Oct. 19, 1948. F. LAMBACH 2,451,498

FLAT WARP KNITTING MACHINE

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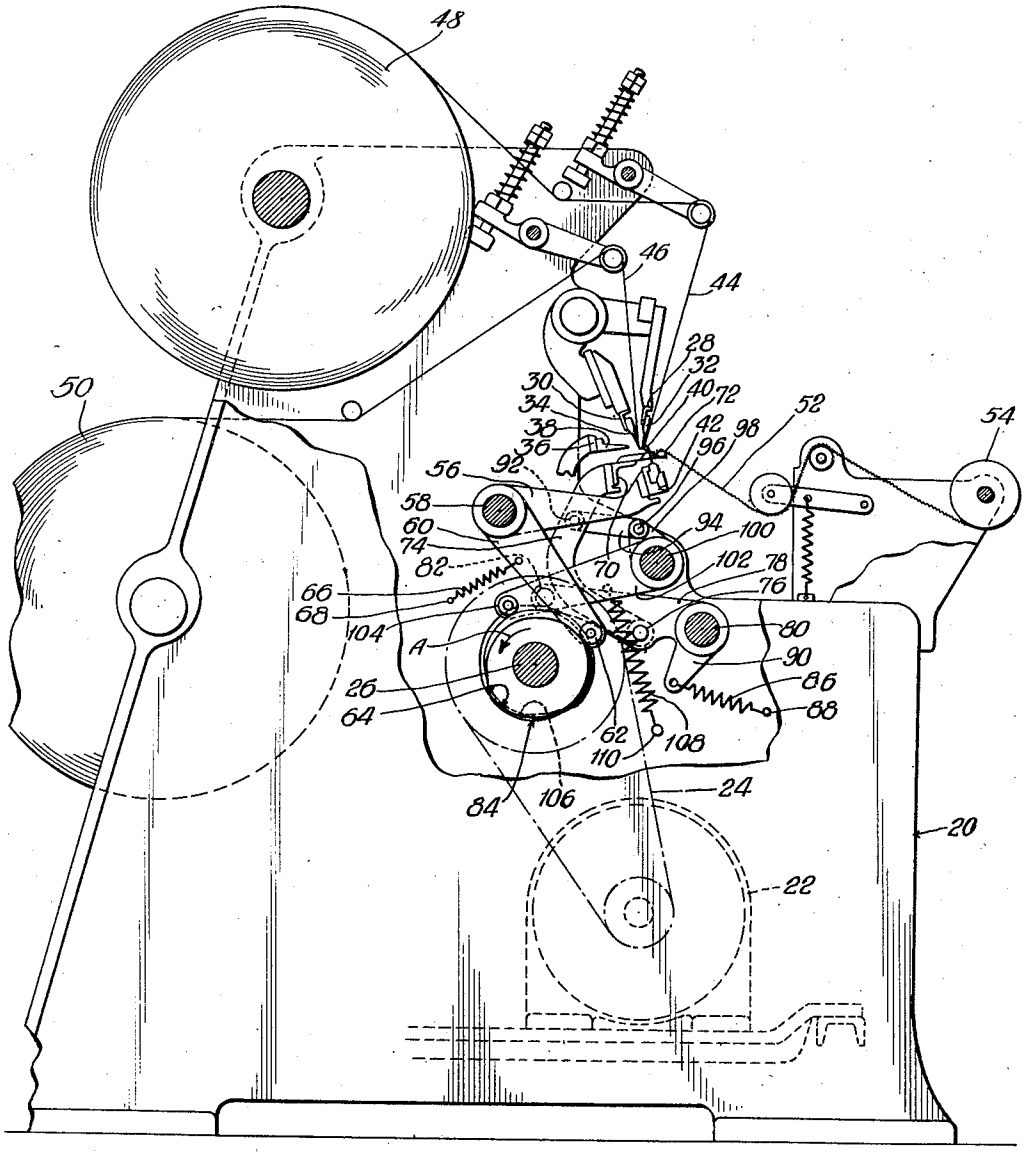


Fig. 1.

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Fig. 2.

