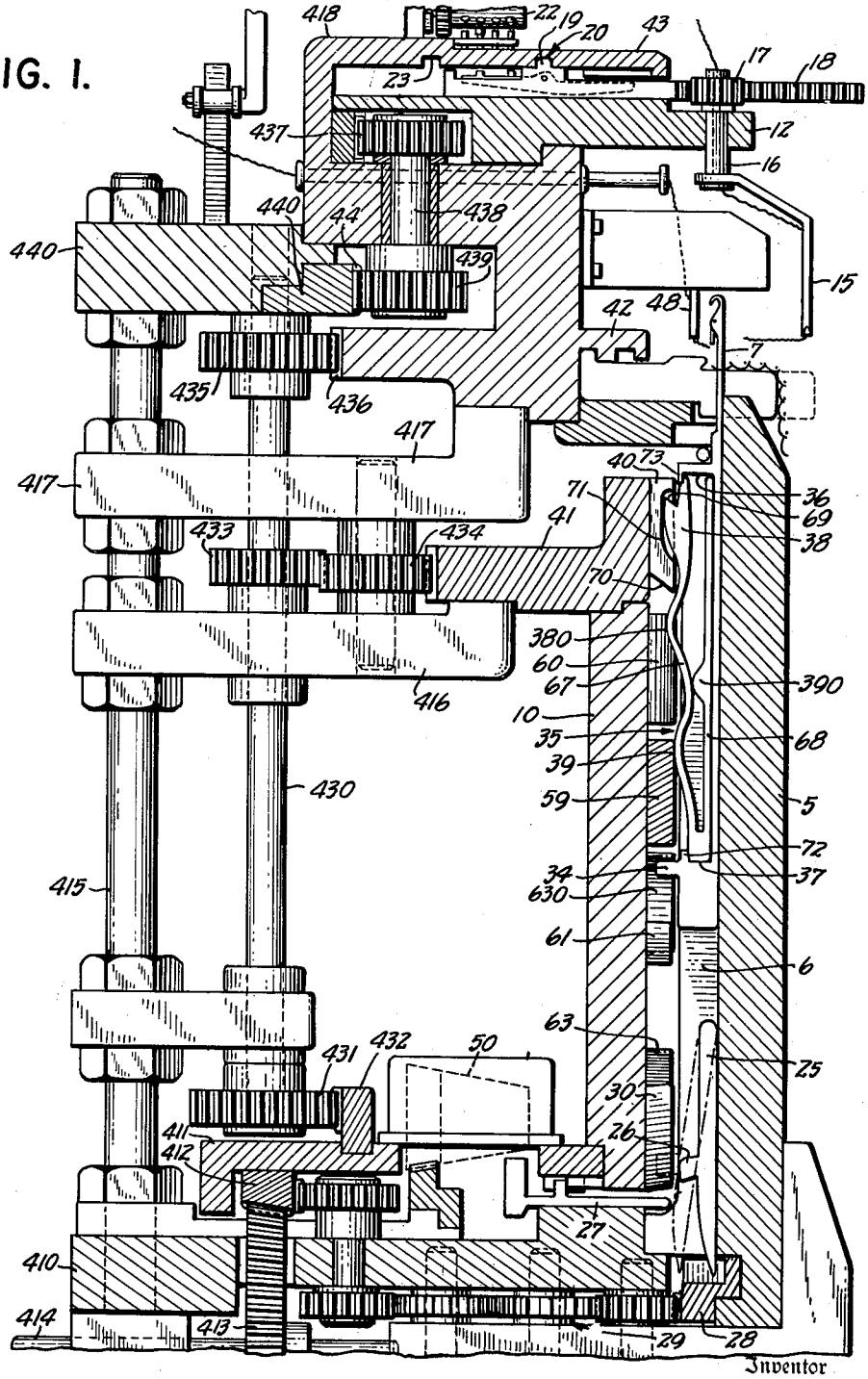
April 3, 1956 V. LOMBARDI 2,740,277

KNITTING MACHINE AND METHOD

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FIG. 1.



Inventor

By VINCENT LOMBARDI

Robert Irving Williams

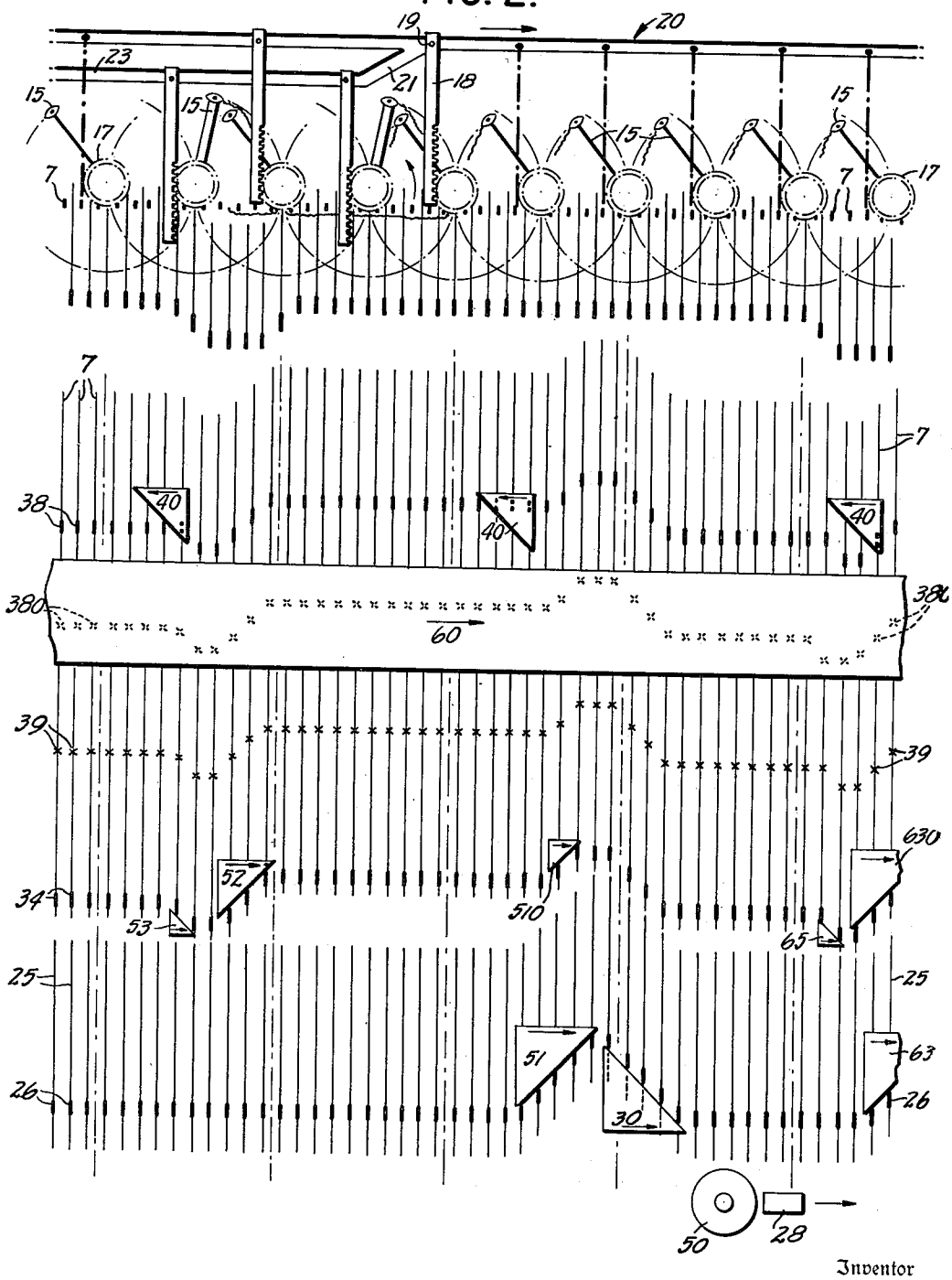
Attorney

April 3, 1956 V. LOMBARDI 2,740,277

KNITTING MACHINE AND METHOD

Filed June 8, 1951 9 Sheets-Sheet 2

FIG. 2.



