March 5, 1946. T. S. HAYHURST 2,395,814

KNITTING MACHINE

Filed April 13, 1944 52 Sheets-Sheet 1

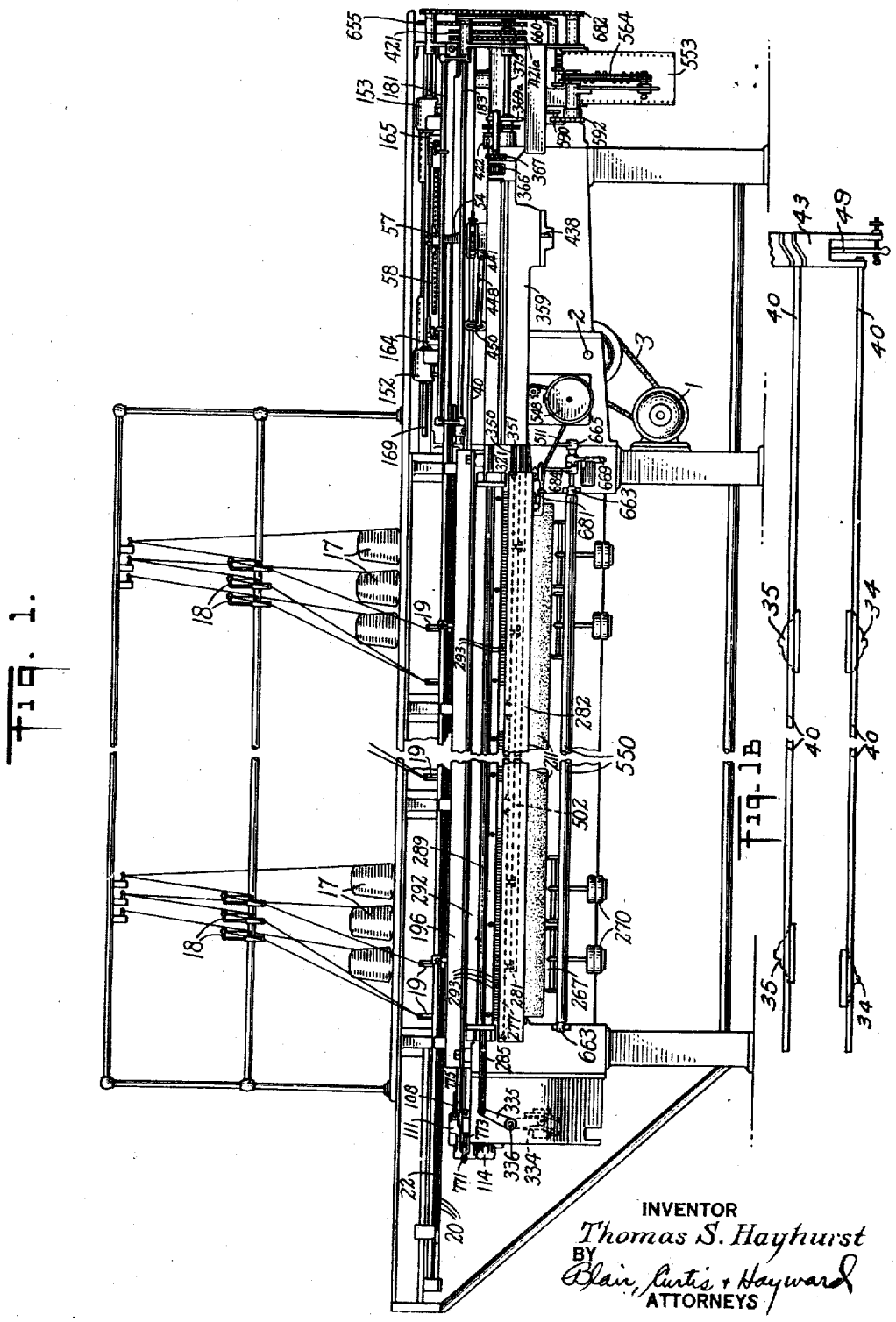


Fig. 1.

Fig. 1b

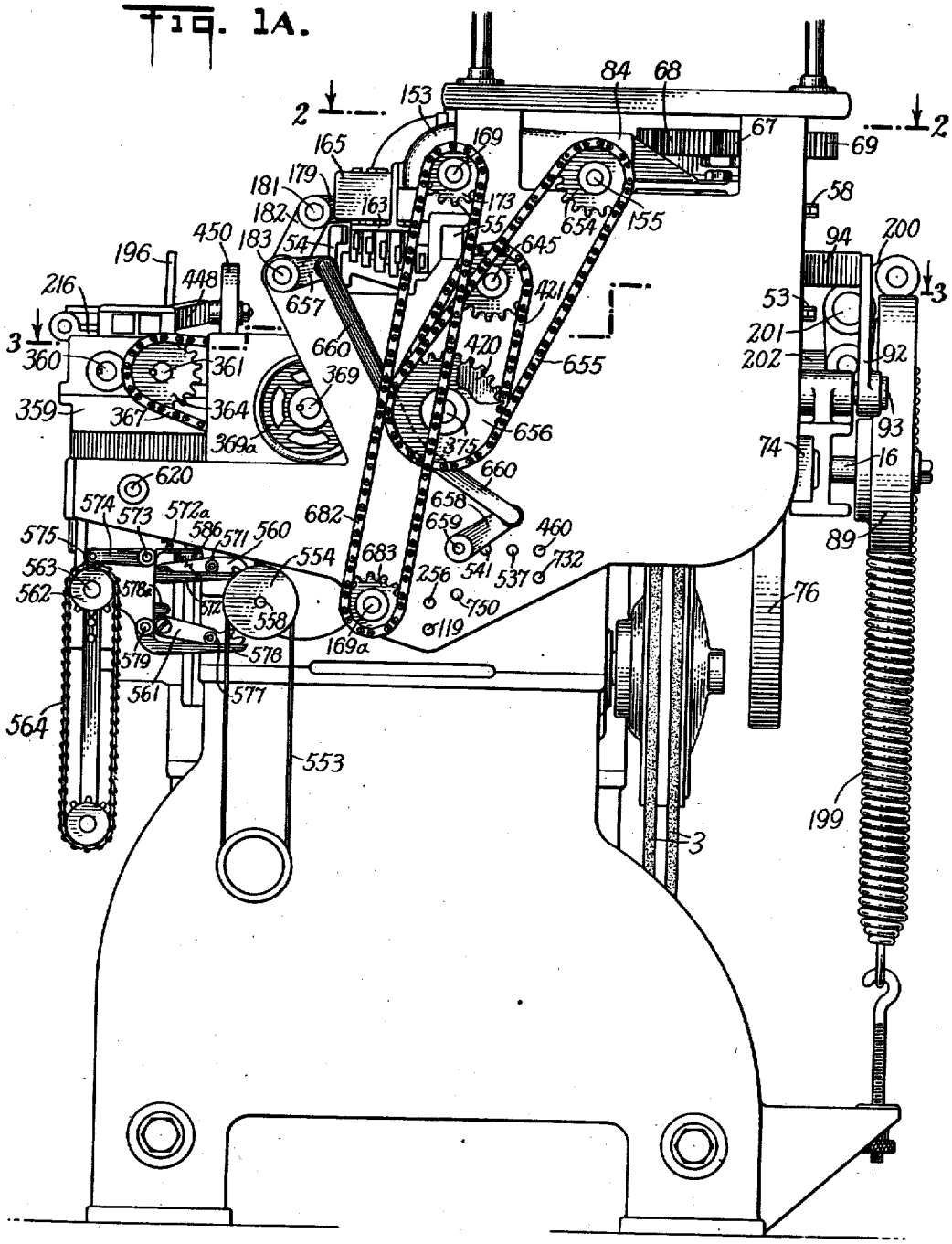
INVENTOR
Thomas S. Hayhurst
BY
Blair, Curtis & Hayward
ATTORNEYS

March 5, 1946. T. S. HAYHURST 2,395,814

KNITTING MACHINE

Filed April 13, 1944 52 Sheets-Sheet 2

Fig. 1A.



INVENTOR
Thomas S. Hayhurst
BY
Blair, Curtis & Hayward
ATTORNEYS

March 5, 1946. T. S. HAYHURST 2,395,814

KNITTING MACHINE

Filed April 13, 1944 52 Sheets-Sheet 3

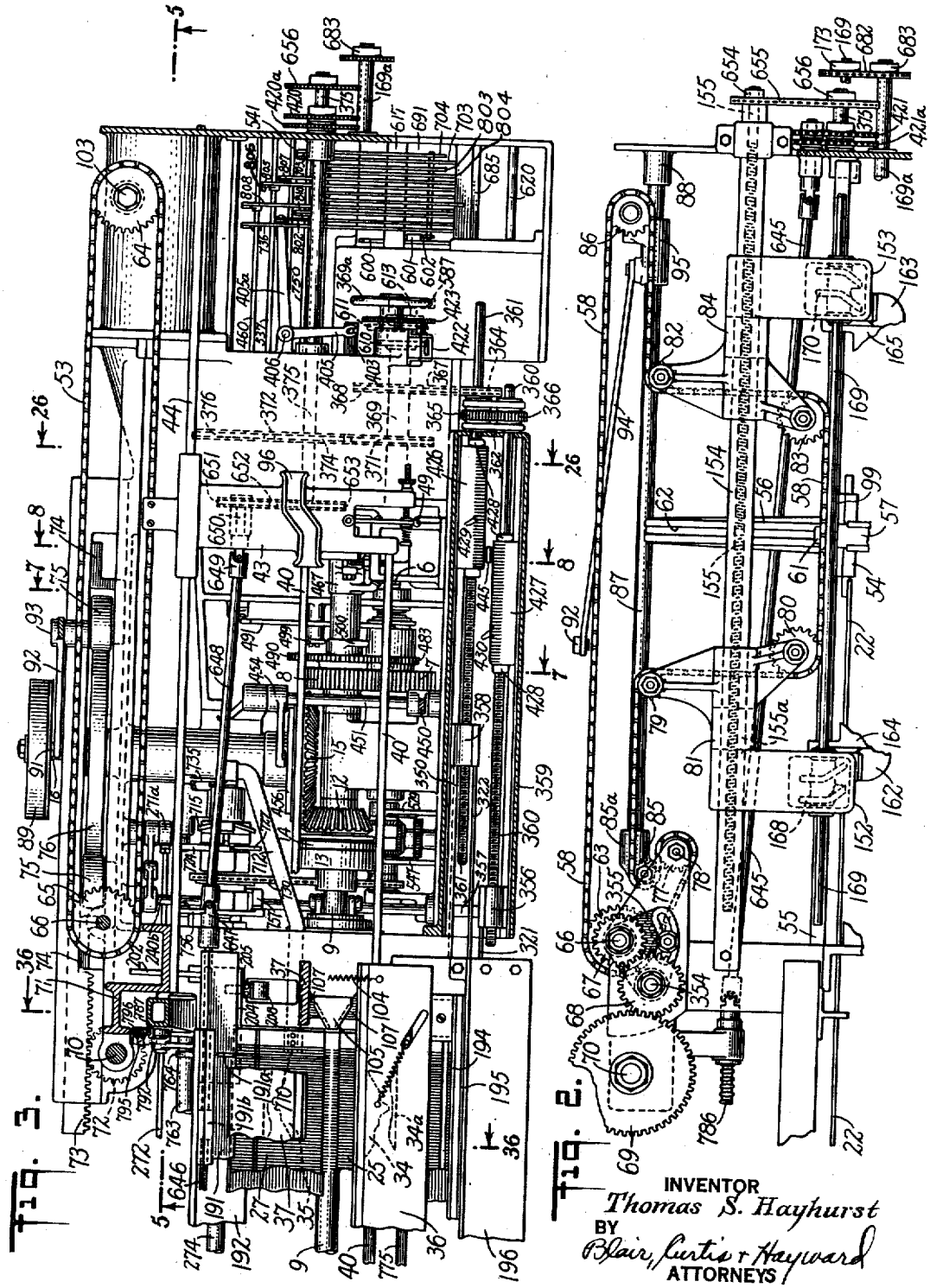


Fig. 3.

Fig. 2.

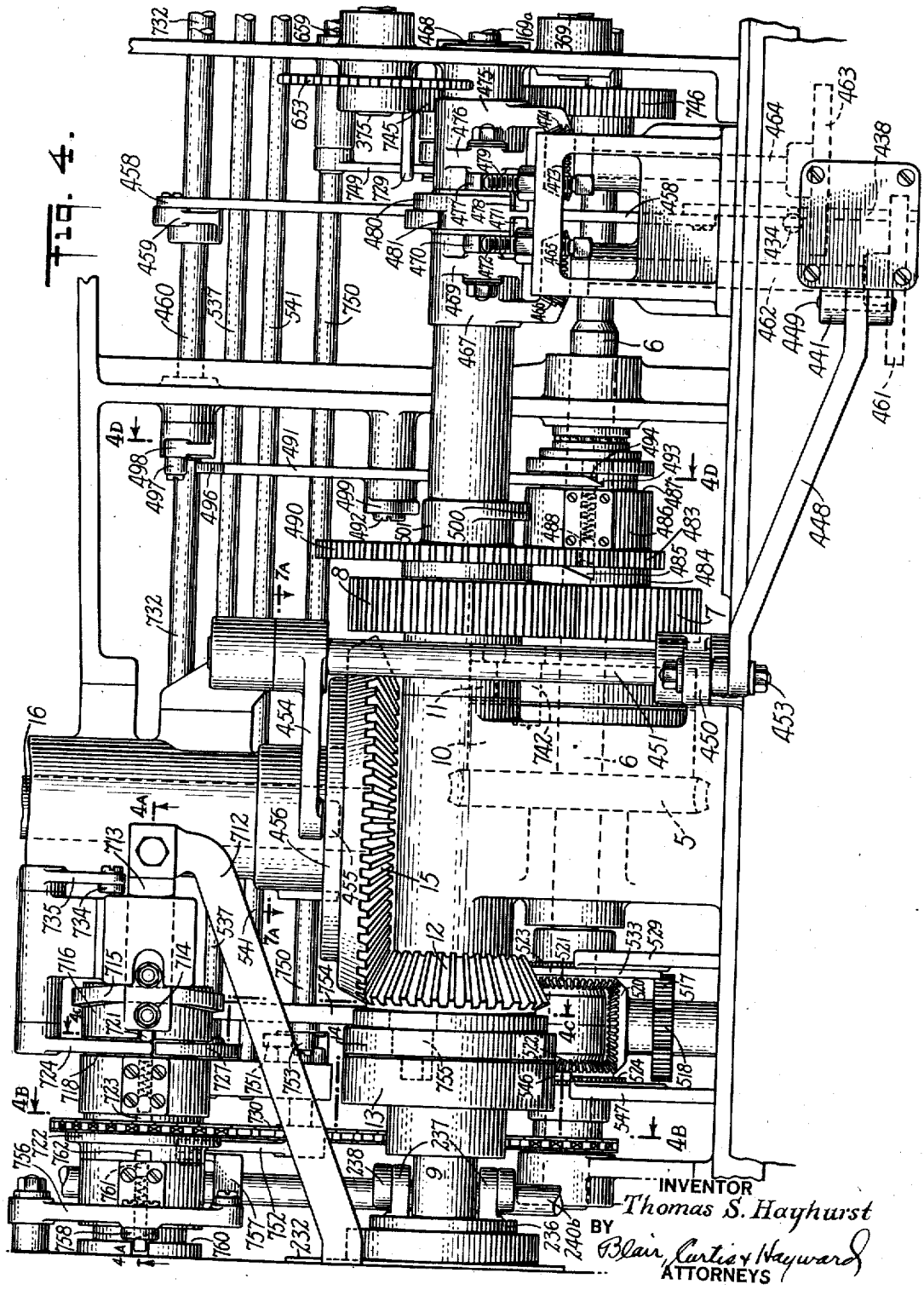
INVENTOR
Thomas S. Hayhurst
BY
Blair, Curtis & Hayward
ATTORNEYS

March 5, 1946. T. S. HAYHURST 2,395,814

KNITTING MACHINE

Filed April 13, 1944 52 Sheets-Sheet 4

Fig. 4.



INVENTOR
Thomas S. Hayhurst
BY
Blair, Curtis & Hayward
ATTORNEYS

March 5, 1946. T. S. HAYHURST 2,395,814

KNITTING MACHINE

Filed April 13, 1944 52 Sheets-Sheet 5

Fig. 4A.

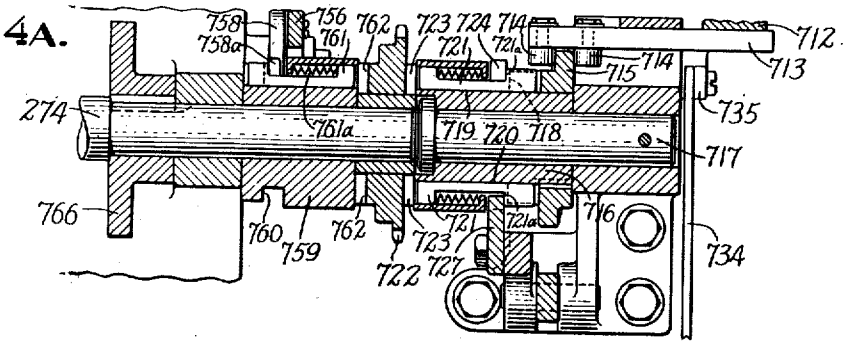


Fig. 4B.

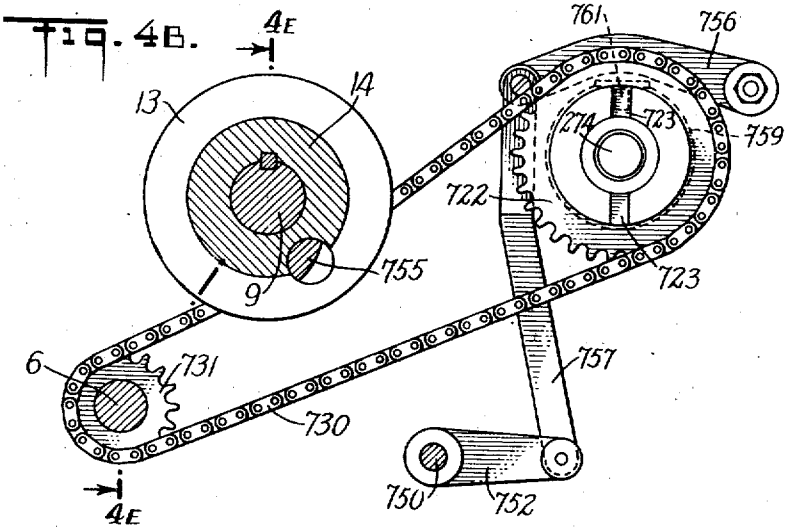
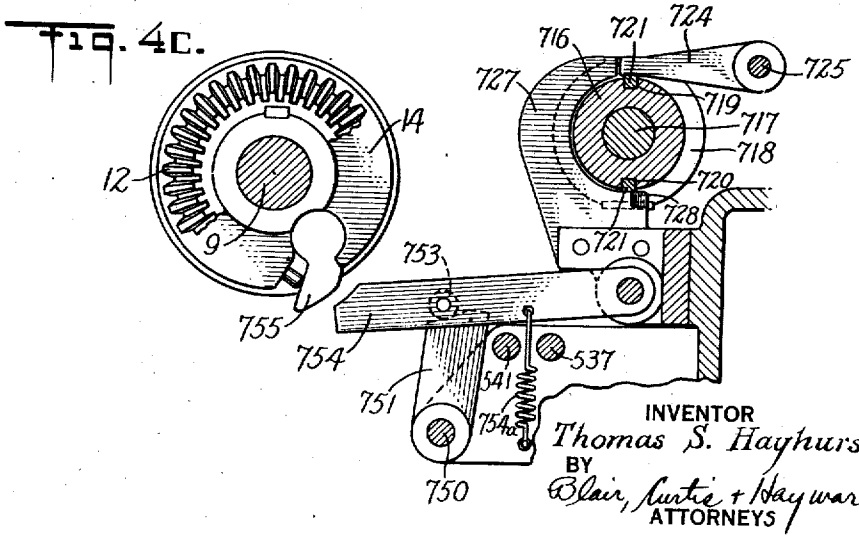


Fig. 4C.



INVENTOR
Thomas S. Hayhurst
BY
Blair, Curtis & Hayward
ATTORNEYS

March 5, 1946. T. S. HAYHURST 2,395,814

KNITTING MACHINE

Filed April 13, 1944 52 Sheets-Sheet 6

Fig. 4D.

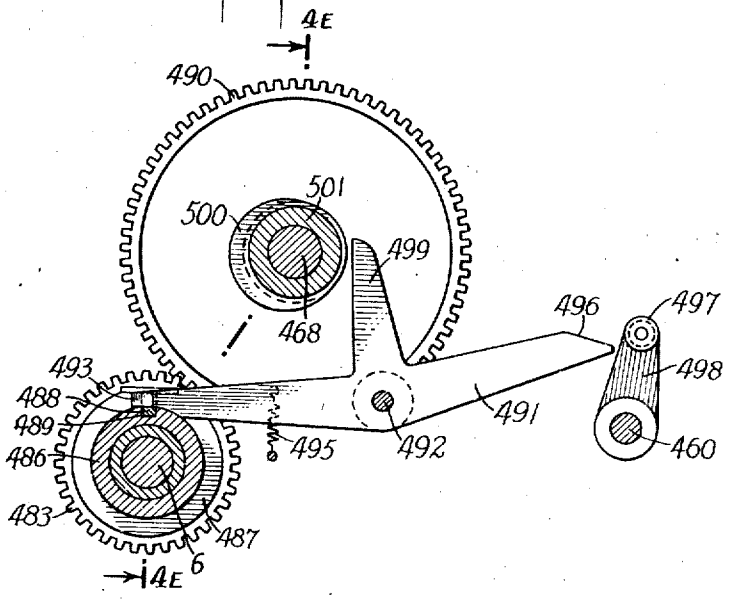
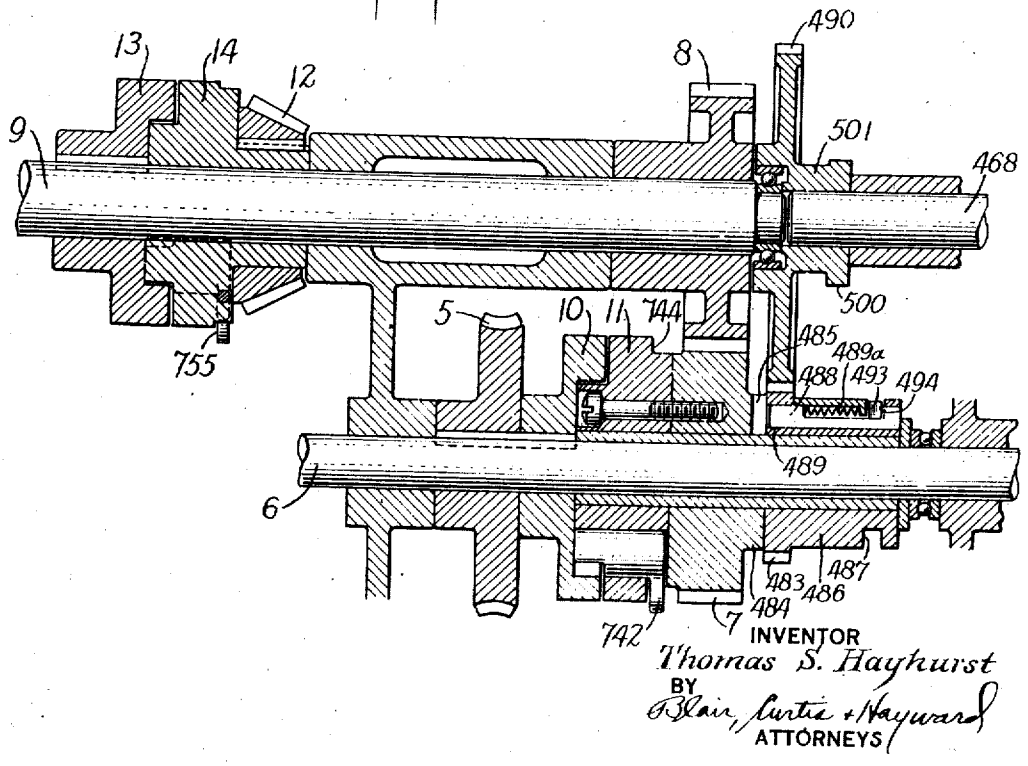


Fig. 4E.



INVENTOR
Thomas S. Hayhurst
BY
Blair, Curtis & Hayward
ATTORNEYS

March 5, 1946. T. S. HAYHURST 2,395,814

KNITTING MACHINE

Filed April 13, 1944 52 Sheets-Sheet 7

Fig. 5.

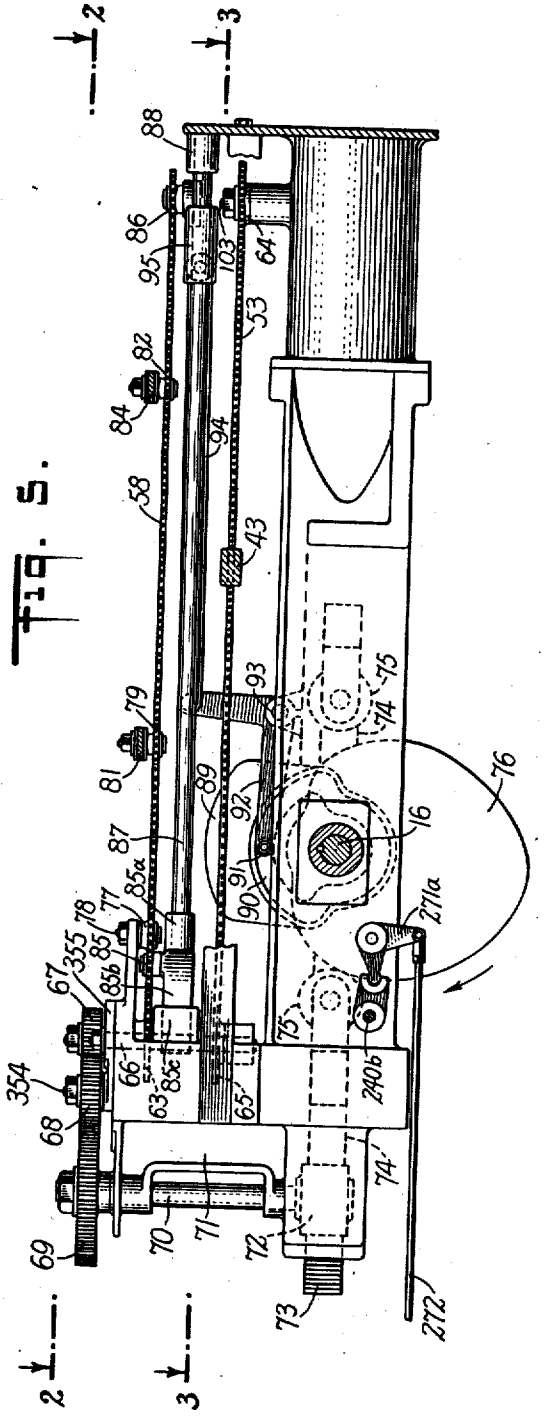
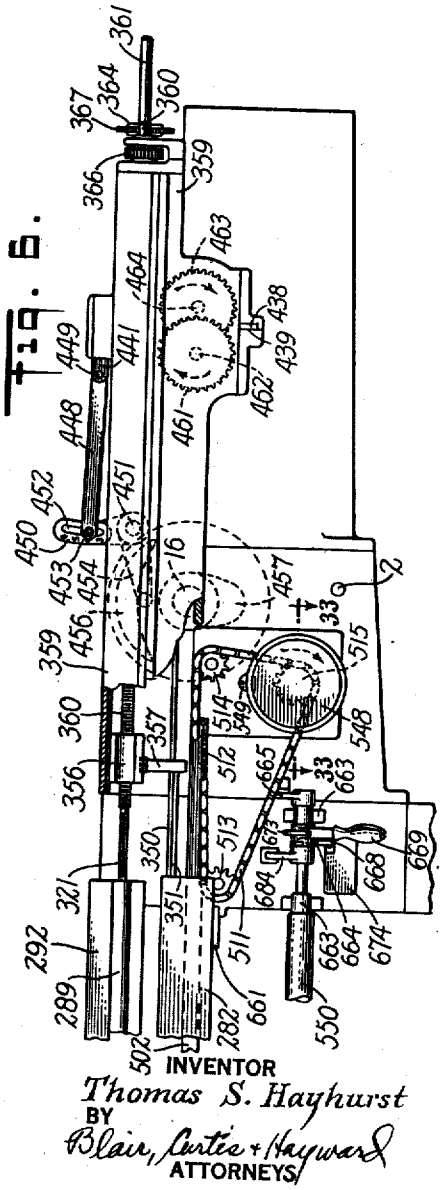


Fig. 6.



INVENTOR
Thomas S. Hayhurst
BY
Blair, Curtis & Hayward
ATTORNEYS

March 5, 1946. T. S. HAYHURST 2,395,814

KNITTING MACHINE

Filed April 13, 1944 52 Sheets-Sheet 8

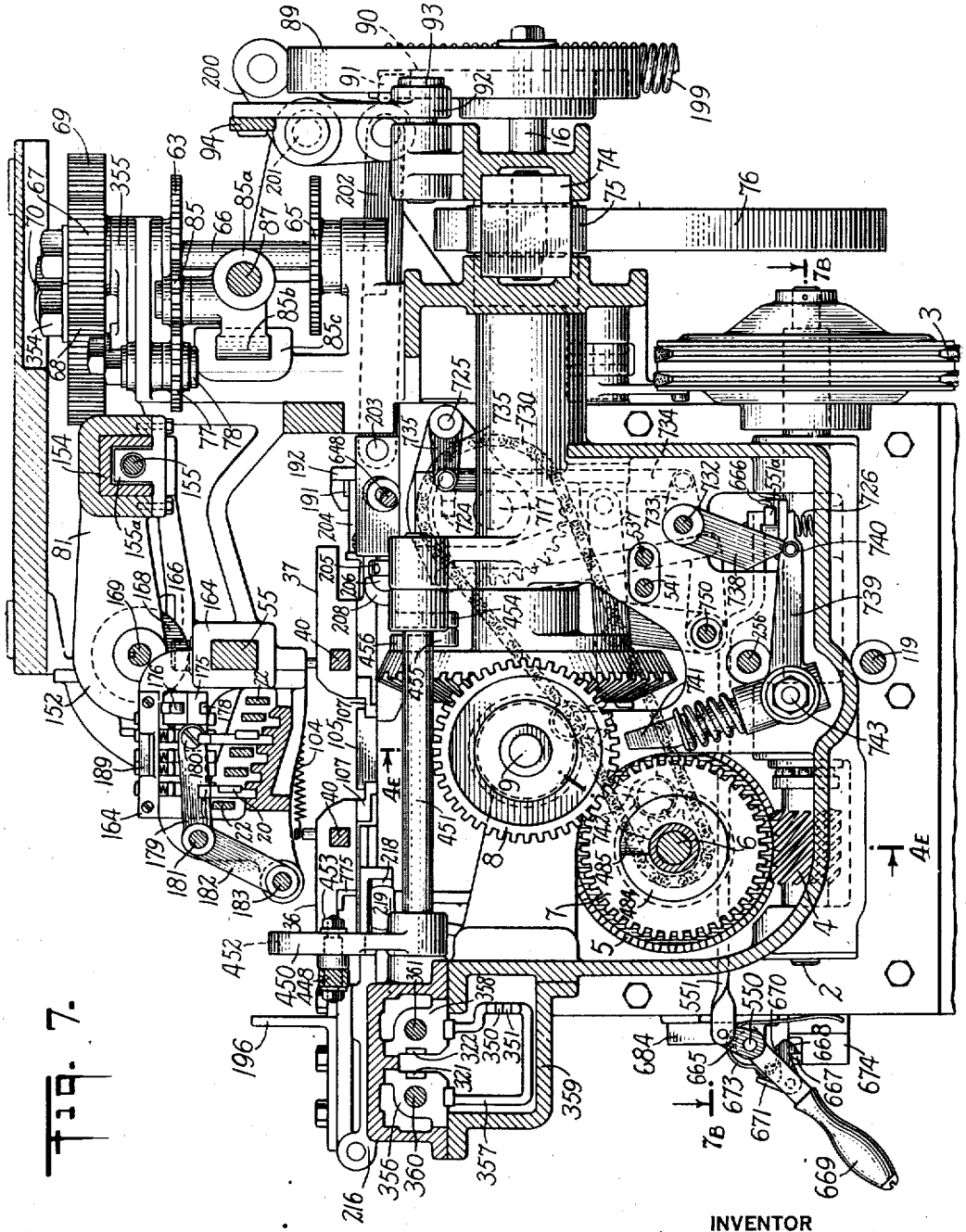


Fig. 7.

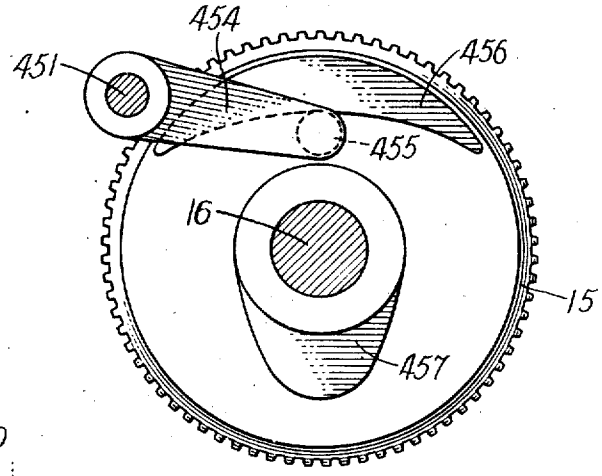
INVENTOR
Thomas S. Hayhurst
BY
Blair, Curtis & Hayward
ATTORNEYS

March 5, 1946. T. S. HAYHURST 2,395,814

KNITTING MACHINE

Filed April 13, 1944 52 Sheets-Sheet 9

Fig. 7A.



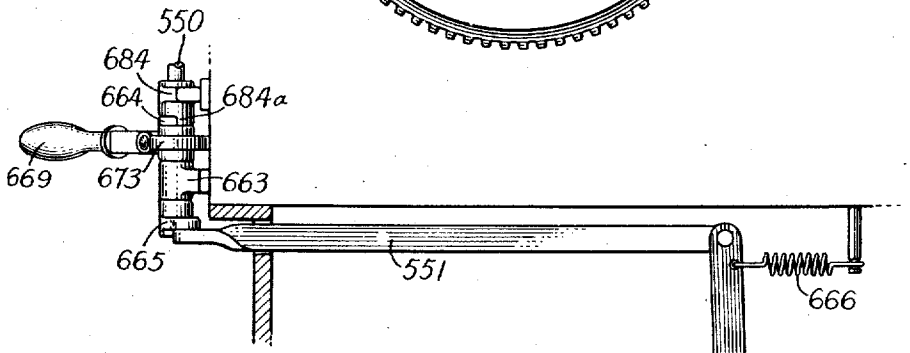
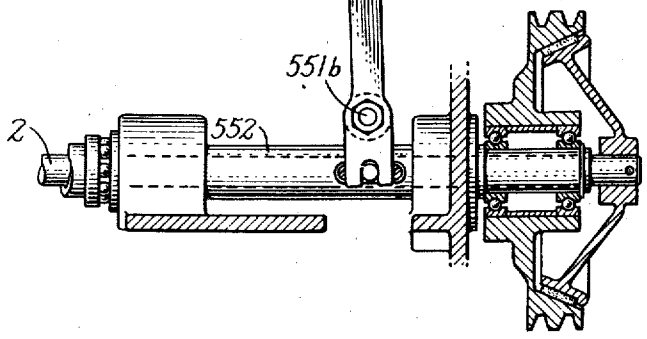


Fig. 7B.



INVENTOR
Thomas S. Hayhurst
BY
Blair, Curtis & Hayward
ATTORNEYS

March 5, 1946. T. S. HAYHURST 2,395,814

KNITTING MACHINE

Filed April 13, 1944 52 Sheets-Sheet 10

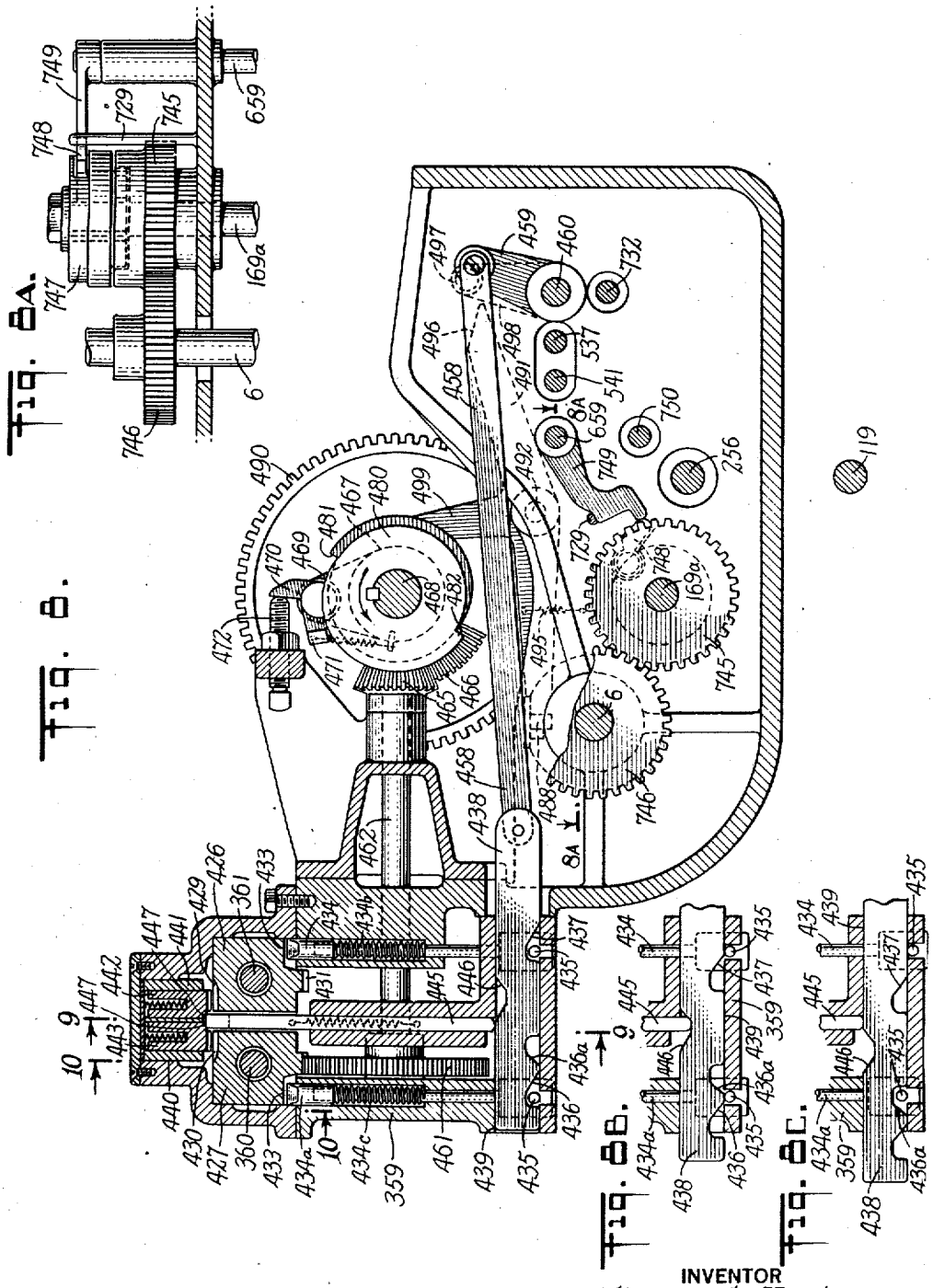


Fig. 8A.

Fig. 8.

Fig. 8B.

Fig. 8C.

INVENTOR
Thomas S. Hayhurst
BY
Blair, Curtis & Hayward
ATTORNEYS

March 5, 1946. T. S. HAYHURST 2,395,814

KNITTING MACHINE

Filed April 13, 1944 52 Sheets-Sheet 11

Fig. 9.

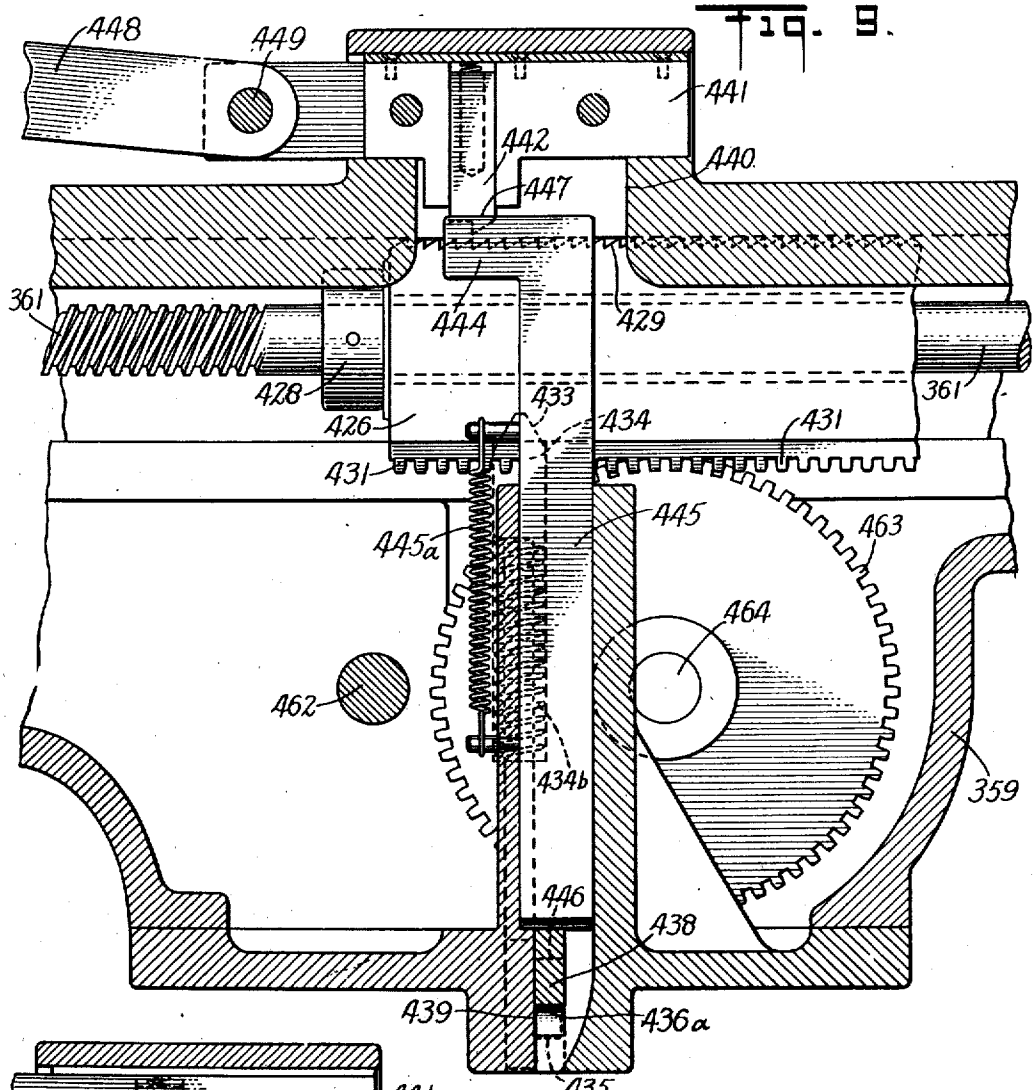
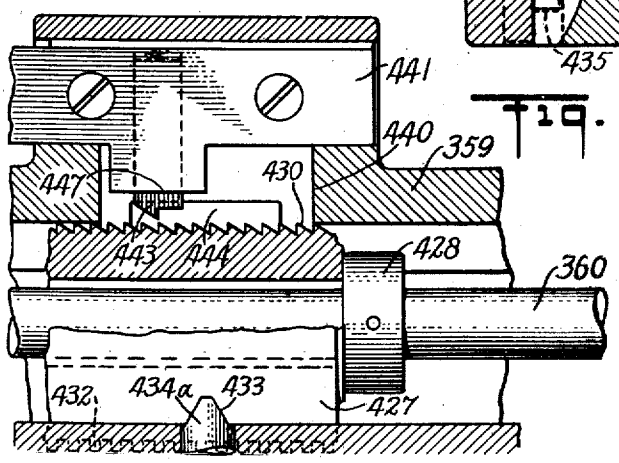


Fig. 10.



INVENTOR
Thomas S. Hayhurst
BY
Blair, Curtis & Hayward
ATTORNEYS

March 5, 1946. T. S. HAYHURST 2,395,814

KNITTING MACHINE

Filed April 13, 1944 52 Sheets-Sheet 12

Fig. 12.

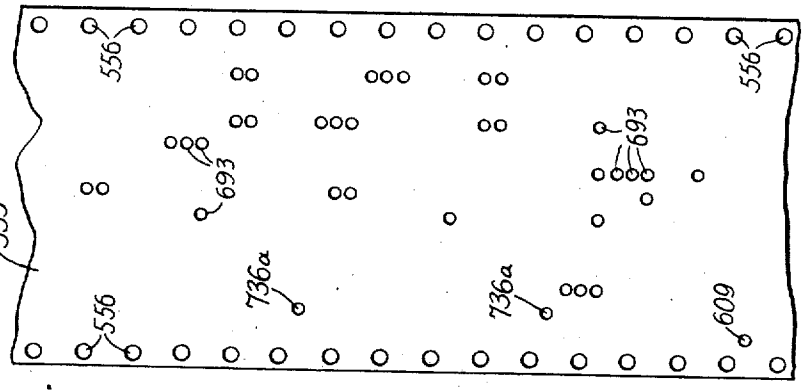
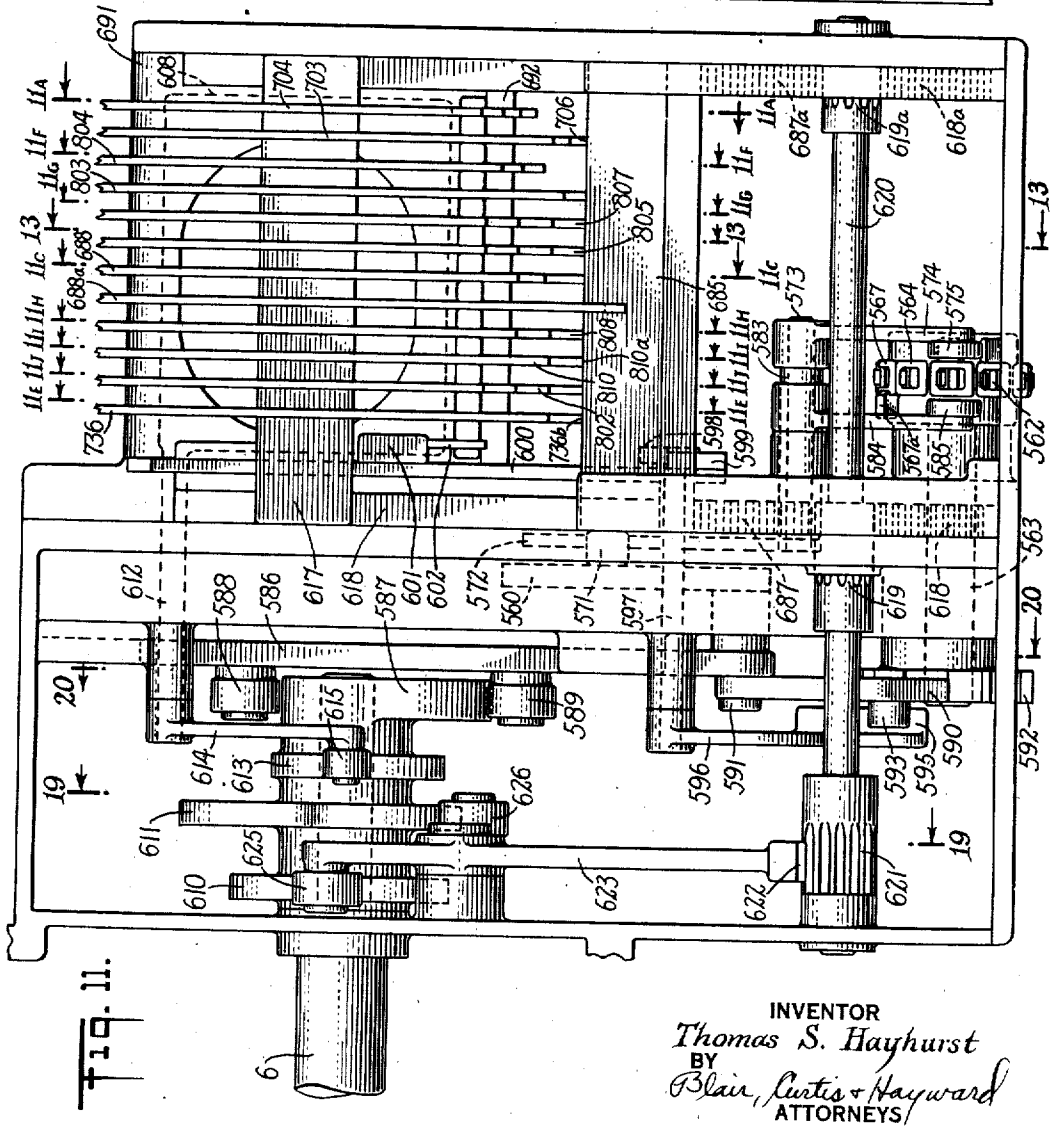


Fig. 11.



INVENTOR
Thomas S. Hayhurst
BY
Blair, Curtis & Hayward
ATTORNEYS

March 5, 1946. T. S. HAYHURST 2,395,814

KNITTING MACHINE

Filed April 13, 1944 52 Sheets-Sheet 13

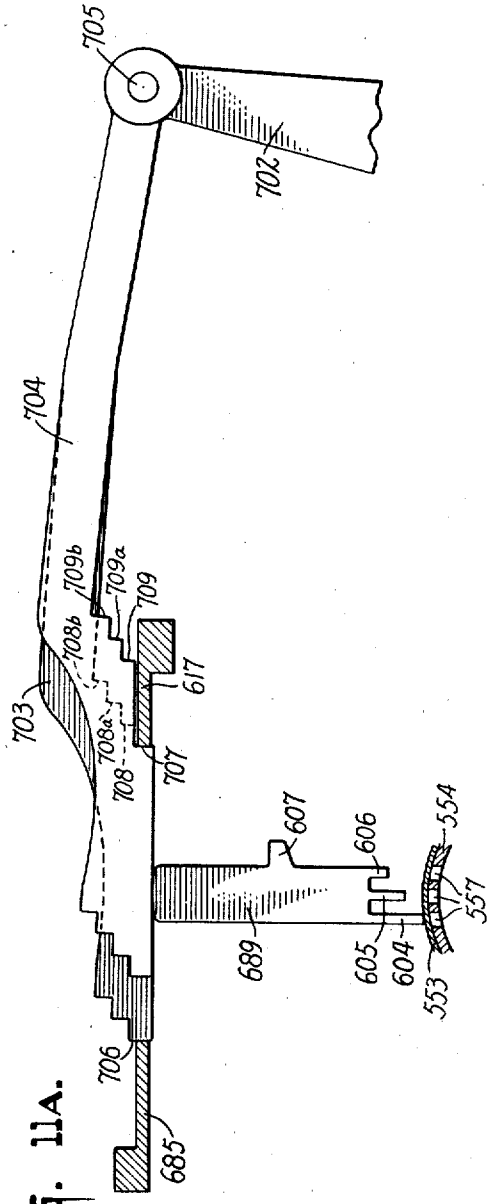


Fig. 11A.

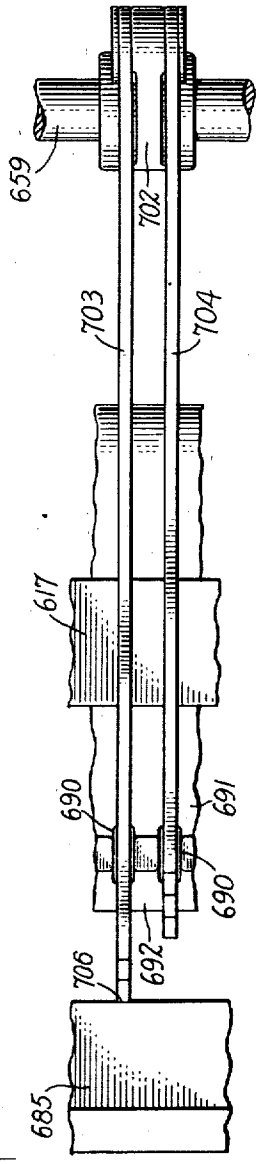


Fig. 11B.

INVENTOR
Thomas S. Hayhurst
BY
Blair, Curtis & Hayward
ATTORNEYS

March 5, 1946. T. S. HAYHURST 2,395,814

KNITTING MACHINE

Filed April 13, 1944 52 Sheets-Sheet 14

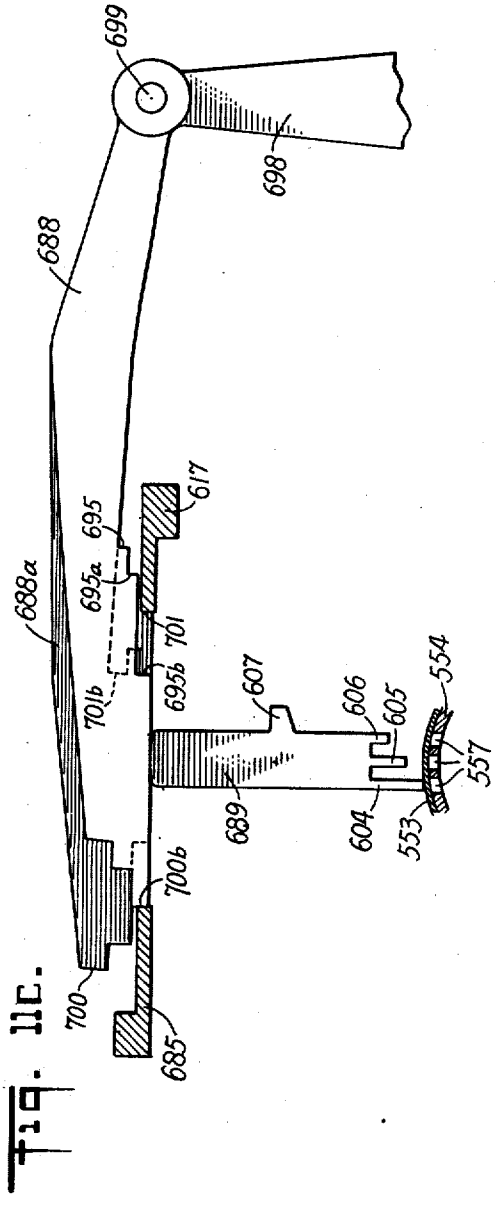


Fig. 11C.