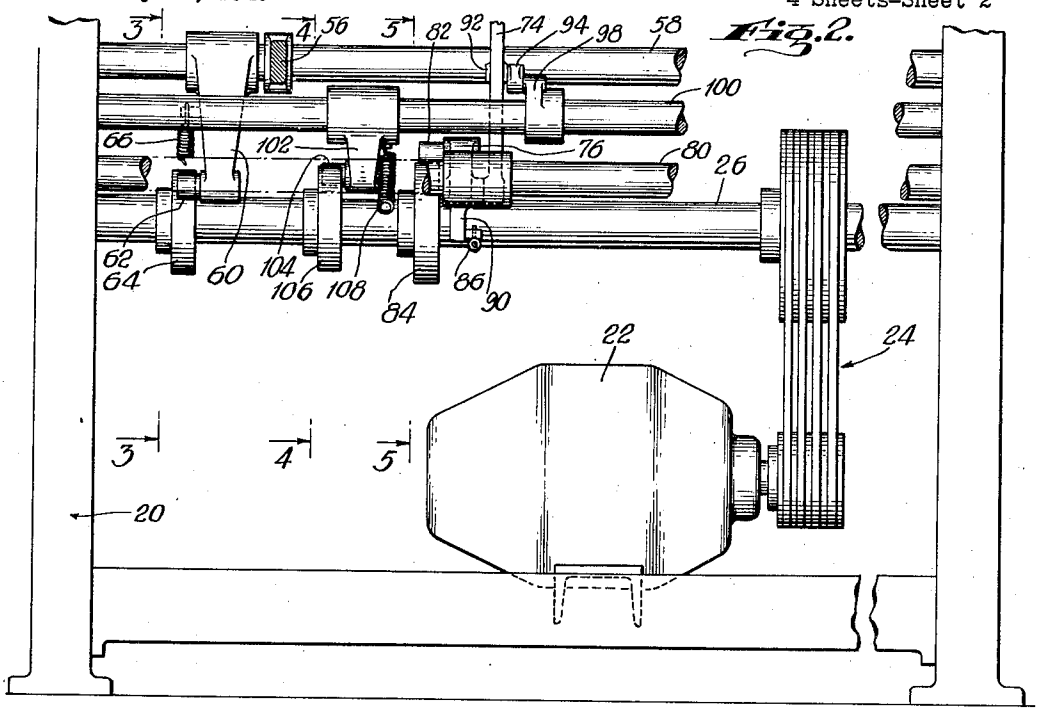
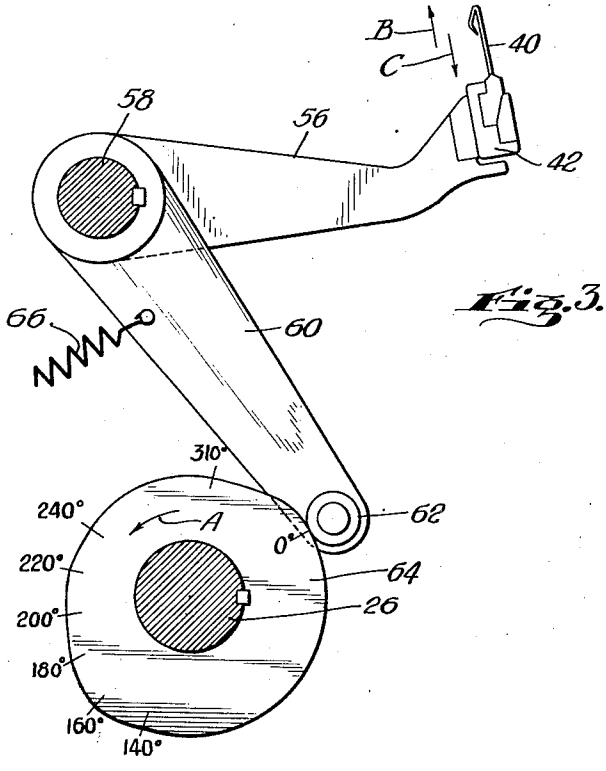


Fig. 3.



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Fig. 4.

