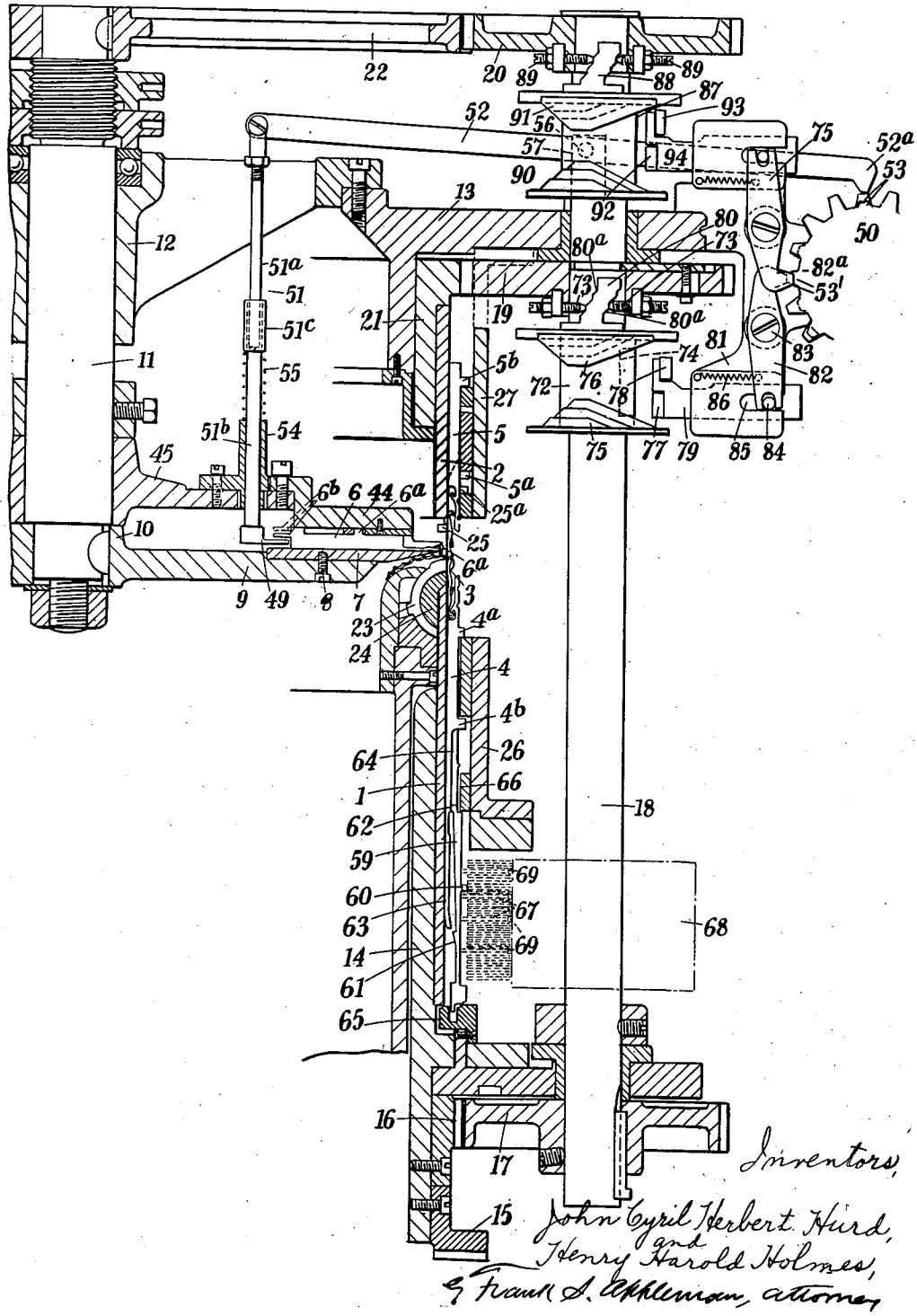
June 16, 1942. J. C. H. HURD ET AL 2,286,805

CIRCULAR KNITTING MACHINE

Filed May 5, 1941 10 Sheets-Sheet 1

Fig. 1.



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CIRCULAR KNITTING MACHINE

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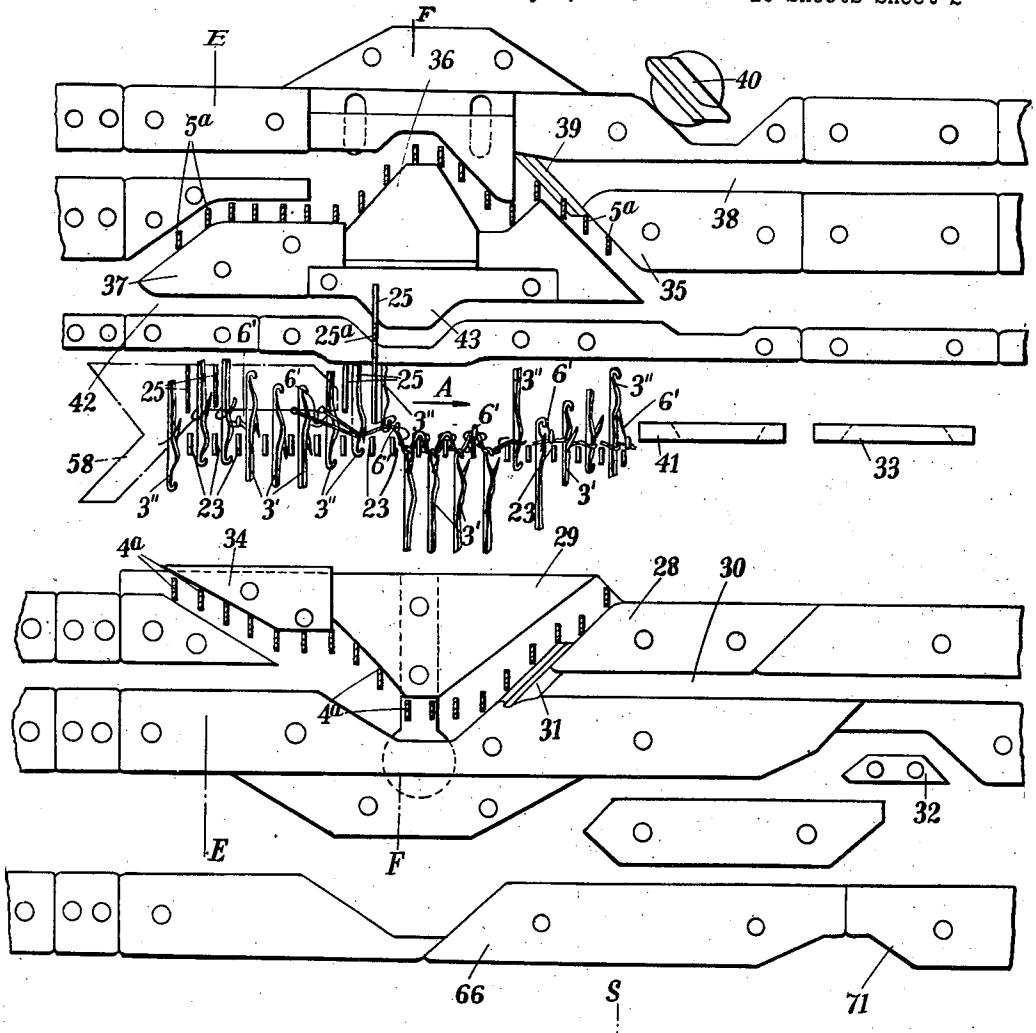


Fig.2.

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CIRCULAR KNITTING MACHINE

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Fig.3.

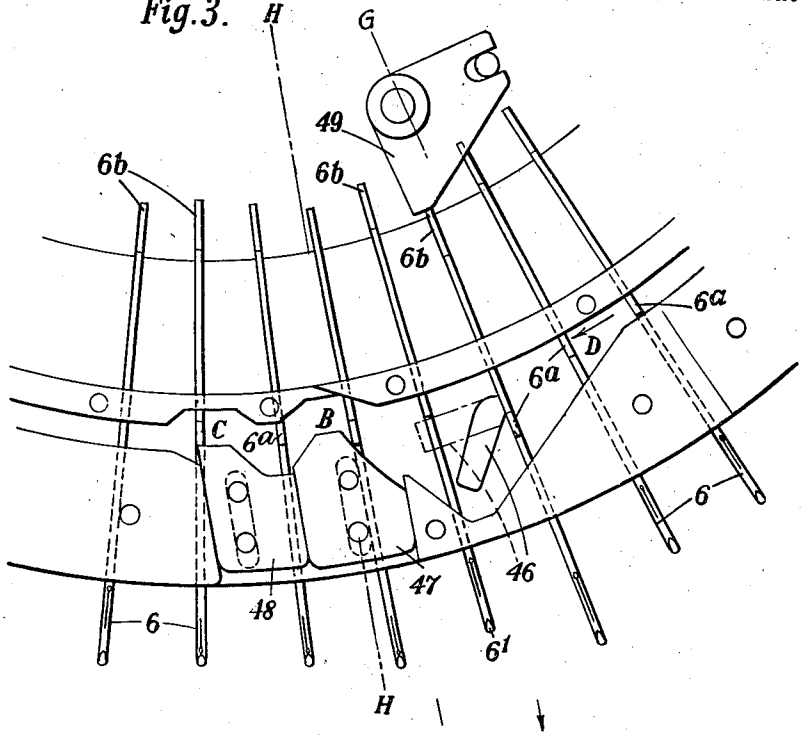


Fig.4.

