Sept. 1, 1953 H. HARTUNG, SR 2,650,486

WARP KNITTING MACHINE

Filed April 26, 1950 5 Sheets-Sheet 1

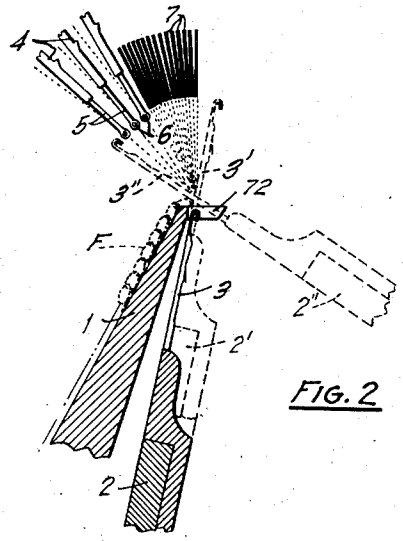


FIG. 2

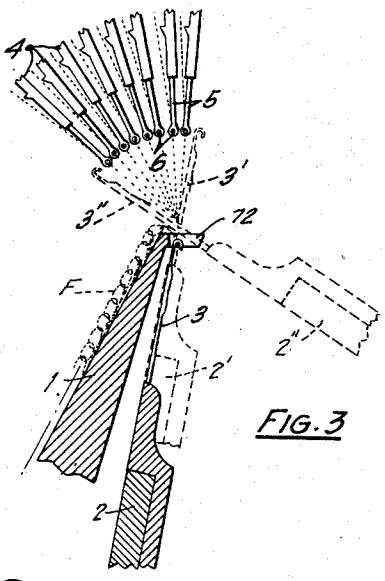


FIG. 3

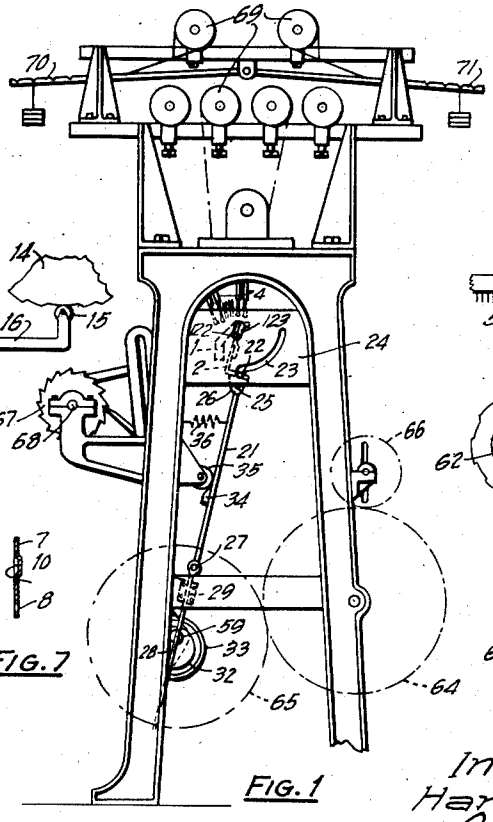


FIG. 1

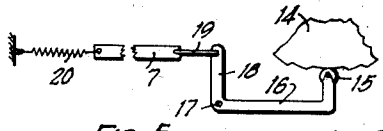


FIG. 5

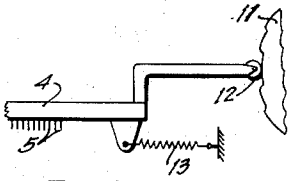


FIG. 4

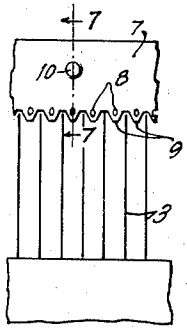


FIG. 6

FIG. 7

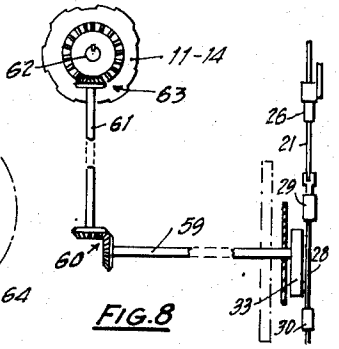


FIG. 8

Inventor
Hans Hartung, Sr.
by
His Attorneys

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WARP KNITTING MACHINE

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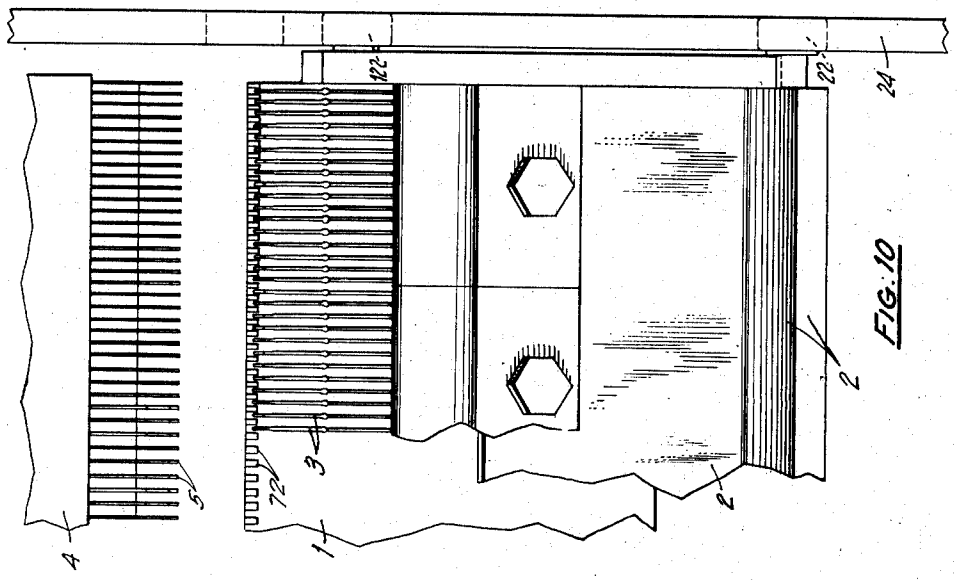


