March 12, 1963 A. B. EAKER 3,080,739

MEANS FOR AND METHOD OF ATTACHING YARN ENDS IN TUBULAR FABRICS

Filed May 15, 1958 4 Sheets-Sheet 1

Fig. 1

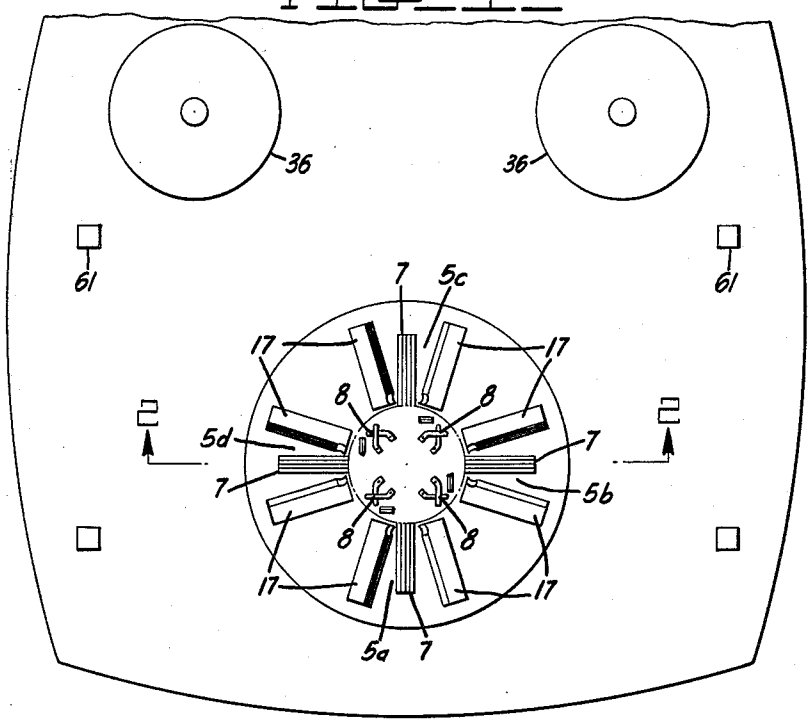
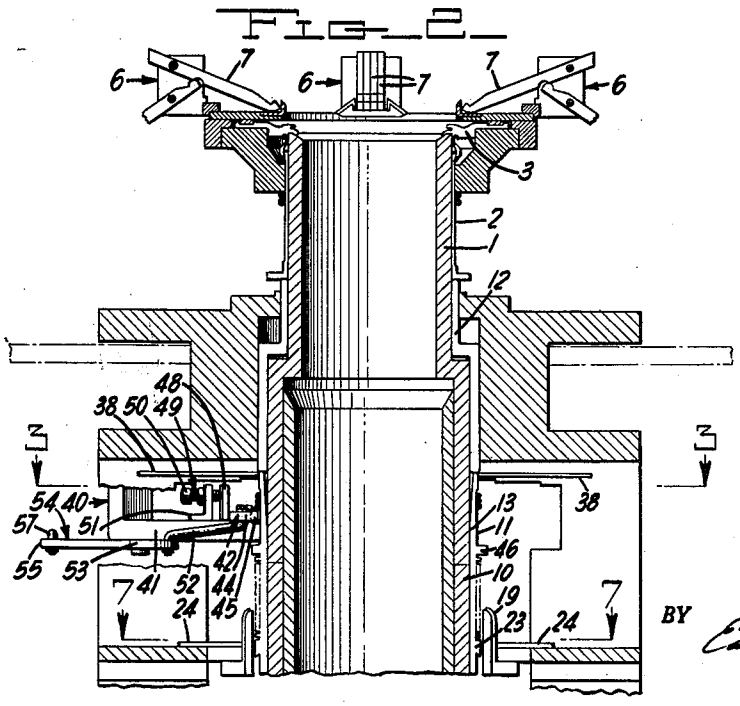