Inventor

VINCENT LOMBARDI

By Robert Irving Williams

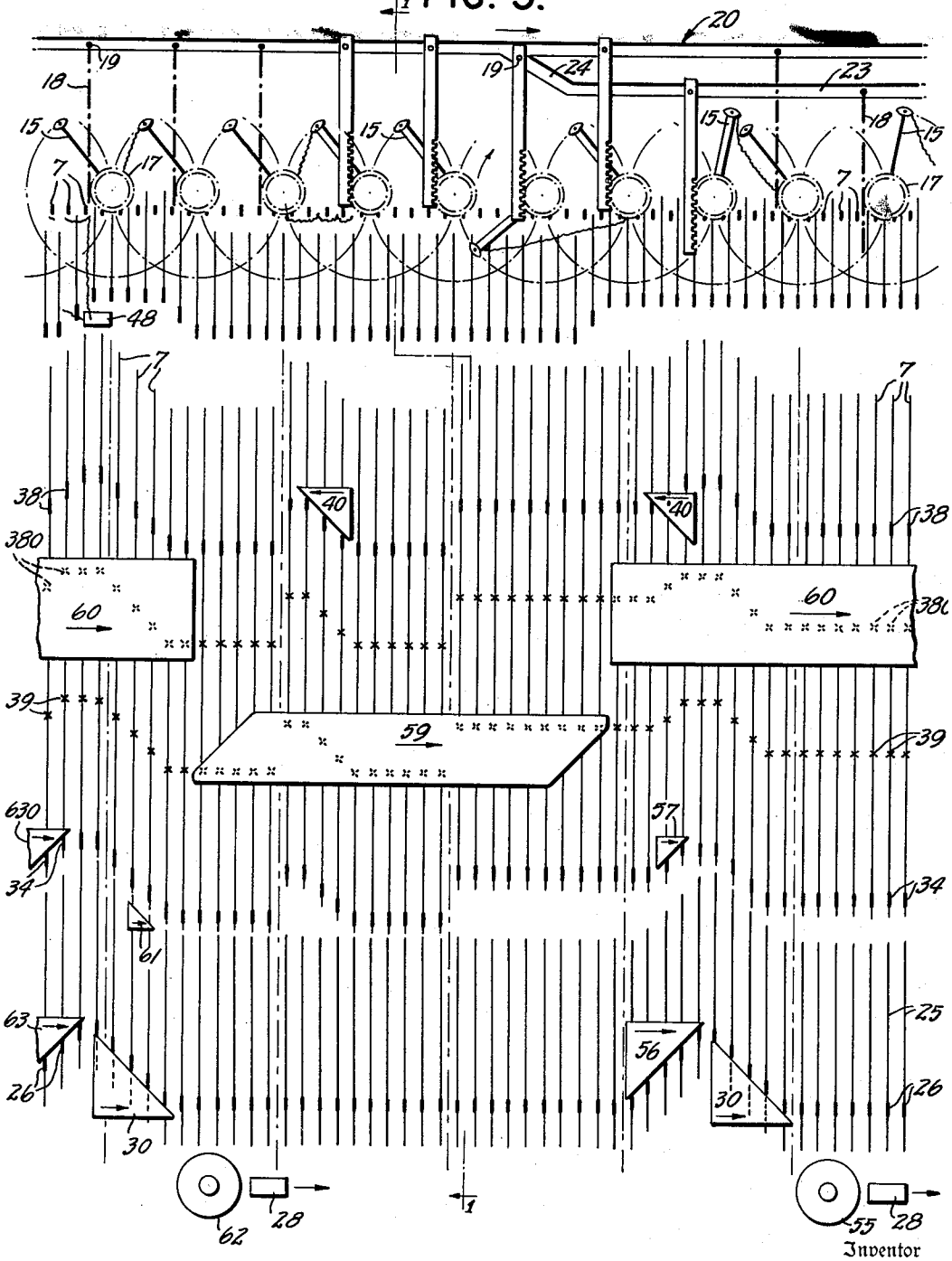
Attorney

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KNITTING MACHINE AND METHOD

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FIG. 3.



Inventor

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KNITTING MACHINE AND METHOD

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FIG. 5.

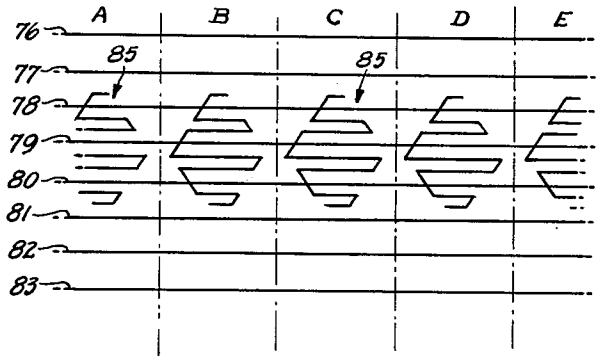


FIG. 4.

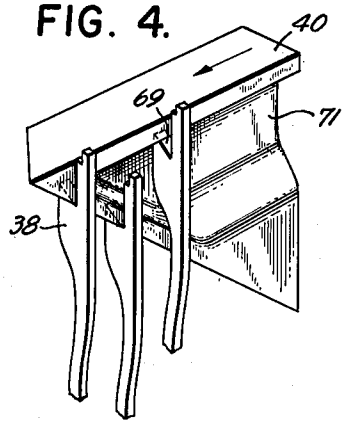


FIG. 6.

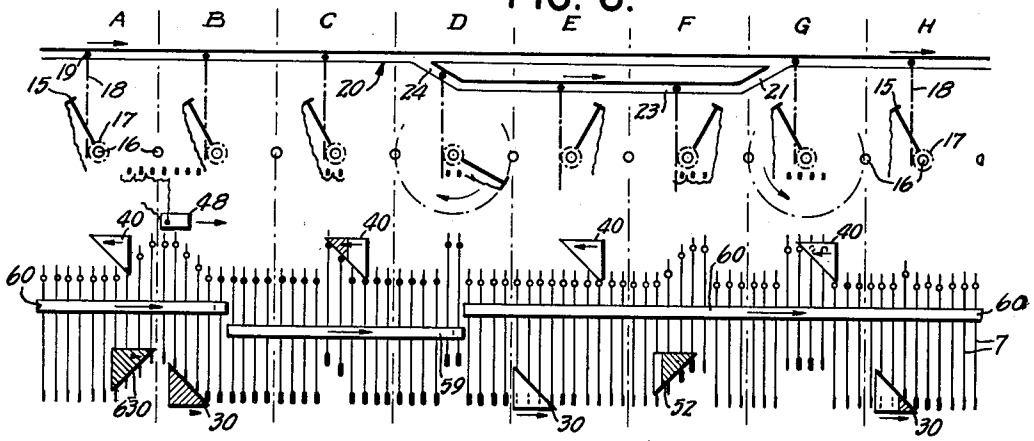
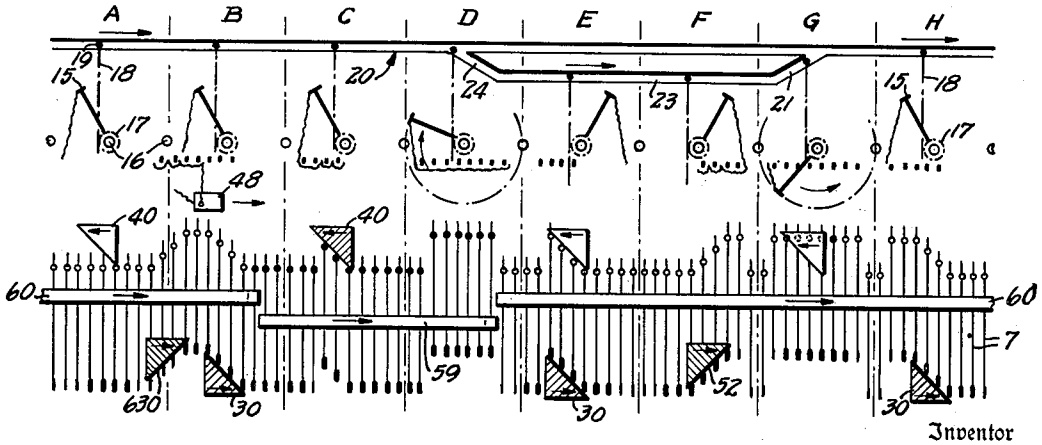


FIG. 7.



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KNITTING MACHINE AND METHOD

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FIG. 8.

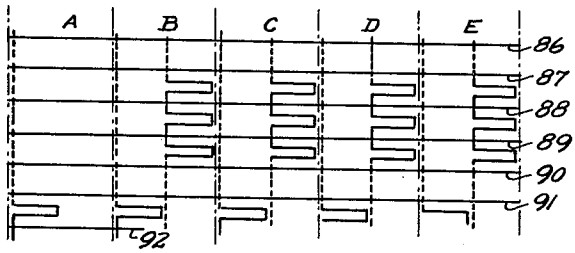


FIG. 9.

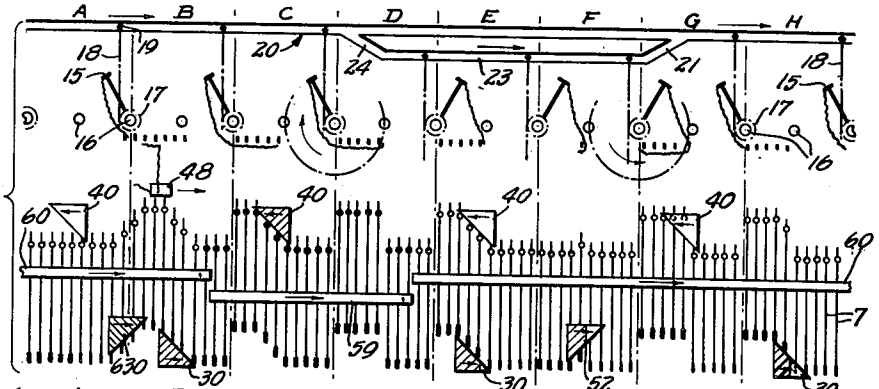


FIG. 10.

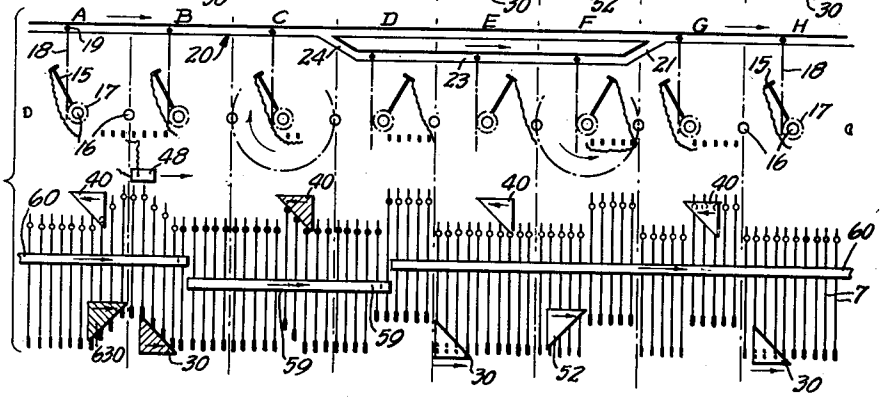


FIG. 11.

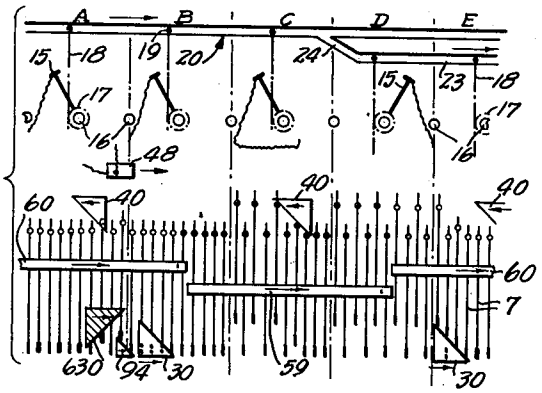
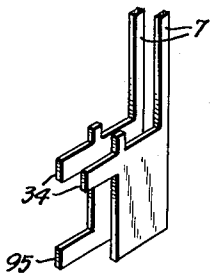


FIG. 12.



