Dec. 15, 1942. H. F. HILKER ET AL 2,304,916

CIRCULAR KNITTING MACHINE

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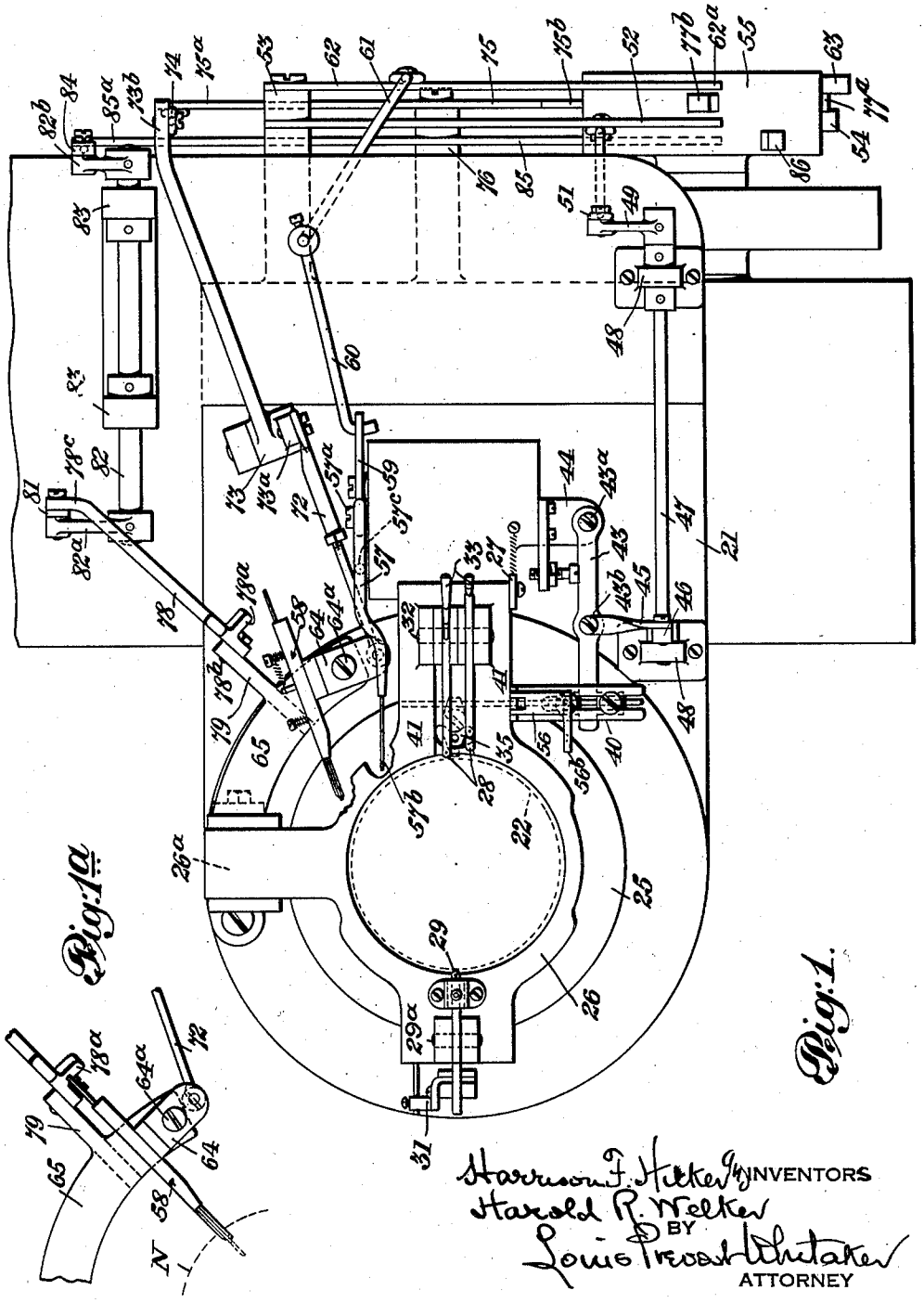


Fig. 1.

Fig. 1a.

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CIRCULAR KNITTING MACHINE

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Fig. 2.

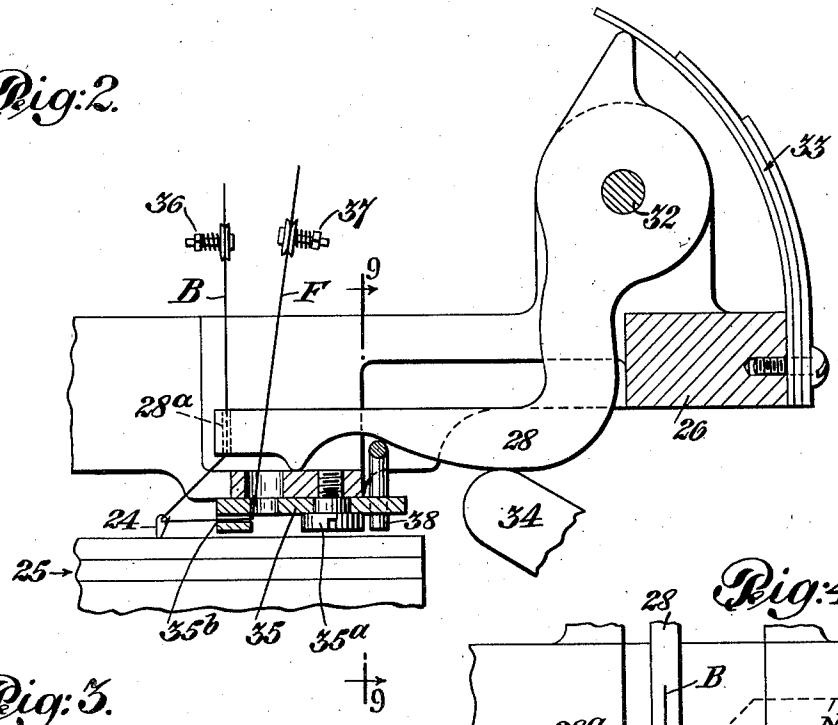


Fig. 4.

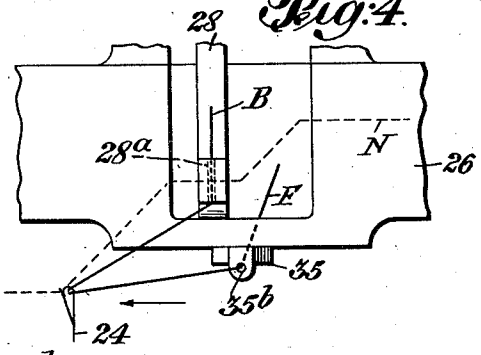
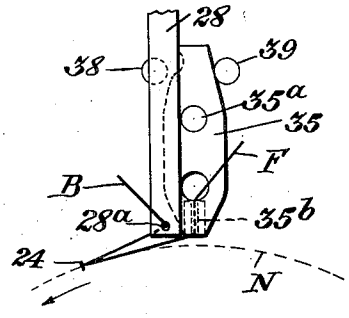


Fig. 3.



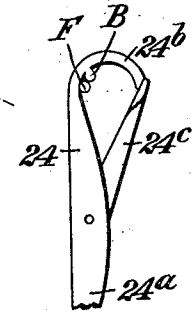


Fig. 6.

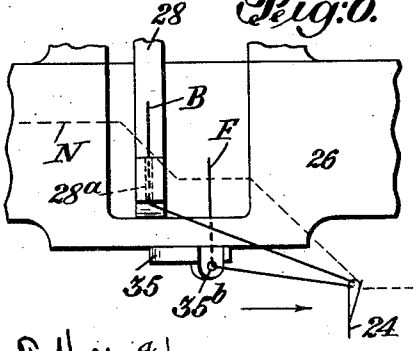


Fig. 5.

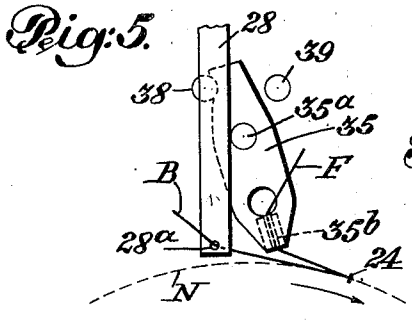


Fig. 7.

