CIRCULAR KNITTING MACHINE
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ABSTRACT OF THE DISCLOSURE
A circular knitting machine having a machine housing supporting thereon a stationary needle cylinder and dial disk, the needle cylinder and dial disk having needles over only a portion of their respective circumferences. Driveable cam rings rotating in the same direction around the needle cylinder and the dial disk actuate the needles mounted thereon. One of the driveable cam rings carries knitting units thereon, which units consist of a yarn guide and a clamping means. The yarn fed through the yarn guide is cut by stationary cutting means as it enters the needle-free sector, the cut end of the yarn being held by the clamp means as it travels throughout the needle-free sector. Upon leaving the needle-free sector, the clamp means is released whereby the yarn is again fed through the needles for knitting thereof.

This application is a continuation-in-part of my copending application Ser. No. 368,907, filed May 20, 1964, and entitled, “Round Knitting Machine,” now abandoned.

FIELD OF THE INVENTION
This invention is concerned with a circular knitting machine for the production of sheet goods. Said invention comprises a machine housing which supports a fixed carrying ring which in turn supports a needle cylinder, and a likewise fixed plate which supports a dial disk, said needle cylinder and dial disk being equipped with needles over only a portion of their respective circumferences, and with driveable cam rings rotating around the needle cylinder and the dial disk for actuating the needles and the yarn guides.

DESCRIPTION OF THE PRIOR ART
Sheet goods are presently produced largely with flat knitting machines. The efficiency of such machines, however, is limited because of the reciprocating movements of the parts and also because much dead space is necessary at the two needle board ends if several groups are employed for knitting.

For this reason sheet goods have previously been produced on known circular knitting machines having cam rings or needle boards rotating in the same direction. The tubular goods thus produced are then cut open lengthwise, resulting in a product whose width always corresponds to the circumference of the circular knitting machine. However, when the goods are cut to the desired size, considerable losses may be incurred.

Also known is a machine which is a cross between a round and a flat knitting machine wherein two flat knitting machines are joined to each other along their long sides. The needles of these machines are activated by a group of cams which run continuously around a closed track which, within the area of the flat knitting machines, consists of straightways running in opposite directions and of arcs connecting these straightways. Such a machine, however, is not as efficient as a circular knitting machine of comparable structural complexity because only about one-half of the large circumference of the cam track is constructed as a needle board. The long actuator track cannot be fully equipped with actuations immediately following each other because the structural complexity would be too great.

A circular knitting machine is also known wherein two oppositely located sectors of the machine circumference are free of needles. The cylinder ring and the cam ring are each divided into two rings rotating in opposite directions. The yarn guides are movably located on a circular track supported by side supports above the dial disk. Each of the two rings forming the cylinder cam ring carries one arm for the moving of the yarn guides. The latter are moved by the arm of one of the rings in one direction over one of the needle-equipped sectors and, at the end of this sector, are returned by the arm of the oppositely rotating ring. This means that the yarn guides move back and forth over the appropriate needle-equipped sector.

Because of the necessity of driving counter-rotating cam rings, the drive arrangement is very complicated. Both cam rings must be driven separately from outside of the machine housing. A driving of one of the rings by drive means from the other ring is impossible because of the yarn guiding means.

The construction of the machine is also complicated by the location of the yarn guides, which is separate from that of the cams, and by the parts regulating the back and forth movement. The efficiency, as in the case of flat knitting machines, is thus limited by parts moving back and forth. In addition, there is a very unfavorable relationship between the size of the needle-equipped and the needle-free sectors. The more knitting units are arranged behind each other for the purpose of increased efficiency, the larger must be the needle-free sectors in order to hold the yarn guides and to make a crossing of the cams possible. This again results in a reduction of efficiency. Also, it is always necessary to process two knitting of limited width. To achieve knittings of a width sufficient for outer wear, such a machine would have to be of a very large size, with the result that the relation between construction difficulties and efficiency would be very unfavorable. This kind of machine is thus not practical.

Finally, a circular knitting machine for the production of flat goods is known wherein the needle-bearing needle cylinder and dial disk rotate but the cams do not move and one sector of the needle cylinder and of the dial disk is free of needles. Circular knitting machines of this type having rotating needle bearing members cannot be simply constructed. Since a rotating device for the holding of goods must be present in the interior of the machine housing, the driving cannot be done from the interior of the housing. Likewise the dial disk cannot be supported from below. The necessity for driving the cylinder and the dial disk from the outside of the housing and for supporting the dial disk from the above makes a complicated and expensive construction necessary. An additional complication in this machine arises from the fact that the fixed cams with the appertaining cutting and clamping devices are distributed over the machine circumference which requires a complicated drive and guide system for the yarns. Lastly, machines with revolving needles always have the great disadvantage that a high capacity and therefore expensive and space-consuming drive gear system must be used.

SUMMARY OF THE INVENTION
The present invention consists of constructing a circular knitting machine of the kind defined above in such a manner that, with the simplest possible machine construction, sheet goods of adjustable width can be pro-
duced while maintaining the efficiency of a circular knitting machine. This invention solves this problem by the following combination of features already known in themselves:

(a) One single needle-free sector on the needle cylinder and on the dial disk.
(b) Cam rings driveable exclusively in the same direction.
(c) Yarn guides connected with the cams.
(d) At least one cutting device for the cutting of the yarns in the area of the needle-free sector.

