

April 19, 1932.

E. SPIERS

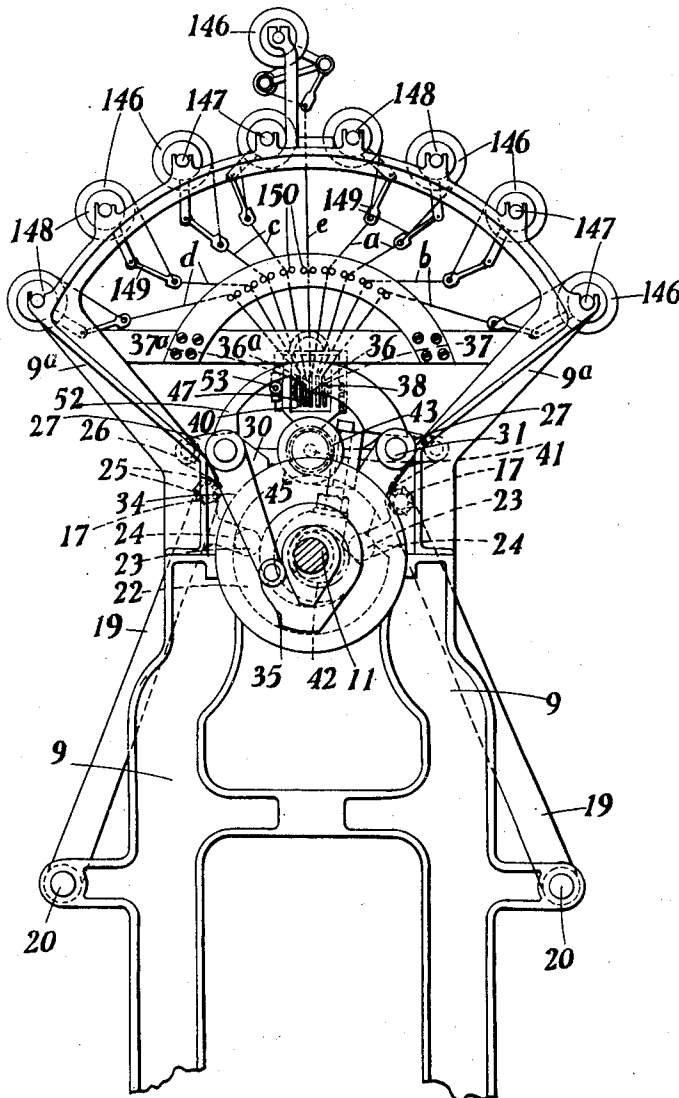
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KNITTING MACHINE

Filed April 15, 1931

10 Sheets-Sheet 1

Fig. 1.



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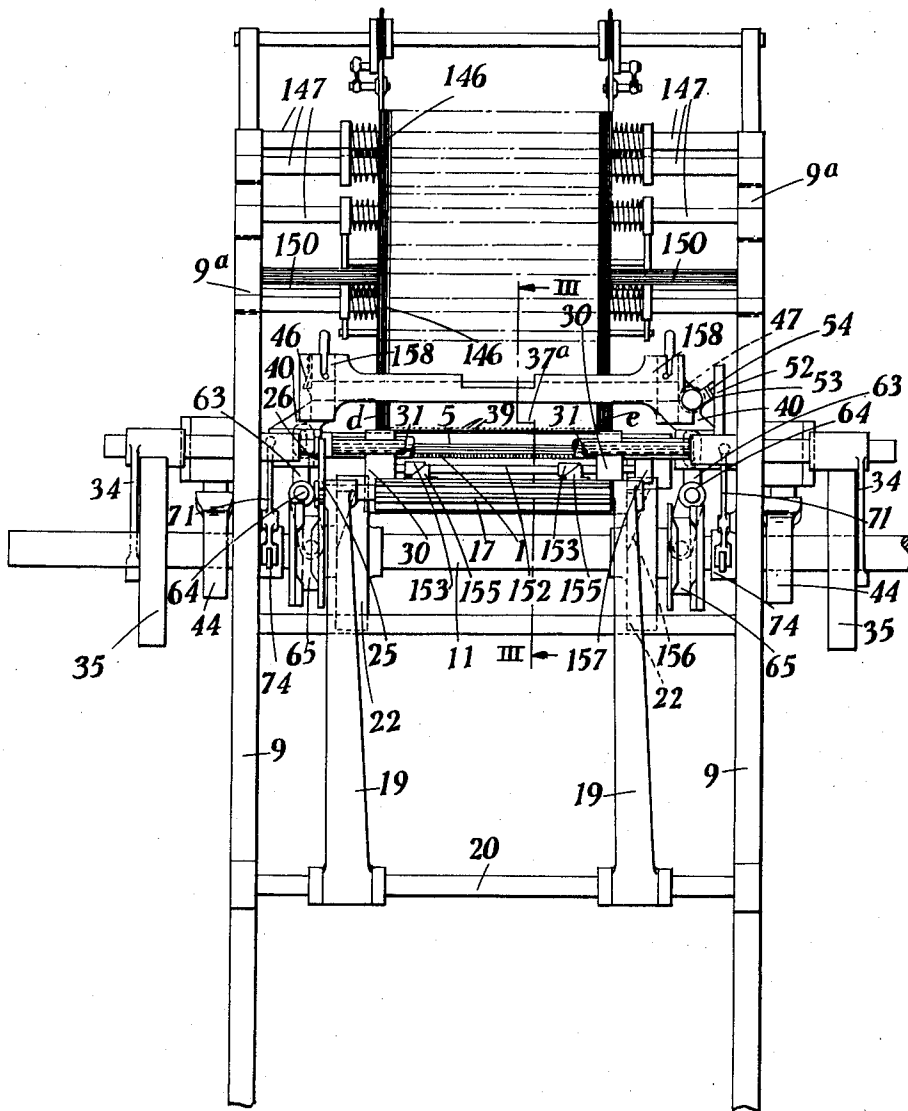
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# KNITTING MACHINE

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*Fig. 2.*



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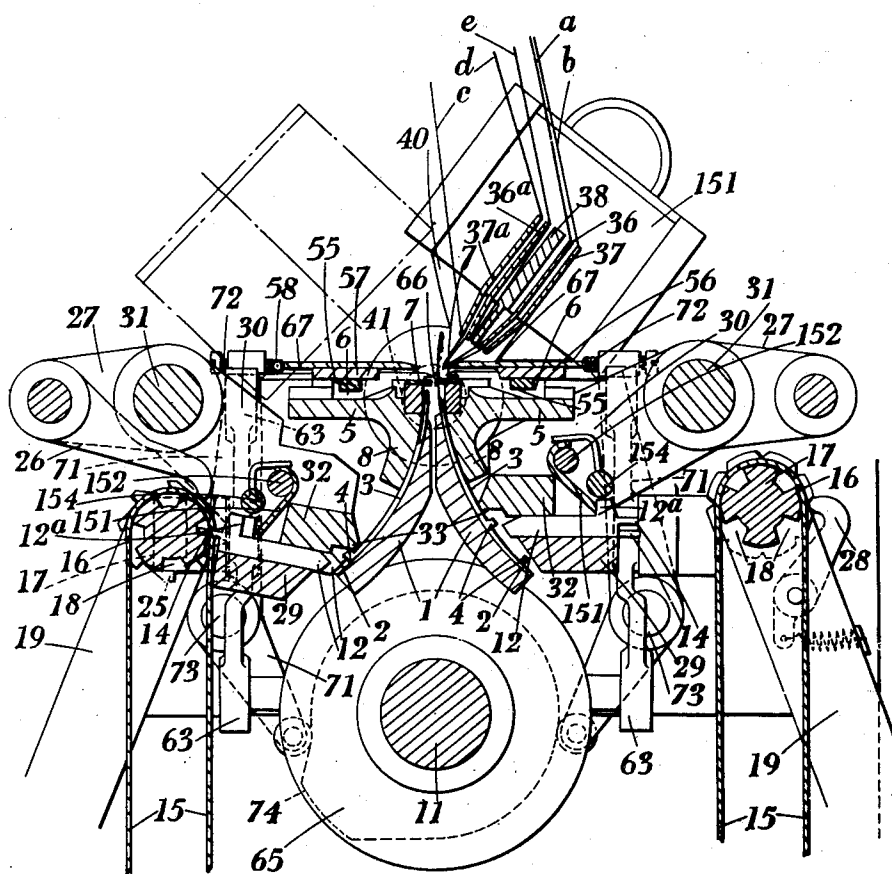
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KNITTING MACHINE

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Fig. 3.



