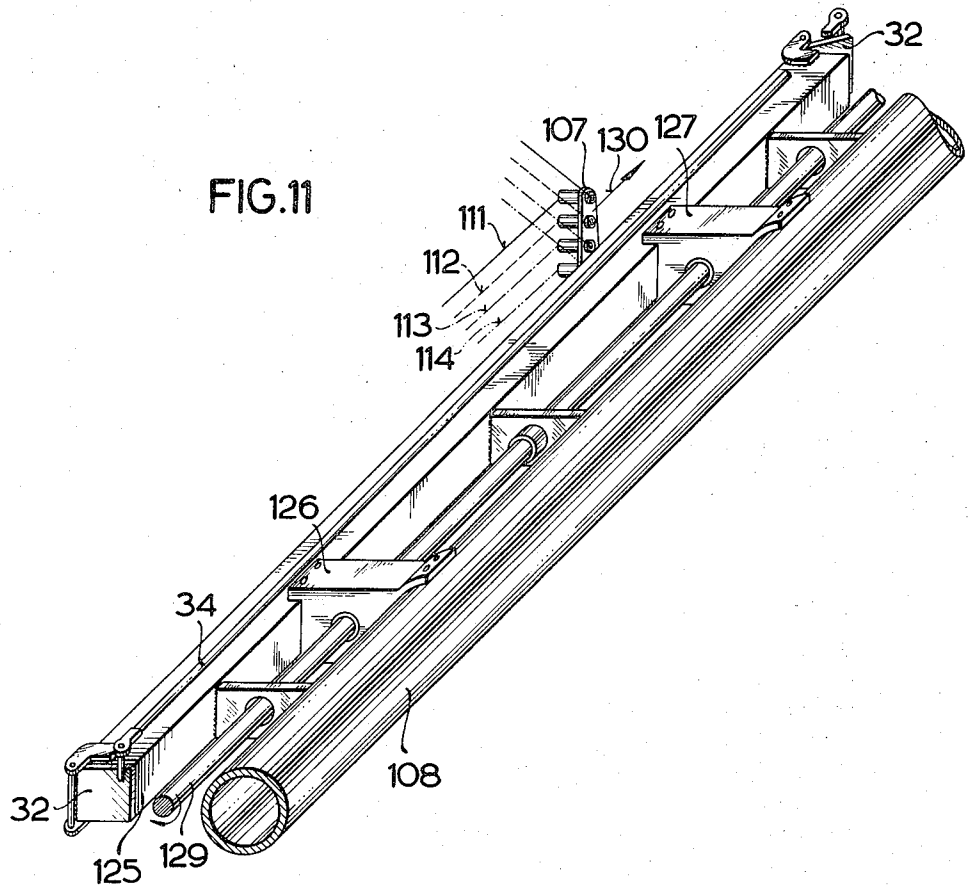


FIG.12

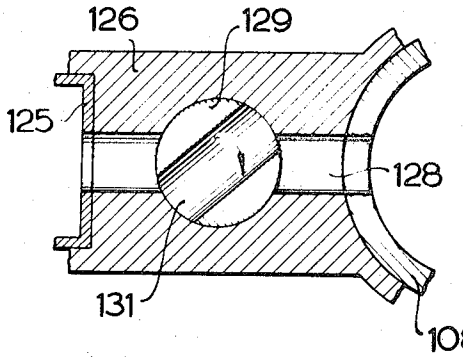


FIG.13

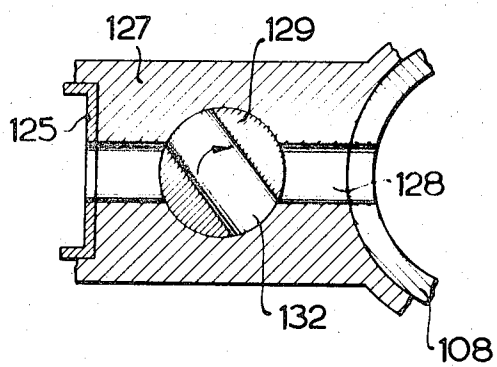


FIG.15

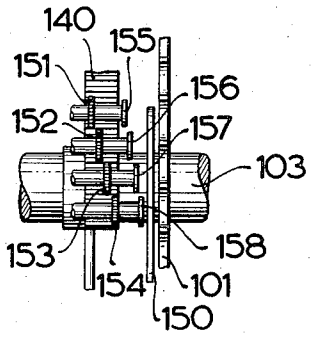

140
155
151
156
152
157
103
153
158
154
101
150

FIG.14

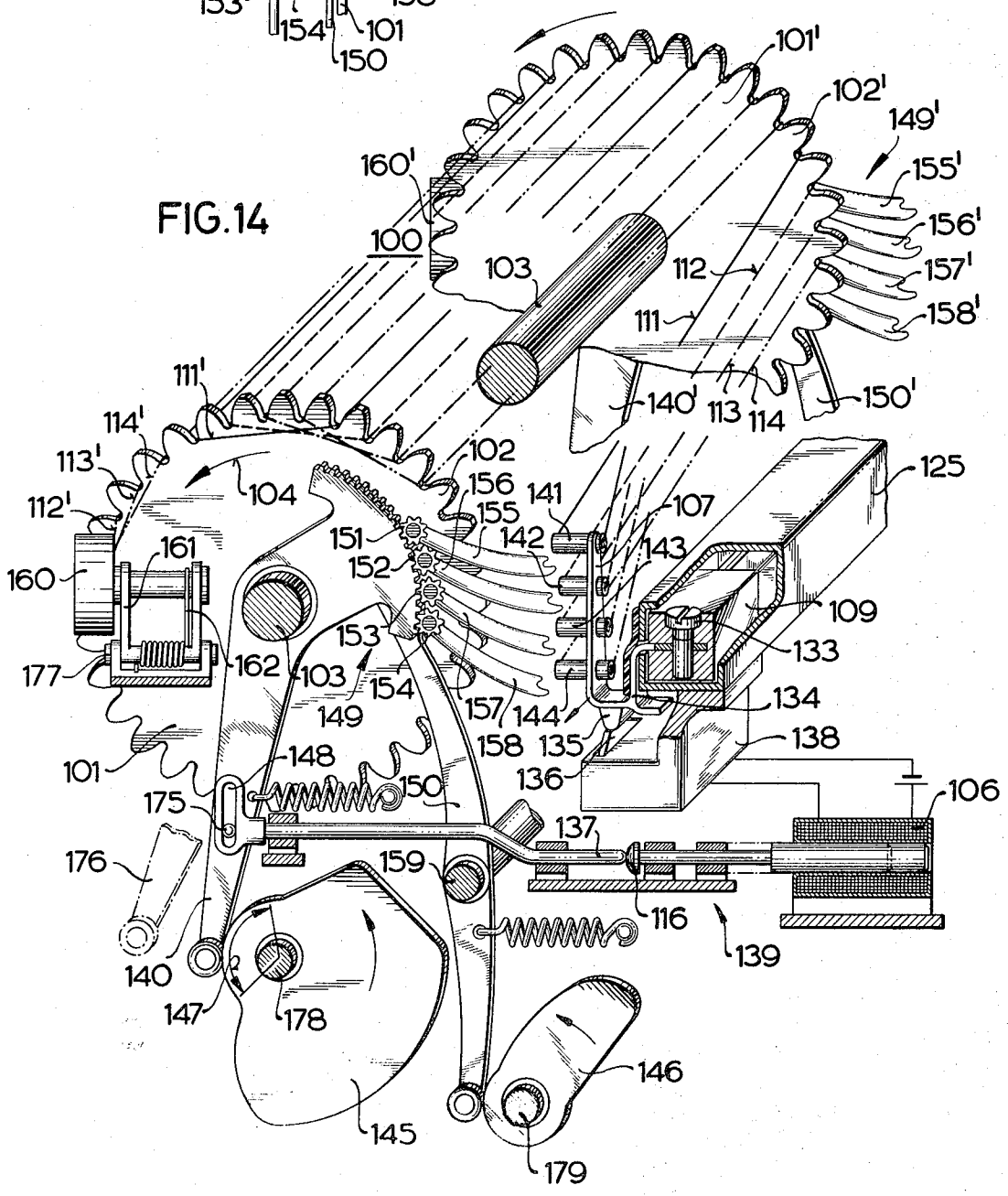

101'
102'
149'
160'
155'
100
156'
103
112
157'
111
158'
140'
113
114
150'
111'
114'
113'
102
125
104
156
155
141
107
112'
151
142
143
161
160
152
109
153
133
177
162
103
154
134
149
157
144
158
135
138
101
148
136
106
175
150
137
176
159
116
139
140
147
178
146
145
179