The above features permit a very simple construction of the single needle-free sector of the present invention. Since tubular open goods are produced on nonrotating mechanisms, the driving device can be housed in the interior of the machine housing. It is also possible to support the dial disk support plate from below in such a manner that the usually necessary support construction of the machine can be omitted and the carrying ring and plate can be firmly connected with each other from below. Since parts rotating in only one direction are present, the drive is uncomplicated. A machine drive system including only one gear set is sufficient and this set need not be of high capacity. Further, only one controlling cam can be driven since the other cam ring can be driven by means of a simple connecting arrangement from the driven cam ring. Furthermore, by means of a single control head mounted on the needle-free sector, it is possible to effect all required control functions in the rotating parts of the machine. Also, the efficiency of the machine is similar to that of ordinary round knitting machines since there are no parts moving back and forth and a very close sequence of cams is possible. The width of the knitting can also be adjusted to the desired size so that losses are avoided.

**BRIEF DESCRIPTION OF THE DRAWINGS**

The drawings show a preferred embodiment of the invention. In the drawings:

FIG. 1 is a central cross-sectional view of a circular knitting machine embodying the invention substantially taken on the line I—I of FIG. 2. For the purpose of clarity parts not belonging to the invention are omitted. FIG. 2 is a top view of the machine according to FIG. 1 with the spool holder omitted for increased clarity.

FIG. 3 is a fragmentary sectional view taken on the line III—III of FIG. 1.

FIG. 4 is a fragmentary sectional view made on the line IV—IV of FIG. 1.

FIG. 5 is an enlarged fragmentary side view, partially broken away, of the circular knitting machine of FIG. 1.

FIG. 6 is a fragmentary sectional view made on the line VI—VI of FIG. 5.

FIG. 7 is a fragmentary sectional view made on the line VII—VII of FIG. 5.

FIG. 8 is a side view of the slide member used in the yarn guide and clamping mechanism.

FIG. 8A is a rear view of the slide member illustrated in FIG. 8.

FIG. 9 is a fragmentary sectional view made on the line IX—IX of FIG. 5.

FIG. 10 is a fragmentary sectional view made on the line X—X of FIG. 5.

FIG. 11 is a fragmentary sectional view made on the line XI—XI of FIG. 5.

FIG. 12 is an oblique fragmentary view of the tensioning mechanism taken in the direction of arrow XII of FIG. 13.

FIG. 13 is a fragmentary sectional view made on the line XIII—XIII of FIG. 12.

FIG. 14 is a fragmentary sectional view made on the line XIV—XIV of FIG. 13.

Certain terminology will be used in the following description for convenience in reference only and will not be limiting. The words "upwardly," "downwardly," "rightwardly" and "leftwardly" will designate directions in the drawings to which reference is made. The words "inwardly" and "outwardly" will refer to directions toward and away from, respectively, the geometric center of the device and designated parts thereof. Said terminology will include the words above specifically mentioned, derivatives thereof and words of similar import.

**DETAILED DESCRIPTION**

The circular knitting machine shown in FIGS. 1-5 as a preferred embodiment of the invention intended for the production of sheet goods comprises a machine housing 1 which essentially has the shape of an upstanding cylinder. Fixed to housing 1 is a carrying ring 2 which carries needle cylinder 3 thereon which in turn supports a plurality of vertical needles 4 within grooves 71 (FIG. 5). A plate 5 is fixed to machine housing 1 and has located thereon a dial disk 6 which supports a plurality of horizontal needles 7. Because of the construction described, neither the dial disk 6 nor the vertical needle cylinder 3 move while the machine is running.

In both the dial disk 6 and the cylinder 3 there is provided at least one portion of their respective peripheries from which the needles are omitted whereby to provide at least one sector on both the dial disk and the needle cylinder free of needles. This sector is indicated in FIGS. 2 and 3 wherein there is shown the needle-free sector E-A, the dial disk 6 and the needle cylinder 3 being free of needles in this sector.

Cylinder cam ring 8 rotates outside of needle cylinder 3 and a dial cam ring 9 rotates above dial disk 6. According to the invention, cylinder cam ring 8 and dial cam ring 9 rotate in the same direction. Since the needles 4 and 7 are mounted within grooves formed in the stationary cylinder 3 and dial disk 6, respectively, they are actuated so as to reciprocate within these grooves by means of the cam rings 8 and 9, respectively. While many conventional devices are available for this purpose, one convenient means for driving the needles is shown in FIG. 7 wherein the cam rings 8 and 9 are provided with grooved drivers 64 and 65 fixedly connected thereto for rotation therewith. The grooved drivers 64 and 65 are provided with cam grooves 66 and 67, respectively, in the inner periphery thereof. The needles 4 and 7 are each provided with sidewardly projecting lugs 68 and 69, respectively, which engage within the respective cam grooves 66 and 67. Rotation of the cam rings 8 and 9 together with their respective cam grooves 66 and 67 causes the needles 4 and 7 to be reciprocated within their guiding grooves in the desired cyclic manner so as to perform the desired knitting operation. While the cam grooves 66 and 67 have been disclosed as being formed within the grooved drivers, it will be apparent that the cam grooves could be formed directly in the cam rings 8 and 9 so desired.