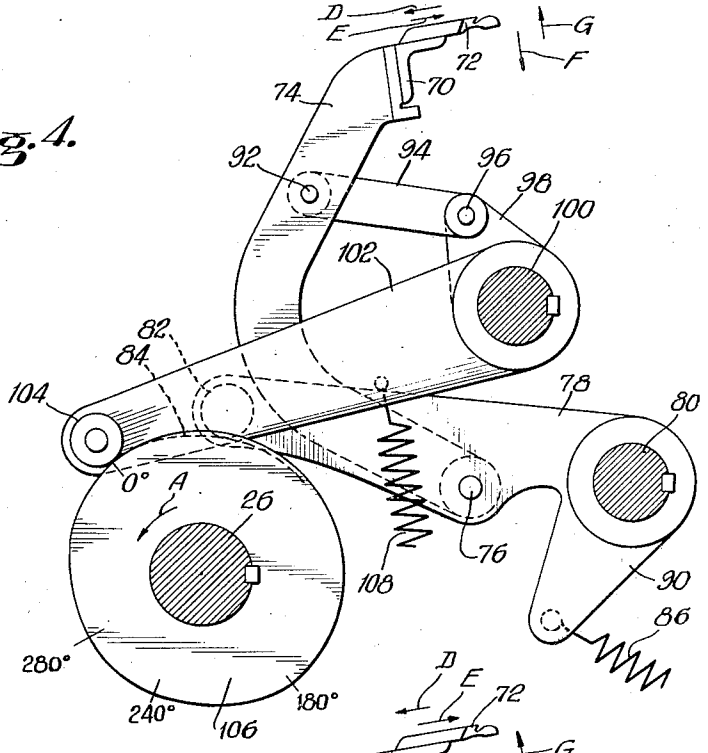
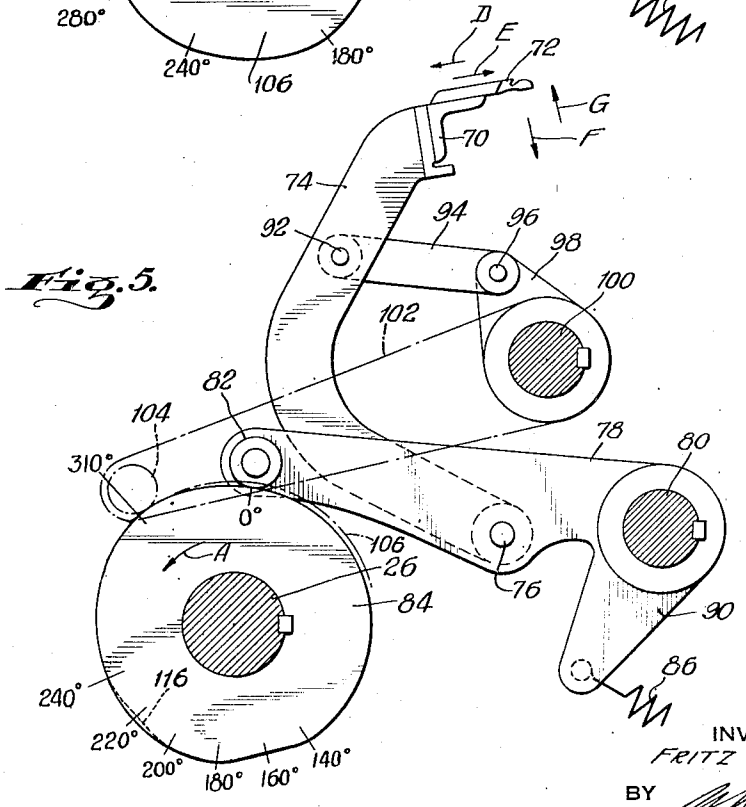


Fig. 5.