Fig. 2



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FIG. 3

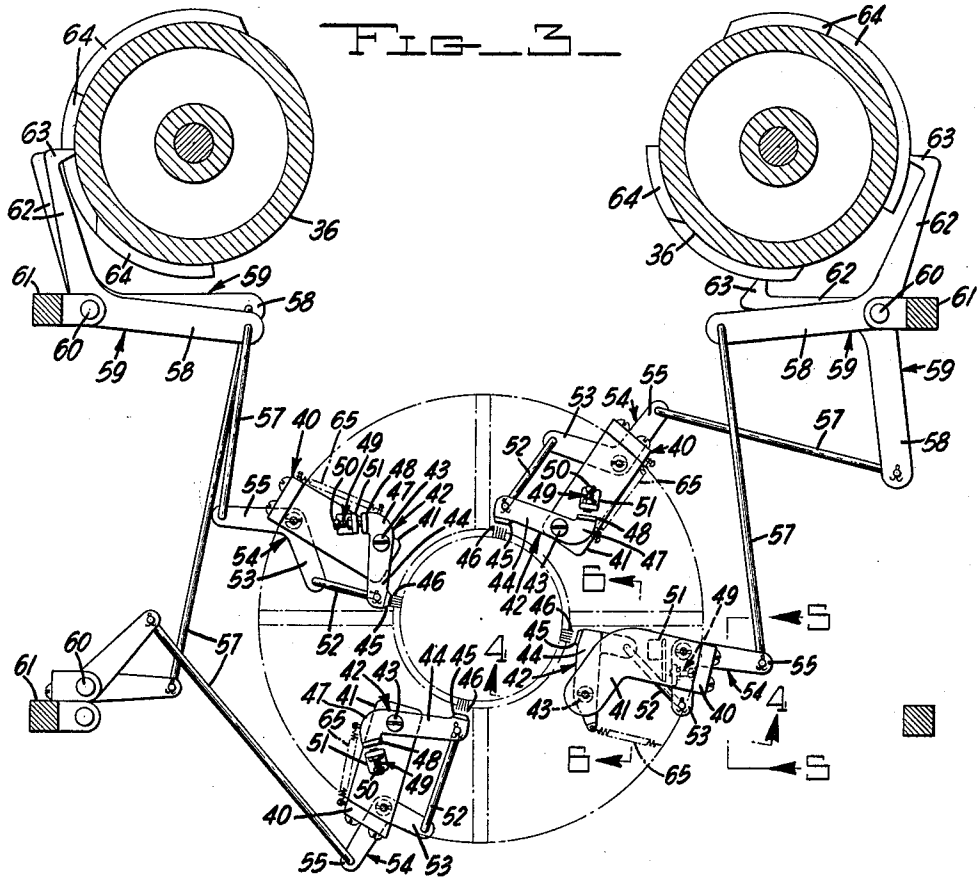
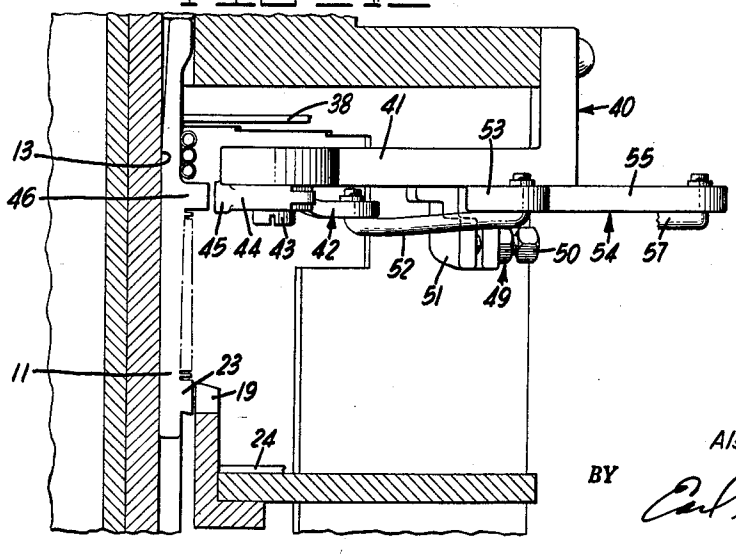


FIG. 4



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Fig. 7.