FIG.16

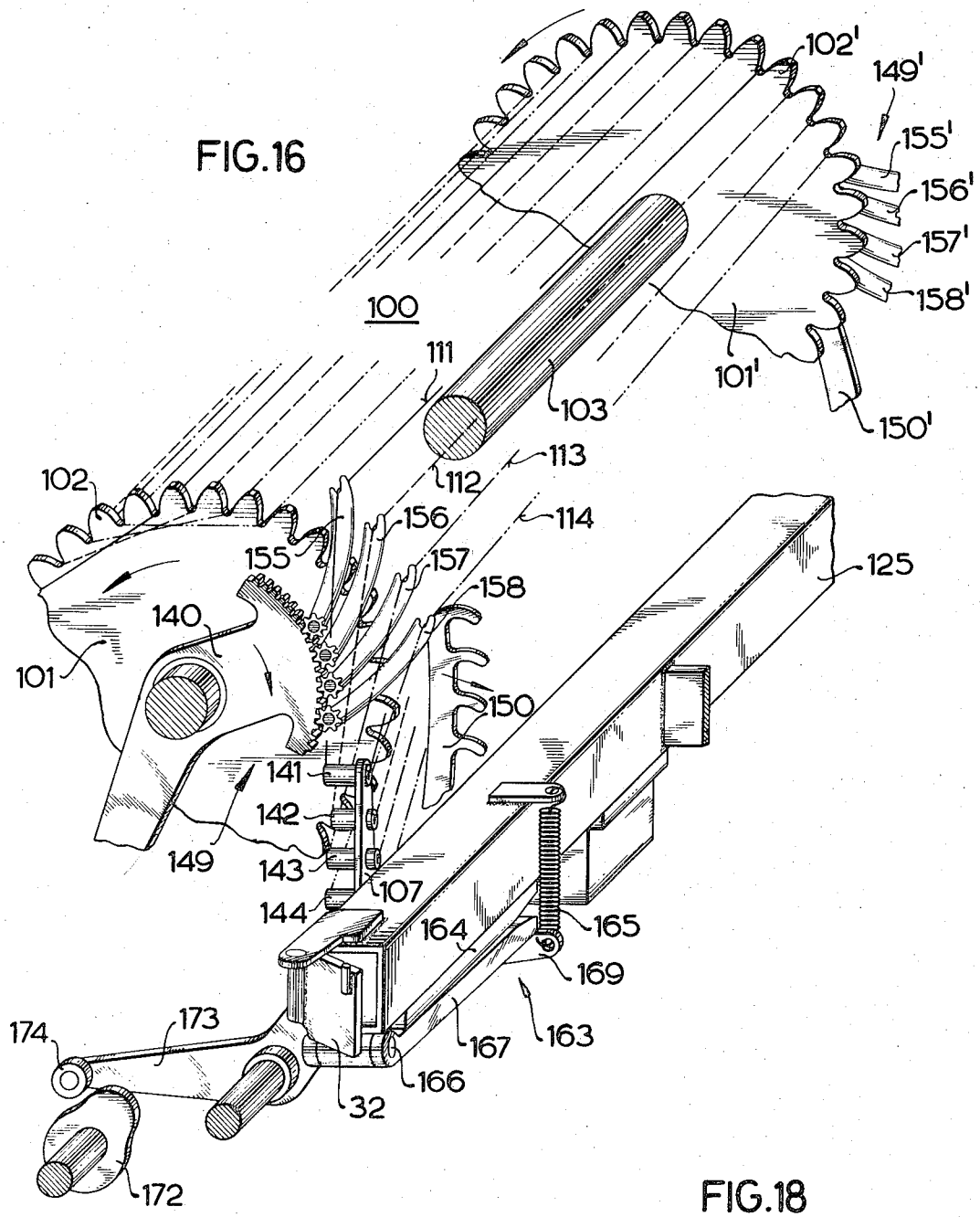


FIG.17

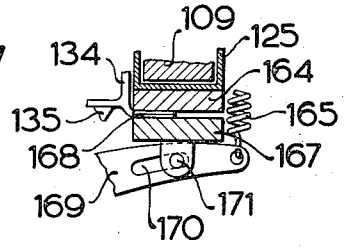


FIG.18

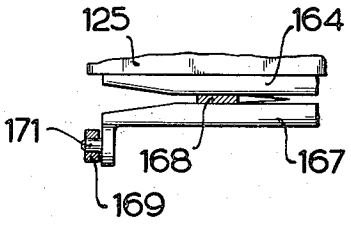


FIG.19

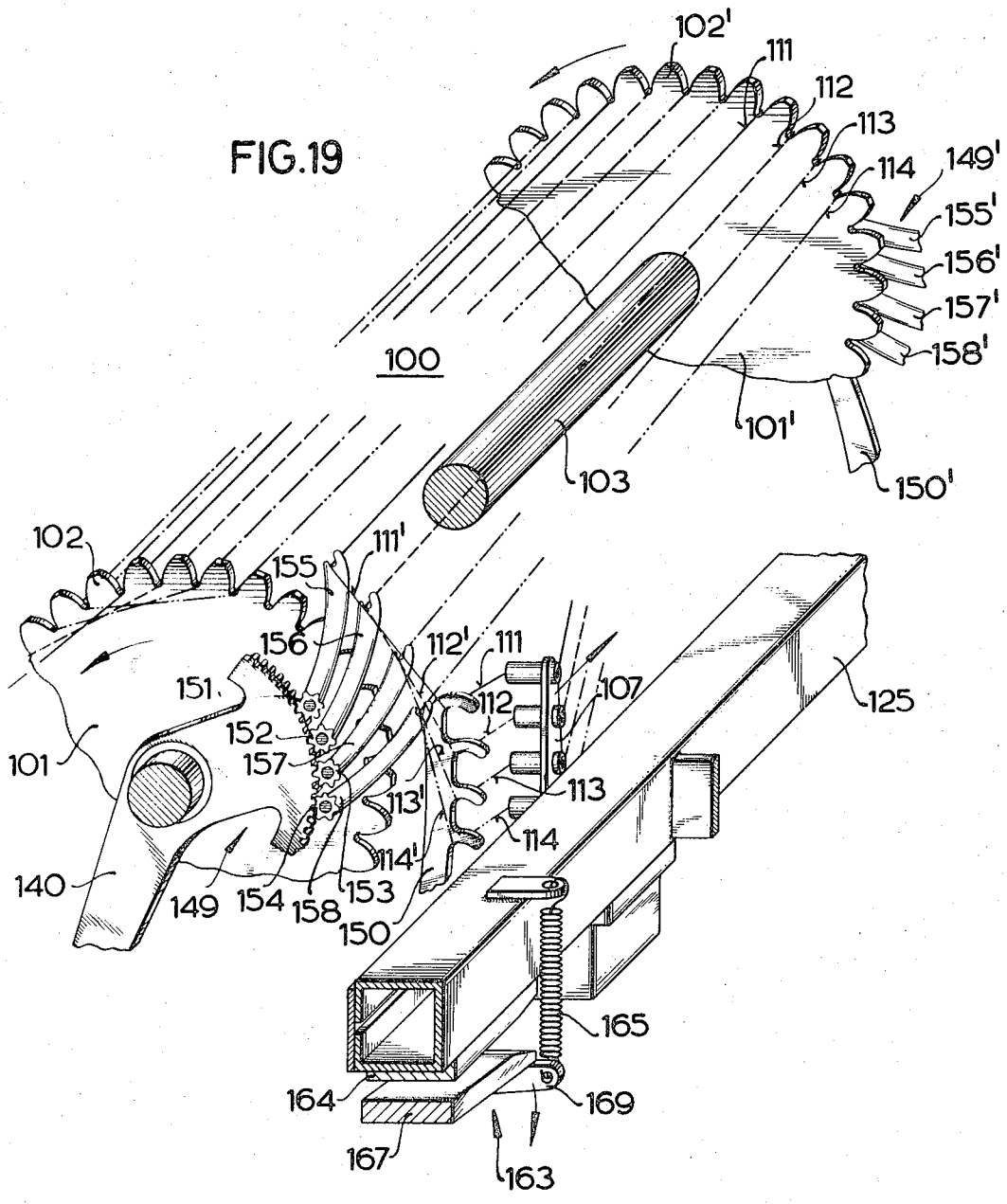

102'
111
112
113
114
149'
155'
156'
157'
158'
100
101'
103
150'
102
155
111'
156
112'
111
151
152
157
112
107
125
101
113'
113
114
114'
140
149
154
158
153
150
165
164
169
167
163

FIG. 20

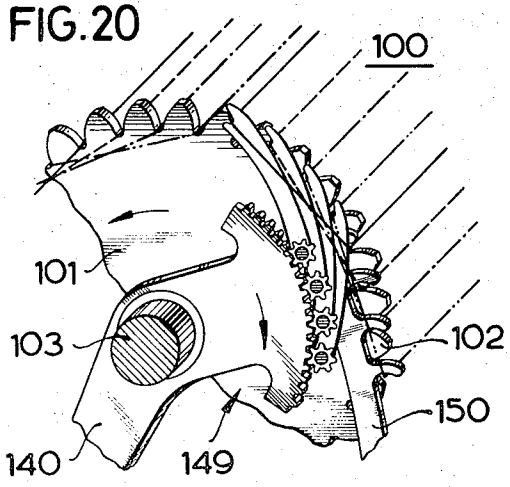