FIG. 10

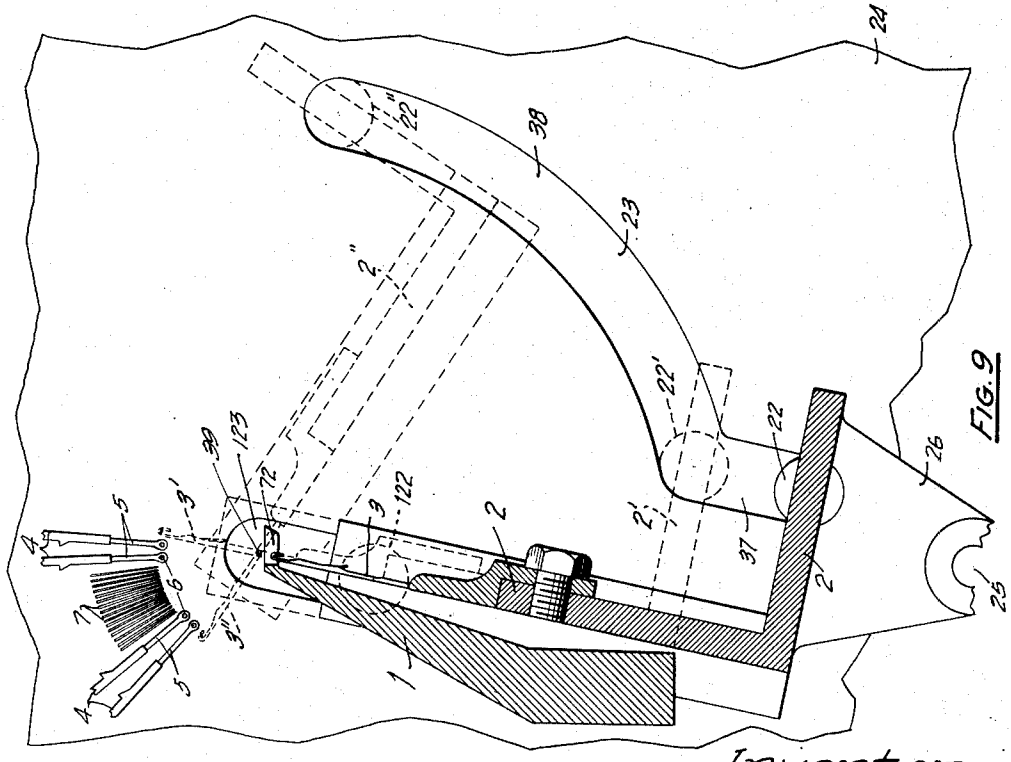


FIG. 9

Inventor
Hans Hartung Sr.
by
His Attorneys

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WARP KNITTING MACHINE

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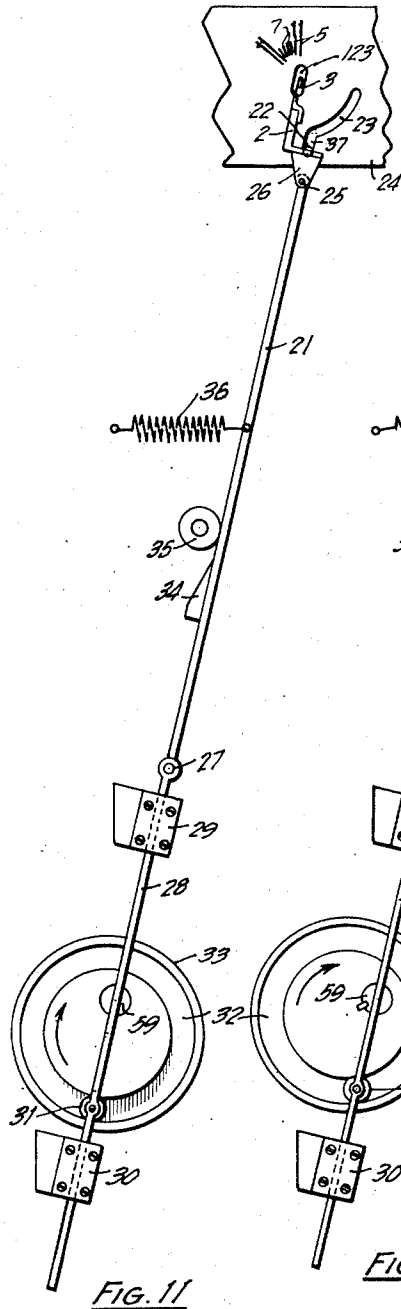