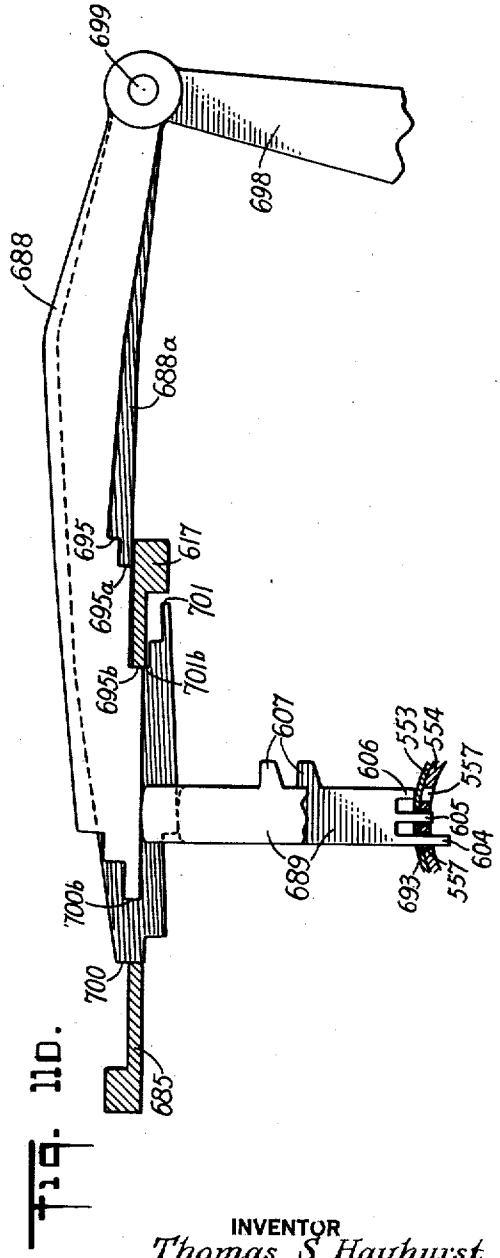


Fig. 11D.

INVENTOR
Thomas S. Hayhurst
BY
Blair, Curtis & Hayward
ATTORNEYS

March 5, 1946. T. S. HAYHURST 2,395,814

KNITTING MACHINE

Filed April 13, 1944 52 Sheets-Sheet 15

Fig. 11E.

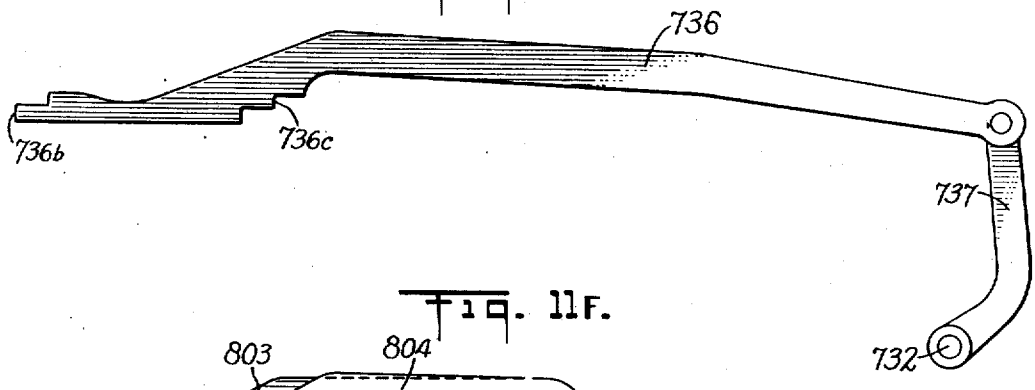


Fig. 11F.

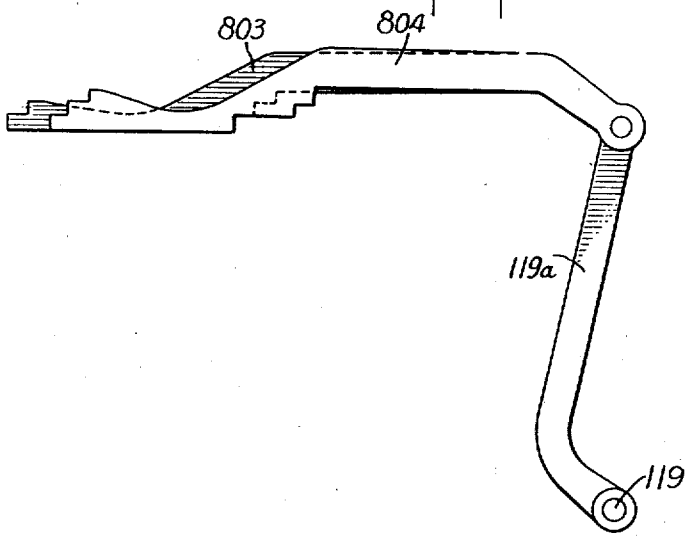
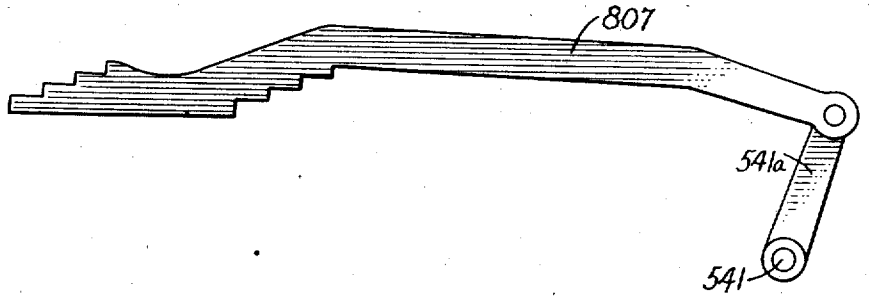


Fig. 11G.



INVENTOR
Thomas S. Hayhurst
BY
Blair, Curtis & Hayward
ATTORNEYS

March 5, 1946. T. S. HAYHURST 2,395,814

KNITTING MACHINE

Filed April 13, 1944 52 Sheets-Sheet 16

Fig. 11H.

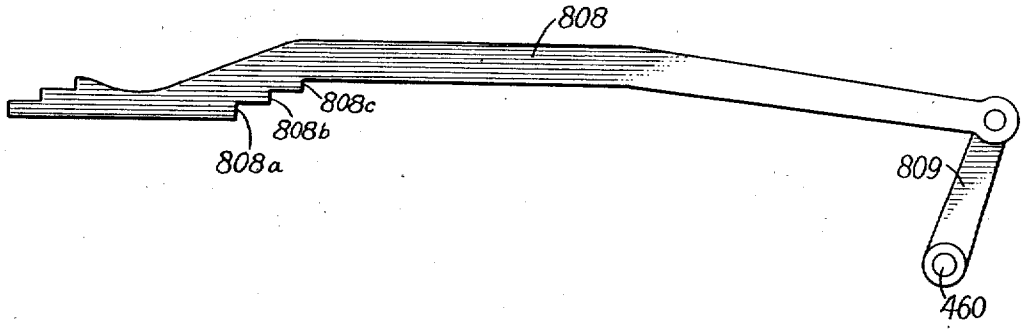


Fig. 11I.

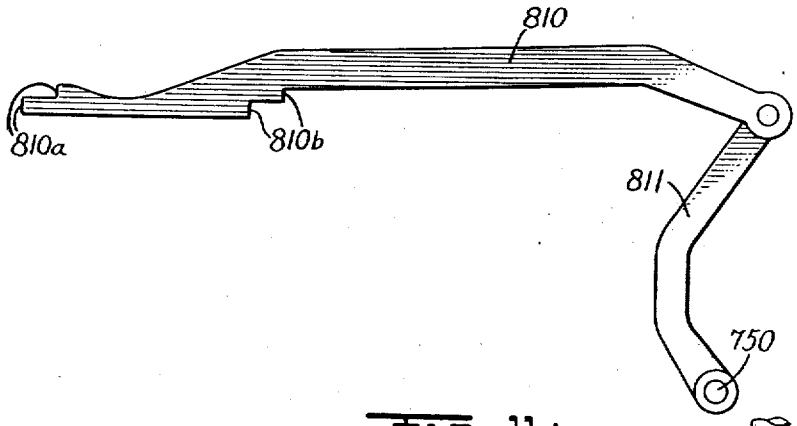
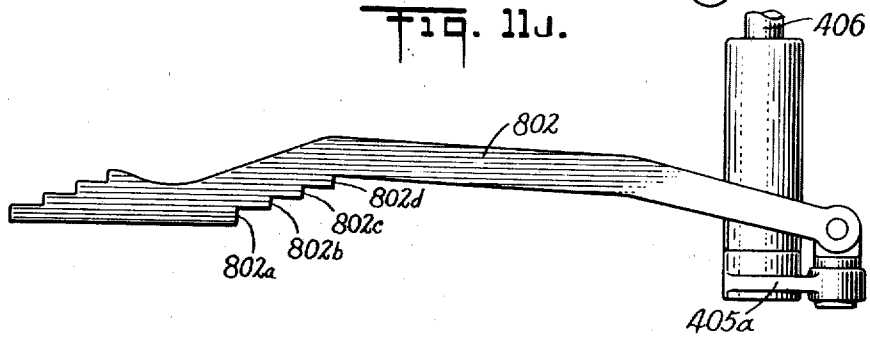


Fig. 11J.



INVENTOR
Thomas S. Hayhurst
BY
Blair, Curtis & Hayward
ATTORNEYS

March 5, 1946. T. S. HAYHURST 2,395,814

KNITTING MACHINE

Filed April 13, 1944 52 Sheets-Sheet 17

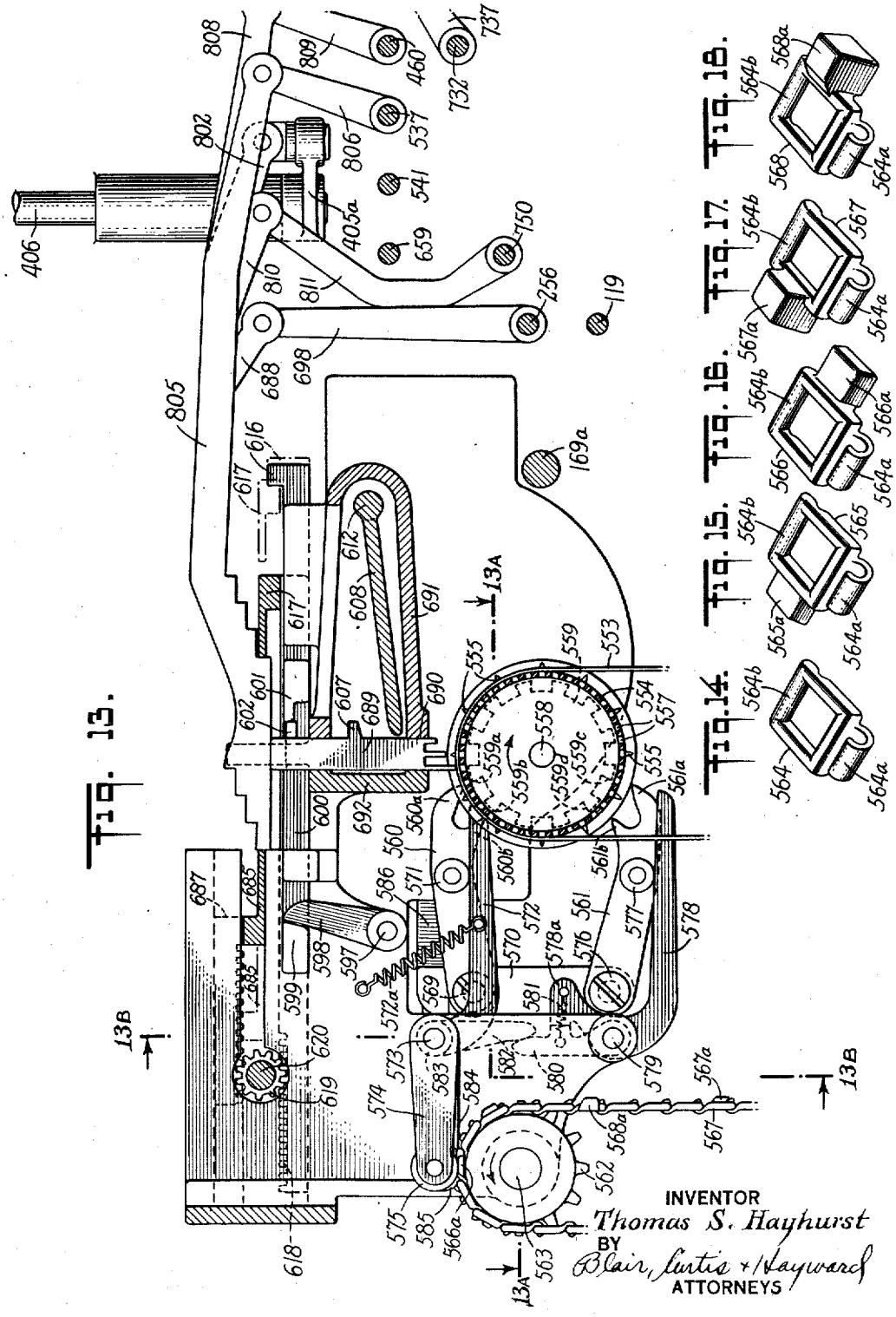


Fig. 13.

Fig. 18. Fig. 17. Fig. 16. Fig. 15. Fig. 14.

INVENTOR
Thomas S. Hayhurst
BY
Blair, Curtis & Hayward
ATTORNEYS

March 5, 1946. T. S. HAYHURST 2,395,814

KNITTING MACHINE

Filed April 13, 1944 52 Sheets-Sheet 18

Fig. 13A.

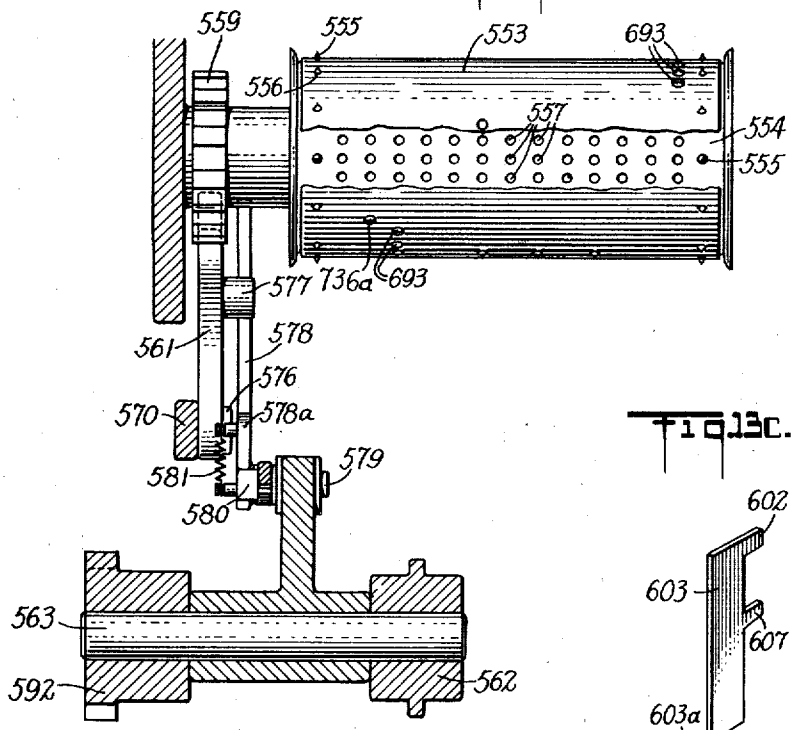


Fig. 13C. Fig. 13D.

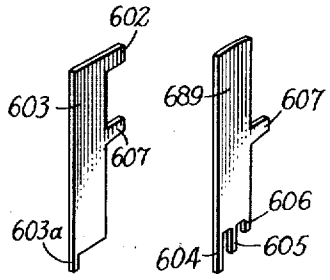
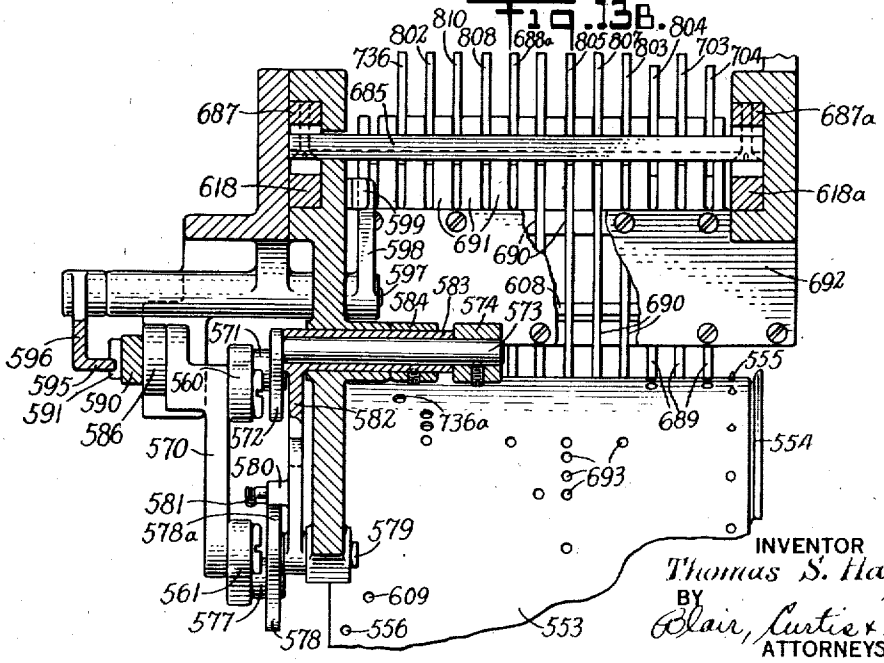


Fig. 13B.



INVENTOR
Thomas S. Hayhurst
BY
Blair, Curtis & Hayward
ATTORNEYS

March 5, 1946. T. S. HAYHURST 2,395,814

KNITTING MACHINE

Filed April 13, 1944 52 Sheets-Sheet 19

Fig. 19.

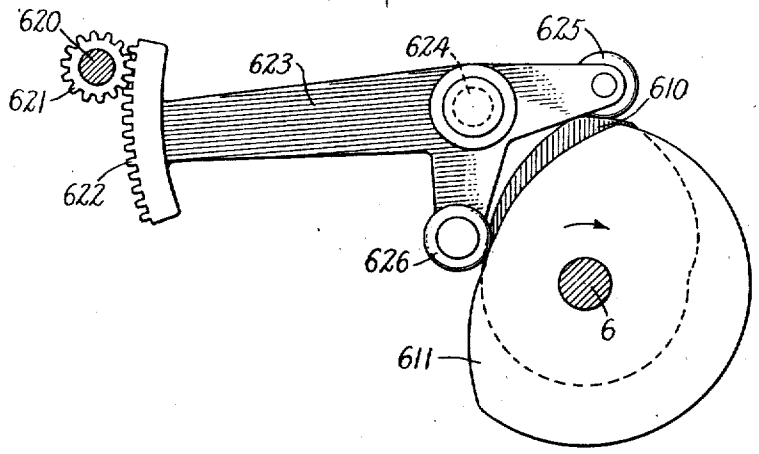
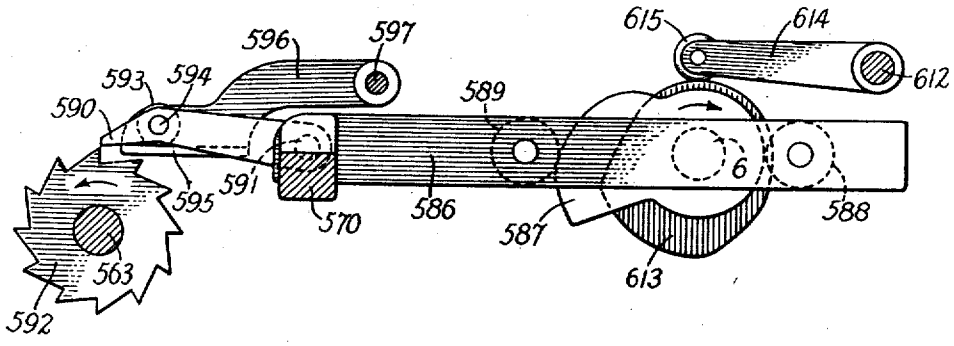


Fig. 20.



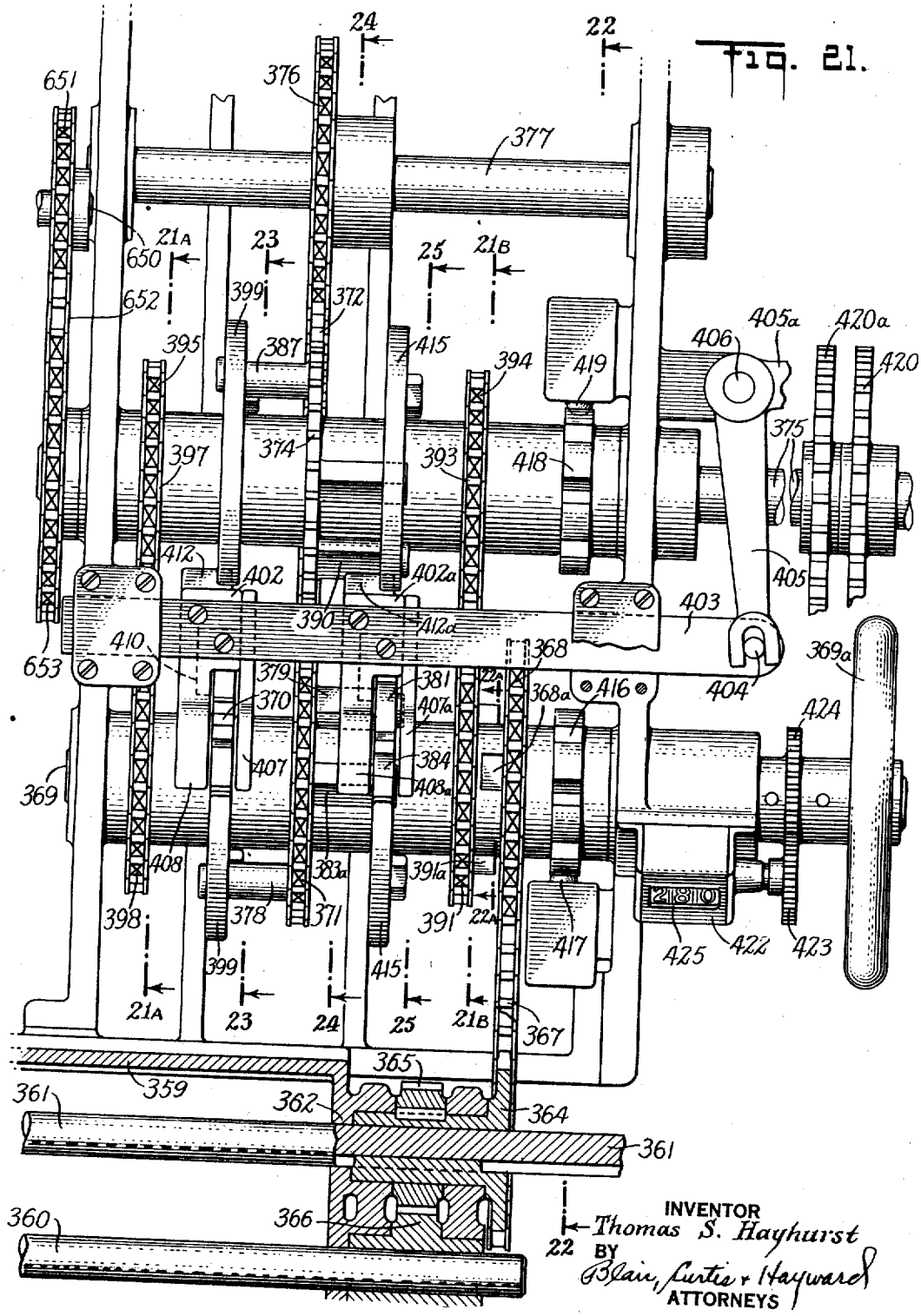
INVENTOR
Thomas S. Hayhurst
BY
Blair, Curtis & Hayward
ATTORNEYS

March 5, 1946. T. S. HAYHURST 2,395,814

KNITTING MACHINE

Filed April 13, 1944 52 Sheets-Sheet 20

Fig. 21.



INVENTOR
Thomas S. Hayhurst
BY
Blair, Curtis & Hayward
ATTORNEYS

March 5, 1946. T. S. HAYHURST 2,395,814

KNITTING MACHINE

Filed April 13, 1944 52 Sheets-Sheet 21

Fig. 21A.

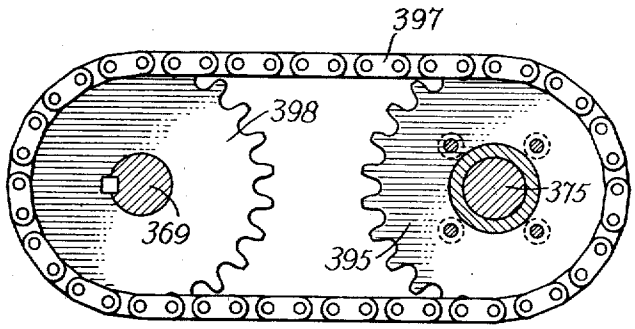
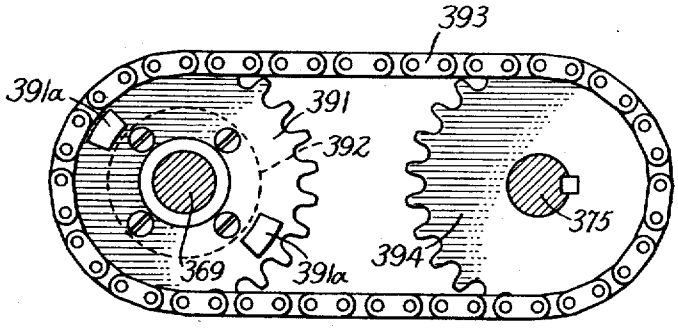


Fig. 21B.

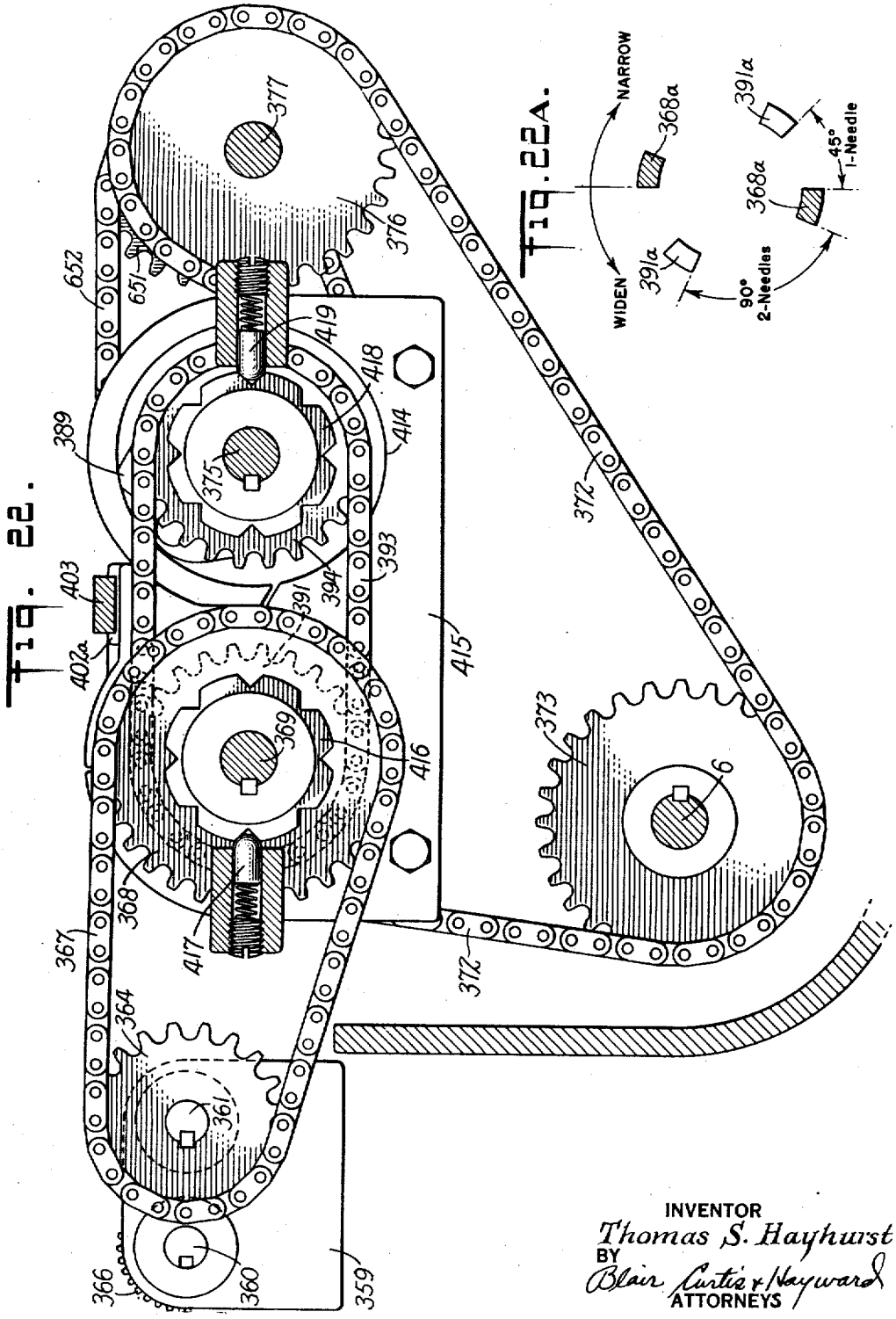


INVENTOR
Thomas S. Hayhurst
BY
Blair, Curtis & Hayward
ATTORNEYS

March 5, 1946. T. S. HAYHURST 2,395,814

KNITTING MACHINE

Filed April 13, 1944 52 Sheets-Sheet 22



INVENTOR
Thomas S. Hayhurst
BY
Blair Curtis & Hayward
ATTORNEYS

March 5, 1946. T. S. HAYHURST 2,395,814

KNITTING MACHINE

Filed April 13, 1944 52 Sheets-Sheet 23

Fig. 23.

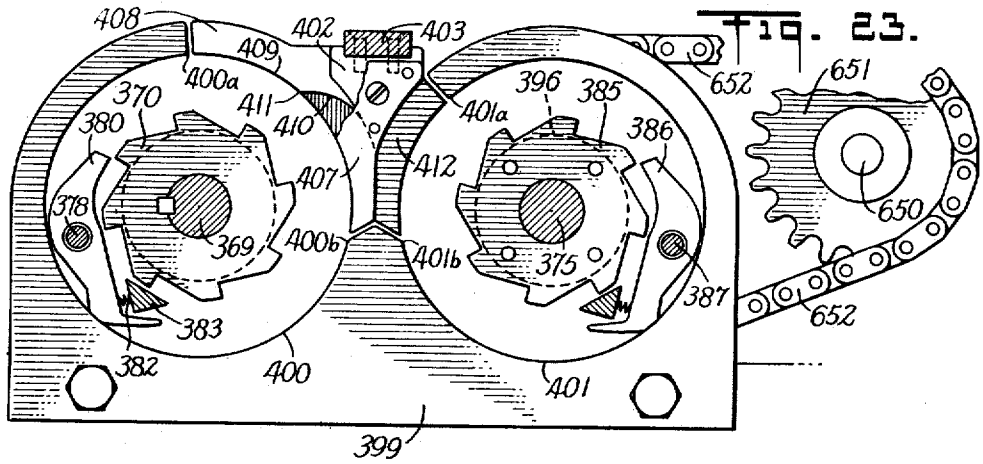


Fig. 24.

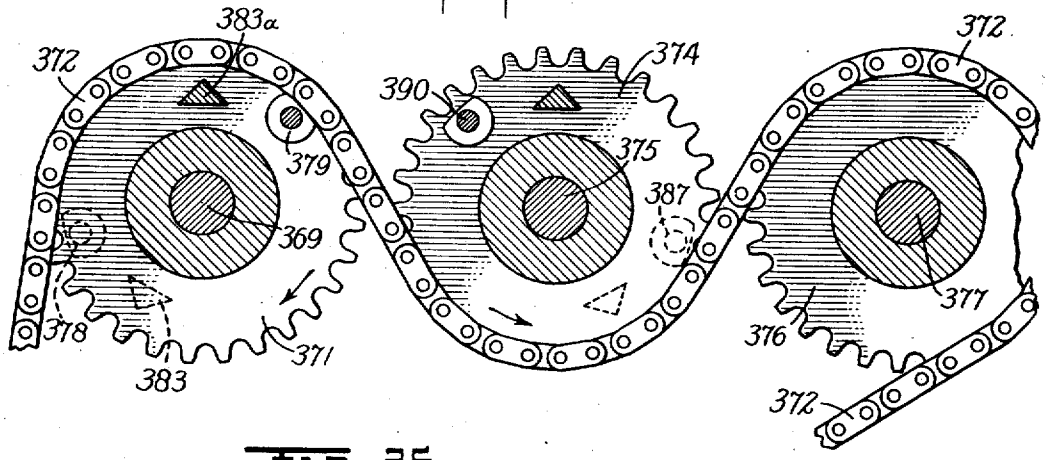
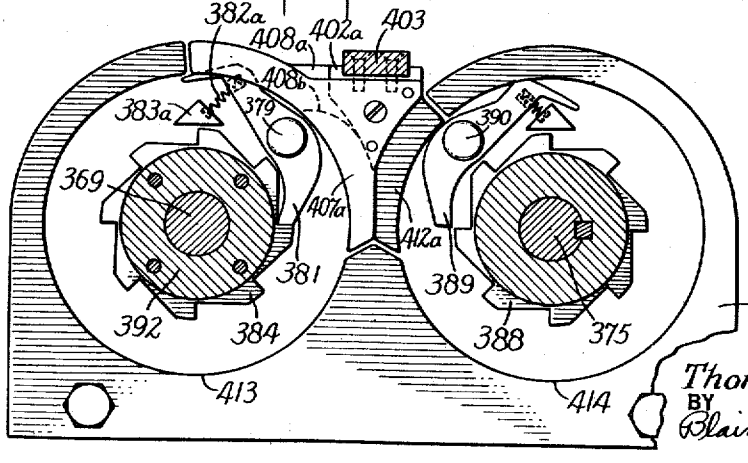


Fig. 25.



INVENTOR
Thomas S. Hayhurst
BY
Blair, Curtis & Hayward
ATTORNEYS

March 5, 1946. T. S. HAYHURST 2,395,814

KNITTING MACHINE

Filed April 13, 1944 52 Sheets-Sheet 24

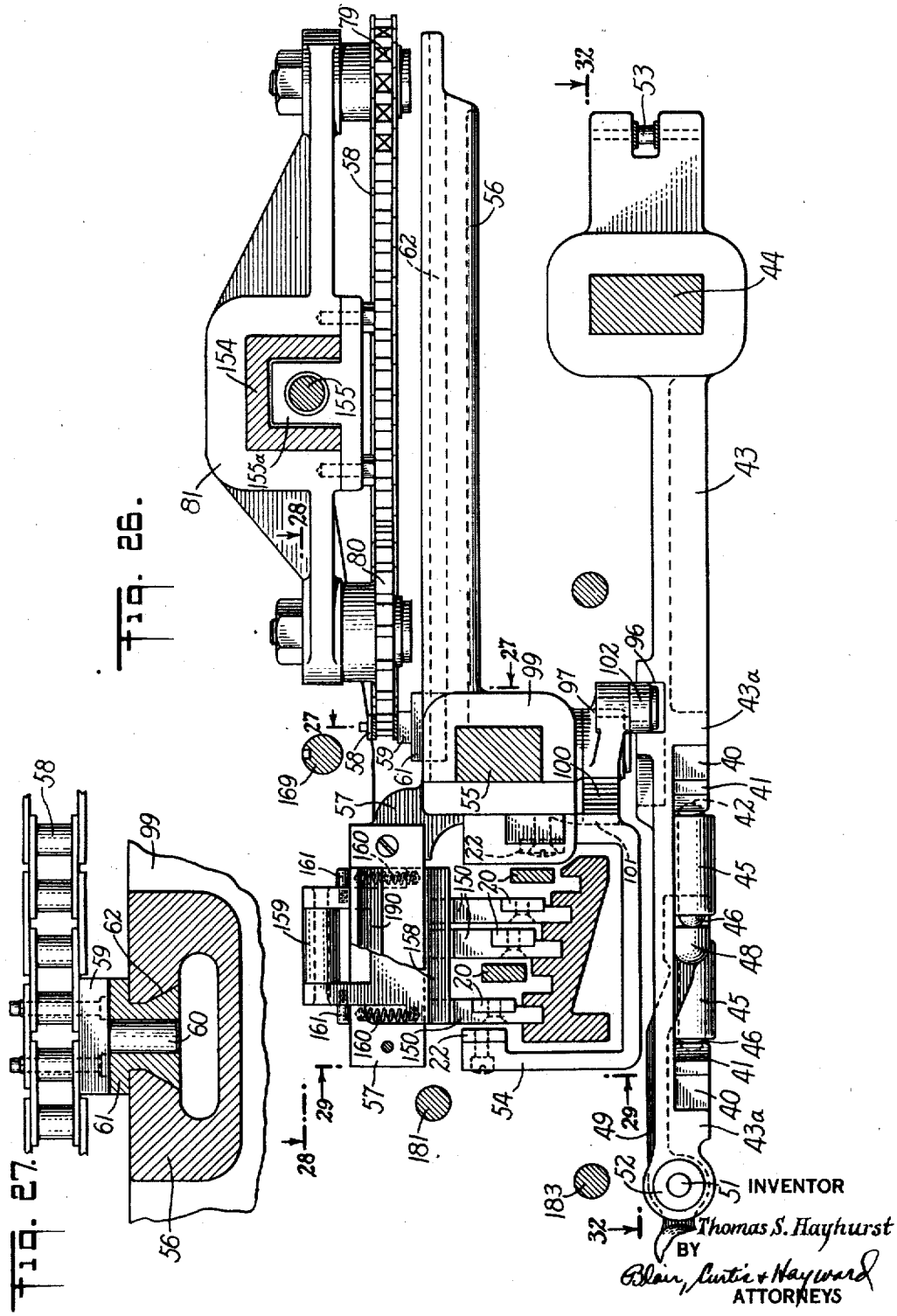


Fig. 26.

Fig. 27.

INVENTOR
Thomas S. Hayhurst
BY
Blair, Curtis & Hayward
ATTORNEYS

March 5, 1946. T. S. HAYHURST 2,395,814

KNITTING MACHINE

Filed April 13, 1944 52 Sheets-Sheet 25

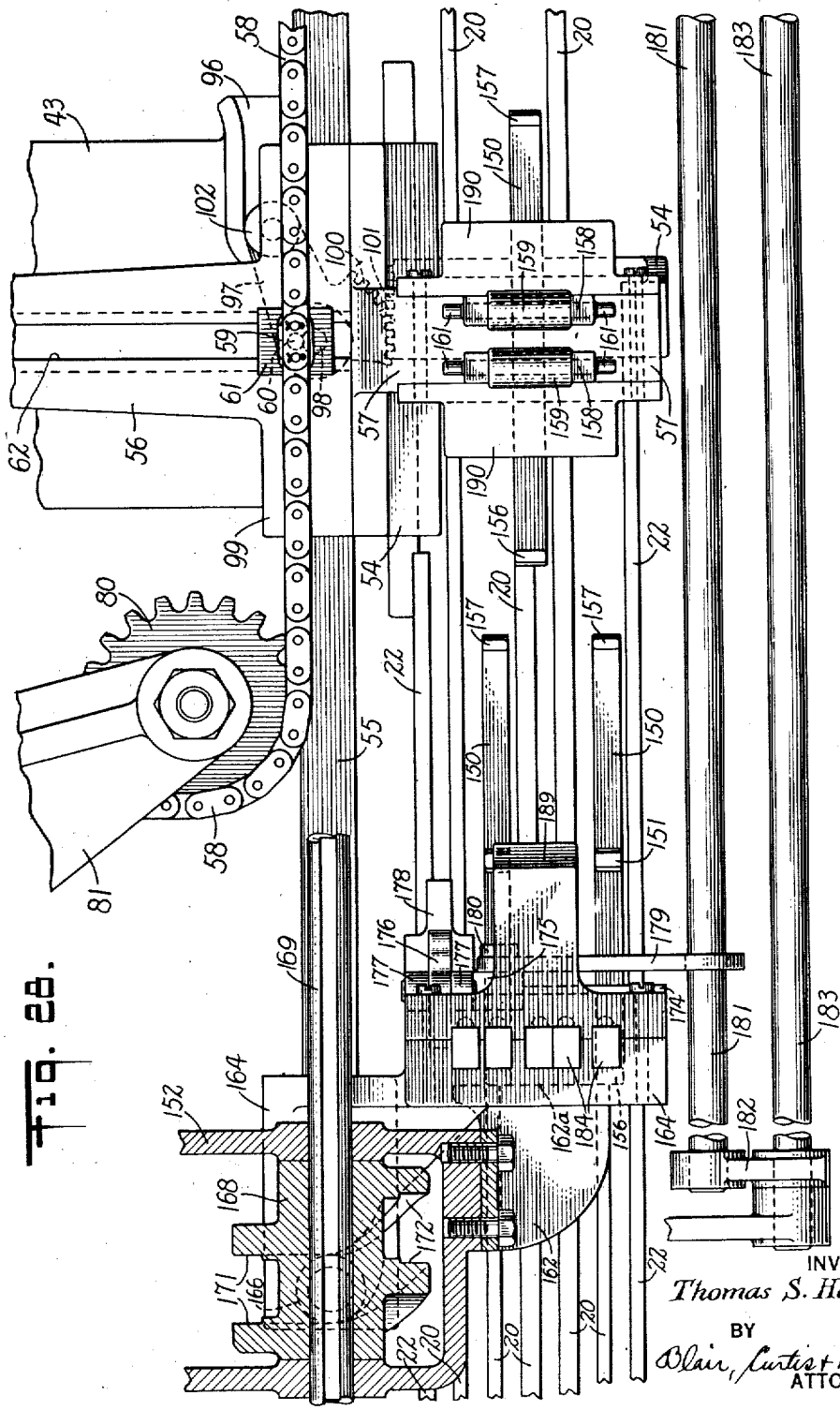


Fig. 28.

INVENTOR
Thomas S. Hayhurst
BY
Blair, Curtis & Hayward
ATTORNEYS

March 5, 1946. T. S. HAYHURST 2,395,814

KNITTING MACHINE

Filed April 13, 1944 52 Sheets-Sheet 26

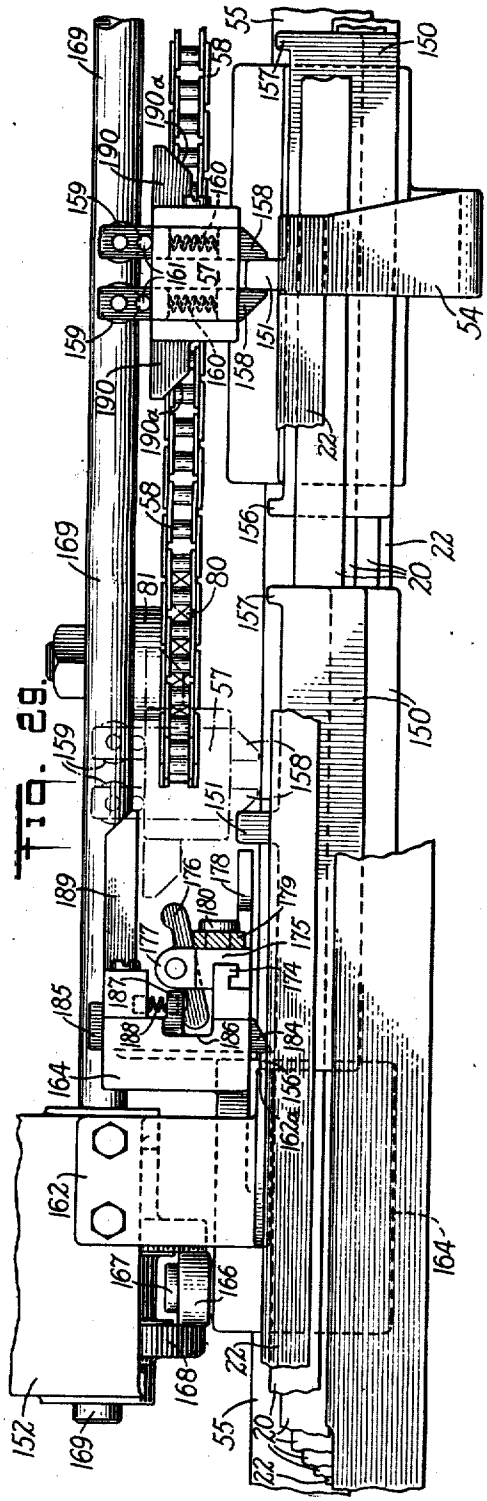


Fig. 29.

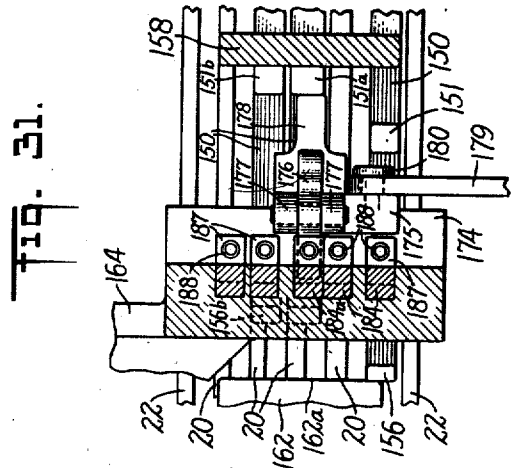


Fig. 31.

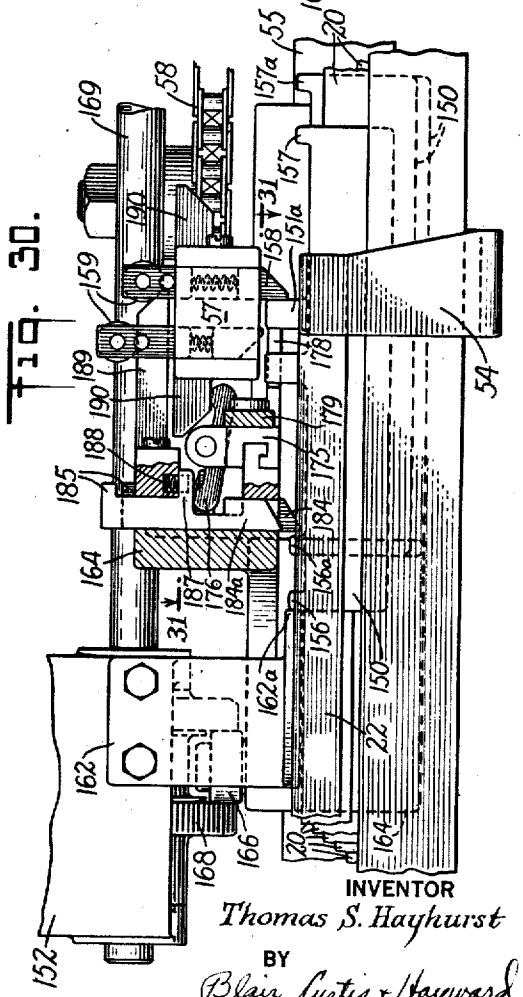


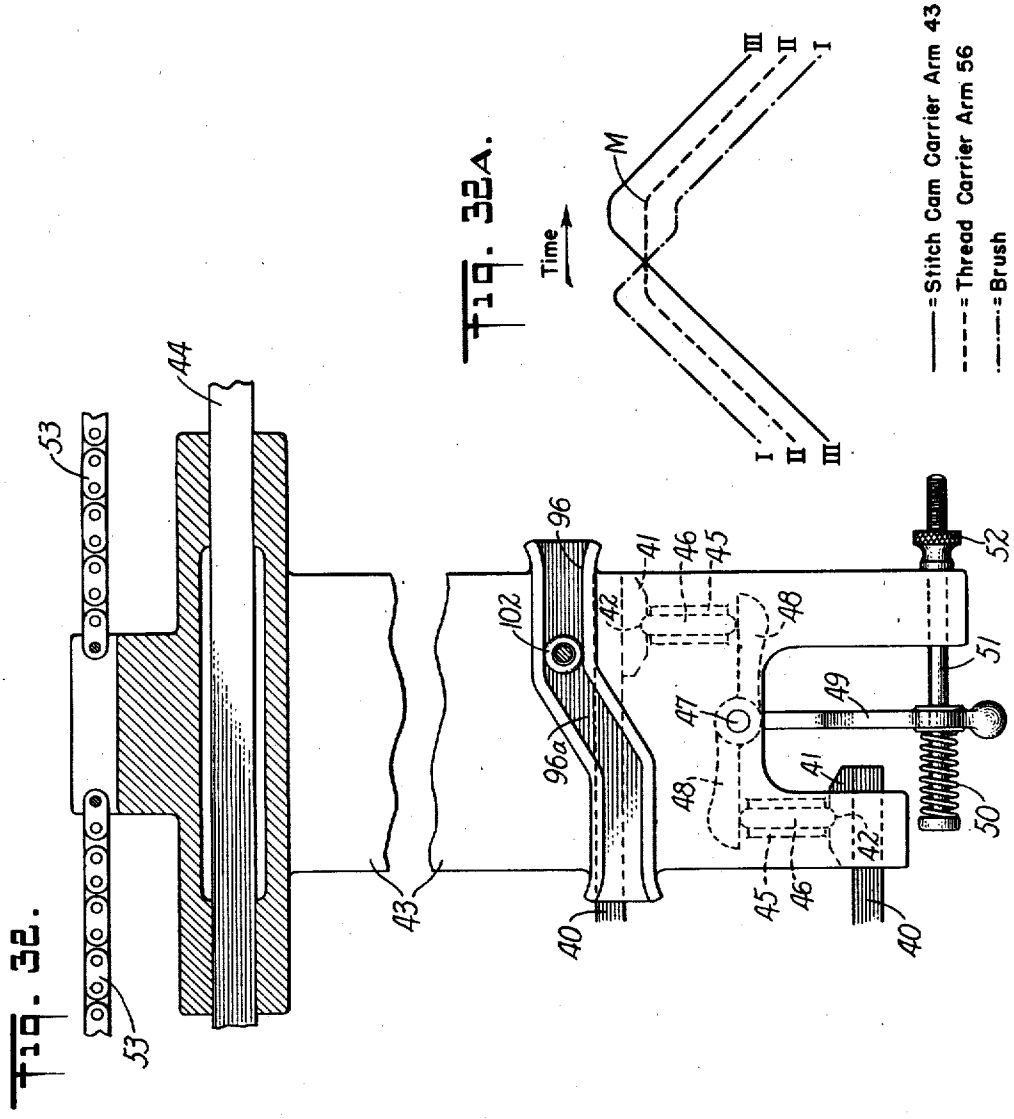
Fig. 30.