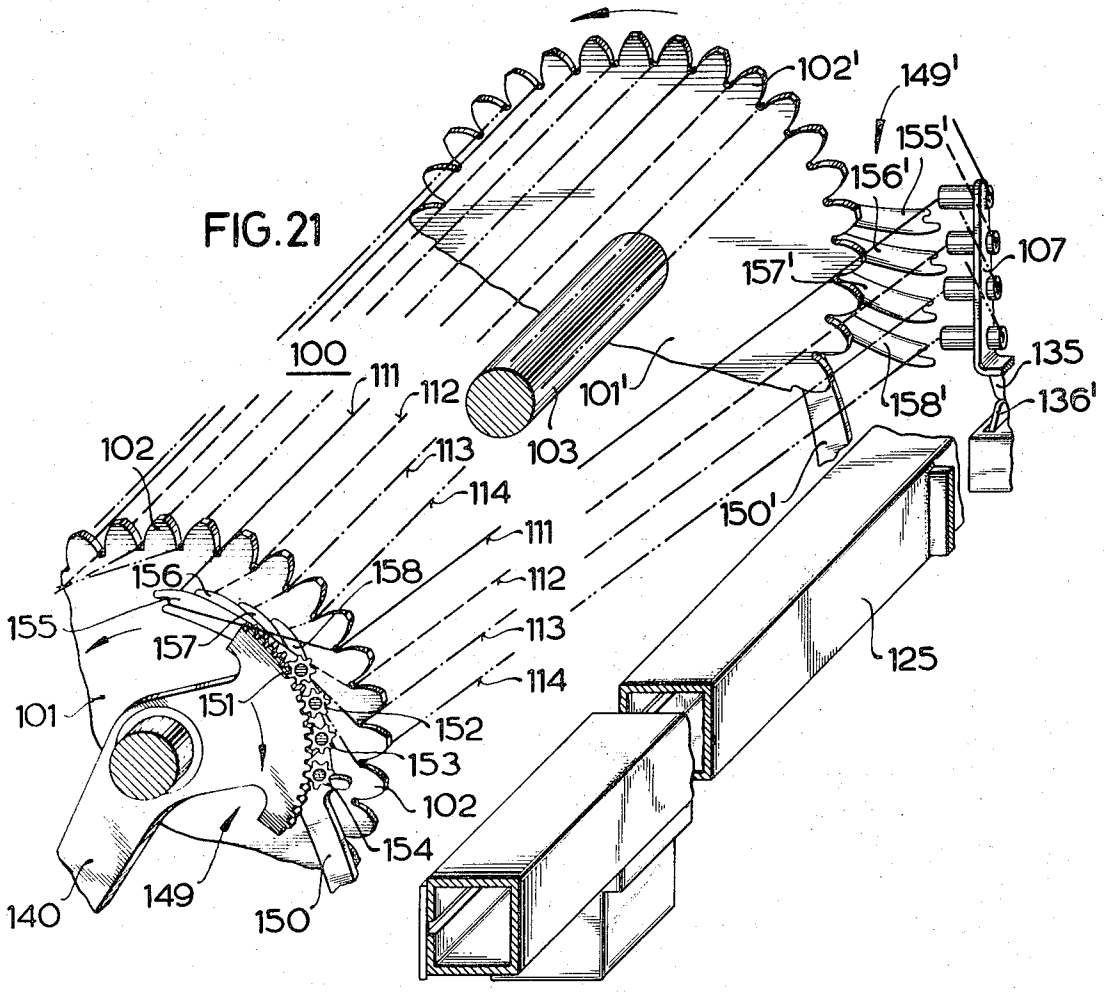

100
101
103
102
150
140
149

FIG. 21


102'
149'
155'
156'
107
157'
135
136'
158'
101'
103
100
111
112
113
114
102
156
158
155
157
101
151
152
153
102
154
140
149
150
150'
125

WARP KNITTING MACHINE

The invention relates to a warp knitting machine and in particular to a Raschel knitting machine having a device for the insertion of weft threads transported by an air stream and drawn off from stationary supply reels.