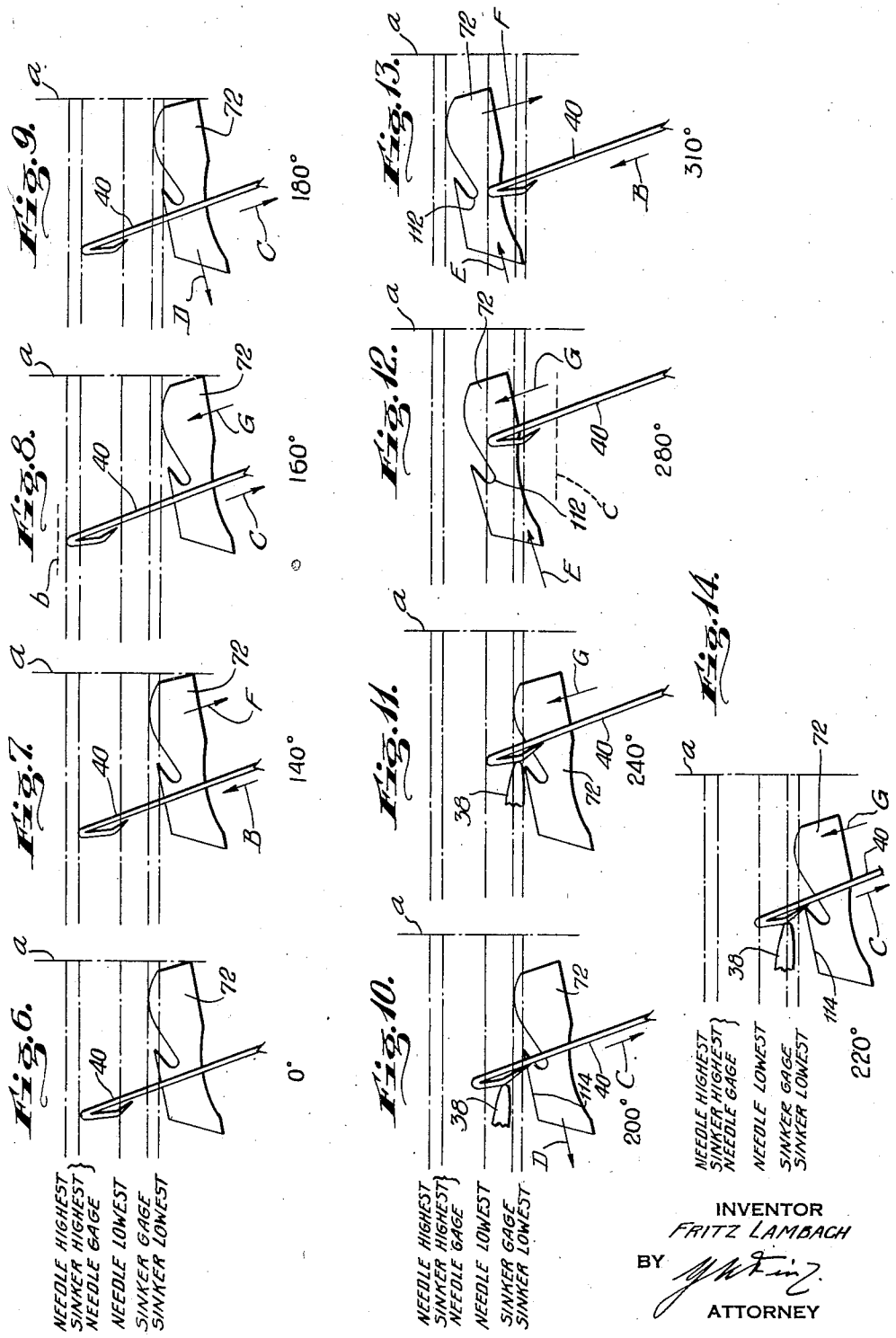


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FLAT WARP KNITTING MACHINE

Fritz Lambach, Tenafly, N. J.

Application May 28, 1945, Serial No. 596,362

19 Claims. (Cl. 66—86)

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My invention relates to flat warp knitting machines, and more particularly to the drive of knitting implements in such warp knitting machines.

An object of my invention is to reduce the individual travelling motion of the knitting implements in a flat warp knitting machine to a minimum so as to reduce the acceleration of the masses of the knitting implements and their drives, for the purpose of increasing the speed of the machine to a maximum.

Another object of my invention is to provide means in a flat warp knitting machine, by which the stroke of the needle bar carrying a series of needles may be reduced to a minimum and yet certain extreme positions of the needles relative to other knitting implements determined by the length of the needle beards may be obtained.

A further object of my invention is to provide means in a flat warp knitting machine, by which sudden high accelerations of the knitting implements and their drives, especially of the needles, the needle bar, and the needle bar drive, are eliminated, so that a smooth running of the machine is obtained and the pressures on the cams and in the bearings of the drives are reduced to a minimum.

Still another object of my invention is to provide means in a flat warp knitting machine, by which the downward movement of the needles may be continued during the pressing of the needles by the press edge.

A further object of my invention is to improve on the timing of the various knitting operations by the various knitting implements relative to each other in flat warp knitting machines as now ordinarily made.

With the above and other objects of the invention in view, the invention consists in the novel construction, arrangement and combination of various devices, elements and parts, as set forth in the claims hereof, certain embodiments of the same being described in the specification and being illustrated in the accompanying drawings forming part of this specification, wherein:

Fig. 1 is a side elevational view of a flat warp knitting machine, some parts being broken away; said figure illustrates only those parts of the flat warp knitting machine which are necessary for an understanding of the invention,

Fig. 2 is a fragmentary front elevational view of the flat warp knitting machine shown in Fig. 1, some parts being broken away,

Fig. 3 is a sectional view taken on line 3—3 of Fig. 2, illustrating the needle bar drive,

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Figs. 4 and 5 are sectional views taken on lines 4—4 and 5—5 respectively of Fig. 2, illustrating the sinker bar drive,

Figs. 6–13 are diagrammatical illustrations of various relative positions between a needle and a sinker of the machine shown in Fig. 1 during a cycle of operation of said machine, and

Fig. 14 is a diagrammatic illustration of the relative position between a needle and a sinker during the pressing of the needles, when the sinker drive of the machine shown in Fig. 1 is somewhat modified.

Referring now to Figs. 1 and 2, 20 generally indicates the frame of a flat warp knitting machine or a so-called tricot machine. A motor 22 mounted in a suitable manner on the frame 20 is connected by a belt drive generally indicated by 24 with the main cam shaft 26 journalled in suitable bearings of the frame. Upon an energization of said motor 22, the main cam shaft 26 is rotated for an actuation of the various knitting implements of the machine driven by cams keyed to said main cam shaft 26. The drive of the guide bars 28, 30 carrying a series of guides 32, 34 and the drive of the press bar 36 carrying the press edge 38 are not described in detail hereinafter, as they are of conventional form. During the operation of the warp knitting machine, the series of needles 40 carried by the needle bar 42 draw yarn 44, 46 from an upper warp beam 48 and a lower warp beam 50 rotatably mounted in suitable bearings of the frame 20 of the machine. Furthermore, in a manner known per se the knitted fabric 52 is taken up by a take-up roller 54.