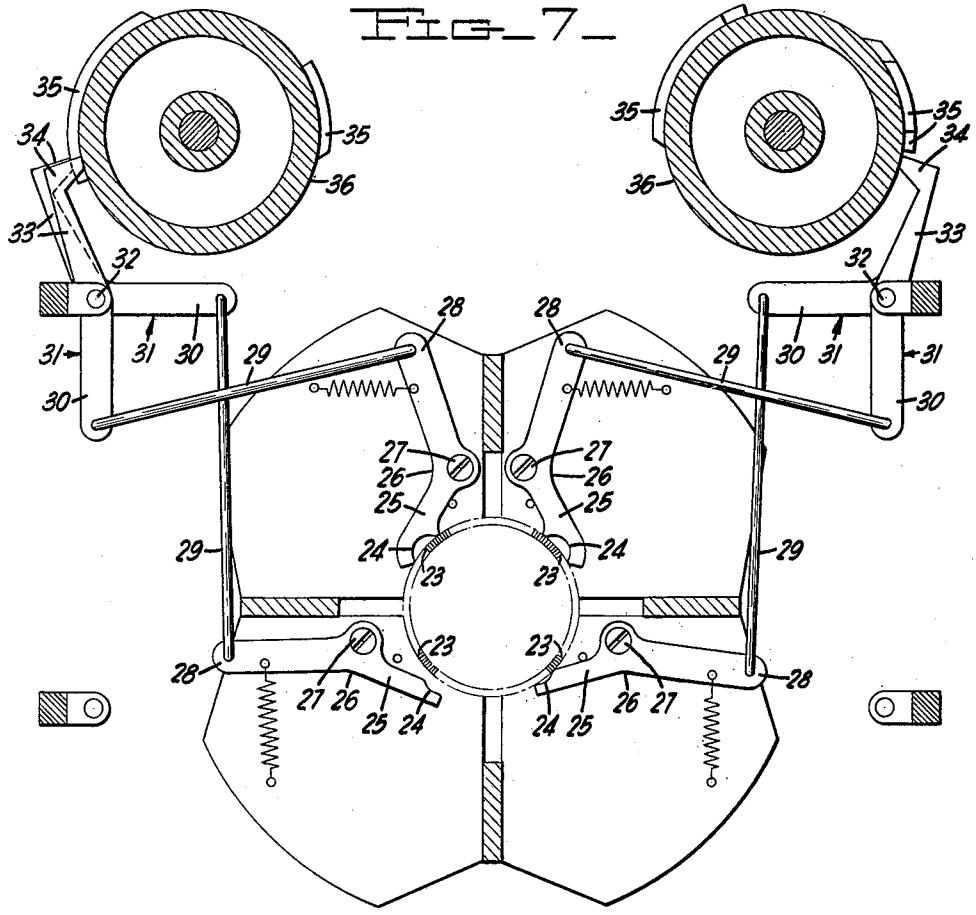


Fig. 5.

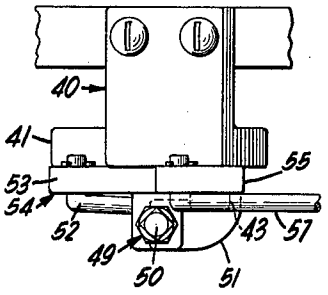
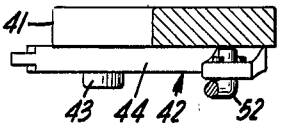


Fig. 6.



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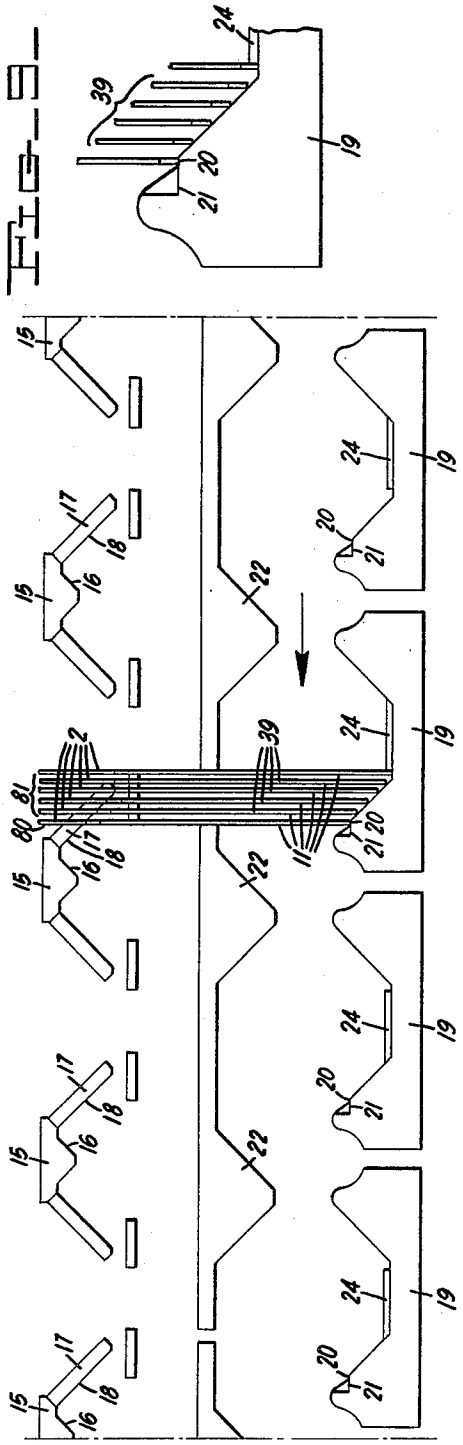
BY Earl H. Olson