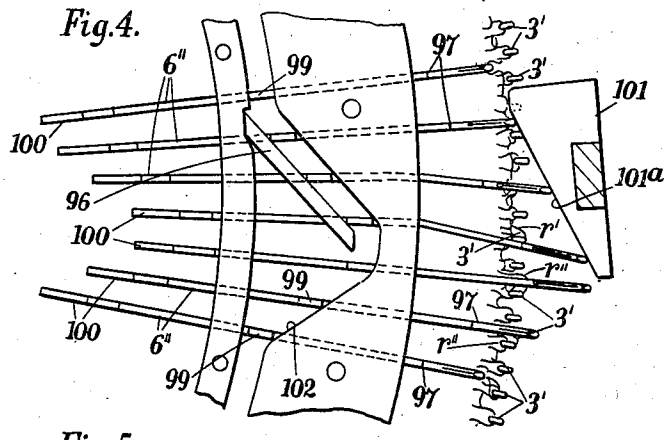
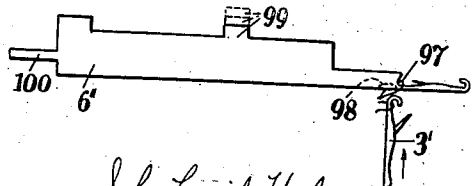


Fig.5.



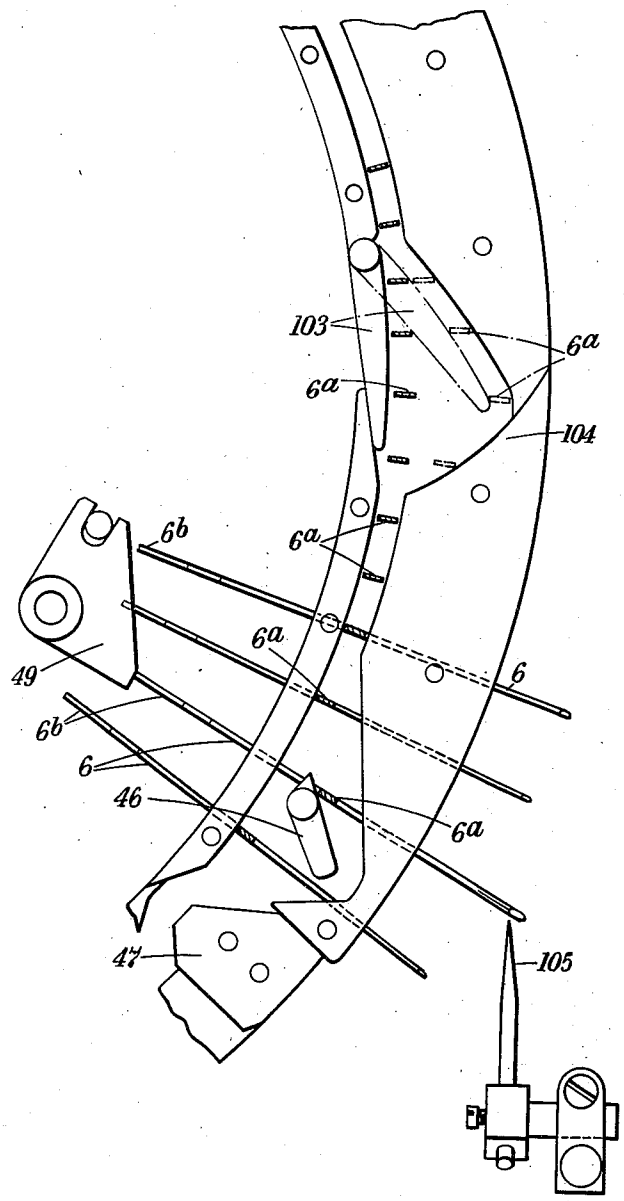
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CIRCULAR KNITTING MACHINE

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Fig.6.



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CIRCULAR KNITTING MACHINE

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Fig. 7.

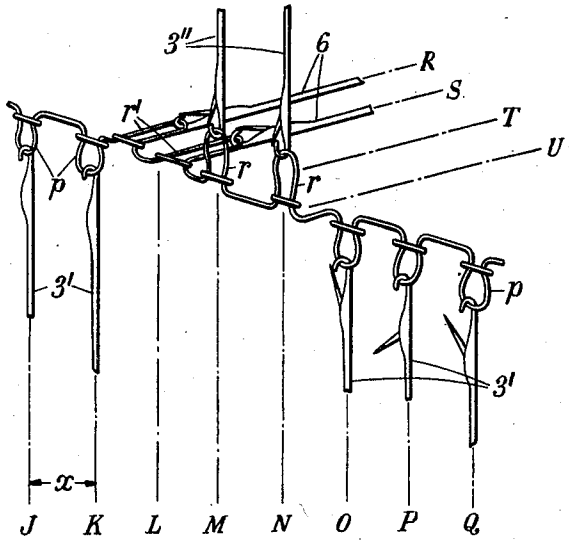
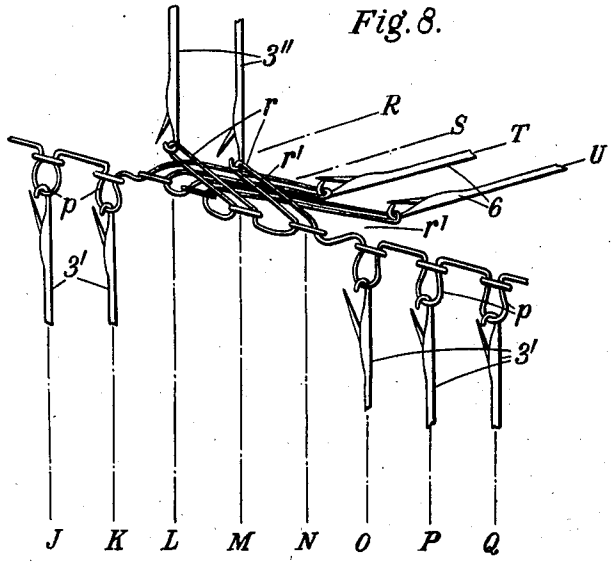


Fig. 8.



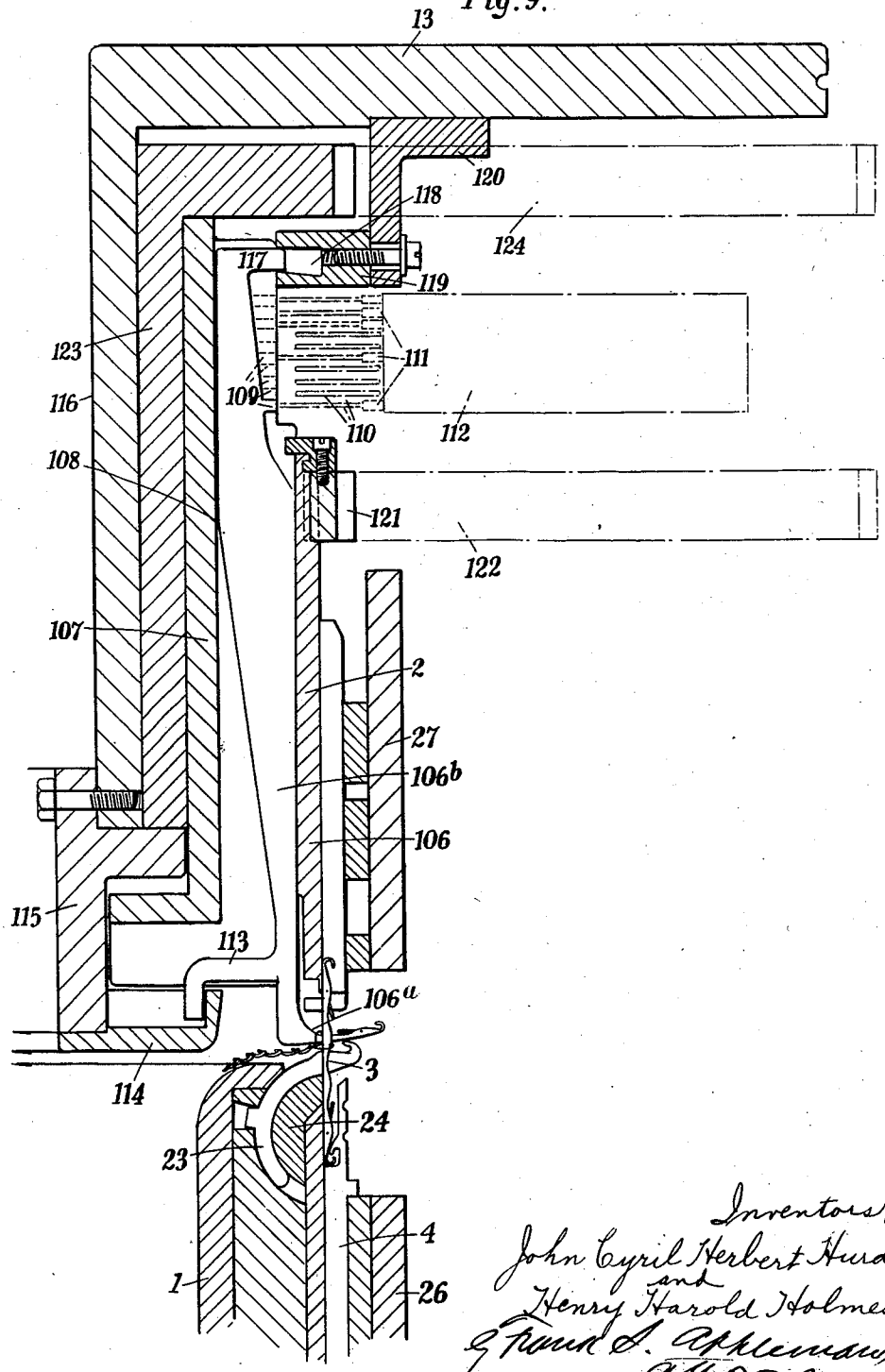
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CIRCULAR KNITTING MACHINE