On machines equipped in this manner, unlike on warp knitting machines with mechanical insertion of the weft theads, knitted goods with cloth-like properties can be produced utilizing substantially higher insertion speeds.

Heretofore, constructions have been known, for example, as disclosed in German Patent application No. 1,435,190, in which a weft thread is pulled off a free-flying device by means of compressed air which flows from several connecting canals into an insertion slot and which is subsequently blown toward the knitting needles. Apart from the fact that such an arrangement is not suited for knitting large material widths, this method of inserting the weft thread has the distinct disadvantage that the twist imparted to the thread during the spinning or twisting process becomes partly undone. The strength of the weft material is not only reduced thereby, but in addition the untwisted weft threads cause undesirable and irregularly recurring effects within the knitted goods.

Through German Patent application No. 1,585,116, a device is further known in which weft threads are inserted by means of a compressed-air cylinder arranged outside the machine and a piston rod which protrudes from the cylinder and which can be moved back and forth. For structural reasons alone, this device would be acceptable and useful only for the manufacture of narrow webs of knitted goods because each machine would have to be made at least twice as wide as the widest web of knitted material that can be produced on it.

Both these known arrangements have the disadvantage of very limited flexibility caused by structural conditions, both as to changing the width of the web of material as well as to the variety of knitting patterns.

It is an objective of the invention to overcome the aforementioned disadvantages of these known prior art devices and provide a device suited for the rapid insertion of weft threads, which can be operated with minimum power requirement, which requires no additional space even for greater material widths, and furthermore, which offers an increase in the choice of patters which may be knitted.

According to the present invention, the aforementioned objectives are achieved by the provision of pneumatically operated projectiles which are guided in one or several profiled tubes extending across the width of the material and which are provided with a longitudinal slot through which means project for pulling off the weft threads. In this manner, weft threads which are pulled from stationary supply reels, may be measured and held in readiness. The projectiles have means for grasping these weft threads so that the projectiles can be guided in profiled tubes and propelled in the latter across the entire width of the material web and in so doing, carry threwith the grasped weft threads. The projectiles may be propelled by means of a suction, air stream or by positive air pressure. The profiled tube or tubes can be arranged parallel or approximately parallel to the rows of knitting needles and associated equipment. The profiled tube has a cross-sectional configuration which corresponds to the cross sectional configuration of the projectile. The sizes are substantially the same but the projectile is free to slide in the profiled tube whereby the projectile is operated with a minimum of air.

For the purpose of weft threads insertion, a single profiled tube may be arranged in the area of the knitting needles. If several profiled tubes are provided, it is advantageous to arrange them in a circle about a central air supply tube and to provide for rotation of the tubes. With such an arrangement, weft threads may be stored prior to insertion, and continuous feeding to the knitted material can thereby be achieved. In addition, it is possible in this manner to increase the choice of patterns, for example, by alternately transporting different weft threads or certain groups of weft threads. According to a further advantageous feature of the invention, if the air supply tube is supported in a manner in which it is fixed against rotation and if the supply tube is provided with openings for controlling the supply of air to the profiled tube, it is possible to accurately control by means of these openings when an individual projectile or several of them simultaneously, are to be fired off in shortened sequence one after another.

In principle, several possible arrangements may be provided in order for the projectile to pull the thread across the width of the web of material. For example, the weft thread may be attached directly to the end face of the projectile. However, a particularly advantageous arrangement consists of providing the projectiles with an extension arm which protrudes through a longitudinal slot in the profiled tube and which is equipped with thread holders situated outside the profiled tube. With such a design of the profiled tube and the projectile, the drawn-off thread can be applied to the knitting tools by means of the thread holders. However, it is also possible to arrange feeders in the vicinity of the web edges which grasp the weft thread at the thread holders, pulls the thread out and then carries it to the knitting tools. In order to keep the air losses to a minimum, particularly air losses through the longitudinal slot, the extension arm for the thread holders may be made, for example, as a sheet-metal part of small thickness, so that the extension arm may operate in a particularly narrow longitudinal slot in the profiled tube. The extension arm protruding from the profiled tube may be equipped with a single thread holder or with thread holders equipped to pull groups of threads.

The air losses occurring through the required longitudinal slot in the profiled tube may, however, also be avoided almost completely if, according to a further advantageous feature of the invention, the longitudinal slot is provided with a sealing element which flexes or gives way to the extension arm of the projectile to automatically close the slot. The sealing element may consists of a pretensioned, resilient, rubber-like round or profiled elongated member which, when suction air is applied to the profiled tube, aligns itself lengthwise in front of the longitudinal slot to rest against the latter and which releases itself only in the immediate vicinity of the stationary or moving extension arm. To particular advantage, however, the sealing element may also consist of a preferably elastic strip. In contrast to a soft, plastically deformable strip, which may also be usable in some cases, a thin elastic ribbon may provide an

even better seal, particularly in the vicinity of the extension arm.

As previously mentioned, several profiled tubes may be arranged rotatably around a stationary, central air supply tube with the stationary air supply tube being provided with openings for controlling the flow of air to or from the profiled tubes. Each individual profile tube may be provided between its two longitudinal ends with one or several connections for admitting a suction air stream. It would be advantageous to arrange the connections for a suction air stream at about two-thirds of the longitudinal length of the projectile travel. By means of such an arrangement, back and forth transport of the projectiles and control of the velocity of the projectile can be achieved in a relatively simple manner. As soon as a projectile has traversed about two thirds of its travel and has passed the connection point for the suction air, the stream of suction air exerts a braking action on the projectile for the remainder of its travel to the end of the profiled tube. The braking is further aided if, according to a further feature of the invention, each profiled tube is provided with controlled shutter elements.

Instead of several profiled tubes arranged rotatably in a circle around a central air supply tube, a single stationary profiled tube for inserting weft threads may also be used, as previously mentioned. In such a case, the extension arm of the projectile is connected, according to the invention, with a thread-laying device which transfers the weft threads in looped form to thread insertion elements arranged on both sides of the web edges and which comprises several sliding elements which leads the threads back and forth. Sliding elements are understood to include those elements by means of which weft threads are led back and forth in a sliding manner. With a thread-laying device equipped in this manner it is possible to transfer one as well as several weft threads simultaneously in looped form to the thread insertion elements during the back and forth flight of the projectile. This results in pulling off the weft thread from stationary supply reels without the need to cut off and clamp the weft thread or threads, so that knit goods with closed material edges are produced.

In order to keep the pulling-off velocity for the weft threads as low as possible relative to the knitting speed proper, several weft threads may be pulled off simultaneously as previously mentioned. By pulling off several weft threads, additional repeat patterns may, however, also be made up. For example, several threads which may differ from one another as to type and color may be threaded into the sliding elements of the thread-laying devices in a given sequence. In contrast to a circular arrangement of several profiled tubes which form in such a manner a weft thread storage arrangement, it is of advantage when a single profiled tube is used, to provide that the thread insertion elements are always pivotally associated with two opposide discs disposed between the profiled tube and the knitting tools and which are equipped with holding elements to form a storage means for the weft threads.