As best shown in Figs. 1–3, the needle bar 42 carrying the series of needles 40 is supported by arms 56 (only one being shown in the drawings) secured to a needle bar shaft 58 journalled in suitable bearings of the frame 20. One end of an actuating lever 60 is keyed to said needle bar shaft 58, the other end of said actuating lever 60 carries a roller 62 held in operative engagement with the surface of a needle bar cam 64 by means of a spring 66 stretched between said actuating lever 60 and a stationary point 68 of the machine. The needle bar cam 64 is keyed to the main cam shaft 26. As will be readily understood, a rotation of the main cam shaft 26 in the direction of the arrow A causes an upward and downward movement of the needle bar 42 with its series of needles 40 in the direction of the arrows B and C (see Fig. 3) in dependence on the shape of the needle bar cam 64.

As best shown in Figs. 1, 2, 4 and 5 a sinker bar 70 carrying a series of sinkers 72 is supported

by arms 74 (only one arm being shown in the drawings). The lower end of each arm 74 is pivoted at 76 to an actuating lever 78 keyed to a sinker bar shaft 80 journalled in suitable bearings of the frame 20. The free end of the actuating lever 78 carries a roller 82 held in operative engagement with the surface of a sinker bar cam 84 by means of a spring 86 stretched between a stationary point 88 of the machine and an arm 90 keyed to said sinker bar shaft 80. The sinker bar cam 84 is keyed to the main cam shaft 26.

At an intermediate point 92 of each arm 74, one end of a connecting link 94 is pivoted to said arm 74. The other end of said connecting link 94 is pivoted at 96 to an arm 98 keyed to another sinker bar shaft 100 journalled in suitable bearings of the frame 20. One end of an actuating lever 102 is keyed to said sinker bar shaft 100, and the other end of said actuating lever 102 carries a roller 104 held in operative engagement with the surface of another sinker bar cam 106 by means of a spring 108 stretched between said actuating lever 102 and a stationary point 110 of the machine. The sinker bar cam 106 is keyed to the main cam shaft 26.

As will be readily understood from above description and from the arrangement of the various elements of said two sinker bar drives clearly shown in Figs. 4 and 5, a rotation of the main cam shaft 26 in the direction of the arrow A causes a backward and forward movement of the sinkers 72 in the direction of the arrows D and E by means of the sinker bar cam 106 in dependence on the shape of its surface and a downward and upward movement in the direction of the arrows F and G by the sinker bar cam 84 in dependence on the shape of the surface thereof. Owing to the coupling of the two drives with each other by means of the connecting link 94 the sinkers 72 will be subject to a movement in the direction D or E simultaneously with a movement in the direction F or G if the rollers 104 and 82 are at the same time in engagement with drops or rises on the sinker bar cams 106 and 84. If, however, one of said rollers is in engagement with a dwell on one of said sinker bar cams and the other roller is at this time in engagement with a drop or rise on the other sinker bar cam, the sinkers 72 will be moved only either in the direction D or E or in the direction F or G.

Figs. 6–13 illustrate various relative positions between a sinker 72 and a needle 40 during one cycle of operation of the warp knitting machine. Fig. 6 illustrates the position of the sinker and the needle at the beginning of such a cycle, i. e. at the position 0°; said 0° position shown in Fig. 6 corresponds to the position of the sinkers and needles and their drives shown in Figs. 1, and 3–5. In the position of Fig. 6, the sinkers 72 are in their most forward position indicated by the line *a* and at their normal level indicated by the line "sinker gauge." Furthermore, the needles 40 are at their normal level indicated by the line "needle gauge." Fig. 7 illustrates the position of the sinker and needle at the position 140°, i. e. after the rotation of the main cam shaft through an angle of 140° from the 0° position shown in Figs. 1, and 3–5. In similar manner, Figs. 8–13 show the various positions of the sinker and needle at the 160° position, 180° position, 200° position, 240° position, 280° position, and 310° position.

When the needle bar cam 64, the sinker bar cam 84, and the sinker bar cam 106 are in the 0° position, they contact their associated cam rollers 62, 82, 104 at the points indicated by 0° in Figs. 3–5. After a rotation of the main cam shaft in the direction of the arrow A through an angle of 140° or 160° or 180° . . . from the starting position shown in Figs. 3–5, the points indicated by 140° or 160° or 180° . . . on said cams are in contact with their respective cam roller.

All of the cams 64, 84, and 106 have a round surface between 0° and 140°, so that, as shown in Fig. 7, the sinkers 72 and the needles 40 remain in the same position as shown in Fig. 6, i. e. the sinkers are still in their most forward position at their normal level and the needles are at their normal level. Thus, during this portion of the cycle of operation of the machine other knitting implements, such as the guides are active.