FIG. 11

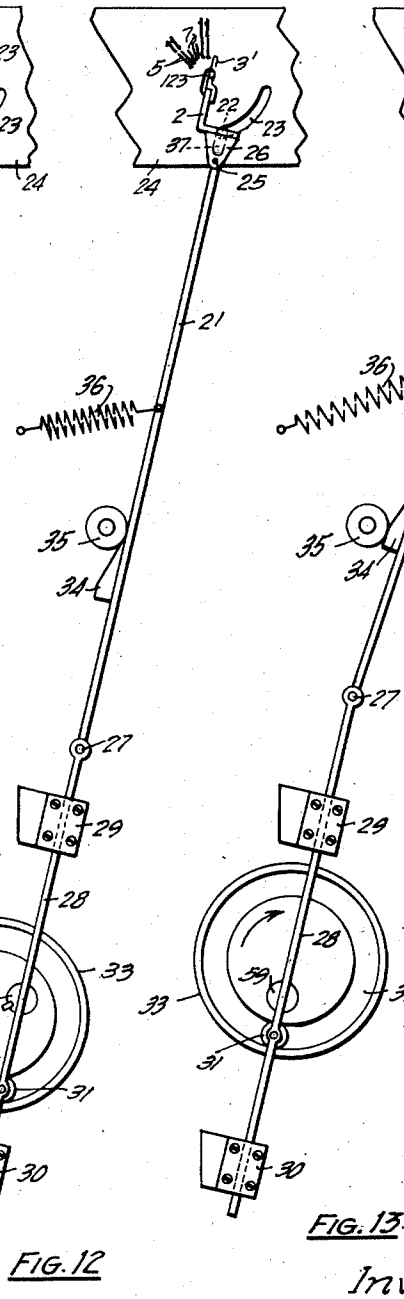


FIG. 12

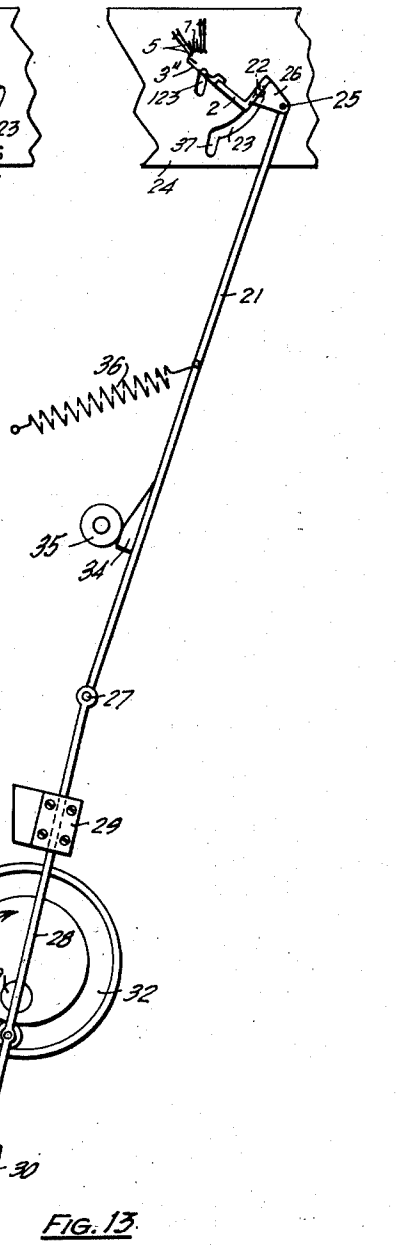


FIG. 13

Inventor
Hans Hartung Sr.
by
His Attorneys

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WARP KNITTING MACHINE

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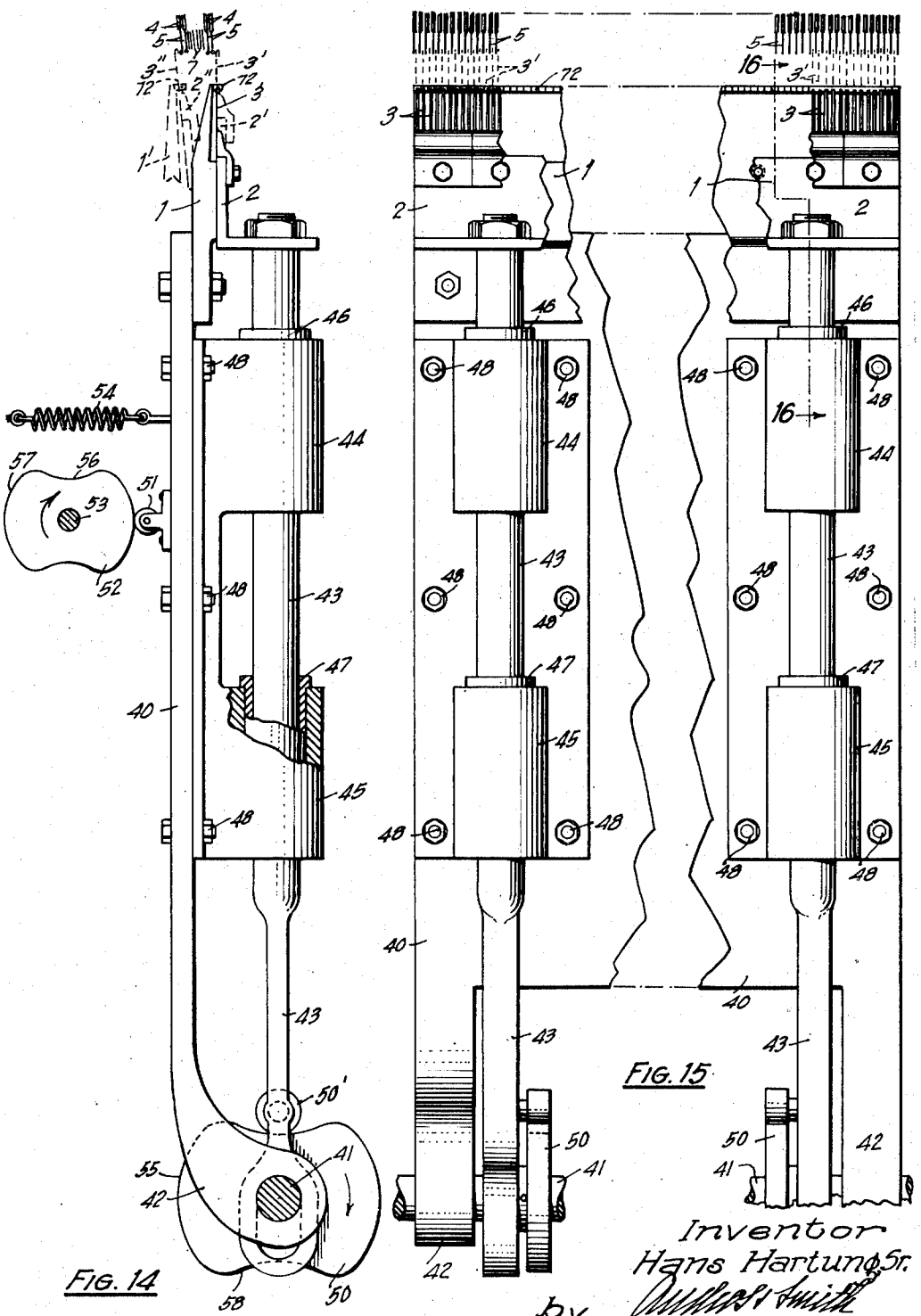