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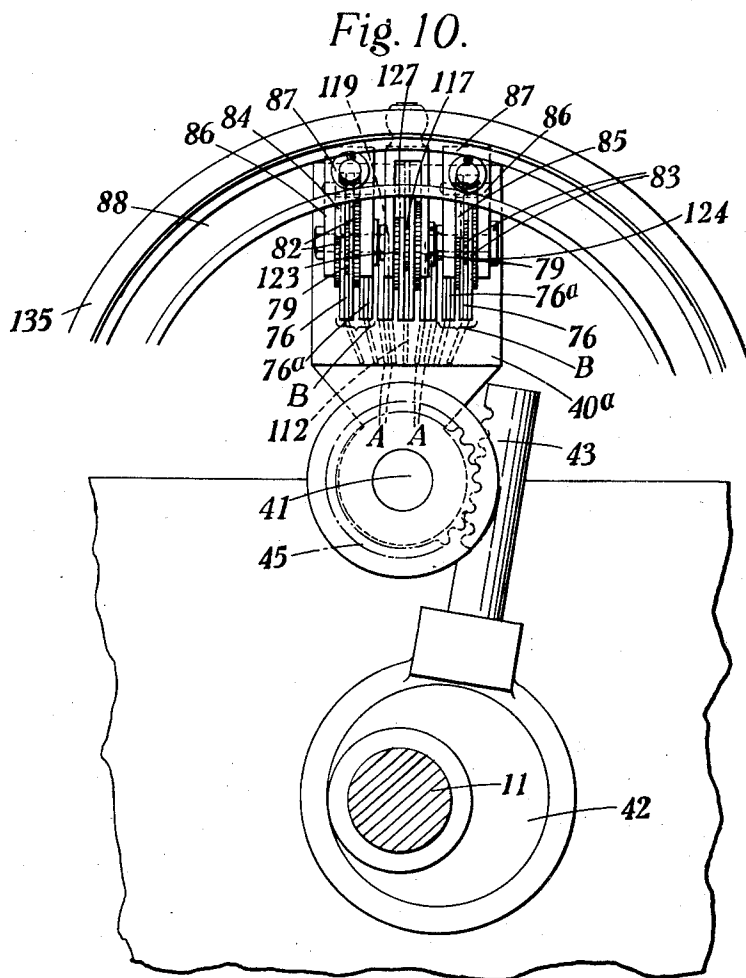
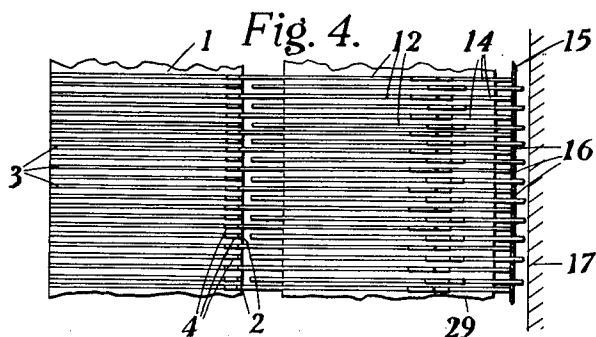
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KNITTING MACHINE

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10 Sheets-Sheet 4



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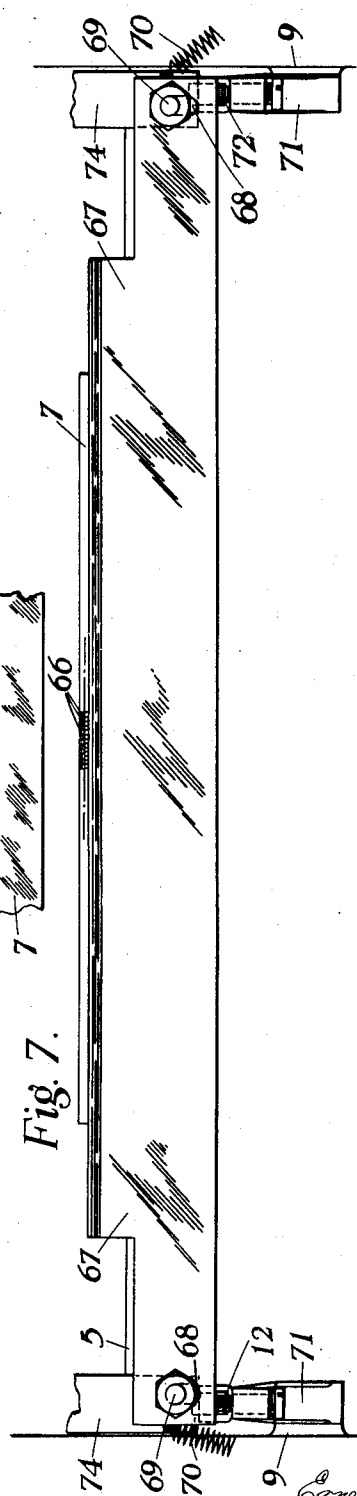
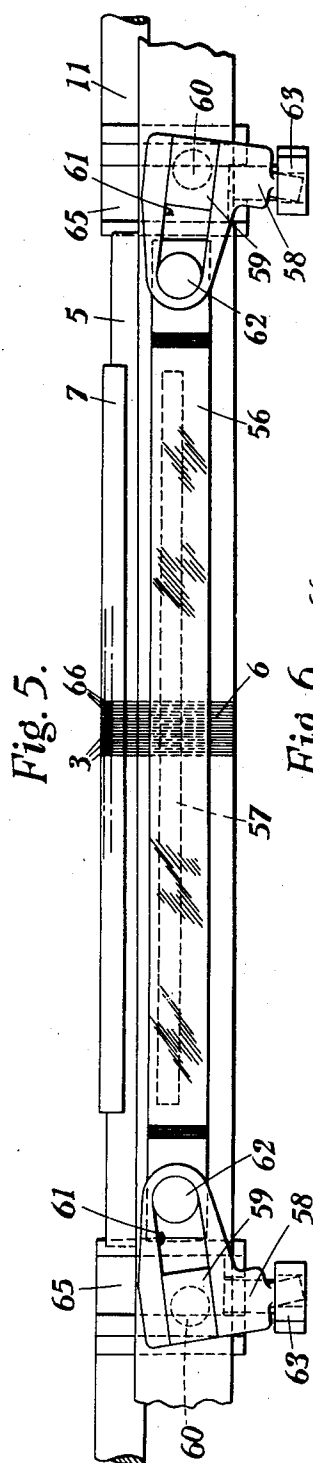
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10 Sheets-Sheet 5



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KNITTING MACHINE

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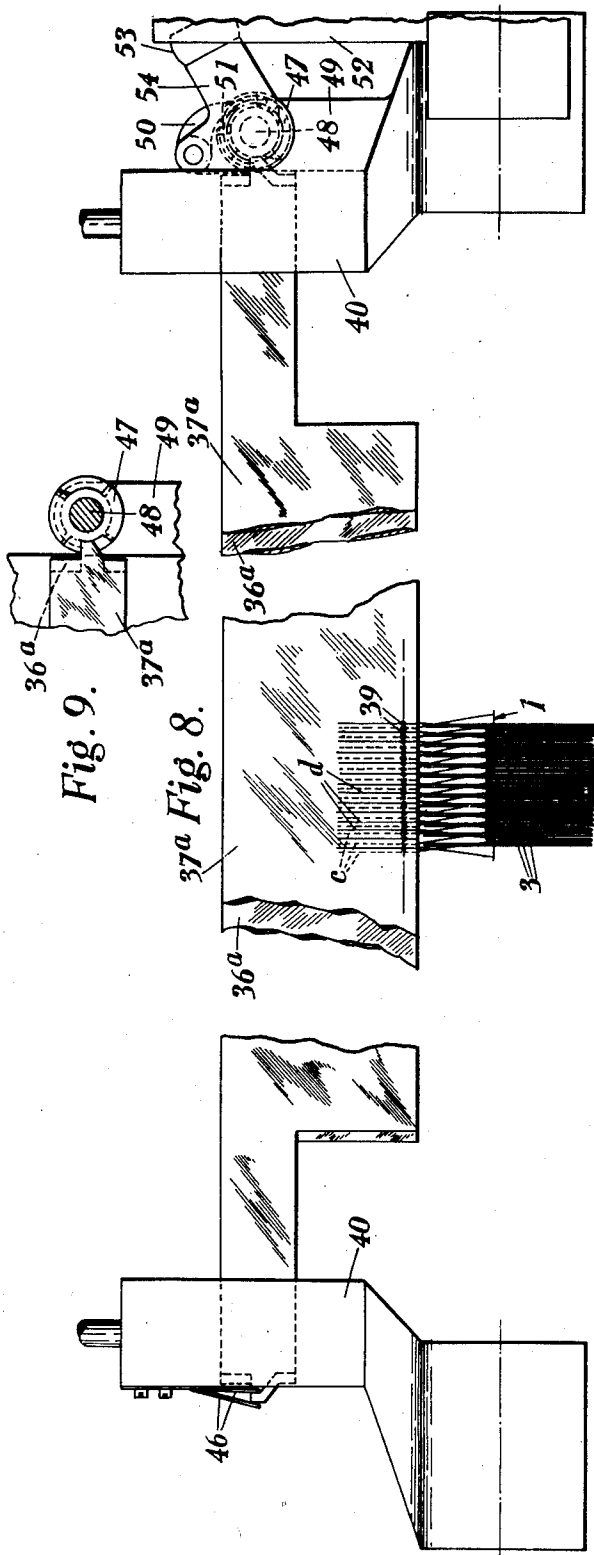
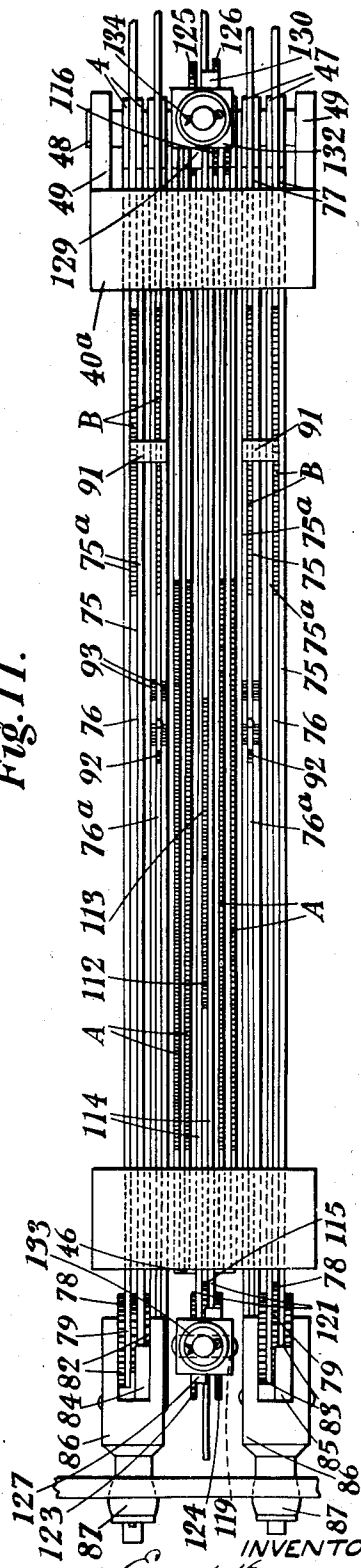


Fig. 11.