Cam rings 8 and 9 further carry knitting groups or units 10 which essentially consist of clamp means 10a and yarn guides 10b. The preferred embodiment shown is equipped with twelve knitting groups of conventional and well-known construction, which groups will be described in detail hereinafter. Because of the grouping of clamp means 10a and yarn guides 10b in knitting groups 10, the corresponding clamp means and yarn guides rotate together.

The machine must also be equipped with a cutting device 36 (FIG. 2) which cuts the yarns in the area of needle-free sector E-A. A particularly favorable construction of such a cutting device is described hereinafter. For reasons of clarity it is not shown in FIG. 1.

The drive for the machine as described can be constructed in a very simple manner. It is sufficient to drive either dial cam ring 9 or cylinder cam ring 8. These rings are best connected by a driver or coupling ele-
ment 11 (FIG. 1) which is simply constructed as an angle arm bridging the zone 12 between the dial and cylinder rings on the outside of said zone.  

The embodiment shown (FIG. 1), the dial cam ring 9 is fixedly connected to center disk 13 which in turn is fixed to a vertical drive shaft 14 protruding from the machine housing 1. On shaft 14, within the interior of the machine housing, is located a gear 15 which cooperates with a gear 16. The latter gear is driven from shaft 17 by a drive mechanism (not shown schematically) mounted within housing 1. Drive device 18 normally consists of an electric motor and a conventional gear drive. In the drawing, gears 15 and 16 are shown as spur gears. However, it would be possible to use bevel gears or the like if a different drive arrangement is desired.  

The machine drive thus functions in a simple manner as follows: The drive 18 activates vertical drive shaft 14 by way of shaft 17, spur gear 16 and spur gear 15. Its rotation is transmitted to center disk 13 which rotates dial cam ring 9. Ring 9, by means of driver 11, also simultaneously drives cylinder cam ring 8 at the same rotational rate and radius.  

In view of the rotating knitting groups, those parts serving as yarn spools and guiding devices must rotate similarly. The machine according to the present invention accomplishes this in a very simple manner. Vertical drive shaft 14 projects through the central disk 13 and carries plate 19 on its upper free end, on which rests spool holders 20 (schematically indicated) and furnishes, if present. Many conventional spool holders are well known in the art and can be used for mounting the yarn spools.  

The plate 5 is advantageously connected to machine housing 1 by a sleeve 21 which depends from plate 5 and is normally fixedly supported on the housing, subject to limited rotation which is usually provided for adjustment purposes only. In this embodiment, a bearing bushing 22 encircles the vertical drive shaft 14 and is solidly connected with the upper part of the machine housing 1. The sleeve 21 encircles and is fixed to the bushing 22 and, in this embodiment, rests on a flange projecting from the bushing 22, which flange in turn rests on the upper end of the housing 1. Sleeve 21 also serves as a support for center disk 13. For this purpose it is equipped with a thrust bearing 23 at its upper end. In addition, sleeve 21 can be axially by any conventional means (not shown) adjustment means such ascams, shims, set screws, etc., being well known in the machinery arts.  

The following arrangement is particularly favorable with regard to construction problems: Carrying ring 2 is solidly connected with the machine housing only in the area of needle-free sector E-A and is also laterally offset with respect to the machine housing 1 in the manner shown in FIG. 1. More specifically, carrying ring 2 is equipped with a side leg 24 which is connected solidly with the upper part of machine housing 1 at the edge thereof. The vertical central axis of carrying ring 2, which is coaxial with drive shaft 14, is offset or laterally displaced with respect to the assumed vertical central axis of cylindrical machine housing 1 in the direction of the side thereof opposite to the needle-free sector E-A. A vertical space or slot 25 (FIGS. 2 and 4) is provided between the upper edge of machine housing 1 and the lower edge of carrying ring 2. The space 25 can be formed in any convenient manner. For example, as illustrated in FIG. 1, the lower surface 2' of the carrying ring 2 can be sloped downwardly relative to the upper surface of the housing 1 so as to meet and join the housing in the region of the side leg 24. Alternatively, the lower surface of the carrying ring 2 would be parallel to the upper surface of housing 1 but variably displaced therefrom by means of the side leg 24. Slot 25 thus makes it possible to pull knitting 26 coming out of needle zone 12 downwardly within carrying ring 2 and outside of machine housing 1. Because of this pulling of the knitting 26 outside of the machine housing 1, the interior of the latter remains free for the housing of the drive assembly and related parts. Slot 25, which on both sides starts from needle-free sector E-A, is in practice sufficiently wide that there exists an uncluttered admission to the fontures from below and from within.  

The pulling of the knitting 26 downwardly is suitably accomplished by means of a plurality of familiar oscillating devices 27. These oscillating devices 27 oscillate in vertical planes located around the needle-equipped circumference of the machine and protrude from the housing 1. Each device 27 is equipped with an activation arm 28 protruding into the housing interior, which arm 28 is energized for periodic up and down movement by means of rotating rollers or cams 29. Rollers or cams 29 are carried by drive ring 30 which is located on the lower end of vertical drive shaft 14. This also results in a considerable simplification of the drive system. Knitting 26 in this operation passes through a guide ring 30a located closely above oscillating devices 27.  