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April 3, 1956 V. LOMBARDI 2,740,277

KNITTING MACHINE AND METHOD

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FIG. 13.

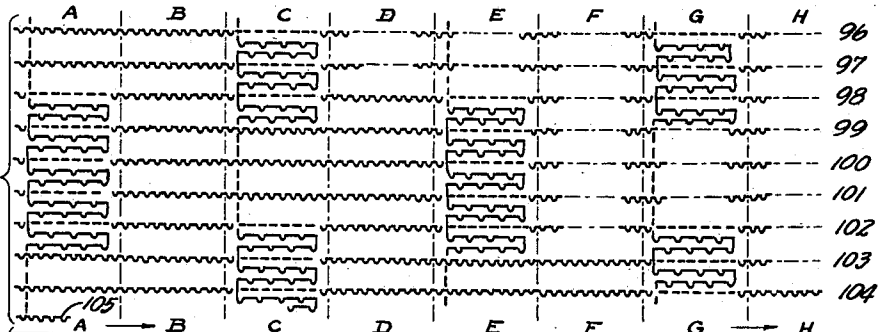


FIG. 14.

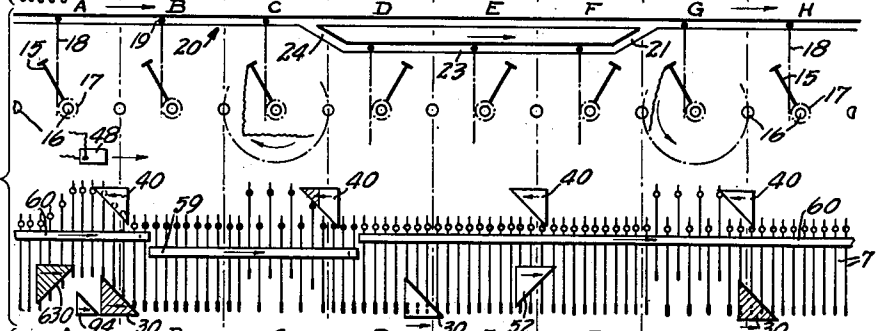


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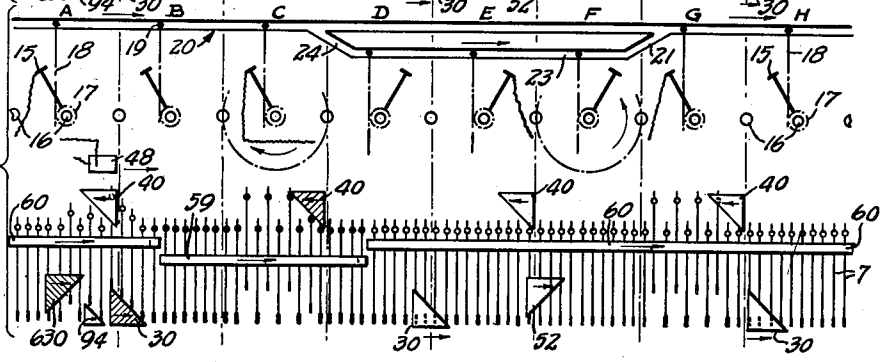


FIG. 16.

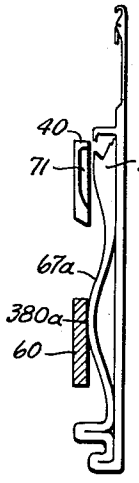


FIG. 17.

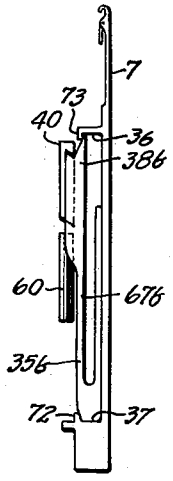
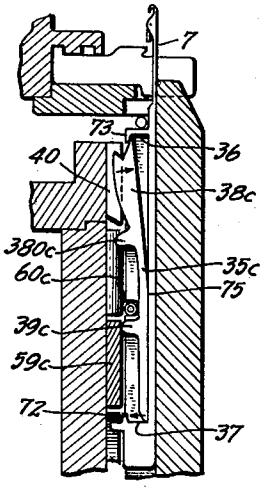


FIG. 18.



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KNITTING MACHINE AND METHOD

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FIG. 19.

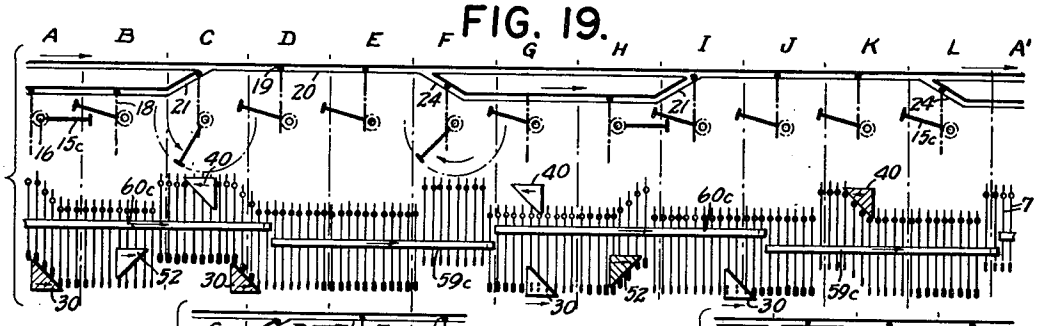


FIG. 20.

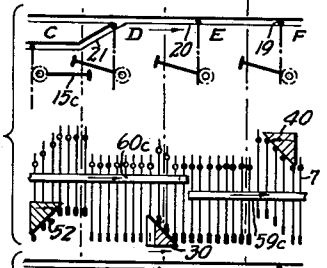


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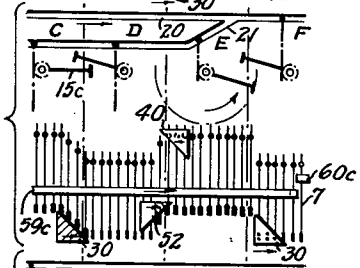


FIG. 22.

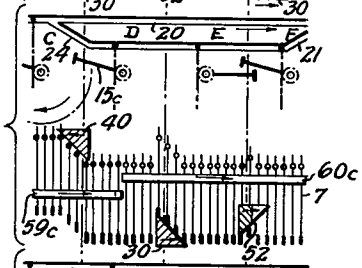


FIG. 23.

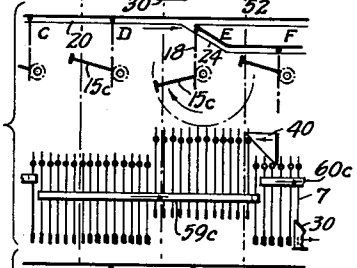


FIG. 24.

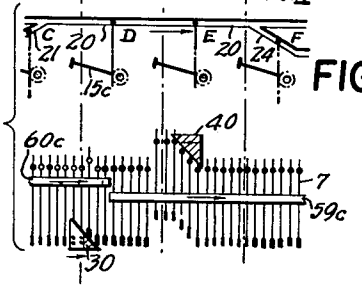


FIG. 25.

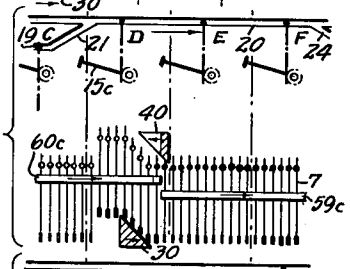


FIG. 26.

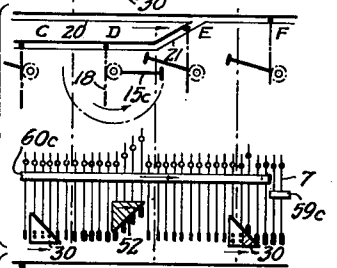


FIG. 27

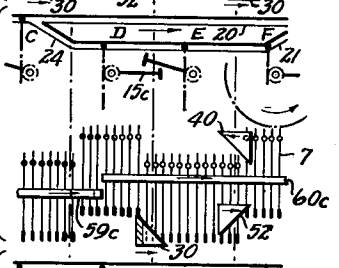


FIG. 28.

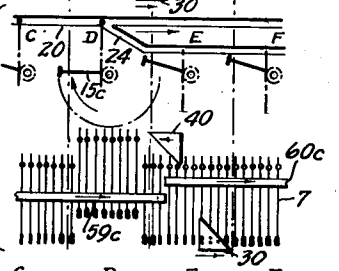
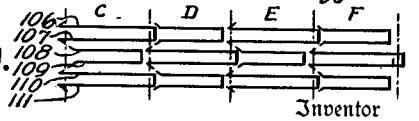


FIG. 28a.



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April 3, 1956 V. LOMBARDI 2,740,277

KNITTING MACHINE AND METHOD

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FIG. 29.