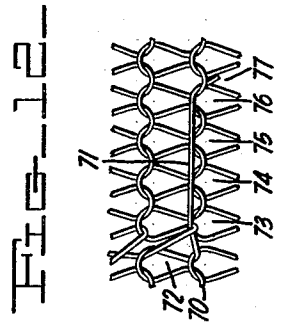
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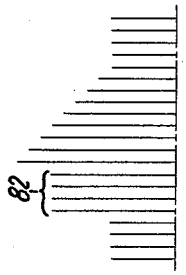
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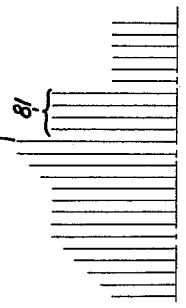
MEANS FOR AND METHOD OF ATTACHING YARN ENDS IN TUBULAR FABRICS

Filed May 15, 1958 4 Sheets-Sheet 4









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3,080,739

MEANS FOR AND METHOD OF ATTACHING YARN ENDS IN TUBULAR FABRICS

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Filed May 15, 1958, Ser. No. 735,501
9 Claims. (Cl. 66—42)

This invention relates to improvements in circular knitting machines having a plurality of feeding stations for knitting multi-feed fabrics in circular motion and more particularly to means for controlling the operation of such machines to tie in yarn ends when a knitting station is placed in or taken out of operation.

In such machines the circle of needles moves through a knitting wave at each knitting station. Yarn feeding means are provided opposite each knitting station such yarn feeding means including one or more yarn feeders movable between active and inactive positions to position a yarn to be taken by the needles or to remove it therefrom, respectively, yarns so removed from action being severed and the end extending from the feeder held by clamping means. In a case where one yarn is substituted for another at a feeding station the ingoing and outgoing yarns are usually overlapped on a few of the needles to prevent the free end of the severed yarn from pulling out of the fabric. Where however a machine is knitting multi-feed and a knitting station is taken out of action with knitting continuing at one or more of the other stations the free end of the yarn extends loosely from the last loop formed at the intermediate station. When tension is applied to the fabric, as usually occurs in use, the free end will partially withdraw thereby permitting stretching or enlargement of the last or last few loops creating an undesirable opening in the fabric. A similar defect occurs when a previously inactivated knitting station is put into action in the course of the knitting operation.

The principal object of the invention is the provision of means for and a method of operating a circular knitting machine in the production of multi-feed fabric for overcoming the above and other difficulties.

Another object of the invention is the provision of means for and a method of operating a knitting machine in multi-feed rotary knitting to secure the free end of a yarn moved into or out of knitting action by interlocking said free end with a yarn knitted at an adjacent feed.

A still further object of the invention is the provision of a multi-feed knitting machine as defined above including means for controlling the needles at a feed to be inactivated to cause the free end of the yarn removed from knitting action to be caught into the fabric at a point spaced at least one needle wale from the last loop formed at the inactive feed.

A still further object of the invention is the provision of means in a multi-feed knitting machine as defined above including means for controlling the operation of the needles at a feed to be activated or inactivated whereby the first or last needle, respectively, operating at that feed takes yarn but does not knit the same, said one needle taking and knitting yarn at a subsequent feed.

With these and other objects in view, which will become apparent from the following detailed description of the illustrative and practical embodiment of the invention shown in the accompanying drawings, the invention comprises the novel elements, features of construction and combination of parts in cooperative relationship as hereinafter more particularly pointed out in the claims.