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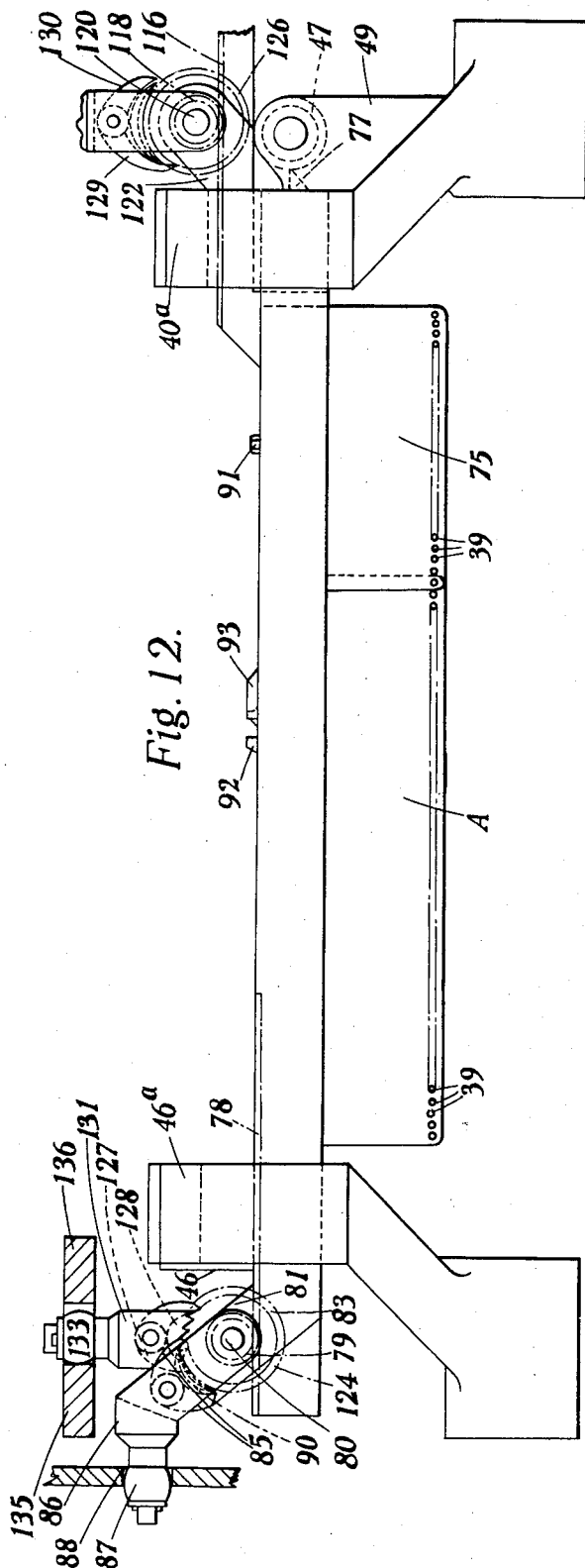


Fig. 12.

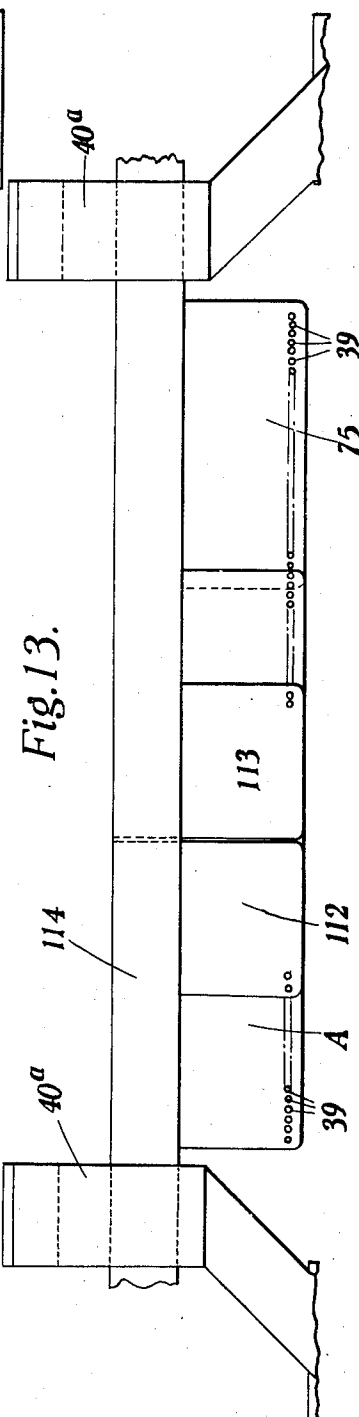


Fig. 13.

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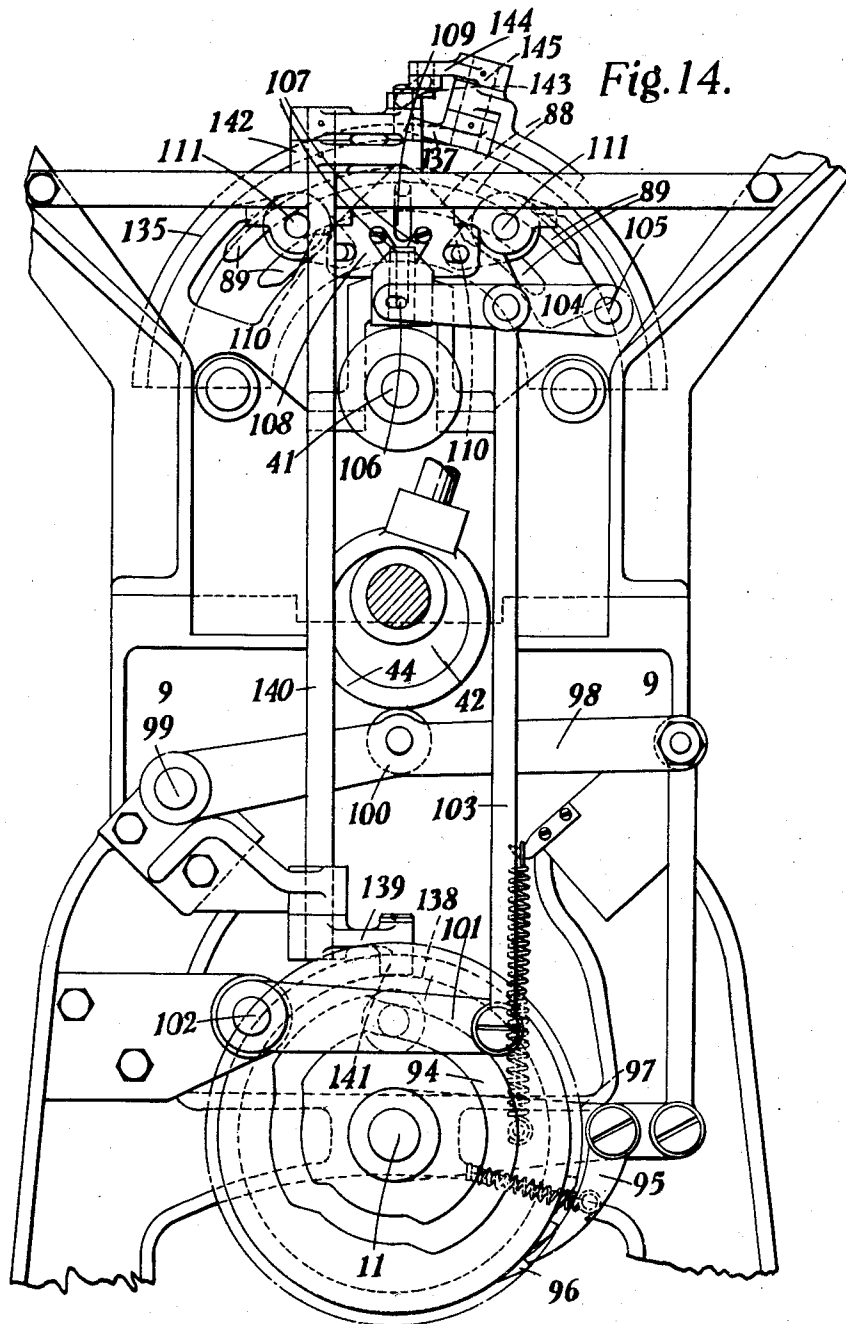
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KNITTING MACHINE

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Fig. 15.

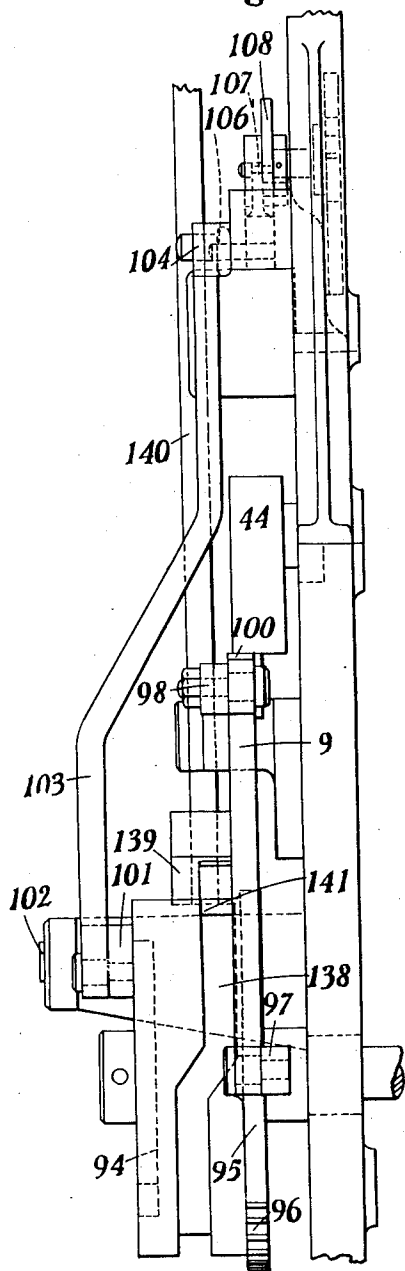
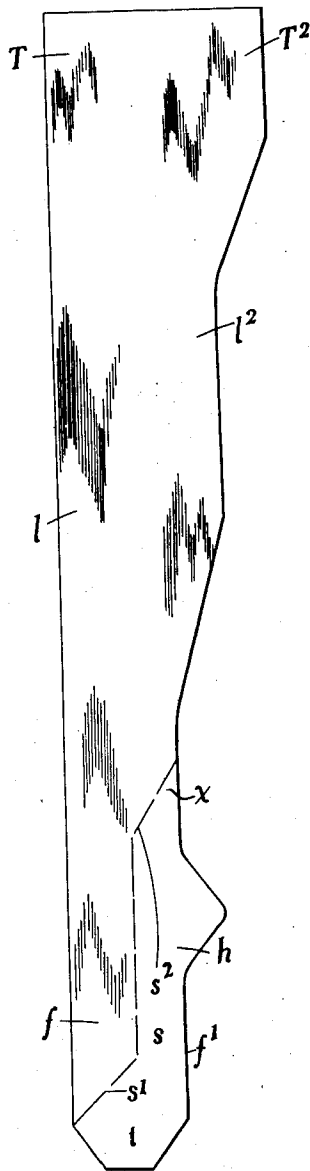


Fig. 16.