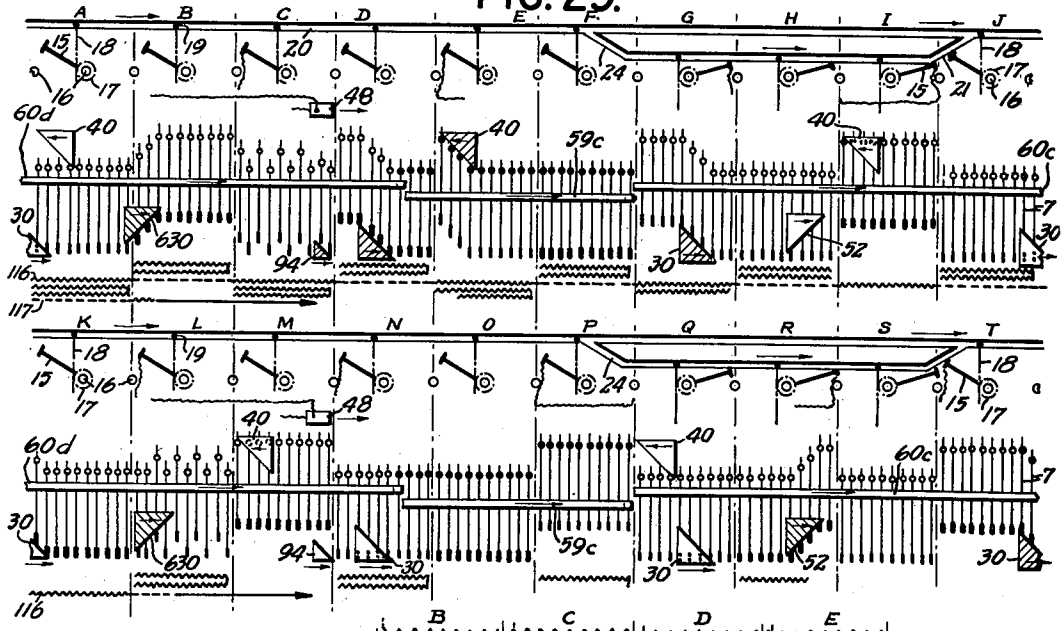


FIG. 30.

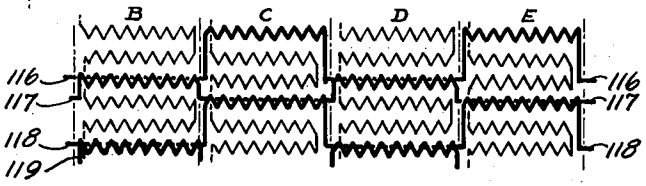


FIG. 31.

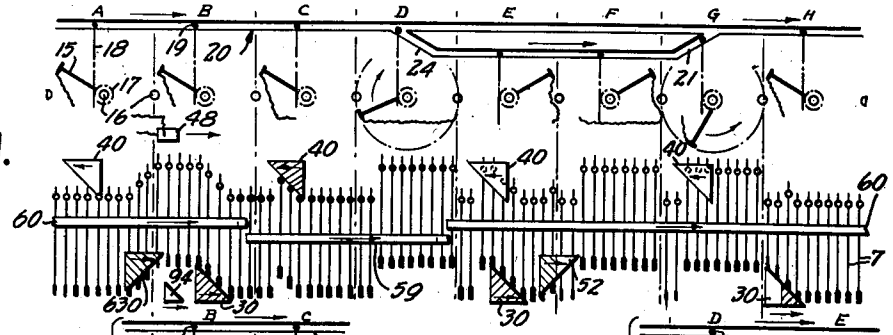


FIG. 32.

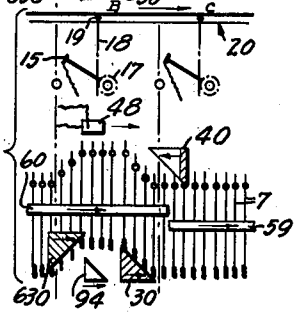
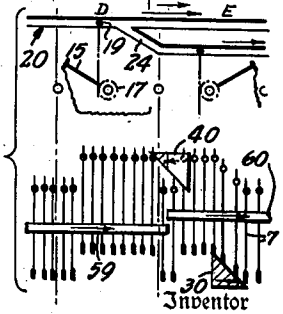


FIG. 33.



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April 3, 1956 V. LOMBARDI 2,740,277

KNITTING MACHINE AND METHOD

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FIG. 34.

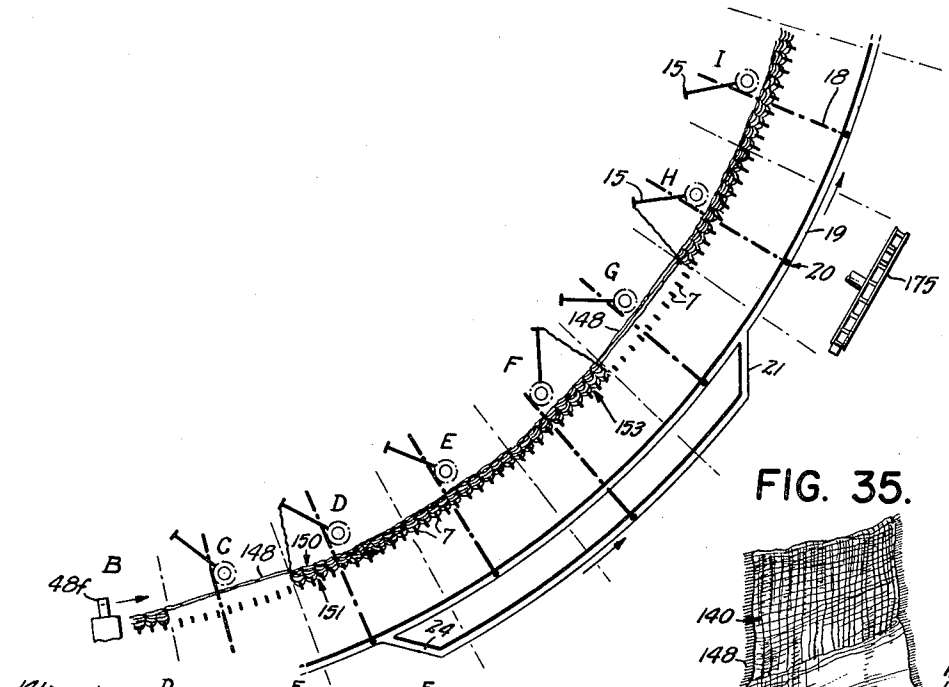
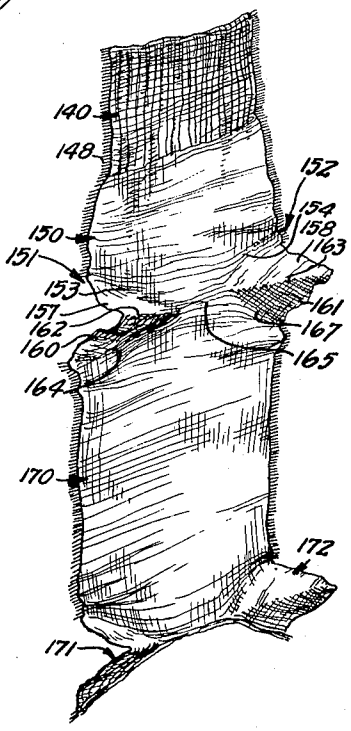


FIG. 35.



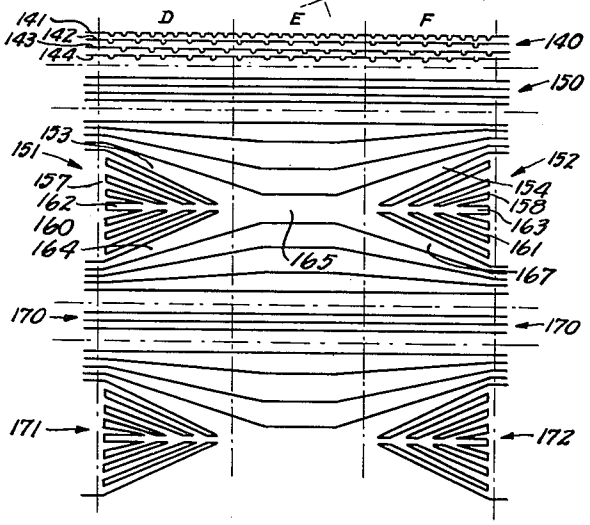


FIG. 36.

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United States Patent Office

2,740,277

Patented Apr. 3, 1956

2,740,277

KNITTING MACHINE AND METHOD

Vincent Lombardi, South Miami, Fla.

Application June 8, 1951, Serial No. 230,543

29 Claims. (Cl. 66—50)

This invention relates to knitting machines and to correlated inventions and discoveries appertaining thereto.

In embodying wrap yarns into a knitted fabric by wrap fingers which first swing in one direction past a multiplicity of needles to feed yarn thereto and then swing in the opposite direction past these needles to feed yarn thereto, the knitting of the yarn fed by the forward swing of the wrap-feed is relatively easily performed by an ordinary knitting cam, but the knitting of the yarn fed to the needles by the return swing of the wrap-feed is beset with difficulties whenever the yarn is to be knit by a considerable number of needles. This is because, if an ordinary stitch cam is employed, the needle nearest the yarn-feed will knit first, and, once the yarn has been knitted into the fabric at this point, the yarn can no longer be pulled out freely from the yarn-feed for the knitting of loops by successive needles. It is accordingly important that the retractive or stitch portion of the knitting wave for this yarn progress in the opposite direction to the retractive knitting wave for the forward or advance swing of the wrap feed, and, especially, in a direction opposite to that of the normal knitting waves.

I have heretofore proposed the provision of means providing certain solutions of these difficulties, but there are many situations wherein demands for simplicity, compactness and general effectiveness of operation require an improved type of mechanism, and it is to the provision of such mechanism that the present invention is directed.

With the foregoing and other considerations in view, the present invention contemplates the provision of simple and effective means for imparting a retractive wave to knitting elements (e. g. needles, jacks, or sinkers), which wave moves in an opposite direction to the normal waves, and, in the more specific aspects of the invention, moving in a direction opposite to that wave whereby the needles are advanced to receive yarn for retraction. As exemplified, the invention provides means in the needle slots having portions which move between an operative position in which a reverse retractive cam will retract such means (and the needles therewith) and an inoperative position wherein a reverse retractive cam will not be operative thereon.

While the invention is exemplified in connection with a stationary cylinder machine comprising retractive cam means moving in the opposite direction to a rotating cam ring, it will be appreciated that the invention is not limited thereto and that it is capable of embodiment in a wide variety of types of knitting machines.

The invention further contemplates the provision of knitting methods whereby hosiery and other knitted articles may be produced with exceptional facility and effectiveness; and in certain of its aspects contemplates the provision of novel and desirable types of design fabrics, hose, and other knitted articles.