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Fig. 9.



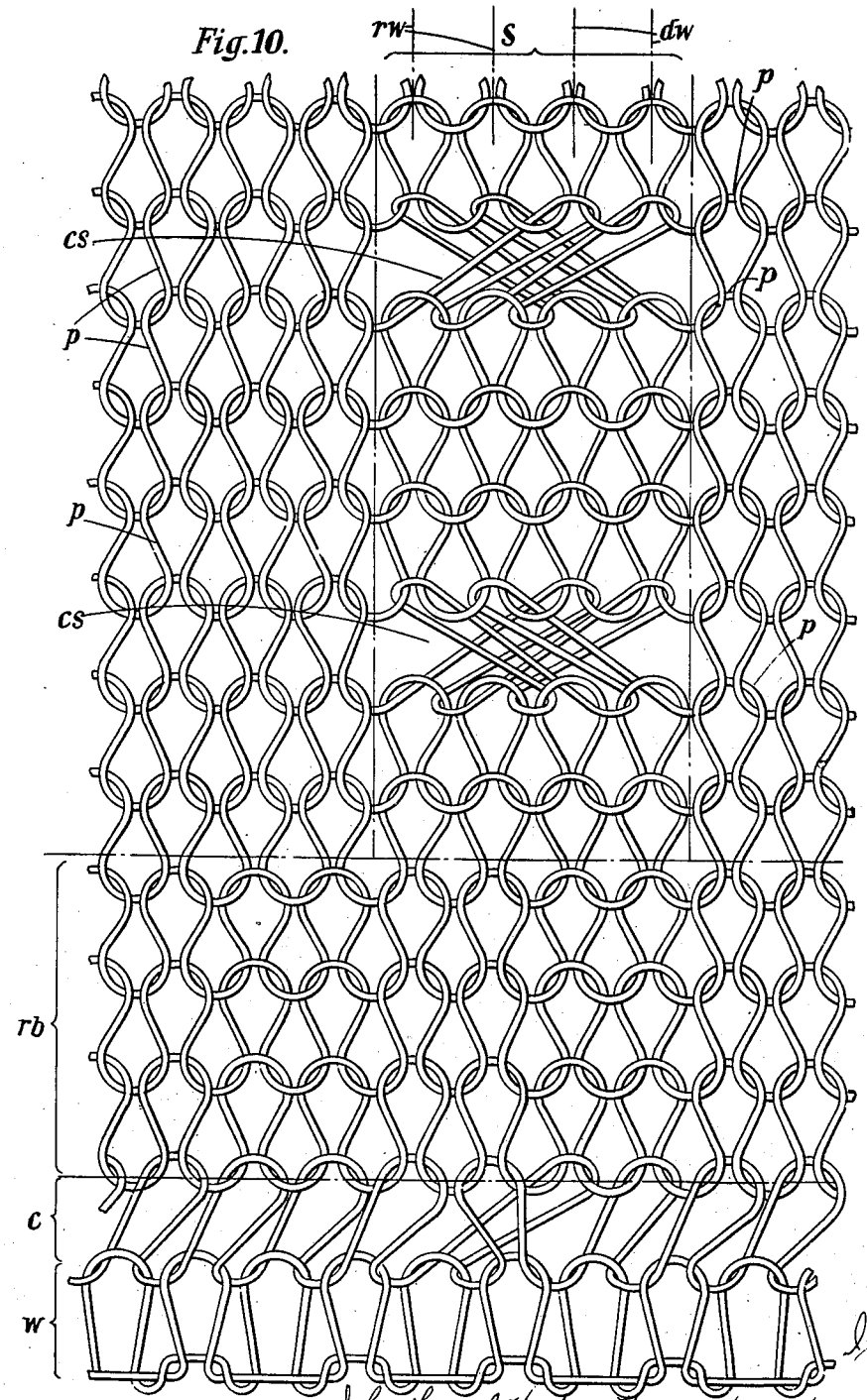
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CIRCULAR KNITTING MACHINE

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Fig.10.



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CIRCULAR KNITTING MACHINE

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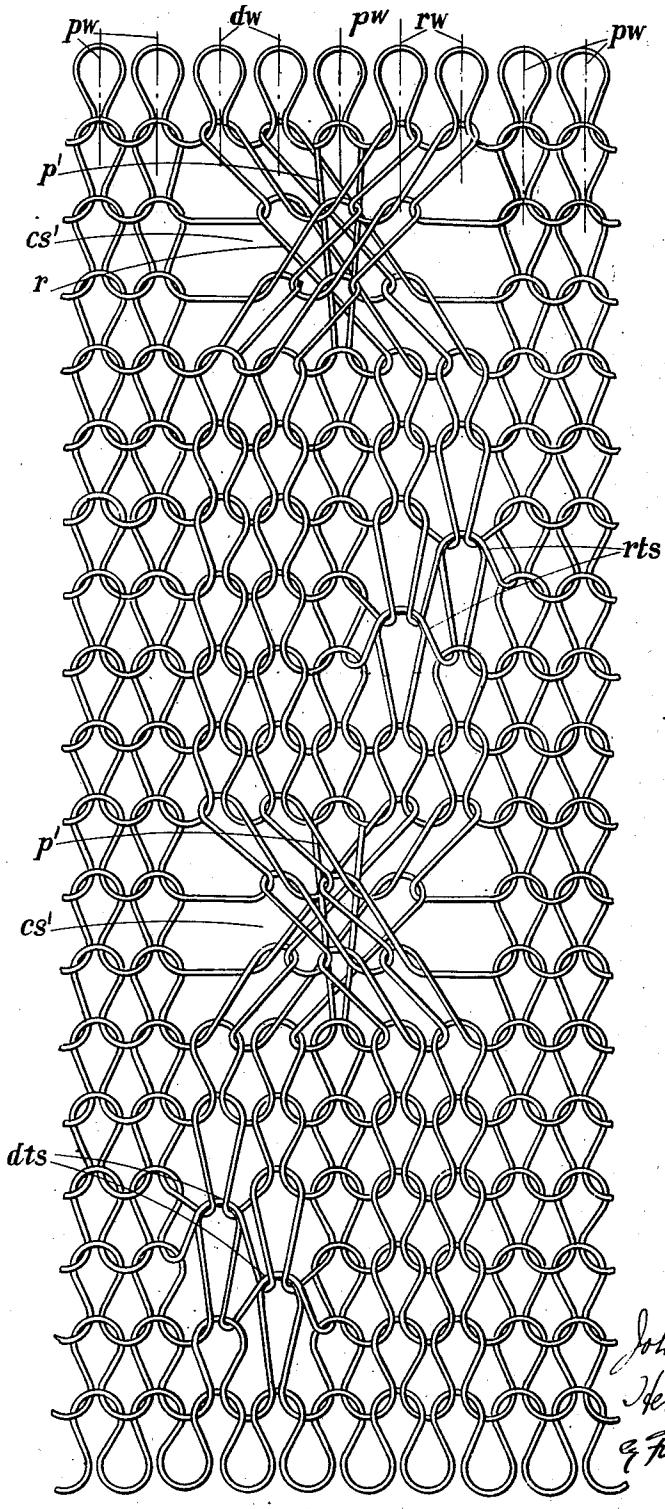


Fig. 11.