FIG. 14

FIG. 15

Inventor
Hans Hartung Sr.
by
His Attorneys

Sept. 1, 1953 H. HARTUNG, SR 2,650,486

WARP KNITTING MACHINE

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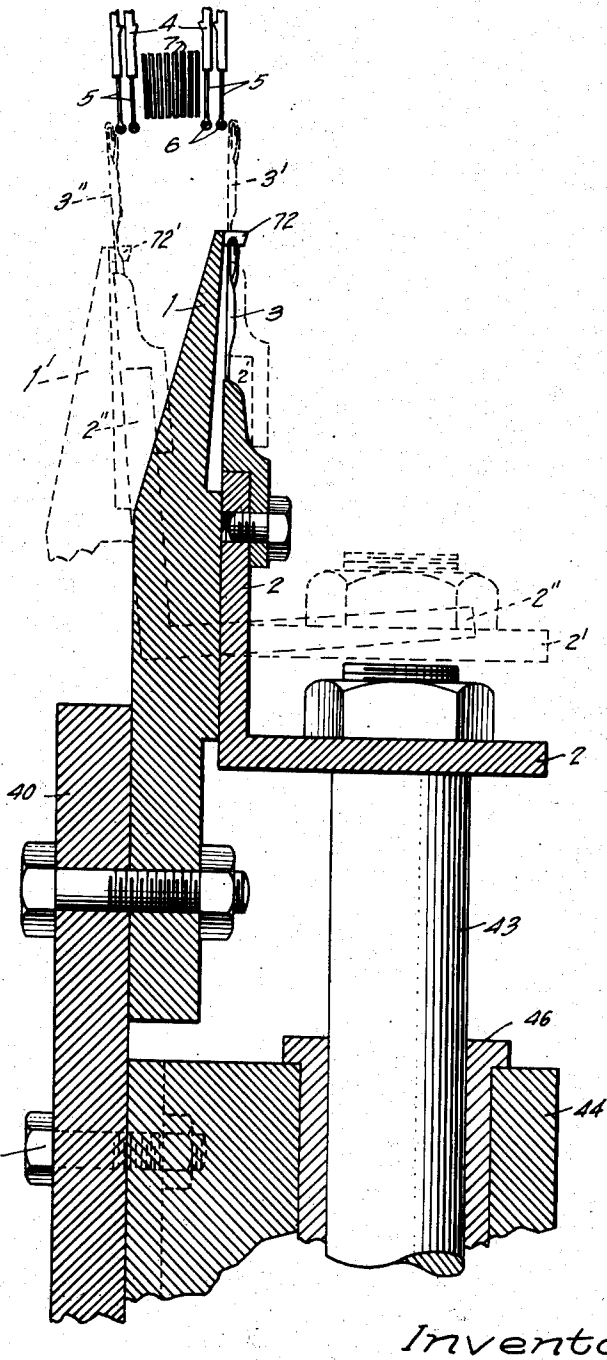


FIG. 16

Inventor
Hans Hartung, Sr.
by
His Attorneys

Patented Sept. 1, 1953

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UNITED STATES PATENT OFFICE

2,650,486

WARP KNITTING MACHINE

Hans Hartung, Sr., Glens Falls, N. Y.

Application April 26, 1950, Serial No. 158,305

18 Claims. (Cl. 66—86)

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My invention relates to knitting machines, and particularly to improvements in machines of the warp knitting type.

In machines of this type the needle bar which carries the knitting needles is moved only in a direction lengthwise of the needles. The guide bars however, of which there are from one to six, which carry the yarn guides or guide needles, have two distinctly different motions or movements. One of these is a swinging or oscillating motion which passes the guides between the needles, and the other is a lapping motion which lays or laps the yarn around the needles.

Warp knitting machines now in use may be classed in two general groups, i. e., (1) Tricot type machines which are commercially built with not more than three guide bars and which are used particularly for the production of plain staple fabrics, such as Jersey, Atlas, and net fabrics in which very little design is used; and (2) Raschel type machines which are commercially built with not more than six guide bars and which are used to produce a great variety of fabrics ranging from very narrow fabrics and hair nets to sweaters and elastic fabrics made with rubber threads. During the last few years the inexpensive type of lace fabrics have been made in increasing quantities on Raschels, but the figures and designs in all of these fabrics are limited mostly to the small types since only six guide bars are available.

The Leavers Lace machines are of a quite different type from those mentioned above, and, on these machines it is possible to produce lace having widely varied and fanciful designs which cannot be produced on the present warp knitting machines.

The operation of Leavers Lace and similar machines, however, is expensive, and is complicated by the fact that thousands of small, wafer-like "brass-bobbins" are used in each machine and the yarn waste is very high. Since the yarns on all of the bobbins do not run out together, and only a very little yarn can be wound thereon, the bobbins must be changed at short intervals. All of the bobbins have to be rewound which means that the yarn remaining on many of the bobbins must be stripped off and discarded. When rewound, the bobbins expand and must be subjected to high pressure (sometimes 20 tons per square inch) and to a steaming and cooling treatment in order to compress them before they can be used in the machine. Furthermore, the nature of the bobbins and the graphite used in lubricating them makes it virtually impossible

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to use certain yarns. Thus, it is very difficult to clean the graphite out of nylon or nylon-rubber fabrics.

