Oct. 4, 1927. 1,644,116

J. E. FEFEL

TUBULAR FABRIC FORMING MACHINE

Filed March 20, 1925 3 Sheets-Sheet 1

Fig. 4

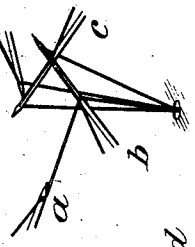


Fig. 6

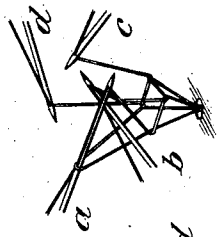


Fig. 3

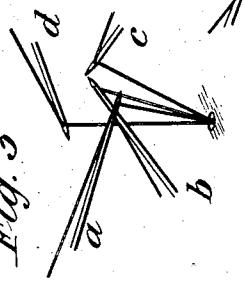


Fig. 5

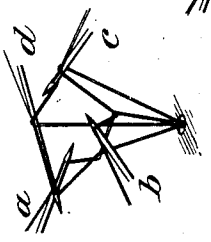


Fig. 7

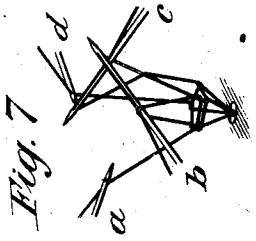
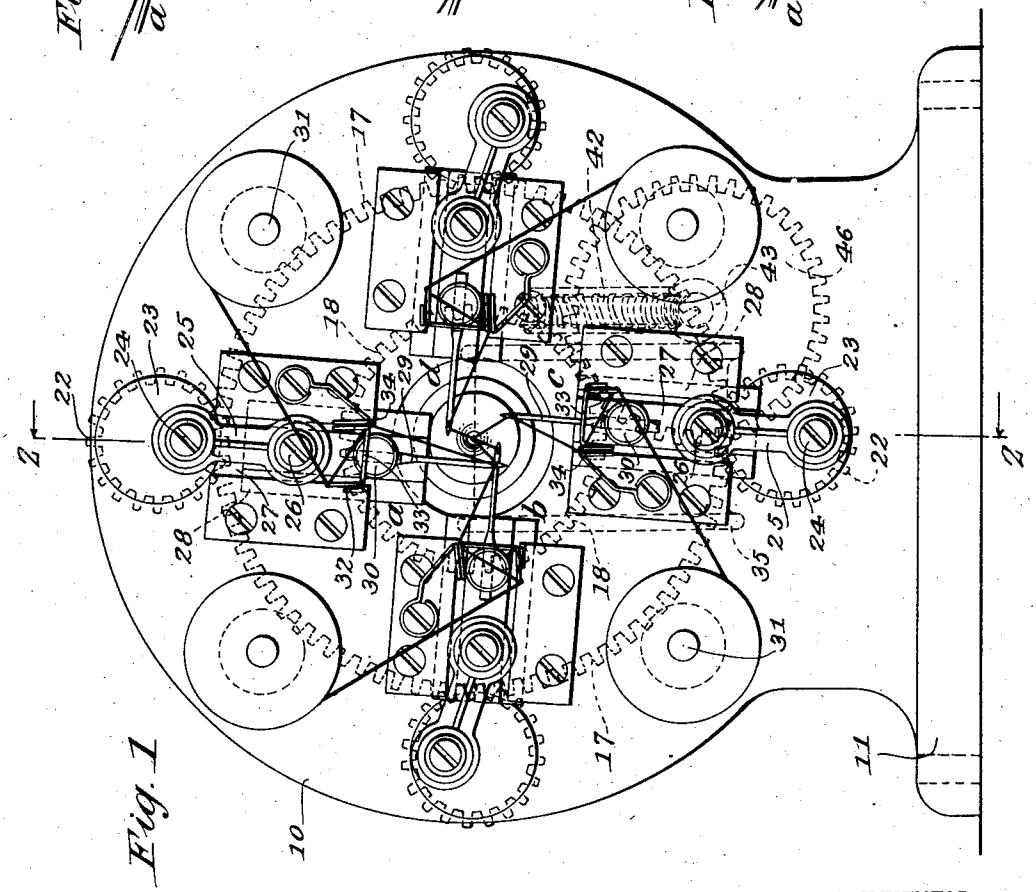