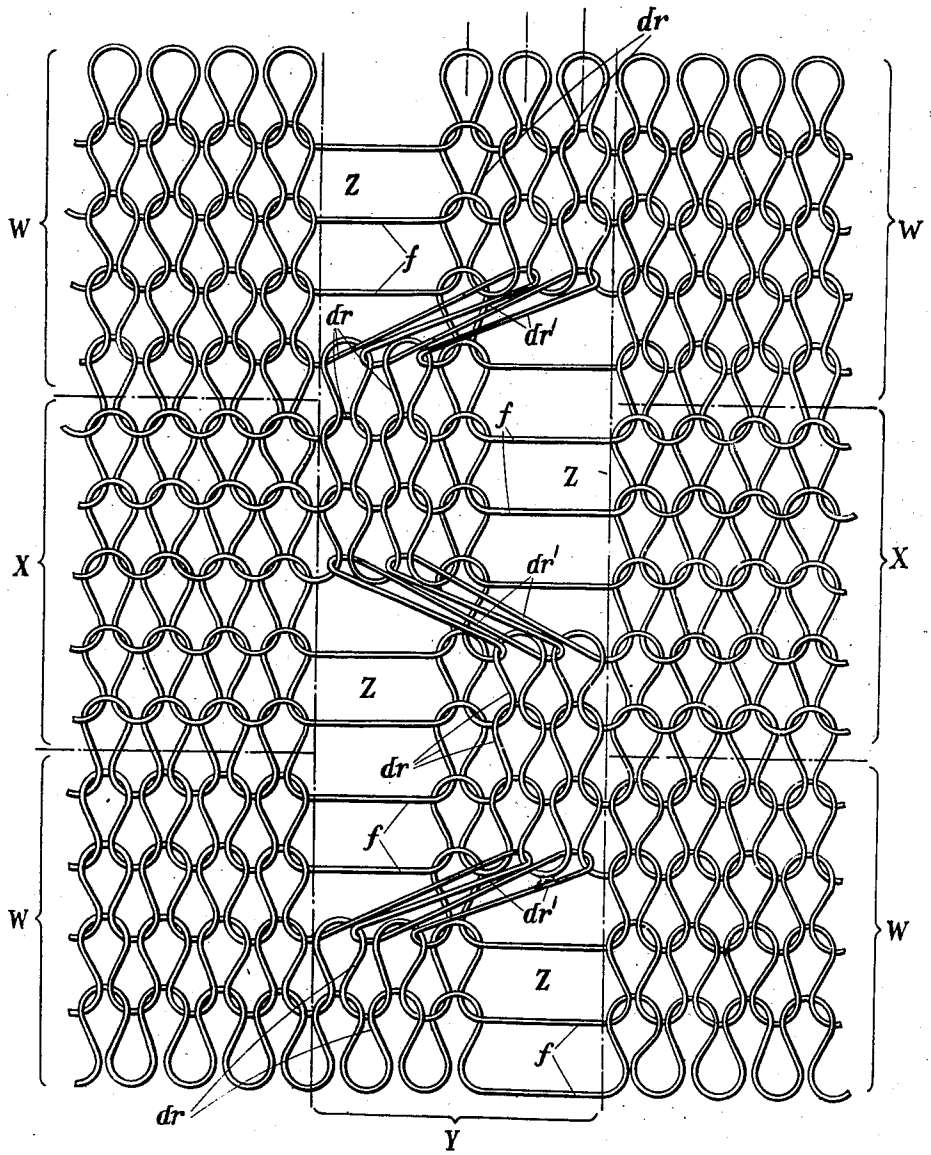
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June 16, 1942. J. C. H. HURD ET AL 2,286,805

CIRCULAR KNITTING MACHINE

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Fig.12.



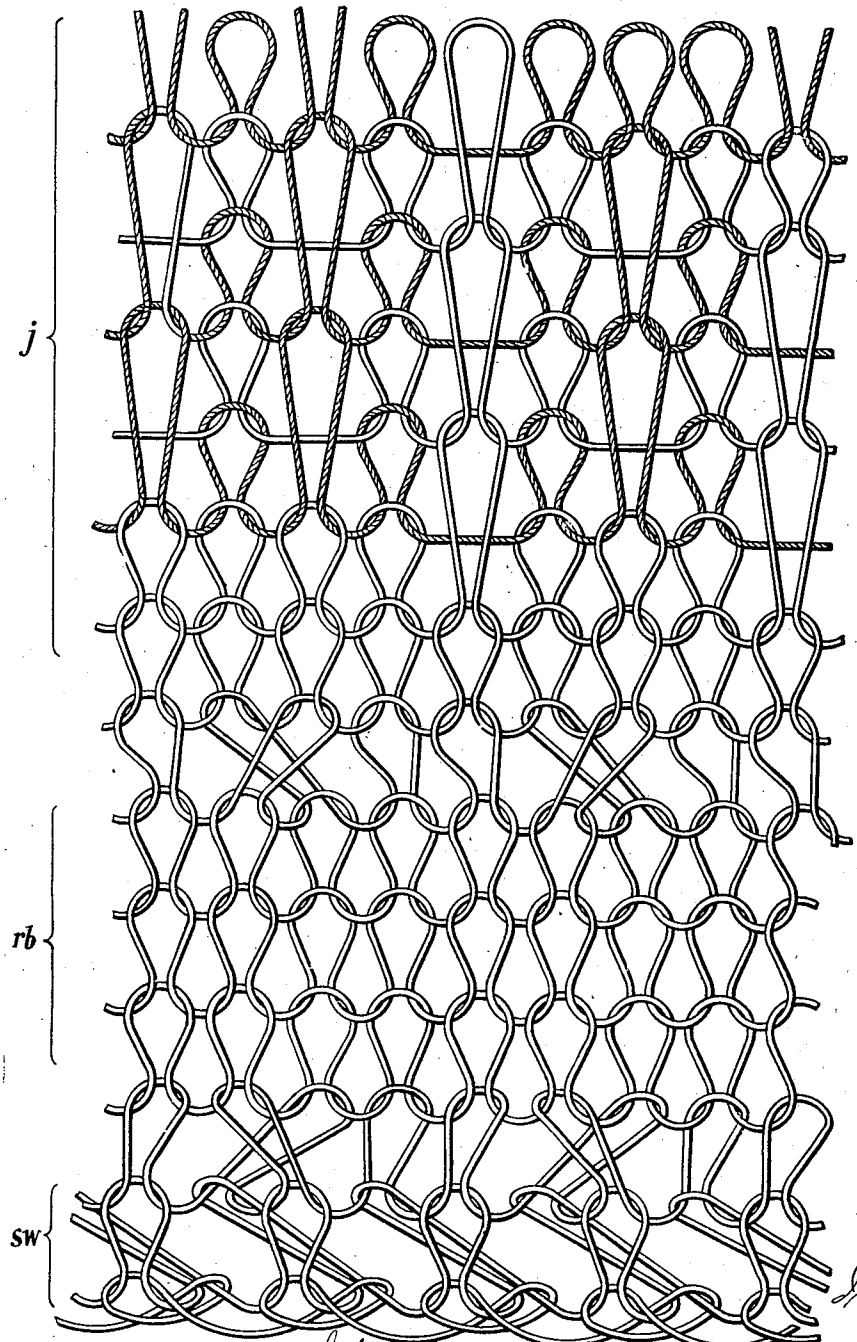
Inventors,
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CIRCULAR KNITTING MACHINE

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Fig.13.



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Patented June 16, 1942

2,286,805

UNITED STATES PATENT OFFICE

2,286,805

CIRCULAR KNITTING MACHINE

John Cyril Herbert Hurd and Henry Harold Holmes, Leicester, England, assignors to Wildt and Company Limited, Leicester, England, a British company

Application May 5, 1941, Serial No. 391,962
In Great Britain June 4, 1940

11 Claims. (Cl. 66—13)

This invention relates to circular independent needle knitting machines, and has for its object to provide an improved circular knitting machine of this tpe for automatically producing knitted fabric with a diversity of stitch effects without interruption of the knitting, either coursewise or walewise, or both coursewise and walewise, according to requirements, and including effects which have been difficult, if not in some instances practically impossible, to produce on existing circular knitting machines except by stopping the machines and manipulating knitted loops by hand, as an example of which true cable stitch effects may referred to.

Among the well known types of existing circular knitting machines there are some with two needle beds or carries, as, for example, machines of the cylinder and dial type, and machines of the double axiallly opposed, e. g. superimposed needle cylinder type, capable of producing a great variety of knitted fabrics or combination of different effects in knitted fabric, garments, garment lengths or articles, as, for example, by selective operation of needles or co-operating instrumentalities, manipulation of contrasting yarns, deflecting or shogging needles or other instrumentalities, such as pelerine or other loop transferring elements, or by a combination of these expedients as well known to those skilled in the art, but even the capacity of such machines has limitations, and the production of other effects, such as the aforesaid true cable stitch effects, if not practically impossible, gives rise to complications.

The present invention, therefore, comprehends the provision of a circular knitting machine of a greater productive capacity than existing machines as regards the production automatically of a diversity of stitch effects in desired sequence, especially in the same piece or length of knitted fabric, garment or article, that is to say a machine capable of producing, automatically, effects in addition to those ordinarily within the capacity of existing machine, as will be hereinafter set forth.