In the drawings:

FIG. 1 is a diagrammatic top plan view of a multi-feed knitting machine with the mechanism of the instant invention incorporated therein;

FIG. 2 is a sectional view on an enlarged scale taken on the line 2—2 of FIG. 1;

FIG. 3 is a sectional view taken substantially on the line 3—3 of FIG. 2;

FIG. 4 is a sectional view on a further enlarged scale taken on the line 4—4 of FIG. 3;

FIG. 5 is a detail view on an enlarged scale taken on the line 5—5 of FIG. 3;

FIG. 6 is a detail view on an enlarged scale taken on the line 6—6 of FIG. 3;

FIG. 7 is a sectional view on an enlarged scale taken on line 7—7 of FIG. 2;

FIG. 8 is a developed view of the jack and needle cam structure of the machine of FIGS. 1 and 2;

FIG. 9 is an enlarged view of one of the jack raising cams of FIG. 8;

FIG. 10 is a diagrammatic view illustrating the movements of needles through a cycle at a knitting station when a knitting station is taken out of action;

FIG. 11 is a view similar to FIG. 10 diagrammatically illustrating the movements of the needles when a knitting station is put into action; and

FIG. 12 is a diagrammatic illustration of the loop formation, as viewed looking outwardly from the interior of the needle cylinder of machine of FIG. 1, of a piece of knitted fabric illustrating the mode of tying in a yarn end.

Referring now to the drawings and more particularly to FIGS. 1 and 2 there is shown a multi-feed circular knitting machine of the type disclosed in British Patent 790,141, published February 5, 1958 hereinafter referred to as the Coile disclosure. While, as will be apparent, the instant invention may be incorporated in multi-feed machines of different types the machine of the Coile disclosure has been selected for purposes of illustration and reference may be made thereto for details of the machine construction and operation not specifically described herein. The machine includes a rotatable needle cylinder 1 having the usual slots therein for receiving a circle of independently operated latch needles 2, the needles cooperating with sinkers 3 for forming courses of knitted fabric at each of a plurality of knitting stations indicated generally at 5*a* to 5*d*. While four knitting stations are shown it will be understood that a greater or lesser number may be employed.

Supported adjacent each of the knitting stations are yarn feeding means 6 each suitably including a plurality of yarn guides 7. Each yarn guide is movable between a lowered position in which it feeds yarn to the needles selected to knit at such knitting station, and an upper inoperative position. Also associated with the yarn feeding means 6 at each knitting station is a yarn cutting and trapping or clamping means illustrated diagrammatically at 8 in FIG. 1 which is mounted in a fixed position centrally of the needle cylinder.

In the machine selected for illustration there is provided one or more jack cylinders 10 in alignment and rotatable with needle cylinder 1, the jack cylinders carrying master jacks 11 and pattern jacks (not shown) adapted for vertical movement in slots in the jack cylinder. A master jack is provided for each needle and between the upper ends of the master jacks and the lower ends of needles 2 lifters 12 are provided for transferring raising movements of the jacks to the needles 2. The movement of the needles through yarn taking and knitting waves at each of the knitting stations, is caused by needle and jack cam assemblies illustrated more particularly in FIGS. 8 and 9, the cam assemblies being carried by portions of the machine fixed relatively to the needle and jack cylinders as

is usual. In the construction illustrated the assemblies are arranged to move the needles through knitting waves in both directions of rotation of the needle cylinder whereby the machine is adapted for both rotary and reciprocatory operation. However, inasmuch as the instant invention is directed to improvements in rotary or round and round knitting, the cams which manipulate the needles and jacks in only one direction of movement of the needle cylinder, namely, that illustrated by the arrow, need be considered and will be specifically referred to.

Each needle cam assembly includes a center cam **15** having cam face **16**, and a stitch cam **17** having a cam face **18**. At the master jack level illustrated there is provided a jack raising cam **19**. In accordance with the instant invention the cam **19** is modified from that shown in the Coile disclosure in that it is formed with two face portions separated by a substantially horizontal flat **20** at the level of a lateral camming portion **21** for purposes hereinafter to be described. Jack raising cam **19** is of a height to raise the needles **2** to the latch clearing level at which fabric loops of a previous course held thereby are moved below the needle latches. Flat **20** is so located on cam **19** that as butts **23** of the jacks **11** reach the height thereof the needles are raised to a yarn taking but not latch clearing level. The jack cam assemblies also include jack lowering or resetting cams **22** adapted to return the jacks to their original lowered positions.