Instead of using guide bars only, as in present machines of the warp knitting type, my machine, like the Leavers Lace machines, will use what are known in the trade as "steel bars" having a multiplicity of orifices therein through which pass the yarns, which cooperate with the yarns on the bobbins. The steel bars are thin metal tapes, and it is therefore possible to use, in a given space, many more bars of this type than bulky, rigid guide bars, thus making possible the production of an extremely wide variety of designs in the fabric.

Broadly, my invention, which can be applied to any of the aforesaid warp knitting machines, comprises a machine in which a large number of steel bars may be used in combination with one or more guide bars, all of which have only a laying or lapping movement longitudinally thereof, and in which the needle bar, instead of moving only longitudinally of the needle, has both a swinging movement and a movement longitudinally of the needles. In other words, the swinging movement of the guide bars has been eliminated and this motion has been imparted to the needle bar.

Since the guide bars do not swing, they can be made very much less bulky and spaced closer together so that a large number can be employed. This results in the production of fabrics of finer quality and design and also in a higher rate of production. Complicated and expensive yarn tension devices are not necessary, and the yarns themselves are not subject to violent pulls and jerks which result in less yarn breakage and more perfect fabrics. Furthermore, it makes it possible to use yarns which were heretofore too frail.

The fact that my machine has needles, and as many as 30 guide bars or steel bars may be employed, makes the designing possibilities practically unlimited, and patterns with gimping and liners, such as produced on the Leavers Lace machine, may be formed thereon. Moreover, my machine is not limited to the making of lace, but may be used to produce any of the aforesaid products with a wide variety of designs therein.

In general, the principal object of my invention is to provide a warp knitting machine in which fabrics of finer quality and a greater latitude of design can be produced than by the present types of machines. Another object is to provide a machine of this type having a much

higher rate of production than the machines presently used. Another object is to provide a warp knitting machine in which it is not necessary to employ complicated yarn tension devices, and in which the yarn is not subject to violent pulls or jerks so that there is less yarn breakage and more perfect fabrics can be produced thereby. Another object is to provide a warp knitting machine in which it is possible to use yarns heretofore considered too frail for use in knitting, and in which there will be less yarn waste. A further object is to provide a knitting machine upon which lace of the character produced by the Leavers Lace machine may be made but which is very much less complicated and much less expensive to construct and operate than the Leavers machines.

I accomplish these and other objects which will be apparent as the description of my invention proceeds, by means of the novel elements and the combinations and arrangements thereof described below and illustrated in the accompanying drawings in which—

Fig. 1 is a more or less diagrammatic end view of a warp knitting machine embodying my invention;

Fig. 2 is a fragmentary, cross section of a machine embodying my invention and illustrating the use thereof with 3 guide bars and 15 steel bars;

Fig. 3 is a fragmentary, sectional view similar to Fig. 2 showing my machine equipped with 8 guide bars and no steel bars;

Fig. 4 is a fragmentary, diagrammatic, elevation view of a rigid guide bar showing a fragmentary portion of a pattern wheel by which or by means of a pattern chain running thereover, said bar is actuated;

Fig. 5 is a fragmentary, diagrammatic, elevation view, similar to Fig. 4 showing one of the steel bars and a fragmentary portion of a pattern wheel by which it is actuated either directly or by means of a pattern chain running thereover;

Fig. 6 is a fragmentary, elevation view of a steel bar and a portion of the needle bar;

Fig. 7 is a section of Fig. 6 in the plane 7—7;

Fig. 8 is a fragmentary, diagrammatic, elevation view showing a mechanical connection between the driving means for the pattern wheels and the means which actuates the needle bar in timed relation to the movements of the guide bars actuated by the pattern wheels;

Fig. 9 is a fragmentary, enlarged, cross-sectional view through the needle bar showing the movements thereof;

Fig. 10 is a fragmentary, front elevation view of the mechanism shown in Fig. 9;

Figs. 11, 12 and 13 are more or less diagrammatic end views of a mechanism which may be employed to reciprocate and oscillate the needle bar;

Fig. 14 is an end view partially in section of a modified means for reciprocating and oscillating the needle bar;

Fig. 15 is a fragmentary, front elevation view of the mechanism shown in Fig. 14, at each end of the machine; and

Fig. 16 is an enlarged, fragmentary, vertical section in the plane 16—16 of Fig. 15.

Referring to the drawings—

1 is the trick bed which supports the fabric F produced on the machine and 2 is the needle bed or needle bar which carries the needles 3, here shown as of the latch type. 4 are guide bars

which carry the guide needles 5 having eyes 6 therein through which the yarns pass and which guide the yarns around the needles to form loops or meshes, or both. So far as the above elements are concerned, they may be substantially identical with the corresponding elements which are found in warp knitting machines of the present type. However, the movements of the needle bar are substantially different from the movements of the needle bars in machines of the present type, as will be described below; and the movements of the guide bars also differ from the movements of the guide bars in machines of the present type.