In order that the invention may be more clearly understood and readily carried into practical effect, constructional forms thereof embodied in machines of the superimposed rotary needle cylinder type, together with examples of fabric which can be produced on such machines, will now be described with reference to the accompanying diagrammatic drawings, wherein,

Figure 1 is a vertical sectional view of so much of such a machine as is necessary to illustrate one form of the invention embodying an inner dial,

Figure 2 is a developed view of portions of the plain and rib cylinder cam systems of the machine at one feed, as seen from the insides of the cylinder cam boxes,

Figure 3 is a plan view of the dial cam system at said feed, with the dial cam cap removed for the sake of clarity,

Figure 4 is a detail plan view of another portion of such a dial cam system illustrating a cam arrangement for effecting transference of dial stitches on to cylinder needles,

Figure 5 is a side view of a dial needle adapted for use in the said transfer cam arrangement, and also illustrates one stage in the transference of a loop from such a needle to a plain needle,

Figure 6 is a plan view of a modified form of dial cam system including cams for casting off dial stitches, without transference thereof to cylinder needles,

Figure 7 is a detail perspective view representing a few of the needles of the three sets during knitting,

Figure 8 is a somewhat similar view of the same after the dial needles and the rib cylinder needles have been displaced laterally in respectively opposite directions,

Figure 9 is a vertical sectional view showing an alternative arrangement wherein needles are arranged for pivotal or rocking movement in a supplementary cylinder fitted within the plain and rib cylinders of the machine, and

Figures 10–13 are structure diagrams, drawn to a greatly enlarged scale, of respectively different portions of fabric capable of being produced on the machines hereinafter to be described.

Like parts are designated by similar reference characters throughout the drawings.

Referring to Figure 1, it will be seen that the machine therein depicted comprises superimposed plain (bottom) and rib (top) cylinders 1 and 2 respectively with independent slidable double-ended latch needles 3 transferable in the customary manner from one cylinder to the other by means of needle actuating sliders such as 4 and 5 so as to be capable of providing two sets of needles, i. e. plain and rib cylinder needles, and is furnished with a third set of independent latch needles 6 slidably arranged radially in an appropriately tricked dial 7. This dial is disposed wholly within the circle of cylinder needles 3 between and concentric with the opposed cylinders 1 and 2. In this example, the disposition of said dial is such, moreover, that the dial

needles 6 extend at right angles to the double-ended needles 3 with their hooks 6a upwards. The invention is, however, unlimited in this respect since the dial may if desired be inclined somewhat with the hooks of the dial needles outwards. The dial 7 is of annular form and attached by means of screws such as 8 to a supporting disc 9 which is centrally bossed and keyed at 10 to a spindle 11. This spindle is disposed along the central axis of the machine and rotatably mounted in a bearing 12 supported in the manner shown from the customary top plate 13.

The plain cylinder 1 is carried by an inner sleeve 14 to the lower end of which latter is attached a crown wheel 15 adapted to be driven at an appropriate speed from the main shaft of the machine. The rib cylinder 2 and the dial 7 are adapted to be driven together from and at the same speed as the plain cylinder 1. The driving means employed for this purpose include a gear wheel 16 which is attached to the sleeve 14—above the crown wheel 15—and arranged to mesh with a pinion 17. This pinion is keyed to a shaft 18 upon which are mounted two further pinions 19 and 20 each having the same number of teeth. The pinion 19 meshes with a toothed sleeve 21 attached to the rib cylinder 2, whereas the pinion 20 meshes with a gear wheel 22 which is keyed upon the upper end of the central spindle 11. The gear wheels 16 and 22 and the upper circumferentially toothed portion of the rib cylinder carrier sleeve 21 are, of course, all of the same diameter. The foregoing, however, is only intended to be a broad description of the driving arrangement since the latter also incorporates in association with the pinions 19 and 20 respectively different sets of mechanism for shogging the rib cylinder 2 and the dial 7 according to patterning requirements as will be hereinafter described.

The machine also includes holding down sinkers or web holders such as 23 mounted in a sinker ring or brass 24 of usual form associated with the plain cylinder 1. For operating these sinkers or web holders there is provided a cam system of any conventional character. A circular series of independently slidable knocking-over bits such as 25 adapted to be rendered operative seriatim at the stitch drawing point are mounted in the lower end of the rib cylinder 2.

The plain and rib cylinder cam systems of the machine are shown in Figure 2, the various cams being mounted, in accordance with usual practice, in conventional bottom and top cam boxes 26 and 27 respectively (see Figure 1). The bottom cam box includes a clearing cam 28, an adjustable stitch cam 29, a welt track 30 entrance to which is controlled by a welt cam 31, a fixed transfer cam 32 for action upon the transfer butts 4b of the bottom sliders 4 and for use in conjunction with pattern mechanism whereby selective operation of said sliders is effected, and a dividing cam 33. There is also a so-called feeder cam 34 for directing the knitting butts 4a of the bottom sliders into the range of the plain stitch cam 29. The top cam box 27, on the other hand, includes a clearing cam 35, an adjustable rib stitch cam 36 and an associated feeder cam 37 all three of which act upon the knitting butts 5a of the top sliders 5, a welt track 38 entrance of the butts 5a into which is controlled by a welt cam 39, a bolt-operated transfer cam 40 and a dividing cam 41. Cams in the top box also provide a track 42 for reception of the operating butts 25a of the knocking-over bits 25, these bits being normally held inoperative but advanced, i. e. lowered, one after another at the knocking-over point by means of a cam 43. The cylinders and the dial rotate anti-clockwise and accordingly the arrow A in Figure 2 indicates the direction in which the various needles move in relation to the cams.

As shown in Figure 1, the cams of the dial cam system are carried by a dial cam cap or similar support 44 which is screwed onto a centrally bossed supporting disc 45 rigidly secured upon the central spindle 11. Referring to Figure 3, it will be seen that the said system includes, at the feed, a swing clearing cam 46 movable either to the full line position for clearing or to the position indicated in dot-and-dash lines for tucking, and adjacently disposed adjustable stitch cams 47 and 48 adapted to provide spaced knocking-over points B and C respectively. The stitch cams 47 and 48 are each adapted to be rendered operative or inoperative according to requirements, so that when the cam 47 only is operative stitch forming and knocking-over take place normally at the point B, whereas at such times as the cam 48 is rendered operative there is a delayed knocking-over action. In Figure 3 the arrow D indicates the direction of movement of the dial needles 6. Each of these needles is formed with an upstanding butt 6a for engagement with the operating cams just described. In addition, each dial needle has a rearwardly extending tail butt 6b so as to enable same to be used in conjunction with selecting or patterning means for controlling the operation of the dial needles according to the effects to be achieved. Conveniently for this purpose the tail butts 6b are formed at respectively different levels so as to be located in correspondingly different planes heightwise, and a vertically movable selecting cam 49 controllable from a control drum 50 (pattern chain or equivalent) is provided for action upon the tail butts to effect selective manipulation of the dial needles 6. The intermediate connections between the selecting cam 49 and the control drum 50 comprise a suitably guided rod 51 to the lower end of which said cam is rigidly secured, and a pivoted lever 52 having a toe portion 52a adapted for engagement with studs or pegs such as 53 of respectively different heights on the aforesaid drum. For convenience in construction the rod 51 is divided more or less centrally between its ends, that is to say made up of two initially separate lengths 51a and 51b joined together. The lower part 51b, which carries the cam 49, slides within a tubular bearing 54 mounted upon the disc 45, and is formed at its upper end with a longitudinally tapped enlarged portion 51c adapted to receive the lower screw-threaded end of the part 51a. The rod is controlled by means of a compression spring 55 which surrounds it and is interposed between the bearing 54 and the shoulder presented by the underside of the enlarged portion 51c. The upper end of the part 51a is pivotally connected to the lever 52 which latter is fulcrumed at 56 upon a bracket 57 carried by the top plate 13. Whenever the toe portion 52a is raised by a stud or peg 53 on the control drum the rod 51 is depressed against the spring action to move the selecting cam 49 into a lower plane; conversely, whenever the toe portion 52a drops either on to a smaller stud or peg or on to the surface of the control drum the rod 51 will move upwards under the reaction of the spring 55 to raise the selecting cam 49 into a higher plane. Selected dial

needles 6, i. e. needles whose tail butts 6a are acted upon by the selecting cam 49, are advanced to bring their operating butts 6a into the path of the swing cam 46 and are thereafter moved to clearing or tucking position, whereas unselected dial needles, such as that indicated at 6^1 in Figure 3, miss the said swing cam and are not advanced. Provision may be made for adjustment within limits of the selecting cam about the axis of the rod 51. The locations marked by the lines E—E and F—F in Figure 2 correspond respectively to the locations marked by the lines G—G and H—H in Figure 3. As hereinbefore alluded to, the various cams shown are those provided at one feed only. In the case of a multi-feeder machine, the appropriate cams would be duplicated at each feed.