As illustrated in FIGS. 2, 4 and 8 jacks **11** are of a type to rock about a fulcrum **13** between a position in which their lower ends are swung outwardly to cause their butts **23** to ride up cams **19** and a position in which the butts ride behind the cams and are not raised thereby. In order to inactivate a knitting station and maintain it inactive for the desired period, pattern controlled means are provided to hold the jacks in the latter positions at the proper times. Such means include (see FIGS. 2, 7 and 8) guard cams **24** between the several knitting stations each comprising preferably a double lobe to be operative in both directions of movement of the cylinder, the lobes forming one end of an arm **25** of a lever **26** pivoted for swinging movement on a pin **27**. The other arm **28** of lever **26** is connected through a link **29** to an arm **30** of a lever **31**. Lever **31** is pivoted as at **32** and includes a second arm **33** having a follower **34** adapted to ride on one or more cams **35** carried by one of two main pattern drums **36** whereby guard cams **24** may be moved into and out of operative position under control of the pattern drum. The jacks are rocked in the other direction when permitted to do so by withdrawal of the guard cam to move the butts **23** into position to ride upon on the cams **19** through the medium of presser cams portions of which are shown at **38** (see FIG. 2) the presser cams being supported for swinging movement into and out of contact with the upper ends of the jacks at points between the knitting stations and under pattern control. The presser cams and their operating structure are not shown in detail herein but reference may be made to the said Coile disclosure for such details. It may be said however that such cams and their operating mechanism substantially duplicate the guard cams and their operating mechanisms, the timing of the operation of the presser cams being determined by the proper positioning of cams on a pattern drum **36**. As illustrated in FIG. 7 the control of both the guard and presser cams is preferably distributed between the two main pattern drums **36**.

In addition to the jack selecting devices described above the Coile disclosure provides means at each of the jack levels to select the jacks of individual needles to knit at a knitting station. However in the rotary operation of the machine with which the instant invention is concerned such jack selection is not required and any detailed description thereof will be omitted.

In the operation of the machine described above for multi-feed circular knitting the guard and presser cams located in advance of each active knitting station are shifted, under the control of one or the other of the pattern drums **36**, into inoperative and operative positions, respectively, whereby the jacks are moved to engage and ride up their respective cams **19** at such knitting station and raise their associated needles to latch clearing height to position the previously formed loops below the latches, the jacks then being returned to their lowered positions by the resetting cams **22**. The needles then proceed through the remainder of their knitting wave under the control of center cam **15** and stitch cam **17** the needles taking yarn from an activated yarn guide at each such station and forming it into a course of stitches.

From time to time in the formation of the fabric it may be desirable to reduce the number of knitting stations in operation or, if less than all of the knitting stations are in operation, to increase the number. Considering, for example, the case where a knitting station is to be removed from operation, at the proper time and under the control of the pattern drum, the presser cam **38** associated with such station is withdrawn from operative position and the guard cam is moved into operative position whereby the lower ends of the jacks are moved inwardly to pass behind raising cam **19** and the needles no longer are raised to take and knit yarn at the station. At the same time the yarn guide which has been in an active yarn feeding position is raised and, as the cylinder continues to rotate, the yarn extending between the last formed stitch and yarn guide is carried into the clamp of the clamp and cutter device **8** and the cutter is operated to sever the yarn between the clamp and the fabric, the loose end of the yarn then being connected to the fabric at the interior thereof. If an inoperative knitting station is to be placed into operation a similar series of events takes place but in reverse order, namely, the guard cam is withdrawn and the presser cam moved into operative position to cause the jacks **11** to ride up the raising cam and at the same time a yarn feed finger, which has been in inoperative position with the end of the yarn fed thereby held by the clamp, is lowered into operation. Thereafter the needles take and knit the yarn into a course of loops and as the cylinder continues to rotate, the yarn end is pulled out of the clamp and is carried with the fabric.

The instant invention now to be described provides a means and method of tying or locking in the loose yarn extending from the last knitted loop of a course in the case of a knitting station going out of operation or from the first knitted loop of a course in the case of a knitting station being placed into operation. For this purpose means are provided (see FIGS. 3, 4, 5 and 6) for causing a terminal group of the needles, preferably between two and four needles, to rise at such station to take yarn without knitting the same, said group of needles however taking and knitting yarn at the next operative knitting station.