When several different weft threads are pulled off, it may happen that a weft thread loop must be placed around more than one of these holding elements. This leads to a greater free thread length during the transfer of a weft thread to the knitting tools. It is therefore advantageous to always hold the weft thread loops slung around the holding elements of the discs of the weft thread storage means until they are transferred to the knitting tools. According to a further feature of the invention, pressure rolls holding the weft thread loops may be provided for this purpose in association with the holding elements of the discs which form the storage means for the weft threads.

As was also heretofore mentioned, the purpose of the thread insertion elements is to grasp the weft threads pulled off by the thread-laying means of the projectile and to transfer them to the holding elements of the weft thread storage means. The motion of the thread insertion elements must therefore by synchronized with the motion of the weft thread storage means as well as with the back and forth movements of the projectile. To equalize possible flight time differences of the projectile, it is advantageous to couple the thread insertion elements, which are driven synchronously with the main shaft of the machine, with actuating means which can be additionally engaged by the projectile in the region of the two ends of the profiled tube. The projectile itself therefore triggers the movement of the thread insertion elements only after the projectile has travelled beyond each side of the material web. Accordingly, assurance is provided that the thread insertion elements start grasping the weft threads only after the projectile in the profiled tube has actually reached its transfer position.

In such a case, the actuating means for the insertion elements may be constructed so that after the release of the first movement for grasping the weft threads, the subsequent swing movements for transferring the weft threads to the holding elements take place again synchronously with the movement of the weft threads storage means and therefore, also with the speed of rotation of the main shaft.

According to the invention, a single profiled tube may be arranged in a stationary position within the knitting machine and may be provided with valves for controlling the feeding of the air. For furnishing the profile tube, for example, with a stream of suction air, the valves may be arranged at a location disposed between the two ends of the profiled tube. However, as in the previously described embodiments, it is advantageous to arrange the valves at about two-thirds of the length of the projectile travel, making it possible to control the velocity of the projectile in the profiled tube. In the case of the stationary profiled tube, the valves may be connected by means of flexible conduits or similar elements with a unit which produces the suction air stream. However, it is particularly advantageous to connect the valves, which are secured against rotation, with a stationary air supply tube which is arranged parallel to the profiled tube. In this connection it is further of advantage to connect the valves with drive elements which are operatively connected to the main shaft of the machine. In this manner, the back-and-forth movements of the projectile will depend on the knitting speed and thereby on the insertion order of the weft threads.

The feeding of one or several weft threads to the sliding elements of the thread-laying device is accomplished from stationary supply reels which may be arranged at various locations on the knitting machine, for example, to one side, above or behind. The arrangement will depend essentially on the design of the knitting machine with respect to the chain thread configu-

ration, number of guide bars, and the like. In order to feed the weft threads to the thread-laying device independently of the point of installation of the supply reels whether inside or outside of the knitting machine, and with the least possible loading due to different looping in the path of the thread, it is advantageous if the weft threads are fed to the sliding elements of the thread laying device through a stationary thread guiding element centrally disposed between the two ends of the profiled tube.

Other features which are considered as characteristic for the invention are set forth in the appended claims.

Although the invention is illustrated and described in relationship to specific embodiments, it is nevertheless not intended to be limited to the details shown, since various modifications and structural changes may be made therein without departing from the spirit of the invention and within the scope and range of equivalents of the claims.

The construction and method of operation of the invention, however, together with additional objects and advantages thereof will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings, in which:

FIG. 1 is an elevational view, partly in section, of a raschel knitting machine showing the various elements for the insertion of weft threads according to one embodiments of the invention;

FIG. 2 is a cross-sectional view of a pneumatically operated profile tube and projectile and also showing the extension arm and thread holder;

FIG. 3 is a front view, on a reduced scale, of the air supply conduit and profile tube and also showing the drive elements;

FIG. 4 is a partial cross-sectional view, on a larger scale, of the air supply conduit and profile tubes shown in FIGS. 1 and 3;

FIG. 5 is a partial longitudinal cross-sectional view of the air supply conduit and profiled tube shown in FIG. 4.

FIG. 6 is a plan view of one of the profiled tubes and showing the various elements for transferring the weft threads;

FIG. 7 is an elevational view of the weft thread transfer elements shown in FIG. 6;

FIG. 8 is another elevational view of the weft thread transfer elements shown in FIG. 6;

FIG. 9 is a perspective view of the air supply conduit, profiled tubes, and various other elements included in the prior figures;

FIG. 10 is a perspective view, partly in section, of a portion of a raschel knitting machine showing portions of the knitting needles and the elements for insertion of weft threads according to another embodiment of the invention wherein a single profiled tube is employed;

FIG. 11 is a perspective view of the air supply conduit and profile tube shown in FIG. 10 and also showing a portion of the thread-laying means;

FIG. 12 is a partial sectional view of one of the valve means shown in FIG. 11 which is disposed between the air supply conduit and the profiled tube;

FIG. 13 is a partial sectional view similar to FIG. 12 of the other valve means shown in FIG. 11;

FIG. 14 is a partial perspective view, partly broken away and in section, of the profiled tube shown in FIG. 11 along with the weft thread storage means and the weft thread insertion means;

FIG. 15 is a detail view of a portion of the thread insertion means shown in FIG. 14;

FIG. 16 is a partial perspective view of the weft thread storage means and thread insertion means shown in FIG. 14 but showing the weft threads as they are being taken up;

FIG. 17 is a partial sectional view of the braking means disposed at the longitudinal end of the profiled tube shown in FIG. 16;

FIG. 18 is a partial elevational view of the braking means shown in FIG. 17;

FIG. 19 is a partial perspective view of the weft thread storage means and weft thread insertion means with the latter in an advanced position relative to the position shown in FIG. 16;

FIG. 20 is a partial perspective view of a portion of the elements shown in FIG. 19 but showing the weft thread insertion elements in a further advanced position; and

FIG. 21 is a partial perspective view similar to FIGS. 19 and 20 but showing the weft thread insertion means in yet a further advanced position.

Referring to the drawings, FIG. 1 shows the front of a side frame 1 of a raschel knitting machine which includes a knock-over bar 2, a latch needle 3 and eye needles 4. Warp threads 5 are brought through the eye needles 4, and behind the knock-over bar 2 a web of material 6 is shown. A weft thread 7 is disposed in the head of the latch needle 3. A stationary air supply tube 8 has disposed thereon rotatably arranged ring sleeves 9 which carry radially disposed tube sections 10, which permit air to be drawn into and to flow into profiled tubes 11. The ring sleeves 9 also serve as supports. Projectiles 12 are guided in the profiled tubes 11. In the example of the illustrated embodiment there are six tubes 11 shown, each consisting of tubing with a square cross section but which alternately may also have other suitable cross-sectional configurations. Attached to the projectiles 12 are extension arms 13 which carry thread holders 14. One of the ring sleeves 36 situated at the ends of the profiled tubes 11 is driven off of a gear box 15 via a chain 16 and a sprocket wheel as shown in FIGS. 2 and 3. All the profiled tubes 11 arranged around the air supply tube 8 are rotated in the direction of the arrow 18 shown in FIG. 1. The speed of rotation of the profiled tubes 11 is controlled depending on the knitting speed of the machine. When a profiled tube 11 has arrived in the position shown in FIG. 1, and a thread holder 14 is opposite the knitting tools, a weft thread pulled off by the thread holder 14 can be grasped by thread feeders 19 which are arranged in the vicinity of the edges of the material web and can be fed to the knitting tools. The thread feeders 19, the thread-grasping part of which can be designed as a thread-clamping and thread-severing device, are actuated by a cam 20. The cam 20 along with a further cam 21 are secured to a main machine shaft 22. The cam 21 transmits via a tappet 21' a pulse to a switch box 23 where it is amplified and each time serves to release the propulsion of a projectile 12. A rod 24 is disposed next to the side frame, and supply reels 25 for feeding weft threads 7 are mounted on the rod 24. In some cases it is also possible to place the entire arrangement for the insertion of the weft threads shown in FIG. 1 so close to the knitting tools that the interposition of thread

feeders becomes unnecessary and the weft threads are taken from the thread holders **14** only by a well-known comb (not shown).