The feeder plate provided at the feed depicted is indicated in dot-and-dash lines at 58 in Figure 2. The feeder plate has therein holes through which a yarn or yarns is or are fed to the needles. In purely diagrammatic fashion this figure also shows knitting in progress on the three sets of needles. Thus, a few plain needles 3^1 (i. e. cylinder needles working in the cylinder 1) are seen co-operating both with rib cylinder needles 3^{11} (i. e. needles working in the cylinder 2) and spaced selected dial needles 6^1.

The patterning mechanism for selecting needles 3 for transference from the plain cylinder 1 to the rib cylinder 2 as occasion demands is of the general character set forth in the specification of our prior United States Letters Patent No. 2,143,832 and will now be briefly described with reference to Figures 1 and 2. The said mechanism includes selecting elements 59—one to each needle actuating slider 4. Each element 59 is provided with a frontal selecting butt 60 and a rearwardly projecting butt 61 at the lower end. At 62 each selecting element 59 is provided with a fulcrum point. Associated with the selecting elements are jack-like extensions 63, one on each slider 4, to be acted upon for patterning purposes. Each slider 4 with its extension 63 is located at the back of the groove or trick 64 in which it is to work and the companion selecting element 59 works in the same groove or trick with its fulcrum point 62 in contact with the front edge of the extension. The arrangement is such that the jack-like extensions 63 have their lower extremities located above the butts 61; normally these butts are out of alignment with the said lower extremities, as shown in Figure 1. When in their normal position, the selecting elements 59 are prevented from falling out of the grooves or tricks 64 by a carrier ring 65 (the primary purpose of which will presently be mentioned) and a sectional ring 66 attached to the inside of the bottom cam box 26. For selectively operating the elements 59 there is provided a bank of spring-controlled selecting cams 67, and a pattern controlling unit 68 furnished with cam actuating pins 69. The mechanism also includes an upthrow or jack raising cam 70 provided on the carrier ring 65 (see Figure 2) for effecting, through the medium of the sliders 4, endwise movement of needles 3 selected for transfer. The selecting elements 59 and the cam 70 are so formed and arranged that all of said elements make contact with the cam but only those which are selected, i. e. engaged by an operative selecting cam 67 and pressed inwards so that they pivot backwards and are thereby positioned with their butts 61 immediately beneath and in operative relationship with the associated jack-like extensions 63, function to operate the corresponding sliders 4 and hence the plain needles, while the remainder are merely moved idly. The sliders 4 which are operated in the manner just described are raised just sufficiently to bring their transfer butts 4b into the range of the transfer cam 32. The cam surface 71 on the underside of one section of the ring 66 serves to return all of the selecting elements 59 to the normal level after they have passed over the upthrow or raising cam 70. Further details of the pattern mechanism may be obtained from a consideration of prior specification No. 2,143,832 aforesaid, and as will be understood this mechanism merely initiates transference of selected needles from the cylinder 1 to the cylinder 2, such transference being completed by the transfer cam 32. However, the patterning mechanism may itself be adapted to effect complete transference of needles. In Figure 2 the selecting point is indicated at S.

Means for shogging the rib cylinder needles and the dial needles are illustrated in Figure 1. Consider first the rib cylinder needles: the pinion 19 is freely mounted on the shaft 18 and has in association therewith a driving member 72 which is keyed on the shaft but adapted for axial adjustment automatically and to act between screws 73 on said pinion for the purpose of imparting independent turning movement to the latter as well as driving it so that the rib cylinder 2 can be shogged one or more times in one direction or the other to an appropriate extent. In this connection it may be mentioned that the shogging mechanism is similar to that described in the specification of prior United States Letters Patent No. 2,065,469. Thus, the driving member 72 consists of a reel slidably keyed at 74 on the driving shaft 18 and furnished with opposed stepped cams 75 and 76 adapted respectively to be engaged by rollers 77 and 78 on a pattern controlled sliding block 79 which is movable to different positions radially with respect to the axis of the shaft 18 so that the reel 72 is moved axially on the shaft in one direction or the other to different extents according to the position to which the sliding block 79 is moved. Mounted on the top of the reel 72 is a tongue 80 having stepped edges 80a, and the opposed screws 73 with which the pinion 19 is furnished are arranged for contact with these stepped edges so that the tongue 80 not only transmits the drive from the shaft 18 to the pinion 19, but when the reel 72 is moved axially it also turns the said pinion in relation to the shaft in one direction or the other to an extent determined by the stepped edges 80a and the amount of axial movement imparted to the reel. The sliding block 79 is mounted for movement horizontally within a bracket 81 supported by the top plate 13. For operating the block 79 there is provided a lever 82 which is pivoted at 83 upon the bracket 81 and formed with a forked lower extremity for engagement with a pin 84 projecting from the side of the block. The pin 84 works in a slot 85 formed in the bracket 81. The lever 82 is controlled by a tension spring 86 and is formed with a nose 82a adapted to be acted upon by studs or pegs such as 53^1 on the control drum 50. For shogging the dial 7 mechanism of a precisely similar character to and operating in the same way as that last described is provided. That is to say, the pinion 20 is freely mounted on the shaft 18 and has associated therewith an axially adjustable reel 87 which is keyed on the shaft and carries a stepped tongue 88 for action

between opposed screws 89 on the pinion 20, said reel being furnished with opposed stepped cams 90 and 91 adapted respectively to be engaged by rollers 92 and 93 on a sliding block 94 similar to the block 79. The block 94 is actuated by a spring-influenced pivoted lever 95 operable from the drum 50.

If desired there may be provided in or in association with the dial cam system of the machine cams for use in the transference of stitches from dial needles on to cylinder needles, e. g. in the plain cylinder 1. In the arrangement illustrated in Figure 4 the dial is furnished with dial needles 6^{11} adapted for the transfer of dial rib loops, and the dial cam system includes a transfer cam 96 for advancing all or desired ones of such needles to or beyond a clearing position during which operation the leading ends of the needles are deflected laterally to displace the rib loops thereon suchwise as to enable the latter to be penetrated and received by adjacent plain needles 3^1. As shown more clearly in Figure 5, each of the dial needles 6^{11} is formed with a shoulder 97 for catching and holding a rib loop to be transferred when the said needle is advanced by the transfer cam 96. Moreover, each needle 6^{11} is recessed at one side as indicated at 98 in Figure 5 to receive and guide the head of a companion plain needle 3^1 as this rises to penetrate and receive the rib loop to be transferred. The cam 96 may be of the bolt type and, in any event, is adapted to be rendered operative or inoperative as occasion demands. The dial needles 6^{11} may be prearranged or selected so that some only are advanced by while others miss the transfer cam 96 (when in operation). In this connection, for instance, the needles may be provided with butts 99 of respectively different lengths for selective operation by a transfer cam of the bolt type or, alternatively, the said needles may be furnished with tail butts 100 in respectively different planes heightwise for engagement with a thin transfer cam adapted for movement into one or another of such planes under suitable control, according to requirements. For deflecting the needles 6^{11} there is provided a fixed deflecting cam 101. The slope of the transfer cam 96 is somewhat greater than the slope in the same direction of the surface 101*a* of the deflecting cam in order that as dial needle heads are forced against and ride over said surface in the direction of the arrow in Figure 4 they will be deflected laterally. At r^1 is indicated a rib loop in the course of being stretched sideways and transferred to a companion plain needle 3^1. r^{11} purport to be transferred rib loops with plain needles 3^1 rising through the same during retraction of the adjacent dial needles 6^{11} by engagement of the butts 99 with the cam surface 102.

The modified dial cam system shown in Figure 6 includes, at a location just in advance of the clearing and stitch cams 46 and 47, a movable cam 103 which, when operative, advances dial needles 6 to clearing position to clear rib stitches from their latches, and a fixed cam 104 for casting stitches off said needles so that the latter are completely empty as they approach the adjacent knitting location. In the particular example illustrated, the cam 103 is of the swing type. When this cam is retracted to render it inoperative as indicated in full lines, the butts 6*a* approach the clearing cam 46 in the normal way; at such times, however, as the cam 103 is rendered operative by moving it to the position indicated in dot-and-dash lines, the butts 6*a* will be engaged thereby with the result aforesaid. A fixed or yieldable latch opener 105 is provided at the location shown to open the latches of empty dial needles previously acted upon by the casting-off cam 104, so as to enable said needles to receive yarn between their hooks and latches before being again retracted by the stitch cam 47. The latch opener 105 would, of course, also be used in the event of rib stitches being transferred to cylinder needles.