The invention accordingly comprises the features of construction, combination of elements, and arrangement of parts, which will be exemplified in the constructions

hereinafter set forth and the scope of the application of which will be indicated in the claims.

For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed description taken in connection with the accompanying drawings, in which:

Figure 1 is a cross-section through one side of the needle cylinder of a form of circular knitting machine embodying the invention;

Fig. 2 is a diagrammatic view of one portion of the needle bed and wrap-feed dial illustrating the operating means and the manner in which they function;

Fig. 3 is a similar view of a portion of the machine disposed just to the left of the portion illustrated in Fig. 2;

Fig. 4 is a perspective inside detail view of a reverse cam of the machine of Figs. 1–3;

Fig. 5 is a schematic view of one form of fabric which may be formed by the machine of Figs. 1–4;

Figs. 6–7 are schematic views further illustrating the operation of the machine in the formation of the fabric of Fig. 5;

Fig. 8 is a schematic view of another form of fabric which may be formed by the machine of Figs. 1–4;

Figs. 9 and 10 are schematic views illustrating the operation of the machine in the formation of the fabric of Fig. 8;

Fig. 11 is a schematic showing of a modified arrangement similar to that of Figs. 2 and 3;

Fig. 12 is a perspective view showing the formation of the butts on alternate needles in the machine of Fig. 11;

Fig. 13 is a diagrammatic view of still another form of fabric which may be formed by the machine of Fig. 11;

Figs. 14 and 15 are schematic views illustrating the operation of the machine of Fig. 11 to produce the fabric of Fig. 13;

Fig. 16 is a detail view of a combined needle and jack;

Fig. 17 is a detail view of a needle with an alternative form of jack;

Fig. 18 is a view similar to Fig. 1 showing another modification;

Fig. 19 is a schematic view showing an arrangement of operating means usable in connection with the form of construction illustrated in Fig. 18 and showing the operating means and needles in a given position;

Figs. 20–28 are schematic views showing the needles of a portion of Fig. 19 in various successive stages in the operation;

Fig. 28*a* is a diagrammatic view of the fabric produced;

Fig. 29 is a schematic view showing a modified arrangement similar to that of Fig. 19 and showing yarn courses as knitted thereby;

Fig. 30 is a diagrammatic view of the courses consolidated in a fabric;

Figs. 31, 32, and 33 are schematic views of a machine similar to that of Fig. 29 showing a particularly compact arrangement for the formation of fabrics having design portions;

Fig. 34 is a schematic top view of a portion of a machine similar to that of Figs. 1–3 operating to knit a series of sock blanks;

Fig. 35 shows a sock blank knitted on the machine of Fig. 34;

Fig. 36 is a schematic view of the sock blank of Fig. 35.

While the machine is not limited to stationary cylinder machines or to other details illustrated, it is exemplified in a machine of the general type shown in my Patents 2,130,769, issued September 20, 1938, 2,231,672, issued February 11, 1941, 2,231,673, issued February 11, 1941, and 2,373,126, issued April 10, 1945, among others.

In the form of construction exemplified in Figs. 1–4

there is exemplified a machine comprising a stationary needle cylinder 5 having slots 6 in which latch needles 7 are slidably mounted for advancement in an upward direction to receive the yarn and for retraction downwardly. Rotatably mounted for counter-clockwise movement about said cylinder is a cam ring 10, and mounted for movement therewith are main yarn feeds 48 in the present instance.

On a stationary annular dial 12 disposed without and slightly above cylinder 5 are mounted a plurality of wrap feeds 15 carried on rotary posts 16 and adapted to be swung in a forward (counter-clockwise) direction from a point inside the row of needles, outwardly thereof, past a group of needles in the direction of cam-ring movement, and thereafter inside the row of needles again, to feed yarn to any or all of the needles of said group, depending on the selection thereof; and to be swung over a return course in a reverse (clockwise) direction past the same needles to feed yarns to any or all thereof, depending on the needle selection. The wrap-feeds 15 may be operated by suitable mechanism such, among others, as described in my said Patent No. 2,373,126; but for the sake of facility of illustration is exemplified as an arrangement whereby a control member is directed into a desired one of a pair of tracks by a suitable selective means such as a pattern drum. The exemplified mechanism includes pinions 17, racks 18, and pins 19 guided in a guide groove arrangement 20 and arranged to be selectably carried into a cam groove 21 pursuant to the selective operation of a pattern drum 22. From the cam groove 21 whereby forward (advance) swings are imparted to the selected wrap feeds, the pins enter a guide groove 23 which carries them to a cam groove 24 whereby the return swings are imparted to the selected wrap feeds.

The needles are selected for advance movement by means of jacks 25 formed with butts 26 adapted to be pushed within the needle slots 6 by means of pushers 27 which are selected for operation by a pattern drum 50 forming a part of the actuating mechanism rotating with the cam ring. Such mechanism may be of any of a number of suitable characters, such, for example, as those illustrated in my said Patents 2,231,672, 2,231,673, and 2,373,126. As exemplified, it is of the character disclosed in my Patent No. 1,797,006, dated March 17, 1931. The selection of the jacks occurs following the movement of all the jacks outwardly, as by a cam 28 driven by gear train 29 and rotating with cam ring 10. After certain jacks have been pushed in by pushers 27, the remaining jacks (those selected for operation) whose butts are still out of the needle slot, will be advanced by an advancing cam, as at 30, and the selected jacks will advance their needles with them. Normal retraction of the needles is caused by ordinary stitch cams 52 carried on the cam ring 10 and acting on needle butts 34.

In order to retract the needles in a reverse direction following the return swing of a wrap-feed, there are provided in the needle slots special jacks 35 extending between upper shoulders 36 and lower shoulders 37. Each jack is formed with an upper butt 38 which is movable into its slot 6 by pressure on an upper pressure surface 380 and out of its slot by pressure on a lower pressure surface 39 by which it may be forced against a protuberance 390 to thrust its butt 38 outwardly. Downward pressure on the top of the butt 38 when it is in operative position (out of the slot) will result in pushing the jack downwardly against the lower shoulder 37, carrying the jacks and the needles down into retracted position. In order to bear against the top of the butts 38 to retract those jacks 35 which have been advanced with their respective needles and which also have been swung to move their butts 38 outwardly, there are provided a series of retracting cams 40 on a reverse cam ring 41.

In order to support and drive both the reverse cam ring 41 and the wrap feeds in a simple and effective manner, and at the same time to permit easy access to

the working parts of the machine when the machine is not operating, there is provided in the present instance a supporting and driving arrangement which is mounted on an annular rim 410 secured to the cylinder 5 and forming the bed for the pushers 27. The rim 410 rotatably supports an annulus 411 carrying cam ring 10 and driven thru toothed ring 412 by a gear 413 on shaft 414. From the rim 410 posts 415 extend upwardly to support a plate 416 which carries the reverse cam ring 41. Posts 415 also support a plate 417 which supports a casting 418 carrying sinker cam ring 42, the wrap-feed dial 12, and a wrap-feed cam plate 43 in which the grooves 20—24 are formed. Journaled in the plates 416 and 417 is a shaft 430 keyed to a gear 431 driven from a toothed rack 432 on annulus 411 and carrying gears 433 driving reversing gear 434 which drives reverse cam ring 41. Shaft 430 also carries gear 435 meshing with toothed rack 436 on casting 418 to which the sinker cam ring 42 and the wrap feed cam ring 43 are fixed. The wrap feed dial 12 is supported on the casting 418 and is held stationary with respect to the cylinder 5 by a gear 437 on shaft 438 which is journaled in casting 418 and carries gear 439 meshing with toothed ring 44 on plate 440 secured to posts 415.

As exemplified, each wrap feed overlaps half of the swing of two other wrap feeds, and all are mounted so that they pass between raised needles, spreading the needles as they do. In the exemplified operation, only every other wrap feed is selected, so as to give a maximum efficiency and at the same time to allow for proper timing of the various cams as they move in opposite directions. In the present instance, moreover, there are provided, in addition to the wrap feeds, main yarn-feeds 48 which may knit continuous rows of loops. It will be appreciated, however, that various arrangements of wrap feeds, with or without main feeds, may be employed without departing from the invention.

While, for the sake of facility of illustration there are exemplified only ten needles within the swing of a wrap feed, it will be understood that many more will ordinarily be used in practice and that wrap feeds having swings encompassing up to one hundred or more needles may be readily employed in accordance with the invention.

In the exemplified machine a cam 28, a pattern drum 50, and an advancing cam 30 is provided before each cam groove portion 21. This is followed by a return cam 51 for the jacks and by a leveling cam 510; and after each cam groove portion 21 there is provided a stitch cam 52 and a restoring cam 53. Before each cam groove portion 24 there is provided a cam 28, a drum 55, an advancing cam 30, a return cam 56 for the jacks, a leveling cam 57; and after the operation of each cam groove portion 24 the surfaces 39 of the jacks 35 are pressed by an arcuate cam 59 to swing their butts 38 outwardly to be acted on by whichever cam 40 next reaches them. In order to positively prevent the cams 40 from acting at other times, an arcuate cam 60 presses against the surfaces 380 of the jacks to hold the butts 38 within the slots 6. As soon as a cam 40 has had an opportunity to act, the cam 59 terminates and a cam 60 again becomes operative. A restoring cam 61 may be provided at this point.

Following the completion of the knitting of the return yarn, there is provided in the present instance a pattern drum 62, an advancing cam 30, and a jack-retracting cam 63 operative before the passage of a main feed 48, and a stitch cam 630 and restoring cam 65 operative thereafter.

Any suitable number of drums 50, 55, and 62 and their associated feeding and manipulating means may be provided about a machine.

Each of the jacks 35 as exemplified comprises a spring arm 67 (which has a slight inward resiliency in the present instance) forming one prong of a fork the other prong 68 of which lies in the base of the slot and provides the pivot 390 in the present instance. As will be ap-

parent, the action of the cam 60 on the spring arm 67 will press and hold the butts 38 within their slots whereas the action of the cam 59 will urge them outwardly. The butts 38 in the present instance are formed with inwardly-sloping upper surfaces 69, and the cams 40 are formed with similar bottom surfaces 70 whereby, once a cam 40 has engaged a surface 69 of a butt 38, it will not release the same until it has completed its retractive action on the jack and the needle, even tho a cam 60 has come into play in the meantime. Similarly, if a cam 59 comes into play while a cam 40 is in front of a butt 38, the resiliency of the arm 67 will enable the butt to remain within the slots without breaking the arm until the cam 40 has passed.