Referring now particularly to FIGS. 3 to 6 and 8 to 10, a mechanism is illustrated adjacent each feeding station for controlling the extent of upward movement of a terminal group of jacks, indicated generally at **39** in FIGS. 8 and 9, and the needles associated therewith. While the mechanims differ to some extent at the different stations in order to accommodate certain physical features of the machine they are the same in all essentials. For the present purposes, it will be assumed that knitting station **5*d*** is to be inactivated and the mechanism associated with this station will be specifically described. Mounted on a fixed part of the machine adjacent the knitting station is a bracket **40** having an inwardly extending arm **41**. A lever **42** is mounted for pivotal movement on the arm **41** by stud **43**, an arm **44** of the lever carrying a lobe **45** adapted to contact butts **46**, positioned below the fulcrums of the master jacks **11**, when the lever is swung in a counterclockwise direction as viewed in FIG. 3. A second arm **47** of lever **42** has an abutment surface **48** adapted to contact an adjustable stop **49** suitably comprising a stud **50** threaded through an ear **51** carried by bracket arm **41**.

Lever 42 is urged to rotate about stud 43 in a direction to bring the abutment surface against the stop by a tension spring 65 having its ends fastened to the arm 47 and bracket 40. Arm 44 of lever 42 is connected by a link 52 to one arm 53 of a bell crank 54 the other arm 55 of which is connected by a link 57 to an arm 58 of a bell crank 59 pivoted at 60 on a post 61. A second arm 62 of bell crank 59 is provided with a follower or node 63 adapted to ride on and off a cam 64 on a main cam drum 36. Normally the node 63 is in engagement with a cam 64 to maintain the lever 42 in inactive position and the lever 42 is moved to active position when the node drops off of the cam.

Raising cam 19 is as previously described preferably provided with flat 20 adjacent camming surface 21, the flat being located at a point in the rise of the jack at which the needle is at a height where it will take yarn but not be at latch clearing height.

In the operation of the mechanism of the instant invention when a knitting station, station 5*d* being used for purposes of illustration, is to be removed from action the pattern drum 36 is racked to cause the associated presser cam 38 and guard cam 24 to move out of and into operative positions, respectively, so that jacks passing the guard cam thereafter will miss lifting cam 19. This operation may be timed by proper positioning of cams 35 on drum 36 to define a particular point in the circle of needles at which knitting stops. During the same movement of the pattern drum a cam 64 is moved from beneath bellcrank 59 and the spring 65 acts to swing lever 42 and bring node or lobe 45 into contact with butts 46 of the jacks of the terminal group 39 as they reach flat 20 of the jack raising cam 19 whereby these jacks are forced off the raising cam, this movement of the jacks being aided by the camming surface 21 and this action terminating the upward movement of terminal needles indicated at 81 in FIG. 10. The yarn guide also under pattern control, is raised to its inoperative position after it has fed yarn to the last needle of the terminal group, the yarn trailing from the guide as the cylinder continues to turn being carried around the terminal needle to the interior of the cylinder where it is clamped and cut. Inasmuch as the group of terminal needles are raised only to yarn taking height by their jacks the yarn taken by these needles is not knit but lies along the terminal needles and passes around the last one thereof to the interior of the cylinder. As the terminal needles reach the next active feeding and knitting station they are carried through the knitting cycle and the yarn end which passed around the last one thereof is caught or locked into the fabric by the loops formed at the active feeding station.

The fabric obtained by the above described operation is illustrated in FIG. 12. In said figure the rear or inside face of the fabric is viewed. As there shown yarn 70 which has been knitted at knitting station 5*d* now being taken out of action, forms its last knitted loop 72 on a needle 80 (FIGS. 8 and 10) which is the last needle to be raised to latch clearing level at said station, the trailing end 71 thereof lying behind the loops 73, 74, 75 and 76 of yarn knitted on the needles associated with the terminal group of jacks 39 at the next active knitting station then passing through a following sinker loop 77 to the interior of the fabric whereby the trailing end is caught into the fabric. It is immaterial whether one or more than one knitting station is taken out of operation as long as one station remains in operation. In the particular setup shown in FIG. 3 the mechanism is controlled so that the group of terminal needles at three stations will be removed from operation, the knitting of such groups of needles all taking place at the remaining station.

As will be apparent, the mechanism of the invention operates on the same principle when an inoperative station is placed in operation. In this case the mechanism is timed so that the first two to four of the forward terminal group of needles indicated diagrammatically at 82 (FIG. 11) are raised only to yarn taking height.

Having thus described my invention in rather full detail it will be understood that these details need not be strictly adhered to but that various changes and modifications may be made all within the scope of the invention as defined by the following claims.