FIG. **2** shows in greater detail the profiled tube **11** with projectile **12** disposed therein. The profiled tube **11** has a longitudinal slot **28** which extends across the width of the material **6.** The extension arm **13** passes through slot **28** and is held in a clamping slot **26** of the projectile **12** by a screw **27.** The arm **13** may be formed of sheet metal. On the profiled tube **11** there is further attached a sealing element **29** which seals the longitudinal slot **28** and which extends outwardly of the extension arm **13** only in the immediate vicinity of the latter. The arm **13** is provided with a latching lip **30** by means of which the projectile **12** may be locked in its launching position. In the illustrated embodiment the extension arm **13** is provided with two thread holders **14,** the operation of which will be described hereinafter. The profiled tube **11** is further provided on the side opposite the longitudinal slot **28,** and in the region of its longitudinal ends, with a hinged bracket **31.** Each bracket **31** has a shutter element **32** pivoted thereon. The shutter element **32** may be pivoted by means of levers **33** as well as a linkage rod **34** for closing off the longitudinal ends of the profiled tube **11.**

FIG. **3** shows schematically how the air supply tube **8** is supported between the side frames **1** and **1'.** A blower **35** is mounted on the side frame **1** and is connected to the air supply tube **8** for producing a reduced pressure and generating a suction air stream. FIG. **3** shows the ring sleeves **9** arranged on the air supply tube **8** along with the tube sections **10** and one of the profiled tubes **11.** The two outer ring sleeves **36** do not carry tube sections but carry the profiled tubes **11** via support posts **37.** The ring sleeves **36** are further provided with discs **38, 38'** for the attachment of elements to be described hereinafter. On the side frame **1** shown in FIG. **3** will also be seen the gear box **15,** also shown in FIG. **1,** which rotates the profiled tubes **11** supported by the ring sleeves **9** and **36** by means of the chain **16** and sprocket wheel **17** which is fixedly connected with the ring sleeve **36.**

FIGS. **4** and **5** show how a stream of suction air flowing through the air supply tube **8** enters the profiled tubes **11.** In FIG. **4,** one of the profiled tubes **11** with its tube section **10** is shown situated opposite one of a plurality of openings **39** arranged in the air supply tube **8,** while the air supply in the air supply tube **8** is shut off to the other profiled tubes **11.** Through the displacement of opening **39** along with other openings **40, 41** and **42** shown in FIG. **5,** it will be seen how the control of the actuation time of the individual profiled tubes **11** can be achieved during their rotation about the air supply tube **8** in a relatively simple manner.

FIGS. **6, 7** and **8** show particularly the operation of means for grasping and transporting individual weft threads across the width of the material being knitted. As soon as the cam **21** (FIG. **1**), which is fixed to the main machine shaft **22,** has actuated the tappet **21',** which occurs at the moment that the thread feeders **19** have grasped an already pulled-out weft thread, an electromagnet located in a switch box **50** is energized by means of the switch box **23.** When this occurs, a tappet **43** (FIG. **6**) is operable to pivot a ratchet lever **44** and thereby release a projectile **12,** as will be further explained. One of the ring sleeves **9,** which is located at about two-thirds of the distance to be traversed by the projectile **12,** has a tube section **10,** associated therewith leading to an adjacent profiled tube **11.** The last-mentioned tube sleeve **9** is situated over one of the openings in air supply tube **9** allocated to that tube section **10,** for example, the opening **41** shown in FIG. **5.** A path for a stream of suction air is thereby established and the projectile **12** is propelled in the tube **11** in the direction toward that side of the machine where the weft threads **7** are held in readiness. As soon as the projectile **12** has travelled two-thirds of its distance along the tube **11** and has passed the opening **41,** it will be seen that the suction air stream acts upon on opposite side of the projectile **12** and in the opposite direction to thereby provide a braking action on the projectile **12.** Control of the suction air stream is facilitated in an advantageous manner by the previously mentioned shutter elements **32** which are connected with each other by a linkage rod **34** such that both shutter elements **32** open and close automatically with the change in direction of the air stream. The braking action of the suction air stream can, of course, be intensified further by additional mechanical braking means acting on the projectile. For example, resilient brake shoes or the like may be provided to protrude into the profiled tube **11.**

Simultaneously with the release of a projectile **12,** a further pulse is transmitted to switch boxes **45** and **46** which contain electromagnets for actuating plungers or tappets **47.** When the switch boxes **45** and **46** are actuated, the tappets **47** are displaced in the direction of the arriving thread holders **14,** and the latter are thereby opened so that they can grasp the weft threads **7** directly in front of thread guiding eyes **48.** Upon a projectile reaching its end position where the thread holders are operable to grasp the weft thread **7,** the projectile simultaneously strikes the shutter element **32** located at said end position and actuates an electric contact **49** (FIG. **6**) whereby the circuit for actuating the tappets **47** is interrupted and the latter can retract in the direction toward the switch boxes **45** and **46.** As a result of such retraction of tappets **47,** the thread holders **14** are closed and hold the grasped weft threads **7.** Immediately thereafter the weft threads **7** are ready to be transported and carried over the length of the profiled tube **11.** This is accomplished by applying a stream of suction air which, this time, is applied in the reverse direction. The stream of suction is applied at a position located at about two-thirds of the distance to be traversed by the projectile **12** in such a manner that the opening of the corresponding tube section **10** coincides with the opening **39** in the air supply tube **8** as shown in FIG. **5.** The braking of the projectile **12** and reversing of the shutter elements **32** also occurs in a similar manner as previously described. The continuous cycling of all the operations heretofore described is achieved by the fact that the entire system consisting of the profiled tubes **11,** the ring sleeves **9** and **36** as well as the discs **38** and **38'** rotates continuously around the air supply tube **8.**