INVENTOR
Thomas S. Hayhurst
BY
Blair, Curtis & Hayward
ATTORNEYS

March 5, 1946. T. S. HAYHURST 2,395,814

KNITTING MACHINE

Filed April 13, 1944 52 Sheets-Sheet 27



INVENTOR
Thomas S. Hayhurst
BY
Blair, Curtis & Hayward
ATTORNEYS

March 5, 1946. T. S. HAYHURST 2,395,814

KNITTING MACHINE

Filed April 13, 1944 52 Sheets-Sheet 28

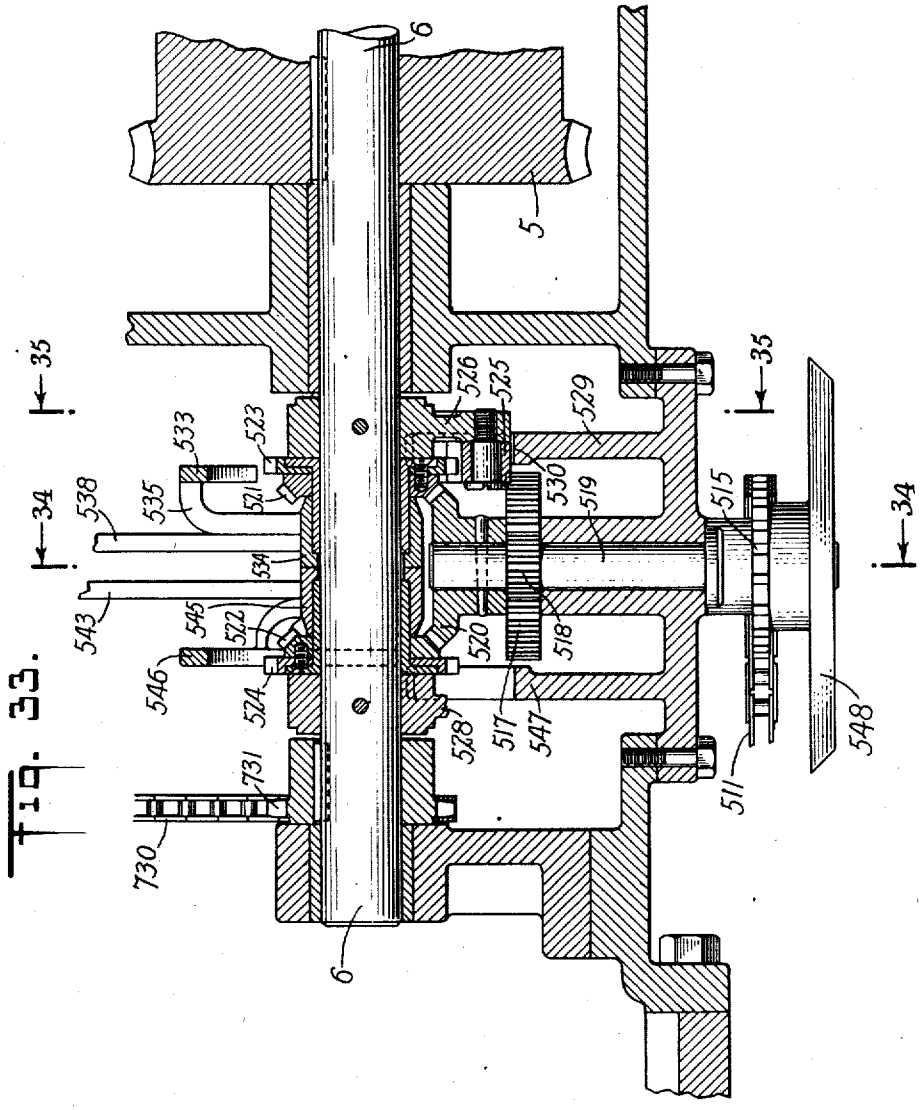


Fig. 33.

INVENTOR
Thomas S. Hayhurst
BY
Blair, Curtis & Hayward
ATTORNEYS

March 5, 1946. T. S. HAYHURST 2,395,814

KNITTING MACHINE

Filed April 13, 1944 52 Sheets-Sheet 29

Fig. 34.

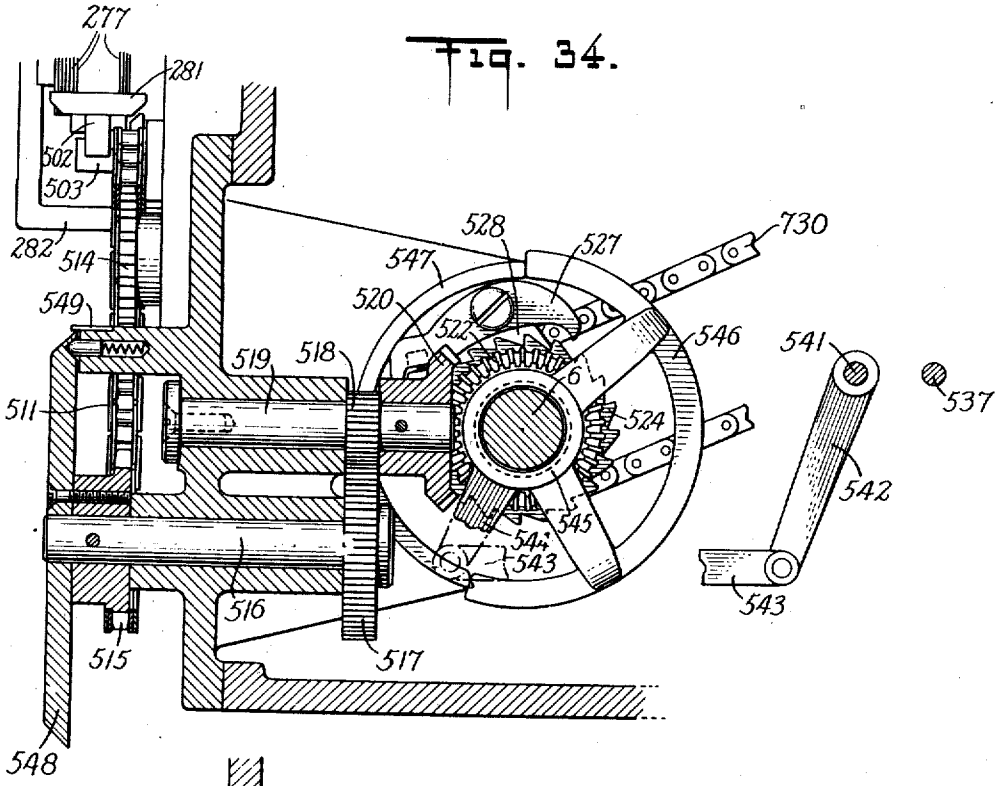
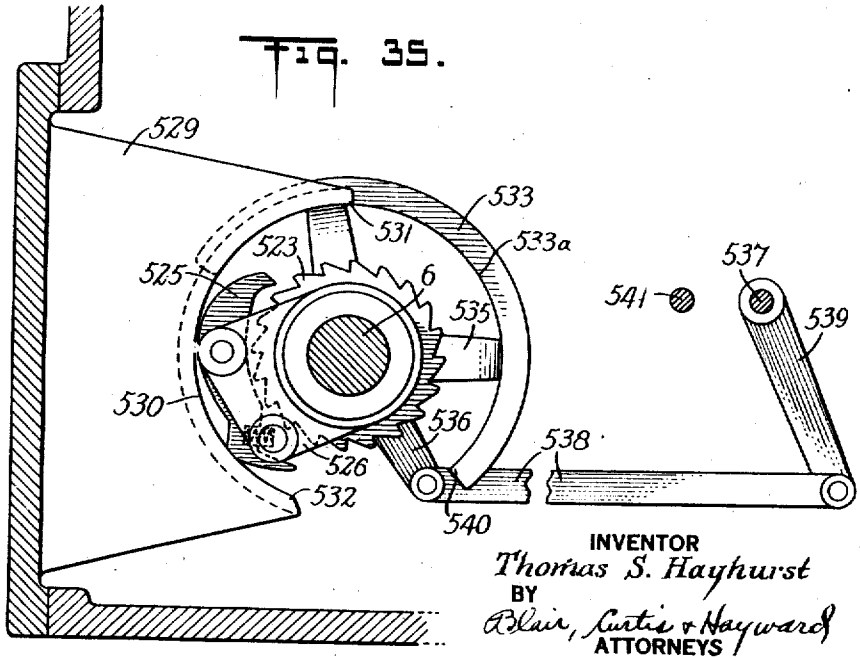


Fig. 35.



INVENTOR
Thomas S. Hayhurst
BY
Blair, Curtis & Hayward
ATTORNEYS

March 5, 1946. T. S. HAYHURST 2,395,814

KNITTING MACHINE

Filed April 13, 1944 52 Sheets-Sheet 30

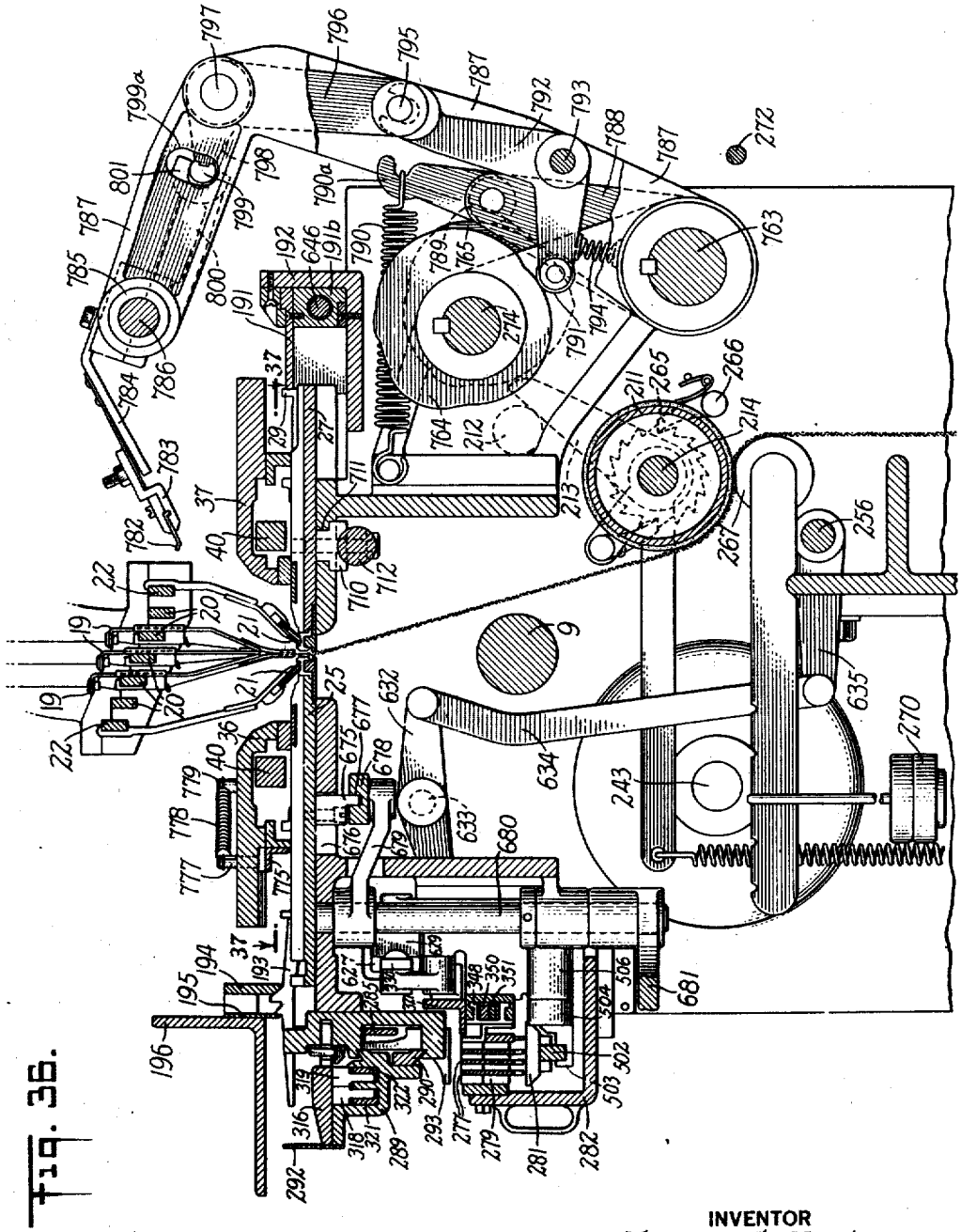


Fig. 36.

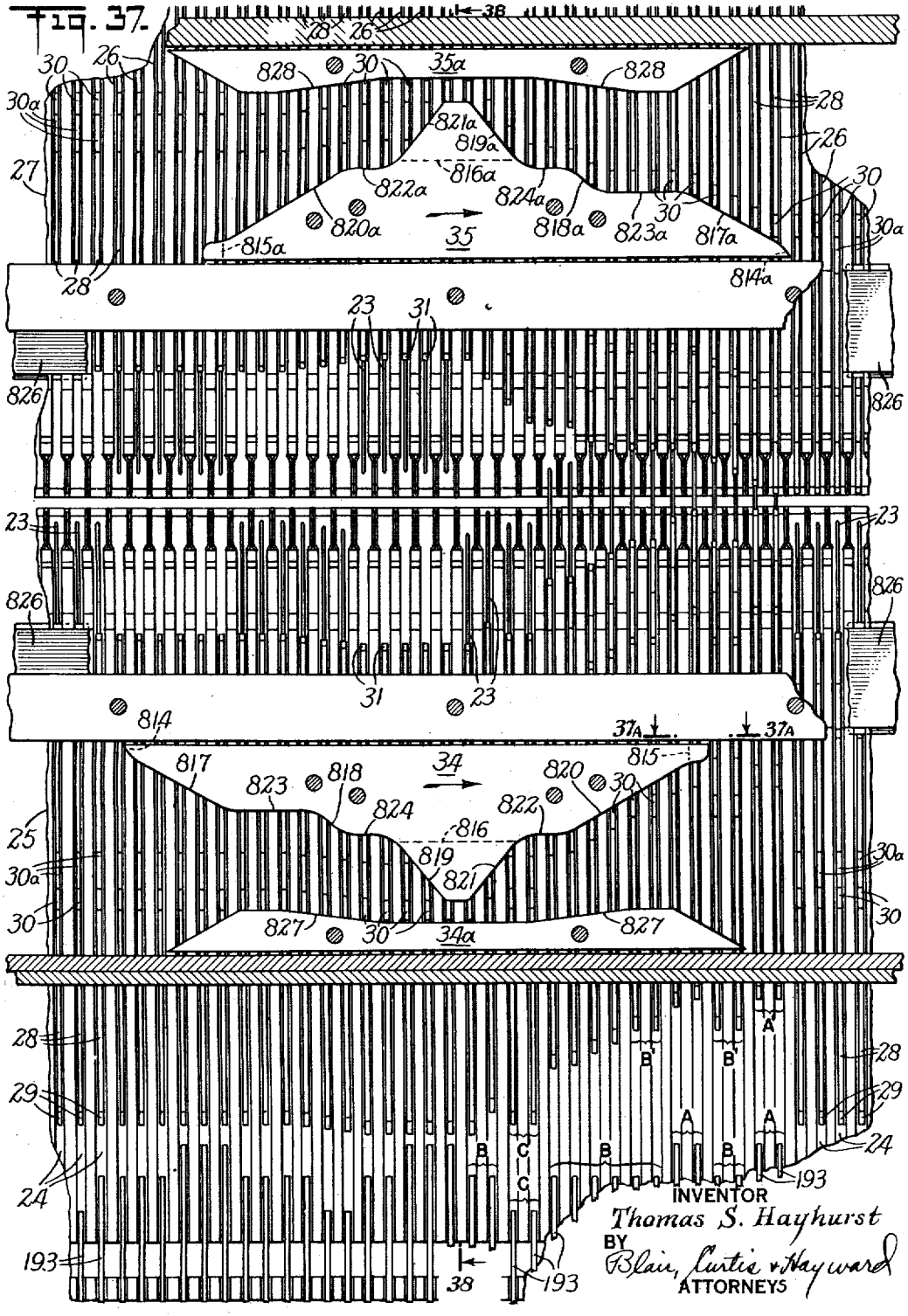
INVENTOR
Thomas S. Hayhurst
BY
Blair, Curtis & Hayward
ATTORNEYS

March 5, 1946. T. S. HAYHURST 2,395,814

KNITTING MACHINE

Filed April 13, 1944 52 Sheets-Sheet 31

Fig. 37.



March 5, 1946. T. S. HAYHURST 2,395,814

KNITTING MACHINE

Filed April 13, 1944 52 Sheets-Sheet 32

Fig. 37B.

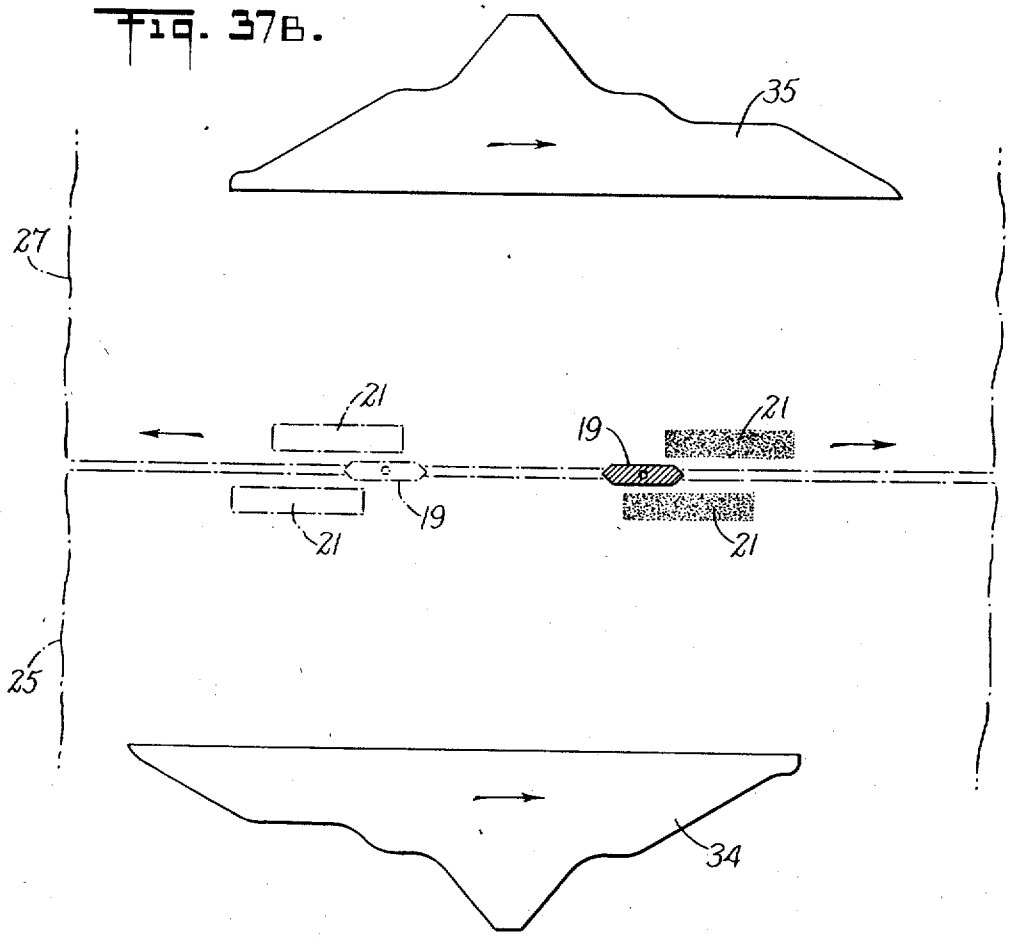


Fig. 37A.

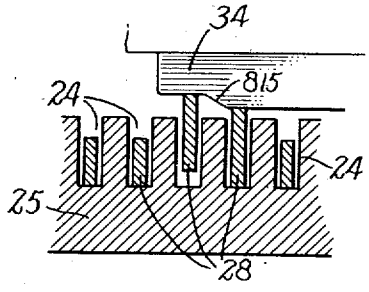
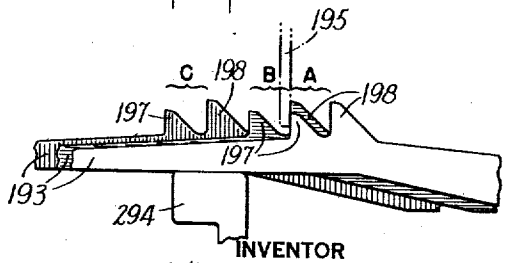


Fig. 37C.



INVENTOR
Thomas S. Hayhurst
BY
Blair, Curtis & Hayward
ATTORNEYS

March 5, 1946. T. S. HAYHURST 2,395,814

KNITTING MACHINE

Filed April 13, 1944 52 Sheets-Sheet 33

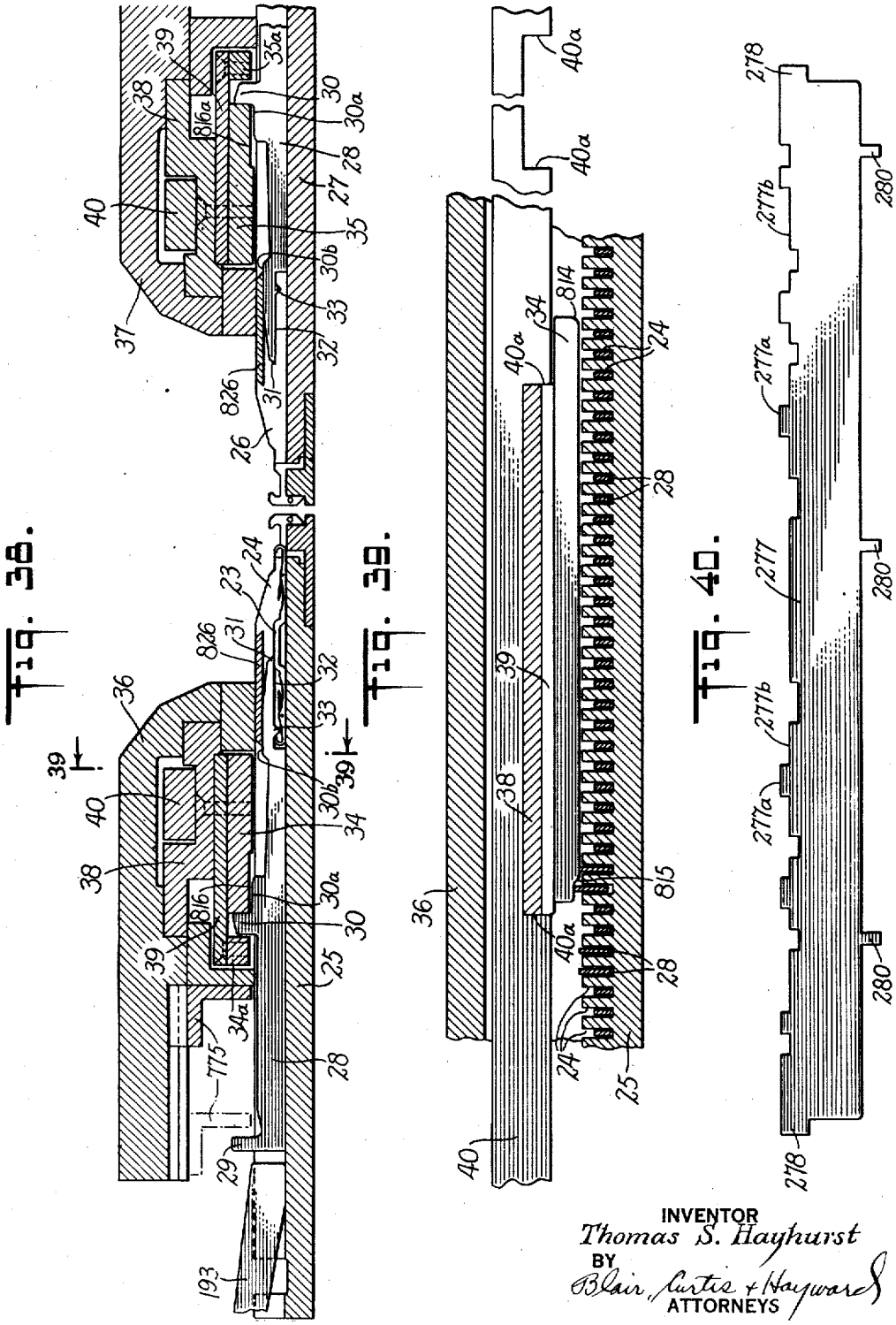


Fig. 38.

Fig. 39.

Fig. 40.

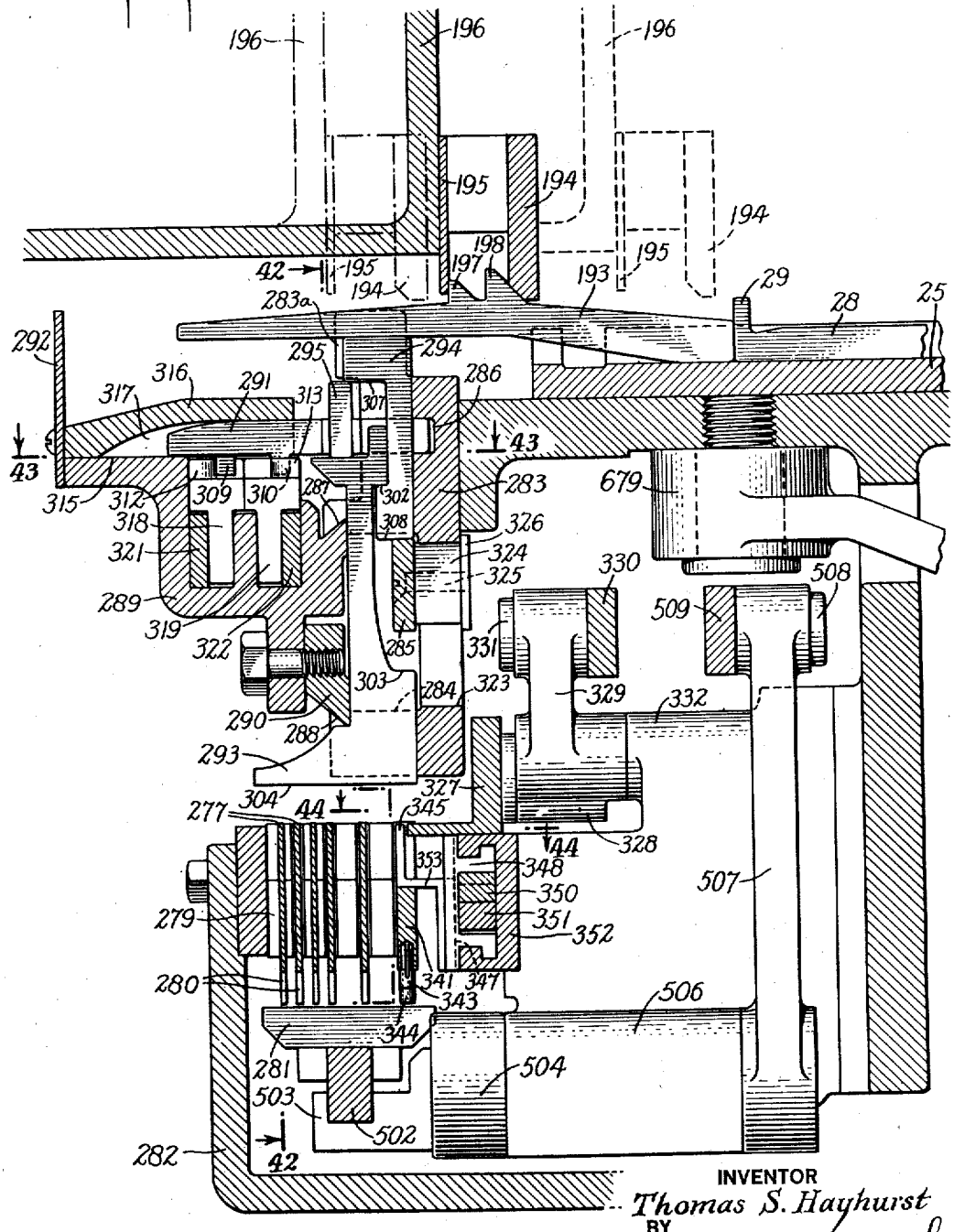
INVENTOR
Thomas S. Hayhurst
BY
Blair, Curtis & Hayward
ATTORNEYS

March 5, 1946. T. S. HAYHURST 2,395,814

KNITTING MACHINE

Filed April 13, 1944 52 Sheets-Sheet 34

Fig. 41.



INVENTOR
Thomas S. Hayhurst
BY
Blair, Curtis & Hayward
ATTORNEYS

March 5, 1946. T. S. HAYHURST 2,395,814

KNITTING MACHINE

Filed April 13, 1944 52 Sheets-Sheet 35

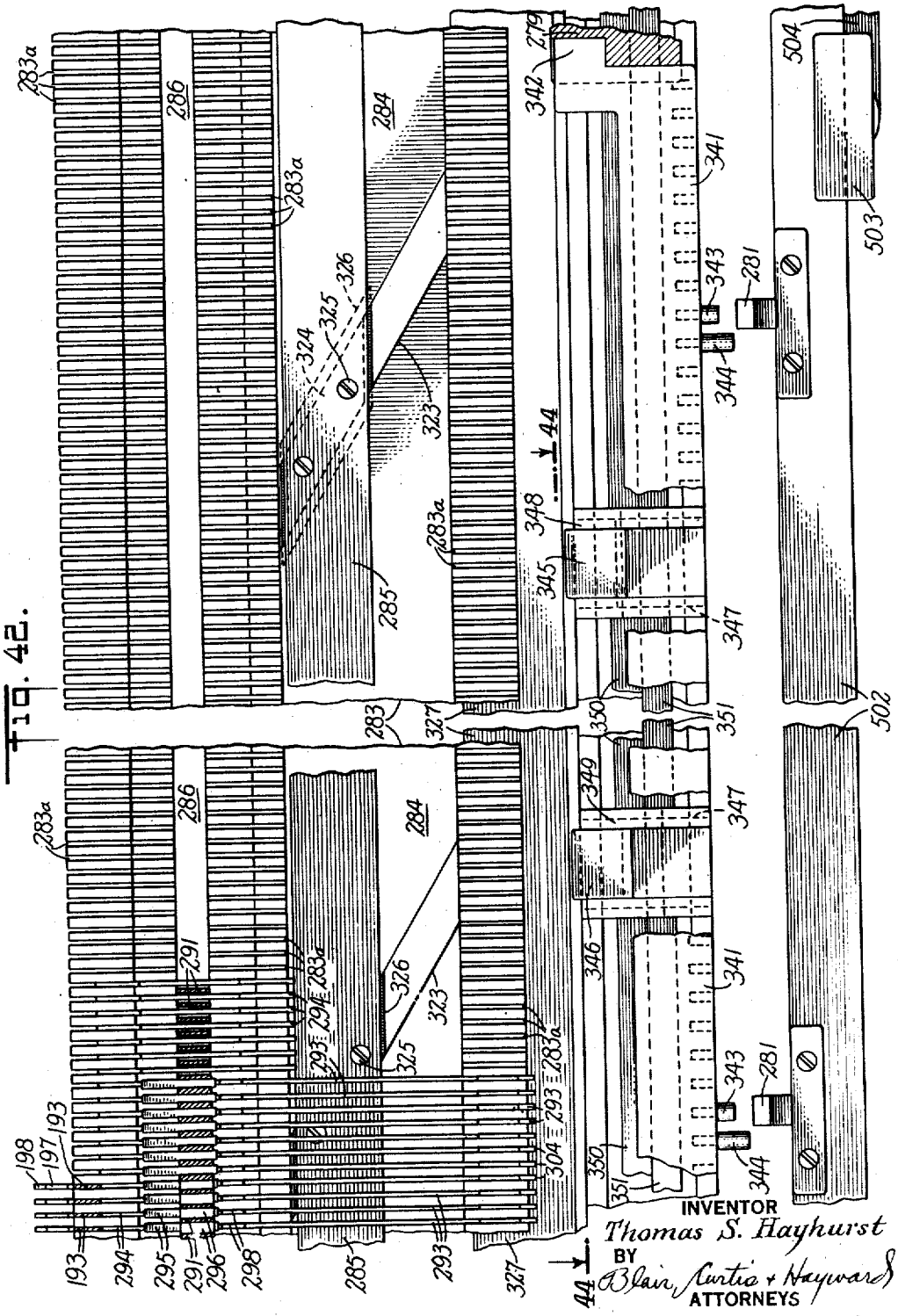


Fig. 42.

March 5, 1946. T. S. HAYHURST 2,395,814

KNITTING MACHINE

Filed April 13, 1944 52 Sheets-Sheet 36

Fig. 43.

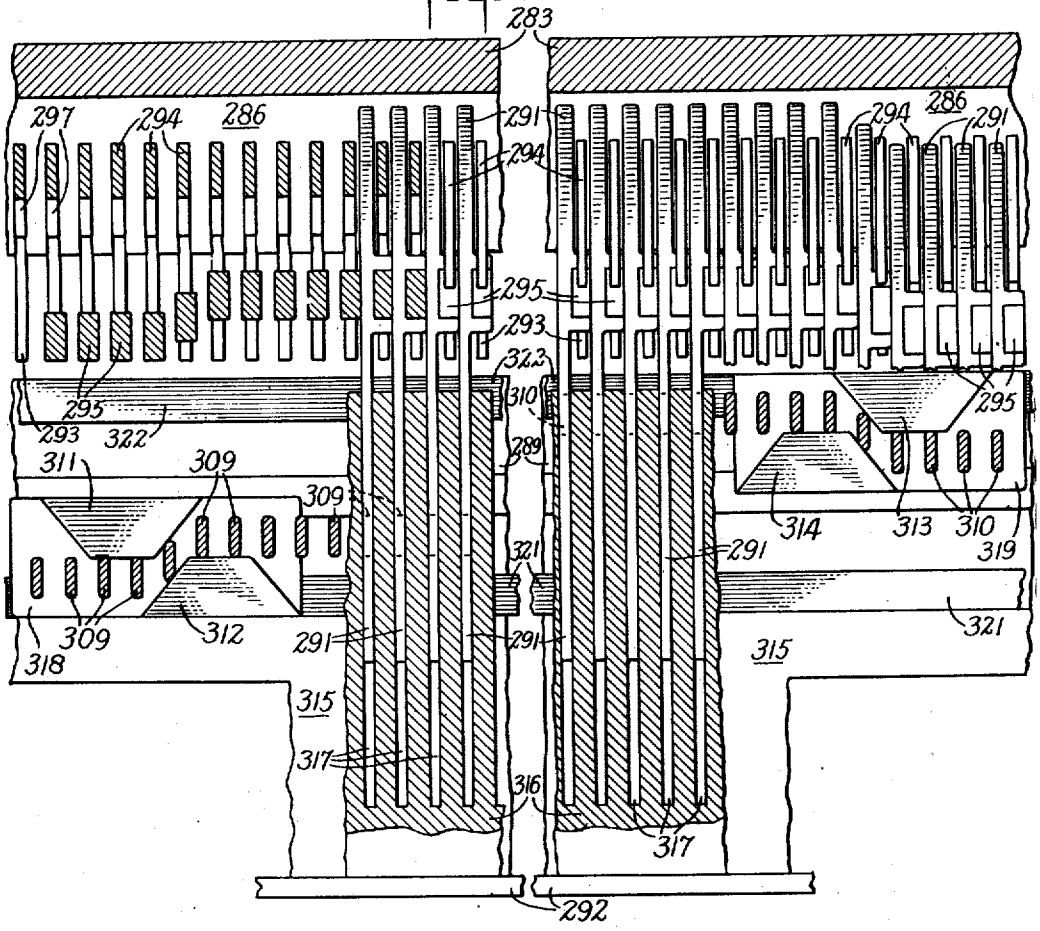
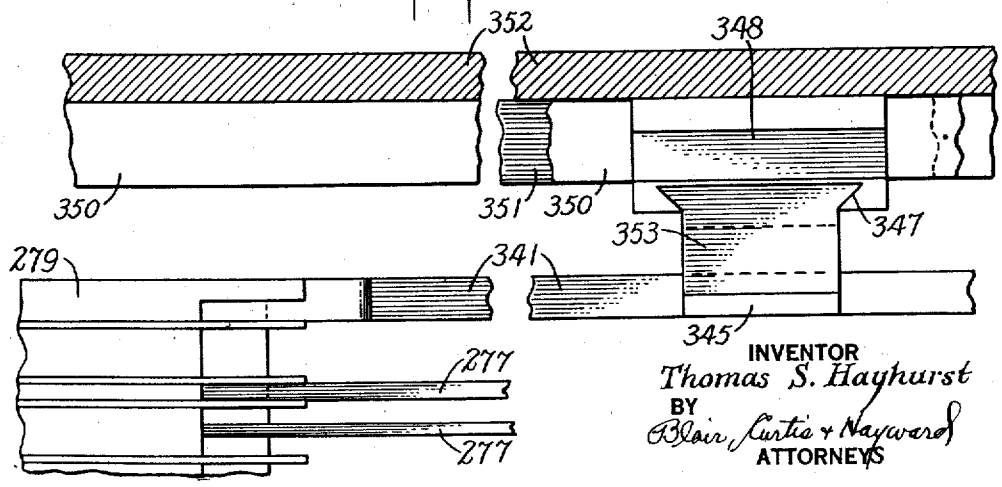


Fig. 44.



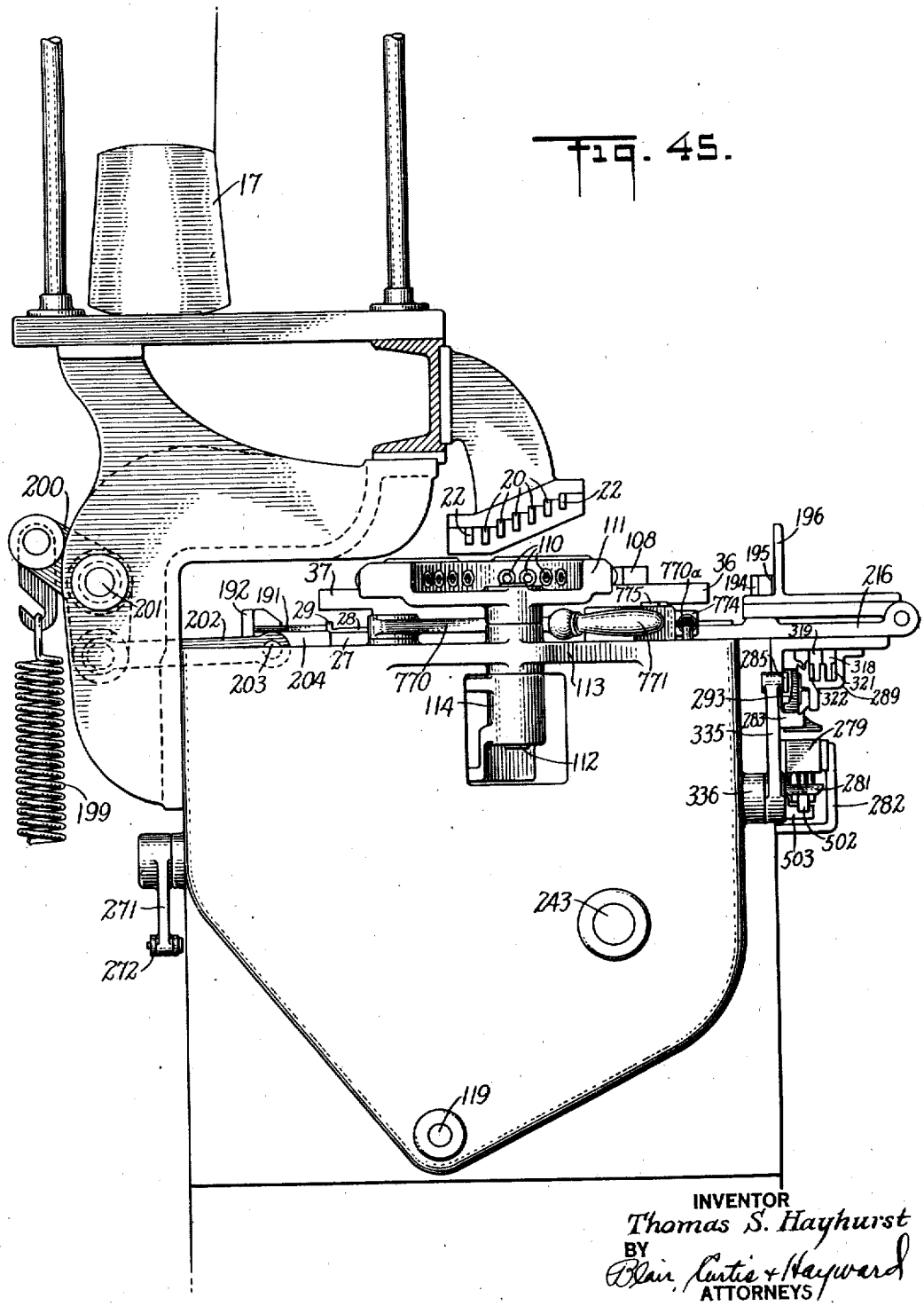
INVENTOR
Thomas S. Hayhurst
BY
Blair, Curtis & Hayward
ATTORNEYS

March 5, 1946. T. S. HAYHURST 2,395,814

KNITTING MACHINE

Filed April 13, 1944 52 Sheets-Sheet 37

Fig. 45.



INVENTOR
Thomas S. Hayhurst
BY
Blair, Curtis & Hayward
ATTORNEYS

March 5, 1946. T. S. HAYHURST 2,395,814

KNITTING MACHINE

Filed April 13, 1944 52 Sheets-Sheet 38

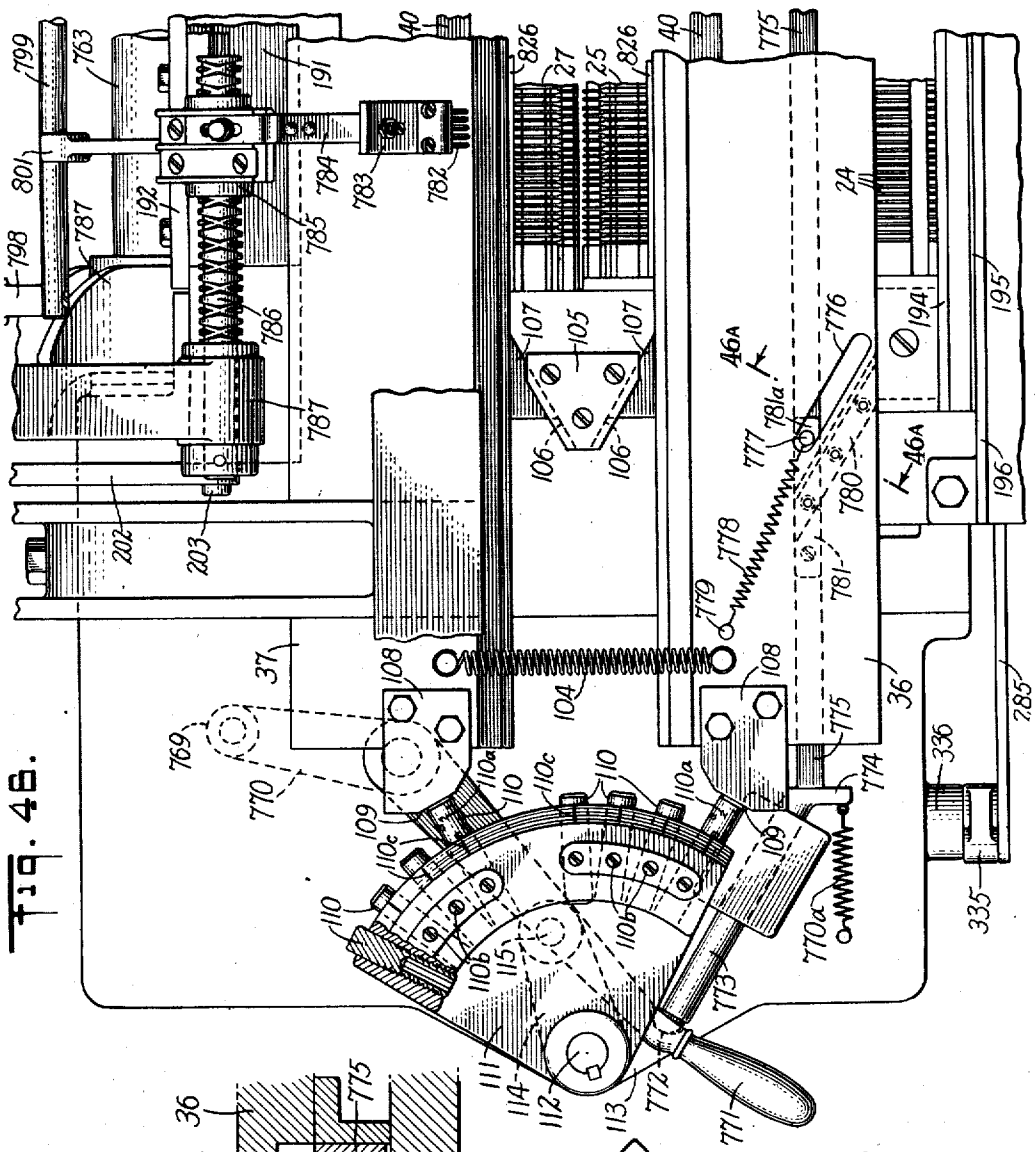


Fig. 46.

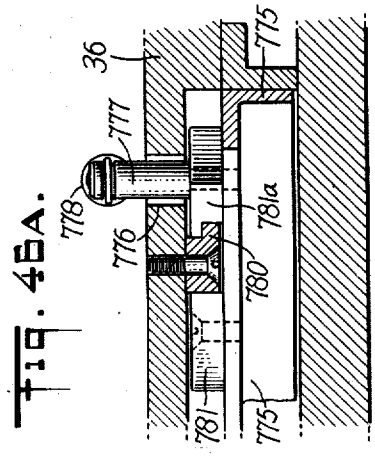


Fig. 46A.

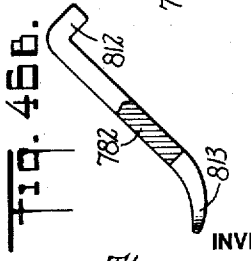


Fig. 46B.

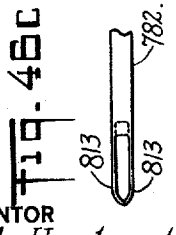


Fig. 46C.

INVENTOR
Thomas S. Hayhurst
BY
Blair, Curtis & Hayward
ATTORNEYS

March 5, 1946. T. S. HAYHURST 2,395,814

KNITTING MACHINE

Filed April 13, 1944 52 Sheets-Sheet 39

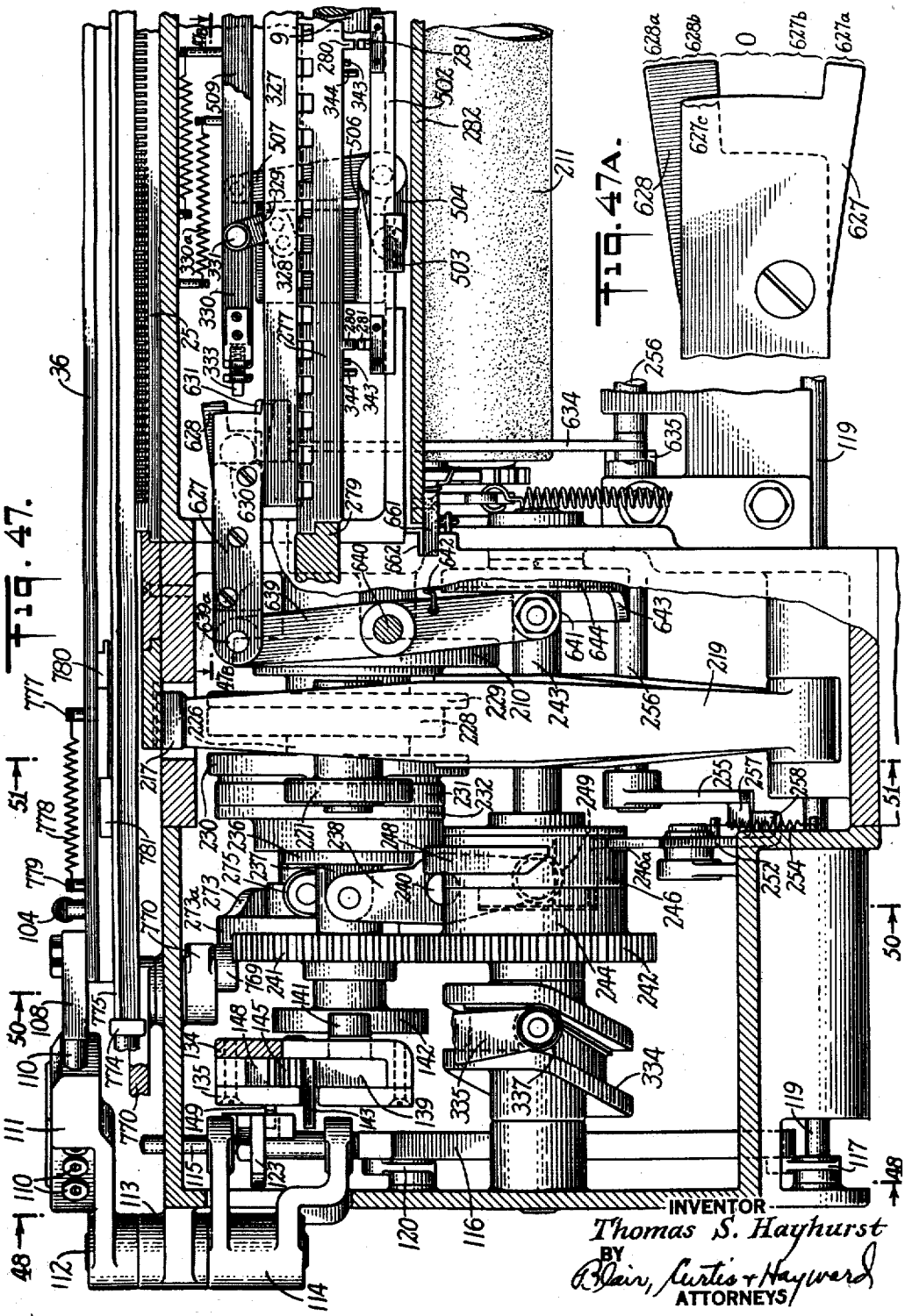


Fig. 47.

Fig. 47A.

INVENTOR
Thomas S. Hayhurst
BY
Blair, Curtis & Hayward
ATTORNEYS

March 5, 1946. T. S. HAYHURST 2,395,814

KNITTING MACHINE

Filed April 13, 1944 52 Sheets-Sheet 40

Fig. 47B.

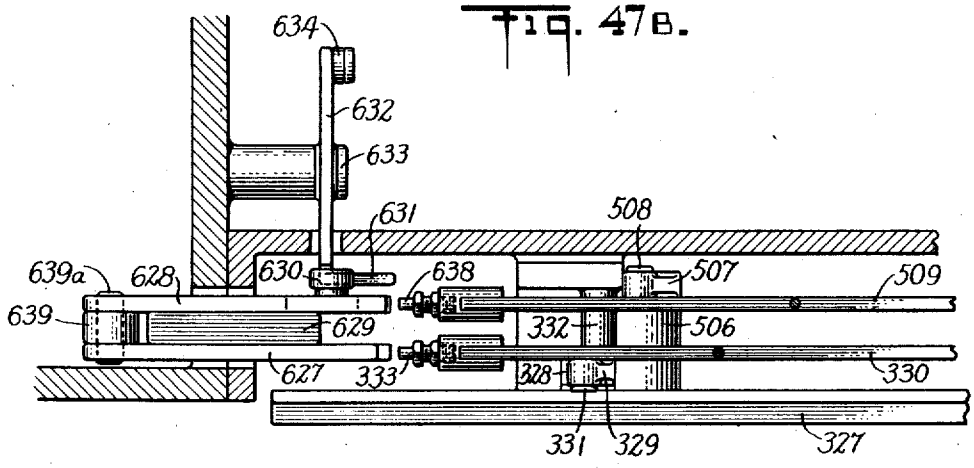
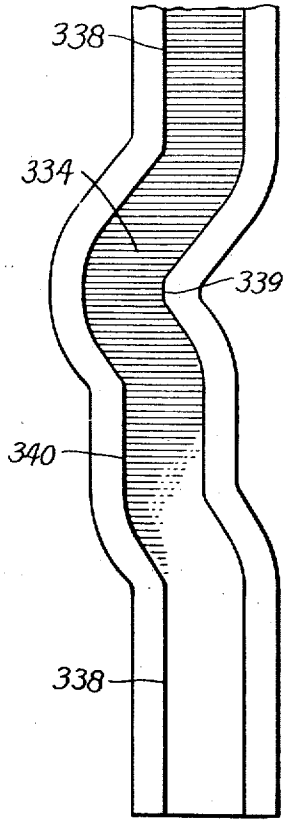


Fig. 47C.



INVENTOR
Thomas S. Hayhurst
BY
Blair, Curtis & Hayward
ATTORNEYS

March 5, 1946. T. S. HAYHURST 2,395,814

KNITTING MACHINE

Filed April 13, 1944 52 Sheets-Sheet 41

Fig. 47D.

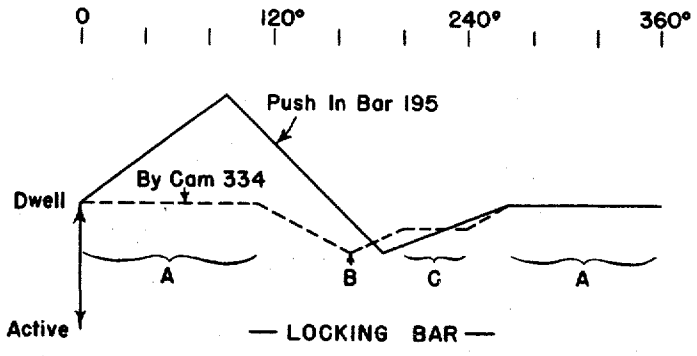
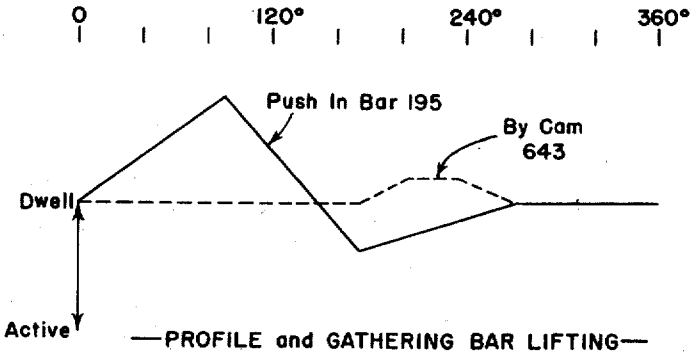


Fig. 47E.



INVENTOR
Thomas S. Hayhurst
BY
Blair, Curtis + Hayward
ATTORNEYS

March 5, 1946. T. S. HAYHURST 2,395,814

KNITTING MACHINE

Filed April 13, 1944 52 Sheets-Sheet 42

Fig. 48.