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CIRCULAR KNITTING MACHINE

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Fig:8.

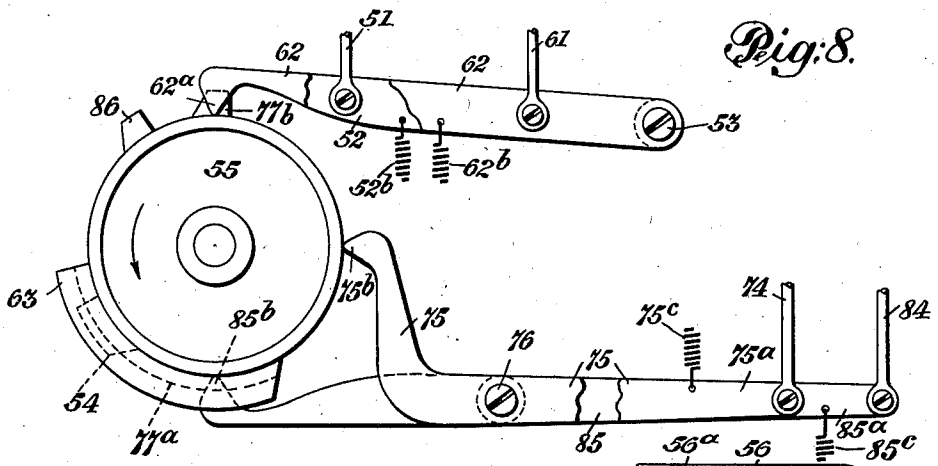


Fig:10.

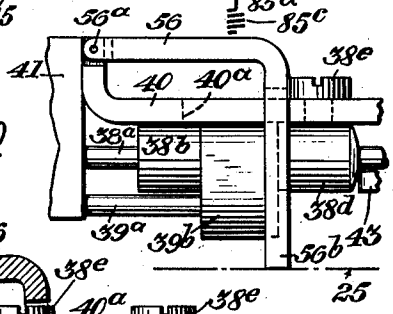
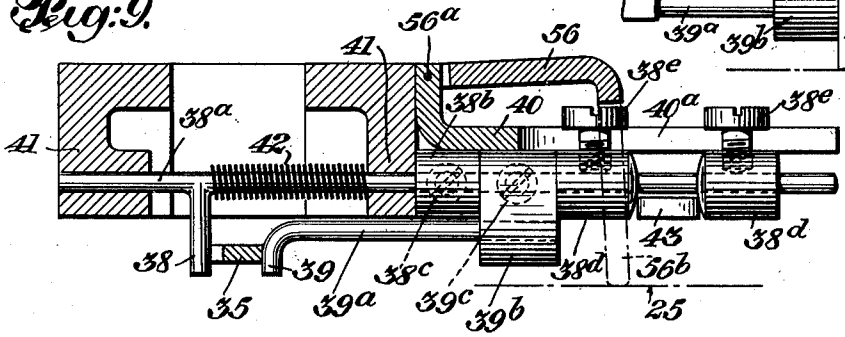


Fig:9.



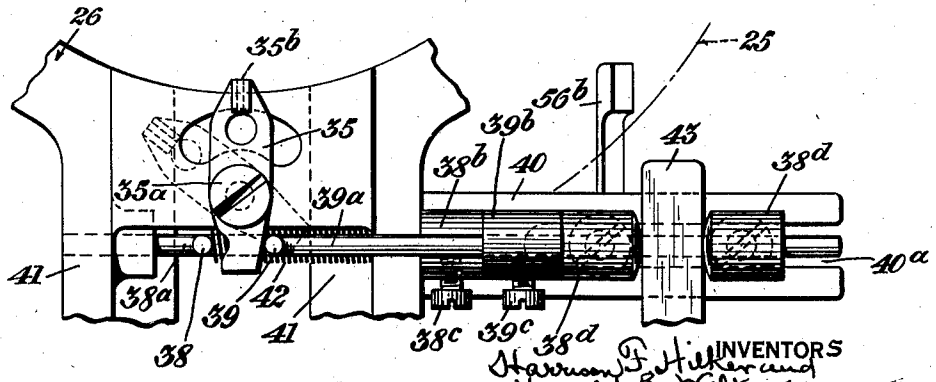


Fig:11.

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CIRCULAR KNITTING MACHINE

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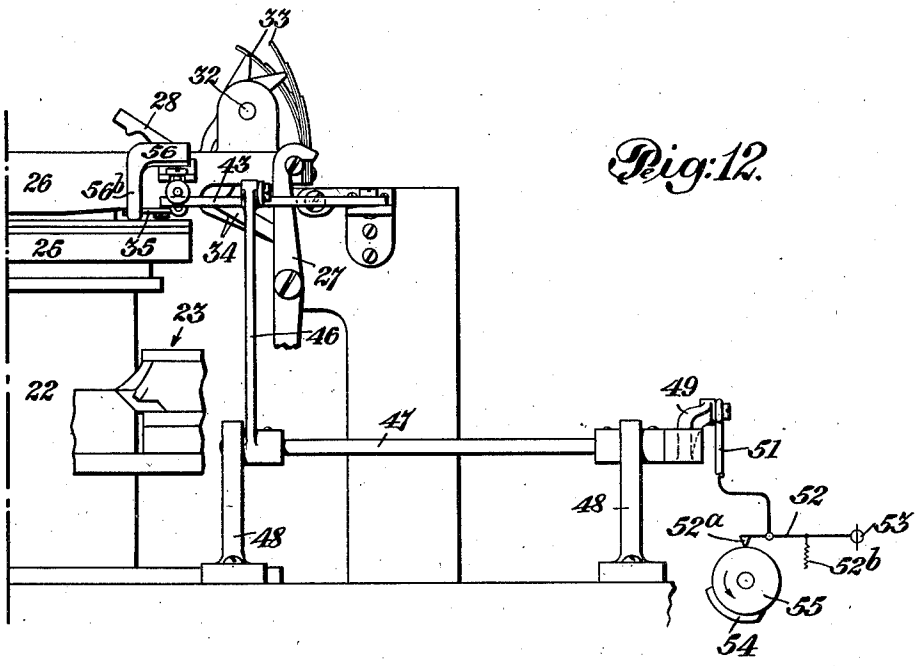


Fig. 12.

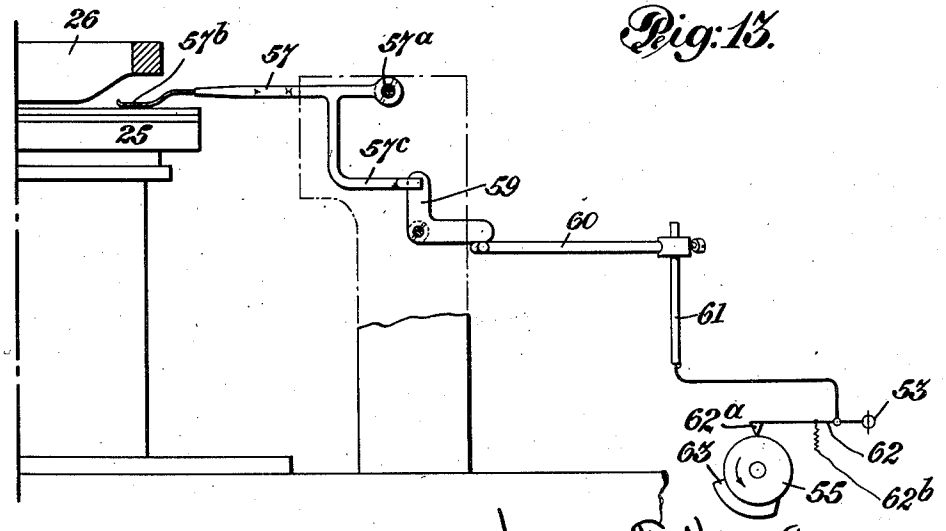


Fig. 13.