As shown in Fig. 3, the needle bar cam 64 has a rise between 140° and 180°, the maximum being at 160°. According to Fig. 4, the surface of the sinker bar cam 106 is round up to the point 180°. As shown in Fig. 5, the sinker bar cam 84 has a drop between 140° and 180°, the minimum being at 160°. Therefore, at 140° the needle bar cam 64 starts to move the needles 40 upwardly in the direction of the arrow B, while at the same time the sinker bar cam 84 starts to move the sinker 72 downwardly in the direction of the arrow F. The arrows B and F are indicated in Fig. 7. At 160° the needle bar cam 64 starts to reverse the direction of movement of the needles 40 and drives same to move downwardly in the direction of the arrow C shown in Fig. 8. Furthermore, at 160°, the sinker bar cam 84 starts to move the sinker 72 upwardly in the direction of the arrow G at 160°. The thus described movement of the needles 40 and 72 is continued until at 180° the sinkers and needles are returned into their starting position as shown in Fig. 9. Owing to the round portion of the sinker bar cam 106, the sinkers remain in their most forward position between 140° and 180°. As will be readily understood, between 140° and 180° the needles 40 and the sinkers 72 are moved in an opposite direction as described above. This movement takes place during the catching of yarn by the needles. The downward movement of the sinkers 72 from their normal position shown in Fig. 7 into their lowest position shown in Fig. 8, according to the invention, causes a downward pull of the fabric by the sinker, which, in turn, results in a downward pull of the yarn connected with the fabric towards the point of the needle beards. Therefore, according to the invention, the upward stroke of the needles 40 from their normal position indicated by line "needle gauge" to their highest position indicated by the line "needle highest" may be reduced as compared with hitherto conventional warp knitting machines, wherein the sinkers remain at their normal level and consequently the needles must be moved upwardly to a greater extent, for example up to the level indicated by the line *b* in Fig. 8, so that the needle may catch the yarn. As will be readily understood, the reduction of the upward movement of the needles 40, according to the invention, results in a reduction of the acceleration of the masses of the needles, the needle bar, and the needle bar drive, whereby the pressures on the needle bar cams and in the bearings of the needle bar drive are reduced, so that the machine may be operated at a considerable higher speed than the hitherto conventional warp knitting machines.

According to Fig. 3, the needle bar cam 64 is of such a shape, that the needles 40 are moved downwardly in the direction of the arrow C from

their normal position shown in Fig. 9 at 180° into their lowest position shown in Fig. 11 at 240°. During the same portion of the cycle of operation between 180° and 240° the sinkers **72** are moved backwardly in the direction of the arrow D by the sinker bar cam **106**, until they reach their most backward position as shown in Fig. 11. According to Fig. 5, the sinker bar cam 84° has a dwell between 180° and 240°, so that the sinkers **72** remain in their normal position between 180° and 240° as shown in Figs. 9–11. Between 200° and 240° the pressing of the needles **40** by the press edge **38** takes place.

According to Fig. 3, the needle bar cam **64** is of such a shape, that between 240° and 310° the needles remain in their lowest position shown in Figs. 11–13, whereupon they are moved upwardly in the direction of the arrow B, until they reach their normal position at the end of the cycle, which coincides with the beginning of the next cycle illustrated by Fig. 6. According to Fig. 5, the sinker bar **84** is of such a shape, that starting at 240° the sinkers **72** are moved upwardly in the direction of the arrow G, until they reach their highest position at 310° as shown in Fig. 13, whereupon they are moved downwardly in the direction of the arrow F, until they are returned into their normal position at the end of the cycle as shown in Fig. 6. According to Fig. 4 the sinker bar cam **106** is of such a shape, that between 240° and 280° the sinkers remain in their most backward position that, however, starting at 280°, the sinkers are moved forwardly in the direction of the arrow E, simultaneously with the lifting and lowering movements caused by the sinker bar cam **84** as described above, until they reach their most forward position at the end of the cycle as shown in Fig. 6. The movements just described represent the knocking over of the fabric by the sinkers. Said knocking over requires, that the end of the needle is brought into a level below the recess **112** of the sinker **72**. As described above, according to the invention, this feature is obtained by moving the sinkers **72** upwardly from its normal position indicated by the line "sinker gauge" into its highest position indicated by the line "sinker highest." Therefore, the arrangement of the sinker drive according to the invention eliminates a continuation of the downward movements of the needles **40** from the position shown in Fig. 11 into a position indicated by the line *c* in Fig. 12, which movement is necessary in hitherto conventional warp knitting machines, wherein the sinkers cannot be moved in upward and downward direction. Thus, according to the invention, means are provided in the machine for considerable reduction of the stroke of the needle bar and its needles during the knocking over of the fabric, which results in a considerable reduction of the acceleration of the masses and consequently permits a considerable higher speed of operation of the machine.