Figure 7 is a diagram showing a few of the needles of the three sets during knitting. The needles 3^1 operating in the plain cylinder 1 draw their loops p in a downward direction, the needles 3^{11} operating in the rib cylinder 2 draw their loops r in an upward direction and the dial needles 6 draw their loops r^1 inwards and rearwardly. That is to say, both the loops r and r^1 are drawn in opposite directions to the loops p. The pitch of the tricks or grooves in the cylinders is indicated at x, and eight successive trick positions are shown at J, K, L, M, N, O, P and Q. Two immediately adjacent dial needles 6 are shown and the opposed cylinder tricks at the position L are both devoid of a cylinder needle. Figure 8 shows the same needles and loops after the rib cylinder and the dial have been displaced circumferentially suchwise as to shog the cylinder rib loops r and the dial rib loops r^1 in respectively opposite directions. As will be seen, each of the loops r has been shogged to the extent of the pitch x of the cylinder tricks, while, by reason of lateral displacement of the two dial needles from the positions R and S to the positions T and U respectively, each of the loops r^1 has been shogged twice this extent. In this way a crossed shogged effect is produced. As the result of these shogging movements, opposed cylinder tricks at the position N are now both devoid of a cylinder needle.

According to the further arrangement shown in Figure 9, instead of providing a set of radially slidable dial needles and a dial cam system, needles 106 each provided with a hooked portion 106*a* disposed at an angle, e. g. at right angles, to the stem 106*b* are arranged for pivotal or rocking movement in a supplementary cylinder 107 fitted concentrically with respect to the plain and rib cylinders 1 and 2. The cylinder 107 is located within and extends upwards beyond the rib cylinder 2, so that the stems 106*b* of the needles extend parallel or substantially so to the common axis of these cylinders and their hooked extremities extend radially from the supplementary inner cylinder 107 towards the same location as the operative ends of the needles in the plain and rib cylinders. The stems of the needles 106 are provided with appropriate butt formations and cam means, or combined needle selecting and cam means suitably disposed in relation to the cylinder 107 for imparting pivotal or rocking movements to the needles about their fulcrum points 108 to enable them to knit, with, if desired, means for causing the needles to assume a tucking or non-knitting position at required times. Thus, in the specific construction depicted in Figure 9, the needles 106 are provided with frontal butts 109 at respectively different positions lengthwise thereon for engagement by a bank of cams 110 adapted to be actuated by pegs or pins 111 on a selecting drum 112. When, therefore, a cam 110 is moved inwards by a peg or pin 111 it will act upon a butt 109 at the corresponding level and thereby

press the stem 106b of the or each appropriate needle backwards so that said needle will pivot or rock about its fulcrum 108 suchwise as to effect an outward projection or advancing movement of the operative portion 106a thereof. By the provision of pegs or pins 111 of different lengths it would be possible to vary the extent of projection of the operative portions 106a of the needles according as to whether the latter were required to assume a clearing, tucking or any other advanced position. For effecting retraction of the operative portions 106a for stitch drawing and other purposes at required times, each of the needles 106 is provided at the back with a rearwardly directed angular butt formation 113 adapted to be acted upon by a cam or cams provided in or on a fixed support 114. This support is carried by a flanged part 115 which in turn is attached to a cylindrical carrier 116 depending from the top plate 13. At its upper end the stem of each needle 106 is formed with an outwardly directed butt 117 for engagement in an annular channel or groove 118 formed in a ring 119. This ring is carried by and is capable of heightwise adjustment upon brackets such as 120 mounted beneath the top plate 13. Engagement of the butts 117 in the channel or groove 118 determines and maintains the position of the needles 106 lengthwise. In this example, a gear wheel 121 keyed to the upper end of the rib cylinder 2 meshes with a pinion 122 mounted on the aforesaid driving shaft 18, while a flanged sleeve 123 to which the supplementary cylinder 107 is attached is toothed to mesh with a pinion 124 similarly mounted upon the said shaft. Preferably the two pinions 122 and 124 are freely mounted upon the driving shaft and driven by independent shogging mechanisms of the general character previously described.

In a still further embodiment of the invention (not shown) instead of or in addition to providing a set of needles in an inner dial or in a supplementary cylinder, and associated needle operating means as hereinbefore set forth, a set of needles may be provided in an annular bed or dial surrounding the plain and rib cylinders in conjunction with a corresponding dial cam system, or associated needle selecting and cam means, for imparting requisite movements to these needles.

It is mainly the intention to carry the invention into effect in the form of a machine of the rotary needle cylinder type in which case the shogging movements may be imparted through the medium of the gearing employed to drive the carrier or carriers for the needles to be shogged as hereinbefore specifically described. The invention may, however, be applied to machines of the stationary cylinder type in which case the carrier or carriers to be shogged would be appropriately mounted for that purpose in conjunction with gearing adapted to impart the shogging movements.

Either latch needles or bearded needles with appropriate pressing arrangements may be employed in the improved machine and, if desired, some of the double-ended needles may be latchless at one end so as to enable them temporarily to hold their loops when transferred from one cylinder to the other.

In the machines described there may be as many dial needles 6 or supplementary cylinder needles 106 as cylinder needles 3 and means may be provided for rendering selected needles inoperative as, for example, by diverting same to non-knitting positions or tracks for the purpose of enabling the remaining (operative) needles to co-operate to produce desired combinations of different effects. In such a machine, commencing with a full complement of needles in the plain cylinder 1, i. e. a needle in every trick or groove in said cylinder, selected needles are automatically transferred therefrom to the rib cylinder 2, thereby to provide two sets of needles, and the third set of needles is provided by operative dial needles 6 or supplementary cylinder needles 105 located directly opposite to or in line with empty tricks in the plain cylinder 1. By reason of the fact that needles operating in the plain cylinder draw their loops in one direction while the needles operating in the rib cylinder and in the dial or supplementary cylinder draw their loops in the opposite direction there can be produced a single continuously knitted web with plain and rib, plain and purl, rib and purl, or plain, rib and purl effects coursewise therein which form continuous contrasting longitudinal panels or stripes. By varying the co-operative relationship of the needles, as for example by regrouping the needles in the two cylinders 1 and 2 by transference or/and shogging either the third set of needles or both the said third set and rib cylinder needles, a diversity of such effects, including different rib combinations, or different combinations of effects including shogged effects, can be produced. Also, by intermittently varying the co-operative relationship of the needles correspondingly different effects can be produced walewise as well as coursewise, i. e. the continuity of the effects in the walewise direction is broken.

Moreover, by appropriate prearrangement of the cylinder needles and needles of the aforesaid third set, shogging the last mentioned needles in relation to the cylinder needles and conventional control of the latter, it is possible to produce welts. Therefore, by means of a suitable arrangement of the three sets of needles and variation of the co-operative relationship as by transfer or/and shogging in desired sequence, it is possible to produce either separately, or in strings, pieces of fabric comprising, successively, a welt, a rib border, e. g. of 2 x 2 or other rib combination, and a length such as the body part of a garment with different effects or combinations of effects, produced by the drawing of loops into different planes or/and lateral displacement of loops, coursewise or walewise, or both coursewise and walewise.

For instance, by providing groups of plain needles with intervening groups of rib cylinder needles and needles of the third set arranged alternately, 2 x 2, and shogging both the rib cylinder needles and the needles of the third set so as to cause the pairs of rib cylinder needles and third set needles to change places, knitted fabric including groups of wales or panels of plain stitches interspersed coursewise with panels of cable stitch effects can be produced. By transference of all the needles initially in the plain cylinder 1 to the rib cylinder 2, or by transferring some of such needles suchwise as to provide a 1 x 1, 2 x 2 or other arrangement of rib and plain needles, panels of purl stitches or 1 x 1, 2 x 2 or other rib combination can be produced in combination with cable stitch effects produced as aforesaid. By effecting such changes intermittently such effects can be produced in any desired sequence. Effects which can be produced in this way include, inter alia, plain or rib pat-

terns on a rib or plain ground, plain or purl patterns on a purl or plain ground, or desired combinations of these effects with or without shogged or cable stitch effects as aforesaid. Moreover, with a 1 x 1 arrangement of the plain, rib cylinder and remaining needles produced by appropriate transfer of cylinder needles and the shogging of the needles of the third set to the extent of one half of the pitch of the needles, it is possible to produce 1 x 1 rib fabric, or a 1 x 1 rib locking course followed by suspension of knitting on either the plain needles or the rib cylinder and third set needles, or on the plain needles and the rib cylinder and third set needles alternately for a desired number of courses to produce either a roll or a French welt.

The cam systems are such as to be capable of producing tuck effects, e. g. tuck rib, tuck purl, and other stitch variations such as held stitch and miss stitch effects, in addition to the production of the primary stitch effects as hereinbefore set forth. The needles of the third set may also be employed to knit up portions of yarn supplied to the cylinder needles 3 and floated at selected cylinder needles, as in the production of different colour effects coursewise in the knitted fabric, by supplying different yarns to different needles in the same set.

By way of example, a few portions of fabric produced on the first described machine will now be described with reference to Figures 10–13. The specific fabric structures illustrated will only be very briefly described since it is thought that any person skilled in the art of knitting machinery will readily understand the diagrams after a consideration of the foregoing detailed description.