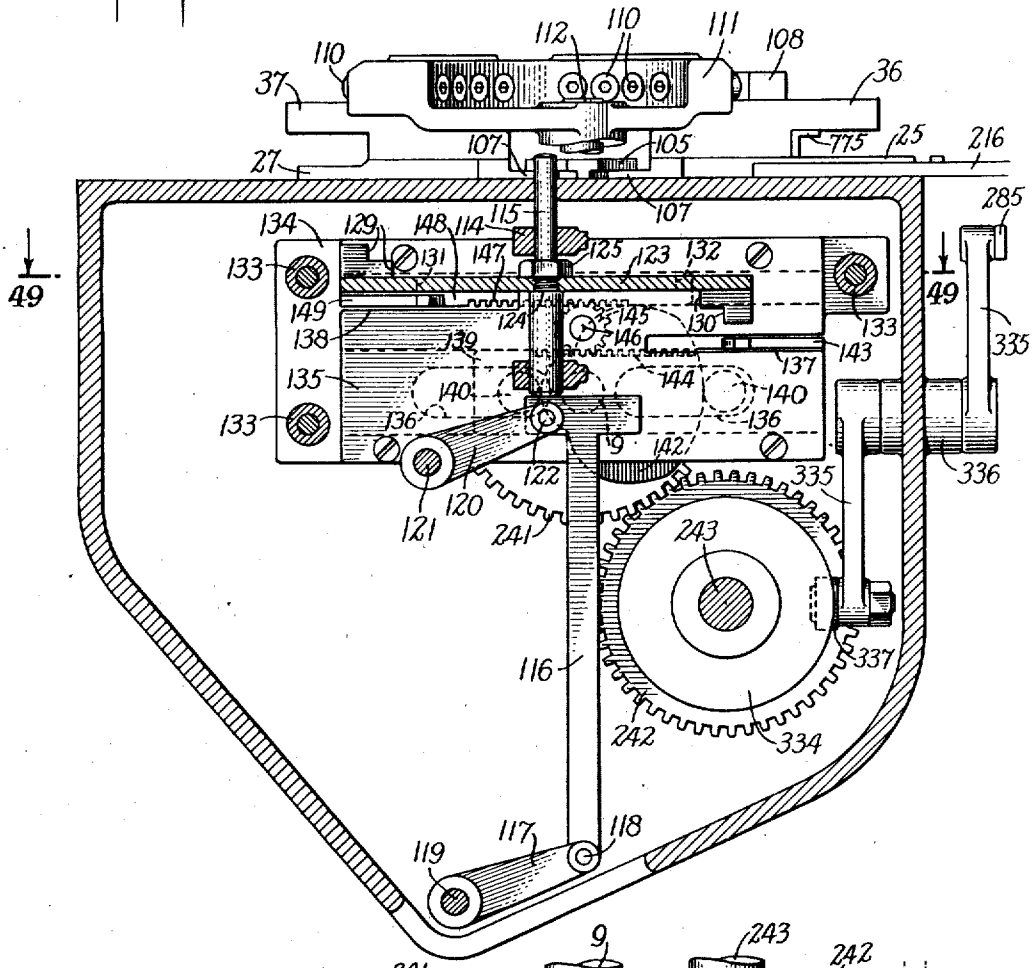
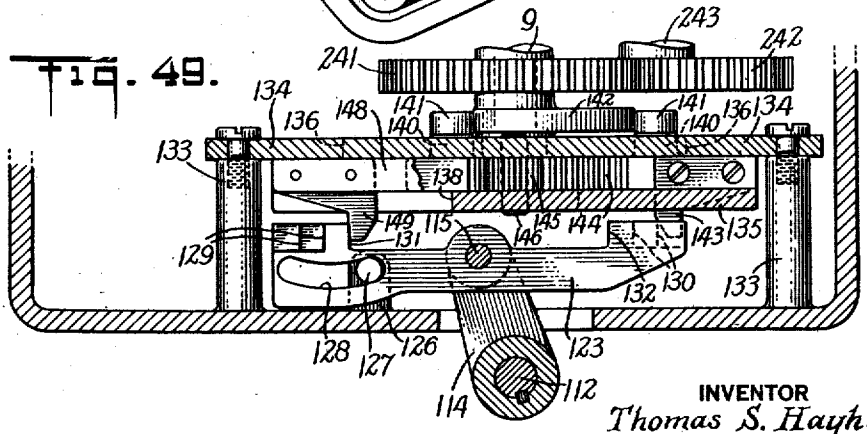


Fig. 49.



INVENTOR
Thomas S. Hayhurst
BY
Blair, Curtis & Hayward
ATTORNEYS

March 5, 1946. T. S. HAYHURST 2,395,814

KNITTING MACHINE

Filed April 13, 1944 52 Sheets-Sheet 43

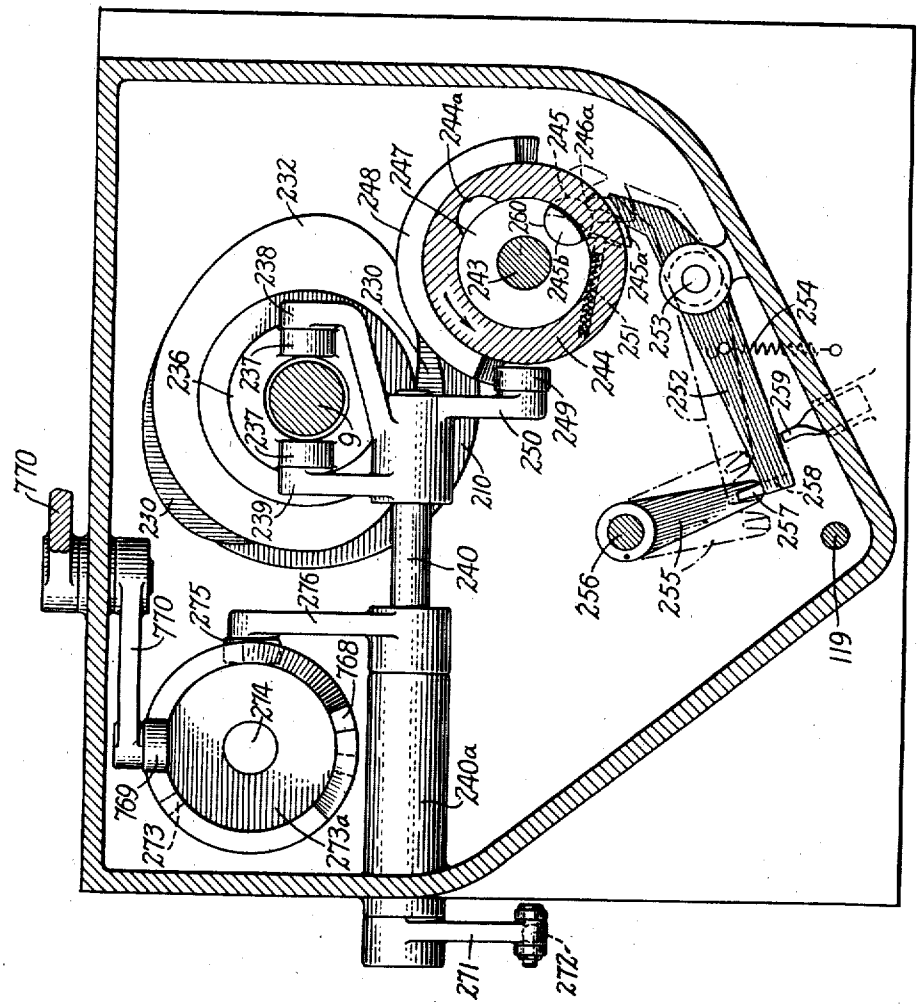


Fig. 50.

INVENTOR
Thomas S. Hayhurst
BY
Blair, Curtis + Hayward
ATTORNEYS

March 5, 1946. T. S. HAYHURST 2,395,814

KNITTING MACHINE

Filed April 13, 1944 52 Sheets-Sheet 44

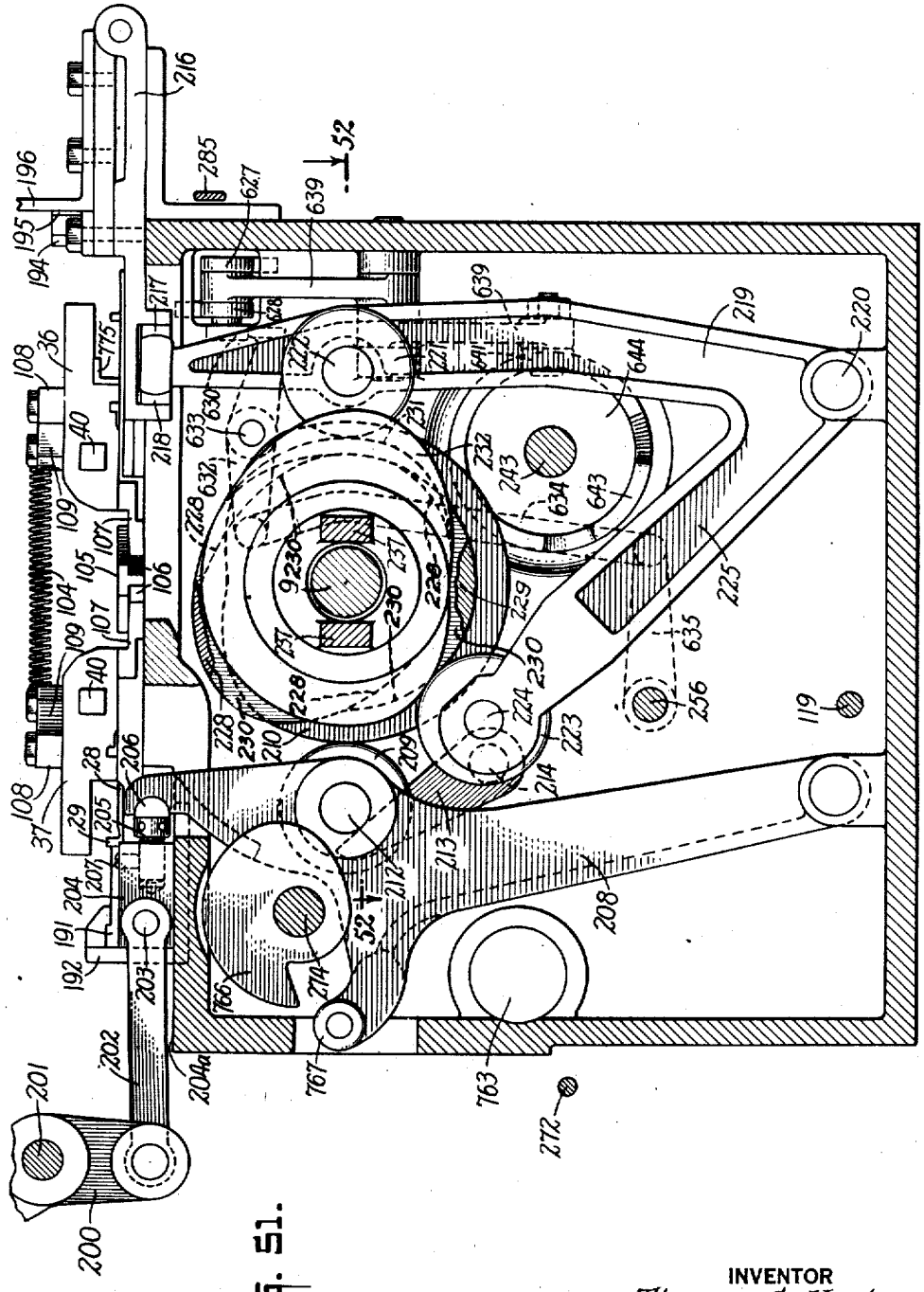


FIG. 51.

INVENTOR
Thomas S. Hayhurst
BY
Blair, Curtis & Hayward
ATTORNEYS

March 5, 1946. T. S. HAYHURST 2,395,814

KNITTING MACHINE

Filed April 13, 1944 52 Sheets-Sheet 45

Fig. 52.

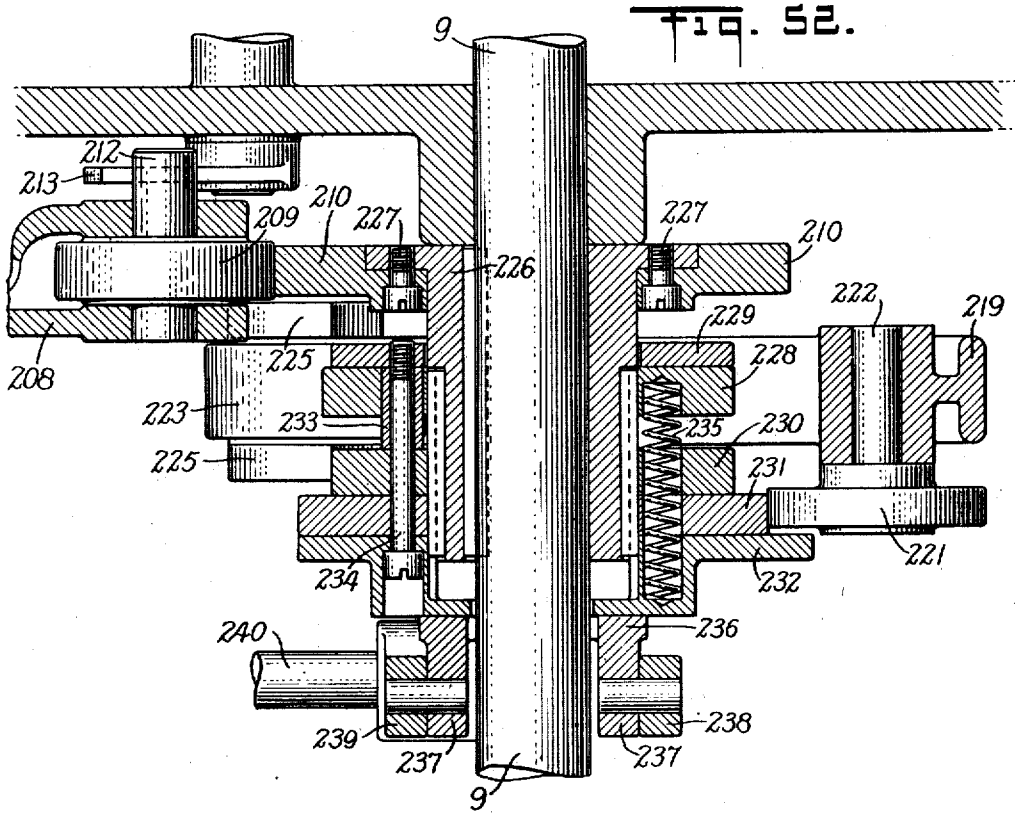
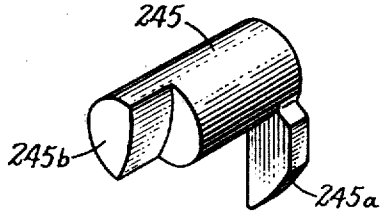


Fig. 53.



INVENTOR
Thomas S. Hayhurst
BY
Blair, Curtis & Hayward
ATTORNEYS

March 5, 1946. T. S. HAYHURST 2,395,814

KNITTING MACHINE

Filed April 13, 1944 52 Sheets-Sheet 46

Fig. 52A.

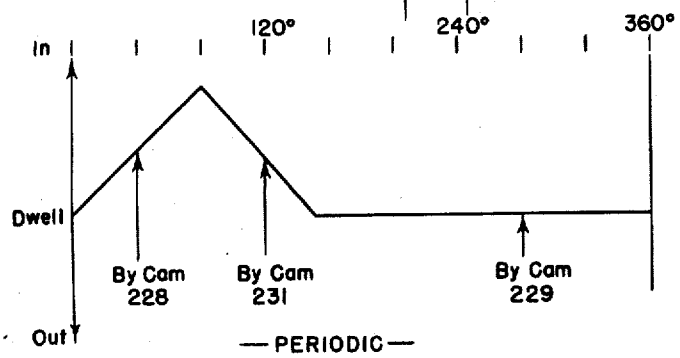


Fig. 52B.

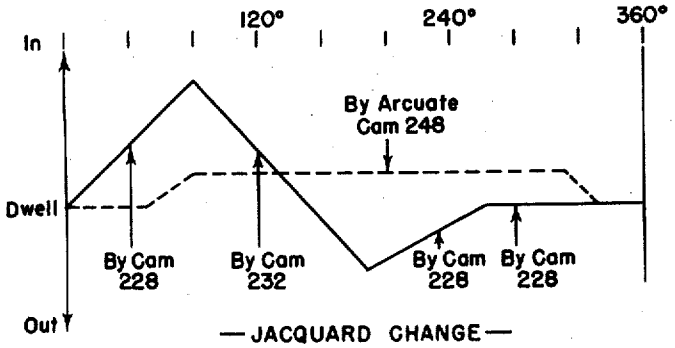
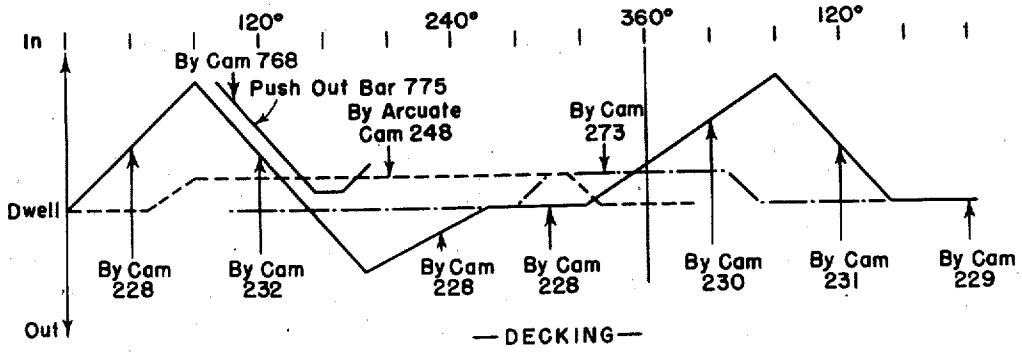


Fig. 52C.

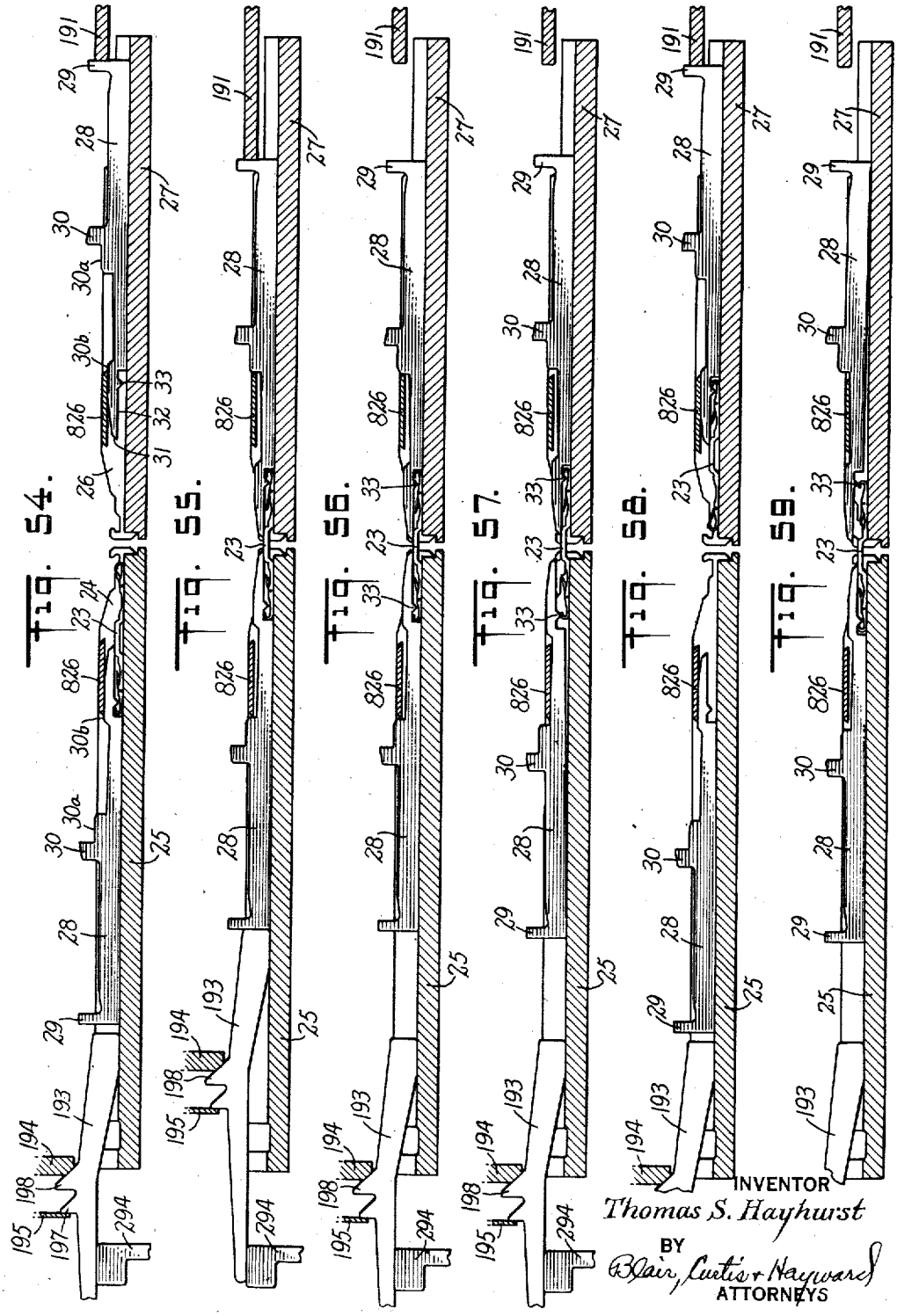


INVENTOR
Thomas S. Hayhurst
BY
Blair, Curtis & Hayward
ATTORNEYS

March 5, 1946. T. S. HAYHURST 2,395,814

KNITTING MACHINE

Filed April 13, 1944 52 Sheets-Sheet 47

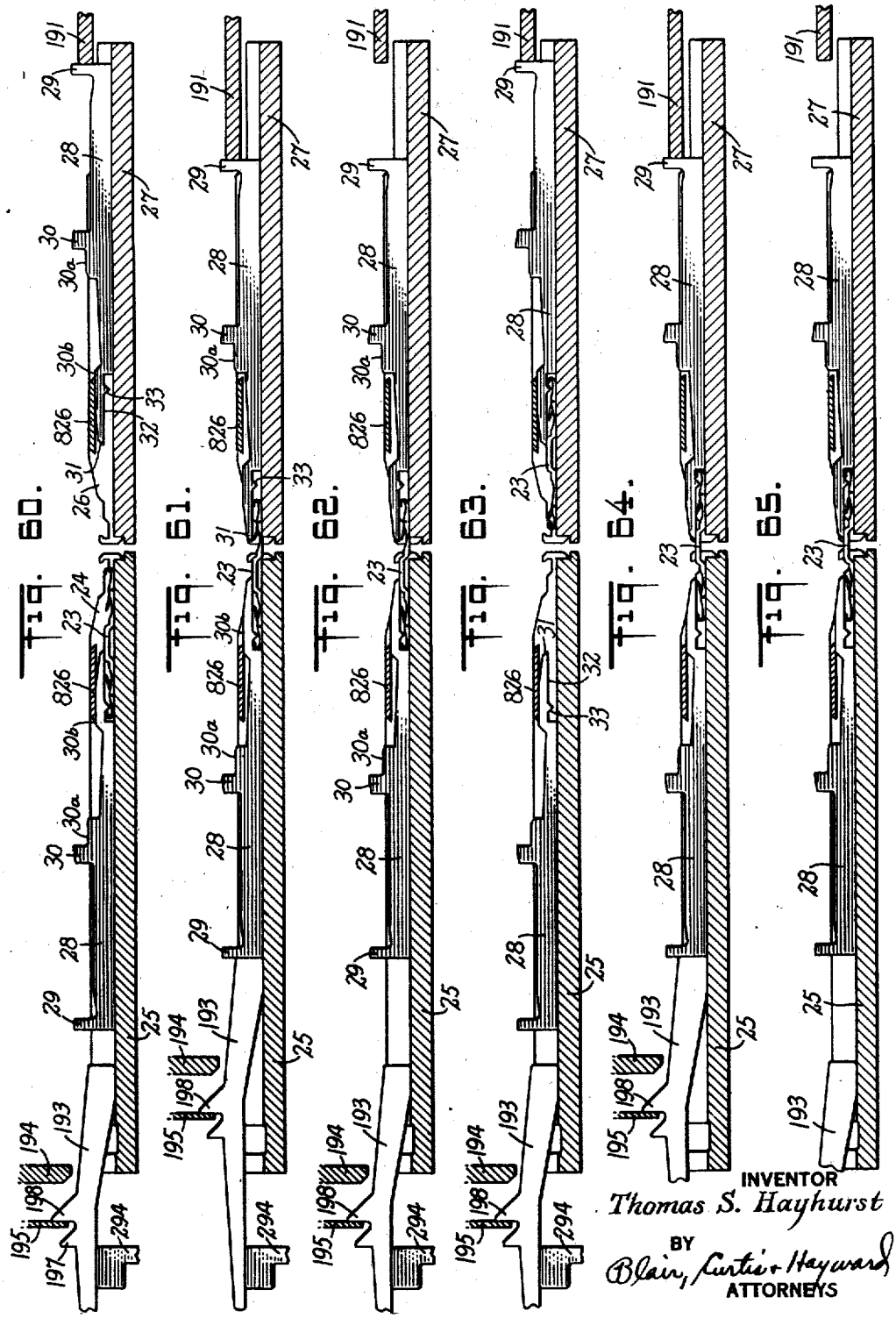


INVENTOR
Thomas S. Hayhurst
BY
Blair, Curtis & Hayward
ATTORNEYS

March 5, 1946. T. S. HAYHURST 2,395,814

KNITTING MACHINE

Filed April 13, 1944 52 Sheets-Sheet 48



INVENTOR
Thomas S. Hayhurst
BY
Blair, Curtis & Hayward
ATTORNEYS

March 5, 1946. T. S. HAYHURST 2,395,814

KNITTING MACHINE

Filed April 13, 1944 52 Sheets-Sheet 49

Fig. 66.

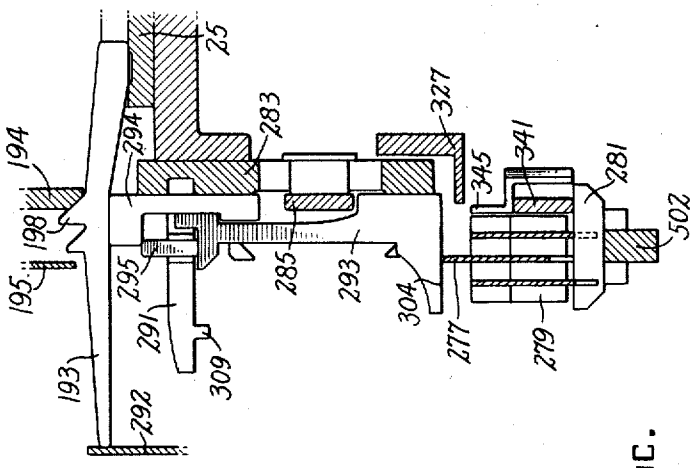


Fig. 66c.

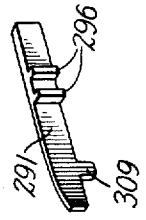


Fig. 67.

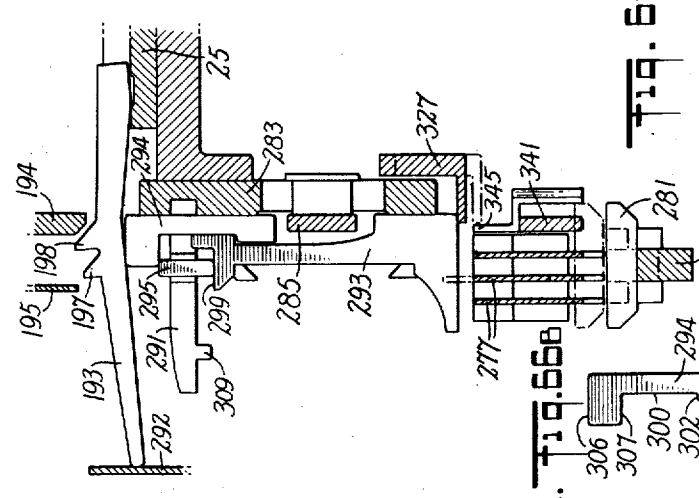


Fig. 66b.

Fig. 66a.

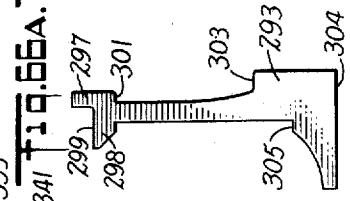
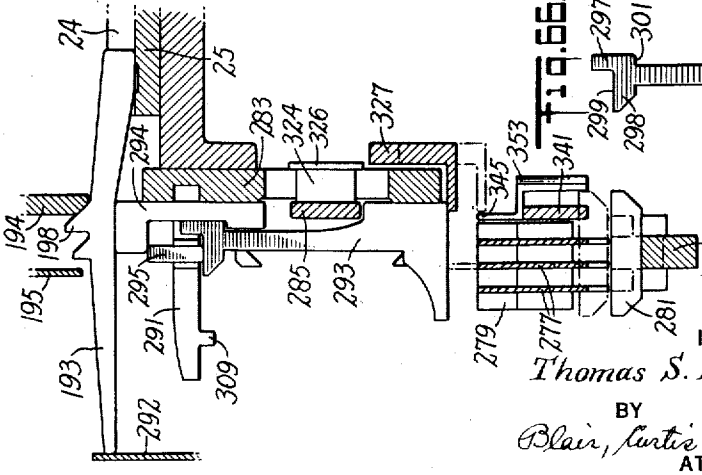


Fig. 66.



INVENTOR
Thomas S. Hayhurst
BY
Blair, Curtis & Hayward
ATTORNEYS

March 5, 1946. T. S. HAYHURST 2,395,814

KNITTING MACHINE

Filed April 13, 1944 52 Sheets-Sheet 50

Fig. 71.

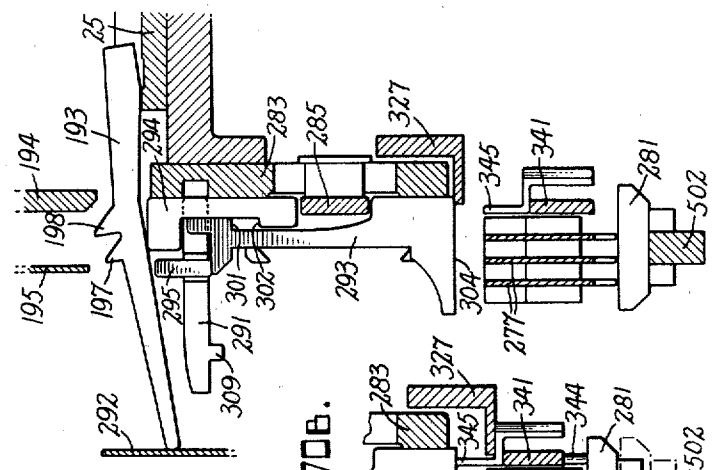


Fig. 70B.

Fig. 70.

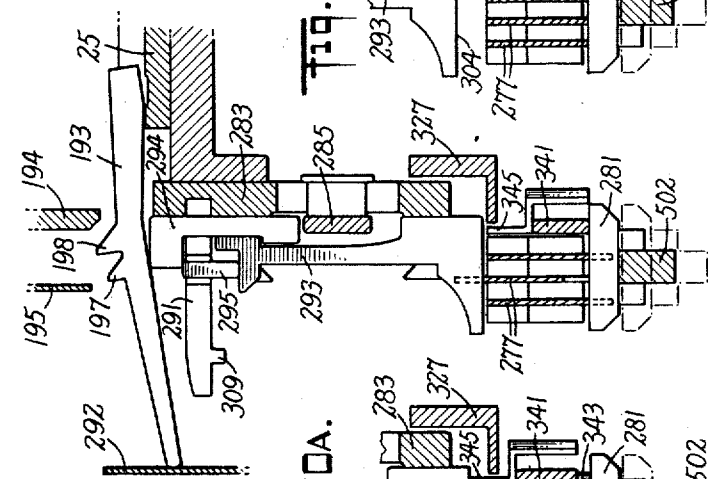


Fig. 70A.

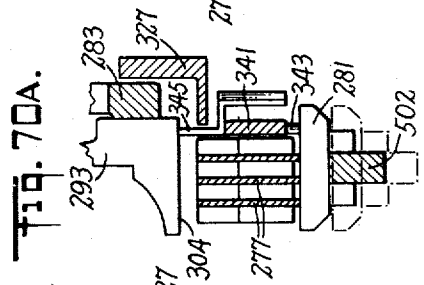
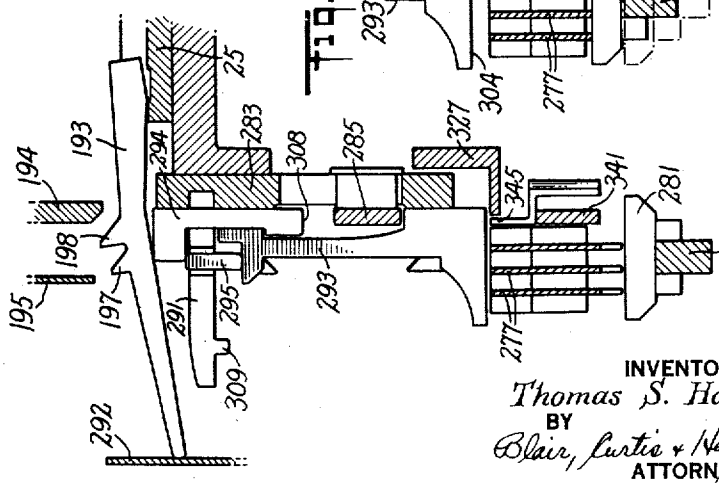


Fig. 69.



INVENTOR
Thomas S. Hayhurst
BY
Blair, Curtis & Hayward
ATTORNEYS

March 5, 1946. T. S. HAYHURST 2,395,814

KNITTING MACHINE

Filed April 13, 1944 52 Sheets-Sheet 51

Fig. 72.

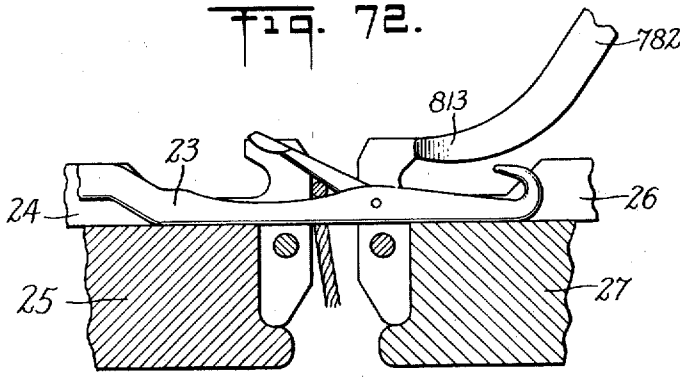


Fig. 73.

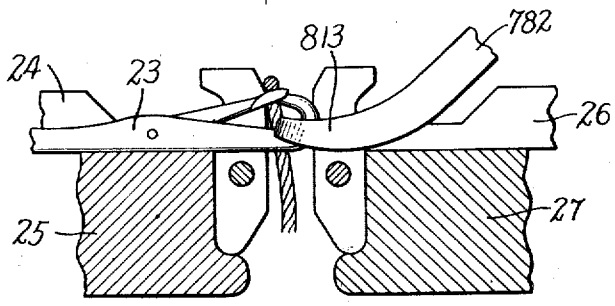
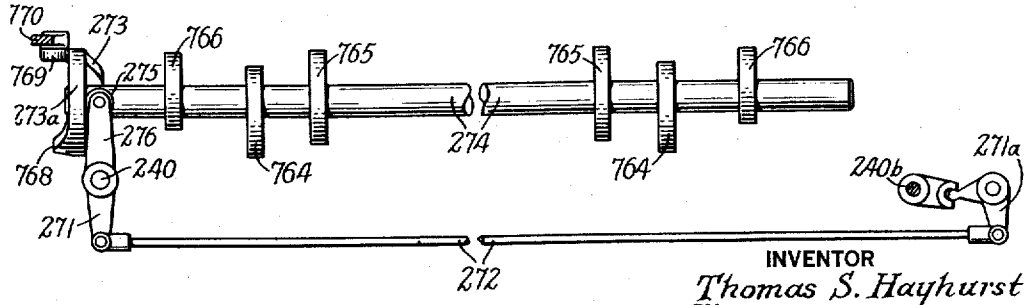


Fig. 74.



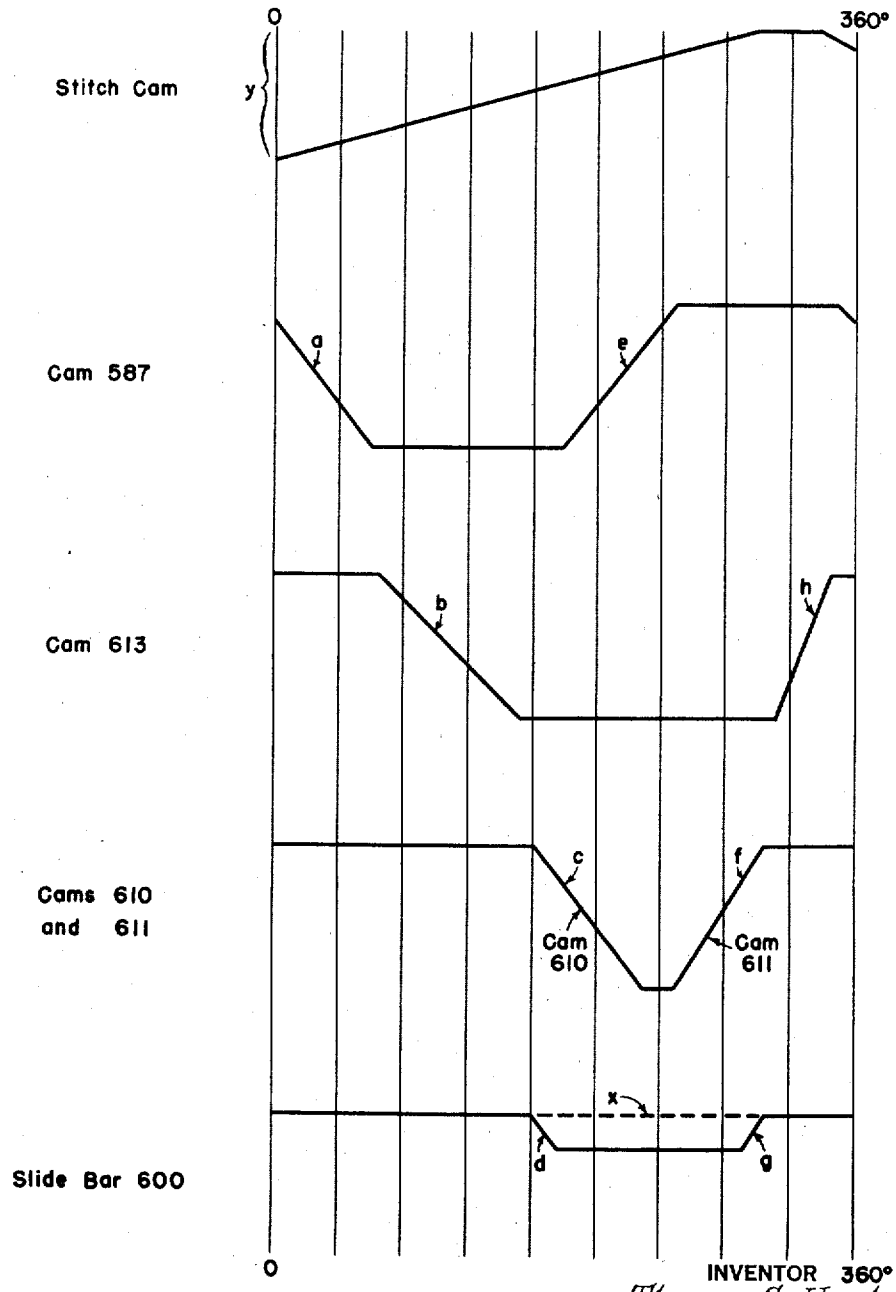
INVENTOR
Thomas S. Hayhurst
BY
Blair, Curtis & Hayward
ATTORNEYS

March 5, 1946. T. S. HAYHURST 2,395,814

KNITTING MACHINE

Filed April 13, 1944 52 Sheets-Sheet 52

Fig. 75.



INVENTOR
Thomas S. Hayhurst
BY
Blair, Curtis & Hayward
ATTORNEYS

Patented Mar. 5, 1946

2,395,814

UNITED STATES PATENT OFFICE

2,395,814

KNITTING MACHINE

Thomas S. Hayhurst, Belle Harbor, N. Y., assignor to Max Nydegger, Summit, N. J.

Application April 13, 1944, Serial No. 530,761

41 Claims. (Cl. 66—63)

The present invention relates to an improvement in knitting machines. An object thereof in general has been to provide knitting mechanism of the links or knit-purl type wherein a plurality of sets of knitting or stitch forming devices operate over a bed on different groups of needles therein with a relatively short stroke in each course to produce simultaneously a plurality of pieces of fashioned or other knit goods products. The number of such sets of knitting devices and corresponding groups of needles for any machine of given over all needle bed length may be varied within practical limits to simultaneously knit different numbers of pieces with different settings or groupings of said needles. Such a machine presents advantages over and is distinguished broadly in operation from known links power machines wherein a set of stitch forming devices operates in each course with a long stroke across the whole needle bed to actuate different groups of needles in succession. Thus, for a given working period, one machine according to my invention, particularly when operating automatically, can be made to produce a materially greater volume of knit goods than is possible on power machines of presently known types and of comparable needle capacity.

Rapid production by use of a machine embodying my invention is promoted where the length of stroke of the knitting or stitch forming devices, as stitch cams, is readily adjustable to the minimum required for producing a piece or product of a given width or size. In this connection, the operating rate, or number of strokes or courses per minute, may be varied approximately in inverse proportion to the length of stroke.

A further object of the invention has been to provide needle conditioning or positioning means involving relatively few parts and comparatively simple construction which permits effective operation at increased velocity of the moving parts as compared with known machines of similar needle capacity.

A further object has been to provide a machine which will produce a fabric having uniform texture in all parts of like pattern and with regular firm edges free from loose or imperfect stitch loops such as commonly occur where the thread "feeds back" into the edges and the previously formed loop is pulled again beyond its intended extent. This advantage over known machines results in part from the provision of stitch forming devices wherein the pushing up or moving of the needles from idle to operative advanced position is accomplished by one set of devices; and the stitch or loop producing motions by a separately operated set of cam type stitch forming devices.

It is contemplated that a machine according to my invention will successfully produce pieces from the more delicate or "tender" yarns without disfiguring the product or impairing the wearing quality of the fabric.

A further object has been to provide a knitting machine wherein an overhead yarn feed (i. e. above the stitch cams) cooperates with said cams to maintain substantially uniform thread tension at all stages of operation. Since no unusual or variable strain is imposed on the thread, more delicate yarns may be successfully knitted than is possible under the contrary conditions. Furthermore, with this type of feed and cooperating parts, the range of stitch lengths producible on a machine of a given gauge (i. e. number of needles per inch of needle bed) is materially increased, as is the range of weights of the products knitted thereon.

A further object has been to provide a machine which permits a wide range of structural and pattern variation in the product by simpler and more dependable mechanisms than those employed in known machines of camparable needle equipment. Accordingly, means are provided whereby all the needles are normally maintained in readiness to be employed as required for any given pattern without special setting; and all needles or any needle or group of needles may operate (form stitches) in the front bed, or in the rear bed, or may shuttle to and from said beds, or may be held idle as the pattern demands.

A further object has been to provide mechanism whereby the number of needles in operation in each group in a multiple machine may be continuously indicated and means cooperating therewith for varying the number of needles to be initially activated for any given piece of work. Thus, in operation, the operator is able to change the setting (i. e. the number of needles initially employed) to produce narrower or smaller pieces (on fewer needles), for example, by a relatively simple adjustment requiring only a few minutes, as compared with the complicated manipulations, taking up to forty-five minutes, commonly required to make a resetting for a similar purpose on known machines. Said adjustment is accomplished without interfering with or modifying the pattern control devices.

A further object of the invention has been to provide a machine wherein the pattern control (jacquard) mechanism is based in part upon the

use of pattern (profile) bars having variously contoured edge portions which cooperate effectively with a system of needle conditioning jacks to determine various operative positions of any predetermined needle or needles. One advantage of this feature is that said bars may be made in any required number very economically from standard blanks; and will operate with accuracy on machines of finer gauge than is possible with commonly known jacquard devices. To provide increased range or flexibility in pattern variations said pattern bars are interchangeable; and means are provided whereby they may be quickly and easily inserted in and removed from the machine. Furthermore, sets each consisting of a greater or less number of differently profiled bars, when arranged in operative position, provide means for producing from said sets pieces embodying more or fewer pattern variations.

A further object has been to provide a machine capable of manufacturing products including widened and/or narrowed fabrics without limiting the scope of pattern or texture variation.

A further object has been to provide a knitting machine which operates to produce a piece or garment having selvedge edges all around so that such a piece may be sewn or joined to others without producing bulky or unsightly seams and thus providing a garment or the like of high quality and pleasing appearance.

A further object has been to provide a knitting machine which will produce pieces or garments wherein the top and/or bottom edges (ends) as well as the side edges, are shaped in the knitting. This provides the desirable selvedge edges above referred to and avoids the waste incident to cutting the knitted pieces which are afterward joined to form a garment.

A further object has been to provide a knitting machine whereby a piece or garment is produced with transverse gores or gussets knitted in to provide added fullness at any required part thereof, for example at the nape and shoulder portion of a sweater.

A further object of the invention has been to provide relatively simple and dependable mechanism whereby all of the necessary or any desired functions of the knitting machine may be controlled to determine the character and sequence of operations involved in producing a given type of fabric or garment. In this connection, a pattern band is provided with perforations which can be made therein quickly and accurately. A pattern chain cooperates with said band and other devices to repeat the operative effect of any desired set of pattern perforations in the band. The band may therefore be of minimum length and thus save time in its preparation.

A further object of my invention has been to provide decking devices which can be supported in operative position above the rear needle bed by means extending from the rear thereof and which are connected with the widening and narrowing control devices so that the decker points are continuously in position to operate on the proper needles at all stages of widening and narrowing.

A further object has been to provide an improved decker point so constructed and arranged that it may be brought into its loop receiving and loop delivering positions accurately and effectively and with a minimum possibility of accidental interference with proper functioning of the needles.

Further objects of the invention include providing in multiple or single unit knitting machines improved instrumentalities or combinations thereof for (*a*) forming the stitch loops; (*b*) varying the stitch length, claimed in my co-pending application Serial No. 530,762, filed herewith; (*c*) effecting thread changes, claimed in my co-pending application Serial No. 530,763, filed herewith; (*d*) conditioning or positioning of needle jacks in relation to stitch cams, claimed in my co-pending application Serial No. 530,764, filed herewith; (*e*) selection of push jacks to control conditioning of needles, claimed in my co-pending application Serial No. 530,765, filed herewith; (*f*) conditioning predetermined control jacks for fashioning, claimed in my co-pending application Serial No. 530,766, filed herewith; (*g*) selectively positioning control jack actuating devices for effecting variation in fabric texture and/or appearance, claimed in my co-pending application Serial No. 530,767, filed herewith; (*h*) conditioning selected needle jacks for shaping in forming gussets, or the like, such as producing a shoulder slant in sweater bodies, claimed in my co-pending application Serial No. 530,768, filed herewith; (*i*) decking, or transferring stitch loops from one or more needles to another or other needles, as in fashioning, claimed in my co-pending application Serial No. 530,769, filed herewith; and (*j*) automatically effecting pattern changes by controlling the operation and sequence of operations of various knitting machine mechanisms and combinations thereof, claimed in my co-pending application Serial No. 530,770, filed herewith.

Other objects and advantages of my invention in its various aspects will in part appear and in part be more specifically pointed out in connection with the following description of one illustrative embodiment thereof and the appended drawings, wherein:

Figure 1 is a front elevation;

Figure 1A, an end elevation of the right end of the machine as shown in Figure 1;

Figure 1B, a fragmentary plan view illustrating diagrammatically the stitch cam carrier rods and a plurality of stitch cams spaced apart thereon;

Figure 2, a plan view on the line 2—2 of Figures 1A and 5, showing portions of the thread and brush carrier actuating mechanisms positioned rearwardly and at the right end of the machine as shown in Figure 1;

Figure 3, a horizontal section on the line 3—3 of Figures 1A and 5;

Figure 4, a plan view, enlarged, of portions of Figure 3 showing parts of the main transmission and of the racking, decking and gusset or shoulder slant forming devices;

Figure 4A, a fragmentary view in vertical section on the line 4A—4A of Figure 4 and showing portions of the decker and racking control devices;

Figure 4B, a fragmentary view partly in vertical section on the line 4B—4B of Figure 4 and showing portions of the decker and racking control devices;

Figure 4C, a fragmentary view, partly in vertical section on the line 4C—4C of Figure 4 and showing portions of the decker and racking control devices;

Figure 4D, a fragmentary view, partly in vertical section on line 4D—4D of Figure 4, showing a portion of the devices for effecting rapid return from gusset forming or shoulder slant narrowing;

Figure 4E, a fragmentary view in vertical section on the line 4E—4E of Figures 4B, 4D and 7;

Figure 5, a longitudinal vertical section on the line 5—5 of Figure 3;

Figure 6, an enlarged view in front elevation and with parts broken away of a portion of the machine at the right-hand end of Figure 1;

Figure 7, an enlarged transverse vertical section on the line 7—7 of Figure 3;

Figure 7A, a fragmentary view in vertical section on the line 7A—7A of Figure 4 and showing a portion of the gusset or shoulder slant control mechanism;

Figure 7B, a fragmentary plan view, partly in horizontal section on the line 7B—7B of Figure 7;

Figure 8, an enlarged transverse vertical section on the line 8—8 of Figure 3;

Figure 8A, a fragmentary view on the line 8A—8A of Figure 8;

Figure 8B, a fragmentary view showing the relative positions of certain parts while effecting narrowing, as in gusset forming;

Figure 8C, a fragmentary view showing the relative positions of said parts during the first step of rapid return or widening in gusset forming;

Figure 9, an enlarged fragmentary view in longitudinal vertical section on the line 9—9 of Figure 8;

Figure 10, an enlarged fragmentary view in longitudinal vertical section on the line 10—10 of Figure 8;

Figure 11, an enlarged fragmentary view in plan of a portion of automatic operation and pattern control devices indicated generally at the right end of Figure 3;

Figure 11A, a fragmentary view partly in section on the line 11A—11A of Figure 11 showing a portion of the thread change control mechanism including the control links, in neutral position;

Figure 11B, a top plan view of the devices shown in Figure 11A;

Figure 11C, a fragmentary view on the line 11C—11C of Figure 11, showing a portion, including the control links, of the jacquard operating shaft control mechanism in neutral position;

Figure 11D, a view similar to 11C but with one control link in a jacquard change effecting position.