According to Fig. 3, the needle bar cam **64** shown in the drawings has a dwell between 240° and 310°, so that the needles **40** are held in their lowest position during this portion of the cycle as shown in Figs. 11–13. If desired, however, the needle bar cam **64** may be shaped in such a way, that the needles are moved once or several times during said portion of the cycle between 240° and 310°.

As a matter of fact, at the beginning of the pressing of the needles by the press edge **38** (approximately between 200° and 220°) the point of the needle beard must remain just slightly below the upper edge **114** of the sinker (see Fig. 10). If the sinkers remain at their normal position shown in said Fig. 10, the downward movement of the needles **40** must be interrupted between 200° and 220° so as to obtain this feature. If desired, however, according to the invention such an interruption of the downward movement of the needles **40** may be eliminated for a smoothening of their motion by a modification of the shape of the sinker bar cam **84** as indicated by the dash and dot lines **116** in Fig. 5. Said line **116** forms a drop on the sinker bar cam **84**, with the minimum at 220°. If the sinker bar cam **84** is of such modified shape, the sinkers **72** are moved downwardly between 200° and 220° until they reach the position shown in Fig. 14, whereupon they are returned into their normal position shown in Fig. 11 for 240°. Under these circumstances, the dwell shown in Fig. 3 for the needle bar cam **64** between 200° and 220° may be omitted and the shape of the needle bar cam **64** may be smoothened out between 180° and 240° so as to obtain a uniform downward movement of the needles. As will be readily understood, the modified sinker bar cam **84** may be easily shaped in such a way, that the sinkers **72** are moved downwardly between 200° and 220° with the needles **40** at the same rate of speed as the latter.

As will be apparent from above, the arrangement of the sinker bar drive **84, 82, 78, 74** permitting the lifting and lowering of the sinkers **72** in the direction of the arrows G and F results in a reduction of the stroke necessary for the needle bar with its needles, so that, owing to the reduced acceleration of the masses, the machine may be operated at a high speed. Furthermore, said sinker bar drive **84, 82, 78, 74** permits the design of a needle bar cam with a rather smooth surface, so that a smooth running of the machines at high speeds is obtained. Moreover, said sinker bar drive **84, 82, 78, 74** permits an improvement of the timing of the various knitting operations by the various knitting implements relative to each other; the reduced stroke of the needle bar permits an actuation of the needle bar by the needle bar cam during a smaller angle of rotation of the cam shaft than in warp knitting machines of hitherto conventional construction, and said reduced angle of rotation leaves a larger angle of rotation of the main cam shaft for the actuation of other knitting implements, for example the guides for laying the yarn.

The drawings illustrate means (the sinker bar drive **84, 82, 78, 74**) for reciprocating the sinkers of a flat warp knitting machine substantially in the direction of movement of the needles. If desired, however, according to the invention, similar drives may be provided for in a flat warp knitting machine for reciprocating another knitting implement (for example the guides) in the direction of movement of cooperating knitting implements (for example, the needles).

I have described preferred embodiments of my invention, but it is clear that numerous changes and omissions may be made without departing from the spirit of my invention. For example, instead of the cams shown in the drawings, double cams including a master cam and a counter cam could be used, and in such a case the various actuating levers include two arms, each of which carrying a roller for actuating with one of said two cams of a double cam.

What I claim is:

1. In a flat warp knitting machine: a rotatable cam shaft, a first cam secured to said cam shaft,

a first actuating lever swingably mounted on the machine and operatively engaged with said first cam, a second cam secured to said cam shaft, a second actuating lever swingably mounted on the machine and operatively engaged with said second cam, a support pivotally connected with said second actuating lever, a mechanism connecting said first actuating lever with said support so as to cause rocking movements of the latter about its pivot on the second actuating lever, and a sinker bar carrying a series of sinkers, said sinker bar being mounted on said support, and the elements of said two cam drives being arranged in such a manner that said first cam causes backward and forward movements of the sinker bar and said second cam causes upward and downward movements of the sinker bar at predetermined intervals during a cycle of the operation of the machine.

2. A flat warp knitting machine comprising: a first series of knitting implements arranged for reciprocating movements, a first drive associated with said first series of knitting implements for imparting periodic reciprocating movements in a predetermined direction to said first series of knitting implements, a second series of knitting implements arranged for movements transversely of and substantially in the same direction as said first series of knitting implements, said second series of knitting implements being arranged for performing movements in coordinated relation with movements of said first series of knitting implements, a second drive associated with said second series of knitting implements for imparting at predetermined intervals periodic movements transversely of the direction of the strokes of said first series of knitting implements to said second series of knitting implements, said second series of knitting implements being further reciprocable substantially in the direction of the strokes of said first series of knitting implements, and an actuating drive associated with said second series of knitting implements for imparting at predetermined intervals an additional movement to said second series of knitting implements in a direction opposite to the direction of movement performed by said first series of knitting implements during a stroke thereof whereby the length of such a stroke of said first series of knitting implements may be reduced in accordance with the length of the additional movement of said second series of knitting implements.