Fig. 1



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Oct. 4, 1927. 1,644,116

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TUBULAR FABRIC FORMING MACHINE

Filed March 20, 1925 3 Sheets-Sheet 2

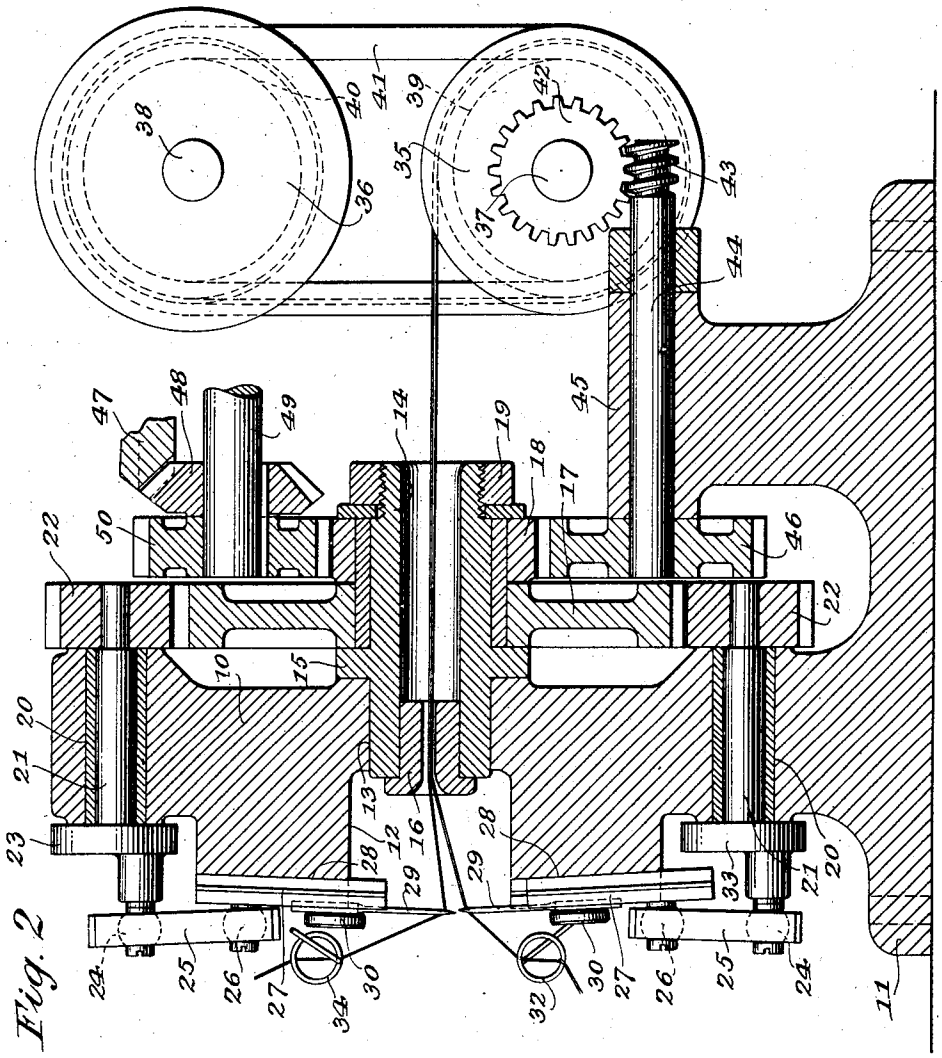


Fig. 2

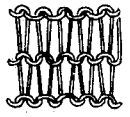


Fig. 8

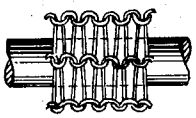


Fig. 9

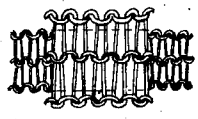


Fig. 10

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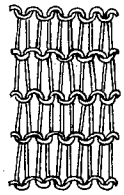
Oct. 4, 1927. 1,644,116

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TUBULAR FABRIC FORMING MACHINE