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KNITTING MACHINE

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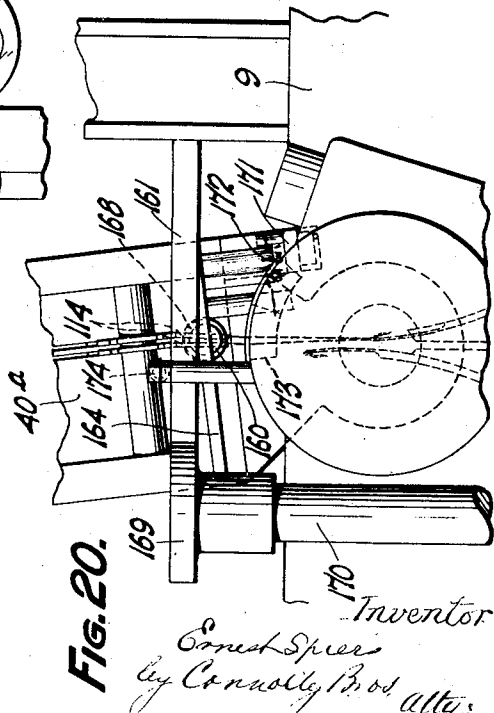
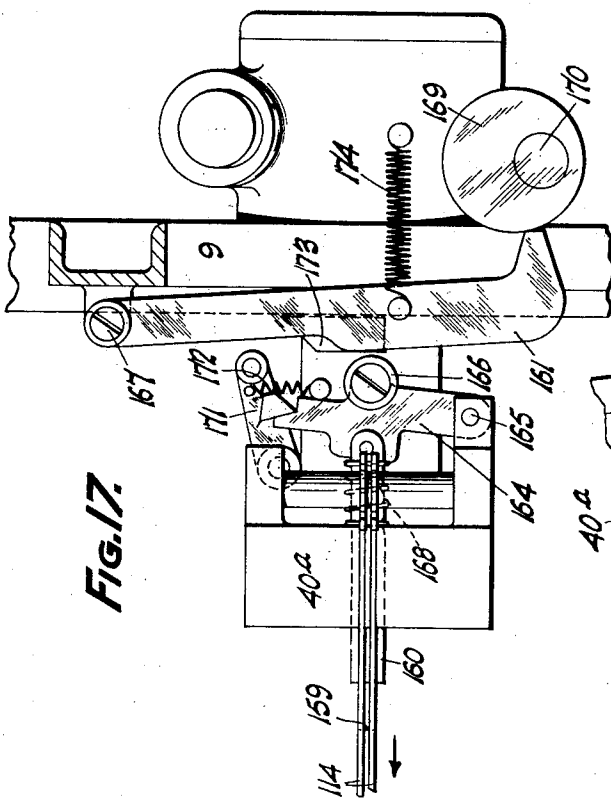
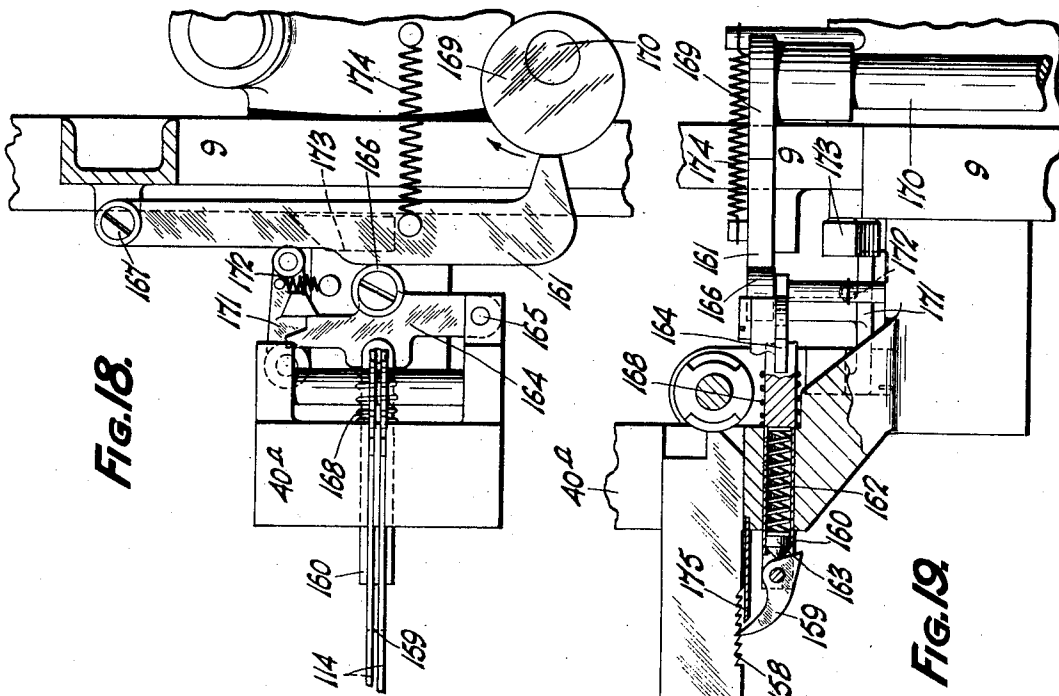


Fig. 20.

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# UNITED STATES PATENT OFFICE

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## KNITTING MACHINE

Application filed April 15, 1931, Serial No. 530,383, and in Great Britain May 19, 1930.

This invention relates to knitting machines and has for its object an improved warp knitting machine of the straight bar type for the purpose of producing tubular fabric.

The primary aim of the invention is to provide an economical machine of the straight bar type capable of producing fashioned seamless non-laddering hosiery, e. g. ladies' stockings, of fine quality, although the invention is not to be regarded as limited in this respect as the machine may be adapted to produce non-laddering tubular fabric, fashioned or non fashioned for underwear or other body garments and other purposes.

According to this invention there is provided a warp knitting machine comprising parallel needle beds for two independent series of individually movable needles, one or more series of thread guides for each series of needles for lapping threads over said needles to produce knitted webs, auxiliary thread guides for lapping threads over needles in both series to unite the knitted webs to form tubular fabric, means for effecting variations in the number of needles forming loops as knitting proceeds to produce fashioned fabric, and means for correspondingly adjusting the auxiliary thread guiding means.

There is also provided according to this invention a warp knitting machine of the straight bar type furnished with curved needles to carry which parallel needle beds furnished with arcuate grooves or tricks are employed. The advantage of providing curved needles is that by reason of their curvature the needles in the respective series function in paths which do not cross each other, and consequently it is possible to locate the needles in one series directly opposite to the needles in the other series with a minimum of space between opposing needle heads and also to employ a greater number of needles to the inch with sufficient space between adjacent needles in each series for the passage of the threads for lapping purposes. In short, a fine gauge machine can be provided, and, consequently, work of fine quality can be produced, especially when—as is preferred—bearded needles are used.

The invention also includes as a feature,

provision for reinforcing or splicing the fabric or desired areas or portions thereof more particularly though not necessarily exclusively in a warp knitting machine designed for the production of fashioned seamless hosiery as previously alluded to herein. For example, in a machine adapted to produce fashioned fabric the one or more series of main thread guides for each series of needles may be divided and arranged so that one division or group may be moved lengthwise relatively to the other division or group so that the threads supplied by two or more divisions or groups are lapped on or over the same needles.

Means may also be provided for shifting one division or group of thread guides gradually in relation to the other division or group in the same series so that the configuration of the spliced or reinforced area may be correspondingly varied.

When bearded needles are employed the machine includes means for pressing the beards in association with web holders and knocking over bits or elements, such as of the form previously referred to herein, and means for actuating the presser or pressers and web holders.

I will now describe by way of example and with reference to the accompanying drawings a machine embodying all of the features hereinbefore mentioned, such machine being designed for the production of fashioned seamless stockings of non-laddering fabric.

In the drawings:

Figure 1 is a sectional end view of the machine.

Figure 2 is a side elevation of the machine.

Figure 3 is a transverse section of the machine taken on line III—III of Figure 2.

Figure 4 is a plan of one of the needle beds and the associated needle selecting means.

Figure 5 is a plan view of the sinker bed and sinker actuating mechanism and shows a few of the sinkers.

Figure 6 shows a portion of the knocking over bar.

Figure 7 is a plan of the needle presser and the actuating means therefor.

Figure 8 is a side elevation of a pair of main thread guides and the means for actuat-

ing the same, as used for knitting a non-fashioned tube of fabric.

Figure 9 is a sectional detail of said guide actuating means.

Figure 10 is an end elevation of an oscillatory carriage, thread guides arranged for use in the production of fashioned hosiery, and means for oscillating the carriage.

Figure 11 is a plan view of the guides shown in Figure 10 and the carriages therefor.

Figure 12 is a side elevation of the guides used for splicing purposes and the means for effecting relative lengthwise adjustment thereof.

Figure 13 is a side elevation of auxiliary guides used in the production of fashioned hosiery and means for adjusting the same longitudinally for fashioning purposes.