Figure 11E, a fragmentary view on the line 11E—11E of Figure 11 showing the control link associated with the automatic rack control mechanism;

Figure 11F, a fragmentary view on the line 11F—11F of Figure 11 showing the control links associated with the automatic stitch length control mechanism;

Figure 11G, a fragmentary view on the line 11G—11G of Figure 11 showing the control link which cooperates with another similar link, as seen in Figure 13, in the automatic control of selector bar positioning devices;

Figure 11H, a fragmentary view on the line 11H—11H of Figure 11, showing the control link associated with the automatic widening and narrowing devices employed in gusset forming operation or the like;

Figure 11I, a fragmentary view on the line 11I—11I of Figure 11 showing the control link associated with the automatic decker control mechanism;

Figure 11J, a fragmentary view on the line 11J—11J of Figure 11 showing the control link associated with the automatic widening and narrowing control devices employed in fashioning;

Figure 12, an enlarged fragmentary view in elevation of a portion of a typical perforated operation and pattern control band;

Figure 13, a transverse vertical section on the line 13—13 of Figure 11;

Figure 13A, a fragmentary plan view partly in horizontal section on the line 13A—13A of Figure 13, showing pattern band advancing portions of the control devices;

Figure 13B, a fragmentary view partly in vertical section on the line 13B—13B of Figure 13, showing pattern band advancing portions of the control devices;

Figure 13C, a view in perspective of a feeler for controlling advance of the pattern control chain;

Figure 13D, a view in perspective of a modified form of feeler for controlling various pattern changes;

Figure 14, a plain link of pattern control chain;

Figure 15, a low left lug link of pattern control chain;

Figure 16, a low right lug link of pattern control chain;

Figure 17, a high left lug link of pattern control chain;

Figure 18, a high right lug link of pattern control chain;

Figure 19, a transverse vertical section on the line 19—19 of Figure 11;

Figure 20, a transverse vertical section on the line 20—20 of Figure 11;

Figure 21, an enlarged fragmentary view in plan of a portion of Figure 3 and with parts broken away to show portions of automatic widening and narrowing control devices employed in fashioning;

Figure 21A, a fragmentary view partly in vertical section on the line 21A—21A of Figure 21;

Figure 21B, a fragmentary view partly in vertical section on the line 21B—21B of Figure 21;

Figure 22, a transverse vertical section on the line 22—22 of Figure 21, showing parts of widening and narrowing control mechanisms for fashioning;

Figure 22A, a transverse vertical section on the line 22A—22A of Figure 21 and in part diagrammatic, showing the parts in normal relative positions for usual knitting operation;

Figure 23, a transverse vertical section on the line 23—23 of Figure 21 showing portions which control movement more particularly of the jack positioning or conditioning devices in widening and narrowing for fashioning;

Figure 24, a transverse vertical section on the line 24—24 of Figure 21;

Figure 25, a transverse vertical section on the line 25—25 of Figure 21 showing portions which control movement more particularly of decking, rack skip, and thread change devices in widening and narrowing for fashioning;

Figure 26, a transverse vertical section on the line 26—26 of Figure 3 showing more particularly parts employed in thread changing, thread and brush carrier actuating, and stitch cam actuating;

Figure 27, a vertical sectional detail on the line 27—27 of Figure 26;

Figure 28, a fragmentary plan view with parts in horizontal section on the line 28—28 of Figure 26, showing portions of the thread change and lead change devices in relation to the stitch cam drive and the thread carrier and brush actuating devices in a course from left to right:

Figure 29, a fragmentary view in elevation from the line 29—29 of Figure 26 of portions of the thread carrier drive, thread carrier selector, and associated devices in position with a thread carrier rod operatively engaged and moving toward change (dotted line) position at the left;

Figure 30, a fragmentary view in elevation on the line 29—29 of Figure 26 showing the relative positions of certain parts at the thread changing phase;

Figure 31, a detail view in horizontal section on the line 31—31 of Figure 30;

Figure 32, a horizontal section on the line 32—32 of Figure 26 showing portions of the stitch cam actuating mechanism, and reversing and safety devices associated therewith;

Figure 32A, a graph of typical stitch cam (full line) thread carrier (dotted line), and brush carrier (broken line) movements in a left to right and the next right to left run thereof;

Figure 33, an enlarged fragmentary horizontal section on the line 33—33 of Figure 6 showing a portion of the profile bar and lifter plate (jacquard) selecting or conditioning mechanism;

Figure 34, a transverse vertical section on the line 34—34 of Figure 33;

Figure 35, a transverse vertical section on the line 35—35 of Figure 33;

Figure 36, a transverse vertical section, enlarged, on the line 36—36 of Figure 3;

Figure 37, an enlarged fragmentary plan view, partly in section on the line 37—37 of Figure 36, of a portion of the needle beds with knitting cams, needle jacks, and needle and jack actuating devices;

Figure 37A, an enlarged fragmentary section on the line 37A—37A of Figure 37;

Figure 37B, a diagrammatic plan view showing different relations in opposite courses of thread carrier and brush carriers to the stitch cams;

Figure 37C, a fragmentary view partly in vertical section illustrating the relative positions of the push-in bar and three differently conditioned push jacks, when the push-in bar is at neutral position, said push jacks being conditioned for links-links, straight, and for idling respectively;

Figure 38, an enlarged fragmentary transverse vertical section on the line 38—38 of Figure 37;

Figure 39, an enlarged fragmentary longitudinal vertical section on the line 39—39 of Figure 38;

Figure 40, a view in elevation of a typical profile or jacquard bar forming part of the needle jack conditioning mechanism;

Figure 41, a portion of Figure 36 further enlarged to more clearly show parts of needle jack conditioning devices;

Figure 42, a view partly in longitudinal vertical section on the line 42—42 of Figure 41 and with portions broken away and with some parts removed;

Figure 43, a horizontal section on enlarged scale on the line 43—43 of Figure 41;

Figure 44, a horizontal section on enlarged scale on the line 44—44 of Figure 42;

Figure 45, an enlarged end elevation of part of the left end of the machine shown in Figure 1;

Figure 46, an enlarged plan view of parts of the left end portion of the machine shown in Figure 1 with some parts removed and some broken away;

Figure 46A, a fragmentary view in vertical section on the line 46A—46A of Figure 46;

Figure 46B, an enlarged side view, with portions broken away, of an improved decker point;

Figure 46C, an enlarged fragmentary top plan view of said decker point;

Figure 47, an enlarged front elevation, with parts in longitudinal vertical section and other parts broken away, showing more clearly jacquard shaft actuating devices at the left end of the machine shown in Figure 1, jack positioning devices, and stitch length setting devices;

Figure 47A, a fragmentary enlarged view of a portion of the free end of the rod pusher for selectively actuating the profile and fashioning bars and the gathering bar;

Figure 47B, a fragmentary plan view partly in horizontal section on the line 47B—47B of Figure 47;

Figure 47C, a development of the operative surface of locking bar cam 334, Figure 47;

Figure 47D, a graph of a cycle of locking bar operation in relation to a cycle of push-in bar movement incident to jacquard change;

Figure 47E, a graph of a cycle of profile and gathering bar operation in relation to a cycle of push-in bar movement incident to jacquard change;

Figure 48, a transverse vertical section on the line 48—48 of Figure 47.

Figure 49, a horizontal section on the line 49—49 of Figure 48;

Figure 50, a transverse vertical section on the line 50—50 of Figure 47;

Figure 51, a transverse vertical section on the line 51—51 of Figure 47;

Figure 52, a horizontal section on the line 52—52 of Figure 51;

Figure 52A, a graph of the periodic in and out oscillation of the front push-in bar for one cycle of normal knitting;

Figure 52B, a graph of the in and out motions of the front push-in bar (solid line) and of movements of the adjustable controlling cams (dotted lines) into and out of operative position for one cycle of jacquard or pattern change;

Figure 52C, a graph of the in and out motions of the front push-in bar and of movements of the adjustable controlling cams into and out of operation for one decking cycle wherein the operative position of the adjustable controlling cams for jacquard change (dotted lines) is maintained for an extended period in decking (broken lines). Movement of the push-out bar is shown superposed on the out movement of the push-in bar during decking.

Figure 53, a detail of the rolling key forming part of the clutch device on shaft 243, Figure 50;

Figures 54, 55 and 56, fragmentary transverse sectional views of the bed plates and connected devices showing a cycle of positioning movement of the push jacks and its effect in conditioning the needle jacks and needles for links-links operation;

Figures 57, 58 and 59, similar views showing effect of stitch cam operation on needle jacks and needles positioned for links-links operation as in Figure 56;

Figures 60, 61 and 62, similar views showing a cycle of positioning movements of the push jacks and its effect in conditioning needle jacks and needles in the front bed for straight knitting;

Figures 63, 64 and 65, similar views showing a cycle of positioning movements of the push jacks and its effect in conditioning the needle jacks and needles in the rear bed for straight knitting;

Figure 66, a simplified section illustrating the relative positions of the parts shown when a main

jack is raised to links-links position by the gathering bar;

Figure 66A, a view in side elevation of the main jack;

Figure 66B, a view in side elevation of the connecting jack;

Figure 66C, a view in perspective of the cross jack;

Figure 67, a simplified section illustrating the relative positions of the parts when a main jack and corresponding push jack are conditioned for straight knitting;

Figure 68, a simplified section illustrating the relative positions of the parts when a main jack and corresponding push jack are conditioned for links-links knitting by a profile bar, while other jacks may be held conditioned for straight knitting by the gathering bar;

Figure 69, a simplified section illustrating the relative positions of the parts when the locking bar is in down position;

Figure 70, a simplified section illustrating the relative positions of the parts when the locking bar is in intermediate or change position and the main jacks are free to be moved upwardly, the selector bar being shown in raised position to engage and lift a profile bar;

Figure 70A, a fragmentary view of parts as shown in Figure 70 and with a lift plate raised to an intermediate main jack lifting position by the selector bar;

Figure 70B, a view similar to Figure 70A with the lift plate raised to a higher main jack lifting position;

Figure 71, a simplified section illustrating the relative positions of the parts where the main jack is lifted but the interposed jack has been displaced by the cross jack so that the push jack is conditioned for idling the corresponding needle jack and needle;

Figure 72, a fragmentary view showing the positions of a needle and a decker point in relation to each other and to the front and rear bed combs when the decker point is about to engage the needle in advanced position of the latter in decking;

Figure 73, a fragmentary view of the parts shown in Figure 72 when the decker point is about to receive the stitch loop from the needle in decking;

Figure 74, a diagrammatic view of the decker or cam shaft and the cams actuated thereby; and

Figure 75, a graph showing the timing of movements of the pattern band or sheet, the chain and pattern control feelers, the push bars for actuating the stop or control links, and the chain drive control pawl adjusting slide bar in the pattern control mechanism, as shown in Figures 11, 13, 19 and 20, in relation to movement of the stitch cams in a left to right knitting course.

Referring to Figures 1, 1A, 6, 7 and 7B, the knitting and control instrumentalities embodied in the illustrated machine are actuated by suitable means, as a motor 1 connected to a transverse drive shaft 2 by belt 3 through a main friction clutch of conventional form and moved manually to and from driving position by means including a hand actuated grip rod 550 extending substantially the length of the needle bed so that it may be seized and turned by the operator from any position along the front of the needle bed portion of the machine and having reduced end portions supported in bearing brackets 663. A stop member 684, having a shoulder portion 684a, Figure 7B, is secured to said reduced end; and a releasable locking device is provided which includes a locking lever 669.

Main clutch operation

As shown in Figures 6 and 7B, the locking lever 669 includes a collar portion loose on rod 550 and having a shoulder 664. An arm 665 secured at the end of said grip rod is pivotally connected to a link 551. One end of a lever 551a, pivoted at 551b, is operatively connected to said link and the other to a sleeve 552 slidably mounted on shaft 2. A spring 666 biases lever 551a toward the right, Figure 7B, that is, toward clutch releasing position. By manually rotating grip rod 550 counter-clockwise (Figure 7) while locking lever 669 is in latched (down) position, until shoulder 684a thereof engages shoulder 664, the free end of arm 665 moves outwardly to a stop position which brings the outer end of link 551 past the center of said grip rod. The clutch is thus engaged and held in releasable operative position. It is disengaged manually by rotating grip rod 550 in the opposite direction to an extent limited by said stop arm 684 fixed on said rod and arranged to engage a portion of the frame to limit clockwise (Figure 7) rotation of said grip rod 550.

Automatic clutch release

Suitable means including a conventional electrically operated automatic stop mechanism of a type commonly known in the knitting art is here used to disengage said clutch automatically, as when a thread breaks during knitting. In the embodiment shown, it includes an electromagnetically controlled detent plunger 667, Figure 7, positioned to be engaged by a latch 668 which is pivoted on said locking lever 669 and biased toward said plunger by a spring 670. A stop arm 671 on latch 668 limits the extent of deflection in one direction of said latch when the latter is released from plunger 667.

Lever 669 carries a flat spring 673 which has one end portion secured to said lever 669 and the other end bearing against a portion of the machine frame. Said spring 673 biases said lever in a clockwise direction, Figure 7, i. e. toward unlatching position, and thus normally holds latch 668 frictionally against detent plunger 667 when the parts are in the locking position shown in said figure. Said detent plunger 667 is mounted in a coil assembly box 674. When magnetic devices therein are energized through wiring connections with switches normally held open against a spring or the like in a well known manner by thread tension, detent plunger 667 is withdrawn downwardly to release latch 668. Spring 673 thereupon deflects hand lever 669 upwardly so that shoulder 664 thereon engages shoulder 684a on stop member 684 to turn said grip rod 550 sufficiently to return the end of arm 665 above center. Spring 666 now operates freely on lever 551a, Figure 7B, to disengage the clutch.

Drive system

A worm 4, Figure 7, fixed on drive shaft 2 engages worm gear 5 fixed on a longitudinally extending main shaft 6 which, in operation, rotates continuously during engagement of said main clutch and, directly or indirectly, actuates needle selecting, needle actuating, racking and decking, and pattern control devices.

Main shaft 6 carries a loose pinion 7, Figure 4,

which meshes with a gear 8 fixed on a longitudinally extending cam shaft 9, Figures 3 and 4, which actuates needle positioning and stitch length changing devices. A suitable clutch for releasably connecting shaft 6 with pinion 7 comprises a driving plate 10 secured to worm gear 5, Figure 4E, a key carrier 11 secured to said pinion 7 and a rolling key 142 thereon and is actuated automatically by means including a plunger 141, Figure 7, to control the operation of said cam shaft 9, more particularly to stop rotation thereof during racking.

A bevel gear 12 loosely mounted on said cam shaft 9 is driven from said shaft through an automatically actuated key clutch, Figure 4C, including a driving plate 13 fixed on said cam shaft 9, a key carrier 14 secured to said bevel gear 12, and a rolling key 155. Said gear 12 meshes with and drives bevel gear 15, Figure 4, fixed on a transverse shaft 16, which actuates certain reciprocating parts, including the stitch cams and the brush and thread carriers hereafter described. Rotation of shaft 16 is automatically arrested during decking by suitable means including a lever arm 154 cooperating with said key 155, Figure 4C.

Thread supply

As shown in Figure 1, the machine includes a plurality of sets of supports for bobbins 17 of thread with tensioning devices 18 interposed between said supports and a plurality of sets of thread feeders or carriers 19, three of which are shown, Figure 36, being provided for each set (front and rear) of knitting or stitch cams and for the group or section of needles actuated thereby. An embodiment utilizing multiple sets of thread carriers and stitch cams, with needle beds of sufficient length to provide at least two groups or sections of needles, is shown in Figures 1 and 1B. It is contemplated that the needle beds of the machine may be made any practicable desired length to provide different numbers of needle sections and corresponding numbers of simultaneously operating sets of stitch cams; that said sets of cams will be suitably spaced apart; and that the end cams of end sets will be spaced from other portions of the machine at the ends of the needle beds to permit adequate "over run" of said stitch cams, i. e. past the active knitting zone, in each direction of their reciprocating movement.

Thread and brush carriers

As seen more clearly in Figure 36, the several thread carriers 19 of each set are removably and adjustably mounted on longitudinally extending reciprocating thread carrier bars 20 of which five are shown. With each set of thread carriers 19 is a set of two needle latch actuating brushes 21, one for each needle bed, removably and adjustably mounted respectively on reciprocating brush bars 22, Figure 36. It will be understood that, in operation, when a thread carrier bar 20 and the several thread carriers 19 spaced thereon are reciprocated, as hereinafter described, to feed thread to the several sections of needles during knitting, both of said brush bars 22 are also reciprocated in a suitable manner to be described. And at each knitting stroke, the brushes 21 thereon travel slightly in advance of the selectively engaged operative thread carrier or carriers to hold the latches of active needles in both beds in open position to receive thread from said carrier or carriers.

Needles and needle beds

The thread carriers 19 of each set are arranged to deliver thread to the hooks of a group of double ended latch needles 23, Figure 38, mounted to slide in transverse slots or grooves 24, Figures 37 and 39, of a front bed 25 and in transverse slots or grooves 26 of a rear bed 27, aligned therewith, as in conventional front and rear flat bed machines, to facilitate the passage of needles from and to each of said beds for purposes well understood.

In the embodiment shown, Figure 36, the front bed 25 is mounted to be moved in and out by hand to facilitate insertion and removal of needles and for other purposes not directly involved in the actual knitting operation. Accordingly, said front bed 25 is provided with lugs 675 extending downwardly through spaced guide slots 676 in the machine frame. The lower ends of said lugs ride in longitudinal grooves 677 in the upper face of a connecting bar 678 pivotally mounted on lever arms 679, Figures 36 and 41, mounted to swing on the frame. One of said arms 679, as shown in Figure 36, is secured on a rock shaft 680 which is turned by a hand lever 681, Figure 1, having its inner end secured to said rock shaft 680. The combined transverse and endwise movement of connecting bar 678 effected by manually swinging lever 681 produces corresponding in and out movement of front bed 25.

Racking movement of rear bed

The rear needle bed 27, Figures 3 and 36, is mounted to be automatically moved endwise, usually to the extent of the width of two needles, in racking. For this purpose, as seen in Figure 36, a sliding head 710 secured at one end of rear bed 27 extends downwardly therefrom through a guide slot 711 and is connected to a portion of one end of an actuating bar 712, the other end of which, Figures 4 and 4A, is secured at one end of a slide bar 713. A pair of cam rollers 714 mounted thereon embrace between them the peripheral cam flange of an annular cam 715 secured on a collar 716 which is loosely mounted on a shaft 717. Said collar 716 has a peripheral annular groove 718 adjacent to said cam, Figures 4 and 4A, and peripheral plunger slots 719 and 720, Figure 4C, extending at one end across said groove and at their other end through the inner end face of said collar. Clutch plungers 721 each having a shoulder 721*a* are slidably mounted in said slots and are spring biased endwise toward a sprocket 722 provided with radially arranged slots 723 exposed to receive the outer ends of said plungers 721 when the latter are released from the position shown in Figure 4A. A control finger 724 mounted at one end of a shaft 725, Figure 4C, has a portion at its free end positioned to engage the shoulder 721*a* of one of said plungers 721.

Sprocket 722 loosely mounted on a decker shaft 274 is continuously rotated by a chain 730 engaging a sprocket 731 on main shaft 6, Figure 4B, the sprocket ratio being such that sprocket 722 makes one complete turn for two rotations of shaft 6.

Normally, the free end of said control finger 724 extends into groove 718 where it engages shoulder 721*a* of upper plunger 721 to hold the latter in retracted position, as shown, Figure 4A. Lower plunger 721 is similarly held by a fixed plate 727 having a bevelled portion 728, Figure 4C.

Racking operation

Finger 724 is raised to release plunger 721 for racking by suitable connections with a racking control shaft 732, Figure 7, to which is secured an arm 733. A link 734 connects arm 733 with an arm 735 secured to shaft 725. Said shaft 725 is rocked to raise finger 724 when rack control shaft 732 is caused to rotate a part turn counter-clockwise, Figures 7 and 13 by any suitable means.

As seen in Figures 3, 11, 11E and 13, automatic devices for this purpose include a control link 736 having a specially shaped stepped outer end and which imparts one step of angular movement and return to said control shaft 732 through an arm 737 secured thereto and pivotally connected to an inner end portion of said link 736. In the type of control device shown, suitably located perforations, as 736*a*, in a pattern sheet or band 553, Figure 12, determine the occurrences of racking which includes both the displacement from and return of rear bed 27 to normal.

When finger 724 is raised in the manner above described, upper plunger 721, Figure 4A, is spring pressed to the left where its end engages radial slot 723 in sprocket 722 thus connecting collar 716 and cam 715 to rotate with said sprocket. During one rotation of main shaft 6, collar 716 and cam 715 rotate 180° with sprocket 722. During this movement, finger 724 is first raised from and then returned to down position where it prevents the other (initially lower Figure 4A) plunger 721 from moving out to engage the adjacent slot 723 in sprocket 722. Simultaneously the first mentioned plunger (now in the lower position) is withdrawn from engagement with its slot 723 by the bevelled portion 728 of fixed plate 727 coming against the rear shoulder portion 721*a*. The above described half turn of cam 715 thrusts slide bar 713 to the right, Figure 4A, and thus causes connecting bar 712 to move rear bed 27, Figure 3, two needles to the right where it remains until another perforation 736*a* occurring in the rack column of the pattern sheet again sets the control mechanism in operation to turn cam 715 another 180° back to its initial position.

Safety controls in racking

To prevent injury to machine parts in racking, operation of the stitch cams and other parts actuated by shafts 9 and 16 is arrested for the period of one revolution of shaft 6; and operation of rear bed needle jack positioning devices is modified.

For arresting operation of the stitch cams, clutch key carrier 11, Figure 4E, is disengaged from clutch plate 10 which stops rotation of cam shafts 9 and 16. As shown in Figure 7, rack control shaft 732 carries a cam arm 738, the free end of which forms a cam surface. One arm of a bell crank 739 has a cam roller 740 arranged to ride on said cam surface. The other arm of bell crank 739 carries the spring cushioned plunger detent 741 with its outer end arranged to intercept the projecting portion of the spring pressed rolling clutch key 742 assembled to rock in a recess in carrier 11. An inner portion of said key extends into the recess of clutch plate 10 and operates in a well known manner to connect and disconnect said plate and said carrier depending on the angular position of clutch key 742, normally spring held in clutch engaging position.

Bell crank 739 is pivotally mounted at 743 and biased by a spring 726 to move detent plunger 741 angularly toward the peripheral groove 744 in carrier 11, Figure 4E, and into the path of movement of the projecting end of key 742. When rack control shaft 732 is actuated as above described, cam arm 738 swings counter-clockwise from its neutral position as shown in Figure 7. Bell crank 739 thereupon rocks counter-clockwise and detent 741 intercepts and rocks back the projecting end of key 742. This disengages clutch 11 from plate 10. Cam arm 738 swings clockwise to restore detent 741 to its initial position so that when plate 10 on shaft 6 has rotated 360° clutch 11 is reengaged and normal knitting operations are restored.

Rack skip mechanism

So-called "skip" mechanism for modifying operation of rear bed needle jack actuating devices incident to racking includes means whereby certain jacks and needles at edge portions of the work are protected against injury by jamming. Where racking over two needles, for example, takes place in a course employing less than all the needles in each section, it is clear that with the active needles conditioned for "one and one" operation, as is customary in racking, certain active needles in the rear bed will be brought into alignment with certain inactive needles at rest in the front bed. Thus, in each needle section, one active end needle in the rear bed will come opposite an inactive needle in the front bed. The next normal jack and needle positioning motion, as by a rear push-in bar 191, Figure 3, would therefore cause said active rear bed needle to be pushed into the slot occupied by said inactive front bed needle.

To avoid this result, said bar 191 is mounted for longitudinal adjustment with the widening and narrowing devices and has portions cut away to provide slots or openings 191*a*, of suitable width in its front edge, the opening shown being two needles wide. In each knitting course, each of said openings 191*a* is maintained, by adjustment of bar 191, in position with at least a portion thereof opposite the needle bed slots holding the first two needles beyond the last needle working in the front bed.

To effect endwise sliding movement of bar 191 and so maintain the proper working position of slots 191*a*, in widening and narrowing, said bar 191 is connected with pawls 381 and 389, Figure 25, through screw 646, Figure 36, engaging block nuts 191*b*. One end of said screw 646 is connected by a universal joint 647 to one end of skip shaft 648, Figure 3, the other end of said shaft 648 being connected by a universal joint 649 to a shaft 650 carrying a gear 651. As shown in Figure 21, gear 651, is driven by chain 652 from sprocket 653 secured on a shaft 375, which forms part of one form of widening and narrowing control mechanism.

Needle jacks

The slots or grooves 24, 26 of the needle beds, Figure 38, are provided with needle jacks 28 slidable therein between idle or retracted position and different advanced or open latch positions, one for straight knitting and decking and another for links-links knitting, and each having at an outer portion an upwardly extending end butt 29 and, at a middle portion, an upwardly extending mid butt 30. Adjacent to said butt 30 is an elevated portion presenting a shoulder 30*a* for engagement with an under surface of front stitch cam 34. As shown in Figure 38, the inner end or needle engaging head of needle

jacks 28 is shaped to present a latch lifting point 31 and an under surface portion 32 from which extends a detent 33 adapted to cooperate with hook portions of a needle. Above said detent 33 the head of said jack 28 has a top edge portion 30b which is parallel with the bottom edge of the body portion of said jack.

Stitch or knitting cams

Stitch forming or outward movement from open latch or advanced position toward idle or retracted position of active needles in each group or section of the needles 23 in the grooves 24, 25 during knitting is effected by a set of knitting or stitch cam assemblies (front and rear) cooperating with said needle jacks 28. Each front assembly comprises a front stitch cam 34 and a positioning cam 34a, Figures 37 and 38, operating over said section of front bed 25; and each rear assembly comprises a rear stitch cam 35 and a rear positioning cam 35a operating over said section of rear bed 27. An end portion of each of said stitch cams extends longitudinally therefrom and beyond the adjacently disposed end of the other or opposite cam, so that rear cam 35 leads the adjacent end of front cam 34 in movements toward the right, Figure 37, and front cam 34 leads the adjacent end of rear cam 35 in movements toward the left.

Said stitch cams 34 and 35 are of like form, as are said positioning cams 34a and 35a. As shown in Figures 38 and 39, one end of the bottom surface of front stitch cam 34 (left as viewed in Figure 37 and right as viewed in Figure 39) presents a rounded cam edge 814; and the other end, another rounded cam edge 815, Figure 37A. The under surface of the outwardly extending intermediate portion of front cam 34 is relieved or cut away at 816, as shown in Figures 37 (dotted) and 38 to avoid unnecessary friction on the needle jacks 28. Parts of rear stitch cam 35 corresponding to those above described are identified as 814a, 815a and 816a respectively.

The left hand irregular edge of front stitch cam 34, Figure 37, presents needle jack butt engaging cam portions including an inner oblique lateral cam face 817, a middle oblique lateral cam face 818, and an outer oblique lateral cam face 819, all arranged and adapted to engage the butts 30 of needle jacks 28 in advanced position for knitting in the front bed 25 when the stitch cams are moved to the left, Figure 37. Corresponding cam faces of rear stitch cam 35 are identified as 817a, 818a and 819a respectively and engage butts 30 of the needle jacks 28 in the rear bed 27 when said stitch cams move to the right, Figure 37.

The right hand irregular edge of front stitch cam 34, Figure 37, presents an inner oblique lateral cam face 820 and an outer oblique lateral cam face 821. The corresponding parts of rear stitch cam 35 are 820a and 821a.

Between the oblique cam faces 820 and 821 on said right hand edge of front cam 34 is a lateral face portion or dwell 822 substantially parallel with the direction of movement of said cam. The left hand edge thereof also presents an inner lateral face portion 823 and an outer lateral face portion 824, both parallel with the direction of movement of said cam. Corresponding lateral face portions or dwells on rear cam 35 are identified as 822a, 823a and 824a respectively.

Between movements of stitch cams 34, 35 in opposite directions, the needle jacks in the rear bed are regularly moved to the same advanced position by rear push-in bar 191 and active needle jacks in the front bed are moved to various positions by a front push-in bar 195, Figure 36. As said cams simultaneously advance in the direction of the arrows, right Figure 37, therefore, the rounded cam edge 814a of rear cam 35 rides over and into engagement with the top edge surface 30a of the rear bed needle jacks 28, whereupon the normal bottom surface of stitch cam 35 bears on said edge and holds said jacks down in position to engage any needle conditioned for operation in the rear bed. With the parts as shown in Figure 56, i. e. for links-links operation, both hooks of the needle are initially engaged behind the hook detents 33 of the opposed needle jacks 28.

The advance of rear cam 35 toward the right also brings the cam face 817a thereof into lateral engagement with butts 30 of needle jacks 28 in the rear bed to move said jacks rearwardly and to carry therewith from the front bed any needles which were brought into links-links position by the front jacks.

As this motion proceeds in its first phase, Figure 57, the front or left end hook of each links-links positioned needle in the front bed disengages from the detent 33 of its front bed needle jack because the inner end of the latter is then free to tilt upwardly; and said needle is drawn rearwardly by the rear bed needle jack actuated by said cam face 817a and the cam faces 818a and 819a to the stitch completing position shown in Figure 58.

In links-links operation, the needle jacks from which needles are to be released are permitted to tilt or rise slightly at their needle engaging ends, Figure 57, so that the hook engaged thereby may pass from behind the detent 33 as the needle moves out into the opposite bed.

A given needle jack 28 at the advanced links-links position in the front bed, for example, remains free to tilt during movement of cams 34 and 35 toward the right and after butt 30 of the corresponding needle jack in the rear bed is engaged by the oblique cam face 817a until said butt reaches the crest of said face. In other words, the front bed needle jack 28 is free to tilt until the needle is securely engaged by the corresponding rear bed needle jack. Thereupon, and as butt 30 of said rear bed jack reaches the crest of 817a as aforesaid, said shoulder portion 30a of said front bed jack comes under rounded cam edge 815 and is pressed and held down by the normal bottom surface of front cam 34. The movement of the front jack with no needle is thereafter substantially symmetrical with that of its counterpart in the rear bed with the needle, as said cams continue stitch forming movement. As said top edge shoulder portions 30a of the needle jacks reach the relieved portions 816, 816a, friction due to downward pressure on the jacks is diminished.

In knitting links-links courses, from right to left and with the same initial positioning or conditioning of the needle jacks, said front and rear stitch cams operate as above described in connection with a right to left course, but do so with their functions reversed.

In "straight" knitting, the needle remains engaged with a needle jack in one bed. The jacks in the rear bed are pushed forward by push-in bar 191 to the advanced position shown in Figures 55, 61 and 64 in both links-links and straight knitting; but in the latter, Figures 61 and 64, the front bed jacks reach a less advanced position than that reached in links-links operation, Fig-

ure 55. Thus, in straight knitting, if a needle is in the front bed, its jack advances it to the position shown in Figure 61; and cam 34, Figure 37, regardless of direction of travel, thereafter moves it back in the front bed to form a stitch toward the front. If the needle is in the rear bed, rear bed jack 28 initially advances it to the position shown in Figure 64; and, if the course is from left to right, cam 35 thereafter moves it back in the rear bed to form a stitch toward the rear in the same manner as that previously described in connection with links-links operation in courses from left to right.

If the straight knitting course is from right to left, the needle jacks 28 and needles occupy the relative positions shown in Figure 65, i. e. with the head of front bed jack engaged under a front jack depressor plate 826 whereas the head of rear bed jack is beyond rear depressor plate 826 and free to lift. With this arrangement, the rounded cam edge 815a of rear stitch cam 35 rides over and into engagement with the shoulder 30a of rear needle jack 28, whereupon the normal bottom surface of stitch cam 35 bears on said shoulder and holds said rear jack down in position to retain engagement with the needle.

As shown in Figures 38, 46 and 54 to 65, a jack retaining or depressor plate 826, extending longitudinally of each of the needle beds, crosses the several needle slots 24, 26 thereof near their inner ends. The under surface of said plate 826 is spaced from the bottom surface of said slots sufficiently to permit the head of jack 28 to slide freely but without vertical play when the top edge 30b of said jack head comes under and engages said under surface of plate 826. This occurs during a portion of its movement in links-links and all of its movement in straight knitting when said jack is moving to and from its extreme "in" positions. As seen in Figures 54 to 58 inclusive, the jack head slides under and beyond plate 826 in moving from its retracted or idle position Figure 54 to its advanced links-links position Figures 55, 56, 57. As the stitch cams operate, jacks 28 are returned toward their retracted positions, Figure 58. While the edge 30b of the jack head is engaged with plate 826, jack 28 is thereby prevented from lifting and thus cannot receive or release a needle hook. It can do so only in the extended positions as shown in Figures 55, 56, 57 and 59. In these positions (links-links) the heads of both front and rear jacks extend beyond the opposed inner edges of plates 826; but in the positions shown in Figures 61, 62, 64 and 65 (straight knitting) the heads of the rear jacks only extend beyond the inner edge of the rear plate 826.

As shown in Figures 37 and 38, the positioning cam 34a which moves with front stitch cam 34, lies opposite and is spaced from said front stitch cam. Positioning cam 35a is similarly related to rear stitch cam 35. In operation said stitch cams displace the needle jacks 28 outwardly to form stitches or loops as above described, to a position slightly beyond their normal neutral or idle position. The cam faces 827 on 34a and 828 on 35a thereafter engage the butts 30 and move said needle jacks inwardly to align them uniformly in neutral or idle position so that when the pattern control or jack positioning devices are next actuated, the needle jacks and needles will be in proper position to operate as intended and the stitch loops are relieved of undue strain.

Stitch cam mounting

The front stitch cams 34 and positioning cams 34a are mounted in a front guide or housing 36 and the rear stitch cams 35 and positioning cams 35a, in a similar rear guide or housing 37 to reciprocate longitudinally in unison. Both housings have end portions extending beyond the end needle sections of the front and rear beds, Figure 46, and slidably supported on the machine frame to permit movement of said housings toward and from each other for varying the stitch or loop length. Each of said housings provides a longitudinal interior recess with guiding and supporting shoulders, Figure 38, for a cam assembly including cam plates 38 and 39 to which said stitch cams and positioning cams are secured in fixed spaced relation to and above their respective needle beds.

As shown in Figure 39, said cam plates 38 and 39 are releasably engaged between longitudinally spaced shoulders 40a of downwardly exposed equally spaced recesses formed in actuating rods 40 which are reciprocated endwise in unison by suitable driving means to impart operative movement to said stitch cams 34, 35 and the positioning cams 34a and 35a simultaneously therewith. The rods 40 are removable and interchangeable with others of the same length and having more or fewer spaced recesses, depending on the number of knitting sections required.

Drive for stitch cams

To reciprocate the knitting or stitch cam assemblies, the outer ends of rods 40 are provided with plates 41 having recesses 42, Figure 32, and are releasably connected to a transversely disposed reciprocating stitch cam rod actuating arm 43 mounted to slide longitudinally of the machine on a fixed support and guide bar 44, Figure 3. Said arm has stop lugs 43a, Figure 26, extending downwardly from its bottom surface which provide inwardly exposed stop faces against which to press lateral end portions of rods 40. Arm 43 also has brackets 45, Figure 26, extending downwardly from its under surface to support plungers 46 having rounded ends which are pressed yieldingly into the respective recesses 42 by a lever pivoted at 47 and having arms 48 and a shank 49, thus pressing the outer ends of said rods into frictional engagement with the stop faces of said lugs 43a. A spring 50 mounted on a pin 51 bears against an outer end portion of shank 49 to bias arms 48 toward plungers 46, the biasing pressure of said spring being regulated by a nut 52 on pin 51. In the illustrated embodiment it is contemplated that rods 40 and associated parts will provide enough flexibility for them to operate at all usual stitch length settings without special adjustment thereto at their driving ends.

Thus, with the parts arranged as shown in Figure 32, the stitch cam rods 40 are so connected to arm 43 as to be actuated thereby in normal operation but to be disengaged therefrom automatically in case a portion of the mechanism including said rods and stitch cams becomes jammed or otherwise obstructed in operation.

Arm 43 is reciprocated by a chain 53 connected to opposite portions of one end of said arm, and supported between an idler sprocket 64 on a spindle 103 and a driving sprocket 65 on a spindle 66, Figure 3. A gear 67 on spindle 66 meshes with an idler 68, Figure 2, driven by a gear 69 removably mounted on spindle 10, Figure 5, journaled in a bracket 71. Idler 68 is journaled on a stud 354 carried by an angularly adjustable slotted

sector plate 355 pivoted on spindle 66. Gear 69 is interchangeable with others of different diameter to vary the length of the driving stroke of chain 53, as when a machine having a needle bed of given length is adjusted to operate with more or fewer knitting sections. A pinion 72 at the lower end of spindle 70 meshes with a reciprocating rack 73 forming part of a slide bar 74 provided with spaced cam following rollers 75 engaging the peripheral cam surface of a cam 76 fixed on shaft 16.

Thus, as shaft 16 rotates when clutch parts 13, 14, Figure 4, are engaged, cam 76 reciprocates slide bar 74 and rack 73 thereon to rotate spindles 70 and 66, and hence sprocket 65 and chain 53, alternately in opposite directions, thus effecting reciprocating movement of arm 43, rods 40 and the stitch cam assemblies connected thereto. The actuating parts are so arranged and proportioned that the main shaft 6 rotates 360° for each stroke in one direction of said stitch cams and associated parts.

Drive for thread and brush carriers

The thread carrier bars 20 and brush bars 22 are reciprocated in synchronized relation to said stitch cam rods 40 and said stitch cam assemblies by operation of shaft 16 through connecting devices hereinafter described. Suitable means are also employed to automatically adjust the relative positions, i. e. the lead, of the brushes, thread carriers, and stitch cams between successive knitting strokes of the latter.

As seen more clearly in Figures 2, 26 and 28, outer end portions of the brush carrier bars 22 are secured to the spaced arms of a U-shaped bracket 54 slidably supported on a fitting 99 mounted to slide on a longitudinally extending fixed bar 55. Fitting 99 also carries an actuating arm 56 having a longitudinal slot 62 open at its rear end and a bracket 57 on which latch devices or keepers are mounted for engaging and disengaging portions of the thread carrier bars 20. Thus, the brush bar actuating bracket 54 and the thread carrier bar actuating bracket 57 are both operatively connected to and slidable with said actuating arm 56 which reciprocates by operation of a chain 58 in unison with the stitch cam operating arm 43 over intermediate portions of the latter's path.

Reciprocating movement is imparted to said brush and thread carrier actuating arm 56 by chain 58 through a driving block 59 having a pintle 60 which pivotally engages a head 61, Figures 27 and 28, mounted to slide in said undercut longitudinal open ended slot 62 extending lengthwise of arm 56. As shown in Figure 2, chain 58 is mounted to be driven alternately in opposite directions, portions thereof being engaged for this purpose by a driving sprocket 63 fixed on spindle 66.

Certain portions of said chain engage and are supported on idler sprocket 77 journaled at 78 in a fixed portion of the machine frame, and on idler sprockets 85 and 86 journaled on fittings 85a and 95, respectively, mounted on opposite end portions of a slidable rod 87 having its outer (right) end supported to slide in a bearing bracket 88. The inner end of said rod 87 is secured to said fitting 85a which has a portion 85b of rectangular cross section to prevent turning, said portion being slidably mounted in a bearing 85c forming part of the frame, Figures 5 and 7.

Other portions of said chain 58 are supported on idler sprockets 79 and 80 journaled on a longitudinally adjustable bracket 81, and on idler sprockets 82 and 83 journaled on a similar bracket 84, said brackets 81 and 84 being adjustable longitudinally toward and from each other on a supporting rail 154 of inverted U-shaped section by means of a screw 155.

As head 61 is moved with block 59 on chain 58 over that part of its course which lies between the adjustable idler sprockets 80 and 83, it imparts corresponding reciprocating movement to arm 56 longitudinally of the machine. Said arm 56 stops when block 59 and head 61 reach and over-run one of said sprockets, which always occurs before the stitch cam actuating arm 43 reaches its end or dwell position. At the left end, Figure 2, for example, head 61 moving in the direction of the stroke is carried by chain 58 beyond idler sprocket 80 and deflected rearwardly along slot 62 in arm 56 toward idler sprocket 79; and, on the stroke to the right, beyond idler sprocket 83 and rearwardly along slot 62 toward idler sprocket 82. During these "over-run" or rearward and corresponding return portions of the movements of head 61 in said slot, arm 56 remains at rest.

Lead change between stitch cams and thread carriers and brushes

During the last described "over-run" of head 61 in slot 62, rod 87 is moved endwise to effect a repositioning of that portion of chain 58 which carries said head 61 by effecting differential movement between said portion and the rest of the chain. This adjusts the position of head 61 so that in the next course arm 56 will be in proper lead relation to stitch cam actuating arm 43.

For this purpose, a cam 89, Figure 3, having a cam groove 90, Figure 5, is secured on shaft 16 in such position that a cam roller 91 mounted on a bell crank 92 pivoted at 93 engages said groove 90. A link 94 connects bell crank 92 with the fitting or collar 95 fixed on rod 87. The contour of cam groove 90 is such that, during each 360° rotation of cam 89, bell crank 92 is rocked to slide rod 87 in one direction, as left, when arm 56 is at rest in its right dwell position, Figure 2, and in the opposite direction, as right, when said arm 56 is in its left dwell position.

These endwise movements of rod 87 in opposite directions are effected in a predetermined relation to the reciprocating movements of rack 73 and rotation of cam 76, and are timed to take place between successive courses and while the thread carrier and brush carrier actuating arm 56 is at rest in one or the other of its dwell positions. During said dwell of arm 56, that portion of chain 58 which carries the block 59 is moved differentially in relation to the rest of the chain by said endwise movements of rod 87 so that head 61 is repositioned a predetermined distance in the direction of its next operating stroke while chain 58 as a whole retains its normal relation to the driving sprocket 67.

Said periodical endwise thrusts of rod 87 affect only that portion of the chain 58 which engages and is supported on and between the idler sprockets 79, 80, 82 and 83 in relation to the drive gear engaging portion thereof. Thus, as rod 87 is moved to the left, Figure 2, carrying idler sprockets 85 and 86, said section of the chain is displaced to the left during the dwell between knitting strokes of the stitch cams. The resulting displacement of head 61 in groove 62 will be in the direction of the next arm driving movement of the chain as a whole and will be of sufficient

extent to cause in the next course movement of the thread and brush carrier bar actuating arm 56 and fitting 99 sufficiently in advance of cam actuating arm 43 to bring both the thread carriers and the brushes into the proper lead relation to the stitch cams. This change and the resulting arrangement is shown diagrammatically by the dotted line representing thread carrier arm 56 and the full line representing stitch cam arm 43 in Figure 32A, M being the point at which arm 56 resumes travel with arm 43 on the next course. The Roman numerals I, II, III represent the order in which the brushes, thread carriers, and cams are arranged in relation to each other as they advance in each course.

Lead change between brushes and thread carriers

To change the lead between the brushes and the thread carriers effective on the next stroke of the stitch cams, the brush bars 22 are moved endwise in relation to the thread carrier bars 20 sufficiently to reposition the brushes ahead of the thread carriers in the direction of the next stitch forming movement of the stitch cams, Figure 32A. For this purpose, the U-shaped bracket 54, Figures 26 and 28, which imparts operative movement to the brush bars 22, is slidably adjustable on fitting 99 in relation to the thread carrier bar actuating bracket 57 by suitable means operatively interposed between said bracket 54 and the stitch cam bar operating arm 43, Figures 3, 26 and 28.

As shown more clearly in Figure 32, such means include said arm 43 which has a cam slot 96 with flared openings at its ends. One end portion of said cam slot 96 is offset laterally from the other end portion and is connected thereto by an oblique middle portion 96a, Figure 32. Interposed operatively between said cam slot 96 and arm 54 is a bell crank 97, Figures 26 and 28, pivoted at 98 on fitting 99 which slides on bar 55 and supports arms 54 and 57 thereon. One end of bell crank 97 is provided with a gear segment 100, the teeth of which engage a rack 101 provided at the rear of slidable bracket 54. The other end of bell crank 97 carries a cam roller 102 which rides in and through the cam slot 96 at the end of each course or stitch forming stroke. The arrangement of the parts is such that the thread and brush carrier actuating assembly which includes arm 56, fitting 99, U-shaped bracket 54, and bracket 57, moves with the stitch cam driving arm 43 over mid portions of each course. But when arm 56 stops the stitch cam actuating arm 43 continues to move beyond said arm 56 and thus carry the stitch cam assemblies toward end positions in their respective "over run" zones regardless of the condition as to widening and narrowing. Thus, at each "over run" in each direction, stitch cam actuating arm 43 moves differentially past fitting 99; and in so doing, brings the oblique middle portion 96a of cam slot 96 into engagement with cam roller 102 whereupon bell crank 97 is rocked to swing the gear segment 100 to slide bracket 54 by means of rack 101 thereon in a direction opposite to that of said "over run" movement of arm 43.

This reverse movement or re-positioning of bracket 54 on fitting 99 brings the brush bars 22 into their new operative position in relation to the thread carrier bars 20 for the return stroke of the stitch cam bars 40. Accordingly, said fitting 99 and both the thread carrier and the brush actuating devices connected thereto will, in the next course, be properly repositioned in relation to the arm 43 and stitch cam bars 40.

Thus, as shown in Figure 32A, when chain 58 is reversed, as at M, to drive carrier actuating arm 56 on the next course, said arm 56 represented by the dotted line will be in proper lead relation to the stitch cam driving arm 43 represented by the full line; and the brush carrier bracket 54, represented by the broken line, will have been adjusted a corresponding extent and sufficiently to establish proper lead of the brush carriers in relation to the thread carriers, as previously described.

From the foregoing description and stated mode of operation of the various mechanisms referred to, it is apparent that in part they present means for effective multiple unit knitting and in part provide improved and simplified stitch or loop forming devices which may be employed, as shown, or along with other types of knitting instrumentalities, either single or multiple. More particularly, the knitting or stitch cams and their mountings are of simplified construction and insure accurate needle operation at high speeds. In this connection, it is noted that in operation a machine embodying the above described features can knit from 45 or more courses per minute; whereas known machines of comparable number of needles knit only 11 or 12 courses per minute.

The stitch cam drive lends itself to effective cooperation with the thread and brush carrier actuating means; and, in its automatic releasing feature, greatly reduces the likelihood of damage to the machine or its product from faulty operation or breakage of parts.

My improved means for racking the rear bed insure accurately controlled operation; and the safety features connected therewith are designed to protect other operating parts during racking movement.

The thread carrier and brush driving and lead changing devices are particularly effective in maintaining rapid and accurate operation on fashioned products.

The above and other illustrated driving, actuating, and control mechanisms cooperate effectively to produce a large output in a wide variety of patterns.

Stitch length change

Further objects of the present invention have been to provide improved stitch length change mechanism adapted for knitting machines, more particularly of the links-links or knit-purl type; to provide effective means for making stitch length changes simultaneously on a plurality of individually operated knitting sections of a multiple machine; and to provide means which permit exact duplication of any given set of stitch lengths in making other units of product and/or at other operating times. More specific aspects of said stitch length change mechanisms are separately claimed in my co-pending application Serial No. 530,762, filed herewith.

In the arrangement, as shown in the drawings, the stitch cams are mounted to reciprocate endwise in front and rear stitch cam guides or housings 36 and 37 respectively, Figures 3 and 46; and for effecting stitch length change, said housings are controllably movable either singly or together toward and away from the knitting off or opposed edge portions of their respective needle beds. Devices for effecting this movement are conveniently arranged to cooperate with con-

trol means whereby movement of said housings or either of them may take place from any one or any other of a plurality of different positions representing a corresponding number of different stitch lengths. Means are also provided which permit adjustment to produce stitches of many different lengths in either bed within practicable maximum limits.

The front and rear stitch cam housings 36 and 37 respectively, as seen more clearly in Figures 3, 7 and 46, are mounted to be adjusted toward and from the inner edges of their respective needle beds to vary the length of stitches by the extent of said movement. This result follows because it produces a like adjustment between said edges and the front and rear stitch cams respectively which are mounted in said housings. The latter are biased toward the edges of their respective needle beds by tension springs 104, each having one end secured near one end of one of said housings and the other end secured to an adjacent end of the other housing.

To facilitate the adjustment just described, said housings 36 and 37 are supported at their ends to slide obliquely, Figure 46, i. e. with a combined endwise and in-and-out displacement in relation to fixed guides, shown in the form of guide plates 105 having angularly disposed guide surfaces 106. Oblique edge faces of wedges 107 extending from the inner edges of housings 36 and 37 slidably engage said guide surfaces 106. It will be clear from the foregoing that, if a suitable force is applied against adjacent ends of said housings to displace them longitudinally, they will also move outwardly against tension of said springs 104 which hold said wedges 107 against the guide surfaces 106; and that in such more outward positions of said housings, the stitch forming displacement of the needles by stitch cams 34 and 35 will be greater.

To effect and releasably maintain the adjustment of the stitch cams in relation to their respective beds for the purpose above stated, each housing is provided with a buffer plate 108, Figure 46, having outer contact faces 109 which lie opposite the path of movement of exposed end portions of a set of longitudinally adjustable pins 110, two such sets of four each being mounted in radially arranged recesses in a quadrant shaped head or carrier 111 fixed at the upper end of a shaft 112.

Inner end portions of said pins 110 are provided with micrometer threads to permit accurate endwise adjustment thereof in their respective recesses to vary the extent to which the outer ends of said pins project beyond the peripheral face of carrier 111. To facilitate this adjustment and insure accuracy thereof, said respective pins 110 are provided with correspondingly spaced or graduated markings 110*a* on their peripheral surfaces and are releasably secured by set screws 110*b* in any desired extended position. This arrangement permits a wide range of stitch length variation to meet various pattern requirements.

In the preferred form shown, Figure 46, the markings "1, 2, 3," etc. are arranged in a helical sequence so that each is clearly visible and may therefore be brought into exact register with fiducial markings 110*c* carried by the bevelled curved peripheral surface of carrier 111. Where the markings 110*a* on each pin 110 define the same increments of adjustment as the markings on each other pin, stitch length conditions can be accurately controlled and reproduced to obtain uniform results in different lots of goods, other conditions being the same.

Assuming that the pins 110 of each set thereof have been adjusted with their outer ends extending the required distances beyond the periphery of carrier 111, the outer ends of any selected pair of said pins are moved into and out of operative relation to the several contact faces 109 by rotating shaft 112 which actuates carrier 111. If by this angular movement, a more extended pin engaging one of the faces 109 is replaced by a less extended pin, a corresponding retractive movement of one of said housings 36 and 37 is effected by springs 104. If the replacement is in the opposite sense, the outer end of a more extended pin, bears cam-like against one of said faces 109 and forces and holds one of the housings 36 and 37 farther from the other until a subsequent change is effected. Likewise, corresponding pins in each set may be adjusted to effect the same extent of change in the positions of both housings.

Automatic stitch length change

For effecting a predetermined rotation of shaft 112 automatically, said shaft is journaled in a bracket 113, Figures 45, 47, 48 and 49, and has fixed to its lower end a fork 114 having spaced arms, end portions of which, Figure 48, provide guide journals for a vertically slidable spindle 115, Figures 47 and 48. The lower end of said spindle 115 is supported to slide freely in an arcuate path on the top surface of a T shaped upright link 116, the bottom end of which is pivotally secured to a lever 117 at 118. Said lever 117 is fixed to and turns with a stitch length control shaft 119 actuated in any suitable manner, as by automatic control devices including control links 803 and 804, Figures 3, 11, and 11F, connected to rock said shaft 119 predetermined increments to and from a neutral or inoperative angular position. An arm 120, Figure 48, has one end journaled in the frame at 121 and the other end pivotally connected to an upper end portion of link 116 at 122. Thus, when lever 117 is actuated by shaft 119 to move link 116 vertically, the latter remains upright and in proper supporting relation to spindle 115.

Selective stitch length change control

As seen in Figures 48 and 49, a selector or stop carrier in the form of a plate 123 is mounted on spindle 115 to move up and down therewith. A mid portion of said plate rests on an annular shoulder 124 of spindle 115 where it is secured by a nut 125. An end portion (left Figure 49) of plate 123 is provided with a curved slot 126 which engages a vertical guide pin 127 supported on a bracket 128. Adjacent said slot, plate 123 has an upwardly extending stop lug presenting two relatively stepped vertically disposed stop faces 129. At the opposite end of said plate 123, a similar but downwardly extending stop lug presents relatively stepped vertically disposed stop faces 130. As seen in Figure 49, an inward extension at the left end of selector plate 123 provides a vertically arranged stop shoulder 131 presenting a vertical face in stepped and aligned relation to said faces 129; and a similar extension at the opposite end provides stop shoulder 132 presenting a vertically arranged face in stepped and aligned relation to said faces 130. Thus, stop shoulder 131 and stop lug faces 129 provide a series of three vertical stop faces at the slotted end of plate 123; and stop shoulder 132 and stop lug faces 130 provide a

series of three vertical stop faces at the other end of said plate 123.

As seen in Figures 47, 48 and 49, actuating devices for imparting endwise motion to the selector plate 123 in its several operative positions and thus to rock fork 114 and rotate shaft 112, include parts mounted in a housing supported on posts 133 and having spaced walls 134 and 135. Inner wall 134 is provided with spaced axially aligned slots 136 (dotted Figure 48); and outer wall 135 with a lower slot 137 at its right end, Figure 48, and an upper slot 138 at its left end. In a lower portion of the space between walls 134 and 135 is a lower slide plate 139 provided with inwardly extending bosses 140 on which are mounted cam rollers 141 engaging the periphery of a cam 142 fixed on shaft 9. Slide plate 139 also carries on a portion of its upper edge a pusher arm 143 which extends horizontally through lower end slot 137 and into position to engage one or another of the stop faces 130, 132 on selector plate 123 depending on the position of said plate. Another portion of the upper edge of slide plate 139 is provided with an upwardly disposed rack 144, Figure 48.

A pinion 145 journaled on a shaft 146 engages said rack 144 and also a downwardly disposed rack 147 on the lower edge of an upper slide plate 148. A pusher arm 149 extending horizontally from said lower edge of upper plate 148 has a portion projecting through said upper end slot 138 in wall 135. Said arm is thus supported and guided in said upper slot 138; and its free end portion is positioned to engage one or another of the stop faces 129, 131 of the stops at the left, Figure 49, on selector plate 123 depending on the position of said selector plate.

In operation of the stitch length change devices above described, cam 142 revolves with rotation of shaft 9 to impart periodic to and fro motion simultaneously in opposite directions to said lower slide plate 139 and said upper slide plate 148, respectively, and consequently to the pusher arms 143 and 149 carried thereby. With cam 142 in the position shown in Figures 48 and 49, the slide plates 139 and 148 are in their extreme end positions, i. e. with pusher arm 143 on slide plate 139 spaced at the maximum distance from pusher arm 149 on slide plate 148. When shaft 9 is rotated to bring cam 142 180° from the illustrated position, pusher arm 143 is spaced the minimum distance from pusher arm 149.

To effect a predetermined angular setting of the pin carrying head or quadrant 111, selector plate 123 is adjusted vertically by any suitable means to bring the corresponding one of its stop faces into position in the line of outward horizontal movement of one of the pusher arms 143 or 149.

In automatic operation suitable control mechanism causes upright link 116 to be moved downwardly from the normal or inoperative position shown in Figure 48 to a selected one of different predetermined operative positions by rotation of control shaft 119. This brings a predetermined stop face on said selector plate 123 into the path of horizontal movement of one of said pusher arms 143 and 149. Said plate is thereupon moved endwise in the direction of movement of the engaged pusher arm.

As shown in Figures 46, 48 and 49, at the last preceding stitch length setting, the selector plate 123 was moved to its extreme left end position, Figure 49, which brought carrier 111 into the end position shown in Figure 46. This setting resulted when selector plate 123 was operatively positioned at the next lower step from the normal inoperative position shown in Figure 48, and so that pusher arm 149, on its periodic outward movement toward the left, engaged stop face 131, Figure 49. Thereafter, control shaft 119 was rotated back to its initial inoperative position, thus restoring selector plate 123 to its inoperative level or position but leaving the carrier in position as adjusted.

If the pattern should now require a stitch length produced, for example, by the effective setting of the pair of pins 110 next respectively to the pair shown in operating position in Figure 46, said last mentioned pair will be displaced and said next pair will be brought into operative position by a suitable clockwise (Figure 46) movement of carrier 111. For this purpose, the control devices bring selector plate 123 to a position two steps below that shown in Figure 48 and such that the end of pusher arm 143, in its next move to the right, will engage the lower stop face 130 to move selector plate 123 toward the right, Figure 48. Obviously, the extent of movement of said plate to the right depends on which of the stop faces 130, 132 is brought into position to be engaged by pusher arm 143. To move selector plate 123 in the opposite direction (left) to different positions, the pusher arm 149 in moving to the left will selectively engage the stop faces 129, 131 by proper controlled vertical positioning of said selector plate.

The stitch length change mechanism above described is of relatively simple construction and well adapted to control the position of a plurality of stitch cams operating simultaneously as a group over different portions of a single needle bed or in parallel groups over opposed beds. It is noted that the cam housings remain at each position of adjustment until a different stitch length is required; and changes may be made to take effect in a course beginning at either end of the needle bed.