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CIRCULAR KNITTING MACHINE

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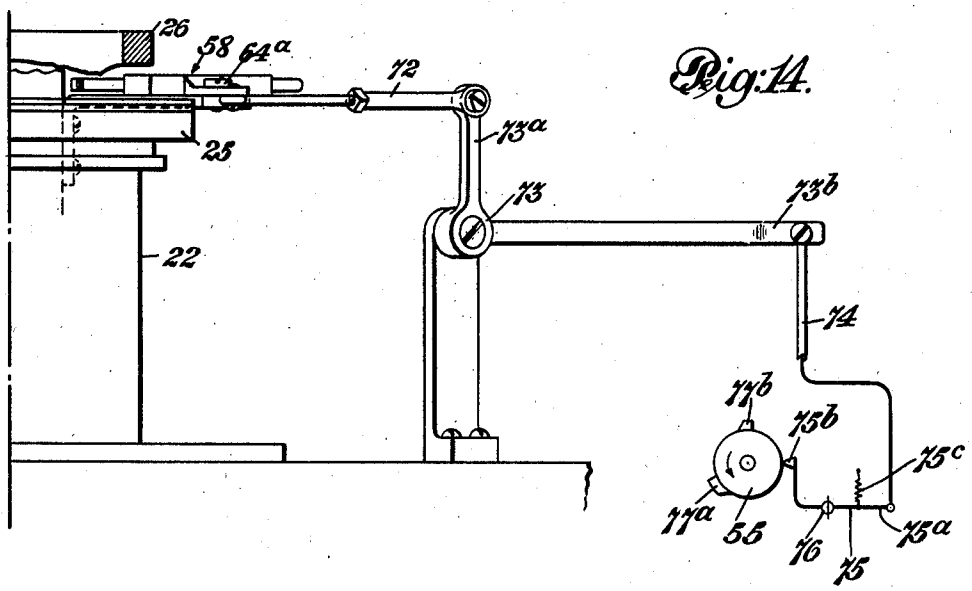


Fig:14.

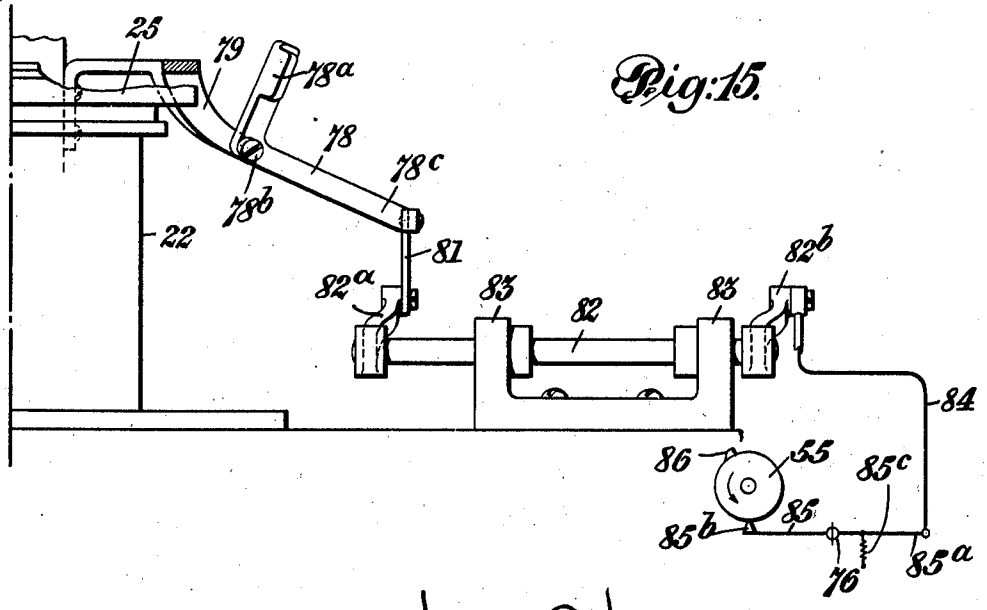


Fig:15.

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CIRCULAR KNITTING MACHINE

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Fig:16.

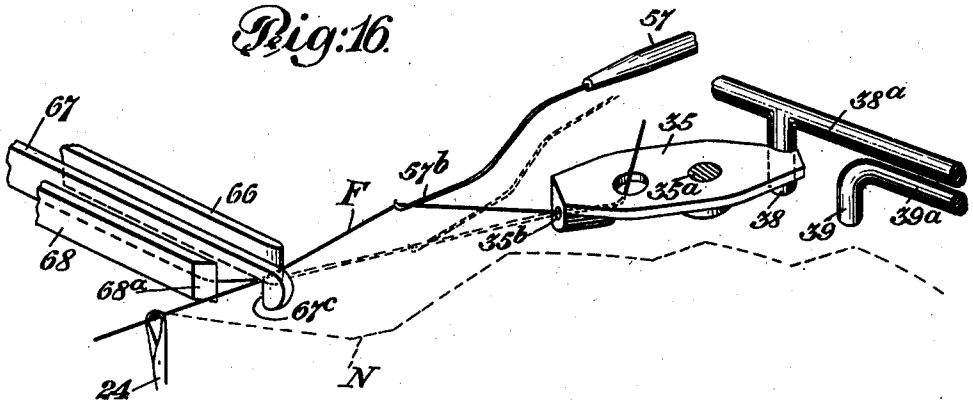
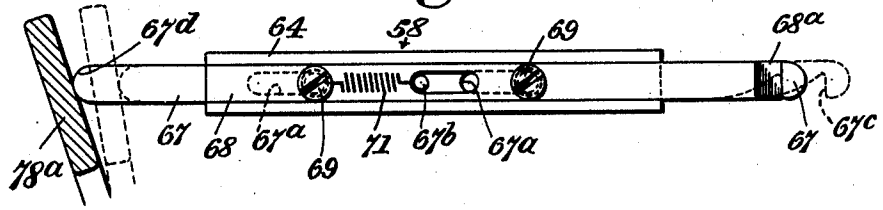


Fig:17.



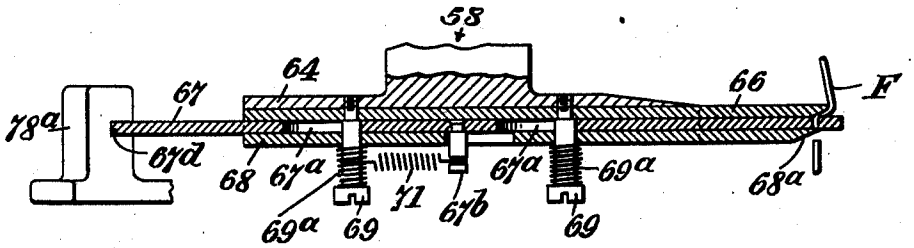


Fig:18.

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Patented Dec. 15, 1942

2,304,916

UNITED STATES PATENT OFFICE

2,304,916

CIRCULAR KNITTING MACHINE

Harrison F. Hilker and Harold R. Welker, Martinsburg, W. Va., assignors to Interwoven Stocking Company, New Brunswick, N. J., a corporation of New Jersey

Application February 11, 1941, Serial No. 378,356

18 Claims. (Cl. 66—134)

The present invention consists in the novel features disclosed in the following description and claims, and in the accompanying drawings, which illustrate by way of example one form of apparatus for carrying said invention into effect.

The invention relates to circular knitting machines for producing plated fabric, i. e., machines in which a plurality of threads are fed to the needles in such manner that one or more threads hereinafter referred to as the plating or face thread forms the outer face of the fabric, and other thread or threads hereinafter referred to as the body or backing thread forms the inner face of the fabric. As is well known, the production of uniform plating presents a difficult problem. It requires that the two threads, namely, the face thread which is to appear at the outer face of the fabric, and the backing thread which is to appear at the inner face of the fabric must at all times be fed to the needles of the machine in such manner that they will be engaged by the hooks of the needles in their proper relations when each stitch is drawn, so that the face thread lies in the hook of the needle closely adjacent the shank and the backing thread lies in the hook of the needle on the outer side of the face thread. To assure that this positioning of the threads is invariably obtained, it is necessary that not only the thread be fed under suitable tension, greater tension being ordinarily placed on the face thread, but also to feed the thread at the proper angle to each other. The angular relationship of the two threads is determined by the positions of the thread guides by which the threads are fed to the needles and the direction the threads are drawn from the thread guides by the needles.