3. In a flat warp knitting machine as claimed in claim 2, said actuating drive being coupled with said second drive.

4. In a flat warp knitting machine as claimed in claim 2, said second drive including a link-mechanism, and said actuating drive being in operative connection with said link-mechanism.

5. In a flat warp knitting machine as claimed in claim 2, said actuating drive including controlling means adjusted for imparting said additional movement to said second series of knitting implements during a movement of said first series of knitting implements in the opposite direction.

6. In a flat warp knitting machine as claimed in claim 2, said actuating drive including controlling means adjusted for imparting said additional movement to said second series of knitting implements during a standstill of said first series of knitting implements.

7. In a flat warp knitting machine as claimed in claim 2, said actuating drive including controlling means adjusted for imparting said additional movement to said second series of knitting implements during a movement of said second series of knitting implements toward the direction of the strokes of said first series of knitting implements.

8. In a flat warp knitting machine as claimed in claim 2, said first series of knitting implements being arranged in the machine for reciprocating movements in an upward and downward direction.

9. A flat warp knitting machine comprising: a needle bar carrying a series of needles and arranged for reciprocating movements substantially in the direction of the longitudinal axis of the needles, a needle bar drive associated with said needle bar for imparting periodic reciprocating movements to said series of needles substantially in the direction of the longitudinal axis of the needles, a sinker bar carrying a series of sinkers arranged for knocking over knitted fabric over said needles and arranged for movements transversely of and substantially in the direction of the longitudinal axis of said needles, a sinker bar drive associated with said sinker bar for imparting at predetermined intervals periodic movements transversely of the longitudinal axis of the needles to said series of sinkers, said sinker bar being further reciprocable substantially in the direction of the strokes of said needles, an actuating drive associated with said sinker bar for imparting at predetermined intervals an additional movement to said sinker bar and said series of sinkers in a direction opposite to the direction of movement performed by said series of needles during a stroke thereof whereby the length of such a stroke of said needles may be reduced in accordance with the length of the additional movement of said series of sinkers.

10. In a flat warp knitting machine as claimed in claim 9, said actuating drive being coupled with said sinker bar drive.

11. In a flat warp knitting machine as claimed in claim 9, said sinker bar drive including a link-mechanism, and said actuating drive being in operative connection with said link-mechanism.

12. In a flat warp knitting machine as claimed in claim 9, said sinker bar drive including swingable supporting arms and a mechanism for rocking same at predetermined intervals, said sinker bar being mounted on said supporting arms, said actuating drive including reciprocable actuating means and a mechanism for imparting periodic reciprocating movements to said actuating means, and said actuating means being in operative connection with said supporting arms.

13. In a flat warp knitting machine as claimed in claim 9, said actuating drive including reciprocable actuating elements and a mechanism for imparting periodic reciprocating movements to said actuating elements, said sinker bar drive including swingable supporting arms and a mechanism for rocking same at predetermined intervals, said sinker bar being mounted on said supporting arms, and said supporting arms being swingably mounted on said actuating elements.

14. In a flat warp knitting machine as claimed in claim 9, said actuating drive including swingable actuating levers and a mechanism for rocking same at predetermined intervals, said sinker bar drive including swingable supporting arms and a mechanism for rocking same at predetermined intervals, said sinker bar being mounted on said supporting arms, and said supporting arms being swingably mounted on said actuating levers.

15. In a flat warp knitting machine as claimed in claim 9, said actuating drive including control-

ling means adjusted for imparting said additional movement to said series of sinkers during a movement of said series of needles in the opposite direction.

16. In a flat warp knitting machine as claimed in claim 9, said actuating drive including controlling means adjusted for imparting said additional movement to said series of sinkers during a standstill of said series of needles.

17. In a flat warp knitting machine as claimed in claim 9, said actuating drive including controlling means adjusted for imparting said additional movement to said series of sinkers during a movement of said series of sinkers toward the longitudinal axis of the needles.

18. In a flat warp knitting machine as claimed in claim 9, said actuating drive including controlling means adjusted for imparting a further additional movement to said series of sinkers in the same direction as the direction of movement of the series of needles during the pressing of the needles.

19. In a flat warp knitting machine as claimed in claim 9, said series of needles being arranged in the machine for reciprocating movements in an upward and downward direction.

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