Each cam 40 is provided with a hollowed-out portion 71 (Fig. 4) extending from a point just behind its cam surface to the opposite edge surface thereof, to relieve frictional pressure thereon of the arms 67 of any jacks 35 which are swung out by a cam 59 or by their own resiliency while the cam 40 is passing. In order to assure that the jacks remain in the slots each needle carries a lower retaining lug 72 and an upper retaining lug 73.

Pursuant to the invention, by the provision or selection of particular wrap feeds and the proper selection of needles, various novel types of fabric with bulges or other design features may be very effectively produced.

In accordance with the invention there may be produced a wide variety of design fabrics including fabrics of the character shown in my Patents 1,728,293, 1,981,057, 2,066,408, 2,229,105, 2,250,588, and 2,378,780, and in my application Serial No. 138,468, filed January 13, 1950. An additional type of design fabric which may be produced is shown in Fig. 5 wherein main yarn is shown knitted in jersey loops thruout the fabric as indicated in courses 76 thru 83; and wrap yarn is shown knitted in diamonds 85 centrally of these courses as in sectors A, B, C, D, and E, each of which has the extent of a wrap feed swing. Between courses 76 and 77, no needles are selected for the reception of wrap yarn, so that plain fabric is knitted. Between courses 77 and 78, no needles are advanced for reception of wrap yarn during the forward swing of the yarn feeds, but the fifth and sixth needles (in a sector of ten needles) are advanced for reception of yarn during the return swings of the wrap feeds (see sector D, Fig. 6) to knit jersey loops. Between the knitting of courses 78 and 79 of main yarn, the four central needles are advanced for the reception of yarn during the forward swings of the wrap feeds to knit jersey loops and the six central needles are advanced for reception of yarn during the return swings of the wrap feeds. Between courses 79 and 80, the eight central needles are advanced for reception of yarn during the forward swings of the wrap feeds (see sector G, Fig. 7) and six needles are selected for the reception of yarn during the return swings of the wrap feed (see sector D, Fig. 7). Between courses 80 and 81 of the main yarn, four needles are advanced for the reception of yarn during the forward swings of the wrap feeds (see sector G, Fig. 6) and two needles are raised for the reception of yarn during the return swings of the wrap feeds (see Fig. 6). Other courses of main yarn, as shown at 82 and 83, are thereafter knitted without any selection of needles (or else without any selection of yarn feeds) therebetween. In this manner there will be knitted a fabric with bulge designs somewhat similar to those of my co-pending application, Serial No. 138,468, filed January 13, 1950. In the exemplified type of fabric this design will be diamond-shaped and will appear in each sector.

Figs. 6 and 7 show the operation, in sectors A–H of the mechanism of Figs. 1–4 at the above indicated stages in the formation of a fabric such as shown in Fig. 5. The showing is simplified for easy understanding, the jacks and needles being combined, and selected yarn feeds being indicated by T-shaped arms. In these and subsequent figures, those needles, the lower jacks 25 of which have been or will be left selected for operation by the succeeding cam 30, are indicated by short heavy lines at their lower ends, and those needles, the lower jacks 25 of which have been or will be pushed into unselected position so as not to be operated by the succeeding cam 30, are indicated by light lines at their lower ends. The upper jacks 35 which are under the influence of a cam 59 are indicated by black dots and the upper jacks 35 which are under the influence of a cam 60 are indicated by small circles. Needles which are to any extent above their normal retracted position are also shown in top view within the swing of a wrap feed. Cams which are inoperative are shown white, whereas cams (other than inlaying cams), which are operative are shown shaded. As will be seen, certain of the cams are shown partly white and partly shaded when they are shown in positions in which they are operating over only part of their full extent.

In Fig. 8 there is exemplified a type of design fabric in which both the alternate wrap feeds (those in the center of the sectors) and intermediate wrap feeds (those on the lines between the sectors) are utilized; and in Figs. 9 and 10 there are shown two stages in the operation of the mechanism of Figs. 1–4 for the formation thereof. The fabric comprises courses of (white) main yarn of which courses 86—92 are shown; courses of (red) wrap yarn from alternate wrap feeds knitted in the (five) wales of the right-hand half of each of sectors B, C, D, and E between courses 87 and 88, 88 and 89, and 89 and 90; and courses of (blue) wrap yarn from intermediate wrap feeds knitted in the (five) wales of the left-hand half of sectors A, B, C, D, and E between a series of successive pairs of main yarn courses, as courses 91—92 et seq. Fig. 9 shows the operations in the knitting of the wrap yarn in the left-hand wales of a sector (as between courses 91 and 92) with the intermediate wrap feeds (those located on the dividing lines between sectors). As will be seen most clearly in sectors D and G, only the left-hand half (five) of the needles in a sector are raised when the intermediate yarn feed is to be swung. This avoids feeding yarn to needles in two sectors at once which would result in negativing the advantage of using the reverse cams 40. Since these cams are positioned just two sectors apart and are designed for operation of the needles over a full sector, they would retract the five right-hand needles in a left-hand sector before the five left-hand needles in a right-hand sector are retracted. In Fig. 10, the cams are shown operating to incorporate the design in the right-hand half of a sector, as between the courses 87 and 88, by knitting from alternate wrap feeds on the right-hand five needles in each sector. As will be seen, very attractive designs incorporating rectangular bulges and other arrangements of symmetrical and asymmetrical bulging and flat design figures may be formed in this manner.

Flat designs may be readily produced by inlaying the main yarn in the design portions wherein the loops of wrap yarn are knit. In order to inlay the main yarn, there may be provided an inlay cam 94 (Fig. 11) in advance of each main yarn feed 48 and its retracting cam 630; and a special butt 95 may be provided on every other needle as shown in the left-hand needle of Fig. 12. The cam 94 will be of such extent as to move to tucking position each needle which carries a butt 95 but which has not been raised to knitting level by a jack 25 under the influence of a cam 30. If the jacks 25 are selected, the cam 30 will advance the needles; but, if the jacks 25 are left unselected, the extra-butt needles will be moved to tucking position as will be apparent from Fig. 11.

In Fig. 13, there is exemplified a novel form of flat design fabric which may be produced in accordance with the invention by the utilization of the cam 94 acting selectively on butts 96 on alternate needles as exemplified in Figs. 11 and 12. The fabric of Fig. 13 comprises

courses 96—105 of main yarn which is knit into jersey loops except in design portions and which is inlaid in the design portions between wrap yarn courses knitted in pineapple stitch fashion. In sector A, the main yarn is knit in all wales in courses 96, 97, 103, 104, and 105 and in the first and last wales of courses 98, 99, 100, 101, and 102, and inlaid in the remaining wales of these courses; and wrap yarn is knit on needles 2, 4, 6, and 8 in its forward course and on needles 9, 7, 5, and 3 in its return course in courses 98, 99, 100, 101, and 102. In sector B, the main yarn is knit thruout; in sector C, the main yarn is knit in all wales in courses 99, 100, and 101. In the other courses, the yarns are incorporated into the fabric in the same manner that they are incorporated in the courses 98—102 of sector A. Sectors D, F, and H repeat sector B; sector E repeats sector A, and sector G repeats sector C. In Fig. 14, the machine of Fig. 11 is shown in the process of knitting parts of courses 104 and 105; in Fig. 15, this machine is shown in the process of knitting parts of courses 98 and 99.

The showing of the knitting in the design portions is schematic, as in the left-hand portions of Figs. 1–5 of my said Patent No. 2,066,408, the actual contour of the yarns being more completely shown in the right-hand portions of those figures.

The type of design formation here exemplified has a marked advantage over an arrangement in which one extent of yarn is knit in all wales and another extent of yarn is inlaid, since, in the latter case, the inlaid yarn, when of a different color or character than the main yarn, tends to show thru and spoil the design effect. There is an even more noticeable advantage over arrangements wherein two yarns are inlaid between a pair of knitted courses, as when the forward extent of wrap yarn is knit, the return extent inlaid, and the main yarn inlaid.

In the form of construction shown in Fig. 16, there is provided a modified arrangement in which no cam such as 59 is utilized, but in which an outwardly resilient arm 67*a* carries the butts 38 into position to be acted on by reverse cams such as 40 except when an annular cam 60 presses them within the slots. In this form of construction, also, each of these resilient arms is made a part of a needle instead of part of an independent jack.

In this form of construction which is adapted for use in connection with various of the arrangements herein illustrated as well as others, the needles 7 carry outwardly-resilient arms 67*a* having at their upper end butts 38 adapted to be engaged by cams 40. Annular cams 60 engage surfaces 380*a* of the arms 67*a* to press the butts 38 within the needle slots except when they are to be engaged by a cam 40. It is to be noted that the cams 60 are operative whenever an advancing cam such as the cam 30 is operative so as to assure that the butts 38 cannot be engaged by a cam 40 which might happen to be passing at the same time when the needles were advanced, as this would tend to break the arms 67*a*. The arms 67*a* in the present intance are formed with outwardly-bent portions 380*a* similar to the portions 380.

In Fig. 17, there is shown another modification. This form of construction comprises a jack 35*b* the arm 67*b* of which has sufficient outward resiliency to maintain it in its outward position unless it is forced inwardly when a cam 60 contacts the lower part of the butt 38*b*, which, like a butt 38, is adapted to be acted on by the cams 40.