Thread change

Further objects of the present invention have been to provide improved thread change mechanism for knitting machines, more particularly of the links-links or knit-purl type to provide means for feeding the thread which involve a minimum amount of travel, thereby reducing friction and permitting the free use of relatively more tender threads or yarns than is otherwise feasible; and to provide thread feeding devices which in operation produce a more continuous and uniform tension on the thread with resulting increased evenness of texture in the knitted product. More specific aspects of said improved thread change mechanism are claimed separately in my co-pending application Serial No. 530,763, filed herewith.

In the construction shown in the drawings, for example Figure 36, five thread carrier bars 20 are employed to actuate a corresponding number (three shown) of different thread carriers 19 in each knitting section of the needle beds. And means are provided for automatically selecting, actuating, and idling said bars in any desired sequence to effect predetermined thread changes through operation of suitable pattern control devices.

As seen in Figures 29, 30 and 31, each thread carrier bar 20 has a fitting 150 at its outer end provided with end detent lugs 156 and 157 and a middle driving lug 151 projecting upwardly and adapted and positioned to be engaged and disen-

gaged by suitable latch devices or keepers mounted respectively on idling or detent latch carrying brackets 164 and 165, Figure 2, movable with control heads or bracket supports 152 and 153, and on the driving bracket 57 which is reciprocated with actuating arm 56, Figure 2, between said brackets 164 and 165.

Head 152 is mounted on a portion of bracket 81 and head 153 on a portion of bracket 84, which brackets are simultaneously movable toward each other in narrowing and from each other in widening.

To effect said simultaneous movements in narrowing and widening, a portion of a nut 155a secured to said bracket 81 is slidably mounted between the flanges of the inverted U-shaped rail 154 and threaded on the screw shaft 155, Figure 26. Thus, when said screw shaft is turned, bracket 81 is moved longitudinally thereon with said nut between one end (left, Figure 2) and an approximately middle point thereof, in a direction depending on the direction of rotation of said screw shaft. The thread on the right end portion of screw shaft 155 is pitched oppositely to that on the left end portion and engages a similar nut secured to bracket 84, so that, when said shaft is rotated in fashioning, bracket 84 moves simultaneously with bracket 81—but in the opposite direction.

Suitable means for controlling the time and direction of rotation of said screw shaft 155 incident to widening and narrowing include the chain 655 and sprocket 656 on shaft 375, Figures 1A, 2 and 3, actuated by fashioning control means of which portions are there shown.

Thread changes for all needle sections are made simultaneously by dropping one or more thread carriers from operation and picking up one or more other thread carriers in each section. This is accomplished at the end of any course and at all positions of the parts in widening and narrowing by effecting appropriate connections and disconnections between said middle or drive lugs 151 of the several thread carrier bars 20 and keepers carried on the reciprocating driving bracket 57 mounted to move with arm 56 which drives said thread carrier bars along with the brush carrier bars 22.

The adjustably mounted control heads 152 and 153 cooperate with devices for controlling the operative change position of the detent and drive lugs on carrier bars 20 and for actuating said idling brackets 164 and 165 respectively to bring the latches thereon into and out of operative detent lug engaging position. Said idling brackets 164 and 165 which are slidably mounted on a longitudinally extending bar 55 carry latches arranged to selectively engage and disengage said detent lugs 156 and 157 respectively. Said lugs 156 are engaged by latches on bracket 164, at the left, Figure 2; and lugs 157 by like latches on the bracket 165, at the right, whereby corresponding thread carrier bars are releasably held in inoperative position, i. e. not connected to move with driving bracket 57 at the end of any course in either direction.

As shown in Figures 26, 29 and 30, when a thread carrier bar 20 is placed in operation, the drive lug 151 thereon is releasably engaged to move (i. e. reciprocate) with driving bracket 57 by means of a pair of spring pressed lug engaging keepers 158 mounted to slide vertically in recesses extending through said driving bracket 57. Upper end portions of keepers 158 provide bearings for rollers 159; and springs 160 are interposed between bracket 57 and keepers 158 to bias the latter downwardly in locking position and to an extent limited by stop pins 161 thereon.

As seen in Figures 2, 28, 29 and 30, brackets 162 and 163 which are secured to the control heads 152 and 153 respectively, present transversely disposed edge portions, as 162a on bracket 162, just above the thread carrier bars 20 and in position to engage the detent lugs 156 and 157 respectively. These edges effect adjustment and maintain alignment (Figures 29, 30) of the detent lugs 156 on the thread carrier bars 20 with widening and narrowing movements of heads 152 and 153 and with reciprocating movements of brackets 164 and 165 in relation thereto. Proper operative relation is thereby maintained between the several detent and drive lugs of the carrier bars and the latch or keeper devices cooperating therewith.

The latch carrier bracket 164, left, in Figure 2, slidably mounted on bar 55, Figures 7 and 28, moves with control head 152 and also has limited reciprocating movement relatively thereto. It is provided with a cam roller 166 mounted on a stud 167, Figure 29. A closed cam 168 having cam flanges is mounted to rotate in head 152. Said cam is splined on a shaft 169 having one portion journaled in said head 152 and another portion journaled in head 153.

A closed cam 170 having cam flanges similar to those of cam 168, but oppositely disposed, and operated by shaft 169 simultaneously with cam 168, is mounted to rotate in head 153 (at the right, Figure 2).

Cam roller 166 rides between the flanges of closed cam 168, each flange having an annular portion 171 extending about 180° and an oblique thrust portion 172, Figure 28, of the same extent. A similar cam roller engaging cam 170 operates in like manner.

Thus, when shaft 169 is rotated 360°, it simultaneously turns closed cams 168 and 170, at all positions of heads 152 and 153. The oblique flanges of said cams 168 and 170, during 180° of their rotation, bear simultaneously in opposite directions against their respective cam rollers. The effect is to initially thrust said brackets 164 and 165 from normal retracted position, Figure 29, to the extended or operative thread change position shown in Figure 30, and then back to said normal position in relation to heads 152 and 153 respectively. When said brackets are brought into extended position, the latch devices thereon cooperate with the detents and lugs on the bars 20 and with other instrumentalities in effecting a thread change as hereinafter described.

Shaft 169 is controllably rotated one turn at predetermined times to effect the above described reciprocating movement of brackets 164 and 165. For this purpose, in the illustrated embodiment a sprocket 173 fixed on said shaft 169, Figure 1A, is driven by a chain 682 from a sprocket 683 fixed on shaft 169a.

As shown in Figures 1A, 8 and 8A, shaft 169a has a gear 745 loosely mounted thereon and meshing with a gear 746 on main shaft 6. Gear 745 has a clutch carrier portion, Figure 8A, cooperating in a well known manner with a clutch plate 747 through a spring pressed rolling key 748. An arm 749 secured on a thread change control shaft 659 normally engages a stop 729 and an exposed outer end portion of rolling key 748, thereby holding clutch plate 747, and shaft 169a to which it is secured, disconnected from gear 745 which is loose on said shaft. However, when the incidence of perforations in the pattern

control sheet 553, Figure 1A, in proper relation to holes in pattern drum 554 effective through a link 703 or 704, Figures 11A, 11B, causes the thread change shaft 659 to rotate counter-clockwise a predetermined extent, Figure 8, the end of key 748 is released from the arm 749, and shaft 169a is rotated one turn with a corresponding turn of main shaft 6.

The aforesaid thrust or reciprocation of idling brackets 164 and 165 effected by rotation of shaft 169 is synchronized with thread carrier bar driving devices to effect any required thread change in accordance with the operation of suitable control mechanism, such for example, as that shown in part in Figures 11A, 11B.

As seen more clearly in Figures 29, 30, 31, an undercut edge portion of bracket 164 presenting an inverted flange 174 engages and supports a slide box 175. A latch lifting lever 176 having rounded ends is pivotally mounted on said box 175 between posts 177.

Slide box 175 also carries a horizontally extending pusher 178 positioned below and in vertical alignment with lever 176 and having its free end projecting beyond the adjacent end of said lever (Figures 29, 31) at a level to pass above the detent lugs 156, 157, but to engage a drive lug 151.

A link 179 has one end pivotally connected at 180 to said slide box 175 and the other end connected to slide freely along rod 181 which extends through a hole in link 179 (Figure 28). Rod 181 is supported between the ends of spaced levers, as 182, secured to and rocked by a shaft 183 having at its outer end, Figure 1A, a lever 657 connected to a lever 658 on thread change control shaft 659. Figures 8 and 8A, by a link 660.

Said shaft 659 is rotated from neutral to any one of a number of angular positions in response to suitable control devices, Figures 3, 11A, 11B, to move said box 175, and consequently said latch lifter 176 and said pusher 178 carried thereby, transversely to any desired one of various operative positions along said flange 174 of bracket 164 to determine which thread carrier bar or bars are to be actuated and which to be idled.

In each of said several operative positions of box 175 the pusher 178 is aligned to engage the drive lug 151 of the one or more thread carrier bars 20 selected for operation in the next knitting course: and the latch lifting lever 176 is in position to engage one or more latch plungers 184 mounted to slide vertically on bracket 164 above the same thread carrier bar or bars 20 as that which has the drive lug or lugs 151 in line to be engaged by pusher 178, Figure 31.

Each latch plunger 184 has a horizontally extending top flange 185 to limit downward movement. The bottom end of each such plunger is tapered to facilitate passage of said plunger if and as it is moved inwardly across a detent lug 156 or 157 with inward movement of the carrier brackets 164 and 165. One side of each latch plunger 184, Figures 29 and 30, is recessed between its ends at 186 to receive one end of said lifting lever 176; and a shoulder 187 extends from said side of latch plunger 184 just above said recess 186. A compression spring 188 mounted between said shoulder 187 and an overlying portion of the carrier bracket 164 normally biases the latch plunger 184 downwardly.

As shown in Figures 28 and 30, the latch carrier bracket 164 is also provided with a keeper lifting arm 189 extending toward driving bracket 57 and having a tapered end arranged and adapted (Figure 30) to engage rollers 159 on keeper 158 to lift the latter out of driving lug retaining position. Thus, when the parts are in the relative positions shown in Figures 30 and 31, i. e. with keeper 158 lifted, the drive lug 151b, Figure 31, last engaged thereby, is cleared by said keeper which, in raised position, Figure 30, is also ready to be lowered behind the drive lug 151a, Figure 31, of the newly selected bar 20. It will be understood that positioning, latching, releasing and controlling devices such as those above described in connection with head 152 are also associated with head 153 (right, Figure 2) for a similar purpose and so that thread changes may be made at the end of any knitting stroke in either direction.

It is assumed for the purpose of explaining the mode of operation of the improved thread change apparatus herein described that the control devices have caused slide box 175 to move from neutral, Figure 28, to an operative position on guide flange 174, in preparation for dropping a thread carrier bar 20 and picking up another selected bar 20. (Figure 31.) This brings the pusher 178 into line operatively with the drive lug 151a (so marked in Figure 31 for the purposes of this description) mounted on the selected bar which is the middle one of the five thread carrier actuating bars 20, and brings latch lifter 176 in line with the middle one, as 184a of the latch plungers 184.

Driving bracket 57 completes its movement toward the still retracted bracket 164 and into the end or change position, shown in broken lines, Figure 29, where it dwells during the over-run phase of the stitch cams.

During this period and after the above described positioning movement of slide box 175, shaft 169 is rotated one turn to cause the previously described oscillation of carrier bracket 164 from the position shown in Figure 29 to that shown in Figure 30 and back. During the initial portion thereof, the pusher 178 advances to the right and, in so doing, moves the drive lug 151a aligned therewith into position, Figure 31, to be presently engaged by the raised keeper 158 on driving bracket 57.

The driving bracket 57 has oppositely extending arms 190 which present downwardly directed cam surfaces 190a positioned and adapted to engage and depress the exposed rounded end of lifting lever 176, when said carrier bracket 164 is advanced to the right from its position, as shown in Figure 29, toward driving bracket 57 while the latter is in its left end or change position, shown dotted Figure 29. This rocks lever 176, as shown in Figure 30, thereby raising its other rounded end to engage the under side of a shoulder 187 to lift the middle one, 184a, of latch plungers 184, Figures 30 and 31, against compression spring 188 so that the lower end of said plunger 184a may pass freely above the upper end of detent lug 156a when carrier bracket 164 is returned from said extended or change position (Figure 30) to normal retracted position (Figure 29). This return movement takes place just before the next stroke of driving bracket 57 to the right.

During said forward and return movements of bracket 164, the other four latch plungers 184 thereon remain biased in operative "down" position. They are therefore set, on forward movement, to engage the detent lug, 156b, Figure 31, for example, on the bar 20 lately free to move toward the left by the lifting of keeper 158 on

driving bracket 57. On the return movement of bracket 164, therefore, detent lug 156b of said bar 20 passes under said lifted keeper and said bar is carried to retracted or idling position (Figure 29).

When said bracket 164 reaches its normal retracted position, the tapered end of lifting arm 189 is disengaged from roller 159, whereupon keeper 158 returns to a "down" or latching position in relation to the newly engaged drive lug 151a. On the next movement of driving bracket 57 to the right (Figure 28), the thread carrier bar 20 corresponding to and carrying said engaged drive lug 151a is brought into operation.

It will be noted that the middle latch plunger 184a and the one below it, as shown in Figure 31, are contiguously arranged. By moving slide box 176 to a slightly less advanced or lower intermediate operative position than that as shown in said figure, the inner end of latch lifter 176 may simultaneously engage both said latch plungers; and the outer end of pusher 178 engages corresponding adjacent drive lugs 151, so that when bracket 164 is advanced and retracted as above described, two thread carrier bars 20 are brought into operation together, as for plating or reinforcing.

The mode of operation above described applies as well to the parts having similar functions located at the right (Figure 2); and thread changes may be made as desired at either end of the travel path of driving bracket 57 in accordance with predetermined settings of suitable control devices.

My improved thread change apparatus as above described provides a sturdy and reliable mechanism which is also flexible and adaptable to knitting machines whether single or multiple employing various types of driving and widening and narrowing devices and involving full or partial automatic control.

Conditioning of needle jacks

Further objects of the present invention have been to provide improved mechanism for conditioning or positioning the needle jacks in relation to the stitch cams in a links-links or knit-purl type of knitting machine to provide means for positioning a group or groups of needles and their corresponding needle jacks in an initial phase of the knitting cycle so that the needles may be actuated to complete the cycle by relatively simple and effective stitch cams and operating devices therefor; and to provide means more completely controllable and thus more flexible to permit a wider range of selection as between needles and/or groups of needles to be rendered active or to be idled as desired. More specific aspects of said improved needle jack conditioning mechanism are claimed separately in my co-pending application Serial No. 530,764, filed herewith.

My invention as exemplified in the drawings, includes devices for moving the needle jacks 28, Figures 37 and 38, into position to be actuated by reciprocating movement of the stitch cams 34 and 35 in knitting and for moving selected needle jacks inwardly from neutral and back in the first phase of the decking cycle. These are conveniently combined with suitable selecting devices for determining which needle jacks and needles shall be so moved, whereby the action of each needle 23 is accurately controlled to produce predetermined pattern features.

Rear push-in bar

The needle position controlling devices include, in both beds, the needle jacks 28 having end butts 29 thereon. Back of the rear bed (right, Figure 36), a rear jack push-in bar 191 is mounted on and moves forward and back with an oscillatable angle bar 192 secured to end bearing blocks 204 which slide on the upwardly exposed surfaces 204a of the frame, Figure 51.

The forwardly exposed longitudinal edge of said rear push-in bar 191 engages end butts 29 of said rear bed needle jacks 28 to advance said jacks, and needles, if any, engaged therewith, inwardly, i. e. toward the narrow space between the inner edges of the front and rear beds, Figures 54 and 55, and into position for said needle jacks 28 to be engaged and actuated by the rear stitch cam 35, Figure 38.

The rack skip slots or openings 191a, Figure 3, in said exposed edge opposite end positioned needle jacks 28 in each knitting section of the rear bed, as previously described, have a function in connection with racking, whereby the butts 29 of needle jacks 28 aligned with said slots are not engaged by said edge and hence are not moved inwardly when the push-in bar 191 is advanced to push the remaining jacks 28 inwardly.

To bring said slots 191a into proper position in widening and narrowing, said push-in bar 191 is adjustable longitudinally of angle bar 192 along with a sliding nut 191b actuated by a screw shaft 846, Figure 36, connected to widening and narrowing devices, including shaft 375, Figure 3.

Front push-in bar

In the front bed, a plurality of push jacks 193, Figures 36, 37, 41, 54, 55, 60 and 61, one in each needle groove, cooperate with and control the effective needle conditioning positions of corresponding needle jacks 28. For this purpose said push jacks 193 are actuated by a front "push-in" bar 195, mounted on an angle bar 196. Various motions are imparted to said push-in bar 195 for different purposes by cam means to be described, Figures 52A, 52B and 52C.

As seen in Figures 37C, 41, 54 and 60, each push jack 193 has a short tapered nib 197 and a longer tapered nib 198 extending upwardly from its upper edge. By suitably adjusting its relation to push-in bar 195 when in pattern change position, each of said push jacks 193 is selectively conditioned either to escape engagement with push-in bar 195 and thus remain idle or to present one or another of said nibs for engagement by said push-in bar 195 to advance a corresponding needle jack 28 into one or another of its active stitch cam engaging positions.

In knitting successive courses without pattern change said push-in bar 195 is moved in regular periodic sequence inwardly toward the right, Figure 52A, from neutral or dwell (full line) position to the dotted line position, Figure 41, and then back to neutral. On each said inward movement of push-in bar 195 the active push jacks 193 engaged thereby, either through their long nibs 198 or their short nibs 197, are similarly moved; and the corresponding needle jacks 28 are thus repeatedly positioned to be actuated by the stitch cams 34 in forming said successive courses.

In connection with jacquard changes, Figure 52B, and in the decking cycle, Figure 52C, push-in bar 195 has a special return movement from said dotted line position through neutral and then outward to the broken line or change position, Figure 41. This motion is faster and greater in

extent than the normal periodic return to neutral (full line).

At the end of a decking cycle, Figure 52C, said push-in bar **195** has a special needle positioning motion inwardly from neutral to the dotted line position, Figure 41, which begins earlier and proceeds more slowly than said regular periodic inward motion. The return from this inward motion to neutral initiates the resumption of normal knitting or the regular periodic sequence above referred to.

Retractor or depressor bar

A retractor or depressor bar **194** is mounted on said angle bar **196** in spaced relation to said push-in bar **195**. During said special and more rapid motion of said push-in bar **195** outwardly to the broken line position, left Figure 41, the beveled lower edge of said retractor bar **194** moving in the same direction engages the oblique edge of long nib **198** which moves jack **193** to its extreme outer or pattern change position. Here said push jacks **193** are selectively adjustable, by suitable means, to control the position of nibs **197** and **198** in relation to push-in bar **195** and thus control the extent of the subsequent inward movement, if any, of said push jacks by the next inward motion of said push-in bar **195**.

Needle conditioning operation of front push-in bar

On moving in from the change position reached on said greater outward motion, the push-in bar **195** selectively engages short nib **197** or long nib **198** of any given push jack **193**, or neither of them, depending on whether jacquard or other suitable selecting or controlling devices shall have positioned the outer end of any such push jack **193** in its "up" (Figure 66), "middle" (Figure 67), or "down" (Figure 71) position.

When push-in bar **195** moving in from said outward position engages a push jack **193** by its short nib **197** and moves in to neutral, full line Figure 41, said push jack **193** is pushed inwardly to the A position, Figure 37, and Figure 54. Thereafter, in the knitting cycle push-in bar **195** periodically moves in to the dotted line position, Figure 41, which advances said push jacks **193** and thereby pushes the engaged needle jack **28**, Figure 55, to the A' position, Figure 37, with the middle butt **30** thereof in the path of front stitch cam **34**. Thus, the free end of any needle engaged by jacks **28** so advanced will be extended into a slot of the rear bed far enough to be engaged and received by a rear jack therein; and the needle will be drawn across and into said rear bed to form a stitch when said rear needle jacks **28** are actuated by the rear stitch cam **35** on a left to right stroke thereof. In said advance (A') position of needle jacks **28** in the front bed the heads or inner end portions of said jacks in both beds have cleared the inner edges of plates **826**, Figure 55, and are therefore free to tilt upwardly, one to release one end of the needle and the other to receive the opposite end of the needle. If no needle is initially engaged by the head of a jack **28** in the front bed as it moves into said advance (A') position, said jack engages a needle which has been simultaneously advanced by rear push-in bar **191** in the rear bed and draws said needle into the front bed to form a stitch on a right to left stroke of the stitch of the stitch cam **34**. This arrangement produces the so-called "links-links" or "knit-purl" operation.

Where on the return to neutral from said special out position, Figure 41, front push-in bar **195** has engaged a push jack **193** by its long nib **198**, said jack **193** is pushed inwardly to B position, Figure 37, and Figure 60. Thereafter, in the knitting cycle, push-in bar **195** periodically moves inwardly to advance said push jack **193** and thereby pushes the engaged needle jack **28** to its B' position Figure 37, with the middle butt **30** thereof in the path of stitch cam **34**, but not far enough for the free hook of needle **23** to be engaged by a needle jack in the rear bed, Figure 61. In this position, jacks **28** in the front bed are prevented from tilting vertically because their heads or inner end portions are held under said cross plates **826**, Figures 61 and 62. If the needle corresponding to a thus engaged needle jack **28** is in the rear bed, it will be simultaneously advanced by rear push-in bar **191** and will receive thread and form a loop by action of the needle cam in that bed. This arrangement produces "straight knitting."

Where push-in bar **195**, in moving from out position to neutral, full line Figure 41, has engaged neither of the nibs **197** or **198** of any given push-in jack **193**, the latter remains in idle position C, Figures 37 and 37C, and is not pushed in at all by the previously described periodic in motion of bar **195** to dotted line position Figure 41. Consequently the corresponding needle jack **28** in the front bed becomes or remains idle, C' position, Figure 37; and no loop is formed on its needle **23** when the stitch cams are operated in regular knitting.

The selection of jacks **193** for positioning in one or another of said A, B, and C positions, Figure 37, is effected in the illustrated embodiment by the selective jack system and associated parts indicated in Figures 41 and 66 and co-related with appropriate control devices which come into operation during each pattern or jacquard change phase.

Actuating rear push-in bar

To effect the contemplated periodic push-in function of rear push-in bar **191** simultaneously with the above described periodic "in" motion of front push-in bar **195**, angle bar **192** (rear) is biased toward its "in" position by tension springs **199**, Figure 45, operating through bell crank levers **200** pivoted at **201**, and links **202**, pivoted at **203** to said end bearing block **204**, one at each end of said angle bar **192**. As shown in Figure 51, each block **204** is provided with a threaded recess to receive an adjusting bolt **205** the head of which bears against a semi-cylindrical rocker or pivot block **206**. A set screw **207** holds bolt **205** in any desired position of adjustment.

Said rocker block **206** is positioned to pivotally engage a conforming recess provided in an upper end portion of a rear rocking lever **208** at each end of the needle bed portion of the machine and on which is pivotally mounted a cam roller **209**, Figure 51. Thus, said rear rocking levers **208** are also normally biased toward "in" position by the operation of said springs **199** and, in knitting, are periodically rocked to move said rear push-in bar **191** outwardly against resistance of said springs by cams **210** secured on collars **226** by screws **227**, which collars are keyed on shaft **9** in position to align said cams **210** with rollers **209**, Figures 51 and 52.

The extent and timing of these periodic oscillating movements of rear push-in bar 191 in normal knitting are such as to permit free outward movement of the needle jacks in the rear bed by stitch cams 35 and to effect the periodic inward movement thereof in proper relation to movements of said stitch cams 35 and of devices including the needles 23 controlled by operation of the front push-in bar and suitable push jack selecting and actuating means cooperating therewith.

Said periodic oscillation of rear push-in bar 191 is arrested by cam 766, Figure 51, engaging roller 767 during a portion of the decking cycle, i. e. while selected end needles are moved into stitch transfer position, to withhold said bar 191 from its normal inward movement which is not needed at this stage because the decker devices, such as those shown in part in Figures 36 and 46, cooperate only with needles in the front bed.

Take down roller

The above described periodic to and fro movement of rear rocking levers 208 is also used in the illustrated embodiment to actuate a take down roller 211, Figure 36, mounted on shaft 214. For this purpose one end of a pivot pin 212, Figure 52, on which cam roller 209 is mounted extends inwardly to engage and deflect a lever arm 213 secured at one end of shaft 214 and thus to actuate the conventional pawl and ratchet drive indicated in Figure 36. A spring pressed pawl 265 pivoted at 266 locks shaft 214 and take down roller 211 against rotation in the wrong direction. The web of material produced by knitting is brought down between said take down roller 211, Figure 36, and a weighted idler roller 267 held in web engaging position by suitable adjustable weights 270.

Actuating front push-in bar

The front angle bar 196 is hinged at its ends to outer end portions of plates 216 mounted to slide in the machine frame, Figure 51. At the underside of each said slide plate 216 is a recess in which spaced bearing pieces 217 and 218 are mounted to slide vertically. Each provides a part cylindrical curved bearing to receive rounded upper end portions of the outer arm 219 of V shaped front rocking levers, one at each end of the needle beds, pivoted at 220. Said slide plates 216, and hence said front push-in bar 195 and depressor bar 194 are reciprocated through the rocking motion of said levers.

A cam roller 221, Figure 51, is pivoted at 222 on each outer arm 219; and a cam roller 223 is pivoted at 224 on each inner arm 225 of said front rocking levers. Said cam rollers 221 and 223 on the front rocking levers are engaged and actuated respectively by identical sets of suitable cams, one set at each end of the needle beds.

Certain of said cams cooperate with said cam rollers 221 and 223 to position the needles repeatedly in knitting successive courses, i. e. to effect the aforesaid periodic inward motion from neutral and return to neutral of push-in bar 195. Others of said cams in each set are adjustable into and out of operative alignment with said cam rollers 221 and 223 to produce the special or additional effects incidental to decking and/or pattern changes.

Slidable cam assembly

Said adjustable cams for producing the aforesaid special or additional movements and effects are included in a slidable cam assembly, Figure 52, and are controllably adjustable into and out of operative alignment with one or the other of said rollers 221 and 223. When moved to functioning position, one of said adjustable cams, at the beginning of each pattern or jacquard change, Figures 52B and 52C, effects a faster and farther outward movement of push-in bar 195 and associated parts; and another, toward the end of the decking cycle, Figure 52C, effects a slower and earlier starting inward movement from neutral of said push-in bar 195 and therefore of the active needles than in normal knitting.

As shown in greater detail in Figure 52, said slidable cam assembly includes the flanged cam carrying collar 226 keyed on shaft 9 at each end of the needle beds and cams thereon for effecting movement of the rear and front rocking levers respectively.

Cam 210 thereon which continuously engages roller 209 on rear rocking lever 208, to actuate rear push-in bar 191 has been previously described.

"In" motion cams

An adjustable dwell cam 229 is slidably mounted on said collar 226 at one side of a fixed cam 228 and is adjustably movable to and from operative position with other cams to be described. Normally, in its operative position, as shown in Figure 52, said cam 229 does not operatively engage said roller 223 during the periodic "in" and "out" motions of push-in bar 195 produced by cams 228 and 231 respectively. However, a "dwell" portion thereof engages said roller 223 to hold said push-in bar 195 in neutral position between said periodic oscillations in normal knitting, Figure 52A.

When cam 229 is moved inwardly as hereinafter described to disengage roller 223, cam 228 remains in engagement with said roller and effects the special "in" motion of said push-in bar 195 which occurs in pattern change or jacquard operations, Figure 52B and in decking Figure 52C.

Said fixed "in" cam 228 is keyed on collar 226 in continuous alignment with roller 223 so that certain portions of said cam 228 normally engage said cam roller 223 to effect said periodic "in" motion of push-in bar 195 and thus move the active needles periodically to "in" position. This arrangement is shown in Figures 50, 51 and 52. Other portions of fixed cam 228, continuing to engage said cam roller 223 after cam 229 is disengaged therefrom, produce said special "in" motion of push-in bar 195 to neutral or dwell position from its extreme outward or jacquard change position, Figure 52B.

An adjustable "in" cam 230 slidably mounted on said collar 226 at the other side of fixed cam 228 is movable into a position to engage said cam roller 223 when said dwell cam 229 is disengaged therefrom and to impart to said front rocking lever and push-in bar 195 a special "in" motion from neutral in connection with decking, Figure 52C, which starts earlier and proceeds more slowly than the periodic "in" motion produced by cam 228.

"Out" motion cams

Front push-in bar 195 and retractor bar 194 are moved outwardly periodically to neutral position, Figure 52A and full lines Figure 41, by an "out" cam 231 slidably mounted on collar 226 and normally aligned to engage with cam roller 221.

For the special longer and faster outward movement beyond neutral in effecting jacquard changes, Figure 52B and for decking, Figure 52C, said "out" cam 231 is displaced from cam roller 221 and the latter is engaged and actuated by slidably adjustable "out" cam 232. Thus, the adjustable "in" cams 229 and 230 and the adjustable "out" cams 231 and 232 are assembled to slide as a group longitudinally on collar 226 in relation to said fixed "in" cam 228 and the cam rollers 221 and 223.

Cam adjusting mechanism

To facilitate sliding movement of said group of adjustable cams incident to jacquard and/or decking changes, the fixed "in" cam 228 has holes parallel with its axis and in which are slidably mounted spacers or sleeves 233 longer than said holes. Bolts 234 pass through said sleeves, through corresponding holes aligned therewith in cams 230, 231 and 232 and are secured in cam 229 to clamp said sleeves between cams 229 and 230 and to secure the latter to cams 231 and 232. Means including compression springs 235 normally bias said slidable cam group toward the position shown in Figures 47 and 52 from which it is moved along said collar 226, upwardly as viewed in Figure 52, against said springs 235 by suitable actuating devices and at times and under circumstances to be described.

As shown in Figures 47, 50 and 52, a pressure ring 236 is slidably mounted on shaft 9 to bear against an adjacent thrust face on or connected with cam 232 of the group of adjustable cams above mentioned and, when actuated, to slide the cams of said group inwardly against springs 235 as described. Said ring 236 has lugs 237 which support bearing pins for a pivotal connection between said ring 236 and end portions of spaced arms 238 and 239 of a yoke fixed on a transversely extending rock shaft 240 journaled in a bearing 240a of the frame. Sliding movement of the adjustably movable cams aforesaid is effected for usual pattern or jacquard changes, Figure 52B, when shaft 240 and said arms 238 and 239 are rocked in response to the actuation of suitable jacquard control devices such as shaft 256 and connected parts, Figure 50.

The position of said adjustable cams is also controlled by other means cooperating with shaft 240 to produce said special earlier starting and slower inward needle movement at the end of decking, Figure 52C.

Said rocking movements of the shaft 240, at the left end of the machine, Figure 50, are transmitted therefrom to simultaneously actuate in like manner the yoke and cam assembly at the opposite or right end of the machine through levers 271, Figure 50, and 271a, Figure 3, a rod or link 272 connecting said levers, and a ball and socket connection between lever 271a and rock shaft 240b located at the right end of the machine.

Actuating the cam group shift incident to jacquard or pattern change

As shown in Figure 47, a gear 241 fixed on shaft 9 drives a gear 242 loosely mounted on jacquard actuating shaft 243. Said gear 242 forms part of a conventional clutch mechanism and, for this purpose, has a hollowed hub 244 provided with a part cylindrical recess 244a, Figure 50, opening inwardly upon the periphery of boss 247 of a cam carrier 246 secured to shaft 243. Said cam carrier 246 and said boss 247 thereof have a bearing recess 260 which is cylindrical in the carrier and part cylindrical in the boss, said boss portion being open outwardly into the annular path of rotation of the opening of recess 244a on hub 244.

Said hub 244 is releasably connected to rotate said cam carrier 246 and jacquard shaft 243 by means including a rolling key, Figure 53, having a cylindrical body or bearing portion 245 mounted in the cylindrical recess 260 of carrier 246, a reduced bearing end 245b extending into the part cylindrical portion of said recess 260 in boss 247, and a trip arm 245a extending outwardly from the cylindrical portion of recess 260 through a radial slot 246a in carrier 246, Figure 47.

Said rolling key is mounted to rock in said cylindrical recess 260 of said cam carrier and with the outer end of its arm 245a extending beyond slot 246a and in position to be engaged by and disengaged from a trip lever 252.

An arcuate cam 248 having tapered ends extends laterally from one side of cam carrier 246 in position to engage a cam roller 249 on an arm 250 secured to rock shaft 240. When said cam carrier 246 is rotated with shaft 243 from said gear 242 through the clutch, cam 248 rocks shaft 240, arms 238 and 239, and arm 276 thereon from their normal positions, Figure 50, to deflected or operative positions.

Rotation of jacquard actuating shaft 243 is also utilized in the illustrated embodiment to actuate portions of jack selecting devices when gear 242 is operatively connected to transmit rotation thereto from gear 241 through the rolling key clutch device above described.

In normal stitch forming operation of the machine, hub 244 of gear 242 rotates freely counter-clockwise, Figure 50, around boss 247 carrying recess 244a past the reduced bearing end 245b of the rolling key. In this phase, trip arm 245a thereof is held in retracted or non-connecting position against resistance of a spring 251 by an end portion of lever 252 (full line position, Figure 50) which is pivoted at 253 and biased toward said position by a spring 254. However, spring 254 exerts relatively light tension on lever 252 compared to the expansion energy of a stronger spring 251 which is applied directly against trip arm 245a, and biases said arm toward the extended or clutch operating position (broken lines). Accordingly, at the point in rotation of hub 244 where the recess 244a thereof comes between recess 260 in boss 247 and the adjacent outer end of lever 252, said end would be deflected from the full line position, Figure 50, by the extension of said spring 251, acting through trip arm 245a except that the lower end of said lever 252 is normally blocked by a detent arm 255 fixed on jacquard control shaft 256. Said arm 255 has a detent lug 257 at its end, Figure 47, which releasably engages a terminal extension or lug 258 on lever 252. A fixed stop 259 limits the extent of downward swing of the lower end of lever 252, Figure 50.

When operation of jacquard actuating shaft 243 is required for the purposes above indicated, control shaft 256 is rotated by suitable means to one of various positions in either direction from the full line position shown in Figure 50. The extent and direction of such rotation beyond the two positions shown in broken lines depend on considerations incident to jack selection and are not here pertinent. Said rotation, however, causes detent lug 257 on arm 255 to clear and thus release extension lug 258 of lever 252. Lever 252 is now biased against the outer end of trip

arm 245a by spring 254; but said key cannot rotate in its bearing recess 260 until recess 244a in the hub 244 of gear 242 comes opposite said recess 260 and the reduced extension 245b of the key.

At that point in the normal rotation of said gear 242 and its hub 244, expansion spring 251 bearing outwardly against trip arm 245a causes said key to rotate against the relatively weak resistance of spring 254 as applied through lever 252. This rotation of said key tilts the reduced partly cylindrical extension 245b into the broken line position, Figure 50, so that a portion thereof now extends into recess 244a thus bringing boss 247 and consequently carrier 246 into driven connection with gear 242.

This operative connection and the consequent rotation of shaft 243 carry trip arm 245a beyond the key engaging end of said lever 252 which immediately snaps back to full line position where it may be again locked by arm 255 and where, at the end of one turn of said shaft, it may again engage trip arm 245a to release the clutch. Said arm 255 is returned to locking position, full line Figure 50, by reverse operation of control shaft 256.

During said single rotation of said jacquard operating shaft 243 and cam carrier 246 thereon, effected as above described, the arcuate cam 248 is revolved with said carrier to engage cam roller 249 on arm 250. This tilts and holds the arms 238 and 239 inward, (toward the right, Figure 47) and effects a corresponding sliding movement and repositioning of the above described slidably adjustable cams as a group to an advanced or operative position on collar 226 where they are held during rotation of shaft 243 for a substantial portion of the jacquard change cycle, Figure 52–B. Similar operation of like parts takes place simultaneously at the other end of the machine.

Operative effect of shifting cams

In said advanced position of said groups of adjustable cams, a portion of the adjustable "out" cam 232 comes into engagement with front arm roller 221 and, in rotating, swings front arm 219 farther out, or to the right, Figure 52, than when roller 221 is engaged only by the normally operative "out" cam 231. This moves the front push-in bar 195, the retractor bar 194, and the push jacks 193 outwardly from neutral, full lines Figure 41, to their extreme extended or pattern changing position, Figure 52B and broken lines, Figure 41.

Any desired or necessary repositioning of suitable "control" devices to vary the operative position of selected ones of the push jacks 193 is completed when push-in bar 195 and the associated push jacks 193 are in this "out" position. The next inward motion to neutral (full line Figure 41) of said front push bar 195, retractor bar 194 and push jacks 193 from said extreme out or jacquard change position is effected by cam 228 while said arcuate cam 248, Figure 50, is engaging roller 249 to hold adjustable cam 229 out of engagement with cam roller 223.

The above described cycle of out and in movements of push-in bar 195 and the interposed jack selecting and repositioning operation incident thereto, are timed to occur during the knitting course immediately preceding that in which the results of the pattern changes are to be incorporated.

Special in-motions of front push-in bar in decking

The operation of "decking" on the illustrated machine starts with a preliminary jacquard change, Figure 52B, effected during the last preceding knitting course, whereby the push jacks 193 thereby selected for advancing predetermined end needles are moved in by operation of cam 228 and push-in bar 195 from broken line position of the latter, Figure 41, to neutral, as B, Figures 37 and 60 as above described.

In the next phase of the "decking" cycle, Figure 52C, those end needle jacks 28 which are engaged by said selected push jacks 193 are advanced by the further inward movement of push-in bar 195 actuated by cam 228, from full line to dotted line position, Figure 41, to move said needle jacks and their needles to the "straight" position B', Figures 37 and 61, where the needle hooks are engaged by the advanced decker points 782 which lift the stitch loops therefrom. Rear push-in bar 191 is held in retracted position during this "in" movement of front push-in bar 195 by cam 766 on decker shaft 274.

During the subsequent "out" movement of said push-in bar 195 and for the remainder of the decking cycle, operation of the stitch or draw cams 34, 35 and of the repositioning cams 34', 35', Figures 37 and 38, is arrested. For this purpose, rotation of stitch cam drive shaft 16 is stopped by releasing a clutch, indicated generally at 13, 14, Figure 3, by suitable means actuated from a decker control shaft not shown.

Push-out bar

Continuing with the decking cycle, the needle jacks 28 of the selected needles from which the stitches are transferred in decking are now returned to neutral or idle position, Figure 60, and C', Figure 37, by push-out bar 775, Figures 38 and 46, which is moved outwardly to broken line position, Figure 38, by endwise thrust of plunger 773, Figure 46, actuated by cam 768 mounted on cam carrier 273a on decker shaft 274 through suitable connections as shown, including a bell crank 770 and a cam roller 769 thereon, Figure 50.

With said outward movement of push-out bar 775, front push-in bar 195 is moved outwardly again by cam 232 to its jacquard change or extreme "out" (broken line) position, Figure 41. The relative timing of said in and out motions of push-in bar 195 and the out motion of push-out bar 775 in a typical decking cycle are represented graphically in Figure 52C by the corresponding movement of their several actuating cams.

Actuating push out bar

Said cam carrier 273a has said push-out bar actuating cam 768 extending outwardly therefrom and movable upon rotation of said carrier into and out of engagement with cam roller 769 on bell crank 770. As seen in Figure 46, one arm of said bell crank has a handle 771 and a socket 772. The rounded outer end of a plunger 773 engages said socket 772. The flat inner end face 774 of said plunger bears against the outer end of the "push-out" or draw bar 775 extending substantially the length of the front cam housing 36 and supported adjacent to portions of the under surface thereof. Said bar is provided with sets of spaced bar retaining plates 781 and 781a having opposed oblique guide faces.

As shown in Figure 46, said front cam housing 36 is provided with an oblique slot 776 at each end to receive a pin 777 mounted on said slide

plate 781a. A spring 778 connects pin 777 with a relatively fixed pin 779 mounted on said housing 36 and biases said bar 775 toward the retracted position shown in Figure 46.

Said bar 775 is supported and its direction of movement determined by obliquely disposed flanged plates 780 engaging flanges on retaining plates 781a and secured to a portion of the under surface of the top wall of said housing 36 adjacent to slots 776. Each of said guide plates 780 is embraced by and between said opposed oblique faces of plates 781 and 781a on "push-out" bar 775.

Through the connections just described, spring 778 normally biases said "push-out" bar toward "in" position, Figures 36 and 46 and, solid line, Figure 38. However, when cam 768 engages cam roller 769 during rotation of decker shaft 274, or if bell crank 770 is actuated to like effect by hand, plunger 773 is thrust inwardly against resistance of spring 770a and imparts oblique endwise and outward movement to "push-out" bar 775, Figure 52C. The latter engages any jack end butts 29, Figure 38, which may be in its path; and, in moving outwardly to the dotted line position there shown, withdraws the corresponding needle jacks 28 and any needles thereby engaged to their initial retracted positions. Push-out bar 775 is returned to normal retracted position by operation of springs 778 as soon as bell crank 770 is restored to inoperative position by spring 770a, which occurs when cam 768, rotating with shaft 274, is moved past the point of engagement with roller 769.

While said push-in bar 195 is in said jacquard change position, the last actuated end needles are idled by narrowing and the remaining active needles are conditioned to produce any desired pattern effect in the next course.

Thereupon, the remaining active push jacks 193 are advanced by "in" motion of push-in bar 195 actuated by cam 228 to neutral position as A and/or B, Figure 37.

Special slower in motion of push-in bar

As a preliminary to resumed knitting and as the final decking step, said push jacks 193 are advanced by a further inward motion of said push-in bar 195 actuated by cam 230, Figure 52C, beginning earlier and proceeding more slowly than its normal periodic "in" motion to bring said push-in bar 195 to the usual "in" position periodically produced by cam 228 in knitting.

This advance of said push-in bar 195 and push jacks 193 carries the corresponding active needle jacks 28 and the hooks of the needles engaged thereby to the A' or B' positions, Figure 37, depending on the jacquard setting. The hooks of the end needles at each end of the row or section of active needles move relatively slowly through the several stitch loops which are held by the decker points, after a proper lateral movement thereof, in position to be received on said hooks, whereupon said loops are deposited on said hooks and the decker points are quickly withdrawn. Rear push-in bar, resuming regular operation, moves inwardly in a normal manner during the last described special "in" motion of front push-in bar 195.

For this special earlier starting, longer and slower "in" motion of bar 195 incident to the end of decking and, in effect, forming also an initial part of the needle positioning operation for the next knitting course, said adjustable "in" cam 230 is retained in engagement with cam roller 223, Figure 52C (while cam 229 remains disengaged therefrom during a longer period than that usually required for effecting jacquard change and terminating substantially with resumed knitting of the next course.

This prolonged engagement of cam 230 with cam roller 223 is effected by operation of a cam 273, Figure 47, projecting inwardly from cam carrier 273a mounted on decker shaft 274, Figure 50, in a position to engage a cam roller 275 mounted on arm 276 secured on shaft 240. Effective engagement occurs at or before the time when said arcuate cam 248 normally disengages from roller 249 after a usual jacquard change operation, Figure 52B. In effect said arm 276 remains in deflected position as previously noted; and cam 273 by moving into operative position, prevents return of said arm 276, and therefore of the group of adjustable cams, including cam 230, to normal inoperative position, Figures 50 and 52C, which, except in decking, occurs simultaneously with disengagement of roller 249 from arcuate cam 248 toward the end of an ordinary jacquard change cycle, Figure 52B.

The mechanism embodying my invention as above described provides effective and reliable needle positioning means well adapted for use in the flat bed type of knitting machine. These improved constructions and combinations are novel and particularly useful in the operation of a multiple flat bed machine provided with decking, fashioning, and/or pattern change devices actuated in whole or in part through automatic controls.

Selection of push jacks to control conditioning of needles

Further objects of the present invention have been to provide improved mechanism for the selection of push jacks to control the conditioning of needles in knitting machines, more particularly of the links-links or knit-purl type; to provide jacquard mechanism capable of operating automatically on a high speed multi-unit machine; and to provide needle conditioning mechanism whereby selective individual needle control devices may be made to cooperate effectively with widening and narrowing and other operations involving needle selection. More specific aspects of said improved needle conditioning or jacquard mechanism are separately claimed in my co-pending application Serial No. 530,765, filed herewith.

Said mechanism includes devices for determining which needles and their needle jacks shall operate or be active in any course or courses and for controlling the extent to which the selected active needles or selected ones or groups thereof will be pushed in toward stitch cam engaging position. This determines for example whether said active needles are to knit one course or successive courses repeatedly in one bed or the other (straight), or alternate courses in each bed (links-links).

In producing a knitted fabric of uniform width, the group of needles necessary thereto is selected by said devices; and the character of the fabric or its intrinsic pattern is determined in part by the concurrent selection of some or all of said group of needles for links-links and/or for straight knitting, respectively.

In producing certain fabric, selection is also made where edge or end needles are progressively idled, as in narrowing for fashioning, or in forming gussets; and said needles are restored to op-

eration again either progressively in widening for fashioning; or are all returned in two courses, as in forming gussets.

In narrowing, a further selection is also made of the end needles from which stitches are to be transferred by decking devices prior to their being dropped or rendered inactive by said progressive idling.

Certain features of the selecting mechanism for needle positioning are employed in producing both kinds of fabric (uniform width and fashioned), while other features are more particularly used in making one or the other of said fabrics.

The selections or determinative positionings above referred to are initially applied to push jacks 193, Figure 38, and by them to needle jacks 28 which in turn control the operative postions of needles 23 in relation to the stitch cams 34, 35. To effect jacquard or other pattern changes involving said determinative needle positionings, said push jacks 193 are assembled in a special change position, Figure 69, by operation of a depressor or retractor bar 194, where they are in uniform aligned relation. At this point they are in position to be selectively reconditioned or repositioned in relation to push-in bar 195 as required, and so that, when said push-in bar is next moved inwardly, any given jack will: Figure 37C, (A) have its short nib 197 engaging said push-in bar 195, which produces links-links operation; or (B) have its long nib 198 engaging said push-in bar, which produces straight knitting; or (C) have neither nib engaged by said push-in bar, which idles the corresponding needle. Retractor bar 194 and push-in bar 195 are both mounted on angle bar 196 and are therefore reciprocated therewith to and from change position together.

Among the possibilities resulting from selective repositioning of said push jacks 193 as aligned in change position are; (*a*) all or less to links-links, Figures 66 and 68; (*b*) all or less to straight knitting, Figure 67; (*c*) some to links-links and some to straight and/or some inactive, Figure 71; (*d*), some simultaneously at different portions for stitch transfer in decking; (*e*) some simultaneously at opposite edges for narrowing; (*f*) some simultaneously at opposite edges for widening; (*g*) some at one edge for narrowing in gusset forming; (*h*) some or all beginning at one edge in one course and beginning at the opposite edge in the next course for widening in gusset forming; and/or (*i*) combinations of some of the above which will suggest themselves to those skilled in flat bed and links knitting.

In effecting said angular repositioning of push jacks 193 at the change position, the outer ends of predetermined ones thereof (1) may remain as aligned, i. e. in down (idle) position, or so that no nib will be in position to be engaged by push-in bar 195, Figures 70, 71; (2) may be moved or tilted to "up" position (links-links), or so that the low nib 197 will be in position to be engaged by push-in bar 195, Figures 66, 68; or (3) may be moved or tilted to middle position (straight), or so that the high nib 198 will be in position to be engaged by push-in bar 195, Figure 67.

Said push jacks 193 are then returned to their respective dwell or neutral positions in relation to push-in bar 195 where they are releasably held in one or more subsequent courses by a locking bar 285 and other devices to be described or until the next pattern change operation. At this phase each of said push jacks 193 occupies one of the three relative positions shown in Figures 37 and 37C and identified as A, links-links; B, straight knitting; and C, idle.

Said movements of push jacks 193 while in change position and when returning to their respective dwell positions for the purposes indicated are effected in part by a series of control jacks and various devices by which the latter are selectively actuated and in part by said push-in bar 195.

Adjacent to the front needle bed, 25, is a control jack and bar carrying and guiding assembly, Figures 41, 42, 43, extending along the front of the machine and including devices for retaining, guiding and actuating various jack members, bars, and other elements which are operatively connected with and adjustably actuate the push jacks 193 and thereby determine the next needle positioning movement of the corresponding needle jacks 28 and needles mounted in the several needle slots of front bed 25.

Locking bar

Said assembly, as shown, includes a longitudinally arranged comb plate 283 having vertical slots 283*a*, Figure 42, cut in its front face to provide in effect a jack guiding and retaining comb co-extensive with the front needle bed. Said plate has a lower end relatively wide channel 284, Figures 36, 41, and 42, extending longitudinally across said front face and intersecting the vertical slots therein. Said channel 284 accommodates a horizontally disposed vertically adjustable locking bar 285 which when in "up" position, as seen in Figure 41, operates to retain certain of the pattern control jacks, as the connecting jacks 294, in their "up" or push jack locking position during knitting; and when moved thence into "down" position, Figure 69, releases and returns said jacks and others to aligned relation. The locking bar is then raised to bring said aligned jacks into an intermediate position, Figure 70, in preparation for the next selective or change operation, as hereinafter described.

An upper and relatively narrow channel 286 extending longitudinally across the front face of said plate 283 and intersecting the vertical slots 283*a* therein is provided to receive and support inner end portions of cross jacks 291 as hereinafter described. Upper end portions of said slots 283*a* are aligned with and open opposite the outer ends of corresponding needle slots in the front needle bed and receive and laterally support intermediate portions of the push jacks 193 whose inner end portions ride in said needle slots and cooperate with the needle jacks 28 therein.

As an aid to assembly of the parts as shown in Figure 41, plate 283 is provided with opposed upper and lower longitudinal V-shaped retaining grooves, of which upper groove 287 is in the upper wall of lower channel 284, and lower groove 288 is in the lower wall of said channel. These grooves receive edge portions of a composite jack and bar housing or supporting member including an upper bracket portion 289 having a V-shaped upper edge, and a lower cooperating portion 290, having a V-shaped lower edge, said upper and lower portions being co-extensive longitudinally with the front needle bed 25 and comb plate 283 and having said V-shaped edges engaged with the V-shaped grooves 287 and 288 respectively of said comb plate.

As shown in Figure 41, said upper bracket portion 289 of said composite housing supports an outer upright wall which provides a stop 292

for determining the limit of outward movement of push jacks 193 and their jacquard change position. Other portions of said assembly including the comb plate 283 serve to guide, support and limit the movement of other jacks interposed between each push jack 193 and the profile bars 277, Figure 40, and/or other jack controlling and actuating devices to be described.

Pattern control jacks

In the embodiment of needle jack control mechanism shown in the drawings, each front bed needle jack 28 renders its corresponding needle active or inactive in response to the movements of a group of jacks comprising, for each needle, the push jack 193 with its inner end or needle jack engaging portion disposed in a front needle bed groove or slot 24 and other portions in the upper end of a comb slot 283*a*, Figure 42, and control jacks cooperating with push jack 193 and having portions sliding in or engaging various portions of said comb slot 283*a*. Such a group, shown in Figure 41, and some thereof individually in Figures 66A, 66B, and 66C, respectively, includes jacks conveniently identified as main jack 293, connecting jack 294, interposed jack 295, and cross jack 291.

Main jack

Main jack 293 is a thin metal plate of irregular contour. Its upper end portion or head, Figure 66A, includes an upward extension 297 and an outward extension 298. An upper edge portion 299 provides a supporting surface for the bottom edge of interposed jack 295, Figures 41 and 69. The inner vertical edge of the head of main jack 293 presents a surface in limited sliding contact with an adjacent vertical edge 300 of the connecting jack 294, Figure 66B. Below said vertical surface of main jack 293, the latter has a downwardly disposed shoulder 301. Figures 66A and 71, adapted to engage an upwardly disposed shoulder 302 of connecting jack 294 when the parts are in the locked or knitting positions shown in Figure 41. An inner upwardly disposed shoulder 303 on main jack 293 is disposed opposite and in the path of downward movement of bottom edge portions of locking bar 285. The bottom edge 304 of the foot portion of main jack 293 lies above and across the path of movement of various jack actuating or lifting devices including the outer edge of gathering bar 327, the several profile bars 277, and the lifting plates 345. An outer upwardly disposed shoulder 305 on said jack 293 is positioned to engage and be stopped by the bottom V-shaped edge of the lower portion 290 of the composite jack retainer, and thus to limit the extent of upward movement of main jack 293 to the position shown in Figure 41.

Connecting jack

Connecting jack 294 is a flat metal plate of the contour shown in Figure 66B. The outer upwardly disposed shoulder 302 thereof, Figure 71, and its relation to main jack 293 have been referred to above. The top edge 306 serves as a vertically adjustable positioning support for the outer end of push jack 193 and engages the under edge of those portions of said jack which engage upper end portions of vertical slot 283*a* of comb plate 283. The downwardly disposed edge 307 of connecting jack 294 is adapted to rest on the top edge of interposed jack 295 when the parts are positioned as shown in Figures 41, 69, 70; but is clear of said top edge when the parts are in the positions shown in Figure 71, i. e. for idling the corresponding needles. The bottom edge 308 of jack 294 is positioned, Figure 41, to be engaged by locking bar 285 when the parts are in locked position and to be disengaged therefrom when said bar is moved downwardly to release or unlock the parts preliminary to a jacquard change, Figure 69.

Cross jack and interposed jack in fashioning

As shown in Figure 66C, each cross jack 291 is a flat metal plate provided at one side with spaced laterally extending lugs 296. These are positioned to receive between them and move the flat interposed jack 295 to and from the positions shown in Figures 69 and 71. It will be apparent that, with jack 295 interposed between shoulder 307 of connecting jack 294 and upper edge portion 299 of main jack 293, as in Figure 69, said connecting jack will be and remain raised when the main jack is lifted; but will not be or remain so raised, if interposed jack is displaced as in Figure 71.