In addition to the guide bars which are rigid structures of substantial thickness and of which only a comparatively few can be embodied in a warp knitting machine, in machines of my design the number of yarns, the variety and the movements thereof may be very substantially increased by the use of thread guides in the form of "steel bars" 7, as they are known in the art, and which are thin, flexible, tape-like elements shown in detail in Figs. 6 and 7. These bars are only about 0.006" or 0.007" in thickness and, therefore, a comparatively large number thereof may be disposed in the space ordinarily occupied by comparatively bulky, rigid guide bars. These steel bars may be substantially identical with the steel bars in the Leavers Lace machines. However, I prefer that the lower edges thereof be toothed or serrated, as shown in Fig. 6, and that the orifices or holes 8 therein and through which the yarns pass and are guided be positioned in the teeth 9 so that the needles 3 pass between the teeth 9, as shown in Fig. 6. In order to maintain the steel bars in slightly spaced relation to each other for the passage of the yarns therebetween, they are provided with longitudinally-spaced, struck-out portions 10 which contact one of the next adjacent bars.

In my machine, the guide bars and the steel bars move, or are moved, only in a direction longitudinally thereof. In the present type of warp knitting machines, the guide bars are moved longitudinally by means of pattern wheels or pattern chains, and in my machine the guide bars may be moved by similar pattern wheels 11, or chains running thereover, one of which is diagrammatically shown in Fig. 4. Since the guide bars are rigid, they may be pushed in one direction from one end thereof by means of the pattern wheel and the roller 12 cooperating therewith and are pulled in the opposite direction and normally held in cooperative relation to the pattern wheels by means of tension springs 13. Since in my machine the guide bars do not swing, the operation of the bars has been greatly simplified and, consequently, the accuracy with which the yarns are guided and otherwise controlled is substantially improved.

In the case of the steel bars, however, which are flexible and therefore can be moved in a longitudinal direction only by tension applied to the ends thereof, the mechanism for moving them is illustrated diagrammatically in Fig. 5 in which 14 is a pattern wheel which cooperates with the roller 15 on the bell crank 16 pivoted at 17. The arm 18 of the bell crank is connected to the end of the steel bar 7 by means of the link 19 so that, when the roller 15 is on an elevated zone of the pattern wheels 14, the steel bars are pulled to the right; and they are pulled to the left and the roller 15 is normally held in contact with the pattern wheel by means of the tension

spring 20. It may be noted that high points on the wheel 14 move the steel bars in a direction opposite that which the wheel 11 moves the rigid guide bars.

Referring to Figs. 1, 11, 12 and 13, I have shown one means for moving the needle bar which is pivotally supported at each end of the machine by rollers 22 and 122 which extend respectively, into slots 23, and 123 in a plate 24 (see Figs. 9 and 10). The rod 21 (it being understood that there is one at each end of the machine) is pivotally connected at 25 to a bracket 26 which is secured to the bottom of the needle bar. The rod 21 is also pivotally connected to 27 to another rod 28 which slides in bearings 29 and 30 and is provided with a cam-following roller 31 which rides in the slot 32 of cam 33. Affixed to one side of each rod 21 is a cam 34 which cooperates which a fixed roller 35; the rods 21 being held in contact with the rollers 35 by means of tension springs 36.

While the movements of the needle bar may be produced by the mechanism just described, it may be well to refer at this time to Fig. 9, which shows how the needle bar moves. In these figures the needle bar and the needles shown in solid outline will be assumed as the initial position thereof when the cam roller 31 is at its lowest point, as shown in Fig. 11. The first portion of the cycle of movement of the needle bar is one in a direction longitudinally of the needles. That is to say, the needles move from the position shown at 3, in solid outline in these figures, to the position 3' shown in dotted outline. At the end of this movement, the roller 22 has moved upwardly to the position 22' at the top of the substantially vertical portion 37 of the slot 23, and the roller 122 has moved to the top of the slot 123. From the position 22' the roller 22 moves in the arcuate portion 38 of the slot 23 which has its center at the point 39, which may be about $\frac{1}{16}$'' above the trick bed and which is also the center of the roller 122 when at the top of slot 123. From the position 3', in which the hooks of the needles are somewhat above the bottoms of the guide needles 4, the needles are swung to the position 3'' by the needle bar as it moves to the position 2''. Thus, the needles are swung between the guide needles and between the teeth 9 (see Fig. 6) on the steel bars. After this movement, and before the needle bar carries the needles back to the position 3', the guide bars and the steel bars, or at least some of them, are moved longitudinally thereof by means of the springs 13 and 20, respectively, or the pattern wheels 11 and 14, respectively so that, when the needles swing back from the position 3'' to the position 3' some of the yarns, depending upon which bars are moved by the pattern wheels or springs, are lapped around the needles.

By reference first to Fig. 12 and then to Fig. 13, it will be noted when the needles are in the position 3', the cam 34 is about to contact the roller 35. As the cam-following roller 31 is moved upwardly to the position shown in Fig. 13, the cam 34 comes into cooperative relation with the roller 35 and imparts the lateral component of the movement of the roller 22 as it travels from the position 22' to the position 22'' shown in Figs. 9 and 13, thus, swinging the needles from the position 3' to the position 3''.

In Figs. 14, 15 and 16, I have shown a somewhat different mechanism for imparting the necessary movements to the needle bar. Here, the trick bed 1 is fixed to a plate 40 which extends

lengthwise of the machine and which is pivotally connected at each end to a shaft 41 by means of the depending arms 42. The needle bar 2 is secured to the top of the plungers 43 which reciprocate in the bearings 44 and 45 having bushings 46 and 47, respectively, therein. These bearings are secured to the plate 40 by means of the bolts 48 so that the needle bar is secured in sliding contact with the trick bed. The lower ends of the plungers 43 are slotted to pass the shaft 41 so that they may reciprocate up and down in the bearings 44 and 45. Affixed to the shaft 41 at each end thereof and adjacent the plungers is a cam 50 which cooperates with the cam-followers 50' mounted on the plungers 43 to reciprocate the plungers and the needle bar from the position shown at 2 in Figs. 14, 15 and 16 in solid lines, to the position 2' shown in dotted lines in Figs. 14 and 16.