Filed March 20, 1925 3 Sheets-Sheet 3

Fig. 12



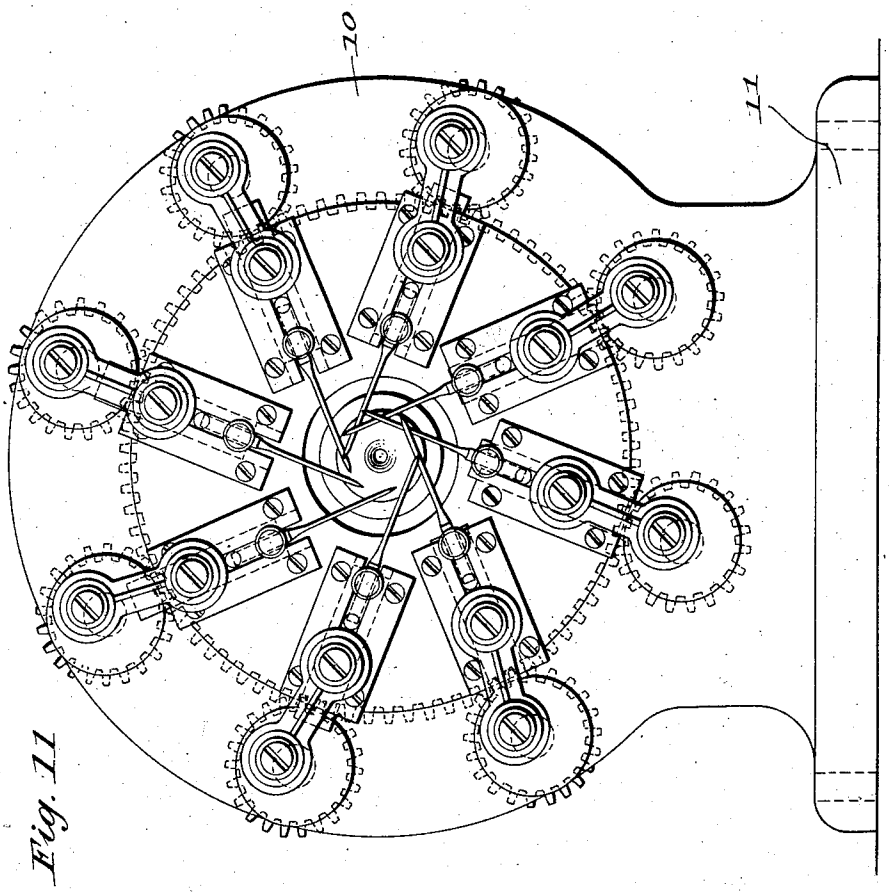


Fig. 11

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UNITED STATES PATENT OFFICE.

JOHN E. FEFEL, OF BRIDGEPORT, CONNECTICUT, ASSIGNOR OF ONE-HALF TO FRANK J. HOEY, OF NEW YORK, N. Y.

TUBULAR-FABRIC-FORMING MACHINE.

Application filed March 20, 1925. Serial No. 17,025.

The present invention relates to tubular fabric forming, and a method and machine therefor, and has for an object the production of a novel type of tubular fabric in a simple, economical and efficient manner. A further object is to provide such a machine by means of which the fabric may be produced as a tubular covering for wire, cord or the like, as a multi-layer tube, or as a single layer tube, and further to enable the production of a close or loosely knitted fabric.

To this end it is proposed in the present embodiment to provide a machine employing a plurality of reciprocating needles having eyes through which threads are carried, and arranged about a common axis, and which needles are successively reciprocated so that each succeeding needle passes through the loop of a preceding needle, and thus produces a tubular fabric in which the threads are knitted together.

With the above and other objects in view embodiments of the invention are shown in the accompanying drawings, and these embodiments will be hereinafter more fully described with reference thereto, and the invention will be finally pointed out in the claims.

In the drawings:

Fig. 1 is a face view of the needle-bar-carrying side of the machine, according to one embodiment in which four needles are employed;

Fig. 2 is a vertical sectional view, taken along the line 2—2 of Fig. 1;

Figs. 3 to 7 are perspective diagrammatic views, showing the several steps of the fabric forming operation of the needles;

Fig. 8 is a side elevation of a piece of tubular fabric, as produced by the machine;

Fig. 9 is a side elevation showing a section of the tubular fabric formed about a wire or cord;

Fig. 10 is a side elevation showing a section of double thickness tubular fabric, as formed by a pair of the machines in tandem;

Fig. 11 is a face view of a modified type, in which eight needles are employed; and

Fig. 12 is a side elevation of a section of the tubular fabric, as produced thereby.