The problem of producing uniform plating is still more difficult when the knitting machine is operated by reciprocation and the needles are manipulated to knit in each direction of rotation of the needle cylinder relative to the cam block and the thread guides, as occurs for example in knitting the heel and toe pockets of a sock or in knitting the high splice, sole and instep portions of a split foot sock. It is obvious that where the threads are fed in proper plating relation to the needles when the cylinder is moving in one direction, the reversal of the direction of rotation of the needle cylinder will disturb the relation of the threads and result in improper plating when the cylinder is moving in the opposite direction. In some instances the relation of the thread is reversed upon each reversal of the needle cylinder, so that one thread appears at the face of the fabric in the alternate courses knit during rotation of the cylinder in one direction, while the other thread appears at the face of the fabric in the intervening courses knit during rotation of the cylinder in the reverse direction. In other instances, the disturbance of the proper plating relation of the two threads is irregular and unpredictable, so that the outer face of the fabric is formed in some places of one thread, and at other places of the other thread. It is an object of the present invention to overcome this difficulty and obtain uniform plating at all times in reciprocating work as well as in work produced by continuous rotation of the needle cylinder in one direction.

It has been proposed to provide a circular knitting machine with auxiliary thread feed fingers and mechanism for mechanically shifting the fingers relative to one another upon each reversal of the needle cylinder in reciprocating work so that in both directions of reciprocation of the needle cylinder both threads will be delivered to the needles at the proper angles to produce uniform plating. However, the mechanism required to shift the auxiliary thread feed fingers is complicated and is subject to considerable wear, as the fingers must be shifted at the end of each movement of the cylinder in each direction of its reciprocation. Moreover, the shifting of the feed fingers exactly simultaneously with the reversal of the needle cylinder presents a difficult problem of timing and if the timing is not correct, imperfect plating will result. It is an object of the present invention to avoid the complicated mechanisms of the prior art.

In accordance with the invention, the shifting of the thread guides with respect to one another to feed the threads in proper relation for uniform plating in each direction of rotation is effected by the pull of the thread itself, thereby eliminating the complicated mechanism for shifting the positions of the thread guides and providing an extremely simple and dependable construction. If desired, the thread guides feeding both the face and the backing threads may be shifted the required amount to place the threads in correct position for accurate plating in each direction. However, a similar construction is provided by maintaining one thread guide stationary so as to remain in the same position in both directions of rotation, and making the other thread guides freely movable in both directions by the pull of the thread being fed to shift the position of said second thread guide upon each reversal of the needle cylinder, thereby changing the relative

positions of the two thread guides and presenting the threads in proper relation for uniform plating in each direction of rotation of the needle cylinder. It will be understood that the movable thread guide has two feeding positions, being in one position during rotation of the needle cylinder in one direction, and in the other position during rotation in the opposite direction. Each tme the direction of rotation is reversed, the portion of thread extending from the thread guide to the needles of the needle cylinder is pulled in the opposite direction, thereby moving the thread guide from one feeding position to the other. The continued pull of the thread as it is drawn from the thread guide by the needles hold the thread guide in proper position for feeding the thread in the new direction of rotation and this position is maintained until the direction of rotaton is again reversed. Adjustable stops are preferably provided to limit the extent the thread guide is moved by the pull of the thread to position the thread guide in proper relation to the thread guide feeding the other thread to obtain uniform plating in each direction of rotation under all conditions. In addition to having two feeding positions, one for each direction of rotation of the needle cylinder, the movable thread guide is preferably movable to an inoperative position in which it does not present thread in position to be received by the needles.

Owing to the restricted space available, and the limited extent to which the movable thread guide can be moved away from the needle circle when in inoperative position, a special cutter and binder unit is provided to sever and hold the thread when the feeding of the thread to the needles is discontinued. The cutter and binder unit is mounted on the machine outside the needle circle, but is movable into a position in which it projects inside the needle circle to cut and bind the thread fed by the movable thread guide when the latter is withdrawn to inoperative position. The unit is of unusual construction in that it has a movable blade having a downwardly opening hook, and a special lifting finger is provided to raise the thread into position to be engaged by the cutter and binder unit. After the thread has been trapped, the cutter and binder unit returns to a position in which it is wholly outside the needle circle and out of the path of the needles. When it is desired to resume feeding the thread, the thread guide is moved to feeding position and the cutter and binder unit is moved temporarily to its inner position to present the thread to the needles.

It will be understood that in referring in the specification and claims to rotation of the needle cylinder, reference is had to rotation of the cylinder relative to the cam block and thread guides and that this relative rotation can be produced either by rotating the needle cylinder or by rotating the cam block and thread guides.

In the accompanying drawings, there is illustrated so much of a circular knitting machine for carrying the invention into effect as is necessary to enable the invention to be clearly understood.

In the drawings:

Fig. 1 is a top plan view of a circular knitting machine embodying the invention.

Fig. 1*a* is a fragmentary top plan view showing the cutter and binder unit in its inner position.

Fig. 2 is a fragmentary vertical sectional view taken on a plane extending radially of the needle cylinder and showing two thread guides for feeding thread to the needles in plating relation.

Fig. 3 is a horizontal plan view showing the relative positions of the two thread guides during rotation of the needle cylinder in the direction indicated by the arrow.

Fig. 4 is a fragmentary elevational view looking radially outwardly from the needle cylinder and showing the thread guides in the same positions as in Fig. 3.

Fig. 5 is a view similar to Fig. 3, but shows the relative positions of the two thread guides when the needle cylinder is rotating in the opposite direction as indicated by the arrow.

Fig. 6 is a view similar to Fig. 4, but shows the thread guides in the same position as in Fig. 5.

Fig. 7 is an enlarged fragmentary view showing the relative positions of the two threads in the hook of a needle for proper plating.

Fig. 8 is an end elevational view of the pattern drum controlling the movable thread guide, the cutter and binder unit and the lifting finger for raising the thread into position to be received by the cutter and binder.

Fig. 9 is a vertical sectional view taken on the line 9—9 in Fig. 2, and shows adjustable means for limiting the movement of the movable thread guide, and part of the mechanism for moving the thread guide to inoperative position.

Fig. 10 is a fragmentary elevational view of a portion of the mechanism shown in Fig. 9, and shows a latch locking the thread guide in inoperative position.

Fig. 11 is a view looking upwardly and showing the underside of the mechanism shown in Fig. 9.

Fig. 12 is an elevational view showing the operation of mechanism for moving the thread guide to inoperative position under control of the pattern drum shown in Fig. 8, the pattern drum and adjacent portion of the mechanism being indicated diagrammatically.

Fig. 13 is an elevational view partially in section showing operation of the lifting finger for raising the thread into the cutter and binder, a portion of the mechanism being shown diagrammatically.

Fig. 14 is an elevational view partially in section showing mechanism for moving the cutter and binder into its inner position, a portion of the mechanism being shown digrammatically.

Fig. 15 is an elevational view partially in section, showing mechanism for actuating the cutter and binder, a portion of the mechanism being shown diagrammatically.

Fig. 16 is a schematic perspective view illustrating the operation of the cutter and binder.

Fig. 17 is a vertical elevational view partially in section, showing the cutter and binder unit.

Fig. 18 is a horizontal sectional view through the cutter and binder unit.

In the accompanying drawings, there is shown by way of example, a circular knitting machine having a frame **21**, and a needle cylinder **22** which is rotatable alternately in opposite directions relative to a cam block **23**, for manipulating the needles **24**, to knit in each direction of rotation. Each of the needles **24** has a shank portion **24***a*, a hook portion **24***b* and a latch **24***c*, and is provided with suitable butts for operation of the needles by the cams of the cam block **23**.

The machine is provided with a sinker ring **25**, and has a latch ring **26**, pivoted to the frame of the machine at **26***a* (Fig. 1), so that the latch ring can be swung up away from the needle cylinder to an inoperative position. The latch ring

is normally held down in operative position by a releasable catch 27 (Fig. 12).