Figure 14 is an end elevation and

Figure 15 is a side elevation of cams for effecting the adjustment of the splicing guides and the auxiliary guides, and the means for controlling said cams.

Figure 16 represents diagrammatically a stocking as produced by means of the improved machine.

Figure 17 is a plan view of mechanism for enabling both series of needles to take the same threads for one or more courses at the commencement of knitting, said mechanism being located at the right hand end of the thread guides—viewing the latter as shown in Figure 11 and being shown in the inoperative position.

Figure 18 is a plan view of the same mechanism in operation.

Figure 19 is a sectional side elevation of the mechanism in the position shown in Figure 18; and

Figure 20 is an end elevation of the said mechanism in the same position.

Figures 1 and 2 are drawn to a smaller scale than Figures 14, 15 and 16, which latter are drawn to a smaller scale than Figures 3, 5 and 7, and Figures 8 to 13 and 17 to 20 are drawn to a larger scale than Figures 3, 5 and 7, and to a smaller scale than Figures 4 and 6. Like parts are designated by the same reference characters.

This machine is preferably provided with independently slidable bearded needles arranged back to back, so that the needles in one series are directly opposite to the needles in the other series in two parallel needle beds 1 having concave outer surfaces in which are formed curved or arcuate grooves 2 for the reception of the correspondingly shaped needles 3 furnished with butts 4 at their lower ends.

The hooks of the curved needles are located on the concave side so that when the needles are located in their beds the tail ends of the opposing needles diverge. Another advantage therefore is that adequate space is pro-

vided for the accommodation of needle beds of ample size, and for the passage of the knitted fabric, and, if necessary, for the accommodation of take-down mechanism in fairly close proximity to the point at which the fabric is knitted.

Associated with these beds are other grooved beds 5 for web holders 6, and knocking over bars 7. The web holder beds have convex portions 8 which oppose the concave surfaces of the needle beds and serve to hold the needles in their beds.

The needle and web holder beds are mounted in or upon end frames 9 suitably braced so that as shown in Figure 3 the two series of needles function in substantially vertical planes with the sinkers or web holders and pressers operating in a horizontal plane.

The machine is furnished with a single cam shaft 11.

For operating the needles 3 we may provide, in association with the two series respectively, corresponding selecting elements 12, bars hereinafter referred to, and jacquard devices of any known or other convenient form.

Conveniently the selectors are furnished with tails 14 and there are provided jacquard bands 15 having perforations 16 formed therein according to the order in which the needles are to be caused to knit, said bands being carried by drums 17 formed with grooves 18 with which the perforations in the bands register, whereby then the bands are presented to the associated selectors, the tails of the selectors which register with perforations pass through the latter into the grooves 18 so that the corresponding selectors are not selected for operation upon the needles. The drums are carried by swing arms 19 mounted on shafts 20 extending between and fixed in the end frames 9, see Figures 1 and 2, said arms being actuated to carry the drums and bands towards and from the associated selector beds by means of face cams 22 on the cam shaft 11, said arms being fitted with rollers 23 carried by lugs 24 for this purpose. The drums are fitted respectively with ratchets 25 which are engaged by pawls 26 carried by fixed arms 27 so that when the jacquard devices are swung away from the selectors the drums are racked round to impart the requisite movements to the jacquard bands. Check pawls 28 are provided to hold the bands in position after each movement. The needle selectors are carried in beds 29 in register with the needle butts 4 so that their inner ends can be projected under the butts as the result of the action of the jacquard device on the outer ends thereof, as shown at the left hand side of Figure 3. The beds 29 are carried by arms 30 mounted on rockshafts 31 supported by bearings in or on the end frames 9. Carried by the arms 30 are bars or plates 32 furnished with lips 33 arranged so as to extend over the butts of the needles as

shown in Figure 3. The axes of the rockshafts 31 are located so that when the selector beds are oscillated the inner ends of the selectors move in a path concentric with the concave faces of the opposing needle beds. The rockshafts are operated by means of levers 34 and cams 35 on the aforesaid cam shaft so that the selectors, selected by the jacquards, and the aforesaid bars or plates respectively impart up and down movement to the selected needles.

The machine is equipped with thread guide members designated 36, 37, 36a, 37a, 38, and represented somewhat diagrammatically in Figures 1 and 3 said members having holes such as 39 therein to guide the threads to the needles and being carried by carriages 40 respectively pivotally mounted by means of shafts 41 on the end frames 9. The said guide members are arranged parallel with each other above the pivotal axis as represented in Figures 1 and 3, for endwise movement to lap the threads about the needles. The carriages are oscillated by means of eccentrics 42 on the cam shaft 11 through the medium of racks 43 associated with the eccentric straps 44 and pinions 45 keyed on the shafts 41. There is a set of main guide members for each series of needles, and between these two sets, an auxiliary slide 38.

For producing non-fashioned tubular fabric I may provide in association with each needle bed, a set of two main thread guide members constituted by slides such as 36, 37, 36a, 37a, Figures 1, 3 and 8, said slides being furnished with a series of holes 39 to guide the threads to the needles. The auxiliary guide 38 may be constituted by a similar single slide furnished with a hole or holes 39 at each end. The main slides in each set are used to lap the threads held thereby over the selected needles in the corresponding series for knitting two similar pieces of fabric and the auxiliary slide laps the threads held thereby over needles respectively at opposite ends of both series of operative needles for the purpose of uniting the said pieces of fabric at their edges i. e. by sutures.

The lapping movements of all of the aforesaid guide members may be imparted in one direction by springs 46 on one carriage and in the other direction by "Dawson" wheels, or cams such as 47 on a spindle 48 mounted in bearings 49 on the other carriage and racked round by pawl and ratchet mechanism 50, 51 operated by a cam 52, Figure 1, appropriately fixed on one of the end frames 9 of the machine so as to be engaged by a roller 53 on a pawl lever 54 as the carriages 40 rock first in one direction and then in the other direction, i. e. from the position shown by dot and dash lines to that shown by full lines in Figure 3, and vice versa, it being understood that the endwise movement of the slides is effected in appropriate timed rela-

tion to the up and down movement of the selected needles by suitable prearrangement of operation of the cams 47.

The springs 46 may be constituted by resilient fingers formed with or applied to a plate 46a attached to the appropriate carriage.

The wheels or cams for the main slides are so arranged and operated that the main slides for each series of needles are shogged respectively in opposite directions, see Figure 8, i. e. when one of the slides moves to the left the other moves to the right, and vice versa, the shogging movement being effected after the threads have been passed between the operative needles, i. e. those which are raised by the selectors of the corresponding series, by the guide members swinging from the back to the front of said needles so that the threads are crossed in front of the operative needles below the hooks as represented in Figure 8. For example, considering Figures 3 and 8, when the carriages 40 are swung over to the position shown by full lines the threads *a* and *b* held by the guide members 36, 37 respectively are passed between the operative needles, e. g. those shown raised, of the adjacent bed, whereupon the guide members are shogged endwise as aforesaid and the threads are crossed so that when the carriages are swung over to the other position the crossed threads *a*, *b*, are laid upon the stems of the said needles below the hooks so as to be engaged by the hooks when the needles are caused to descend by the action of the associated bar 32. Similarly when the carriages take up the position shown by dot and dash lines in Figure 3 the threads *c*, *d* are passed between the operative needles of the other bed and then the guide members 36a, 37a are shogged respectively in opposite directions so that when the carriages are again swung in the other direction the threads *c*, *d* are laid upon the corresponding operative needles below the beards and in due course are taken thereby, when they in their turn are caused to descend. By reason of the swinging movements of the carriages and appropriate endwise movements of the auxiliary member 38 conjointly with the movements of the needles, the threads held by the auxiliary guide member i. e. at the ends thereof respectively, are lapped over the endmost needles of those operated in each course so that said needles knit the said threads and thereby join together the courses formed by the needles which knit the main threads. It will be understood that the thread guide members are arranged so that the threads *a*, *b*, held by the guides 36, 37 pass between the operative needles of the left hand bed viewing Figure 3 and that the threads *c*, *d* held by the guides 36a, 37a pass between the operative needles of the other bed when the carriages swing from side to side as already explained without be-

ing engaged by the said needles. Also when the guides in each set have been moved oppositely for one course of knitting they are moved in the reverse manner i. e. back to their original positions for the next course.

The web holders 6 in each of the beds are each furnished with a notch or recess 55 near one end thereof and are operated by a transversely movable bar 56 furnished with a strip 57 for insertion into the notches, the said bar being mounted on the bed 5 and actuated by levers 58 pivoted on the bed by means of blocks 59 and pins 60 and bifurcated or slotted as shown at 61 for engagement with pins 62 in the bar 56. The levers 58 are engaged by other levers 63 pivoted at 64 in the machine frame and oscillated by groove cams 65 on the cam shaft 11 in appropriate timed relation with the needle movements. The bar is thus positively actuated in both directions.

The knocking over bars 7 (see Figure 6) are furnished with openings 66 and fixed horizontally on the web-holder beds so as to enable the needles to work through the openings whereby during descent of the needles the old loops thereon are knocked over.

For pressing the beards of the needles I provide transversely movable bars 67 each suitably shaped along one edge for action upon the corresponding needle beards and operable by cams and suitable intermediate connections.

Conveniently, as shown in Figures 3 and 7, each presser bar is slidably mounted on the corresponding bed 5, said bar having slots 68 therein and being held in position by means of stud and nut fastenings 69 the studs of which pass through the slots 68 whereby the requisite transverse movements of the presser bar are permitted. The transverse movements are imparted by springs 70 and levers 71 fitted with screws 72 for engagement with the bar and pivoted at 73 on the end frames for actuation by cams 74 on the cam shaft 11.

As already alluded to herein it is mainly my intention to provide a machine capable of producing seamless fashioned hosiery of the form represented diagrammatically in Figure 16 i. e. having a fashioned toe *t*, a foot *f*, a heel *h* made by narrowing and widening, a fashioned leg *l* and a fashioned top *T*.