To receive the finished goods, a receptacle 31 is provided which can be rolled up by means of wheels 32. Seen from above (FIG. 2), this receptacle is U-shaped with its inner circumference adapted to the outer circumference of machine housing 1. Receptacle 31 can thus be rolled into a position adjacent the machine housing from the side opposite the needle-free sector E-A, and can be removed from the housing in the opposite direction. The removal of the finished goods and the placing of a new receptacle adjacent the machine is thus an easy and fast operation.  

The circular knitting machine according to the present invention offers an excellent opportunity to control activation of the rotating means, primarily the needle actuating cams, and also other rotating parts from one location. To accomplish this, the preferred embodiment of the machine has a control head 33 mounted on a base 34 extending from eccentric leg 24 adjacent needle-free sector E-A. The control head mechanism is driven by any convenient means (not shown), such as cams or the like from cylinder cam ring 8. Control head 33 contains conventional information storage means 35 for controlling the necessary movements of the machine. If necessary, a pattern storage for Jacquard patterns can also be provided at the same location. More particularly, as in other known machines, a plurality of movable segments (not shown) which are positioned by suitable programming cams. These cams have in the past been placed as desired in the path of said segments at various locations around the circumference of the machine. With the machine of the invention, said programming cams are, if desired, combined into the control head and moved as desired according to a preselected program. Such control head can also move and control the cams hereinafter further mentioned by which the yarn guides and cutters are actuated.  

No knitting is done in needle-free sector E-A. This means that yarn supplied by yarn guides 106 must be cut at this point. Alternatively, one may permit the yarns to float over this sector and to cut them subsequently in the interior of the needle cylinder by means of a fixed cutting device. The result is a desirable open hose-like product, but considerable losses of yarn might accompany this method.  

It is considered better, therefore, to coordinate a cutting and clamping device with every yarn guide, cutting and clamping the yarn when entering the needle-free sector (at E), and releasing the yarn again when leaving the needle-free sector (at A). However, even this would still present a difficult construction problem since each yarn guide would have to be equipped with a cutting and clamping device.  

An advantageous development of the present invention therefore contemplates only a single fixed pair of cutting
means 36 (FIG. 2) which sequentially cuts all yarns as they enter the needle-free sector E-A. This means that every yarn guide 10b needs only a clamping device 10a of any convenient type which grasps the cut yarn at the beginning of the needle-free sector and prevents it from getting to the needles when entering the needle-equipped sector. The clamping device, described in detail hereinafter, can be constructed in a known manner and operated either mechanically or pneumatically.

FIGS. 5 and 6 show a particularly favorable construction of such a fixed pair of cutters 36 and the manner in which they are operated. The yarn guide 37b (FIG. 5) adjacent to it, and a guide bar 39 adjacent the other side of the notched bar 37 for guiding the movement thereof, all held in place in needle grooves in the needle-free sector by any convenient and easily releasable means, such as the yoke 37b. This facilitates changing the cutter bar 37 as desired for the extent of the needle-free sector is changed. Notched bar 37 is reciprocably movable in a vertical direction by drive means of any convenient type connected with cylinder cam ring 8. One convenient means for driving the notch bar 37 is shown in FIG. 6 wherein the bar 37 is provided at its lower end with a sidewardly projecting lug 62 which engages within a cam groove 63 formed within grooved driver 64. Cam groove 63 is designed so as to linearly reciprocate bar 37 in a vertical direction, the bar 37 being confined between the guide plate 39 and the cutting bar 38 with the reciprocation being imposed due to the lug 62 being confined between the sidewalls of the cam groove 63. Consequently, rotation of the cam ring 8 together with the attached grooved driver 64 causes the cutting bar 37 to be moved downwardly and upwardly in a desired cyclic relationship with the cam ring 8, the cutting bar 37 being moved downwardly shortly after the yarn guide 10b moves into the needle-free sector. Such reciprocating means for cutting devices are well known in the cutting art as shown by U.S. Pat. No. 2,810,280.

At its upper end, bar 37 is equipped with hook-like head 37a (FIG. 6) underneath which yarn guide 10b introduces yarn 40. This operation is carried out in a particularly dependable manner if a controlled closure device (not shown), such as for example, the usual camming latch is coordinated with the hook-like head 37a. A similar result can be achieved by locating a conventional latch needle substantially directly beside the notched bar 37. Fixed cutting bar 38 has a knife edge 41 at its upper end adjacent notched bar 37. As can be seen from FIGS. 5 and 6, the yarn guide bar 37a is drawn downward over edge 41 and cut thereby when notched bar 37 is moved downwardly. This movement is controlled by the cam groove 63 in such a manner that each yarn successively introduced by the yarn guides is cut off shortly after entering the needle-free sector, thereby leaving a projecting yarn end 40 of substantial length. Thus, it is sufficient to provide a single pair of cutters for all threads.

The devices for connecting cutters 36 to the machine are so constructed that the cutters 36 can be inserted into the grooves 71 of needle cylinder 3 wherever desired. However, the cutters 36 could also be carried by dial disk 6 if desired.