In order to effect the oscillating or swinging movement of the needles, the plate 40 is provided at each end with a cam-following roller 51 mounted on the back thereof and which cooperates with a cam 52 mounted on shaft 53. The roller 51 is normally held in contact with the cam 52 by means of the tension spring 54.

When the parts are in the positions shown in solid outline in Fig. 14, the needles are fully retracted so that the hooks thereof are below the top of the trick bed. As the shaft 41 turns the cam 50 in the direction of the arrow thereon, the plungers 43 are raised by the cooperation of the cam-follower 50' with the cam 50 and are held at their highest points in a position to swing into cooperation with the thread guides while the cam-follower 50' is riding on the circular portion 55 of the cam 50 which functions as a dwell. When the cam-follower 50' has reached the dwell 55 on cam 50, the follower 51 begins to move into the lower portion 56 of the cam 52 and the needle bar is swung about the axis of the shaft 41 as a center to the position 2'' shown in Fig. 14 when the roller 51 has reached the lowermost point of the portions 56 of the cam 52. As the cam follower 51 passes beyond the lowermost point of the portion 56 of cam 52, the needle bar begins to swing back to the position 2' and reaches this position as the cam-follower 51 reaches the circular dwell 57 of cam 52. The swinging motion of the needle bar now ceases and the downward movement thereof to the position 2 begins as the cam-follower 50' moves into the lower portion 58 of cam 50. When the cam-follower 50' reaches the lowermost point of the portion 58 of the cam 50 the needle bar is fully retracted to its initial position shown at 2 in Fig. 14, and the cycle of movement just described is then repeated. Thus, for each complete turn of the cams 50 and 52, there are 2 cycles of movement of the needle bar.

Except for the novel manner in which my needle bar and the guide and steel bars move relative to each other, my machine operates in substantially the same way as machines of the present type, at least insofar as the formation of the loops or stitches is concerned when the needles cooperate with the yarn running through the guide needles.

It is not necessary to use any steel bars insofar as the operation of my machine is concerned. In other words, all of the yarn guides may be carried by rigid guide bars. On the other hand, at least one guide bar having guide needles thereon must be used with whatever number of steel bars are desired.

The needle bar must be moved in timed relation to the guide bars and the steel bars, and hence there must be some positive mechanical connection between the mechanism which moves the needle bar and the mechanism which moves the guide bars and the steel bars. This connection may be substantially identical with the connections now used in the present types of warp knitting machines and I have shown diagrammatically in Fig. 8 such a connection in which the various parts are indicated by the same numerals as used in other figures. Thus, the shaft 59 upon which the cam 33 is mounted may be connected by bevel gearing 60 to a shaft 61 which may drive the shaft 62, on which the pattern wheels or drums 11 and 14 are mounted, by means of a worm and worm wheel, or by means of the bevel gearing 63 shown in Fig. 8.

In Fig. 1 I have shown in a diagrammatic way, a gear 64 driven by a motor (not shown) which drives a wheel 65 which, in turn drives the shaft 59 and the cams 33. 66 is a diagrammatic representation of the usual hand wheel for manually moving the knitting mechanism; 67 is a ratchet wheel which operates the cloth roll mounted on shaft 68; 69 are the usual warp beams; and two of the usual tension regulating devices are shown at 70 and 71.

In short, my machine insofar as the general makeup thereof is concerned, does not differ from the present types of warp knitting machines except that a multiplicity of yarn guides in the form of steel bars may be used with one or more rigid guide bars; the needle bar swings, instead of the guide bars; and the guide bars and the steel bars have merely a lapping movement.

While I have shown the needle bar as equipped with latch needles, it is to be understood that springbeard needles may be used if desired. Furthermore, since the sinkerbars and presser bars may be identical with those used on the present types of machine and play merely auxiliary parts in the formation of the fabric, depending on the particular type of needles which are used, they are not illustrated in the drawings.

The operation of the needles, insofar as the loop-forming function thereof is concerned, is the same as that of the needles in the present types of warp knitting machines. Thus, as the latch needles rise above the tricks 72 on the trick bar or bed, the previously formed loop thereon will slide below the latch. The needle bar will then swivel or swing and pass the needles between the guide needles and under and past the steel bars whereupon, the guide bars and steel bars, or at least some of them, will move sideways or longitudinally thereof to lay or loop the yarns around the needles as they swing back. The needle bar will then move down to cast off the stitch or loop and thus complete the cycle.

What I claim is:

1. In a warp knitting machine, the combination with a guide bar having a multiplicity of thread guides thereon; of mountings for said guide bar restricting its movements to directions longitudinally thereof; a needle bar having a multiplicity of needles thereon adapted to cooperate with said thread guides; means for reciprocating said guide bar longitudinally thereof; a trick bed; and means for imparting reciprocating movements to said needle bar longitudinally of the needles thereon and, after each complete reciprocating movement thereof, swinging said needle bar about an axis above said trick bed to move said needles into and out of cooperative relation with said thread guides in timed relation to the reciprocating movements of said guide bar.

2. In a warp knitting machine, the combination with a guide bar having a multiplicity of thread guides thereon; of a plurality of steel bars having a multiplicity of thread guides therein; mountings for said guide bar and said steel bars restricting their movements to directions longitudinally thereof; means for reciprocating said guide bar longitudinally thereof; means for reciprocating said steel bars longitudinally thereof; a needle bar having a multiplicity of needles thereon adapted to cooperate with said thread guides; a trick bed; and means for imparting reciprocating movements to said needle bar in directions longitudinally of the needles thereon and, after each complete reciprocation thereof, swinging said needle bar about an axis above said trick bed to move said needles into and out of cooperative relation with said thread guides in timed relation to the reciprocating movements of said guide bar and said steel bars.