It is also my intention to commence knitting at the toe end of the article and to fashion the same by widening. Following the formation of the toe *t* and foot *f* and heel *h* and ankle portion, the leg portion *l* is widened by introducing additional needles—by means of the jacquard and needle selectors hereinbefore described—at one end only of the groups of needles already in action, and adjustment of the auxiliary guide member in a manner to be hereinafter more particularly described. At the commencement of

the knitting operation one or each series of main thread guides may be operated as will be hereinafter described so that both series of needles take the same threads, the initial courses of the toe being thereby interlocked. During the formation of the toe and foot of the article a certain number of threads i. e. those which form the part *l*<sup>2</sup> of the leg and *T*<sup>2</sup> of the top normally would be idle. To economize in thread I propose to use some at least of these threads for splicing or reinforcing purposes e. g. for splicing the toe, foot bottom, heel and forming a high splice *x* which may be tapered, stepped or of some other suitable form. To this end the main thread guide members for each series of needles are divided and the sections are arranged in pairs with one pair set back with respect to the other pair so as to enable one pair to be moved endwise relatively to the other pair—apart from being shogged endwise as a whole for lapping purposes—so that the number of threads supplied to desired needles is correspondingly increased. Provision is also made for shifting the splicing sections gradually so as to enable the width of the spliced areas to be reduced gradually as for example from the full width of the toe *t* to the foot bottom *f*, and from the heel *h* to the termination of the high splice *x*, by shifting the said sections back towards their original positions.

A convenient arrangement is shown in Figures 10 and 11 and in Figure 11 the parts of the guide members which actually hold the threads are shaded for clearness. A designates in each set of guide members the sections which serve the needles on which the narrowest portions of the articles are produced, and B designates the sections which, in conjunction with A, serve needles in the production of the wider portions of the article and are used for splicing purposes. Since the arrangement and operation is the same in each set, only one arrangement need be considered for the purpose of the following description. In Figure 11 the sections are shown in position for knitting the widest portion of the article, i. e. the top *T*. The guide sections A consist of single plates which are slidably mounted in the carriages 40*a* and to which lapping movements are imparted by means of the character described with reference to Figures 8 and 9. The guide sections B comprise respectively outer elements 75 and 75*a* and inner elements 76, 76*a* carried slidably by the outer elements, e. g. by means of angle plates or pins in the one of the outer elements and a slot in the other. The outer elements are slidably mounted in the carriages 40*a* and are shogged bodily for thread lapping purposes by means of the form described with reference to Figures 8 and 9, appropriate cam wheels of which act upon formations such as 77. For splicing pur-

poses the element 76 is moved to locate its thread holding part alongside that of the guide member A and the element 76b is moved to a position wherein the inner ends of the thread holding parts of the two elements slightly overlap so as to provide the required number of the splicing threads, the reason for this being that the elements 76, 76a hold a less number of threads than the member A so that it is necessary to supplement the number of the threads held by the element 76 by some at least of the threads held by the element 76a. The elements 76, 76a remain in this position during the formation of the toe *t* and then for gradually reducing the width of the splicing e. g. along the lines S' and S2 the elements are gradually racked back towards their original position at appropriate intervals. To enable the movements of the said elements in both directions to be effected automatically the following construction is provided. The element 76 is formed with rack teeth 78 and pinions 79 mounted on a spindle 80 rotatable in bearings 81 on the outer elements 75 so as to mesh with the rack teeth. The spindle 80 also has fast thereon ratchet wheels 82, 83 engaged respectively by pawls 84, 85 pivoted on a lever 86 freely mounted on the spindle 80 and furnished with a roller 87 and operated by a cam arrangement comprising a track 88 and pivotally movable cams 89, see Figures 14 and 15, on the adjacent end frame of the machine, the roller being acted upon by the cam arrangement as the carriages 40a oscillate. The pawl 84 and ratchet wheel 82 effect the movement of the element 76 into the splicing position and the other pawl 85 and ratchet wheel 83 effects the reverse movement, the operation of the pawls being dependent upon the position of the cams 89. When the pawl 84 is caused to engage the wheel 82 the pawl 85 works inoperatively over a bluff 90 formed by the rounded ends of the bearings 81. When the pawl 85 is caused to engage the wheel 83 the pawl 84 works on the bluff. The element 76a is moved at the required time and to the requisite extent in company with and by means of the element 76, for which purpose the latter has thereon a pivoted catch 91 adapted to engage a notched plate 92 on the element 76a. When the element 76 is being racked into the splicing position it first moves independently of the element 76a since it has to move further. Eventually however the catch 91 comes into register with the notch in the plate 92 whereupon the element 76 picks up the element 76a and carries it along with it into the required position. When the elements 76, 76a take up their splicing positions the operation of the pawl 84 is interrupted by placing the cams 89 in a neutral position so that said elements remain in the splicing position until they are to be moved in the reverse direction i. e. racked out to reduce the width of the splicing for the foot bottom *f'*, whereupon the pawl 85 is caused to operate by moving the cams 89 back to their initial position and the two elements move together until the required reduction has been effected, the operation of the pawl 85 thereupon being again interrupted. Upon completion of the foot bottom and heel *h* the pawl 85 is again caused to operate for the production of the high splice *x*. When during the racking out action the element 76a reaches its original position the two elements are disconnected as the result of the engagement of the catch 90 with a cam formation 93 on one or each of the outer elements 75, 75a, after which the element 76 moves alone until it also reaches its original position whereupon the operation of the pawl 85 is again interrupted, and the said elements remain in this position until they are to be racked in again for splicing the next article. It will of course be understood that the racking in and out movements aforesaid are timed to take place when the threads are clear of the needles. The cams 89 are controlled by means of a face cam 94 racked round by pawl and ratchet mechanism 95, 96, 97, operated by the eccentric strap 44 through a lever 98 fulcrumed at 99 on the adjacent end frame and fitted with a roller 100 for engagement with the strap. The cam 94 operates through mechanism comprising a lever 101 fulcrumed at 102 and connected by a link 103 with another lever 104 pivoted at 105, said lever being connected by means of a pin and slot connection 106 and a plunger 107 with a plate 108 in turn connected by pin and slot connections 109 with levers 110 attached to the pivot pins 111 of the cams 89. The cam 94 is designed so that the cams 89 are held in an inactive position as shown in Figure 14 or raised or lowered so as to cause either the pawl 84 or the pawl 85 to operate according to requirements.

The heel of the article is produced by widening and narrowing on appropriate needles selected by the jacquards and needle selectors.

For adjusting the auxiliary thread guide member in accordance with variations in the number of needles operated in different courses, said member is also made in two sections 112, 113 slidably mounted end to end between outer elements 114. The sections 112, 113 are furnished with holes 39 to hold the threads and the inner sections and outer elements are moved as a whole for lapping purposes by means of the form already described with reference to Figures 8 and 9. The sections 112, 113 are formed with rack teeth 115, 116, for engagement respectively by pinions 117, 118 in spindles 119, 120 carried by bearings 121, 122 on the sec-

tions 114. The spindles 119, 120 are furnished respectively with ratchet wheels 123, 124, and 125, 126 and pawls 127, 128, and 129, 130 are carried by levers 131, 132 freely mounted on the spindles and fitted with rollers 133, 134. As the carriages 40 oscillate these rollers work in cam tracks formed between arcuate members 135, 136 suitably fixed on the end frames and each of these cam tracks has associated therewith a switch cam 137. By the movement of these switch cams to different positions one or both of the spindles 119, 120 may be rotated either clockwise or anti-clockwise, or allowed to remain stationary, depending on whether either or both of the sections 112, 113 are to be moved outwards or inwards or to remain unadjusted. Thus for the toe portion of the article the sections 112, 113 are both moved outwards as additional needles are brought into action at both ends of the operative series in successive courses until the number required for the foot are in operation, and then the section 112 remains unadjusted throughout the formation of the foot and leg, while the section 113 is adjusted outwards and inwards in accordance with the gradual increase and decrease of the number of needles during the formation of the heel and outwards during fashioning i. e. while the number of needles in action is increased at one end of the operative series in successive courses to form the wider or fashioned portions of the article.

Each of the switch cams is controlled for the purpose aforesaid by a groove cam 138 and intermediate mechanism comprising a lever 139 fast on a rockshaft 140 and furnished with a roller 141 to work in the cam groove, a lever 142, link 143, lever 144 and a pin 145 on which the cam is mounted. The cam 138 is formed in the periphery of the blank in which the face cam 94 is formed.

A feature of the machine designed to produce fashioned fabric is that the threads are wound on separate bobbins 146 preferably of a construction similar to the bobbins employed in a lace machine. In this connection it is preferred to provide half as many bobbins and main thread guide holes 39 in each series as there are needles in the corresponding bed and to knit first on alternate needles in one bed, then on alternate needles in the other bed, then on the remaining needles of the first bed, and then on the remaining needles of the second bed, the jacquard band or equivalent associated with each bed being set out so that when one series of perforations is brought opposite to the selectors 12 the alternate selectors are selected as represented in Figure 4. and when the next series of perforations is brought into the selective position the other selectors are selected. The purpose of this is to avoid the necessity for providing abnormally thin bobbins for use

on a fine gauge machine. Time is also saved in setting up the machine for knitting. The perforations in one series are preferably staggered in relation to those of the next adjacent series and alternate selectors have their butts 14 at a higher level than the butts of the remaining selectors, as shown in Figure 3, so that for a fine gauge machine the perforations may be made at the required pitch without impairing the strength of a comparatively thin band.

It will be understood that there is a set of bobbins for each series of main guides and two or more bobbins for the auxiliary guides. Preferably the several sets of bobbins are arranged radially with respect to the pivoted axis of the oscillatory carriages in which the aforesaid slides are mounted, so that the threads are supplied under substantially uniform tension. Conveniently the sets of bobbins are carried by rods or bars 147 fitted into slots or recesses 148 formed in the end frame members 9a along a line concentric with the pivotal axis of the carriages 40 or 40a. As shown pivoted thread tensioning members 149 are provided in association with the bobbins. The threads from the bobbins may be passed between guide rods 150 from which the threads extend substantially radially with respect to the pivotal axis of the aforesaid carriages.