Similar reference characters indicate corresponding parts throughout the several figures of the drawings.

Referring to the drawings, the main frame 10, which may either be vertically or horizontally disposed, is provided at one side with a base extension 11, which may rest on a horizontal support or be secured to a vertical support, as a side wall. The frame is provided centrally with a circular opening 12, having a reduced cylindrical portion 13 at its lower end, and in which there is secured a tubular drive gear bushing 14, threaded at its lower end and provided intermediate its ends with a flange 15 abutting the under side of the frame.

In the upper end of the bushing there is seated a flanged tubular guide member 16 having its passage flared at the upper end and through which the formed tubular fabric passes; this member being removable, so that it may be replaced by similar members having different diameter passages, depending upon the particular character of the work being produced.

A large drive gear 17 having a pinion gear 18 keyed thereto is rotatably supported on the bushing 14 by means of a collar nut 19 screwed upon the threaded end of the bushing. At equally spaced points adjacent its periphery the frame is provided with passages 20, in which are journaled needle-bar crank shafts 21 (four in the present embodiment) provided at their lower ends with pinions 22 meshing with the drive gear 17, and at their upper ends there are provided eccentric cranks 23 provided with ball studs 24, each engaged in the outer apertured end of a link 25 engaged at its inner apertured end with the ball stud 26 provided on each of the reciprocating needle bars 27.

The needle bars are slidably engaged in T-slots 28 in the upper side of the frame, and have projecting needles 29 secured therein by needle holding screws 30. The central axial lines of the needles and needle bars are arranged tangentially to an imaginary circle concentric to the central axis of the guide member 16, and the needle bars and their T-slot slide-ways are furthermore inclined upwardly, so that the needles move inwardly at an upward incline.

Adjacent each needle bar there is mounted in the frame a spindle 31, upon which a thread spool is rotatably mounted, the thread passing therefrom through a loop 32 provided in the end of a wire thread tension 33, and between friction producing spring coil 34 therein to the needle eye in the point

the needle, and through which it passes downwardly through the guide member 16.

The threads from the several needles are carried about a feed drum 35, to which the central axis of the member 16 is tangential, and from said drum to a receiving spool or reel 36. The respective shafts 37 and 38 of the drum and spool are mounted in suitable bearings, and are provided at one end with pulleys 39 and 40, over which an endless friction drive slip belt 41 is engaged, and at its other end the shaft 37 is provided with a spiral gear 42 meshing with a worm 43 provided upon one end of a shaft 44 journaled in a bearing portion 45 of the frame, and provided at its other end with a gear 46 meshing with the drive gear 18. Thus as the drive gear simultaneously rotates the several needle crank shafts it drives the feed drum in synchronism therewith, the ratio of the speed of the feed drum to the operation of the needles being determined by the pitch of the worm, so that by changing the pitch the relative speed may be regulated, as desired, and the closeness or looseness of the fabric determined.

As the fabric is formed, as will hereinafter more fully appear, it passes about the feed drum 35 and is wound upon the spool 36, the slippage permitted by the friction belt drive compensating for the growing diameters as the fabric is wound thereon.

The machine is preferably powered by an electric motor driven bevel drive gear 47, meshing with a bevel gear 48 mounted on a shaft 49 and to which a spur gear 50 is keyed and meshes with the pinion gear 18. It will be understood that the drive may be directly on the large gear 17, or at any other desired point.

The operation is as follows:

The needles are successively reciprocated, so that each passes beneath the preceding needle and through the loop of its thread. This is due to the inclination of the beds upon which the slides are mounted. As shown in Figs. 1 and 3 to 7, the order of the needles is indicated as *a*, *b*, *c* and *d*, Fig. 3 showing the beginning of the fabric forming operation at the point where the needle *a* is projected above the needle *b*, and the latter needle has started through the loop of the needle *a*. The needle *b* continues its projecting movement to a point beyond the line of movement of the needle *c*, the point of which in its fully retracted position is clear of the line of movement of the needle *b*. The needle *c* now starts on its projecting movement, (Fig. 4), and simultaneously the needle *a* is retracted drawing its thread over the needle *b*. The needle *d* now moves beneath the needle *c*, and the needle *b* moves in retracting direction, drawing its thread over the needle *c* and beneath the thread of the needle *a*, thus forming the first thread loop (Fig. 5). As the needle *d* reaches its fully projected position, its thread passing over the thread of the needle *a*, the needle *a* starts its projecting movement beneath the needle *d*, looping the thread of needle *a* about the thread of needle *d*, forming the second thread loop, and as the needle *c* is retracted drawing its thread over the needle *d* and under the thread of the needle *b*, forming the third thread loop (Fig. 6). As needle *b* starts beneath the projected needle *a*, needle *d* is retracted, drawing its thread over needle *a* and beneath the thread of needle *c*, forming the fourth thread loop, the complete cycle being performed as the needle *a* is retracted, drawing its thread over the needle *b* and under the thread of the needle *d*, (Fig. 7). As the threads are fed downwardly by the feed drum, and the needles continue their operation a continuous tubular fabric is produced, and by controlling the relative speed of the feed the tightness of the knitting may be determined, as desired.

In Fig. 8 there is shown a section of the tubular fabric as produced by the four needle machine. The tube may be woven about a wire or cord as a covering, as shown in Fig. 9, by feeding a wire or cord downwardly through the member 16 and about the feed drum simultaneously with the knitting operation; or a multi-layer tube may be produced by arranging two or more of the machines in line, and feeding the product of one through the other, so that the latter forms a tube about the tube formed by the former.

In Fig. 11 I have illustrated a machine in which eight needles are employed, their axes of reciprocation being tangential to an imaginary circle concentric to the passage through the frame. The product of this machine is illustrated in Fig. 12. It will be understood that any desired number of needles may be employed to produce tubular fabric of any size or type, it being proposed, for instance, to form tubular braid, neck-ties, sweaters, or other forms of tubular fabrics.

I have illustrated and described preferred and satisfactory embodiments of the invention, but it will be obvious that changes may be made therein, within the spirit and scope thereof, as defined in the appended claims.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

1. In a tubular fabric forming machine, a plurality of reciprocating needles arranged about a common axis, each of said needles having an eye through which a thread is adapted to pass, and means for reciprocating said needles, whereby each succeeding needle passes through the thread loop of a preceding needle.

2. In a tubular fabric forming machine, a plurality of reciprocating needles arranged about a common axis, each of said needles having an eye through which a thread is adapted to pass, means for continuously supplying thread to each needle, and means for reciprocating said needles, whereby each succeeding needle passes through the thread loop of a preceding needle.

3. In a tubular fabric forming machine, a plurality of reciprocating needles arranged about a common axis, each of said needles having an eye through which a thread is adapted to pass, means for supplying thread to each needle, means for reciprocating said needles, whereby each succeeding needle passes through the thread loop of a preceding needle, and continuous feeding means for feeding said threads from said thread supplying means through the needle eyes.

4. In a tubular fabric forming machine, a plurality of reciprocating needles arranged about a common axis, each of said needles having an eye through which a thread is adapted to pass, and means for reciprocating said needles, whereby each succeeding needle passes beneath and through the thread loop of a preceding needle.

5. In a tubular fabric forming machine, a plurality of reciprocating needles arranged about a common axis, each of said needles having an eye through which a thread is adapted to pass, the axes of reciprocation of said needles being arranged tangentially to an imaginary circle concentric to said common axis, and means for reciprocating said needles, whereby each succeeding needle passes through the thread loop of a preceding needle.

6. In a tubular fabric forming machine, a plurality of reciprocating needles arranged about a common axis, each of said needles having an eye through which a thread is adapted to pass, the axes of reciprocation of said needles being arranged at an upward and inward inclination to said common axis, and means for reciprocating said needles, whereby each succeeding needle passes through the thread loop of a preceding needle.

7. In a tubular fabric forming machine, a plurality of reciprocating needles arranged about a common axis, each of said needles having an eye through which a thread is adapted to pass, a gear for causing the reciprocation of said needles, whereby each succeeding needle passes through the thread loop of a preceding needle, and feeding means for said threads geared to said gear and whereby the threads are fed in synchronism to the operation of said needles.