Half of the cross jacks 291 of each needle section are provided with downwardly extending cam butts 309, and the others with similar butts 310 differently located along the length of the jack. The cross jacks 291 corresponding to needles in the left half of each needle section, Figure 43, have the butts 309; whereas the other cross jacks 291 at the right half of each said needle section, Figure 43, have the cam butts 310. The cross jacks 291, at the left in each section, Figure 43, are moved endwise by a set of cams 311 and 312 engaging butts 309 thereof and which are mounted to slide horizontally in one direction for narrowing; while those at the right in said section are actuated by a set of cams 313 and 314 engaging butts 310 thereof and mounted to slide horizontally to the same extent in the opposite direction. Thus, the number of active needles employed and hence the width of the product at any course is controllably adjustable by moving said sets of cams toward and from each other.

The cross jacks 291 and interposed jacks 295 hereinabove described also operate to progressively condition one or more needles at a time, more particularly in fashioning and gusset forming. Each increment of converging movement of said cams 311 and 313, Figure 43, for example, causes outward displacement from normal or interposed position of a predetermined number of interposed jacks 295, Figure 71, as two, or other desired practicable number, at each edge of the work in each section. This produces narrowing, since it idles the end or edge needles corresponding to said displaced interposed jacks 295 independently of any contrary selection or determination imposed on the corresponding main jacks 293 by other control devices operatively related thereto.

When cams 312 and 314 of a needle section are moved divergently from each other, they move the engaged cross jacks 291 inwardly and return interposed jacks 295 to normal interposed position, Figure 70, in relation to main jacks 293 and connecting jacks 294 which thereupon respond to positioning by said main jacks 293 and permit the corresponding needles to be restored to active operation.

The offset position of cam butts 309 on some of said cross jacks 291 in each needle section in relation to cam butts 310 on others of said cross

jacks 291 permits effective reduction down to a small number of active needles by setting at any stage or in narrowing by successive convergent movement of cams 311 and 313 toward each other.

As seen in Figures 41 and 43, inner end portions of cross jacks 291 extend into and are supported in upper channel 288 of comb plate 283. Outer end portions of the under edges of said cross jacks 291 ride on the upwardly disposed surface or shoulder 315 of a portion of the bracket member 289 where they are retained in upright sliding position by an elongated cover plate 316 having transverse slots 317 forming in effect a comb opening inwardly and downwardly and in which end portions of said cross jacks 291 are slidably engaged. Cover plate 316 is mounted on bracket 289 with part of its slotted or comb portions overlying the paths of movement of the slidable cam blocks 318 carrying said cams 311 and 312, and the slidable cam blocks 319 carrying said cams 313 and 314.

The bracket 289 provides a longitudinally extending guide rib which forms with wall portions of said bracket 289 parallel channels below said cover plate 316 to receive and support said cam blocks 318 and 319, respectively, one set thereof to each needle section. The slide rod 321 moves endwise in the outer one of said channels to actuate cam blocks 318 in the several needle sections; and the slide rod 322 operates in the inner channel to actuate the cam blocks 319 in each needle section.

Suitable means for actuating said fashioning slide rods 321 and 322, as well as the slide rods 350 and 351 which selectively position the lifting plates 345 mounted thereon, include devices, as shown in Figure 6 for example, operatively connected with fashioning control mechanism and/or with gusset forming control mechanism where those are embodied in the machine. One form of fashioning control mechanism includes the control link 802, Figures 3 and 11J; and said gusset forming control includes the link 806, Figure 11H.

As seen in Figure 42, the comb plate 283 is provided with oblique guide slots 323. Blocks 324 are secured in spaced relation on locking bar 285, as by screws 325, and slide lengthwise in said guide slots 323 where they are retained by plates 326 of which edge portions overlap adjacent edge portions of said slots at the inner side of comb plate 283. The desired up and down adjustment of said locking bar 285 is the vertical component of oblique sliding movement of said blocks 324 and is effected by suitable means to be described.

Operation of locking bar

Locking bar 285 is actuated at appropriate times in relation to operation of the aforesaid control jacks and other change devices from jacquard shaft 243 through a closed cam 334 thereon, Figures 47, 47C, 47D, and 48, and a crank arm 335 journaled in a bearing 336 of the frame and carrying at one end a cam roller 337 which engages the track of said closed cam 334, the other end of said crank arm 335 being pivotally connected to one end portion of said bar 285. When said crank arm 335 is rocked in one direction (clockwise Figure 47) by operation of cam 334 on shaft 243, bar 285 is moved obliquely to the right, Figure 42, from normal locking position (A), Figure 47D, and downwardly away from the bottom edges 308 of connecting jacks 294 to bear downwardly on the shoulders 303 of main jacks 293, thereby forcing the latter to "down" or (B) position, Figure 47D and Figure 69.

When crank arm 335 is rocked in the opposite direction (counterclockwise Figure 47), bar 285 is moved obliquely to the left and upwardly, Figure 42, toward said bottom edges 308 of connecting jacks 294, first, to the intermediate or change position, (C), Figure 47D and then back to normal knitting or (A) position, Figure 47D, and against said bottom edges of the connecting jacks raising those not previously lifted. In this position of said bar 285 all the connecting jacks are locked until released for the next jacquard change.

The cam surfaces of closed cam 334 which actuate cam roller 337 include three relatively offset portions, namely 338, 339 and 340, Figure 47C, producing said A, B and C positions respectively, Figure 47D, of said locking bar 285. When cam 334 is rotated with jacquard shaft 243 for pattern change purposes, these portions determine, in the sequence indicated, said three positions of locking bar 285 which are respectively the "up," or jack locking position, as during knitting, Figure 41, the "down," or jack releasing position, Figure 69, solid line, and the "middle," or jack selecting or change position, Figure 70. In a typical cycle, Figure 47D, locking bar 285 drops from "up" (A) to "down" (B) position; moves up to middle (C) position where it rests momentarily while the jack selecting devices are actuated; and then returns to "up" (A) or locking position at or about the time the push-in bar 195 reaches the full line position, Figure 41, or dwell, Figure 47D. The timing is such that, as push-in bar 195 moves toward said dwell position, it engages and advances any push jacks 193 whose high nibs 196 or low nibs 197 have been raised into the path of said push-in bar 195 by the preceding conditioning or change operation. Those push jacks 193 which have not been so conditioned are lifted by the said last "up" movement of locking bar 285 but reach "up" position only after push-in bar 195 has moved out of change position and are therefore not advanced by said bar into either of the two active positions.

After said return of locking bar 285 to operative locking position and during knitting, said push-in bar 195 operates in each course to actuate the selected active push jacks 193 and thus to advance the needle jacks thereby engaged. The effective position of each needle jack so advanced is determined by whether the previous operation of the push jack positioning devices at change position shall have brought the short nib 197 of push jacks 193, as in Figure 66, or the long nib 196, as in Figure 67, into position to be engaged by said push-in bar 195.

For any given course or succession of courses of knitting, and after the locking bar has been raised to "up" or locking position, some of the push jacks 193 may remain unengaged by push-in bar 195, C, Figure 37C; some may be engaged by said bar through their long nibs 196, B, Figure 37C; and others through their short nibs 197, A, Figure 37C, depending on the pattern requirements. Also, any needle controlled by a push jack 193 having its long nib 196 engaged by push-in bar 195 operates to knit in the same bed (straight) in which it is positioned when the pattern change takes place. Where, however, the short nib 197 of a push jack 193 is engaged by push-in bar 195, the corresponding needle in one bed is caused to work for the next course in the

opposite bed and thereafter, until further selection is made, alternately from one needle bed to the other (links-links) during knitting.

Profile bars

Selecting devices according to my invention also include jack lifting means in the form of pattern or profile bars, as **277**, Figures 36, 40, 41, 47 and 66–71 inclusive, suitable means for selecting and actuating the same, and means for transmitting the resulting selective effect to the push jacks **193** and thence to the needle jacks.

A typical profile bar, as shown in Figure 40, has extensions **278** at its ends which, when the bars are operatively assembled, rest on brackets **279** which provide vertical guide slots for said ends and are supported in the angle bar housing **282** extending across front portions of the machine, Figures 42, 44 and 47, and forming in effect a magazine. Other bars having top edges presenting different pattern contours, if required, are removably supported on the same or like brackets and parallel with the first mentioned bar to form a set of as many bars as may be needed for the contemplated pattern changes in the fabric being produced. The brackets **279** are removable and/or adjustable to different spaced relations to accommodate profile and other bars of different lengths, and/or other bars for a different purpose.

The irregular top edge or profile of a typical profile bar **277**, Figure 40, presents surfaces, as **277***a*, **277***b*, at different elevations for engaging the bottom edge of and lifting the main jacks **293** previously described. The lengths, numbers and relative longitudinal positions of said several surfaces, which may be widely varied, determine for certain purposes the numbers and relative positions of the needle jacks affected by the movement of said control jacks; and the relative elevation of each such surface determines whether or not the needle jacks controlled thereby become active, and if so, whether for links-links or for straight knitting. Thus, each profile bar **277** in a set is equipped to introduce one or more distinctive pattern features into the fabric at any desired course or courses of the several products in process of knitting.

Each profile bar **277** also has a set of two or more equi-spaced lugs **280** extending downwardly from its bottom edge. Said sets of lugs **280** are arranged on their several profile bars at different distances from the ends thereof. A plurality of sets of lifters **281** is supported on a slidable selector bar **502** and movable longitudinally therewith as a group in relation to said sets of lugs **280** to various operative lifting positions. Each of such positions is co-related with the set of lugs **280** of a particular one of said profile bars by the differential positioning of said lugs **280** along the length of said different respective bars **277**.

Suitable means are provided for moving or sliding said selector bar **502** endwise to and from different positions to bring lifters **281** into engagement with one or another of said sets of lugs **280**, or to neutral, or into engagement with one or another of the lugs of plate lifter bars **341** to be described. For automatic operation, a preferred embodiment of means for controllably sliding said bar **502**, including chain **511**, and link **807**, is shown in part in Figures 3, 6, and 11G.

Means for lifting said selector bar **502** at its various positions of adjustment in relation to said lugs **280** and thus to lift selected ones of said profile bars **277** through said lifters **281**, Figures 36 and 69 to 71, will be described later along with means for lifting the gathering bar **327**.

Each end of said housing **282** is secured to a plate **661**, Figure 47, mounted to slide in slots **662** provided in the frame. Thus, said housing and the parts carried thereby may be withdrawn outwardly by hand from their operative position as shown in Figure 41, for any desired or necessary purpose, for example, to replace one or more of the profile bars **277** with another or others thereof.

Gathering bar

Devices other than the profile bars **277** for engaging and lifting the main jacks **293** include an elongated angle plate, Figures 41, 42 and 47, extending across the length of the front needle bed and having a horizontal outwardly extending flange, conveniently identified as a "gathering" bar **327**. The outer edge portion thereof extends under the bottom ends of all the main jacks **293** in such a manner that, when said gathering bar **327** is raised, all of said jacks **293** are lifted a corresponding extent. Thus, the gathering bar is conveniently employed where the pattern requires a change to some arrangement whereby all the active needles operate alike either for links-links or for straight knitting.

As shown in Figures 41, 47 and 47B, a left end portion of gathering bar **327** is pivotally mounted on one arm **328** of a rocking lever pivotally supported in a bearing at **332** and having its other arm **329** pivotally connected to a spring biased push rod **330** at **331**, Figure 47. Similar suspensions are provided at suitably spaced positions along the length of gathering bar **327**. When the lever arms **328** are tilted upwardly from normal inoperative position, as by thrusting said push rod **330** to the right, Figure 47, against tension of spring **330***a* which normally biases said push rod **330** toward the left, gathering bar **327** is raised part way from its inactive or down position to lift all the main jacks **293** to an intermediate (straight) position, Figure 67. When said gathering bar **327** is raised the whole distance to its up position, Figure 66, all said jacks **293** are raised to their top or links-links position. These movements of main jacks **293** effect corresponding repositionings of push jacks **193**, except where interposed jacks **295** are in the "out" position, Figure 71.

Actuating the gathering bar and the profile bars

Said spring biased push rod **330** for lifting gathering bar **327** has at its left end, Figure 47B, an adjusting bolt **333** by which to more accurately adjust the operating relation of said push rod to adjacent selective rod actuating devices, better shown in Figures 47 and 47A, and which have operative connection with jacquard shaft **243**, Figure 51. Said devices for actuating push rod **330** are in part the same as those employed in actuating a push rod **509**, Figure 47B, which, with connected parts, operates to lift the selector bar **502** and hence the profile bar lifters **281** and thereby the profile bars **277**, previously described, and/or the adjustable lifting plates **345**, hereinafter described.

As shown in Figures 47 and 47A, the free end of adjusting bolt **333** on gathering bar lifting push rod **330** lies opposite and, in operation, is engaged by one of three end face portions of an arm **627** of a combined rod pusher pivotally connected to the upper end of a rocking lever **639** at **639***a*. The other arm **628** thereof is parallel with said

arm 627 and spaced therefrom by a weight 629 secured between them, Figure 47B. Said arm 628 which actuates profile bar lifting push rod 509 is also provided with two end face portions arranged to cooperate with the end of an adjusting bolt 638 on the end of said rod 509.

A roller 630 journaled at one side of and near the free end of said arm 628 is positioned to bear on the upper surface of an extension 631 at the outer end of a lever 632 pivoted at 633, Figures 36, 47B and 51. The free end of said combined rod pusher which includes said arms 627 and 628 is angularly adjustable in a vertical direction on pivot 629a to present said different face portions of the ends of arm 627 for engagement with said bolt 333 to actuate gathering bar lifting push rod 330; or to present said different face portions of the end of arm 628 for engagement with said bolt 638 to actuate said profile bar lifting push rod 509, or under some conditions to simultaneously present a portion of arm 627 and a portion of arm 628 for engagement with said bolts 333 and 638 respectively.

Said adjusting or vertical angular movement of the ends of arms 627 and 628 is effected by any suitable means, such for example as the devices shown in Figures 36, 47B and 51, by which said arms are operatively connected to jacquard control shaft 256. For said purposes, a link 634 connects the other (inner) end of said lever 632 with an arm 635 secured on said control shaft 256, which, as seen in Figure 50, also carries the detent arm 255 movable by rotation of said control shaft 256 in either direction to and from the inactive or full line position there shown to control operation of said jacquard operating shaft 243.

In the full line position of detent arm 255, as shown, jacquard shaft 243 is at rest; and lever 632, Figures 36 and 51, occupies its intermediate or inoperative position whereby said combined rod pusher is disposed in its middle or neutral angular position, as shown in Figure 47. When said shaft 256 is rotated in one direction from neutral, said arm 635 thereon is displaced to bring push arm 627 into position to actuate push bar 330 and thus to lift gathering bar 285 into one or another of its operative positions. When said shaft 256 is rotated in the opposite direction from neutral, arm 635 is displaced to bring push arm 628 into position to actuate push bar 509 and thus to lift a profile bar into its operative jack lifting position, and/or a fashioning bar 341 into one or another of its operative positions.

As shown more clearly in Figure 47A, the free end of arm 628 has the face portions 628a and 628b, which operate rod 509 to effect the lift imparted to the selector bar 502 and hence to profile bars 277. Arm 627 has the face portions 627a, 627b, at one side of a zero position and 627c at the other side thereof, respectively, which operating through rod 330 determine the extent of lift imparted to the gathering bar 327. Said faces are arranged in two stages of lateral projection, 628a, 628b and 627a being more extended, and 627b and 627c being less extended.

With the bolts 333 and 638 on the ends of rods 330 and 509, respectively, adjusted as shown in Figure 47B, one or the other or both of said rods will be displaced from the idle position shown by endwise thrusts of said arms 627 and 628 toward the right, depending on which of said face portions thereof are thereby brought against the ends of said bolts. The illustrated embodiment provides for angular movement of said arms 627 and 628 to bring said end faces thereof into any of four different operative positions of vertical adjustment in relation to the ends of said rods 330 and 509, two positions above and two below the zero or neutral position shown in Figure 47 at which no endwise thrust is imparted to said arms 627 and 628.

The gathering bar 327 is movable to two different elevations, the lower one for straight knitting, Figure 67, and the higher for links-links operation, Figure 66. Accordingly, the free ends of arms 627 and 628 are adjusted upwardly to bring the face portion 627b of arm 627, Figure 47A, into line with the end of push rod 330 for straight knitting; or to bring the face portion 627a into said position for links-links. In both of these positions of arm 627, the free end of arm 628 is out of operative position; and, therefore, no thrust is imparted to the profile bar actuating rod 509.

The profile bar lifting and selecting bar 502 is lifted only one step in actuating said profile bars 277 or the lifting plates 345, hereinafter described. The elevations of the several top edges of each profile bar 277 determine their effect on the pattern in terms of straight or links-links knitting, or idling.

If the free ends of arms 627 and 628 are adjusted downwardly to bring the face portion 628a opposite the end of profile bar actuating push rod 509, selecting bar 502 is lifted and the profile bars 277 control the pattern without modification from the gathering bar.

If, however, said downward adjustment of the free ends of arms 627 and 628 is of less extent than that last described and brings the face portion 628b opposite the end of said rod 509, it also brings the face 627c opposite the end of gathering bar push rod 330; and both said rods are actuated when arms 627 and 628 are thrust to the right, Figure 47. The effect on the pattern is to produce straight knitting on all needles except such as might be made links-links by profile characteristics, if any, of one of the profile bars 277 or the lifting plates 345 lifted simultaneously with the gathering bar 327.

To produce the effect first above noted on gathering bar 327, control shaft 256 is actuated to swing arm 635, Figure 36, downward through a predetermined short arc. Lever 632 is thereby tilted and raises the free ends of arms 627 and 628 to the position wherein the face portion 627b comes opposite bolt 333 on gathering bar lifting push rod 330. When said arm 627 is moved endwise toward the right, Figure 47, rod 330 is moved a short or part distance against resistance of spring 330a as described; and rod 509 is not moved. In the second raised position of arm 627, rod 330 is moved the full distance by face 627a; and rod 509 is not moved.

Profile bar push rod 509 is actuated when arm 635 on control shaft 256 is deflected upwardly, Figure 36, to bring one or the other of the face portions 628a or 628b of arm 628 down into first or second lowered position of said arm, in relation to adjusting bolt 638 on profile bar push rod 509, under the circumstances above described.

The endwise or thrust movements to the right of arms 627 and 628, respectively, above referred to are effected by the rocking lever 639, Figure 47, pivoted at 640. The lower arm of said lever 639 carries a cam roller 641, Figure 51, and is biased by a spring 642, Figure 47, in a direction to engage said roller with a cam 643 on a cam disc 644 fixed to jacquard shaft 243.

Thus, when said shaft 243 is rotated to effect a jacquard change by operation of devices for that purpose, as shown in part in Figures 47 to 51 inclusive, cam 643 engages cam roller 641 which rocks arm 639 to impart endwise reciprocating movement to the push member comprising the previously described parallel pivoted arms 627 and 628. This actuates one or the other of rods 330 and 509, depending on whether operation of the pattern control devices, at that stage, has deflected the free ends of said arms upwardly or downwardly from the neutral position shown in Figure 47, except that both rods 330 and 509 are actuated, as previously described, when said free ends are in one of their two down positions. The direction and extent of these movements is determined by control devices including the links 688, 688a, Figures 3, 11C and 11D. The timing of said movements in relation to the cycle of push-in bar 195 is shown in Figure 47E.

Jack selection for decking

Means for lifting predetermined ones of main jacks 293, more particularly to condition the corresponding needles for casting off in the decking operation which accompanies each narrowing and for another purpose to be described, includes jack lifting or fashioning plates 345, 346, means for moving said plates to and from different operative positions in relation to main jacks 293, and means for lifting said plates while in said operative positions to one or another raised position.

An intermediate element for raising the jack lifting plates 345, 346 in each knitting section is the fashioning bar 341, Figure 42, arranged at one side of and parallel with the profile bars 277, Figure 44, and having end extensions 342 which rest on the spaced shoulder brackets 279. Extending downwardly from the bottom surface of the fashioning bar 341 are spaced short lugs 343 which are actuated when it is desired to condition edge needles for casting off stitches in narrowing, said lugs being shown as insertable and removable split pins mounted in downwardly opening recesses, Figure 41.

Similarly mounted and spaced long lugs 344, offset from short lugs 343, are provided for fashioning bar 341 and actuated when it is desired to bring edge needles from the rear to the front bed, or to make a fashioned product having a links-links edge.

The lifters 281 on selector bar 502 are movable therewith on endwise adjustment of said selector bar into positions to engage either said short lugs 343 or said long lugs 344. Thus, when selector bar 502 is in one of these positions and is lifted by operation of push bar 509, said lifters 281 raise plate lifter bar 341 upwardly from its "down" position to its middle position, if engaging said short lugs 343, and to its "up" position, if engaging said long lugs 344, with different operative effects hereinafter described and which are produced through the resulting operation of lifting plates 345, 346 controllably adjustable in relation to the main jacks 293 and to each other.

The jack lifting or fashioning plates

The above described raising of plate lifter bar 341 is transmitted in each knitting section to a set of longitudinally adjustable spaced jack lifting plates 345 and 346 respectively, Figures 41, 42, 43 and 44, which are mounted to slide vertically in undercut V-slots 347 provided in carriers or blocks 348 and 349, Figure 43. To adjust the spacing between said plates 345 and 346, i. e. to move said plates toward and from each other, and thus to determine which main jacks 293 and consequently which end needles are to be affected by lifting movement thereof, said blocks 348 and 349 are slidable toward and from each other in each knitting section. For this purpose block 348 is secured to a portion of the upper slide rod 350; and block 349 to a portion of the lower slide rod 351. Endwise motion is imparted simultaneously to both of said slide rods 350 and 351, but in opposite directions, by suitable means shown in part in Figure 6 and which simultaneously actuate the previously described fashioning slide rods 321 and 322. Said blocks 348 and 349 are thereby actuated to slide horizontally in an undercut channelled longitudinally extending guide way 352, Figure 41. The direction and extent of this movement is determined by endwise movement of said slide rods 350 and 351 effected in response to control devices including the control link 802, Figures 3 and 11J, which also control the corresponding widening and narrowing endwise movements of said slide rods 321 and 322, respectively, in actuating the fashioning cams 311, 312, 313 and 314.

As shown in Figure 41, each lifting plate, as 345, includes a lower flange and an upper flange offset therefrom and connected thereto by a shoulder 353 which rests on an upper surface portion of fashioning bar 341, or in position to be raised and lowered when and to the extent that said bar 341 is raised and lowered. The top edge of said upper flange is long enough to underlie portions of the bottom edges 304 of one or more of said main jacks 293, for example five, as shown, Figure 42.

Since different pattern characteristics in knitting may require the lifting of more or fewer of the main jacks 293 for conditioning more or fewer needles at the opposite lateral edges of the work, as in connection with decking for narrowing, or for the other purposes stated, lift plates 345, 346 with upper flanges having different appropriate widths of top lifting surface or edge for affecting different numbers of needles within appropriate limits under the particular circumstances of each case may be interchangeably mounted in said vertical slots 347 of blocks 348 and 349. The extent of positioning movements of slide rods 321 and 322 is also varied to accommodate narrowing by different numbers of needles at each edge of the work.

A set of said lift plate carriers or blocks 348 and 349 is provided for each needle section; and the sets of said blocks for all needle sections are moved simultaneously by said slide rods 350 and 351. Also, each set of said blocks is effectively co-related in operation with a corresponding set of said cam blocks 318, 319. For example, the lift plate carrying block 348, Figure 44, operates with cam carrying block 319, Figure 43; and said blocks are advanced and retracted in proper synchronized relation. Accordingly, in decking for narrowing, if the pattern requires decrease of two needles, for example, at each edge of the work, the top edges of the lifting plates, as 345, 346, will be of sufficient width to lift at least that many jacks and hence to advance at least that many needles from which to remove the stitch loops as a preliminary to idling of said two needles in the next course. The several mechanisms hereinafter described for simultaneously moving said lift plate carrying blocks 348 and 349 toward and from each other and for simultaneously moving

said cam blocks 318 and 319 toward and from each other are operatively connected to affect the proper needles in each narrowing and widening operation.

In selecting for decking in advance of narrowing, the effect of raising the lifting plates 345 and 346 to middle position, as when the short lugs 343 of the plate lifter or bar 341 are engaged by the lifters 281, Figure 70A, is to insure that the so selected needles at the edges of the work shall be moved inwardly into position to have the stitch loops removed from them by the decking devices which later transfer said loops to the next adjacent needles. Said selected needles are then dropped or idled in the jacquard change for the next course, thereby nullifying any needle affecting condition which might otherwise be imposed on them by an accompanying pattern change operation of the profile bars 277 or of the gathering bar 327 in relation to the main jacks 293. If narrowing continues, said lifting plates 345 and 346 and said blocks 318 and 319, respectively, are meanwhile again moved toward each other and the cycle repeated.

The lifting plates 345 and 346, may also be raised to lift one or more main jacks 293 at each end of each knitting section to links-links or extreme "up" position, Figure 70B. In such case, selector bar 502 brings lifting lugs 281 under the long lugs 344 of lifting bar 341. When said bar 502 is then raised by endwise thrust of arm 628 through face 628a or face 628b thereof to actuate profile bar push rod 509, the needles controlled by the raised main jacks 293 will move from the rear bed to the front bed, or will operate links-links, regardless of any different mode of operation of the remaining needles.

In widening, the cam blocks 318 and 319 are moved away from each other. Hence cams 312 and 314 actuate cross jacks 291 to return interposed jacks 295 to normal position, as in Figure 41, thereby insuring that the affected edge needles will be "picked up" in the next course. If the lifting plates 345 and 346 are not actuated in said widening, the edge needles so picked up will be restored to the normal conditioning or positioning effect of profile bars 277 and/or the gathering bar 327 in relation to main jacks 293 incident to a pattern change operation. If, however, in picking up the edge needles in widening, the pattern requires links-links operation thereof, or a shift of said needles from rear to front bed, the lifting plates 345 and 346 are actuated through the long lugs 344 on fashioning bar 341 to raise selected push jacks 193 to the "up" position, shown in Figure 66.

The illustrated machine also includes devices for actuating the control jack system in a manner to form gussets. This involves a special form of narrowing wherein selected needles are idled at one end only of each course and alternately at the opposite ends of successive courses without however, casting off their loops. Narrowing is followed by a single widening step or return at each edge to normal or unnarrowed width to produce graduated fullness or a gusset in a portion of the knitted fabric, as for example, in the shoulder or nape portion of a sweater, or in other garments or products.

Actuating the needle selecting devices

As previously noted, the fashioning cams 311 and 312, Figure 43, are actuated by slide rod 321; and fashioning cams 313 and 314, by slide rod 322. The lifting plates 345 and 346 employed in decking are also moved toward and from each other for selective positioning in cooperation with the above mentioned fashioning cams by slide rods 350 and 351 respectively.

Said slide rods 321 and 322, and 350 and 351 may be actuated and controlled by any suitable means. For automatic operation in connection with the machine illustrated wherein the fashioning cams 311, 312, 313, 314 are subjected to dual control, i. e., for fashioning and for gusset forming, said means include the devices shown in Figures 3, 6 and 7. As there shown, outer end portions of said slide rods 321 and 351 are operatively connected to a sliding nut 356, which, for the purpose of actuating said rod 351, has a depending arm 357, Figure 7, supporting the outer end portion of said rod. Outer end portions of rods 322 and 350 respectively are operatively connected to a sliding nut 358. Wall portions of a longitudinally extending housing assembly 359 provide guiding and supporting interior surfaces for said sliding nuts 356 and 358. These are actuated to move back and forth endwise for fashioning by rotatable and slidable worm shafts 360 and 361, respectively, having threaded portions on which said nuts are engaged.

The outer end wall portion of housing 359 provides bearings, Figure 3, for smooth end portions of said worm shafts 360 and 361, also for the hub of a sprocket 364 which is splined on said shaft 361. A pinion 365 is keyed on the hub of sprocket 364 and meshes with a pinion 366 having hub portions journaled in said outer end portion of housing 359, said pinion 366 being splined at the end of worm shaft 360. Thus, when sprocket 364 is rotated by any suitable means, its worm shaft 361 rotates a corresponding extent in one direction; and the other worm shaft 360 rotates the same amount and at the same rate in the opposite direction. This rotation of said form shafts 360 and 361 moves the nut 356 and the rods 321 and 350 and the nut 358 and the rods 322 and 351 thereto attached simultaneously in opposite direction. This rotation of said worm controllably rotating said worm shafts to effect the resulting widening or narrowing in fashioning is indicated in part in Figures 3 and 11J and includes link 802.

For gusset forming, said slide rods 321 and 322 and 350 and 351 are actuated by sliding said worm shafts 360 and 361 endwise and thus producing the required endwise movement of the sliding nuts 356 and 358 to which said slide rods are secured. A preferred mechanism including a link 808 for controllably sliding said worm shafts endwise is indicated in part in Figures 3 and 11H.

The above described needle selection and control devices embodying my invention provide a relatively simple compact and rugged mechanism having features which adapt it particularly to high speed production on automatic machines, as where the stitch cams run up to fifty or more courses per minute.

Said devices also present advantages in multiple operation, as where a plurality of garments, or parts, are simultaneously knitted on the same machine; and the pattern of all is determined by a common pattern control mechanism.

My improved needle selection and control devices as described have great flexibility in use and are capable of being operated under automatic or other control to produce in minimum time the widest variety of textures and other pattern characteristics, some of which cannot be

produced commercially on conventional power knitting machines.

Conditioning control jacks for fashioning

Further objects of the present invention have been to provide improved mechanism for conditioning predetermined control jacks in knitting machines, more particularly of the links or knit purl type, to effect widening and narrowing in connection with fashioning; and to provide corresponding adjustments of the operative positions of decker devices, of thread feeding and thread changing devices, and of the rear bed push-in bar for racking.

More specific aspects of said improved control jack conditioning mechanism are claimed separately in my co-pending application Serial No. 530,766, filed herewith.

As shown in Figure 41, the needle jacks 28, are selectively positioned to effect narrowing and widening, as well as other pattern characteristics, by a group or set of control jacks for each needle, including the push jack 193, connecting jack 294 engaging an under edge portion of said push jack, a main jack 293, an interposed jack 295, and a cross jack 291.

In fashioning, the effect of said control jacks on the positioning of the needle jacks is determined by cross jack 291 and said interposed jack 295 engaged thereby. Thus, when said cross jack is moved outwardly, left Figure 41, interposed jack 295 is displaced from its normal operative position so that connecting jack 294 is not influenced by any positioning lift of main jack 293. Accordingly, the corresponding push jack 193 and needle jack 28 remain or become idle and the fabric is narrowed to that extent in the next course. Said jacks can be restored to active condition for widening only when interposed jack 295 again occupies its normal position between connecting jack 294 and main jack 293.

Each operation of narrowing in fashioning is accompanied by a decking operation. Where the narrowing includes idling of two needles at each edge, for example, stitches are transferred inwardly from a group of needles including said two idled needles to a group of corresponding number located inwardly and adjacent to said two idled needles. Therefore, some of said control jacks are also conditioned to position the predetermined number of needles for decking in proper synchronism with the idling or narrowing step.

Accordingly, cams 311, 312 and 313, 314 which operate said cross jacks 291, as two at each edge with each step of narrowing, are mounted on and moved respectively by endwise movement of rods 321 and 322, Figure 43. The lift plates 345 and 346 each of which imparts conditioning movement to the group of main jacks at each edge of the work selected for decking are mounted on and are moved to the extent of two needles with each step of narrowing by endwise movement of rods 350 and 351 respectively, Figure 42. Movement of rods 321, 322, 350 and 351 in the reverse directions produces the necessary changes in reconditioning of the control jacks for widening.

As shown in Figures 3 and 6, rods 321 and 351, are secured to nut 356 on worm shaft 360 and rods 322 and 350 are secured to nut 358 on worm shaft 361. Both said shafts are rotated together by suitable connections from a sprocket 364 on worm shaft 361, Figure 22, to move said nuts 356 and 358 simultaneously in opposite directions.

The mechanism presently to be described controls the direction and extent of rotation of said worm shafts 360 and 361 and of the resulting endwise movement of the several slide rods 321, 322, 350 and 351 actuated thereby. Said movement determines how many and which needles shall be involved in each widening or narrowing operation and in the decking operation immediately preceding each narrowing. Accordingly, sprocket 364 on the outer end portion of the worm shaft 361, is driven by a chain 367 actuated by a sprocket 368 on widening and narrowing or fashioning control shaft 369, Figures 21 to 25.

Mechanism is also provided whereby portions of decking, thread feeding, thread change, and rear bed needle jack pushing in or actuating devices are positioned in synchronism with said narrowing and widening movements of said slide rods 321, 351 and 322, 350 respectively.

For positioning the holder or carrier 783 of the decker points 782 longitudinally of the needle bed, connection is made between said fashioning shaft 369, shaft 375, decker drive shaft 645, and worm shaft 786, Figures 1A, 2 and 36, by which the sets of decker points, as 782, Figure 46, in each needle section are adjusted toward and from each other in narrowing and widening.

Shaft 369 is also operatively connected with worm shaft 155 and the thread and brush carrier actuating and thread carrier changing devices adjustably positioned thereby through shaft 375 and chain 655, Figures 1A, 2 and 21. Accordingly, in narrowing and widening, the thread and brush carriers operate over courses which vary in length in accordance with the number of needles idled or added; and portions of the thread change mechanism including the thread carrier retaining heads 152, 153 and connected devices are adjusted correspondingly so that a thread change may be made in any course and at any condition of widening and narrowing.

As shown in Figure 3, the rear push-in bar 191 is cut away at spaced intervals to form rack skip openings or slots 191a in its needle jack engaging edge. One such opening is provided for each needle section and is of such extent and so positioned as to lie above at least those two of the rear needle bed slots which are next adjacent to the last active needle in the direction of racking. Connection of said rear push-in bar 191 with fashioning shaft 369 to insure proper operative relation of said rack skip slots 191a under all conditions of widening and narrowing, is made through shaft 375, worm shaft 646, and shaft 648, Figures 3, 21 and 36.

As shown in Figure 24, a sprocket 371 loosely mounted on shaft 369 is driven continuously in one direction by a chain 372 from a drive sprocket 373 secured on main drive shaft 6, Figure 22.

A sprocket 374 loosely mounted on shaft 375 is driven continuously in the opposite direction by said chain 372 which also engages an idler sprocket 376 on a shaft 377.

Shaft 369 has a ratchet wheel 378, Figure 23, and a sprocket wheel 398, Figure 21A, keyed thereon at one side, left, Figure 21, of sprocket 371. A ratchet wheel 385, Figure 23, and a sprocket wheel 395 secured thereto, Figure 21A, are loosely mounted on said shaft 375 at the left, Figure 21, of said sprocket wheel 374. These devices at the left of sprocket wheels 371 and 374, respectively, cooperate with each other and with other devices to actuate shaft 369 in widening and narrowing.

Shaft 375 is actuated by similar but slightly modified devices at the right, Figure 21, of

sprockets 371 and 374 respectively to effect adjustments of decking, thread carrying and changing, and rack-skip mechanisms in connection with widening and narrowing.

Control of the direction and extent of rotation of fashioning shaft 369, and hence of the selection of needles to be idled in narrowing, or to be conditioned for return to active in widening, and control of the direction and extent of rotation of shaft 375 and hence of the direction and extent of adjusting movement of the several mechanisms thereby controlled, is effected through clutch devices operatively interposed between said shaft 369 and sprocket 371 and between shaft 375 and sprocket 374.

In the illustrated embodiment, Figures 21, 23 and 24, said sprocket 371 has a pawl supporting lug 378 extending to the left, Figure 21, toward ratchet wheel 370, and a similar pawl supporting lug 379 extending to the right but angularly spaced from said lug 378. A narrowing pawl 380, Figure 23, is mounted at the end of lug 378 in position to engage said ratchet wheel 370 keyed on shaft 369; and a similar narrowing pawl 381, Figure 25, is mounted at the end of lug 379 in position to engage ratchet wheel 384 secured to the hub 392 of a sprocket wheel 391 loosely mounted on shaft 369, Figures 21B and 25. Pawl 380 is biased by a spring 382 interposed between said pawl and an arm 383 also extending laterally from sprocket 371 adjacent to lug 378, Figure 23. A similar arrangement at the right of sprocket 371, Figure 21, biases pawl 381 by means of spring 382*a* bearing on an arm 383*a*, Figure 25.

The narrowing control devices including the ratchet wheel 370 fixed on fashioning shaft 369 and its pawl 380 cooperate with widening control devices including the ratchet wheel 385 loose on shaft 375, widening pawl 386, and the sprockets 395 and 398, Figure 21A, to control the direction and extent of rotation of shaft 369. Said pawl 386 is mounted at the end of a pawl supporting lug 387 extending to the left of said sprocket 374 loose on shaft 375, Figure 21.

As seen in Figure 25, the narrowing control devices including the ratchet wheel 384, loose on shaft 369, pawl 381, and the sprockets 391 and 394, Figure 21B, cooperate with widening control devices including the ratchet wheel 388 keyed on shaft 375 and the widening pawl 389 which is mounted at the end of a pawl supporting lug 390 extending to the right of said sprocket 374, Figure 21, to control the direction and extent of rotation of said shaft 375. As shown in Figures 21 and 21B, the sprocket 391 is loose on said shaft 369 but secured, as by screws, to hub 392 of said ratchet wheel 384, Figure 25, which is loose on shaft 369. A drive chain 393 connects sprocket 391 with sprocket 334 keyed to shaft 375, Figure 21B. Sprocket 395, Figure 21A, is loose on said shaft 375 and secured, as by screws, to hub 396 of ratchet wheel 385, Figure 23. A chain 397 connects sprocket 395 with the sprocket 398 keyed to shaft 369, Figure 21A.

The machine illustrated in the drawings provides selective clutch control devices which permit narrowing by one notch, narrowing by two notches, and widening by one notch. The same control devices determine the direction and extent of rotation of shafts 369 and 375. Although the latter operates in each instance shortly after the former, all settings and repositionings are completed in the same change cycle.

Said control is exercised in part through the pawls 380 and 386 at the left of sprockets 371 and 374 and through the pawls 381 and 389 at the right thereof, Figure 21.

Means for controlling the operation and extent of movement of the above mentioned pawls 380 and 386 and their respective ratchet wheels 370 and 385, Figure 23, and thus to actuate shaft 369 include a fixed plate 399 provided with spaced openings, one of which, left in said Figure 23, has its interior cylindrical surface 400 concentric with shaft 369 and the other of which, right in said Figure 23, has its interior cylindrical surface 401 concentric with shaft 375. The thickness of plate 399 is such as to provide an adequate guide bearing and retainer for said pawls 380 and 386, portions of which ride on the interior surfaces 400 and 401 thereof, respectively.

Pawl guiding surface 400 is interrupted by a long gap for narrowing to the extent of two needles as shown, and guiding surface 401 by a short gap, for widening to the extent of one needle, as shown. It will be apparent that when, during rotation of drive sprocket 371, Figure 24, and with the parts positioned as shown in Figure 21, the lug 378 thereon is advanced clockwise, Figure 23, the heel of pawl 380, will disengage guide surface 400 as it passes the edge 400*a* thereof, unless prevented by control means to be described. During such disengagement, the nose of pawl 380 is deflected inwardly by the spring 382 to engage a tooth of ratchet wheel 370 and so to advance said wheel and rotate shaft 369 through a corresponding angle to effect narrowing. This motion will be arrested as soon as the heel of pawl 380 re-engages guide surface 400 at edge 400*b*.

Pawl 386 operates in a similar manner but opposite direction, to effect widening, being disengaged from its guide surface 401 at edge 401*a* and re-engaged therewith at edge 401*b*, unless obstructed, as by closing of the short gap, between edges 401*a* and 401*b*. The rotation of shaft 369, when effected as above described, does not rotate sprocket 391 which is loose thereon, Figure 21B. Hence no motion is transmitted by said shaft 369 to shaft 375 through chain 393 and sprocket 394, Figure 22. These are, however, subsequently rotated to a like extent in each change cycle by devices at the right of sprockets 371 and 374, Figure 21, in a manner to be described.

Means for controlling, i. e. opening and closing, the aforesaid gaps 400*a*—400*b* and 401*a*—401*b* in plate 399 to actuate shaft 369 comprise a gate assembly including a block 402 secured to a slide bar 403 provided with a lug 404, Figure 21, and mounted to slide endwise to and from different operative positions. Controlled endwise sliding movement is imparted to said slide bar 403 by a yoke lever 405 secured at the upper end of vertical shaft 406 and actuated to advance and retract said bar different distances by any suitable means. In the automatically controlled machine, as illustrated in the drawings, an arm 405*a* on the lower end of shaft 406 is pivotally connected at its outer end with a link 802, Figure 3, which is actuated endwise to swing said arm 405*a* to and from different angular positions by means indicated in part in Figures 1A, 3 and 11J.

As shown in Figures 21 and 23, block 402 on slide bar 403 carries at one side (right, Figure 21) a narrow gate piece 407 having a cylindrical under surface which, when moved left, Figure 21, to an operative position in the long gap of frame 399, closes the same to prevent any deflec-

tion of pawl 380 during rotation of drive sprocket 371.

Spaced from said gate piece 407 and at the other (left) side of block 402, Figure 21, is a wide gate piece 408 having a cylindrical under surface 409, Figure 23, the upper portion of which extends across the whole width of said gate piece 408. The lower portion of said under surface is interrupted by a recess 410 about half the width of said surface and forming therewith a disengagement edge at 411, Figure 23. This arrangement provides in effect a gate piece with a long cylindrical under surface and an adjacent short cylindrical under surface. Thus, when said gate piece 408 is moved with a block 402 one stage to the right, Figure 21, and above the long gap with said recess 410 opposite the path of pawl 380, the heel of said pawl 380 will ride along the short under surface and disengage at edge 411. This provides in effect a short gap, (the recess 410) corresponding in extent to the short gap in guide surface 401. If the gate piece 408 is moved farther to the right to bring the unrecessed or long outer portion of its cylindrical under surface opposite the path of pawl 380, the long gap (400*a*—400*b*) will remain closed during rotation of drive sprocket 371.

Block 402 also carries a third gate piece 412, Figure 23, positioned to close short gap 401*a*—401*b* in all positions of block 402 except that wherein gate piece 407 is in position to close the long gap 400*a*—400*b* previously described.

Slide bar 403 which carries the block 402 and the set of gate pieces 407, 408 and 412, Figure 23, above described, also carries a similar block 402*a*, Figure 25, and another similar set of gate pieces, both of which sets are selectively movable simultaneously by said bar 403 to and from a neutral and three operative positions in relation to the pawls 380 and 386, Figure 23, and pawls 381 and 389, Figure 25, respectively. For example, as to pawls 380 and 386, in a first operative or extreme left position, Figure 21, of said slide bar 403, the long gap 400*a*—400*b* is closed by gate piece 407; and the short gap 401*a*—401*b*, Figure 23, is open. This permits operation of pawl 386 during rotation of sprocket 374 to actuate shaft 369 counterclockwise, Figure 23, through sprocket 395, chain 397, and sprocket 398, Figure 21A, to the extent of one notch for widening.

A second operative position of slide bar 403 is that shown in full lines in Figure 21, and wherein the long gap is full open and the short gap is closed by gate piece 412. This permits operation of pawl 380 to actuate shaft 369 through ratchet wheel 370, two notches for narrowing.

In a third operative position of said slide bar 403, the recess 410 of gate piece 408 comes opposite the path of movement of pawl 380 to actuate shaft 369 one notch for narrowing; and the short gap 401*a*—401*b* is closed by gate piece 412.

In the neutral or extreme right position of slide bar 403, Figure 21, gate piece 408 closes the long gap (narrowing) and gate piece 412 closes the short gap (widening). In this position of said gate pieces, no pawl is actuated and both shafts 369 and 375 remain at rest.

Operation of the devices for controlling the position of slide bar 403 is so timed in relation to the angular position of the pawl carrying sprockets 371 and 374 that selective endwise movements of said bar 403 occur only when the pawls carried by said sprockets are in retracted condition, i. e. with their heel portions riding respectively on the several cylindrical guiding and retaining surfaces 400 and 401 of the openings in the plate 399, Figure 23, and surfaces 413 and 414 of the openings in plate 415, Figure 25.

As shown in Figures 21 and 22, the shaft 369 has keyed thereto a notched wheel 416 cooperating with a spring pressed friction detent 417; and shaft 375 has a similar notched wheel 418 cooperating with a spring pressed friction detent 419. When for example as above described, bar 403 is in "third" position and pawl 380 is actuated to turn shaft 369 for narrowing, the extent of rotation thereof and of shaft 375 will be the equivalent of the angular distance 45° from one peripheral notch to the next on said wheels 416 and 418. The detents 417 and 419 bear frictionally on the peripheries of said notched wheel 416 and 418, respectively, to arrest rotation of shafts 369 and 375 and thus more accurately control the extent of movement of narrowing, widening, decking, thread carrying, thread changing, and rack skip controlling instrumentalities operatively related thereto.

In the embodiment shown, the pawls 380 and 386, Figure 23, operating shaft 369, control the positioning of the selective jack actuating devices in widening and narrowing; whereas the pawls 381 and 389 operating shaft 375, Figure 25, control movement of translation of the thread feeding and thread changing, the rack skip means and the decking devices. Movement is transmitted to the latter from shaft 375, through a sprocket 420 thereon, a chain 421, an auxiliary sprocket 420*a* and an auxiliary chain 421*a*, Figure 3, to a decker assembly moving shaft 645, Figures 1A and 2. Sprocket 420*a* is loose on shaft 375 and has a spring connection with sprocket 420 for controlling back-lash or lost motion. In a suitable arrangement for this purpose, not illustrated, the hub of sprocket 420*a*, for example is provided with spaced arcuate recesses, each of which receives a compression spring with one end thereof bearing against an end of the recess. Sprocket 420 has lugs each extending laterally into one of said recesses and each engaging the other end of the spring therein.

Said pawls 381 and 389 also control widening and narrowing movement of the brackets 81 and 84, Figure 2, thereby effecting equivalent adjustment of the idler gears 80 and 83 connected with thread feeding and of the heads 162 and 163 connected with the thread change mechanisms. For this purpose the screw shaft 155, Figure 2, carries a sprocket 654 driven by a chain 655 from sprocket 656 fixed at the end, right, of shaft 375, Figure 1A. The connection for control of the rack skip devices via shaft 648 is made through sprocket 653 at the inner, left, end of shaft 375, Figure 21, as previously described.

With slide bar 403 in the "second" position, a narrowing operation takes place involving a number of needles determined by the rotation of shaft 369 to the extent of two notches. If the parts be so calibrated that one notch of said angular movement corresponds to transverse movement of the narrowing cams 311 and 313, Figure 43, past one cross jack 291, and transverse movement of lifting plates 345 and 346, Figure 42, past the corresponding main jack 293, the described two notch rotation of shaft 369 effected by the control parts in their said "second" position will produce narrowing by two needles at each edge of the work. The "third" position which produces a one notch rotation of shaft 369 will, therefore, produce narrowing by one needle at each edge.

With slide bar 403 in the "first" position, as

above described, i. e. with the long gap closed and the short gap open, shaft 369 is rotated in the opposite direction from that occurring in the "second" and "third" positions. In this case, said shaft rotates only one notch which therefore produces widening at each edge of the fabric by one needle.

Considering further the mode of operation of pawls 381 and 389, Figure 25, it is noted that these pawls are mounted on the lugs 378 and 390, respectively, Figure 24, which are angularly spaced on their several sprockets 371 and 374 about 210° behind the lugs 378 (dotted) and 387 (dotted), respectively, in the direction of rotation of said sprockets, as shown by the arrows applied thereto. As seen in Figures 21 and 25, slide bar 403 carries the block 402a and a second set of gate pieces like those previously described in connection with block 402, Figure 23, and actuated simultaneously therewith to control the long gap in guide surface 413 and the short gap in guide surface 414 of plate 415. Accordingly, during each rotation of sprockets 371 and 374, with bar 403 in the first, second, or third positions, pawls 380 and 385 are actuated and shaft 369 is thereby rotated a predetermined extent and direction to effect corresponding narrowing or widening. Therefore, when the lugs 378 and 390 reach their pawl releasing positions 210° later in the same cycle of rotation of said sprockets 371 and 374, a corresponding effect is produced on shaft 375 and therefrom in a manner previously described to portions of the decking devices, to the thread feeding and change devices and to said rack skip actuating devices for imparting endwise movement to the push-in bar 191.

In terms of operating result, controlled movement of devices employed in selecting needles for widening and narrowing is transmitted from main shaft 6 through intermediate shaft 369; whereas for decking, thread feeding and thread change, and skip slot positioning in racking, corresponding adjustment thereof is effected through intermediate shaft 375. Control in widening and in the corresponding outward movement of translation or adjustment of portions of the aforesaid decking and other controlled devices is related to sprocket 374; whereas control in narrowing and in the corresponding inward movement of translation or adjustment of portions of the decking and other controlled devices is related to sprocket 371.

Manual adjustment of fashioning devices and connected mechanisms

Under conditions which require manual adjustment of the fashioning devices and other instrumentalities operatively connected therewith, lengthwise of the needle bed, shafts 369 and 375, Figure 21, are rotatable by hand. For this purpose, a hand wheel 369a is secured to an end portion of one of them, for example shaft 369, so that said shaft may be manually rotated at will in either direction when slide bar 403 is in neutral position. This directly controls the position of devices actuated by said shaft through chain 367 to narrow the fabric by idling predetermined edge needles and to widen it by restoring said needles to active condition.

Equivalent and simultaneous widening and narrowing adjustments of the decker point carriers, of portions of the thread and brush carriers and the thread change devices, and of the rack skip slot in the rear push-in bar are transmitted from said shaft 369 through sprocket 368 thereon to sprocket 391 and thus to chain 393 and shaft 375, Figures 21 and 22A.

For this purpose, said sprocket 368 is fitted with laterally extending lugs 368a and sprocket 391 with similar lugs 391a. The angular extent of said lugs and their arrangement on the respective sprockets is such that, at each rotation of shaft 369 and therefore of sprocket 368 and lugs 368a thereon in either direction from normal operating position as shown in Figure 22A, there is a lag between the beginning of that rotation and the rotation of shaft 375. For example, with shaft 369 and the lugs 368a being manually rotated in the direction of widening, counterclockwise, Figure 22A, they will turn to the extent of one notch, or the equivalent of movement of the widening devices to the extent of one needle, before lugs 391a and shaft 375 begin to rotate for widening. Also, with shaft 369 and the lugs 368a being manually rotated in the direction of narrowing, clockwise, Figure 22A, they will turn to the extent of two notches before lugs 391a and shaft 375 begin to rotate for narrowing. Therefore, after any such rotation of shaft 369 by hand and before resuming operation, said shaft must be reversed manually 45° or one notch on the notched wheel 416 from its position for manual widening and two notches from its position for manual narrowing. This adjustment restores the parts to proper operative relation, Figure 22A, for normal knitting procedure.

Manual operation of shaft 369 as above described is effected independently of rotation of main drive shaft 6, because the narrowing pawls 380 and 381 and the widening pawls 386 and 389 are maintained out of engagement with their respective ratchet wheels by the gates 408, 408a, 412 and 412a, with slide bar 403 in inoperative position. It will also be clear that the lugs 368 and 391a, Figures 21 and 22A, do not engage operatively in normal operation because the rotative movements of shafts 369 and 376 are controlled by separate clutch devices including the pawls 380, 381, 386 and 389 and ratchets 370, 384, 385 and 388 above described. Thus, in narrowing to the extent of two needles for example, or 90° rotation of shaft 369, lugs 368a, Figure 22A, are moved 90° clockwise and stop without moving lugs 391a. Thereafter with continued rotation of sprocket 371, lugs 391a on sprocket 391, are moved 90° in the same direction with hub 392 on which sprocket 391 is mounted, Figure 21B, to rotate shaft 375 the same angular extent.

Active needle indicator

As shown in Figure 21, a device for continuously indicating how many needles are idle and/or working includes an adding and subtracting instrument 422 of any suitable construction connected by a pinion 423 to a gear 424 on shaft 369. In a multiple machine, i. e. one having a plurality of needle sections, each set of cooperating front and rear knitting cams will be adjusted initially to operate over a given maximum number of needles. During full width operation, this is the number which will be indicated at the window 425. Assuming such number to be 280, the instrument will be set accordingly at the beginning of the working of a given pattern; or, if the initial courses of the work are narrower than later courses, the indicator can be set to show the actual number of active needles employed at the start. Thereafter during widening and narrowing the ind

cator reading will vary in response to each widening and narrowing rotation of shaft 369. This arrangement provides a convenient check on the accuracy of the needle selecting portions of the widening and narrowing control devices.

The above described mechanisms provide adequately flexible and positively operating devices for co-ordinating various functions in knitting machine operation. They are effectively employed especially in a full automatic multiple machine of the links type, wherein instrumentalities are provided by which the widest range of pattern variations or characteristics can be introduced into the product. Thus, where the contour of the product requires narrowing and widening steps, i. e. the idling and activating of end or edge needles in some predetermined sequence, my improved control mechanism insures not only accurate and certain idling but also the necessary corresponding adjustments of decking, thread feeding, thread changing, and rear push-in devices, the adjustment of the latter being related to racking.

Selectively positioning devices for actuating control jacks

A further object of the present invention has been to provide improved mechanism by which to selectively position devices for actuating control jacks in knitting machines, more particularly of the links or knit purl type, whereby predetermined ones of said devices may be selected to operate predetermined control jacks or sets thereof. More specific aspects of said improved mechanism and more particularly those directed to the positioning of the selector bar are claimed separately in my co-pending application Serial No. 530,767 filed herewith.

In the knitting machine shown in the drawings, the needles are positioned or conditioned to produce predetermined pattern effects by appropriate operation of the needle jacks, as 28, Figures 36 and 41, which are moved inwardly to different operative positions by push jacks 193 actuated by push-in bar 195. A set of control jacks is used in conjunction with other devices to determine the operative effect on each said needle jack and needle of each corresponding push jack 193.