3. In a warp knitting machine, the combination with a plurality of guide bars each having a multiplicity of thread guides thereon; of a plurality of steel bars each having a multiplicity of thread guides therein; mountings for said guide and steel bars restricting their movements to directions longitudinally thereof; means for reciprocating each of said guide bars and each of said steel bars in directions longitudinally thereof; a needle bar having a multiplicity of needles thereon; a trick bed; and means for first moving said needle bar longitudinally of said needles in an upward direction, then swinging it about an axis above said trick bed into and out of cooperative relation with said thread guides in timed relation to the movements of said guide and steel bars, and thereafter moving it in a direction opposite the first movement thereof.

4. The structure set forth in claim 2 in which the lower edges of said steel bars are provided with depending, tooth-like projections spaced to pass said needles therebetween.

5. The structure set forth in claim 2 in which the thread guides in said steel bars are disposed in tooth-like projections depending from the lower edges of said bars and spaced to pass said needles therebetween.

6. In a warp knitting machine, the combination with at least one guide bar having a plurality of thread guides depending therefrom; of a plurality of steel bars provided with thread guides therein adjacent the lower edges thereof; a trick bar having tricks thereon; a needle bar having a plurality of needles thereon; means cooperating with said needle bar for moving said needles, from positions below said tricks, upwardly and substantially between said thread guides to positions beyond said guides and thereafter moving said needles back between said guides to their positions below said tricks; and means cooperating with said guide bar and with said steel bars for moving said guide bar and at least some of said steel bars longitudinally thereof while said needles are beyond said guides.

7. A steel bar adapted for use in a warp knitting machine of the character described; said bar comprising an elongated, metal, tape-like element having a lurality of uniformly spaced openings adjacent one edge thereof adapted to form thread guides, and characterized by having tooth-like projections along said edge in

transverse alignment with said openings for the passage of needles therebetween.

8. In a warp knitting machine, the combination with at least two guide bars having thread guides thereon; of a plurality of steel bars disposed between said guide bars and having a plurality of thread guides therein; a needle bar having needles thereon, a pivotal mounting for said needle bar; a trick bar having tricks thereon cooperating with said needles; means for moving said needles from a position below said tricks to a position above said tricks and thereafter swinging said needle bar about said pivotal mounting to swing said needles between and beyond said thread guides, and thereafter swinging them back and lowering them to their initial position below said tricks; and means for moving at least some of said guide bars and some of said steel bars longitudinally thereof after each passage of said needles between said guides.

9. The structure set forth in claim 3 in which the lower edges of said steel bars are provided with depending, tooth-like projections spaced to pass said needles therebetween.

10. The structure set forth in claim 3 in which the thread guides in said steel bars are disposed in tooth-like projections depending from the lower edges of said bars and spaced to pass said needles therebetween.

11. The structure set forth in claim 6 in which the lower edges of said steel bars are provided with depending, tooth-like projections spaced to pass said needles therebetween.

12. The structure set forth in claim 6 in which the thread guides in said steel bars are disposed in tooth-like projections depending from the lower edges of said bars and spaced to pass said needles therebetween.

13. The structure set forth in claim 8 in which the lower edges of said steel bars are provided with depending, tooth-like projections spaced to pass said needles therebetween.

14. The structure set forth in claim 8 in which the thread guides in said steel bars are disposed in tooth-like projections depending from the lower edges of said bars and spaced to pass said needles therebetween.

15. In a warp knitting machine, the combination with a plurality of guide bars each having a plurality of thread guides thereon; of mountings for said guide bars restricting their movements to directions longitudinally thereof; means for reciprocating said guide bars longitudinally thereof; a needle bar having a multiplicity of needles thereon; a trick bed; means for imparting reciprocating movements to said needle bar in directions longitudinally of said needles and, after each complete reciprocating movement thereof, swinging said bar about an axis above said trick bed into and out of cooperative relation with said thread guides in timed relation to the movements of said guide bars.

16. In a warp knitting machine, the combination with at least one guide bar having a multiplicity of thread guides thereon; of means for reciprocating said guide bar in directions longitudinally thereof; a needle bar having a multiplicity of needles thereon adapted to cooperate

with said thread guides; means for imparting reciprocating movements to said needle bar in a direction longitudinally of the needles thereon and, after each complete reciprocating movement thereof, swinging said needle bar about an axis to move said needles into and out of cooperation with said thread guides in timed relation to the reciprocating movements of said guide bar; and means cooperating with said needles following their cooperation with said guides for casting off the loops formed thereon.

17. In a warp knitting machine, the combination with at least one guide bar having a multiplicity of thread guides thereon; of a plurality of steel bars having a multiplicity of thread guides therein; means for reciprocating said guide bar longitudinally thereof; means for reciprocating said steel bars longitudinally thereof; a needle bar having a multiplicity of needles thereon adapted to cooperate with said thread guides; means for imparting reciprocating movements of said needle bar in directions longitudinally of the needles thereon and, after each complete reciprocation thereof, swinging said needle bar about an axis to move said needles into and out of cooperative relation with said thread guides in timed relation to the reciprocating movements of said guide bar and steel bars; and means cooperating with said needles following their cooperation with said guides for casting off the loops formed thereon.

18. In a warp knitting machine, the combination with a plurality of guide bars each having a multiplicity of thread guides thereon; of a plurality of steel bars each having a multiplicity of thread guides therein; means for reciprocating each of said guide bars and each of said steel bars in directions longitudinally thereof; a needle bar having a multiplicity of needles thereon; means for first moving said needle bar longitudinally of said needles in an upward direction, then swinging it about an axis to move said needles into and out of cooperative relation with said thread guides in timed relation to the movements of said guide and steel bars, and thereafter moving it in a direction opposite the first movement thereof; and means cooperating with said needles following their cooperation with said guides for casting off the loops formed thereon.

HANS HARTUNG, SR.

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