As soon as the projectile **12** has reached its new end position, the previously mentioned ratchet lever **44** pivots over the holding lip **30** of the extension arm **13** of the thread holder **14** and holds the latter with the pulled-out weft threads **7** in this position. At the same time the circuit leading to the switch box **50** (FIG. **6**) is interrupted by means of the previously described contact **49** so that the tappet **43** can be displaced in the

direction toward the switch box **50** (FIG. **6**) and thereby release the ratchet lever **44.** While the profiled tubes **11** revolve in the direction of the arrow **18** shown in FIG. **1,** the discs **38, 38'** also revolve therewith. By means of this rotary motion, the operating means for severing the weft threads, which operating means are mounted on the disc **38',** can be actuated. In FIG. **7,** there is shown clamping and cutting scissors **51** for this purpose and which are mounted on disc **38'.** The halves of the cutting scissors **51** are biased to a closed position by the action of a torsion spring **52** and are thereby operable to cut the pulled-out weft threads **7** and initially hold the cut ends. The clamping and cutting scissors **51** are opened by means of an opening linkage **53** designed in the form of a pantograph and which include rollers **54** which engage a cam segment **55** disposed in a stationary position between the switch boxes **45** and **46.** In FIGS. **7** and **8,** the clamping and cutting scissors **51** have just opened and the weft thread end previously held between the halves of the scissors **51** has been released and can be grasped by the thread holders **14** which reach through the halves of the scissors. As soon as the rollers **54** have passed over the stationary cam segment **55,** the clamping and severing scissors **51** will again close and clamp the pulled-out weft thread at this point and cut it.

FIG. **9** shows once again the arrangement of all essential parts of the device according to the invention. In FIG. **9,** for example, the ratchet lever **44** which is pivotably mounted on the disc **38,** has just released a projectile (not shown) which is guided in the profiled tube **11.** With the thread holder **14** in the open position, it will be seen that in the next operation, the weft threads **7** are to be grasped and pulled off the supply reels **25.** It will further be seen that three extension arms **13** have already transported their weft threads across the width of the web of material **6** and are ready to transfer these weft threads to the knitting tools. FIG. **9** also shows at the outer rim of the disc **38',** how the clamping and cutting scissors **51** associated with the profiled tubes **11** hold the weft threads while in the closed position.

FIG. **10** shows once again the knitting tools of a double-rib machine including parts of the knock-over bar **2,** latch needle **3,** and eye needles **4.** Warp threads **5** are led through the eye needles **4.** Behind the knock-over bar **2** a portion of the web of material **6** being knitted is visible. The parts shown next to the knitting tools are included to provide a view of the overall arrangement within the machine. Enlarged details of these various elements are shown in the figures which follow. FIG. **10** shows a weft thread storage means **100** which includes two storage discs **101, 101'** (only **101** is shown in FIG. **10**) which face each other and which are located in the vicinity of the material web edges. The storage disc **101** has holding elements **102** and a drive shaft **103** (FIG. **14**) is provided common to both storage discs **101, 101'.** The weft thread storage means **100** rotates during the machine cycle synchronously with the knitting speed in the direction of the arrow **104** (FIG. **10**) toward the knitting tools, so that the weft threads situated between the holding elements **102** can be brought for intermeshing to the knitting tools by the comb **105** which oscillates back and forth in a manner known per se. The thread insertion elements associated with the storage discs **101, 101'** are not shown in FIG. **10** for the sake of clarity. These parts are likewise shown enlarged in the following figures and their operation will be explained hereinafter.

A thread-laying device **107,** in the example of the illustrated embodiment is operable to simultaneously pull off four weft threads **111, 112, 113** and **114.** The four weft threads may differ from each other as to color and type, but they may also be identical. The weft threads **111, 112, 113** and **114** are pulled from supply reels **121, 122, 123** and **124,** respectively, which are disposed adjacent one another on a cross piece **115** in the center of the web width within the double-rib machine. All the weft threads pass to the thread-laying device **107** through a thread guiding element **110** which, in the illustrated embodiment, is provided with four thread guiding eyes **117, 118, 119** and **120.** FIG. **10** also shows a single profiled tube **125** with a projectile **109** and its extension arm **134.** Also shown is a stationary air supply tube **108** connected with the profiled tube **125** and a front valve **126** operated by a valve shaft **129.**

FIG. **11** shows particularly how the stationary air supply tube **108** is connected with the profiled tube **125** by means of valves **126** and **127.** FIGS. **12** and **13** show a cross section through the valves **126** and **127,** respectively. The valves **126, 127** each have passages **128** through which a suction air stream passes from the air supply tube **108** to the profiled tube **125.** The suction air stream is controlled by means of the valve shaft **129,** which is driven synchronously off main machine shaft. If, for example, the thread-laying device **107,** driven by the projectile **109** and carrying the weft threads **111, 112, 113** and **114** is on its way in the direction of the arrow **130** (FIG. **11**) and at the position shown in FIG. **11,** that is adjacent the valve **127,** the valve shaft **129** with its passage **132** will have reached the position shown in FIG. **13.** The suction air stream is thereby cut off at valve **127** and instead, a suction air stream is applied behind the projectile **109** by means of the valve **126** and particularly the open passage **131** in valve **126.** A braking effect is thereby exerted on the projectile **109** before it reaches its end position, that is, the right-hand position in FIG. **11.** This process also occurs analogously in the reverse direction. The action of the suction air stream is aided in an advantageous manner by the shutter elements **32,** which are linked to one another by means of the linkage rod **34** and which open and close automatically with the change in the direction of the air stream.

FIG. **14** shows one-half of the projectile **109** in the partially broken away profiled tube **125.** At the center of the projectile **109** there is shown a cylinder-head screw **133** which connects the thread-layer device **107** firmly to the projectile **109** via the extension arm **134.** The thread-laying device **107** has, as already mentioned, four sliding elements **141, 142, 143** and **144** in the example of the illustrated embodiment. The thread-laying device **107** is shown in FIG. **14** with the projectile **109** at the end of the profiled tube **125** and is located in the vicinity of the storage disc **101** of the weft thread storage means **100** at the beginning of the operating cycle as previously mentioned. In this position, a switching lip **135** on the extension arm **134** actuates a resiliently supported contact shoe **136** and sets an actuating mechanism **139** in operation by means of a switch **138.**

Actuation of the contact shoe **36** energizes an electromagnet **106** forming part of the actuating mecha-

nism 139 and a tappet 136 thereupon moves a push rod 137 within its elongated guide. A gear-segmented lever 140, which is pivoted on the drive shaft 103 and which includes a pin 175, is swung into the broken line position shown in FIG. 14 by the aforementioned movement of the push rod 137. The gear-segmented lever 140 is in continuous engagement at its geared-segmented portion with pinions 151, 152, 153, 154 and, during the above-described swing movement, which was initiated by the electromagnet 106, pivots all the insertion hooks 155, 156, 157 and 158 which are firmly connected with the respective pinions 151 to 154 the weft threads 111 to 114 which have been grasped by the insertion hooks 155 to 158 are also swung and displaced a certain amount in the direction toward the holding elements 102. The position reached in this manner of all parts which participate in the swinging motion and which together comprise the thread insertion means 149 is shown in FIG. 16.

A cam 145 (FIG. 14) associated with the gear-segmented lever 140 as well as a cam 146 associated with a shift lever 150 and which also forms part of the thread insertion means 149, are firmly fixed to the shafts 178, 179, respectively, and rotate continuously during the operation of the machine synchronously with the main machine shaft. A portion 147 on the cam 145 corresponds to a predeterminable time interval within which the time that the projectile is being propelled from one side of the web to the other may exhibit deviations without the occurrence of a disturbance in the event of a weft insertion over a longer period.