The machine is provided with a main feeding station at which are provided any desired number of thread guides 28, for feeding thread to the needles of the needle cylinder, and an auxiliary feeding station at which is located one or more thread guides 29 (Fig. 1). The single thread guide 29, shown by way of example in the drawings, is pivotally mounted on the latch ring at 29a, and has associated therewith suitable mechanism 31 for moving the thread guide into and out of feeding position. In Fig. 2 of the drawings, there is shown in side elevation one of the thread guides 28 at the main feeding station. It will be seen that the thread guide has a thread feeding eye 28a, and is pivotally mounted on a shaft 32, supported by the latch ring 26 so that the thread guide may be swung upwardly to an inoperative position from the feeding position illustrated in Fig. 2. The thread guide 28 is normally held in feeding position by a spring 33, and can be moved to inoperative position by a finger 34 which is operable by suitable mechanism under control of the pattern drum of the machine.

While the thread guide 28 is movable into and out of operative position, it remains in the same feeding position in both directions of rotation of the needle cylinder, and for convenience of terminology will be referred to as a stationary thread guide. At the main feeding station there is also provided a movable thread guide for feeding thread to the needles in plating relationship with the thread fed by thread guide 28. The movable thread guide has two feeding positions, being in one position during rotation of the needle cylinder in one direction and in the other position during rotation in the opposite direction. By thus shifting the relative positions of the two thread guides in accordance with the direction of rotation of the needle cylinder, the guides are properly positioned to feed the two threads in correct relation for accurate and uniform plating in both directions of rotation. In accordance with the present invention, no mechanism is required for shifting the movable thread guide from one feeding position to the other as the thread guide is so arranged that upon reversal of the direction of rotation of the needle cylinder, the thread guide is automatically shifted by the pull of the thread which it feeds.

In the embodiment of the invention shown by way of example in the drawings, the movable thread guide 35 is mounted on the latch ring 26 below the stationary thread guide 28, being pivotally supported by a screw 35a so that it may swing from one feeding position, shown in Figs. 3 and 4, to the other feeding positions shown in Figs. 5 and 6. The thread guide 35 is thus arranged to swing in a plane transverse to the axis of the needle cylinder. At its inner end the thread guide 35 is provided with an eye 35b for feeding thread to the needles.

In threading up the machine, the backing thread B is fed by stationary thread guide 28 and the face thread F is fed by movable thread guide 35. Suitable tension and take up mechanism is provided for each thread and is indicated diagrammatically at 36 and 37 in Fig. 2. The tension device for the face thread F will ordinarily be adjusted to apply heavier tension than is applied to the backing thread B. By referring to Figs. 3 and 4 it will be seen that when the needle cylinder is rotating in a counterclockwise direction, the threads are drawn to the left by the pull of the needles, and hence the pull of the face thread F on the movable thread guide 35 positions the thread guide in its left hand feeding position. When the needle cylinder is reversed and rotates in a clockwise direction, as shown in Figs. 5 and 6, the thread is pulled to the right and this swings the movable thread guide 35 over to its right hand feeding position and maintains it in that position during rotation of the needle cylinder in a clockwise direction. Thus, upon each reversal of the direction of rotation of the needle cylinder, the movable thread guide 35 is automatically swung from one feeding position to the other by the pull of the thread which it feeds. By reason of this automatic shifting of the movable thread guide 35 with respect to the stationary thread guide 28, the two thread guides are placed in proper position to feed the face thread F and the backing thread B in correct angular relation to one another, so that they will always be received in the hooks of the needles in proper position for accurate plating. The relative positions of the two threads in the hooks of the needles is illustrated in Fig. 7, where it will be seen that the face thread F is caused to lie closely adjacent to the shank 24a of the needle and the backing thread B lies in the hook on the outer side of the face thread. The path of travel of the needles in each direction is represented by the broken line N in Figs. 3, 4, 5 and 6.

It will be understood that instead of having one stationary thread guide and one movable thread guide as described above, the same result can be obtained by making both of the thread guides movable and limiting the extent of movement of each thread guide in such manner that upon reversal of the needle cylinder, the relative position of the two thread guides is changed to feed the threads in proper plating relation. However, a simpler construction is provided by maintaining one of the thread guides stationary, and moving the other relative thereto to change the relative positions of the thread guides in accordance with the direction of rotation of the needle cylinder. In the particular embodiment of the invention shown in the drawings, the exent of movement of the movable thread guide 35 is limited by spaced abutments 38 and 39. To provide for adjustment of the abutments in order to regulate the feeding positions of the movable thread guide 35, the abutment 38 is carried by a shaft 38a (Figs. 9 and 11), which is longitudinally slidable in suitable brackets 41 provided on the underside of the latch ring 26 and the abutment 39 is carried by a shaft 39a which is slidably mounted on shaft 38a by means of a collar 39b having a set screw 39c. The position of shaft 38a and hence abutment 38 is adjusted by means of a sliding collar 38b having a set screw 38c for locking it in position. The collar 38b is held in engagement with one of the brackets 41 by a spring 42 which tends to move shaft 38a towards the left as viewed in Fig. 9. Adjustment of the position of shaft 39a and hence of abutment 39 is obtained by sliding shaft 39a relative to shaft 38a by means of the sliding collar 39b. By suitable adjustment of the abutments 38 and 39, the two feeding positions of the movable thread guide 35 can be accurately determined.

In order to discontinue the feeding of plating

thread F when desired, provision is made for moving the thread guide **35** to an inoperative position in which it does not feed thread to the needles. This is accomplished by moving the shaft **38***a* to the right as viewed in Fig. 9 against the action of spring **42**, so that the abutment **38** engages the thread guide **35** and swings it to an inoperative position shown in dotted lines in Fig. 11. It will be understood that the shaft **39***a* moves with shaft **38***a* so that the spacing of the abutments **38** and **39** remains the same. Mechanism for moving the thread guide **35** to inoperative position at a predetermined time under control of a pattern drum is shown in Fig. 8 to Fig. 12. On a projecting portion of shaft **38***a* there are provided spaced collars **38***d* adjustably held in fixed position on the shaft by set screws **38***e*. The projecting ends of the set screws **38***e* are slidably received in a slot **40***a* of a guiding bracket **40** which thereby supports and guides shaft **38***a*. One end of an operating lever **43** is pivotally connected at **43***a* to a suitable bracket **44** on the frame of the machine and the other end fits between the spaced collars **38***d* provided on shaft **38***a*. At an intermediate point **43***b*, the lever **43** is connected by a link **45** (Fig. 1) to the upper end of an arm **46** on a horizontal shaft **47**, rotatably supported by brackets **48**. A second arm **49** provided on shaft **47** at approximately right angles to arm **46** is connected by a link **51** with a cam follower **52** pivotally mounted on a stud shaft **53** and having a nose portion **52***a* adapted to be engaged by a cam **54** on pattern drum **55**. When the nose portion **52***a* rides up on cam **54**, the cam follower **52** is swung upwardly against the action of a spring **52***b* and acting through link **51** and arm **49**, rotates the horizontal shaft **47** in a counterclockwise direction as viewed from the right hand end of the shaft in Figs. 1 and 12. This swings the arm **46** and lever **43** forwardly and pulls the shaft **38***a* outwardly (to the right in Figs. 9 and 11) against the action of the spring **42**, thereby bringing abutment **38** into engagement with thread guide **35** and swinging the thread guide to inoperative position. It will be understood that the timing of this operation is controlled by the position of cam **54** on pattern drum **55**.

As the operating lever **43** is mounted on the frame of the machine, while the thread guides together with the abutments **38** and **39** and the shaft **38***a* are carried by the latch ring, the operating lever is disconnected from the thread guide when the latch ring is swung upwardly about pivot pin **25***a* to its raised position. As the operating lever **43** is not attached to sliding shaft **38***a*, but merely fits in between spaced collars **38***d* on said shaft, the operating mechanism for thread guide **35** in no way interferes with the raising of the latch ring. In order to hold the thread guide **35** in inoperative position against the action of spring **42** when the latch ring is raised there may be provided a catch **56** pivotally connected to the latch ring at **56***a* and having a detent portion **56***b* adapted to engage the set screw **38***e* of one of the collars **38***d* to hold the shaft **38***a* in its outer position (Fig. 10). To provide for the release of the shaft **38***a* when the latch ring is again returned to its lower position, the catch **56** has a downwardly extending portion **56***b* adapted to engage the sinker ring indicated by a dot and dash line in Figs. 9 and 10 to raise the detent portion of the catch out of engagement with the set screw **38***e* of collar **38***d* when the latch ring is lowered (Fig. 9).