I claim:

1. In a circular knitting machine comprising a needle cylinder and a circle of independent needles carried thereby, jacks associated with said needles, a plurality of knitting station including yarn feeding means, means adjacent each knitting station for lifting said jacks and the needles associated therewith, means adjacent each knitting station for selecting jacks to be lifted by said lifting means, means for causing a trailing terminal group of jacks selected at a knitting station to be disconnected from said lifting means when the associated needles have risen to a height to take a yarn but not to knit, means to provide a loose end of said yarn extending around an end one of said associated needles to the interior of said needle circle, and means to cause said group of jacks to raise their associated needles to knitting height at a subsequent knitting station.

2. In a circular knitting machine comprising a needle cylinder and independent needles carried thereby, butted jacks associated with said needles, a plurality of knitting stations including yarn feeding means, jack raising cams at each of said knitting stations having inclined cam faces for operation on the butts of said jacks, means adjacent a knitting station for selecting jacks to be raised by the raising cam at such station, and means for causing the butts of a trailing terminal group of jacks selected at such knitting station to be removed from the raising cam face at a point intermediate the ends thereof.

3. In a multi-feed circular knitting machine comprising a needle cylinder and independent needles carried thereby, butted jacks associated with said needles, a plurality of knitting stations including yarn feeding means, jack raising cams at each of said knitting stations having inclined cam faces for operation on the butts of said jacks, the cam face of said raising cam at a knitting station having a flat intermediate its ends, means adjacent such knitting station for selecting jacks to be raised by the raising cam and means for causing the butts of a trailing terminal group of the jacks selected for such knitting station to be removed from the cam face when they reach said flat.

4. A knitting machine as defined by claim 2 having pattern controlled means independent of said jack selecting means for operating said means for causing the butts of a terminal group of jacks to be removed from the cam face.

5. In a multi-feed circular knitting machine comprising a needle cylinder and independent needles carried thereby, butted rocking jacks associated with said needles, a plurality of kniting stations including yarn feeding means, jack raising cams at each of said knitting stations having inclined cam faces for operation on the butts of said jacks when said jacks are rocked outwardly, means adjacent a knitting station for selecting jacks to be raised by the raising cam at said station, said selecting means including means for outwardly rocking the butts of the selected jacks, and pattern controlled means independent of said jack selecting means for inwardly rocking the butts of a terminal group of such selected jacks off of the jack raising cam face at a point intermediate its ends.

6. A knitting machine as defined in claim 5 having said means for inwardly rocking the butts of a terminal group of selected jacks at each of a plurality of said knitting stations.

7. A knitting machine as defined in claim 5 in which the last named means comprises an arm mounted for swinging movement between a position in which it rocks

said jacks to remove the butts thereof from said raising cam and a position removed therefrom, and means for moving said arm between said two positions.

8. In a multi-feed circular knitting machine comprising a needle cylinder and independent needles carried thereby, butted rocking jacks associated with said needles, a plurality of knitting stations including yarn feeding means, jack raising cams at each of said knitting stations having inclined cam faces for operation on butts of the jacks when the jacks are rocked outwardly, means adjacent each of said knitting stations for selecting jacks to be raised by the raising cam at such knitting station, said selecting means including means for outwardly rocking the butts of said selected jacks, means independent of said jack selecting means for inwardly rocking the butts of a terminal group of the jacks selected for a knitting station when they have travelled part way of said inclined cam face, said last named means comprising an arm mounted for swinging movement, a contact element carried by said arm, and pattern controlled means for moving said arm between a position in which said contact element presses against said jacks and a position in which it is removed therefrom.

9. In the operation of a circular knitting machine comprising a circle of needles, butted jacks associated with the needles and a plurality of knitting stations including yarn feeding means shiftable into and out of yarn feeding positions, and jack raising cams at each of said knitting stations for operation on the butts of said jacks and means for selecting the jacks to be raised by said cams, the method of removing a knitting station from operation comprising withdrawing the jack selecting means at such knitting station, removing the butts of a terminal group of selected jacks from the jack raising cam when their associated needles have reached a yarn taking but not latch clearing level at such station, causing said associated needles to take a yarn without knitting at said station, severing said yarn to form a loose end extending around the end one of said associated needles to the interior of said needle circle, and feeding yarn to and knitting it by the needles associated with said terminal group of jacks at a subsequent knitting station.

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