Various other forms of operative members may be provided. For example, the use of non-resilient jacks is sometimes advantageous. In the form of construction of Figs. 18–28, there is shown an arrangement wherein rocker jacks are used and wherein these jacks are swung at periods when no return cam such as one of the cams 40 is passing. In this instance the jacks 35*c* (Fig. 18) are themselves the arms which carry the butts 38*c* and by which the butts are moved into and out of the needle slots. These rocker jacks 35*c* are centrally pivoted at 75. The butts 380*c* are adapted to be acted on by cams 60*c*, and butts 39*c* at their lower ends are adapted to be acted on by cams 59*c*. The butts 38*c*, like the butts 38, are engaged by cams 40 to cause retraction of the rockers and their respective needles. In order to assure that a rocker will not be raised or lowered when being swung in either direction on its pivot, the reverse retracting cams 40 are so spaced (Figs. 19–28) with respect to the forward advancing cams 30 that a cam 40 will pass a forwardly-moving cam in a sector in which the needles may be unselected, whereas, in other sectors where the needles are selected, a cam 40 or one of the forward cams will be operative but not both. In a sector where a cam 40 is operative it will pass a cam 59*c* which, as will be seen, has a length equivalent to the width of the two sectors plus the width of a cam 40 itself so that, during the entire period of operation of a cam 40 in a sector, the cam 59*c* will be operative in that sector. Cams 60*c* fill the intervals between the cams 59*c*. In the schematic showing of Fig. 19, there are indicated sectors A—L and A′, each illustrated as containing ten needles, altho, as above indicated, many more will ordinarily be provided in a sector.

As will be seen, two cams 59*c* and two cams 60*c* are provided for each sequence of operations, and the arrangement is such that, in any sector wherein there is no needle selection at the passage of one cam 59*c* or at the passage of one cam 60*c* there will be needle selection at a passage of a succeeding cam 59*c* or a succeeding cam 60*c*, respectively, so that no part of a fabric will necessarily miss more than two courses of knitting before yarn is knitted in that sector. For example, in sector G of Fig. 19 and sector D of Fig. 20, the jacks 25 are shown unselected so that the rockers will be free to be swung by cam 59*c* while cam 40 is crossing cam 30; whereas in sector K of Fig. 19 and sector E of Fig. 20, the needles have been selected and a cam 59*c* and a cam 40 will be operative. In sector D of Fig. 19, the needles are shown unselected prior to the passage of a cam 52, whereas in sector D of Fig. 24, the needles are shown selected and the cam 52 will be operative in this sector (see Figs. 25 and 26).

It will be observed that the active wrap feeds 15*c*, while spaced ten needles apart, have a swing encompassing twelve needles, thus enabling a full intarsia fabric to be produced. While twelve needles may be raised for each swing of each wrap feed over its respective sector and a fabric with thickened ridges at the sector lines thereby produced; a flat intarsia fabric in which the various wrap yarns are securely united thruout the fabric may be produced by advancing needles ten, one, two, three, four, five, six, seven, eight, and nine for one (e. g. a forward) swing of a wrap feed and advancing needles two, three, four, five, six, seven, eight, nine, ten, and one for another (e. g. a return) swing of the wrap feed, or by advancing needles ten, one, two, three, four, five, six, seven, eight, nine, ten, and one for one or more swings of the wrap feed (two as exemplified in sector E of Figs. 21 and 23) and advancing needles two, three, four, five, six, seven, eight, and nine at the next one or more swings of the wrap feed (two as exemplified, see sector F of Fig. 19). Other variations will suggest themselves.

As will be seen, in each of Figs. 20–28 the cams shown in the preceding figures are shown (if they have not moved out of the figure) as having advanced a fraction over one sector.

In Fig. 28*a*, there is shown a form of fabric as produced by sectors C, D, E, and F of the machine of Figs. 18–28.

Courses 106—111 are exemplified. In courses 106 and 107, wrap yarn is knit in sector C in twelve wales including wale ten of sector B and wale one of sector D

in both the forward and return swings of the wrap feed, and wrap yarn is knit in sector E in twelve wales including wale ten of sector D and w.le one of sector F in both the forward and return swings of the wrap feed. Thereafter, in sectors D and F, wrap yarn is knit in wales two thru nine by both the forward and return swings of the wrap feed. In courses **108** and **109**, wrap yarn is knit in wales two thru nine in sectors C and E in both the forward and return swings, and thereafter, wrap yarn is knit in sectors D and F in twelve wales including the wales preceding the sector and the wales succeeding the sector in each case in both the forward and return swings. Courses **110** and **111** repeat courses **106** and **107**, and succeeding pairs of courses will repeat in alternate pairs thereafter.

In Fig. 29, there is shown (in an upper tier, and continued in a lower tier) the operation of an arrangement similar to that of Figs. 18–28 except that the wrap feeds swing over only (the ten needles of) one sector (as in Fig. 2), main feeds are included, and there is provided in connection with each of the main feeds an inlaying cam **94** operative on butts **95** on alternate needles whenever their jacks **25** have been moved to unselected position.

In this case, as in the case of the other schematic showing, cams **51**, **56**, and **63**, tho actually present and operating, are, for the sake of facility of illustration, omitted, the showing being as if the needles and the jacks **25** were retracted together by the needle-retracting cams.

In sector T (at the end of the lower tier of Fig. 29), needles are shown raised by a cam **30** for the reception of yarn during the forward swing of a wrap feed; and, in sector R, there is shown a wrap feed which has swung forwardly, and needles to which wrap yarn has been fed are shown being retracted by a cam **52** (in sector S, as in sectors A, C, H, J, L, N, O, and Q, there is no selection for knitting wrap yarn during the particular operation shown).

In sector P, needles which have been advanced by that cam **30** which is now in sector Q are shown raised. A wrap feed has just fed yarn to them in its return swing and the reverse cam **40** now in sector Q is about to retract them.

In sector M, main yarn from a feed **48** is being fed to raised needles for retraction by the cam **630** now in sector L. In sector I, the needles have been raised for the reception of yarn from the wrap feed which has just swung forward and are ready to be retracted by the cam **52** now in sector H.

In sector E, needles to which yarn has been fed by the return swing of the wrap feed are shown being retracted by a reverse cam **40**.

In sector C, the main feed is shown feeding yarn to alternate needles which have not been selected for raising by a cam **30** but have been raised by a cam **94** and which will be retracted by a cam **630** since their jacks **35***c* are held within the slots by a cam **60***d* (similar to the cams **60** and **60***c*, but longer) so that the approaching cam **40** will not effect them.

Portions of fabric knitted thereby are shown beneath the sectors of Fig. 29 and in Fig. 30. In Fig. 30 there are shown main yarn extents **116**, **117**, **118**, and **119**. In extents **116** and **118**, the main yarn is knit in sectors A, C, E, etc., and inlaid in sectors B, D, F, etc. In extent **117**, the main yarn is knit in sectors B, D, F, etc., and inlaid in sectors A, C, and E. Forward and return wrap yarn courses are knit before extents **116** and **117** and between them and extents **118** and **119** in sectors B, D, F, etc. and between extent **116** and extents **117** and **118** and after extents **117** and **118** in sectors A, C, and E.

In Figs. 31–33 there is shown a similar arrangement except that the reverse cams are nearer together. This arrangement is so arranged that design portions formed of wrap yarn may be provided very near together (separated, in the present instance, only by two of the ten needles shown), and yet most of the needles (eight in the present instance) in every sector may be selected at a single passage of a cam **30** in every sector to receive wrap yarn. The two needles unselected will knit each time at the passage of a main feed, but will be unselected at the time a cam **40** passes them and a cam **59**.

A machine of the general character exemplified is admirably adapted for the production, not only of tubular fabric, but also of strips of fabric, either temporarily connected or fully disconnected. It is particularly adapted for the production of such articles as gloves and hosiery wherein the usual reciprocatory operations may be avoided by the use of wrap feeds. In Fig. 34, there is shown schematically a machine of the general character heretofore exemplified adapted for the formation of sox without a reciprocatory action; the main feed cooperating with certain of a series of wrap feeds in the formation of a series of sock blanks.

As will be seen, sock blanks are being formed in sectors D, E, and F. Others are being formed in the sector to the left of sector A, sector A itself, and sector B; in sectors H, I, and J; and in other spaced sets of three sectors about the machine. The operation of the machine is shown to be at a stage wherein the leg portion of the sox has just been completed, and wrap yarns in sectors D and F (and in B and H and other sectors not shown) are beginning to knit the heel portions.

Figs. 35 and 36 show one of the sock blanks so formed. This sock blank is shown with the numbers of courses and wales greatly reduced for the sake of facility of illustration. It is composed of a top portion **140** formed of main yarn knit on alternate needles (the jacks **25** of such needles, (as one, three, five, etc.) having been selected for raising by a cam **30**) in every other course (as **141**, and **143** in Fig. 36) and intermediate needles (as two, four, six, etc.) in the remaining courses (as **142** and **144** in Fig. 36), forming a full accordion-stitch arrangement giving a mock-ribbed effect. As will be seen, the main yarn extends beyond each side of the sock blank as shown at **148** in Fig. 35 to connect the sock blanks, as shown in Fig. 34. These loose ends are later cut away before the sides of the sock are joined together.

Below this is a leg portion **150** wherein main yarn is knit in jersey courses in every wale. Following this, the wrap feeds in sectors D and F (and elsewhere, as in the sector to the left of A—not shown—and sector B, and in sectors H and J) knit the two sides **151** and **152** of the heel by first knitting a jersey course from the outside edge inwardly to a point about three-quarters of the way across the sector to unite the heel portions with the leg portions on lines **153** and **154** by the loops of the heel itself, then knitting jersey courses of decreasing extents to complete portions **157** and **158**; then jersey courses of increasing extents to complete symmetrical portions **160** and **161** which are united by their own loops to the portions **157** and **158** on lines **162** and **163**. Main yarn is then knit by its own jersey loops to the portion **160** on line **164**, to the central part of the leg portion (sector E and the inside quarter of the sectors D and F) on a line **165**, and to the portion **161** on a line **167**. This jersey knitting is continued to complete a foot portion **170**, following which wrap yarn is knit to form toe portions **171** and **172** in the same manner as the formation of the heel portions **151** and **152**. During the knitting of the heel and toe, the main feeds **486** may be taken out of action by control mechanism of any well known type under control of a pattern chain **175**.