When the thread guide **35** is moved to inoperative position, it is desirable to cut and bind the thread. As the regular cutter and binder for the threads fed by thread guides **28** and any threads fed at the auxiliary feeding station **29** occupies the space inside the needle circle, and as the thread guide **35** does not swing far enough away from the needles to cause the thread fed thereby to be caught by a cutter and binder outside the needle circle, the cutting and the binding of the thread fed by movable feed finger **35** presents a difficult problem. This problem is solved in accordance with the present invention by mounting the cutter and binder unit on the machine outside the needle circle and providing means for moving said unit to an inner position in which it projects inside the needle circle, whereupon it is operated to trap and sever the thread and is then returned to its normal position wholly outside the needle circle. The operation of the cutter and binder units is of course timed with the operation of the thread guide **35** so that the cutter and binder unit is moved to its inner position to trap and sever the thread when the thread guide is moved to inoperative position. The cutter and binder unit is thereafter returned to its outer position and remains there as long as the thread guide **35** is inoperative. When feeding of the thread is to be resumed, the thread guide **35** is moved to feeding position and the cutter and the binder unit is moved momentarily to its inner position to present the thread to the needles and thereupon return to a position wholly outside the needle circle.

Cooperating with the cutter and binder unit, there is provided a lifting finger **57** for raising the thread into position to be caught by the cutter and binder (Fig. 13 and Fig. 16). In the form illustrated in the drawings, the lifting finger **57** is pivotally mounted on the frame of the machine at **57***a* (Figs. 1 and 13) and the inner end **57***b* of the finger normally lies on the sinker ring **25** between the thread guide **35** and the cutter and binder unit which is indicated generally by the reference numeral **58**. The lifting finger **57** has an angular arm **57***c* which projects downwardly from the lifting finger and engages one arm of a bell crank lever **59**. The other arm of bell crank lever **59** is engaged by a laterally projecting arm **60** on a vertically movable riser **61**, the lower end of which is connected to a cam follower **62** (Figs. 8 and 13) which is pivoted on stud shaft **53** and has a nose portion **62***a* adapted to engage a cam **63** on pattern drum **55**. When the nose portion **62***a* of cam follower **62** rides up on cam **63**, the riser **61** and projecting arm **60** are lifted, thereby rocking bell crank lever **59** in a counterclockwise direction (Fig. 13), against the action of a spring **62***b*. This causes lifting finger **57** to be swung in a clockwise direction about its pivot **57***a*, thereby lifting the inner end **57***b* of the finger.

The timing of the operation of lifting finger **57** is controlled by the position of cam **63** on pattern drum **55**, and is such that the finger is raised shortly after the thread guide **35** swings to inoperative position. The movement of the thread guide to inoperative position moves the thread out over the inner end of lifting finger **57**, whereupon the lifting finger is raised to lift the thread into position to be acted upon by the cutter and the binder unit. The manner in which the thread is lifted is clearly illustrated in Fig. 16 in which the thread and the lifting finger are shown in

their lower positions by dotted lines and in their raised positions by full lines. The path of travel of the tops of the needles is indicated in Fig. 16 by the broken line N. It will be understood that the lifting finger **57** and the cutter and binder unit **58** are operated during rotation of the needle cylinder in a counterclockwise direction as viewed in Fig. 1 so that the thread is drawn from the thread guide in the proper direction to be acted upon by the lifting finger and the cutter and binder.

The cutter and the binder unit has a body portion **64** which is pivotally mounted on a bracket **65** on the frame of the machine, the pivot pin being indicated by the reference numeral **64***a* and permitting the cutter and the binder to swing in a plane transverse to the axis of the needle cylinder (Figs. 1 and 1*a*). A binder plate **66**, a movable blade **67** and a stationary blade **68** are secured to the body portion **64** by means of threaded pins **69** (Figs. 17 and 18). The pins **69** extend through elongated holes **67***a* in movable blade **67** to permit limited longitudinal movement of the blade relative to the binder plate **66** and stationary blade **68**. Compression spring **69***a* on pin **69** holds the movable blade **67** and stationary blade **68** in engagement with each other and with the binder plate **66**. A tension spring **71** acting on a pin **67***b* projecting laterally from the movable blade **67** tends to move the blade to the retracted position shown in Fig. 18. At its inner end the movable blade **67** has a downwardly opening hook portion **67***c*. When the movable blade is in its extended position illustrated in Fig. 16, and shown by dotted lines in Fig. 17, the downwardly opening hook portion **67***c* is exposed and is adapted to receive the thread when the latter is lifted by finger **57** (Fig. 16). Upon release of the movable blade **67**, it is retracted by spring **71** severing the thread between the hook portion **67***c* of the movable blade and a cutting edge **68***a* provided at the inner end of the stationary blade **68**. The end of the thread extending from the thread guide **35** to the cutter and binder unit is firmly gripped between the movable blade **67** and the inner end of binder plate **66** so that the thread is not released and may be again presented to the needles by swinging the thread guide **35** to feeding position and moving the cutter and binder unit momentarily to its inner position in which it projects inside the needle circle.

Mechanism for swinging the cutter and binder unit about its pivot pin **64***a* to move the unit to its inner position is illustrated in Figs. 1, 1*a* and 14. The body portion **64** of the cutter and binder unit is connected by a link **72** to one arm **73***a* of a bell crank lever **73**, the other arm **73***b* of which is connected by a vertically movable riser **74** to a rearwardly projecting end **75***a* of a cam follower **75** pivotally mounted on a stud shaft **76** and having at its other end a nose portion **75***b* adapted to engage cams **77***a* and **77***b* on pattern drum **55**. When the nose portion **75***b* of the cam follower rides up on one of the cams **77***a* or **77***b* the cam follower **75** is rocked about its pivot **76** in a clockwise direction against the action of a spring **75***c*, thereby rocking bell crank lever **73** in a clockwise direction and drawing links **72** to the right as viewed in Figs. 1, 1*a* and 14. This swings the cutter and binder unit about its pivot **64***a* in a counterclockwise direction as viewed in Fig. 1, to an inner position shown in Fig. 1*a* in which the inner end of the cutter and binder unit projects inside the needle circle indicated by the broken line N. The cams **77***a* and **77***b* (Fig. 14) are so arranged on pattern drum **55** as to move the cutter and binder into its inner position to cut and bind the thread when the thread guide **35** is moved to inoperative position and again to present the thread to the needles when the thread guide is returned to feeding position.

Movement of the cutter and binder unit to its inner position illustrated in Fig. 1*a*, brings it into position for operation of the movable blade **67** by suitable actuating mechanism to sever and trap the thread. The actuating mechanism is shown in Figs. 1, 1*a*, 15, 17 and 18, and comprises a hammer **78***a* provided on one end of a bell crank lever **78**, pivoted at **78***b* to a suitable bracket **79** on the frame of the machine, and having its other arm **78***c* connected by a link **81** to an arm **82***a* at one end of a horizontal shaft **82** rotatably supported by suitable brackets **83**. An arm **82***b* at the other end of shaft **82** is connected by a vertically movable riser **84** to the rear end **85***a* of a cam follower **85** pivotally supported on stud shaft **76** and having a nose portion **85***b* adapted to be engaged by a cam **86** on pattern drum **55**. (Figs. 8 and 15). When the nose portion **85***b* of the cam follower **85** rides up on cam **86**, the cam follower is rocked in a counterclockwise direction (Fig. 15) against the action of a spring **85***c*, lifting the riser **84** and rotating shaft **82** in a counterclockwise direction as viewed from the right hand end of the shaft. The rotation of shaft **82** raises link **81** and arm **78***c* of bell crank lever **78** causing the bell crank lever to be rocked in a counterclockwise direction (Fig. 15) about its pivot **78***b* and moving the hammer **78***a* inwardly toward the needle cylinder of the machine. The cam **86** is so positioned on pattern drum **55**, as to actuate the hammer **78***a* shortly after the cutter and binder has been moved to its inner position. It will be seen from Fig. 1*a* that movement of the cutter and binder unit to its inner position brings the outwardly projecting end **67***d* of the movable blade **67** into alignment with the hammer **78***a* of the actuating mechanism. The inward movement of hammer **78***a* causes the blade **67** to be moved inwardly so that the inner end projects beyond the binder plate **66** and stationary blade **68**, exposing the downwardly opening hook portion **67***c* as indicated in dotted lines in Fig. 17. When the nose of the cam follower **85** rides off of cam **86**, the hammer **78***a* is withdrawn to the full line position of Fig. 17, and the movable blade **67** is retracted by spring **71** to cut and bind the thread as illustrated in Fig. 18. The cutter and binder unit is thereafter returned to its outer position, wholly outside the needle circle by the mechanism heretofore described.