As has been mentioned above, a clamping means is preferably provided at each of the yarn guides 10b and rotates with the dial cam ring 9 in the direction of the arrow U, clamping and holding the yarn 40 as soon as the yarn is cut upon its entrance into the needle-free sector and then releasing said yarn as soon as the yarn guide enters into the needle sector.

As illustrated in FIGS. 5, 7, and 9-11, yarn 40 is guided in the yarn guide 10b by means of an eyelt 101 and an opening 102. Between these two guides, the yarn passes by a pressure surface 103 formed on the front of the yarn guide 10b. A clamping piece 60 is carried on the end of leaf spring 61, which spring is fastened to the yarn guide 10b at 104 by any convenient means, such as by a screw or by spot welding. Yarn 40 is clamped between the coating surfaces of the clamping piece 60 and the pressure surface 103 whenever the clamping piece 60 is clamped against the pressure surface 103 by the leaf spring 61 as shown in FIG. 11. Clamping the yarn 40 is permitted to run freely through the yarn guide whenever the clamp piece 60 is maintained in a spaced relationship from the pressure surface 103 as illustrated in FIG. 10.

The knitting mechanism 10 has a clamp actuator mounted thereon for controlling the clamping piece 60, which clamp actuator comprises a member 54 slideably mounted within a vertical groove 105 formed in each yarn guide 10b. Each slide 54 (FIG. 8) is provided with an inwardly extended flange 106 on the lowermost end thereof, the upper surface of the flange 106 forming an inclined surface 57 and the lower surface of the flange forming an inclined camming surface 57 (FIG. 8A). Slide 54 is further provided with a recess 59 intermediate its ends.

The slide members 54 are reciprocably moved upward and downward by means of switch cams 107 and 108 affixed on the upper edge of the stationary needle cylinder 3. As shown in FIG. 7, the switch cam 107 is affixed within a groove 109 to the upper edge of the needle cylinder 3 at the end of the needle-free sector. The cam 107 is provided with a guide surface 56 which tapers downwardly in the direction of rotation of U. The camming surface 57 formed on the slide 54 works with the downwardly facing guide edge 56 during the operation of the knitting machine.

The other sequence switch cam 108 is also affixed within the groove 109 to the upper edge of the needle cylinder 3 such as is shown in FIG. 9 and is located near the entrance of the needle-free sector. The cam 108 is also provided with an upwardly facing guide control edge 58, the edge 58 being tapered upwardly in the direction of rotation of U so as to contact with the inclined surface 57 formed on the slide 54.

When sheet goods are produced in the form on an opened tube, at whose edges the threads are cut off, it has been discovered that the edges of the sheet goods become slightly curled or otherwise improperly formed, which is undesirable to present the yarn to the knitting needles when entering the needle-equipped sector (at A) with a certain amount of tension. To eliminate the danger of warping and to achieve the desired tension, the machine according to the present invention provides tensioning or brake devices, all of which are identical and designated with the number 42 in FIGS. 2 and 5. These tensioning or braking devices are fixed to cylinder 3 and dial disk 6 near the edges of needle-free sector E-A. They are so constructed that they retain the yarn ends protruding from the knitted goods in a yielding manner. For this purpose, they are equipped with cooperating friction surfaces between which the yarn ends can be inserted by means of a movable insert member. The details of such a braking device are shown in FIGS. 12-14.

More specifically, each braking device 42 is equipped with two combs 43 and 44, one of which is fixed to dial disk 6 preferably within groove 110 and the other of which is fixed to needle cylinder 3. The combs 43 and 44a of each of these combs are partially interlaced between the prongs of the other. Said prongs 43a and 44a have respective slanted head edges 43b and 44b which protrude into zone 12. Located between the prongs of one comb (comb 43 in the particular embodiment shown) is a plurality of movable insert members or combs 46 pivots around horizontal shaft 45 and having prongs
46a which can enter into the intervals or spaces between prongs 43a and 44a of the fixed combs. Insert combs 46 are moved rhythmically up and down in the direction of double arrow B (FIG. 13) by any conventional reciprocating mechanism that rotates it in the direction of U. As the yarn guide and clamping mechanism 10 moves into contact with the switch cam 107, the trailing yarn end 400 will be moved directly over and positioned in the inactive tensioning device 42. Continued rotational movement causes the inclined camming surface 55 on the slide 54 to bear against and draw downwardly directed guide edge 56 of the switch cam 107 causing the slide 54 to be pulled downwardly. The recess 59 formed within the slide 54 is thus moved downwardly from beneath the clamping piece 60, causing the clamping piece 60 to be cammed or pushed away from the pressure surface 103 in opposition to the leaf spring 61, the yarn 40 thus being released from the clamp and being permitted to freely run through the yarn guide 10b.

Tensioning device 42 is actuated almost simultaneously with the release of the clamping mechanism. The ramp 117 of the rotatable cam ring 116 cams follower portions 112 upwardly, which in turn pivots the insert combs 46 into the open position against the top 112 thereon, which portion is biased into engagement with a ring cam 116 fixedly connected to the dial cam ring 9 and rotatable therewith. As indicated in FIG. 14, the ring cam 116 is provided with ramps 117 thereon for successively actuating the respective combs 46. While the tensioning device has been illustrated as using a plurality of separate combs 46, the insert comb could be formed as a single integral comb member having a plurality of prongs 46a thereon if desired.