Thread insertion means 149', similar to thread insertion means 149, are associated with the storage disc 101' in the same manner previously set forth in describing the thread insertion means 149 and storage disc 101. Thus FIG. 14 shows insertion hooks 155' to 158', a portion of the shift lever 150' rotatably supported on the shaft 159 as well as the lower part of the gear-segmented lever 140'.

In FIG. 14, there is shown a pressure roll 160 located in front of the storage disc 101 and behind the storage disc 101', its counterpart in the form of a pressure roll 160'. Both pressure rolls 160 and 160' are advantageously made of resilient or elastic material and are rotatably supported in brackets 161 pivoted on a pin 177 and biased against the weft thread loops 111', 112', 113' and 114' by means of a coiled spring 162. In FIG. 14, the frontmost weft thread loop 111' is not visible as it is covered up the pressure roll 160.

FIG. 15 is a side view of a section of FIG. 14 from which the lateral relationship of the pinions 151 to 154 with their insertion hooks 155 to 158 with respect to the gear-segmented lever 140 and to the shift lever 150 can be seen.

As previously mentioned, in FIG. 16 a group of weft threads consisting of the weft threads 111 to 114 has been grasped and swung by the insertion hooks 155 to 158. The insertion hooks 155 to 158 are therefore situated at the beginning of the further swinging motion, which is to be controlled only by the cam 145 (FIG. 14) in the direction toward the holding elements 102 of the storage disc 101. FIG. 16 also shows how, in the meantime, the shift lever 150 which is provided with four projections, has swung beyond the periphery of the holding elements 102 in order to engage the weft threads 111 to 114 when the threadlaying device 107 has reversed its direction, and moves in the direction toward the storage disc 101'.

The profiled tube 125 in FIG. 16 is further equipped at both its ends with a brake means 163 which supports and increases the braking action on the projectile 109 of the reverse suction air stream. In FIG. 16, there is shown a brake shoe 164 which is rigidly connected to the profiled tube 125 and a movable brake shoe 167 which is pretensioned by a tension spring 165 and which is pivotable about a pin 166. FIGS. 17 and 18 show how a brake plate 168 carried by the arm 134 is inserted between the brake shoes 164 and 167 shortly before the end position of the projectile 109 is reached. As soon as the projectile 109 in the profile tube 125 reverses its direction, the brake 163 is released. This release is effected by means of a lever 169 which has an elongated slot 170 receiving a pin 171. The lever 169 is lifted by a cam 172 which is likewise driven synchronously with the launching sequence and which actuates a roll 174 carried at the end of a lever 173.

In FIG. 19, the brake 163 is shown in its released condition and the thread-laying device 107, together with the weft threads 111 to 114 is on its way from the storage disc 101 in a direction toward the storage disc 101'. The projections on the shift lever 150 have grasped the weft threads 111 to 114 and have thereby formed weft thread loops 111' to 114' which, in the course of the swing motion of the insertion hooks 154 to 158, as well as the shift lever 150, are placed over further holding elements 102.

FIG. 20 show a section of the thread storage device 100 and illustrates one of the subsequent phases of the swing motion in the direction toward the holding elements 102.

It further becomes clear from FIG. 21 how four weft threads 111 to 114 have now been placed on the storage disc 101 by the insertion hooks 155 to 158, and how four further weft threads 111 to 114 have been placed into the gaps between the holding elements 102 by the shift lever 150. In the meantime, the thread-laying device 107 has arrived at the storage disc 101' and has actuated the contact show 136' with its switching contour 135. The parts forming the thread insertion elements 149', of which the insertion hooks 155' to 158' as well as part of the shift lever 150' are shown in FIG. 21, are now put in operation by means of the parts which are already known from the description pertaining to FIG. 14 and which are also present on this side of the weft thread storage device. The same process as is required for the insertion of the weft threads and which took place and was described on the other side is repeated on this side of the weft thread storage device. At the conclusion of each insertion operation all insertion hooks as well as the two shift levers swing out of the weft thread loops and return to their initial positions which is shown in FIG. 14.

What is claimed is:

1. In a warp knitting machine for knitting a web of material, a stationary supply reel for weft threads to be inserted in the material being knitted, a tube extending alongside the space wherein the web of material is being knitted, a projectile disposed in and pneumatically operable within said tube, said tube having a longitudinally extending slot, and projecting means carried by said projectile and projecting through said slot for pulling the weft threads from said stationary supply reel for insertion thereof in the material being knitted.

2. In a warp knitting machine according to claim 1, a plurality of said tubes, means mounting said tubes in a circular disposition about a central axis, and a central air supply conduit having a longitudinal axis coincident with said central axis.

3. In a warp knitting machine according to claim 2, means mounting said central air supply conduit against rotation, said conduit being formed with a plurality of openings, and passageway means providing selective communication between said air supply conduit and said tubes through said openings in said conduit.

4. In a warp knitting machine according to claim 1, said projecting means comprising an extension arm projecting through said longitudinal slot of said tube, and thread holders on said arm externally of said tube.

5. In a warp knitting machine according to claim 4, a resilient sealing means disposed along said longitudinal slot for sealing the latter as said extension arm moves back and forth along said slot.

6. In a warp knitting machine according to claim 5, said sealing means comprising an elastic strip.

7. In a warp knitting machine according to claim 1, evacuating means disposed between the longitudinal ends of said tube through which air is evacuated from said tube.

8. In a warp knitting machine according to claim 7, one evacuating means being disposed at about two-thirds of the longitudinal distance from one end of said tube and another evacuating means being disposed at about two-thirds of the longitudinal distance from the other end of said tube.

9. In a warp knitting machine according to claim 1, shutter elements pivotally mounted at the longitudinal ends of said tube.

10. In a warp knitting machine according to claim 4, thread insertion means disposed on both sides of said web of material, and thread laying means mounted on said extension arm externally of said tube, said thread laying means comprising sliding elements engagement and leading said weft threads back and forth for transferring said weft threads in loop form to said thread insertion means.

11. In a warp knitting machine according to claim 10, knitting needles, weft thread storage means disposed between said knitting needles and said tube, said weft thread storage means comprising storage discs provided with holding elements, said thread insertion means being pivotally mounted in operable association with said storage discs.

12. In a warp knitting machine according to claim 11, said weft thread storage means further comprising pressure roller means operatively associated with said holding elements of said storage discs for holding said weft thread loops on said storage discs.

13. In a warp knitting machine according to claim 10, said thread insertion means being driven synchronously with said knitting machine, and actuating means engageable by said projectile when the latter reaches the end portion of its path of travel in said tube, said actuating means being operably connected to said thread insertion means for operating the latter.

14. In a warp knitting machine according to claim 1, said tube being stationary, and valve means being provided for controlling the air in said tube.

15. In a warp knitting machine according to claim 14, a stationary air supply conduit disposed parallel to said tube, said valve means being operable to control the air flow between said air supply conduit and said tube.

16. In a warp knitting machine according to claim 14, said valve means comprising a stationary part and a rotary part, and means operating said rotary part cyclically with the operation of said knitting machine.

17. In a warp knitting machine according to claim 10, a stationary thread guiding element disposed centrally between the longitudinal ends of said tube, said weft threads being fed to said sliding elements of said thread laying means by said stationary thread guiding element.

* * * * *