The operation of the machine will be understood from the foregoing description of the structure, but will be briefly summarized. In threading up the machine the backing thread B will be threaded through the eye **28***a* of thread guide **28** (Fig. 2) and the face thread F will be threaded through the eye **35***b* of movable thread guide **35**. It will be understood that the threads are passed through their respective tension and take up devices which are adjusted to apply the desired tension to each thread. With the machine threaded in this manner, the thread guides **28** and **35** will cooperate to knit the two threads in uniform plating relation so that the thread F will always be at the front face of the fabric and the thread B will always be at the back face of the fabric, whether the machine is operated by continuous rotation in one direction or by reciprocation. Knitting circular seamless fabric, for example, the leg portion of a sock, the needle

cylinder is rotated continuously in a counterclockwise direction (Fig. 1). With the cylinder rotating in this direction, the movable thread guide **35** is moved to and held in the left hand feeding position illustrated in Figs. 3 and 4 by the pull of the face thread F so that the two threads F and B are presented to the needles in proper relation to one another for accurate plating.

Uniform plating is likewise produced by the machine of the present invention when the machine is operated by reciprocation. For example, in knitting a split foot sock, the needle cylinder is rotated alternately in opposite directions, and one set of needles constituting approximately one-half the needle circle is operated to receive and knit thread fed at one feeding station, while a second set of needles constituting the other half of the needle circle is operated to receive and knit thread fed at the other feeding station, one or more needles at each side of the cylinder being operated to take both threads to form a suture between the portion knit at one station and that knit at the other. Thus, thread may be fed to one set of needles by a feed finger **29** at the auxiliary feeding station to form the instep portion of a sock and two or more threads may be fed in plating relation to the other set of needles by a thread guide **28** and movable thread guide **35** at the main feeding station to form a plated sole. When the machine is operated in reciprocation, the movable thread guide **35** is in one operative position (Figs. 3 and 4) when the needle cylinder is rotating in a counterclockwise direction, and is in a different operative position (Figs. 5 and 6) when the needle cylinder is rotating in a clockwise direction, the thread guide being automatically shifted back and forth between the two feeding positions by the pull of the thread F upon each reversal of the direction of rotation of the needle cylinder, so that thread guides **28** and **35** are always in proper position with respect to one another to feed the threads B and F in correct plating relationship in each direction of rotation. As no mechanism is required to shift the movable thread guide **35** from one feeding position to the other, the shifting being effected automatically by the pull of the thread fed by the thread guide, an exceptionally simple and reliable construction is provided by the invention.

When it is desired to discontinue the feeding of the thread fed by thread guide **35**, the thread guide is swung to an inoperative position shown in dotted lines in Fig. 11, by movement of shaft **38***a* to the right (Figs. 9 and 11) by means of operating lever **43** and associated mechanism. The movement of thread guide **35** to inoperative position is timed to occur during rotation of the needle cylinder in a counterclockwise direction. At approximately the same time, the cutter and binder unit **58** is moved to its inner position (Fig. 1*a*) and the hammer **78***a* is thereupon actuated to move blade **67** of the cutter and binder inwardly to present the downwardly opening hook **67***c* for reception of the thread. It will be understood that with the needle cylinder rotating in a counterclockwise direction, the needles in passing through the knitting wave are drawn down by the knitting cams and are in a lowered position at a point adjacent the cutter and binder unit so as not to interfere with movement of said unit to its inner position. The path of travel of the tops of the needles is indicated by the broken line N in Fig. 16. Shortly after the thread guide **35** has been moved to inoperative position and the cutter and binder unit has been moved to its inner position, the lifting finger **57** is raised (Fig. 16) lifting the thread into the downwardly opening hook **67***c* of the movable cutter and binder blade **67**. The actuating hammer **78***a* is thereupon withdrawn allowing blade **67** to be retracted by spring **71**, thereby severing the thread and gripping the severed end between the blade **67** and binder plate **66**. The cutter and binder unit is then returned to its outer position.

When the feeding of thread F is to be resumed, the thread guide **35** is swung around to feeding position during rotation of the needle cylinder in a counterclockwise direction, and at approximately the same time, the cutter and binder unit is moved to its inner position, carrying the end of the thread to a point inside the needle circle and thereby causing the thread to be caught by the needle. As soon as the needles have caught the thread, they pull it out of the cutter and binder unit and said unit is thereupon returned to its outer position wholly outside the needle circle. It will be noted that when the needle cylinder is rotating in a clockwise direction, the needles pass the cutter and binder unit in a raised position (Fig. 6) and would strike the cutter and binder if it were in its inner position. However, before rotation of the needle cylinder in a clockwise direction occurs, the cutter and the binder unit is withdrawn to its outer position where it is entirely outside the needle circle and in no way interferes with the operation of the needles. The cutter and the binder mechanism in accordance with the present invention thus fully solves the problem of cutting and binding the thread, and subsequently presenting the thread to the needles without interfering with other mechanism or operations of the machine.

Where it is desired to plate the instep portion of a split foot sock, the movable thread guide **35** with the associated mechanism may be located at the auxiliary feeding station to feed a thread in plating relation with the thread fed by thread guide **29**, while if it is desired to plate both the sole and the instep duplicate thread guides may be provided both at the main feeding station and at the auxiliary feeding station. The invention is thus susceptible of application in the production of a wide variety of knitted articles where accurate and uniform plating is essential.

What we claim and desire to secure by Letters Patent is:

1. In a circular knitting machine having a needle cylinder rotatable alternately in opposite directions relative to a cam block for manipulating the needles to knit in each direction of rotation, the combination of two thread guides for feeding thread to the needles in plating relation, one of said guides remaining in the same position in both directions of rotation and the other being freely movable in both directions by the pull of the thread being fed, to present the threads in proper relation for uniform plating in each direction of rotation.

2. In a circular knitting machine having a needle cylinder rotatable alternately in opposite directions relative to a cam block for manipulating the needles to knit in each direction of rotation, the combination of two thread guides for feeding thread to the needles in plating relation, one of said guides remaining in the same position in both directions of rotation and the other

being pivotally mounted and freely swingable in both directions by the pull of the thread being fed, to shift the position of said second thread guide upon each reversal of the needle cylinder and present the threads in proper relation for uniform plating in each direction of rotation.

3. In a circular knitting machine having a needle cylinder rotatable alternately in opposite directions relative to a cam block for manipulating the needles to knit in each direction of rotation, the combination of two thread guides for feeding thread to the needles in plating relation, one of said guides remaining in the same position in both directions of rotation and the other being pivotally mounted to swing in a plane transverse to the axis of the needle cylinder and being freely swingable in both directions by the pull of the thread being fed to shift the position of said second thread guide upon each reversal of the needle cylinder and present the threads in proper relation for uniform plating in each direction of rotation.

4. In a circular knitting machine having a needle cylinder rotatable alternately in opposite directions relative to a cam block for manipulating the needles to knit in each direction of rotation, the combination with a thread guide for feeding thread to the needles with a second thread guide for feeding thread to the needles in plating relation with the first mentioned thread, said second thread guide being freely movable in both directions by the pull of the thread being fed to shift the position of said second thread guide with respect to the first mentioned guide upon each reversal of the needle cylinder and present the threads in proper relation for uniform plating in each direction of rotation, means being provided for limiting the extent of movement of said second thread guide by the pull of the thread fed thereby.