As shown in FIGS. 12 and 13, the yarn 40 is inserted into the angle between prongs 43e and 44e due to the rotational movement of the dial disk 9 and the associated knitting groups 10, the angle between the prongs being substantially circumferentially aligned with the hooked ends of the needles 4 and 7. Insert combs 46 are initially in their ready position indicated by the broken line 46c. Prongs 46a are then successively moved downwardly by drive means 47 and press yarn 40 between prongs 43a and 44a. Since these prongs intermesh yarn 40 in the manner shown in FIG. 12, yarn 40 bends around head edges 43b and 44b of prongs 43a and 44a and acquires a wave-like shape, i.e., zigzags, in the process of being pressed against the prongs. As shown in FIG. 13, several layers of yarn 46 are moved simultaneously as another in tensioning device 42. These wave-like yarns slide downwardly and inwardly along the head edges 43b and 44b into the zone 12. The yarns successively leave tensioning devices 42 as the knitted ware is pulled downwardly by the devices 27. A warping of the knitting edge cannot take place because any movement of the yarns in the direction of arrow C (FIG. 12) is opposed by the friction at head edges 43b and 44b of the prongs. Yarn portions 40 and the meshes of the knitting thus move only in the direction of zone 12. To secure a sure introduction of the yarns into the wave-like slot between prongs 43a and 44a, lower edge 46d of prong 46a is slightly curved concavely.

While a tensioning device of the kind described above is particularly suitable for the circular knitting machine according to this invention, it can also be used for other knitting machines producing knit goods with open edges.

The tensioning device 42 is attached to the dial disk 9 or to another peripheral location can be selected for this purpose. Combs 43 and 44 may each consist of one piece. The combs 43 and 44 are attached to the dial disk and needle cylinder by any convenient means, such as by bolts or the like, not shown.

OPERATION

The operation of the yarn guide and clamping mechanism 10 and its coaction with the cutting means 36 will now be described.

As the yarn guide and clamping mechanism 10 moves from the needle-free sector (at A) into the needle-equipped sector (FIG. 5), the yarn end 400 projecting from the yarn guide will be trailing behind the yarn guide movement. As the yarn guide and clamping mechanism 10 moves into contact with the switch cam 107, the trailing yarn end 400 will be moved directly over and positioned in the inactive tensioning device 42. Continued rotational movement causes the inclined camming surface 55 on the slide 54 to bear against and draw downwardly directed guide edge 56 of the switch cam 107 causing the slide 54 to be pulled downwardly. The recess 59 formed within the slide 54 is thus moved downwardly from beneath the clamping piece 60 causing the clamping piece 60 to be cammed or pushed away from the pressure surface 103 in opposition to the leaf spring 61, the yarn 40 thus being released from the clamp and being permitted to freely run through the yarn guide 10b.

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As shown in FIGS. 12 and 13, the yarn 40 is inserted into the angle between prongs 43e and 44e due to the rotational movement of the dial disk 9 and the associated knitting groups 10, the angle between the prongs being substantially circumferentially aligned with the hooked ends of the needles 4 and 7. Insert combs 46 are initially in their ready position indicated by the broken line 46c. Prongs 46a are then successively moved downwardly by drive means 47 and press yarn 40 between prongs 43a and 44a. Since these prongs intermesh yarn 40 in the manner shown in FIG. 12, yarn 40 bends around head edges 43b and 44b of prongs 43a and 44a and acquires a wave-like shape, i.e., zigzags, in the process of being pressed against the prongs. As shown in FIG. 13, several layers of yarn 46 are moved simultaneously as another in tensioning device 42. These wave-like yarns slide downwardly and inwardly along the head edges 43b and 44b into the zone 12. The yarns successively leave tensioning devices 42 as the knitted ware is pulled downwardly by the devices 27. A warping of the knitting edge cannot take place because any movement of the yarns in the direction of arrow C (FIG. 12) is opposed by the friction at head edges 43b and 44b of the prongs. Yarn portions 40 and the meshes of the knitting thus move only in the direction of zone 12. To secure a sure introduction of the yarns into the wave-like slot between prongs 43a and 44a, lower edge 46d of prong 46a is slightly curved concavely.

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OPERATION

The operation of the yarn guide and clamping mechanism 10 and its coaction with the cutting means 36 will now be described.
as preferably incorporating therein a clamping means 10a in combination with each of the guides 10b, it has been experimentally determined that the machine of the present invention works in a satisfactory manner when the clamp means are provided. In this embodiment, the yarn ends 400 are permitted to hang loosely out of the yarn guides 10b as they travel through the needle-free sector E-A. Therefore, while the machine of the present invention preferably uses clamp means thereon to insure proper holding and positioning of the projecting yarn ends, the scope of the invention also encompasses use of such a machine without clamp means thereon.

As can be seen in the preceding description, the machine according to this invention can produce sheet goods with the efficiency of a circular knitting machine. The width of the goods can easily be adapted to the demand by adjusting the size of the needle-free sector. For such an adjustment, it is only necessary to insert or remove needles as desired. The devices at the edges of this sector, such as cams 107–108, cutters 36, and brake devices 42, can also be adjusted to the new needle-free sector size merely by remounting them in the desired location.