The selectors 12 are furnished with butts 12a for engagement by operable members 151 as shown in Figure 3 whereby the selected selectors are restored to the normal position subsequent to their action upon the corresponding needles. Each of these members 151 conveniently consists of a metal strip fixed on a shaft 152 furnished with cams 153, see Figure 2, and pivotally and slidably mounted in the arms 30. Associated and parallel with each of the shafts 152 is a rod 154 fixed in the same arms 30 and furnished with cams 155 for co-operation with the cams 153 whereby when the shaft 152 is moved endwise in one direction, i. e. to the right, the co-acting cams 153, 155 cause the shaft to turn with the result that the member 151 acts upon opposing selector butts 12a and restores the corresponding selectors to their normal position as shown at the right hand side of Figure 3. The said turning movement of the shafts 152 may be effected against spring action and the endwise movements may be effected also against spring action by means of cam pieces, one of which is shown at 156 in Figure 2 on the cams 22, said cam pieces acting on rollers, one of which appears at 157 in Figure 2 on the adjacent ends respectively of the shafts.

To enable both series of needles to take the same threads for one or more courses at the commencement of knitting for the purpose hereinbefore set forth, I may provide at one end of the pairs of main guide members 114



a plurality of teeth 158 for engagement by a pawl 159 carried by a plunger 160 slidable in the adjacent oscillatory carriages 40a and actuated by means of a cam 161 movably arranged on the adjacent end frame 9 of the machine. Conveniently the pawl 159 is pivoted on the plunger 160 and controlled by a spring 162 operating through a poppet pin 163 in the plunger so that the pawl is held up to the teeth 158 but can yield when required to slide over same. The plunger 160 is engaged by a lever 164 pivoted at 165 on the carriage 40a and furnished with a roller 166 for engagement with the cam 161 pivoted at 167 on the adjacent end frame 9, whereby when the cam is rendered operative as shown in Figs. 18 and 19 the lever is moved against the action of a spring 168 to operate the plunger 160. The cam 161 is moved into the path of the roller 166—i. e. from the normal inoperative position shown in Fig. 17 to the operative position shown in Fig. 18 at the appropriate time during the swinging movement of the guide members 114 by means of an eccentric 169 on a cam actuated rockshaft 170 and by action upon the lever 164 causes the pawl 159 to shift the guide members 114 endwise in the direction of the arrow (Fig. 17), when between the two sets of needles 3 as shown in Fig. 20 so that the said members, after having lapped their threads over the needles of the right hand bed, are in a position to engage the same threads with the operative needles of the other i. e. the left hand bed instead of passing said threads idly between the said needles as occurs after the initial courses as previously set forth herein. A catch 171 controlled by a spring 172 is provided on the carriage 40a for engagement with the lever 164 as represented in Fig. 18 to hold the guides in this position until the guide members have swung from the back to the front of the needles concerned, i. e. those of the left hand bed viewing Fig. 20 whereupon the catch is released by a tripping member 173 fixed on the end frame 9, and the eccentric 169, by rotation in the direction of the arrow in Figure 18, is moved momentarily to the position shown in Figure 17 so that the cam 161 moves under the action of its spring 174 clear of the path of the roller 166 and the guide members are shifted back to their original position by their own springs (see 46 Fig. 8) so that when swung in the opposite direction the threads become completely lapped round the needles. Any suitable means may of course be adopted for actuating the rockshaft 170 to render the cam 161 operative and inoperative in timed relation to the cycle of operations of the machine. When the cam 161 is rendered definitely inoperative the pawl 159 is disengaged from the teeth 158 by a bluff plate 175 on the carriage 40a so as to prevent any interference by the pawl with the subsequent lapping

movements of the thread guide members 114 under the control of the cam 47 (Figures 8 and 9) as previously described herein.

What I claimed then is:—

1. A warp knitting machine comprising parallel needle beds, two independent series of individually movable needles, one or more series of thread guides for each series of needles for lapping threads over said needles to produce knitted webs, auxiliary thread guides for lapping threads over needles in both series to unite the knitted webs to form tubular fabric, means for effecting variations in the number of needles forming loops as knitting proceeds to produce fashioned fabric, means for correspondingly adjusting the auxiliary thread guiding means, and means for causing the needles to knit.

2. A warp knitting machine comprising parallel needle beds, two independent series of individually slidable needles arranged back to back, one or more series of thread guides for each series of needles for lapping threads over said needles to produce knitted webs, auxiliary thread guides for lapping threads over needles in both series to unite the knitted webs to form tubular fabric, means for effecting variations in the number of needles forming loops as knitting proceeds to produce fashioned fabric, means for correspondingly adjusting the auxiliary thread guiding means, and means for causing the needles to knit.

3. A warp knitting machine of the straight bar type which includes curved needles, means for feeding threads to said needles, and means for causing the needles to knit.

4. A warp knitting machine which includes individually movable curved needles, parallel needle beds furnished with arcuate grooves in which said needles are arranged so as to provide two series back to back, means for feeding threads to said needles, and means for causing the needles to knit.

5. A warp knitting machine which includes individually movable curved needles, parallel needle beds furnished with arcuate grooves in which said needles are arranged so as to provide two series back to back, thread lapping means for each series of needles to produce two independently knitted webs, auxiliary thread lapping means common to needles at the ends of both series for joining said webs at the edges to produce tubular fabric, and means for causing said needles to knit.

6. A warp knitting machine comprising parallel needle beds, two independent series of individually movable curved needles arranged back to back respectively in arcuate grooves or tricks in said beds, one or more series of thread guides for each series of needles for lapping threads over said needles to produce knitted webs, auxiliary thread guides for lapping threads over needles in both series

to unite the knitted webs to form tubular fabric, means for effecting variations in the number of needles forming loops as knitting proceeds to produce fashioned fabric, means for correspondingly adjusting the auxiliary thread guiding means, and means for causing the needles to knit.

7. A warp knitting machine comprising parallel needle beds, two independent series of individually movable needles, one or more series of thread guides for each series of needles for lapping threads over said needles to produce knitted webs, auxiliary thread guides for lapping threads over needles in both series to unite the knitted webs to form tubular fabric, means for effecting variations in the number of needles forming loops as knitting proceeds to produce fashioned fabric, means for correspondingly adjusting the auxiliary thread guiding means, means for causing the needles to knit, and means for reinforcing the fabric where desired.

8. A warp knitting machine which includes individually movable curved needles, parallel needle beds furnished with arcuate grooves in which said needles are arranged so as to provide two series back to back, thread lapping means for each series of needles to produce two independently knitted webs, auxiliary thread lapping means common to needles at the ends of both series for joining said webs at the edges to produce tubular fabric, means for causing the said needles to knit, and means for reinforcing the fabric where desired.

9. A warp knitting machine comprising parallel needle beds, two independent series of individually movable curved needles arranged back to back respectively in arcuate grooves or tricks in said beds, one or more series of thread guides for each series of needles for lapping threads over said needles to produce knitted webs, auxiliary thread guides for lapping threads over needles in both series to unite the knitted webs to form tubular fabric, means for effecting variations in the number of needles forming loops as knitting proceeds to produce fashioned fabric, means for correspondingly adjusting the auxiliary thread guiding means, means for reinforcing the fabric where desired, and means for causing the needles to knit.

10. A warp knitting machine comprising parallel needle beds, two independent series of individually movable needles, one or more series of thread guides for each series of needles for lapping threads over said needles and divided into groups arranged so that one group can be moved lengthwise relatively to the other group, auxiliary thread guides for lapping threads over needles in both series, means for effecting variations in the number of needles forming loops as knitting proceeds, means for correspondingly adjusting the aux-

iliary thread guides, and means for causing the needles to knit.

11. A warp knitting machine comprising parallel needle beds, two independent series of individually movable curved needles arranged back to back respectively in arcuate grooves in said beds, one or more series of thread guides for each series of needles for lapping threads over said needles and divided into groups arranged so that one group can be moved lengthwise relatively to the other group, auxiliary thread guides for lapping threads over needles in both series, means for effecting variations in the number of needles forming loops as knitting proceeds, means for correspondingly adjusting the auxiliary thread guides, and means for causing the needles to knit.

12. A warp knitting machine comprising parallel needle beds, two independent series of individually movable needles, one or more series of thread guides for each series of needles for lapping threads over said needles and divided into groups arranged so that one group can be moved lengthwise relatively to the other group, means for shifting one group or division gradually in relation to the other group in the same series, auxiliary thread guides for lapping threads over needles in both series, means for effecting variations in the number of needles forming loops as knitting proceeds, means for correspondingly adjusting the auxiliary thread guides, and means for causing the needles to knit.

13. A warp knitting machine comprising parallel needle beds, two independent series of individually movable curved needles arranged back to back respectively in arcuate grooves in said beds, one or more series of thread guides for each series of needles for lapping threads over said needles and divided into groups arranged so that one group can be moved lengthwise relatively to the other group, means for shifting one group or division gradually in relation to the other group in the same series, auxiliary thread guides for lapping threads over needles in both series, means for effecting variations in the number of needles forming loops as knitting proceeds, means for correspondingly adjusting the auxiliary thread guides, and means for causing the needles to knit.

14. A warp knitting machine comprising parallel needle beds for two independent series of individually movable needles, two series of thread guides for each series of needles, means to cause said series of guides respectively to lap in opposite directions, auxiliary thread guides for lapping threads over needles in both series to unite the knitted webs to form tubular fabric, means for effecting variations in the number of needles forming loops as knitting proceeds to produce fashioned fabric, means for correspondingly

adjusting the auxiliary thread guiding means, and means for causing the needles to knit.

15. A warp knitting machine comprising parallel needle beds for two independent series of individually slidable needles arranged back to back, two series of thread guides for each series of needles, means to cause said series of guides respectively to lap in opposite directions, auxiliary thread guides for lapping threads over needles in both series to unite the knitted webs to form tubular fabric, means for effecting variations in the number of needles forming loops as knitting proceeds to produce fashioned fabric, means for correspondingly adjusting the auxiliary thread guiding means, and means for causing the needles to knit.