5. In a circular knitting machine having a needle cylinder rotatable alternately in opposite directions relative to a cam block for manipulating the needles to knit in each direction of rotation, the combination of two thread guides for feeding thread to the needles in plating relation, one of said guides remaining in the same position in both directions of rotation and the other being movable in both directions by the pull of the thread being fed to shift the relative positions of the two thread guides upon reversal of the direction of rotation, means being provided for adjustably limiting the extent of movement of the second thread guide to position said guide to present the thread in proper relation to the thread fed by the first mentioned thread guide for uniform plating in each direction of rotation.

6. In a circular knitting machine having a needle cylinder rotatable alternately in opposite directions relative to a cam block for manipulating the needles to knit in each direction of rotation, the combination with a thread guide for feeding thread to the needles of a second thread guide arranged to feed thread to the needles in plating relation with the first mentioned thread and movable in both directions by the pull of the thread fed thereby to shift said thread guide from one position to another upon reversal of the direction of rotation to present the threads to the needles in proper relation for uniform plating in each direction, and means for moving said second thread guide to an inoperative position to discontinue the feeding of said second thread.

7. In a circular knitting machine operable by reciprocation to knit in both directions of rotation, the combination with a thread guide for feeding thread to the needles, of a second thread guide located below the first mentioned thread guide and arranged to feed thread to the needles in plating relation with the first mentioned thread, said second thread guide being pivotally mounted and swingable in both directions by the pull of the thread fed thereby to shift the position of said second thread upon each reversal of the direction of rotation and abutments for limiting the extent the thread guide is swung by the pull of the thread to position the thread guide in proper relation to the first mentioned thread guide for uniform plating in each direction of rotation.

8. In a circular knitting machine having a needle cylinder rotatable alternately in opposite directions relative to a cam block for manipulating the needles to knit in each direction of rotation, the combination of two thread guides for feeding thread to the needles in plating relation, one of said guides remaining in the same position in both directions of rotation and the other being pivotally mounted and swingable in both directions by the pull of the thread fed thereby to shift the position of said second thread upon each reversal of the direction of rotation, means for limiting the swing of said thread guide to position it in proper relation to the first mentioned thread guide for uniform plating in each direction of rotation, and means for swinging said second thread guide to an inoperative position.

9. In a circular knitting machine having a needle cylinder rotatable alternately in opposite directions relative to a cam block for manipulating the needles to knit in each direction of rotation, the combination of two thread guides for feeding thread to the needles in plating relation, one of said guides remaining in the same position in both directions of rotation and the other being pivotally mounted and swingable in both directions by the pull of the thread fed thereby to shift the position of said second thread upon reversal of the direction of rotation, stops carried by a movable member for limiting the swing of said thread guide, and means for moving said member to swing said second thread guide to inoperative position.

10. In a circular knitting machine having a needle cylinder rotatable alternately in opposite directions relative to a cam block for manipulating the needles to knit in each direction of rotation, the combination of a thread guide carried by a latch ring and adapted to feed thread to the needles, a second thread guide pivotally mounted on the latch ring below the first mentioned thread guide and having one feeding position for feeding thread to the needles during relative rotation of the needle cylinder in one direction and a second feeding position for feeding thread to the needles during rotation in the opposite direction, said second thread guide being swingable from one feeding position to the other by the pull of the thread fed thereby to present said thread in proper relation for uniform plating with the thread fed by the first mentioned thread guide in both directions of rotation.

11. In a circular knitting machine having a needle cylinder rotatable alternately in opposite directions relative to a cam block for manipulating the needles to knit in each direction of rotation and a latch ring capable of being raised

and lowered, the combination of a thread guide carried by the latch ring and adapted to feed thread to the needles, a second thread guide pivotally mounted on the latch ring and having one feeding position for feeding thread to the needles during relative rotation of the needle cylinder in one direction and a second feeding position for feeding thread to the needles during rotation in the opposite direction, said second thread guide being swingable from one position to the other by the pull of the thread fed thereby, and means for moving said second thread guide to an inoperative position, said means being disconnected from said thread guide when the latch ring is raised.

12. In a circular knitting machine having a needle cylinder rotatable alternately in opposite directions relative to a cam block for manipulating the needles to knit in each direction of rotation and a latch ring capable of being raised and lowered, the combination of two thread guides carried by the latch ring and adapted to feed thread to the needles in plating relation, one of said thread guides being pivotally mounted and swingable from a feeding position for feeding thread to the needles during relative rotation of the needle cylinder in one direction to a second feeding position for feeding thread to the needles during rotation in the opposite direction, said thread guide being swung from one feeding position to the other by the pull of the thread fed thereby, means for swinging the thread guide to an inoperative position in which the thread is not fed to the needles, said means being disconnected from the thread guide when the latch ring is raised, and a catch carried by the latch ring for holding said thread guide in inoperative position when the latch ring is raised and releasing the thread guide when the latch ring is lowered to operative position.

13. In a circular knitting machine having a needle cylinder rotatable alternately in opposite directions relative to a cam block for manipulating the needles to knit in each direction of rotation, the combination of two thread guides for feeding thread to the needles in plating relation, one of said guides being located below the other and movable in both directions by the pull of the thread being fed to position the thread in proper relation to the thread fed by the other thread guide for uniform plating in each direction of rotation, means for moving the first mentioned thread guide in a horizontal plane to inoperative position, a cutter and binder unit mounted on the machine outside the needle circle and movable into a position in which it projects inside the needle circle to cut and bind the thread fed by said first mentioned thread guide.

14. In a circular knitting machine operable by reciprocation and having a thread guide for feeding thread to the needles and means for moving said thread guide to an inoperative position, a cutter and binder unit mounted on the machine outside the needle circle, means for moving said unit to a position in which it projects inside the needle circle, operating said unit to trap and sever the thread and thereupon returning the said unit to a position outside the needle circle while holding the thread that has been trapped each time the thread guide is moved to inoperative position.

15. In a circular knitting machine having a thread guide for feeding thread to the needles and means for moving said thread guide to an inoperative position to discontinue the feed of thread, the combination of a cutter and binder unit mounted on the machine outside the needle circle and movable to an inner position in which it projects inside the needle circle, a finger located between said thread guide and cutter and binder unit for lifting said thread into position to be engaged by the cutter and binder unit when in its inner position and means for operating the cutter and binder unit to trap and sever said thread.

16. In a circular knitting machine having a thread guide for feeding thread to the needles and means for moving said thread guide to an inoperative position to discontinue the feed of thread, the combination of a cutter and binder unit mounted on the machine outside the needle circle and having a stationary blade and a movable blade with a downwardly opening hook, means for moving said unit to an inner position in which at least the hook portion of the movable blade projects inside the needle circle, and subsequently returning said unit to a position wholly outside the needle circle, means for lifting said thread into the hook of said movable blade when the cutter and binder unit is in its inner position and means for actuating said movable blade to sever and trap said thread.

17. In a circular knitting machine having a thread guide for feeding thread to the needles and means for moving said thread guide to an inoperative position to discontinue the feed of thread, the combination of a cutter and binder unit mounted on the machine outside the needle circle and operating mechanism for moving said unit to an inner position in which it projects inside the needle circle, actuating said unit to trap and sever said thread upon movement of the thread guide to inoperative position, returning said unit to an outer position wholly outside the needle circle while holding the thread that has been trapped, again moving the said unit to its inner position to present the thread to the needles to resume feeding of the thread and thereupon restoring said unit to its outer position.

18. In a circular knitting machine having a needle cylinder rotatable alternately in opposite directions relative to a cam block for manipulating the needles to knit in each direction of rotation, the combination of a thread guide for feeding a body thread in the same position in both directions of rotation and another thread guide for feeding a plating thread below the first mentioned thread guide, said second thread guide being freely movable in both directions by the pull of the thread being fed to shift the position of said second thread guide with respect to the first mentioned thread guide upon each reversal of the needle cylinder and present the threads in proper relation for uniform plating in each direction of rotation.

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