If it should be desired to adjust the dial cam ring and the cylinder cam ring tangentially with relation to each other, this can be achieved in a very simple manner by attaching an appropriate adjuster of any convenient type to the driver 11. Many such adjustment means, wherein one member is rotatably adjusted relative to another, are known in the mechanical arts. For example, the adjustable clamp could be of the slot-and-bolt type, as shown in U.S. Pat. No. 2,669,104, with driver 11 being connected to cam ring 3 by means of a bolt 72, the driving being provided with a circumferentially extending slot 73 so as to permit such angular adjustment.

The invention is not restricted to the particular embodiment described since all the remarks made in connection with the circular knitting machine are also valid as to weaving machines. In addition, many variations of the drive mechanism are possible. For instance, by means of an extension of shaft 17 and an appropriate gear, not shown, on the center disk 13, drive device 18 can act directly on said center disk 13. Also, it would be possible to drive the cylinder cam ring 8 instead of the dial cam ring 9. The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A circular knitting machine for the continuous, unidirectional, production of sheet goods, the combination comprising:
   a. substantially cylindrical housing;
   b. a needle cylinder partially provided with needles thereon but having a needle-free sector thereon and first means supporting same nonrotatably with respect to said housing;
   c. said first means supporting said needle cylinder including a carrying ring and mounting means affixed to said carrying ring adjacent said needle-free sector for mounting said carrying ring to said housing, said carrying ring being mounted on said housing and being laterally offset and vertically spaced with respect thereto whereby a slot is formed between the upper edge of said housing and the lower edge of said carrying ring for permitting the knitted ware to be pulled inside the carrying ring and outside of said housing;
   d. a disk positioned adjacent the upper end of said needle cylinder and second means supporting the dial disk nonrotatably with respect to said housing, said dial disk partially provided with needles thereon but having a needle-free sector thereon in registry with the needle-free sector of the needle cylinder;
   e. a needle cylinder cam ring and a dial disk cam ring and means rotatably mounting said cam rings for rotation with respect to said needle cylinder and said dial disk, respectively;
   f. drive means connected to said cam rings for rotating same in one direction only for progressive actuation of the needles in said needle cylinder and the needles in said dial disk;
   g. yarn feeding means operatively associated with said cam rings for rotational movement around said needle cylinder and said dial disk for feeding yarn to said needles; and
   h. at least one cutting means for cutting said yarn adjacent said needle-free sector as the yarn feeding means enters the needle-free sector.

2. A circuit knitting machine for the continuous, unidirectional, production of sheet goods, the combination comprising:
   a. a housing;
   b. a needle cylinder partially provided with needles thereon but having a needle-free sector thereon and first means supporting same nonrotatably with respect to said housing;
   c. a dial disk and second means supporting the dial disk nonrotatably with respect to said housing, said dial disk partially provided with needles thereon but having a needle-free sector thereon in registry with the needle-free sector of the needle cylinder;
   d. a needle cylinder cam ring and a dial disk cam ring and means rotatably mounting said cam rings for rotation with respect to said needle cylinder and said dial disk, respectively;
   e. drive means connected to said cam rings for rotating same in one direction only for progressive actuation of the needles in said needle cylinder and the needles in said dial disk;
   f. yarn feeding means operatively associated with said cam rings for rotational movement around said needle cylinder and said dial disk for feeding yarn to said needles;
   g. a cutting device for cutting said yarn adjacent said needle-free sector as the yarn feeding means enters the needle-free sector.

3. The circular knitting machine defined in claim 2, wherein:
   a. said pair of cutters is stationarily mounted on one of said needle cylinder and dial disk.

4. A circular knitting machine for the continuous, unidirectional, production of sheet goods, the combination comprising:
   a. a housing;
   b. a needle cylinder partially provided with needles thereon but having a needle-free sector thereon and means supporting same nonrotatably with respect to said housing;
   c. a dial disk and means supporting same nonrotatably with respect to said housing, said dial disk partially provided with needles thereon but having a needle-free sector thereon in registry with the needle-free sector of the needle cylinder;
   d. cam rings rotatably arranged for rotation with respect to said needle cylinder and with respect to said dial disk, in one direction only, for progressive actuation of the needles in said needle cylinder and the needles in said dial disk;
   e. yarn feeding means operatively associated with said cam rings for rotational movement around said nee-
13. The circular knitting machine defined in claim 4, wherein:

- said drive means includes a member connecting said cam rings whereby to drive both of said cam rings at equal speeds in response to an external driving source supplied to only one thereof.

14. A circular knitting machine for the continuous, unidirectional, production of sheet goods, the combination comprising:

- a housing;
- a needle cylinder partially provided with needles thereon but having a needle-free sector thereon and first means supporting same nonrotatably with respect to said housing;
- a dial disk positionned adjacent the upper end of said needle cylinder and second means supporting the dial disk nonrotatably with respect to said housing, said dial disk partially provided with needles thereon but having a needle-free sector thereon in registry with the needle-free sector of the needle cylinder;
- a needle cylinder cam ring and a dial disk cam ring and means rotatably mounting said cam rings for rotation with respect to said needle cylinder and said dial disk, respectively;
- drive means connected to said cam rings for rotating same in one direction only for progressive actuation of the needles in said needle cylinder and the needles in said dial disk;
- shaft means nonrotatably secured to the dial disk cam ring, said shaft means extending upwardly from the upper surface of said dial disk cam ring;
- yarn feeding means operatively associated with said cam rings for rotational movement around said needle cylinder and said dial disk for feeding yarn to said needles;
- spool holder means secured adjacent the upper end of said shaft means, said spool holder being rotatable with said shaft means and said dial disk cam ring for supplying yarn to said yarn feeding means; and
- at least one cutting means for cutting said yarn adjacent said needle-free sector as the yarn feeding means enters the needle-free sector.