8. In a tubular fabric forming machine, a frame having a guide passage therethrough, a plurality of reciprocating needles arranged at one side of said frame about said passage, each of said needles having an eye through which a thread is adapted to pass, means for reciprocating said needles, whereby each succeeding needle passes through the thread loop of a preceding needle, and feeding means arranged at the other side of said frame and adapted to feed the thread through said passage from said needles.

9. In a tubular fabric forming machine, a frame having a guide passage therethrough, a plurality of reciprocating needles arranged at one side of said frame about said passage, and having their axes of reciprocation tangential to an imaginary circle concentric to the axis of said passage, each of said needles having an eye through which a thread is adapted to pass, means for reciprocating said needles, whereby each succeeding needle passes through the thread loop of a preceding needle, and feeding means arranged at the other side of said frame and adapted to feed the thread through said passage from said needles.

10. In a tubular fabric forming machine, a frame having a guide passage therethrough, a plurality of needle bars arranged for reciprocation at one side of said frame about said passage, rotary means for reciprocating said needle bars, means for simultaneously rotating said rotary means, needles carried by said bars, each having an eye through which a thread is adapted to pass, each succeeding needle adapted during reciprocation to pass through the thread loop of a preceding needle, and feeding means arranged at the other side of said frame and adapted to feed the threads through said passage from said needles.

11. In a tubular fabric forming machine, a frame having a guide passage therethrough, a plurality of needle bars arranged for reciprocation at one side of said frame about said passage, rotary means for reciprocating said needle bars, and each including a gear, a single drive gear meshing with the gears of said rotary means, whereby they are simultaneously rotated, needles carried by said needle bars, each having an eye through which a thread is adapted to pass, each succeeding needle adapted during reciprocation to pass through the thread loop of a preceding needle, and feeding means arranged at the other side of said frame and adapted to feed the threads through said passage from said needles.

12. In a tubular fabric forming machine, a frame having a guide passage therethrough, a plurality of needle bars arranged for reciprocation at one side of said frame about said passage, rotary shafts for each of said bars, means carried by said shafts connected to said bars to reciprocate them, means for simultaneously rotating said shafts, needles carried by said needle bars, each having an eye through which a thread

is adapted to pass, each succeeding needle adapted during reciprocation to pass through the thread loop of a preceding needle, and feeding means adapted to feed the threads through said passage from said needles.

13. In a tubular fabric forming machine, a frame having a guide passage therethrough, a plurality of reciprocating needles arranged at one side of said frame about said passage, each of said needles having an eye through which a thread is adapted to pass, means for reciprocating said needles, whereby each succeeding needle passes through the thread loop of a preceding needle, and feeding means arranged at the other side of said frame and geared to said needle reciprocating means, whereby said feeding means is operated in synchronism to said needles, said feeding means adapted to feed the threads through said passage from said needles.

14. In a tubular fabric forming machine, a frame having a guide passage therethrough, a plurality of reciprocating needles arranged at one side of said frame about said passage, each of said needles having an eye through which a thread is adapted to pass, means for reciprocating said needles, whereby each succeeding needle passes through the thread loop of a preceding needle, a feed drum to which the axis of said passage is tangential and about which the threads pass through said passage from said needles, and means for rotating said drum in synchronism to the operation of said needles.

15. In a tubular fabric forming machine, a frame having a guide passage therethrough, a plurality of reciprocating needles arranged at one side of said frame about said passage, each of said needles having an eye through which a thread is adapted to pass, means for reciprocating said needles, whereby each succeeding needle passes through the thread loop of a preceding needle, a feed drum to which the axis of said passage is tangential and about which the threads pass through said passage from said needles, means for rotating said drum in synchronism to the operation of said needles, and a reel for receiving the threads from said drum.

16. In a tubular fabric forming machine, a frame having a guide passage therethrough, a plurality of reciprocating needles arranged at one side of said frame about said passage, each of said needles having an eye through which a thread is adapted to pass, means for reciprocating said needles, whereby each succeeding needle passes through the thread loop of a preceding needle, a feed drum to which the axis of said passage is tangential and about which the threads pass through said passage from said needles, means for rotating said drum in synchronism to the operation of said needles, a reel for receiving the threads from said drum, and a slip drive for said reel adapted to compensate for the growing diameter as the fabric is wound thereon.

Signed at Bridgeport in the county of Fairfield and State of Connecticut this 19th day of March A. D. 1925.

JOHN E. FEFEL.