Figure 10 purports to show the face or front of a portion of tubular knitted fabric as made and as it comes off the machine. At *w* is shown a welt in 1 x 1 formation followed first by a course *c* of knitting produced with the dial of the machine shogged to the extent of one needle wale, and then a rib border *rb* of 2 x 2 rib combination. Following this there is a ground of plain stitches *p* with a vertical stripe *s* comprising a pair of rib cylinder needle wales *rw* and an adjacent pair of dial needle wales *dw*. In the stripe *s* there are spaced crossed shogged effects *cs* produced by shogging the rib cylinder and the dial in opposite directions.

Figure 11 represents the inside or back of another portion of tubular knitted fabric viewed as it comes off the machine. Dial needle wales are indicated at *dw*, rib cylinder needle wales at *rw* and plain needles wales at *pw*. *dts* are tuck stitches produced on dial needles, whereas similar stitches produced on rib cylinder needles are indicated at *rts*. The crossed shogged effects depicted at cs^1 are here again produced by shogging the rib cylinder and the dial in opposite directions. By way of further exemplification it may be mentioned that the plain loops p^1 are held during shogging and that the loop *r* is a rib cylinder loop which is held while the rib cylinder is shogged.

The portion of tubular knitted fabric represented in Figure 12 comprises unpatterned areas W of knitting produced entirely on rib cylinder needles, similar areas X of knitting produced entirely on plain cylinder needles and a vertical stripe Y including shogged effects. Dial rib stitches are indicated at *dr* and at *pw* there is indicated a plain needle wale which, as will be seen, extends uninterruptedly throughout the fabric. The shogged effects are produced by shogging the dial to the extent of three needle wales first in one direction and then in the opposite direction at intervals of three courses. The laterally displaced dial rib stitches dr^1 therefore incline in opposite directions. The small openings Z, which are devoid of knitted loops but bridged by floats *f*, are there as the result of leaving appropriate tricks in the cylinders empty. With reference to Figure 12 it ought to be explained that the inside or back of the fabric is shown.

Finally, Figure 13 shows the face or front of a portion of tubular knitted fabric as it comes off the machine, this fabric comprising a shogged welt *sw* followed by a course of knitting wherein shogging takes place to effect a change to 2 x 2 rib knitting, a 2 x 2 rib border *rb* followed by a course of knitting wherein shogging takes place to effect a further change to 1 x 1 rib knitting and a portion *j* which may conveniently be described as two-colour jacquard fabric, i. e. fabric patterned in any desired manner and knitted from yarns of two contrasting colours.

What we claim then is:

1. A circular knitting machine comprising, in combination, two axially opposed cylinders, independent needles operable in each of said cylinders, a supplementary cylinder arranged within said opposed cylinders, a further set of independent needles operable in said supplementary cylinder, means for feeding yarn to the needles, and means for operating the needles in the respective cylinders.

2. A circular knitting machine comprising, in combination, axially opposed plain and rib needle cylinders, independent slidable double-ended needles in said cylinders, needle-actuating sliders in the cylinders, said sliders being capable of transferring double-ended needles from one cylinder to the other to provide two sets of needles, a dial which is arranged between and concentric with said opposed cylinders, a third set of independent needles slidably arranged with their hooks upwards in said dial, and independent cylinder and dial cam systems in association with the respective sets of needles for imparting the requisite movements thereto.

3. A circular knitting machine comprising, in combination, axially opposed plain and rib needle cylinders, independent slidable double-ended needles in said cylinders, needle-actuating sliders in the cylinders, said sliders being capable of transferring double-ended needles from one cylinder to the other to provide two sets of needles, a supplementary cylinder arranged concentrically within said opposed needle cylinders, a third set of needles each having a hooked portion disposed at an angle to a stem, said last mentioned needles being arranged for rocking movement in the supplementary cylinder suchwise as to extend substantially parallel to the axis of the cylinders with their hooked extremities directed towards the same location as the operative ends of the needles in the plain and rib cylinders, means for feeding yarn to the needles, and means for operating the needles in the respective sets.

4. A circular knitting machine comprising, in combination, axially opposed plain and rib needle cylinders, independent slidable double-ended needles in said cylinders, needle-actuating sliders in the cylinders, said sliders being capable of transferring double-ended needles from one cylinder to the other to provide two sets of needles, pattern controlled variable needle selecting mechanism in association with the plain cylinder

for initiating transference of needles from said cylinder to the rib cylinder, at least one other needle bed which is arranged in association with the plain and rib cylinders for knitting purposes, a third set of independent needles in said other bed, means for feeding yarn to the needles, and means for operating the respective sets of needles.

5. A circular knitting machine comprising, in combination, axially opposed plain and rib needle cylinders, independent slidable double-ended needles in said cylinders, needle-actuating sliders in the cylinders, said sliders being capable of transferring double-ended needles from one cylinder to the other to provide two sets of needles, a dial which is arranged between and concentric with said opposed cylinders, a third set of independent needles slidably arranged with their hooks upwards in said dial, cam means for effecting selective operation of the dial needles, a pattern unit for automatically controlling said cam means, connections between said pattern unit and the cam means, said connections extending through the rib cylinder component of the machine, and independent cylinder and dial cam systems in association with the respective sets of needles for imparting the requisite movements thereto.

6. A circular knitting machine comprising, in combination, axially opposed plain and rib needle cylinders, independent slidable double-ended needles in said cylinders, needle-actuating sliders in the cylinders, said sliders being capable of transferring double-ended needles from one cylinder to the other to provide two sets of needles, a third set of independent needles slidably arranged with their hooks upwards in said dial, said dial needles being furnished with tail butts formed at respectively different levels so as to be located in respectively different planes, a selecting cam movable into one or another of said planes for action upon these tail butts, a pattern unit for automatically controlling said selecting cam, and independent cylinder and dial cam systems in association with the respective sets of needles for imparting the requisite movements thereto.

7. A circular knitting machine comprising, in combination, axially opposed plain and rib needle cylinders, independent slidable double-ended needles in said cylinders, needle-actuating sliders in the cylinders, said sliders being capable of transferring double-ended needles from one cylinder to the other to provide two sets of needles, at least one other needle bed which is arranged in association with the plain and rib cylinders, a set of additional independent needles in said other bed, the operative portions of said additional needles being directed towards the same location as the operative portions of the double-ended needles, means for feeding yarn to the needles, and means for operating the respective sets of needles.

8. A circular knitting machine comprising, in combination, axially opposed plain and rib cylindrical needle beds, independent slidable double-ended needles in said cylindrical beds, needle-actuating sliders in said beds, said sliders being capable of transferring double-ended needles from one cylindrical bed to the other to provide two sets of needles, at least one other needle bed which is arranged in association with the plain and rib cylindrical beds, a set of additional independent needles in said other bed, the operative portions of said additional needles being directed towards the same location as the operative portions of the double-ended needles, means for feeding yarn to the needles, means for operating the respective sets of needles, and means for automatically effective relative shogging movements between the needle beds.

9. A circular knitting machine comprising, in combination, axially opposed plain and rib cylindrical needle beds, independent slidable double-ended needles in said cylindrical beds, needle-actuating sliders in said beds, said sliders being capable of transferring double-ended needles from one cylindrical bed to the other to provide two sets of needles, at least one other needle bed which is arranged in association with the plain and rib cylindrical beds, a set of additional independent needles in said other bed, the operative portions of said additional needles being directed towards the same location as the operative portions of the double-ended needles, means for feeding yarn to the needles, means including gearing for rotating the beds all at the same speed, means for operating the respective sets of needles, and means in association with the gearing whereby relative shogging movements between the needle beds can be automatically effected.

10. A circular knitting machine comprising, in combination, axially opposed plain and rib needle cylinders, independent slidable double-ended needles in said cylinders, needle-actuating sliders in the cylinders, said sliders being capable of transferring double-ended needles from one cylinder to the other to provide two sets of needles, a dial which is arranged between and concentric with said opposed cylinders, a third set of independent needles slidably arranged with their hooks upwards in said dial, said dial needles being furnished with knitting butts of respectively different lengths, means for feeding yarns to the needles, and independent cylinder and dial cam systems in association with the respective sets of needles for imparting requisite movements thereto, said dial cam system including cam means for engagement with desired ones of said knitting butts whereby the dial needles can be actuated selectively for patterning.

11. A circular knitting machine comprising, in combination, axially opposed plain and rib needle cylinders, independent slidable double-ended needles in said cylinders, needle-actuating sliders in the cylinders, said sliders being capable of transferring double-ended needles from one cylinder to the other to provide two sets of needles, a dial which is arranged between and concentric with said opposed cylinders, a third set of independent needles slidably arranged with their hooks upwards in said dial, said dial needles being furnished with knitting butts of respectively different lengths, means for feeding yarns to the needles, and independent cylinder and dial cam systems in association with the respective sets of needles for imparting requisite movements thereto, said dial cam system including a movable transfer cam for engagement at appropriate times with desired ones of said knitting butts whereby dial needles can be selectively advanced, and an associated cam for effecting deflection of needles so advanced during transference of stitches from said needles to cylinder needles.

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