15. The circular knitting machine defined in claim 4, wherein:

- said second means supporting the dial disk comprises a plate positioned below the dial disk, said plate being supported on the housing by means of a sleeve which is fixed with respect to the housing.

16. The circular knitting machine defined in claim 4, wherein:

- said yarn feeding means includes a yarn guide coordinated with said cutting means and said clamp means whereby said yarn is cut and clamped as said yarn enters the needle-free sector and released again as it leaves the needle-free sector.

17. A circular knitting machine for the continuous, unidirectional, production of sheet goods, the combination comprising:

- a housing;
- a needle cylinder partially provided with needles thereon but having a needle-free sector thereon and first means supporting same nonrotatably with respect to said housing;
- a dial disk positionned adjacent the upper end of said needle cylinder and second means supporting the dial disk nonrotatably with respect to said housing, said dial disk partially provided with needles thereon but having a needle-free sector thereon in registry with the needle-free sector of the needle cylinder;
- a needle cylinder cam ring and a dial disk cam ring and means rotatably mounting said cam rings for rotation with respect to said needle cylinder and said dial disk, respectively;
- drive means connected to said cam rings for rotating same in one direction only for progressive actuation of the needles in said needle cylinder and the needles in said dial disk;
- shaft means nonrotatably secured to the dial disk cam ring, said shaft means extending upwardly from the upper surface of said dial disk cam ring;
- yarn feeding means operatively associated with said cam rings for rotational movement around said needle cylinder and said dial disk for feeding yarn to said needles;
- spool holder means secured adjacent the upper end of said shaft means, said spool holder being rotatable with said shaft means and said dial disk cam ring for supplying yarn to said yarn feeding means; and
- at least one cutting means for cutting said yarn adjacent said needle-free sector as the yarn feeding means enters the needle-free sector.

18. A circular knitting machine for the continuous, unidirectional, production of sheet goods, the combination comprising:

- a housing;
- a needle cylinder partially provided with needles thereon but having a needle-free sector thereon and first means supporting same nonrotatably with respect to said housing;
- a dial disk positionned adjacent the upper end of said needle cylinder and second means supporting the dial disk nonrotatably with respect to said housing, said dial disk partially provided with needles thereon but having a needle-free sector thereon in registry with the needle-free sector of the needle cylinder;
- a needle cylinder cam ring and a dial disk cam ring and means rotatably mounting said cam rings for rotation with respect to said needle cylinder and said dial disk, respectively;
- drive means connected to said cam rings for rotating same in one direction only for progressive actuation of the needles in said needle cylinder and the needles in said dial disk;
- shaft means nonrotatably secured to the dial disk cam ring, said shaft means extending upwardly from the upper surface of said dial disk cam ring;
- yarn feeding means operatively associated with said cam rings for rotational movement around said needle cylinder and said dial disk for feeding yarn to said needles;
- spool holder means secured adjacent the upper end of said shaft means, said spool holder being rotatable with said shaft means and said dial disk cam ring for supplying yarn to said yarn feeding means; and
- at least one cutting means for cutting said yarn adjacent said needle-free sector as the yarn feeding means enters the needle-free sector.

The circular knitting machine defined in claim 14, wherein:

- the support element of said first support means comprises a cylindrical support ring positioned adjacent to and concentric with the needle cylinder and fixedly secured thereto, said support ring having a lower portion fixedly interconnected to said housing.

19. The circular knitting machine defined in claim 14, wherein:

- the support element of said first support means is affixed to said housing adjacent the needle-free sector of said needle cylinder.
directional, production of sheet goods, the combination comprising:

- a housing;
- a needle cylinder partially provided with needles thereon but having a needle-free sector thereon and first means supporting same nonrotatably with respect to said housing;
- a dial disk positioned adjacent the upper end of said needle cylinder and second means supporting the dial disk nonrotatably with respect to said housing, said dial disk partially provided with needles thereon but having a needle-free sector thereon in registry with the needle-free sector of the needle cylinder;

Said second support means including a plate positioned below said dial disk for supporting same, and a post member positioned below the dial disk for fixedly supporting said plate relative to said housing, said post member having its upper end affixed to said plate and having its lower end nonrotatably secured to said housing;

- a needle cylinder cam ring and a dial disk cam ring and means rotatably mounting said cam rings for rotation with respect to said needle cylinder and said dial disk, respectively;
- drive means connected to said cam rings for rotating same in one direction only for progressive actuation of the needles in said needle cylinder and the needles in said dial disk;
- yarn feeding means operatively associated with said cam rings for rotational movement around said needle cylinder and said dial disk for feeding yarn to said needles; and

at least one cutting means for cutting said yarn ad-

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