Since certain changes may be made in the construction, methods, and articles set forth, which embody the invention, without departing from its scope, it is intended that all matter contained in the above description or shown in the accompanying drawing shall be interpreted as illustrating and not in a limiting sense.

I claim:

1. A circular knitting machine comprising a bed formed with a series of slots, knitting elements in said slots, actuating means, said bed and said actuating means being mounted for relative rotation to impart yarn-manipulating waves in one direction, arms in said slots, butts on said arms, said arms being mounted for movement of said butts laterally into and out of said slots, means for controlling the positioning of said butts, and cam means mounted for rotative movement relative to said bed and to said actuating means and adapted to act on the butts of those arms which are out of the slots to impart to certain of said knitting elements yarn-manipulating waves in a direction opposite to said one direction.

2. A circular knitting machine comprising a bed, knitting elements on said bed, movement-imparting means individual to at least certain of said knitting elements and movable between operative and inoperative position, actuating means, said bed and said actuating means being mounted for relative rotative movement, means forming part of said actuating means to control the positioning of said movement-imparting means, and means mounted for rotative movement relative to said bed and to said actuating means adapted to cause those movement-imparting means which are in operative position to impart movement to their respective knitting elements.

3. A knitting machine as set forth in claim 1 wherein said bed is a needle bed and said knitting elements are needles.

4. A circular knitting machine comprising a stationary needle bed, slots in said bed, needles in said slots, arms in at least certain of said slots, butts on said arms, said arms being mounted for movement of said butts into and out of said slots, a cam ring mounted for rotation in one direction, needle operating means on said cam ring, means on said cam ring to control the position of said butts, and cam means mounted for rotation in the opposite direction to retract said arms when their butts are out of the needle slots, said arms and said needles being so arranged that the needles will be retracted when the arms are retracted.

5. A knitting machine as set forth in claim 1 wherein the butts on said arms are resiliently mounted.

6. A knitting machine as set forth in claim 1 wherein the arms are in the form of the rockers so that one end portion of each serves as a butt and is within the slot when the other end portion is out.

7. A knitting machine as set forth in claim 1 wherein a cam forming part of said actuating means maintains the butts on said arms within said slots whenever any part of said actuating means is operative to move said knitting elements.

8. A circular knitting machine comprising a bed formed with a series of slots, knitting elements in said slots, actuating means, said bed and said actuating means being mounted for relative rotation to impart yarn manipulating waves in one direction, arms in said slots, butts on said arms, said arms being mounted for movement of said butts laterally into and out of said slots, cam means forming part of said actuating means for moving said butts in one of said lateral directions, means whereby said butts are moved in the other of said lateral directions at other periods, and cam means mounted for rotative movement relative to said bed and to said actuating means and adapted to act on the butts of those arms which are out of the slots to impart to certain of said knitting elements yarn-manipulating waves in a direction opposite to said one direction.

9. A knitting machine as set forth in claim 8 wherein a plurality of the first-mentioned cam means are provided at spaced intervals about the machine and wherein there are provided arcuate means extending from each of said cam means along part of the interval between it and the next of said cam means to maintain said butts in the position into which they have been moved by the cam means from which it extends and wherein each of said arcuate means terminates prior to the end of said interval to provide a space for longitudinal movement of said knitting elements prior to the operation of said next of said cam means.

10. A knitting machine as set forth in claim 9 wherein there are provided near the termination of each of said arcuate means additional means to maintain said butts in the other of their lateral positions during said spaces.

11. A knitting machine as set forth in claim 10 wherein said arms are outwardly resilient, wherein said first-mentioned cam means move said butts inwardly, and wherein the cam means which is last mentioned in claim 8 acts during said spaces.

12. A knitting machine as set forth in claim 8 wherein a plurality of the first-mentioned cam means are provided at spaced intervals about the machine and wherein said arms are resilient, wherein said cam means move said butts inwardly, and wherein there are provided arcuate means extending from each of said cam means to maintain said butts in the position into which they have been moved by the cam means and wherein each of said arcuate means terminates in advance of the next of said cam means to leave a space for longitudinal movement of said knitting elements.

13. A knitting machine as set forth in claim 1 wherein said arms are integral with the knitting elements.

14. A knitting machine as set forth in claim 1 wherein said arms are resilient and are carried on jacks disposed in the slots with the knitting elements and wherein the knitting elements are formed with shoulders at each side of said jacks so that movement will be imparted to the knitting elements by the jacks.

15. In or for a knitting machine, a cam element having side surfaces and having edge surfaces one of which is a diagonal cam surface and another of which is opposite said cam surface, and a longitudinal groove in one of said side surfaces extending from a position near but spaced from said cam surface to and thru said opposite surface.

16. A knitting machine comprising a slotted bed, knitting elements in the slots of said bed, resilient arms on said knitting elements, portions on said arms movable into and out of said slots, a cam element movable past said slots in line with said portions and having side surfaces and having edge surfaces one of which is a diagonal cam surface and another of which is opposite said cam surface, and a longitudinal groove in one of said side surfaces extending from a position near said cam surface to and thru said opposite surface for receiving those portions moved outwardly when said cam element is in front of them.

17. In or for a knitting machine, a needle and a jack disposed edge to edge with the needle, said needle having a portion extending generally perpendicular to said needle above the upper end of said jack and a lug extending generally parallel to said needle outside of said jack.

18. A circular knitting machine comprising a stationary needle bed, a rotatable member, a cam ring driven thereby, a rotatable post driven from said rotatable member, a cam ring driven from said rotatable post, a bed freely carried by the last mentioned cam ring, a stationary support, and gearing connecting said bed with said support to hold said bed stationary.

19. A circular knitting machine comprising a stationary needle bed, a rotatable member, a cam ring driven thereby, a rotatable post driven from said rotatable member, a cam ring driven from said rotatable post, and a cam ring driven in the reverse direction from said post.

20. A circular knitting machine comprising a needle cylinder, a sinker bed supported thereon, an annular plate forming a lower rim for said cylinder, an annular plate rotatably supported on said rim, means to drive said rotary plate from beneath said rim, a cam ring carried on said rotary plate, upwardly extending posts, at least one of said posts being rotatable and being driven from

said rotary plate, sinker cam means, and means for driving said sinker cam means from said rotatable post, a wrap feed dial, means for supporting said wrap feed dial stationarily with said bed, a wrap feed cam ring, and means for driving said wrap feed cam ring from said rotatable post.

21. A circular hosiery knitting machine comprising a needle bed, needles on said bed, needle-actuating means, said bed and said actuating means being mounted for relative rotation in a single direction, main yarn feeding means forming a unit with said actuating means in said relative rotation, a support forming a unit with said bed in said relative rotation, wrap feeding means carried on said support for reciprocation past a group of said needles to feed yarn thereto; and selectively-operating means to cause yarn from said main yarn feeding means to be knit to form a hosiery leg portion, and to cause yarn from wrap feeding means to be knit by selected needles in both directions of movement of said wrap feeding means to form a heel portion.

22. A knitting machine as set forth in claim 21 wherein the means for forming the leg portion comprises wrap feeding means swinging in a forward direction and in a return direction, means forming a part of said actuating means for advancing needles to receive yarn by wrap feed swings in either direction and retracting needles to knit after wrap fed swings in said forward direction, and means operative on said needles in the reverse direction to cause them to knit after wrap feed swings in said return direction.

23. A method of knitting hosiery comprising successively feeding main yarn to a series of needles in a given direction, knitting yarn thereon in said direction to form a series of rows of loops of yarn providing a leg, feeding wrap yarn to a limited number of successive ones of part of said needles in one direction and knitting it in said direction and then feeding the wrap yarn in said direction and knitting it in the opposite direction, then repeating the last-mentioned manipulations on various extents of said wrap yarn to provide a heel attached to said leg, and thereafter knitting yarn on all said series of needles to provide a foot which is attached by its own loops to said leg and heel.

24. A method as set forth in claim 23 wherein, after the formation of the foot, wrap yarn is manipulated in the formation of a toe in a manner similar to the formation of the heel.

25. A method as set forth in claim 23 wherein heel halves are knitted in the form of bulges in each side of a central portion where the leg and heel meet.

26. A method as set forth in claim 23 wherein the heel is composed of yarn different from the yarn of which the leg is composed.

27. A method of knitting hosiery as set forth in claim 23 wherein at the beginning of the operation yarn is successively fed to the needles in said given direction and is knit in said direction at each feeding by alternate needles, by intermediate needles, by alternate needles, by intermediate needles, and so forth to knit a top portion.

28. The method of making hosiery which comprises knitting a plurality of crosswise spaced hosiery legs from main yarn on a circular knitting machine with the legs connected crosswise by unknitted main yarn, knitting two heel portions of wrap yarn as continuations of the lateral portions of each leg, knitting foot portions in which main yarn is utilized as continuations of the heel portions and the central portions of the legs, main yarn being utilized in said foot portions and extending unknitted therebetween, knitting toe portions of wrap yarn as continuations of the foot portions, cutting the unknitted yarn to separate the hose, and sewing together the lateral portions of each hose.

29. In or for a knitting machine, a knitting needle, a resilient jack attached thereto at one end, said needle having a portion extending perpendicularly to the needle beyond the other end of the jack and a lug extending generally parallel to the needle outside of the jack.

References Cited in the file of this patent

UNITED STATES PATENTS

7,368	Crane	Oct. 31, 1876
729,005	Steber	May 26, 1903
1,077,370	Robinson	Nov. 4, 1913
1,084,194	Blackburn et al.	Jan. 13, 1914
1,317,897	Scott	Oct. 7, 1919
1,589,474	Lombardi	June 22, 1926
1,893,589	La Montagne	Jan. 10, 1933
1,998,473	Welch et al.	Apr. 23, 1935
2,158,189	Lawson et al.	May 16, 1939
2,199,637	Lawson	May 7, 1940
2,203,711	Agulnek	June 11, 1940
2,229,105	Lombardi	Jan. 21, 1941
2,319,771	Beers	May 18, 1943
2,373,126	Lombardi	Apr. 10, 1945
2,503,838	Page	Apr. 11, 1950