16. A warp knitting machine which includes individually movable curved needles, parallel needle beds furnished with arcuate grooves in which said needles are arranged so as to provide two series back to back, two series of thread guides for each series of needles, means to cause said series of guides respectively to lap in opposite directions, auxiliary thread lapping means common to needles at the ends of both series for joining said webs at the edges to produce tubular fabric, and means for causing said needles to knit.

17. A warp knitting machine comprising parallel needle beds, two independent series of individually movable curved needles arranged back to back respectively in arcuate grooves or tricks in said beds, two series of thread guides for each series of needles, means to cause said series of guides respectively to lap in opposite directions, auxiliary thread guides for lapping threads over needles in both series to unite the knitted webs to form tubular fabric, means for effecting variations in the number of needles forming loops as knitting proceeds to produce fashioned fabric, and means for correspondingly adjusting the auxiliary thread guiding means.

18. A warp knitting machine comprising parallel needle beds, two independent series of individually movable needles, two series of thread guides for each series of needles and divided into groups arranged so that one group can be moved lengthwise relatively to the other group, auxiliary thread guides for lapping threads over needles in both series, means for effecting variations in the number of needles forming loops as knitting proceeds, means for correspondingly adjusting the auxiliary thread guides, and means for causing the needles to knit.

19. A warp knitting machine comprising parallel needle beds, two independent series of individually movable needles, two series of thread guides for each series of needles, and divided into groups arranged so that

one group can be moved lengthwise relatively to the other group, means for shifting one group or division gradually in relation to the other group in the same series, auxiliary thread guides for lapping threads over needles in both series, means for effecting variations in the number of needles forming loops as knitting proceeds, means for correspondingly adjusting the auxiliary thread guides, and means for causing the needles to knit.

20. A warp knitting machine comprising parallel needle beds, two independent series of individually movable needles, sets of thread guides for said series of needles respectively for lapping threads over the needles to produce two knitted webs, means whereby for at least one course at the commencement of the knitting action one at least of said sets of thread guides is operated so that initially both series of needles are caused to take the same threads, auxiliary thread guides for lapping threads over needles at the ends of both series to unite the webs at the edges, and means for causing the needles to knit.

21. A warp knitting machine comprising parallel needle beds, two independent series of individually movable needles, sets of thread guides for said series of needles respectively for lapping threads over the needles to produce two knitted webs, means whereby for at least one course at the commencement of the knitting action one at least of said sets of thread guides is operated so that initially both series of needles are caused to take the same threads, auxiliary thread guides for lapping threads over needles at the ends of both series to unite the webs at the edges, means for varying the number of needles rendered active as knitting proceeds, means for correspondingly adjusting the auxiliary thread guides, and means for causing the needles to knit.

22. A warp knitting machine comprising individually movable curved needles, parallel needle beds in which said needles are arranged so as to provide two series back to back, sets of thread guides for said series of needles respectively for lapping threads over the needles to produce two knitted webs, means whereby for at least one course at the commencement of the knitting action one at least of said sets of thread guides is operated so that initially both series of needles are caused to take the same threads, auxiliary thread guides for lapping threads over needles at the ends of both series to unite the webs at the edges, and means for causing the needles to knit.

23. A warp knitting machine comprising individually movable curved needles, parallel needle beds in which said needles are arranged so as to provide two series back to back, sets of thread guides for said series of needles respectively for lapping threads over

the needles to produce two knitted webs, means whereby for at least one course at the commencement of the knitting action one at least of said sets of thread guides is operated so that initially both series of needles are caused to take the same threads, auxiliary thread guides for lapping threads over needles at the ends of both series to unite the webs at the edges, means for varying the number of needles rendered active as knitting proceeds, means for correspondingly adjusting the auxiliary thread guides, and means for causing the needles to knit.

24. A warp knitting machine comprising parallel needle beds, two independent series of individually movable needles, sets of thread guides for said series of needles respectively for lapping threads over the corresponding needles and each divided into groups arranged so that one group can be moved lengthwise with respect to the other group, means whereby for at least one course at the commencement of the knitting action one at least of said sets of guides is operated so that initially both series of needles are caused to take the same threads, auxiliary thread guides for lapping threads over needles respectively at the ends of both series to unite the webs at the edges, means for varying the number of needles rendered active as knitting proceeds, means for correspondingly adjusting the auxiliary thread guides, and means for causing the needles to knit.

25. A warp knitting machine comprising parallel needle beds, two independent series of individually movable curved needles arranged back to back respectively in arcuate grooves in said beds, sets of thread guides for said series of needles respectively for lapping threads over the corresponding needles and each divided into groups arranged so that one group can be moved lengthwise with respect to the other group, means whereby for at least one course at the commencement of the knitting action one at least of said sets of guides is operated so that initially both series of needles are caused to take the same threads, auxiliary thread guides for lapping threads over needles respectively at the ends of both series to unite the webs at the edges, means for varying the number of needles rendered active as knitting proceeds, means for correspondingly adjusting the auxiliary thread guides, and means for causing the needles to knit.

26. A warp knitting machine comprising parallel needle beds, two independent series of needles, sets of thread guides for said series of needles respectively, and each divided into groups arranged so that one group can be moved lengthwise with respect to the other group, means for shifting one group gradually in relation to the other group, means whereby for at least one course at the commencement of the knitting action one at

least of said sets of guides is operated so that initially both series of needles are caused to take the same threads, auxiliary thread guides for lapping threads over needles respectively at the ends of both series to unite the webs at the edges, means for varying the number of needles rendered active as knitting proceeds, means for correspondingly adjusting the auxiliary thread guides, and means for causing the needles to knit.

27. A warp knitting machine comprising two independent series of individually movable curved needles arranged back to back respectively in arcuate grooves in parallel beds, sets of thread guides for said series of needles respectively and each divided into groups arranged so that one group can be moved lengthwise with respect to the other group, means for shifting one group gradually in relation to the other group, means whereby for at least one course at the commencement of the knitting action one at least of said sets of guides is operated so that initially both series of needles are caused to take the same threads, auxiliary thread guides for lapping threads over needles respectively at the ends of both series to unite the webs at the edges, means for varying the number of needles rendered active as knitting proceeds, means for correspondingly adjusting the auxiliary thread guides, and means for causing the needles to knit.

28. A warp knitting machine comprising parallel needle beds, two series of independently slidable bearded needles in said beds respectively, sets of thread guides for said series of needles respectively, means for operating the thread guides for thread lapping purposes, auxiliary thread guides for lapping threads over needles at the ends of both series, means for operating the auxiliary guides, means for operating the needles, means for pressing the needle beards, web holders co-operating with the needles, knocking over means, and means for operating the pressing means and the web holders.

29. A warp knitting machine comprising parallel needle beds two series of curved bearded needles arranged back to back, said needles being slidable independently in arcuate grooves in said beds, sets of thread guides for said series of needles respectively, means for operating the thread guides for thread lapping purposes, auxiliary thread guides for lapping threads over needles at the ends of both series, means for operating the auxiliary guides, means for operating the needles, means for pressing the needle beards, web holders co-operating with the needles, knocking over means, and means for operating the pressing means and the web holders.

30. A warp knitting machine comprising parallel needle beds, two series of independent needles in said beds respectively, main and auxiliary thread guide members for said

series of needles respectively, oscillatory carriages in which said members are carried so as to be movable endwise, means for oscillating said carriages to carry the threads between the needles, means for operating said guide members, and means for causing the needles to knit.

31. A warp knitting machine comprising parallel needle beds, two series of independent curved needles in said beds respectively, main and auxiliary thread guide members for said series of needles respectively, oscillatory carriages in which said members are carried so as to be movable endwise, means for oscillating said carriages to carry the threads between the needles, means for operating said guide members, and means for causing the needles to knit.

32. A warp knitting machine comprising parallel needle beds, two series of independently movable bearded needles in said beds respectively, main and auxiliary thread guide members for said series of needles respectively, oscillatory carriages in which said members are carried so as to be movable endwise, means for oscillating said carriages to carry the threads between the needles, means for operating said guide members, means for operating the needles, means for pressing the needle beards, web holders co-operating with the needles, knocking over means, and means for operating the pressing means and the web holders.

33. A warp knitting machine comprising parallel needle beds, two independent series of individually movable needles in said beds respectively, main and auxiliary thread guide members comprising respectively sections movable as a whole, and adjustable individually, oscillatory carriages for said sections, means for oscillating the carriages to carry the threads between the needles, means for operating the sections as a whole for thread lapping purposes, means for operating the needles, means for causing different numbers of needles to knit in different courses, and means for adjusting the aforesaid sections for the purposes set forth.

34. A warp knitting machine comprising parallel needle beds, two independent series of individually movable needles in said beds respectively, main and auxiliary thread guide members comprising respectively sections movable as a whole, and adjustable individually, oscillatory carriages for said sections, means for oscillating the carriages to carry the threads between the needles, means for operating the sections as a whole for thread lapping purposes, means whereby for at least one course at the commencement one at least of the main guide members is operated so that initially both series of needles take the same threads, means for operating the needles, means for causing different numbers of needles to knit in different courses, and means

for adjusting the aforesaid sections for the purposes set forth.

35. A warp knitting machine comprising parallel needle beds, two series of independently slidable bearded needles in said beds respectively, main and auxiliary thread guide members comprising respectively sections movable as a whole, and adjustable individually, oscillatory carriages for said sections, means for oscillating the carriages to carry the threads between the needles, means for operating the sections as a whole for thread lapping purposes, means whereby for at least one course at the commencement one at least of the main guide members is operated so that initially both series of needles take the same threads, means for operating the needles, means for causing different needles to knit in different courses, means for adjusting the aforesaid sections for the purposes set forth, means for pressing the needle beards, web holders co-operating with the needles, knocking over members, and means for operating the pressing means and the web holders.

In testimony whereof I affix my signature.  
ERNEST SPIERS.

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