Such a set of control jacks includes, Figure 41, said push jack 193, the connecting jack 294, main jack 293, interposed jack 295, and cross jack 291. Connecting jack 294 engages an under portion of push jack 193 and is vertically adjustable to vary the angular position of said push jack 193 and thus to determine whether the latter, when moved inwardly, shall cause its corresponding needle to remain idle, to knit links-links, or to knit straight.

Unless idled, as by operation of cross jack 291 and interposed jack 295, or otherwise, the connecting jack 294 is raised, when locking bar 285 is in change position, Figures 66 to 68, and 70 to 71 inclusive, by lifting main jack 293 to one or another of two positions to produce either links-links or straight knitting. This is effected by various means for different purposes: as by the gathering bar 327, to position all active needles to knit alike, i. e. all links-links or all straight; by lifter plates 345, 346, Figures 41, 42, 70A and 70B, to condition predetermined end needles for decking, in which case said end needles are positioned as for straight knitting, or to condition said end needles for links-links; and by profile bars 277, Figure 68, to differentially and selectively position the active needles, some for links-links and some straight, to produce different pattern characteristics in the same course of the knitted product.

Said gathering bar 327 is lifted by operation of push rod 330 and parts connected thereto.

Said lifting plates 345, 346 are actuated to raise main jacks 293 by raising fashioning bar 341 against an under surface thereof. This in turn in effected by raising the selector or slide bar 502 to bring the lift lugs 281 thereon against one or the other of the sets of depending short lugs 343, or long lugs 344 on fashioning bar 341, Figures 70A, 70B.

The profile bars 277 are provided in sets having different pattern producing characteristics, as the five bars shown, Figure 41. Each bar 277 has spaced depending lugs 280; and the lugs of each of said bars are differently positioned longitudinally in relation thereto from the lugs of each other bar. Said differential positioning corresponds in extent to the space between each short lug 343 and its adjacent long lug 344 on fashioning bar 341. Said bars 277 are actuated to raise main jacks 293 by raising selector bar 502 from normal position (dotted line, Figure 70) to bring said lift lugs 281 thereon into engagement with the depending lugs 280 of one or another of said sets of bars 277.

Selector bar 502 is raised to lift said fashioning bar 341 and thereby said lifting plates 345, 346 to raise said profile bars 277 through lift lugs 281 by push rod 509 and suitable devices connected therewith.

Selector bar

Means have been described above whereby the main-jack lifting instrumentalities, as the profile bars 277, the fashioning bar 341 and thereby the lifting plates 345 and 346, are raised to effect the operation of predetermined selected needle jacks 28 and their needles through corresponding sets of control jacks.

Means are also provided for determining which ones of said profile bars shall be lifted and to what level said lifting plates shall be raised while the latter are in any position of adjustment to actuate one or more predetermined or selected main jacks. One embodiment of such means and of parts operatively related thereto is hereinafter described.

As seen in Figure 42, the profile and fashioning bar lift lugs 281 are secured on a sliding carrier, as the selector bar 502, at intervals corresponding to the space between the depending selector lugs 280 on each of the profile bars 277, which is the same as that between the depending short lugs 343 and between the depending long lugs 344 on each of the fashioning bars 341. Said lift lugs 281 are thus movable with said selector bar 502 to various predetermined operative positions in relation to said profile bars and said fashioning bars where they engage one or another of said different sets of depending selector lugs 280, or lugs 343, 344 according to pattern requirements.

Selector bar 502 is supported at intervals and near its ends in suitable bearings, as the channeled blocks 503, Figures 34, 36 and 41, which are pivotally supported on levers 504, secured at the outer ends of rock shafts journaled in bearings 506. The inner ends of said shafts carry crank arms 507, Figure 41, pivotally connected at 508 to push bar 509. Said push bar 509 is reciprocated endwise against spring resistance by suitable means. This endwise movement of push bar 509 is employed to rock crank arms 507 and thereby levers 504 which raise selector bar 502

and its lifters 281 while the latter are disposed in any selected lifting position.

Devices for imparting endwise movement i. e. selective positioning to selector bar 502, and thus to lift lugs 281, include a chain 511, Figure 6, having one end connected directly to said selector bar 502 and the other end connected thereto through a spring 512. Said chain 511 is supported between idler sprockets 513 and 514; and is driven by a sprocket 515 secured on a shaft 516, Figures 33 and 34. Controlled rotation in either direction is imparted to shaft 516 by suitable clutch devices interposed between drive shaft 6 and said shaft 516 in accordance with pattern requirements.

Shaft 516 has at its inner end, Figure 34, a gear 517 which meshes with a pinion 518 on a countershaft 519. A bevel gear 520 fixed on an inner end portion of said countershaft 519 meshes with opposed bevel gears 521 and 522 loosely mounted on the continuously rotating main drive shaft 6, Figure 33, said gear 521 being mounted to turn with a ratchet wheel 523, and said gear 522, with a ratchet wheel 524.

A spring biased pawl 525, Figure 35, is pivoted at the outer end of a pawl arm 526 secured to shaft 6 and operates under controlled conditions to rotate shaft 516 in one direction through said countershaft 519. A similar pawl 527, Figure 34, is pivoted at the outer end of a similar pawl arm 528 secured to shaft 6 and operates under other controlled conditions to rotate shaft 516 in the opposite direction through said countershaft.

Means for controlling the extent of rotation of countershaft 519 when actuated by said pawl 525 are shown in part in Figure 35. A plate 529 forming in effect a fixed segment of a pawl controlling or retaining ring provides an inwardly exposed cylindrical surface 530 concentric with shaft 6 and positioned to afford a bearing for the tail portion of said pawl 525 on arm 526 by which the other end portion thereof is held out of engagement with ratchet wheel 523. Said segment defines a gap having its maximum opening extending from shoulder 531 clockwise, Figure 35, to shoulder 532. The extent of said gap is controllably varied by a rotatable ring segment 533 carried at one side of said fixed segment 529 on a spider having a central collar 534 and arms 535, said collar being loose on shaft 6. An actuating arm 536 extends radially from said collar 534 and is operatively connected with control devices, as a control shaft 537, through a link 538 and a crank arm 539 secured on said shaft 537. Said shaft 537 is connected at its outer end portion and actuated by a control link 805 through an arm 806, Figures 3 and 13, said link being moved endwise for this purpose by an automatic control device.

The rotatable ring segment 533 provides an inwardly directed cylindrical bearing surface 533a concentric with shaft 6 and of substantially the same angular extent as the gap from shoulder 531 to shoulder 532, and in effect, forms a continuation or extension of the fixed surface 530 in that the tail of pawl 525 normally rides on portions of both of said surfaces during rotation of shaft 6 to hold the nose end of said pawl out of engagement with ratchet 523. However, when during a single rotation of main shaft 6 control shaft 537 is rotated to bring said ring segment 533 into one of its operative positions, as that shown in Figure 35, for example, a gap is left between fixed shoulder 532 and the lower end shoulder 540 of said rotatable ring segment 533. When the tail of pawl 525, moving clockwise, Figure 35, with rotation of pawl arm 526 secured to shaft 6, passes said shoulder 540, ratchet 523 is engaged and turned by the nose of said pawl until further rotation of pawl arm 526 brings said tail portion of pawl 525 against shoulder 532 which disengages the nose of said pawl 525 from driving engagement with ratchet 523.

The parts are so calibrated that each rotation of ratchet 523 to the extent of one tooth thereof, effects one unit of linear movement of the selector bar 502, i. e. the distance from one operative lifting position to the next. Also, the extent of opening of the gap between fixed shoulder 532 and the lower end shoulder 540 of the ring segment 533 determines the extent of operative movement of pawl 525 and hence of ratchet 523. Thus, the various operative lifting positions of said selector bar 502 may be numbered, or otherwise identified, for pattern purposes; and suitable selective control devices are provided to govern the timing, extent, and direction of movement of said selector bar 502. It will be clear that the aforesaid controlled rotation of ratchet 523 will impart equivalent movement to bevel gear 522 and thence through the previously described connections to sprocket 515 in the direction of the dotted arrow, Figure 6. This imparts outward movement (right Figure 6) to selector slide bar 502.

Parts of like function to those above described and as shown in Figure 34, operate in a similar manner to produce controlled rotation of sprocket 515 and therefore linear movement of selector bar 502 in the opposite direction (left Figure 6). For this purpose, a separate control is provided including the control shaft 541 having a crank arm 542. A link 543 connects said arm 542 with a radial arm 544 extending from the hub 545 of a spider which supports a rotatable ring segment 546 in cooperative relation to a fixed segment 547. For controlling adjustment of selector bar 502 in said opposite direction, control shaft 541 is operatively connected at its outer end portion to be rocked by endwise movement of a control link 807 similar to link 805 and actuated by an automatic control device, Figures 3 and 11G.

A dial 548, Figures 6 and 34, is secured at the outer end of shaft 516 and carries on its beveled perimeter a series of markings, as ordinals, which identify the various jack lifting positions of bar 502. A fiducial mark or pointer 549 is fixed at a point adjacent the periphery of said dial so that an operator may conveniently ascertain which lifting position of bar 502 is currently effective at any stage of operation.

Said bar 502 will retain any given setting until moved therefrom by operation of the repositioning devices. Thus if bar 502 is at what may be designated as the fifth place it can be repositioned to the third place by a two point reverse movement. The pattern will be so laid out and the profile bars 277 so arranged that the adjustments in any direction will be within the limits of movement of the control mechanism.

My invention, as embodied in the machine above described, provides a relatively simple and rapidly acting mechanism for varying the position of the selector slide bar 502 and thereby determining which of the various profile bars 277 shall be raised or to what extent the fashioning bar 341 shall be lifted. In either case, the effect is to determine which active needles shall produce links-links and which straight knitting in any course where both are required.

The improved arrangement is especially effective when used with the devices, as shown, for automatically determining which needles shall be active and which idle in any course and with other devices cooperating therewith to produce a variety of pattern effects in knitted products.

Needle jack conditioning for gusset forming and shaping

Further objects of the present invention have been to provide improvements in needle jack conditioning mechanism to effect shaping or gusset forming in knitting machines; and to provide devices for progressively idling needles at edges of the work, either in single or multiple machines, and returning them to active knitting under various conditions to produce extra length at locations where required in the fabric. More specific aspects of said improvements are separately claimed in my co-pending application Serial No. 530,768 filed herewith.

Gusset forming or shaping

A variation in the control of fashioning devices of the type shown in the appended drawings in part supplements the jacquard and is conveniently employed to produce added fullness in certain portions of the work; and/or to create shaped end edges.

For producing said fullness or shaping, the selected needles are idled alternately at the opposite edges of the work and retain their loops instead of being idled simultaneously at both lateral edges with decking as in fashioning. Said idling in any given course is effected at that edge of the work toward which the stitch cams are moved in forming that course. After this modified narrowing over the required number of courses, all needles thus idled are restored to knitting condition. The resulting fullness or gusset-like portion, when knitted into the proper part of the back of a sweater, for example, produces in effect a garment with a slanting shoulder section having shape or fullness, thereby conforming more nearly to normal body contours at the nape and shoulder. Other useful applications will be apparent to those skilled in the art of knitting.

For the purposes above stated, parts of devices provided for fashioning, as widening or narrowing with decking, may be actuated and controlled by means operating independently of the actuating and controlling means provided for fashioning. Such fashioning parts, in the illustrated embodiment, include the narrowing cams **311** and **313**, the widening cams **312** and **314** and their actuating rods **321** and **322**, Figures 41 and 43; the actuating rods **350** and **351** for positioning the lift plates **345** and **346**, Figures 41, 42 and 44; and the nuts **356** and **358** mounted on threaded portions of the shafts **360** and **361**, respectively, Figure 3.

In fashioning with said parts, said actuating rods **321**, **322**, **350** and **351** are advanced and retracted by endwise movement of nut **356** on shaft **360** and nut **358** on shaft **361** which occurs with rotation of said shafts. But in gusset forming, said parts are actuated by endwise movement of said nuts along with endwise movement of said shafts **360** and **361**, slidably mounted for that purpose, and the blocks **427** and **426**, respectively, Figures 3, 8, 9 and 10, mounted thereon.

As seen in Figure 3, the smooth outer ends of shafts **360** and **361** are slidably supported by bearings in the end wall of housing **359** which forms a bracket **362**. Thus, when said shafts are moved endwise in opposite directions for gusset forming, nuts **356** and **358**, secured thereon by collars **428**, are moved with them and impart equivalent sliding movement to the rods **321**, **322** and the cams thereon, and rods **350** and **351** and the lifting plates carried thereby.

Idling of the needles for fashioning and gusset forming in the illustrated machine is effected by operation of the idling cams **311** and **313**, Figure 43, which are movable to engage the butts **309** of substantially one half and the butts **310** of the other half of the needle condition controlling cross jacks in each knitting section of a multiple section machine.

Each needle jack **26**, Figure 41, may be selectively conditioned: (*a*) to effect idling of its corresponding needle; (*b*) to effect links-links operation thereof, or (*c*) to effect straight knitting, depending on the operative position of its push jack **193**. Said position is determined by a set of control jacks, Figure 41, including a connecting jack **294** engaging said push jack **193**, a main jack **293**, an interposed jack **295**, and a cross jack **291**. When interposed jack **295** is positioned between main jack **293** and connecting jack **294**, as shown in Figure 70, push jack **193** can be conditioned, i. e. angularly adjusted, by suitable devices operating through main jack **293** to render its needle active. However, with interposed jack **295** withdrawn from between main jack **293** and connecting jack **294**, Figure 71, push jack **193** will not be moved inwardly by push-in bar **195**. Its needle will, therefore, be or remain idle, regardless of the operation of any other pattern controlling device having the effect of raising main jack **293** to an active position.

Idling or narrowing at one side of the work (left) is effected in any course by moving the narrowing cam **311** to the right, Figure 43, by means of rod **321**. Said cam thereby bears successively against depending lugs **309** of one or more cross jacks **291**; and moves the latter outwardly (left Figure 41), thus displacing corresponding interposed jacks **295**. For narrowing at the right side, Figure 43, rod **322** and narrowing cam **313** thereon are moved endwise to the left, thus moving outwardly the cross jacks **291** having the depending butts **310**. When said respective rods are moved in the opposite directions, the restoring or widening cams **312** and **314**, operatively engage the depending lugs **310** and **309** respectively, to push the corresponding cross jacks **291** inwardly and return interposed jacks **295** to normal operative position, as in Figure 41.

In fashioning, the narrowing and widening changes just described occur simultaneously at opposite sides or edges of the work and involve one or more needles at each side. In the illustrated machine, automatic narrowing by one or two needles at each edge and automatic widening by one needle at each edge in any course, are effected through suitable control devices shown in part in Figure 3. However, in forming gussets or the like, the number of needles idled at one edge of the work in any course may be more widely varied, as up to six needles, for example, in the illustrated machine; and all needles idled at one side in one or more previous courses may be returned to active condition in one course (rapid return).

Narrowing or shaping without decking in gusset forming

Said blocks **426** and **427** through which endwise

movement is imparted to rods 321, 322, 350 and 351 in gusset forming are loosely mounted on the smooth end portions of said worm shafts 361 and 360, respectively, on which the nuts 356 and 358 are threaded to permit rotation of said shafts in relation to said blocks for effecting fashioning. Said blocks are held against endwise movement on said shafts between retaining collars 428 secured to said shafts at each end of said blocks.

As seen in Figures 3 and 8, said blocks 426 and 427 are also mounted to slide on and are guided by interior surface portions of the housing 359. In fashioning, these blocks are releasably locked in inoperative condition, as shown in Figure 3, with a right end portion of block 427 overlapping a left end portion of block 426; and the smooth or unthreaded ends of shafts 360 and 361 rotate freely therein.

In gusset forming or shoulder slant narrowing, however, block 426, after release, is moved to the left, Figure 3, in one course; and block 427, to the right in another course, in predetermined increments depending on the number of needles to be idled in each narrowed course. These movements transmit corresponding narrowing displacement to shafts 360 and 361 and thence to the cams, as 311, 312, etc. and lifting plates 345 and 346, alternately at opposite edges of the work, although said lifting plates here perform no function in relation to decking, since none is required.

The top surfaces of said blocks are provided with sets of transversely extending obliquely disposed teeth to form respectively a ratchet 429 on the inner block 426 and a ratchet 430 on the outer block 427. The outer faces of the teeth of ratchet 429 are exposed obliquely to the left and those of ratchet 430 are exposed obliquely to the right, Figures 9 and 10.

Said blocks 426 and 427 also have sets of downwardly directed teeth forming an inner rack 431 and an outer rack 432, respectively. Each block has a longitudinally extending smooth under surface portion interrupted by a notch or recess 433, Figure 8. When the blocks are in their normal inoperative or "zero" position, the tapered upper end of a locking detent 434 mounted in the housing 359 and biased upwardly by a spring 434b engages the V-notch 433 of inner block 426; and the tapered end of a similar detent 434a biased upwardly by a spring 434c engages the V-notch 433 of outer block 427.

At the lower end of the shank of each upwardly biased detent 434, 434a, is a laterally extending lug 435 which bears yieldingly against the bottom edge of a cam bar 438 slidably mounted in a transverse slot having an opening 439 through the outer side wall of the housing 359, Figure 8. Said bottom edge of cam bar 438 is interrupted by two end recesses having oblique portions forming the cam surfaces 436 and 437, respectively, and by an intermediate recess 436a adjacent to cam surface 436.

An inner end portion of said cam bar 438 is connected by a link 458 with a lever 459 secured at an intermediate portion of a control shaft 460 which is rocked to and from different angular positions by any suitable means, as, in the illustrated embodiment, by the operation of automatic control devices of which parts, including link 808, are shown in Figures 3 and 11H.

As seen in Figures 8, 9 and 10, the housing 359 has a top opening 440 through a portion of its top wall above the ratchets 429 and 430. A sliding reciprocatable head 441 carries a pair of plunger pawls 442 and 443, respectively, which are spring biased downwardly and extend through said opening 440. Pawl teeth provided at the lower ends of said pawls and which, in gusset forming operation, cooperate with the ratchets 429 and 430 respectively, are held normally in "up" or disengaged position above said ratchets by the head 444 of a spring pressed plunger 445 when the latter is held in "up" position. A tension spring 445a biases said plunger 445 downwardly, Figures 8 and 9. But the bottom end of said plunger 445 normally bears on a portion of the top edge of cam bar 438 at one side (left) of notch 446 to hold plunger 445 in "up" position. Thus, the head 444 of said plunger, normally engages the downwardly exposed shoulders 447 of said spring biased plunger pawls 442 and 443 and holds said pawls in "up" position and out of engagement with their respective ratchets.

As seen in Figure 9, the head 441 which carries said pawls 442 and 443 is pivotally connected to one end of a link 448 at 449; and periodic reciprocating movement is imparted thereto by means including a lever 450, Figures 4 and 6, secured at an outer end portion of a transverse rock shaft 451, Figure 7. Lever 450 has a curved slot 452, Figure 6, adjacent to which may be placed indicia, as numeral markings, to indicate different effective lengths of said lever which correspond to different numbers of needles to be involved in a given shoulder slant or gusset narrowing operation for any course or courses. Accordingly, the outer end of link 448, is releasably and adjustably secured to said lever 450 by suitable means, as a bolt 453, Figure 6, extending through said slot at one or another of said indicated positions. Suitable adjustment of said connection along slot 452 selectively determines the length of stroke of head 441 and, therefore, of the plunger pawls 442 and 443.

Regular periodic reciprocating movement of head 441 is effected through said lever 450 from the cam shaft 9 which has the bevel gear 12 meshing with bevel gear 15 on transverse shaft 16, Figure 4. As seen in Figures 4 and 7A, rock shaft 451 carries a lever 454 near its inner end. A cam roller 455 at the free end of said lever 454, is disposed in the paths of a crescent cam 456 and a lobe cam 457 on the rear surface of said bevel gear 15, Figures 6 and 7A. When the free end of lever 454 is rocked to its down position, dotted line Figure 6, head 441 is brought to its extreme left position. Continued turning of gear 15 brings lobe cam 457 into engagement with cam roller 455 thus rocking said free end of lever 454 into "up" position, whereby head 441 is brought to its extreme right position. The extent of this movement of head 441 will, of course, be determined by the relative position of engagement of link 448 along curved slot 452, as previously described.

To release said blocks 426 and 427 from locked engagement with locking detents 434 and 434a and to release said plunger pawls 442 and 443 into engagement with the racks on said blocks to produce shoulder slant narrowing, the cam bar 438, Figure 8, is thrust outwardly, left, from the position shown in Figure 8, to that shown in Figure 8B. This is done by rocking control shaft 460 counterclockwise a predetermined extent to its first or narrowing operative position. The oblique cam edges 436 and 437 at the under side of cam bar 438 thus come into engagement with said lugs 435 to withdraw the locking detents 434 and 434a from notches 433 in the under

surfaces of blocks 426 and 427, Figure 8B. At the same time, notch 446 in the upper surface of cam bar 438 comes opposite the bottom end of plunger 445 which slides down into said notch 446. This releases head 444 of said plunger from engagement with shoulders 447 of the plunger pawls 442 and 443 which are now spring pressed downwardly into operative engagement with the ratchets 429 and 430 respectively.

The setting of the parts for narrowing, as above described, is timed to occur between successive strokes of pawl head 441 in opposite directions. On the next succeeding stroke thereof, one of said plunger pawls, as 443, operatively engages the ratchet 430 of the outer block 427 moving it to the right, Figure 3, while pawl 442 rides over ratchet 429 of the inner block 426, whereupon the desired number of needles, as indicated at the edge of slot 452, Figure 6, are idled at one side of the work in the next knitting course.

The following or return sroke of pawl head 441 to the left produces a similar effect on a like number of needles at the opposite edge of the work in the next knitting course by bringing plunger pawl 442 into actuating engagement with ratchet 429. This moves block 426 to the left, Figure 3, while pawl 443 rides over ratchet 430 of block 427. The mode of operation here described may be repeated in successive courses until the desired number of needles have been idled at opposite ends of alternate courses, at which time a different setting or angular positioning of control shaft 460 is made to restore or return the idled needles to active condition.

Quick return from narrowing in shaping or gusset forming

The rack 432 on the under side of outer block 427 continuously engages a gear 461 on a countershaft 462; and the rack 431 on inner block 426 engages a gear 463 on another countershaft 464. In the narrowing operation above described, each of said racks successively rotates its connected countershaft, one in one direction, the other in the opposite direction, arrows Figure 6, to a cumulative extent corresponding to the total number of needles idled in one or more courses of narrowing at one side of the work.

These racks 432 and 431 and gears 461 and 463, along with other connected devices, are thereafter moved in reverse to rapidly return the blocks 427 and 426 to "zero" position and thus to restore the previously idled needles to active knitting condition by a rapid operation as compared to the widening procedure in fashioning. More specifically, for shaping or gusset forming, in each knitting section, all the cumulatively idled needles at one edge are returned to knitting condition in one course; and all the cumulatively idled needles at the other edge are returned in the next following course. The restoration of needles in any given course is effected at that edge of the work toward which the stitch cams are moved in forming that course.

As seen in Figures 4, 6 and 8, counter-shaft 462 carries at its inner end a bevel pinion 465 which meshes with a bevel gear segment 466 mounted on a hub 467 loosely supported on the "rapid return" shaft 468. Hub 467 also carries a radially extending pawl arm 469 at the free end of which is pivoted a spring biased pawl having a trip 470 at one end and a laterally extending detent 471 at its other end, Figures 4 and 8. A fixed stop in the form of a bolt 472 is threaded in the machine frame with one end extending adjustably into the path of movement of said trip 470.

As indicated in Figure 4, a bevel pinion 473, a bevel gear segment 474, a hub 475, a pawl arm 476 having a trip 477 and a detent 478, and a bolt or stop 479 like those just described are provided for cooperation with said other countershaft 464.

Between said hubs 467 and 475, a collar 480 is secured to shaft 468. One portion (180°) of its peripheral surface is of spiral contour interrupted to form the shoulder or movable stop 481; and another portion (180°) of its peripheral surface of similarly spiraled contour is interrupted to provide shoulder or movable stop 482, Figure 8, angularly spaced 180° from shoulder 481, both of which face counterclockwise. The detents 471 and 478 extend into the paths of rotation of said shoulders or stops 481 and 482 respectively.

As the bevel gear segments 466 and 474, loosely mounted on said return shaft 468, are rotated alternately, in narrowing successive courses, by the bevel pinions on countershafts 462 and 464, respectively, the pawl arms 469 and 476 secured on said segments are deflected clockwise a corresponding angular extent, Figure 8. Thus, the pawl arm 469 is moved step by step from a normal zero position, clockwise, toward the shoulder or stop 481 which, at this phase, is angularly positioned as shown in said Figure 8. With said clockwise movement of pawl arm 469, detent 471 thereon rocks counterclockwise into position to be engaged by shoulder 481. The detent 478 is carried with rotation of arm 476 in the same angular direction toward shoulder or stop 482. Thus, the aggregate angular displacement of pawl arms 469 and 476, respectively, during such narrowing is a measure of the extent of reverse movement effected on the "rapid return" to restore the idled needles at the opposite edges of the work to active knitting condition.

In effecting said rapid return, shaft 468 is rotated 360° counterclockwise, Figure 8, which actuates collar 480 thereon and thus rotates said shoulders 481 and 482 counterclockwise. Said rotation of shoulders 481 and 482 imparts return movement first to detent 471 and then to detent 478, to actuate and so reverse the endwise movement of blocks 426 and 427 in the same sequence.

Said quick return is thus made in two steps, each of which widens one side or edge of the work during said counterclockwise 360° rotation of return shaft 468. Thus, in the first 180° of rotation of said shaft, shoulder or stop 481, in moving 180° counterclockwise, engages detent 471 and thereby pushes pawl arm 469, bevel gear 466, gear 461 and block 427 back to their initial or zero positions before narrowing. When block 427 reaches zero position, it is again locked by engagement of outer plunger 434*a* with its V-notch 433.

To bring about the first return step, the cam bar 438 is moved by the control devices to its most extended (left) position, Figure 8C, where recess 436*a* comes opposite the lug 435 on detent 434*a* which is therefore free to move up to locking position, although detent 434 is still held in down position by cam bar 438. And plunger 445 riding on the top edge of cam bar 438 and out of recess 446 is raised to lift the pawls 442 and 443 out of engagement with the ratchets on blocks 426 and 427 which are thus free to return to their respective initial or zero positions.

On the return of block 427 to zero position by operation of the means described, the top end of detent 434*a* snaps into the V notch 433 there-

of. At this point also, the trip 470, in rotating counterclockwise with shoulder 481 and return shaft 468, encounters the end of fixed stop 472, whereupon detent 471 is rocked upwardly and out of the path of movement of shoulder 481; and return shaft 468 completes its first 180° rotation. The first widened course is now run by the knitting cams.

In the second and final step of "rapid return," which occurs in advance of the next knitting course, further or continued rotation of return shaft 468 to the extent of 180° in the same direction as before brings shoulder 482 to bear against detent 478, thereby returning pawl arm 476 and connected parts including block 426 to their initial or zero positions before narrowing. When block 426 reaches its zero position, it is again locked against endwise movement by engagement of detent 434 with the notch 433 in said block 426.

To effect said second and final return step, cam bar 438 is moved endwise to the right from the position shown in Figure 8C and thus back to its normal or initial position, Figure 8, by a clockwise turn of control shaft 460. This brings the inner notch on the lower edge of said cam bar 438 opposite the lug 435 on detent 434 which is thus freed to move up to locking position. In this reverse movement of cam bar 438, the lower end of plunger 445 rides across and beyond recess 446; and plunger 445 is brought to its initial "up" position, Figure 8, thereby holding the plunger pawls 442 and 443 disengaged from their ratchets on blocks 426 and 427.

With said clockwise turn of control shaft 460, roller 497, Figure 4D, on arm 498 is caused to disengage and free the tapered end of racking lever 491; but shaft 468 continues rotation. As shaft 468 continues to rotate into its second 180°, the detent 478, Figure 4, is moved counterclockwise by shoulder 482, Figure 8, and is rocked upwardly and out of the path of movement of said shoulder when trip 477 encounters fixed stop 479 at the end of said second 180° of rotation of shaft 468. Shoulders 481 and 482 now occupy their initial relative angular positions, as shown in Figure 8.

Rotation of shaft 468 and of the collar 469 thereon, synchronized with the several endwise movements of cam bar 438, as above described, is controlled from control shaft 640 through a clutch having parts operatively interposed between said shaft 468 and main shaft 6. As shown in Figures 4, 4D and 4E, a gear 483 is loose on said main shaft 6 adjacent to the hub 484 of gear 7 secured to said main shaft 6 and having a laterally exposed notch 485. Gear 483 has a hub 486 provided with an annular groove 487. A spring biased plunger 488, Figure 4E, is slidably mounted in a transverse recess 489 which, at one end, opens through the web of said gear 483 and at its other end intersects a portion of said annular groove 487. One end of said plunger, when extending into notch 485, provides a latch by which said gear 483 is releasably held in driven engagement with the hub of gear 7. Rotation is thereby imparted to gear 490 secured on shaft 468 and controlled to effect a single complete rotation of return shaft 468 for two complete rotations of gear 483.

As seen more clearly in Figures 4D and 4E, the position of clutch plunger 488 which is biased by spring 489a toward engagement with notch 485, is controlled by the spring biased rocking lever 491 pivoted at 492. The left end, Figure 4D, of said lever 491 is bevelled at 493 to engage a shoulder 494 of the plunger 488, when said left end of lever 491 is held by spring 495 in the declutching, or down position shown in Figures 4D and 4E.

The right end of lever 491 is tapered to present an oblique upper surface 496 in the path of cam roller 497 on lever 498 (dotted, Figure 8) which is secured at the inner end of shaft 460, Figure 4. Rocking lever 491 also has a vertically extending arm 499, an end portion of which is normally disposed in the path of rotation of a portion of cam 500 projecting from the hub 501 of gear 490, Figure 4D.

At times when rapid return widening is not in effect, the bevelled end 493 of lever 491 lies in the annular groove 487 and holds plunger 488 in retracted non-clutching position, Figure 4.

To effect the shoulder slant narrowing previously described, control shaft 460 is rotated or rocked an initial extent which also rocks end lever 498 thereon counterclockwise, Figure 4D, sufficiently to bring roller 497 into a position over the tapered end 496 of lever 491 but not far enough however, to press said end of lever 491 downwardly.

To effect return of the needles idled at one side of the work by the narrowing operations previously described, control shaft 460 and therefore lever 498 are first rocked or rotated counterclockwise to a greater extent than for said shoulder slant narrowing. This greater rotation of shaft 460 carries roller 497 on lever 498 downwardly against the tapered end 496 and so rocks lever 491 against tension of spring 495 to disengage its other or bevelled end 493 from plunger 488 which then snaps into clutching engagement with notch 485 and so initiates the first 180° rotation of return shaft 468 during which the first return step is effected.

To effect return of the remaining needles idled at the other side of the work control shaft 460 is rotated or rocked clockwise back to its initial or normal position, Figures 4D and 8; and rotation of return shaft 468 continues as hereinafter described until it has completed 360°.

Rotative or rocking movements of control shaft 460 to and from said different operative positions are effected by any suitable means, here shown as automatic control devices including the control link 808, Figures 3 and 11H, connected to shaft 460 by an arm 809 cooperating with other instrumentalities.

The first 180° rotation of the return shaft 468 as above described, effects return, through gear 461 and block 427, of the needles previously idled at one side of the work. At this point, those portions of the clutch devices connected with gear 7, including loose gear 483 and clutch plunger 488, have turned 360°. Said plunger 488 would be disengaged from notch 485 by the bevelled end 493 of lever 491, if the latter were here returned by spring 495 to the normal angular position shown in Figure 4D—which, unless prevented, would occur upon the above described clockwise rotation of control shaft 460. However, to insure the further continued 180° rotation of return shaft 468 for the final widening step, the crest of cam 500 which has turned 180° with return shaft 468, is now in position to bear against and hold vertical arm 499 and therefore lever 491, in tilted position, as when lever 491 is initially rocked clockwise by roller 497 on arm 498. This holds rocker lever 491 disengaged from annular groove 487 until continued rotation of gear 483 carries the plunger 488 past its clutch disengaging position.

As appears from the foregoing description and stated mode of operation, apparatus according to

my invention affords an effective and relatively simple means for conditioning the needles in a knitting machine so as to produce products having fullness. When applied to a full automatic machine, wherein provision is made for fashioning, said gusset forming or shaping devices utilize portions of the fashioning devices, thus attaining the additional production features with a minimum of special or additional parts.

A further advantage of my improved device, as described, is that it operates effectively with automatic control at high knitting speeds, i. e. of the order of 45–55 courses per minute on a multiple unit machine.

Decking and decker point

Further objects of the present invention have been to provide an improvement in decking mechanism for flat links knitting machines; to provide decking devices which are adapted to operate effectively in automatic knitting machines of the links type; and to provide an improved decker point construction which can be mounted and controlled to cooperate with a needle of the latch type in a manner to remove stitch loops therefrom and deposit stitch loops thereon regardless of whether the latch is then open or closed. More specific aspects of my invention as aforesaid relating to improvements in decking mechanism are separately claimed in my co-pending application Serial No. 530,769 filed herewith, and in my co-pending application Serial No. 574,451 filed January 25, 1945.

Decking

The decker mechanism of the type shown in the accompanying drawings comprises devices for removing or casting off stitches from predetermined needles in the front bed, transferring said stitches laterally, and placing them on other selectively conditioned needles. Although the decker mechanism is described herein as operating on edge needles, as in fashioning for example, it is contemplated that parts thereof may also be employed in knitting lace designs, eyelet effects, feathered designs and cable stitch effects.

Instrumentalities provided for selecting and positioning said predetermined edge needles for decking include the lifting plates **345** and **346**, the fashioning bar **341**, and slide rods **350** and **351**, Figures 41, 42 and 44; and for idling or activating respectively in fashioning, include the narrowing or idling cams **311** and **313** and the widening or activating cams **312** and **314**, Figures 41 and 43, and parts operatively associated therewith, as the slide rods **321** and **322**. These instrumentalities cooperate with a main jack **293**, a connecting jack **294**, an interposed jack **295** and a cross jack **291** operating as a set to condition each push jack **193** whereby the corresponding needle is selectively positioned for decking, as well as for other purposes, through its needle positioning jack **28** and suitable actuating devices as the push-in bar **195**.

The selection and conditioning of the push jacks **193** which control the operative position of those predetermined needles from which the stitch loops are to be cast off, in a given decking operation incident to narrowing, is accomplished by actuating the lifting plates **345**, **346** during the pattern or jacquard change phase of the last knitting cycle preceding the decking cycle in which the stitches are cast off.

In the casting off or decking cycle, the selected needles are advanced to straight knitting condition where their hook portions are engaged by the decker points. Said loops are left on said points when said needles and their push jacks are retracted by push out bar **775**, Figures 36 and 46. In the jacquard change phase of this cycle, the push jacks of the next active adjacent needles to which the cast off stitch loops are to be transferred are selectively actuated to condition said needles to receive said loops; and the narrowing mechanism operates to condition the push jacks of the needles from which the loops were removed to idle said needles in the next knitting cycle. During the decking cycle, knitting movement of the stitch cams **34**, **35** on rods **40**, Figures 36 and 38, and of the thread carriers **19** and brushes **21** is arrested.

In this decking cycle, only needles in the front bed selectively conditioned by the lifting plates **345**, **346** when the latter and connected parts are actuated to intermediate or straight knitting position by selector bar **502**, Figure 41, are initially advanced by operation of the push-in bar **195**. Said push-in bar actuated by cam **228** and associated parts, moves said needles in the front bed toward the rear bed in proper synchronized relation with the decker points **782**, Figure 36, which are simultaneously moving forward and down toward said needles.

The latches of said needles are opened by the stitch loops suspended thereon, as the advancing inner ends or hooks of the needles move out of the front bed and past adjacent comb portions of the rear bed to their "in" position, as seen in Figure 72, or to the same extent as if advanced for straight knitting operation.

The advanced hooks of said needles with latches open are engaged at said "in" position by the decker points **782**, after which, said needles are returned, or moved outwardly, by push-out bar **775** engaging end butts **29** of the corresponding needle jacks **28**, to their normal retracted position, Figures 38 and 52C.

Said decker points, while engaging said hooks, are simultaneously moved therewith from the position shown in Figure 72 to the stitch loop receiving position, about as shown in Figure 73, which is reached toward the end of said combined movement of the needles and the decker points **782**. Said points thereupon move into the stitch loops as the latter are intercepted and cast off of the withdrawing needles by adjacent comb portions of the front bed. The decker points carrying said loops are then raised to clear the comb.

During said decking cycle, the selecting or jacquard change devices and the widening and narrowing control devices operate to determine the new number of active needles to be actuated in the next course by the knitting cams. The decker points are then moved laterally to present the removed loops in position to be received on the hooks of the selected active needles after narrowing has been effected.

When the decker points with the removed stitch loops thereon are moved to position with said loops opposite the inner ends of the selected active needles upon which said loops are to be received, the front push-in bar **195** brings all the active needles toward thread receiving position. For this purpose, and as indicated diagrammatically in Figure 52C, a special "in" motion is imparted to the front push-in bar **195** by operation of cam **230**. Said "in" motion starts near the end of the decking cycle and continues into the initial portion of the next knitting cycle.

Said "in" motion begins earlier but proceeds more slowly than the corresponding "in" motion of said push-in bar 195 produced by cam 228 to advance the needles for a normal knitting course. The advancing hooks of the loop receiving needles are, therefore, pushed slowly and smoothly into engagement with said decker points and through said stitch loops suspended thereon.

During the loop transferring phase as last described, the decker points move rearwardly across the gap between the needle beds along with the advancing needle hooks engaged thereby, so that the suspended stitch loops are intercepted by comb portions of the rear bed, stripped from the decker points, and deposited on portions of the advanced needles aligned therewith.

Accelerated motion is imparted to swing the now free decker points upwardly and back out of the path of the brush and thread carriers; and normal knitting is resumed.

Knitting stopped during decking cycle

Details of mechanism for interrupting or skipping a knitting course while effecting the movements of parts during the decking cycle, as above described, are shown in Figures 4, 4A, 4B and 4C. For this purpose, a decker control shaft 750 carries a cam arm 751, Figure 4C, which interrupts knitting during the period of one course and another arm 752, Figure 4B, which simultaneously therewith, starts decker actuating cam shaft 274 and stops it at the end of the decking cycle. Said decker control shaft 750 is actuated from suitable pattern control mechanism which includes a control link 810, Figures 3 and 11I, connected thereto by an arm 811.

To arrest knitting during the decking cycle, cam arm 751, when moved by rotation of shaft 750, cooperates with cam roller 753 to lift lever arm 754, which is normally biased to the inoperative position shown in Figure 4C by a spring 754a. The free end of lever arm 754, when so lifted, engages and depresses the spring biased rolling key 755 of a clutch which includes clutch plate 13, Figure 4, thereby disengaging cam shaft 9 and said clutch plate 13 keyed thereon, Figure 4E, from clutch key carrier 14 and gear 12 secured thereto. This stops rotation of said gear 12, the bevel gear 15, and the stitch cam and thread carrier actuating shaft 16, Figure 4. Interruption of knitting as aforesaid occurs when, by operation of the control devices or other suitable means, decker control shaft 750 is rotated a part turn counterclockwise, Figure 4C. The same turn starts operation of decker cam shaft 274 by lifting the free end of an arm 752, Figure 4B, which is pivotally connected to a cam carrying lever arm 756 by a link 757.

Starting and stopping decking cycle

As seen more clearly in Figures 4 and 4A, which show details of parts of the devices for starting and stopping rotation of said decker or cam shaft 274, Figure 74, lever arm 756 carries a cam piece 758 having a bevelled edge portion 758a normally positioned in relation to a clutch device to maintain the decker shaft 274 disengaged from sprocket 722 which is loosely mounted on said shaft 274 and connected to be driven by chain 730 from shaft 6, Figure 4B.

Said clutch device comprises a collar 759 fixed on shaft 274 and having a peripheral annular groove 760 and a transverse plunger slot opening at one end into said groove. A plunger 761 slidably mounted in said slot, is biased toward the right, Figure 4A by a spring 761a. Normally, the bevelled portion 758a of cam piece 758 rests in said annular groove 760 in position to engage a shoulder at one end of plunger 761 to hold the latter in retracted position in said slot. However, when cam piece 758 is raised out of said groove 760, said plunger 761 is spring pressed inwardly to bring its other end into engagement with a radial slot 762 in the hub of sprocket 722. The gear ratio of said sprocket in relation to sprocket 731 on shaft 6 is such that decker shaft 274 is thereby rotated a full turn while shaft 6 is making two full turns.

Decker frame and cams actuating same

A decker point carrying and actuating frame including a rock shaft 763 located below and to the rear of rear bed 27, Figure 36, and arranged parallel with decker shaft 274, is rocked forward and back at appropriate times by a pair of cams 765 keyed to said decker shaft 274, Figure 74, at spaced positions thereon and actuated in cooperation with other devices to be described. Decker point carrying portions of said decker frame, operating above the rear needle bed 27, are also rocked or tilted relatively to said frame and independently of its rocking movement by suitable connection with a pair of cams 764 carried in spaced relation on decker shaft 274.

Needle motion controlling cams

As shown in Figure 74, said shaft 274 also supports in addition to the two pairs of cams above mentioned, other devices related more particularly to mechanisms which effect needle movements. These include a pair of rear push-in bar controlling cams 766, Figure 51; and a cam carrier 273a, Figure 50, having the push-out bar actuating cam 768 at its outer side and the special "in" motion producing cam 273 at its inner side.

Rear push-in bar arresting cams

Said cams 766 engage cam rollers 767 on rear rocking levers 200, Figure 51, and, in operation, prevent said levers, and consequently the rear push-in bar 191, from moving inwardly when the front push-in bar 195 is actuated to advance the end needles selected for stitch transfer to operative decking positions, Figure 72.

Special in motion cam

The function of cam 273 extending inwardly from the inner face of cam carrier 273a, Figures 47 and 50, is to maintain the slidable cam assembly shown in Figure 52 in effective position for cam 230 thereof to produce the aforesaid special "in" motion of the front push-in bar 195, Figure 52C, at the end of the decking cycle. Thereby all the active needles are advanced earlier and more slowly than for the usual knitting course, which insures that those at the edge selectively conditioned for the purpose will accurately and effectively engage the decker points and receive the stitch loops therefrom.

Push out bar and actuating cam

Said carrier 273a also has the push out bar actuating cam 768 extending outwardly therefrom and movable upon rotation of said carrier into and out of engagement with a cam roller 769 on a bell crank 770. As seen in Figure 46, one arm of said bell crank has a handle 771 and a socket 772. The rounded outer end of a plunger 773 engages said socket 772. The flat inner end face 774 of said plunger bears against the outer end of a "push-out" or draw bar 778

supported on and extending substantially the length of the front cam housing 36. Said bar is provided with sets of spaced slide plates 781 and 781a.

As shown in Figures 46, 46A, said front cam housing 36 is provided with an oblique slot 776 to receive a pin 777 mounted on said slide plate 781a. A spring 778 connects pin 777 with a relatively fixed pin 779 mounted on said housing 36 and biases said bar 775 toward the retracted position shown in Figure 46.

The direction of movement of said bar 775 is determined by suitable devices including flanged guide plates 780 secured to and obliquely disposed on a portion of the under surface of the top wall of said housing 36. Each of said guide plates 780 is embraced by and between edge portions of said slide plates 781 and 781a on "push out" bar 775.

Through the connections just described, spring 778 normally biases said "push-out" bar toward "in" position, Figures 36 and 46 and, solid line, Figure 38. However, when cam 768 engages cam roller 769 during rotation of decker shaft 274, or if bell crank 770 is actuated to like effect by hand, plunger 773 is thrust inwardly against tension of spring 770a and imparts oblique endwise and outward movement to "push-out" bar 775. The latter engages any jack end butts 29, Figure 38, which may be in its path; and, in moving outwardly to the dotted line position there shown, withdraws the corresponding needle jacks 28 and any needles thereby engaged to their initial retracted positions. This withdrawal of the selected edge needles in the decking cycle is timed to begin after the decker points have engaged the hooks of said needles, Figure 72, and after push-in bar 195 has started back toward its outer position, Figure 52C. The stitch loops previously formed on said edge needles are deposited on said points as the needles and the points reach the position shown in Figure 73.

Motions of decker points

During that portion of the decking cycle in which the above described "in" movement by cam 228 and "out" movement by cam 768 of the selected edge needles are effected through the push-in and push-out bars respectively and other parts provided for that purpose, the decker points mounted on a decker frame are first brought forward simultaneously in all needle sections to engage the advanced hook portions of said needles, as 23, Figure 72. They then continue to move with retracting movement of said needles to stitch loop receiving position, Figure 73. The needles are further withdrawn to normal position to disengage the stitch loops; and the decker points with the loops thereon, are all simultaneously raised, moved laterally and lowered. Later, after the stitch loops have been deposited as previously described, said points are returned rearwardly to inoperative position.

Decker frame and decker point mounting

Means are provided to effect operation of the decker frame and the decker points 782 carried thereby in proper direction and in synchronized relation with the forward and back movement of the selected edge needles, Figures 36, 46, 72 and 73. Said decker points 782 are mounted in a point holder 783 secured at the outer end of a decker carrying member in the form of an arm 784. The inner end of said arm 784 has a slot through which a screw bolt extends to adjustably secure said arm on a laterally movable and tiltable nut assembly 785, two of which are provided, as a pair, for each needle section, Figure 46. In narrowing, the nut assemblies of each pair move toward each other and in widening, away from each other. And in decking, said nut assemblies are rocked or tilted both in relation to the frame and along with the frame to define the path of operative movement of the decker points mounted on said arms 784.

Endwise adjustment of decker point carrier on decker frame

Each of said nut assemblies includes a bushing mounted on screw shaft 786 and internally threaded to travel endwise along the left and right-hand threaded portions thereof when said shaft is rotated. Said screw shaft 786 is rotated by means including link shaft 645, Figures 1A, 2 and 21, which rotates in one direction for narrowing and in the opposite direction for widening along with operation of narrowing and widening control mechanism. Screw shaft 786 is supported between and journaled in upper end portions of the several arms 787 forming part of the decker frame.

Shaft 645 is rotated without back lash by chains 421, 421a, from spring connected sprockets 420, 420a, on shaft 375 which operates automatically in response to the same devices, including slide bar 403, that control operation of fashioning shaft 369, Figure 21; or which may be operated for some purposes by hand.

Said control devices also include the pawls 380 and 386, Figure 23, for controlling rotation of fashioning shaft 369, and pawls 381 and 389, Figure 25, for controlling rotation of decker control shaft 375. The latter pawls are mounted on lugs 379 and 390, respectively, which extend laterally (right), Figure 21, from the sprockets 371 and 374 and are angularly spaced in the direction of rotation of said sprockets about 210° from similar lugs 378 and 387 extending laterally (left), Figure 21, from said sprockets 371 and 374 and carrying the pawls 380 and 386 respectively. Sprockets 371 and 374 are continuously driven in opposite directions by chain 372 from sprocket 373 on shaft 6, Figures 22 and 24.

As seen in Figures 21 and 25, slide bar 403 carries a block 402a on which are mounted gate pieces 407a, 408a, and 412a which correspond in function and construction to similar pieces, 407, 408 and 412, Figure 23, cooperating with said pawls 380 and 386 which are included in the narrowing and widening control devices. Said decker control pieces 407a and 408a are mounted to control the extent of opening of a long gap in the pawl guiding surface 413 of plate 415; and the other decker control piece 412a is positioned to control the short gap in the pawl guiding surface 414 of said plate 415.

Bar 403 is slidable endwise to and from different operative positions wherein one or another of said gate pieces 407a, 408a is brought into the gap of surface 413; or gate piece 412a is brought into the gap of surface 414, Figure 25.

The parts are so calibrated that an open short gap represents lateral adjustment of the decker point carrying arm 784 equivalent to the width of one needle slot; and an open long gap, two needle slots. Accordingly, when bar 403 is in a first operative or extreme left position, Figure 21, the long gap in 413 is closed by gate piece 407a and the short gap in 414 is open. This permits operation of pawl 389 counterclockwise to the

extent of one notch. Decker point carrying arm 784 is, therefore, moved laterally on screw shaft 786, to the extent of one needle groove in widening, by equivalent rotation of shaft 375, link shaft 665, and screw shaft 786, Figures 1A and 2.

With bar 403 in second position, as shown full lines Figure 21, the long gap in 413 is full open and the short gap in 414 is closed by gate piece 412a. This produces lateral adjustment of decker point carrying arm 784 to the extent of two needle grooves in narrowing.

In the third operative position of slide bar 403, the short gap is closed and the recessed portion, 408b of gate piece 408a is in the gap of 413, which produces lateral adjustment of decker point carrying arm 784 to the extent of one needle groove in narrowing.

In the neutral or extreme right position of slide bar 403, gate piece 408a closes the long gap in 413 and gate piece 412a closes the short gap in 414. In this position of said gate pieces no pawl is actuated and both shafts 369 and 375 remain at rest.

Slide bar 403 is moved endwise to and from said several positions by the yoke lever 405 secured at the upper end of vertical shaft 406, Figures 3 and 21, and actuated by any suitable means. In the illustrated embodiment, an arm 405a on the lower end of shaft 406 is pivotally connected at its outer end with a link 802 which is actuated endwise to swing said arm 405a to and from different angular positions by automatic control means shown in part in Figures 3 and 11J.

The previously described lateral adjusting movement of the nut assemblies lengthwise of the decker frame in fashioning serves to move the decker points from loop receiving to loop delivering position which, after delivery of the loops, becomes a new loop receiving position for the next decking operation in a subsequent course. Such adjustment, therefore, constantly maintains said decker points in loop receiving relation to the edge needles.

Manual adjustment of decker points simultaneously with widening and narrowing devices

Under conditions which require manual adjustment of the decker points 782 and other instrumentalities operatively connected therewith, lengthwise of the needle bed, shafts 369 and 375, Figure 21, are rotatable by hand. For this purpose, a hand wheel 369a is secured to an end portion of one of them, for example shaft 369, so that said shaft may be rotated at will in either direction when slide bar 403 is in neutral position. This directly controls the position of the fashioning devices.

Equivalent and simultaneous widening and narrowing adjustments of the decker point carriers and other devices are transmitted from said shaft 369 through sprocket 368 thereon to sprocket 391 and thus to chain 393 and shaft 375, Figures 21 and 22A. For this purpose, said sprocket 368 is fitted with laterally extending lugs 368a and sprocket 391 with similar lugs 391a. The angular extent of said lugs and their relative arrangement on the respective sprockets is such that, at each rotation of shaft 369 in either direction there is a lag between the beginning of that rotation and the rotation of shaft 375. For example, with shaft 369 rotating in the direction of widening, it will turn to the extent of one notch, or the equivalent of movement of the widening devices to the extent of one needle, before shaft 375 begins to rotate for widening. Also, with shaft 369 rotating in the direction of narrowing, it will turn to the extent of two notches before shaft 375 begins to rotate for narrowing. Therefore, after any such rotation of shaft 369 by hand and before resuming power operation, said shaft must be reversed manually one notch on the notched wheel 416 from its position for manual widening and two notches from its position for manual narrowing. This adjustment brings the parts into proper operative relation for normal knitting procedure.

Manual operation of shaft 369 as above described is effected independently of rotation of main drive shaft 6, because the narrowing pawls 380 and 381 and the widening pawls 386 and 389 are maintained out of engagement with their respective ratchet wheels by the gates 408, 408a, 412 and 412a, with slide bar 403 in inoperative position.

"In" and "out" decker motion

Said nut assemblies 785 which with the decker points 782 are adjusted endwise automatically or by hand along the screw shaft 786, as above described, also turn freely around and swing with said shaft 786 through a limited arc in decking. Accordingly, at all operative positions of said assemblies and, therefore, of the decker points 782 thereon, the free ends of said terminal members or arms 784 move in a predetermined path by means hereinafter described to carry said decker points 782 into and out of operative stitch loop receiving and transferring or delivering positions.

End and intermediate portions of said screw shaft 786 are journaled at and between upper end portions of the arms 787 which are keyed on rock shaft 763, Figure 36, of the decker frame. Said rock shaft 763 is journaled in bearings below and at the rear of the rear needle bed. As seen in Figure 36, said arms 787 are bent to bring their upper end portions and said screw shaft 786 above the level of said rear bed. Lever arms 788, also secured on said rock shaft 763 carry cam rollers 789 which ride on the peripheries of the cams 765 on decker shaft 274 where they are yieldingly held by springs 790 engaging arms 790a on shaft 763. Thus, the required "in" and "out" rocking or angular component of the decker point movement is imparted to the decker frame and thence to the decker points through said rock shaft 763 by rotation of the cams 765 on decker shaft 274.

Up and down motion of decker points

Said decker frame also carries devices which cooperate with other parts of the machine for producing an independent angular or vertical swinging or rocking component of the decking movement of the terminal members 784 and the decker points mounted at the free end portions thereof. For this purpose, Figure 36, cams 764 on decker shaft 274 engage cam rollers 791 on bell cranks 792 pivoted at 793 on one or more of the several arms 787 of the decker frame. A compression spring 794 bears against said bell crank 792 to maintain each said cam roller 791 in effective engagement with the periphery of its cooperating cam 764.

The upper end of bell crank 792, Figure 36, is provided with a yoke to embrace a pin 795 extending laterally from arm 796 secured on a rock shaft 797 which is journaled in aligned bearings provided by the several spaced arms 787 of the decker frame. Shaft 797 also has arms 798 secured thereto. The outer ends of said arms 798 support and are connected by a toggle rod 799 of rounded contour, Figure 46. An arm 800

extends rearwardly from each nut assembly 785 and has a yoke 801 which embraces said toggle rod 799 and is free to slide lengthwise of said rod with lateral movement of said nuts 785 and the members 784 on screw shaft 786.

Thus, when cam 764 rotates with the decker shaft 274, each bell crank 792 is rocked about pivot pin 793 on arm 787. This rocks arms 796, shaft 797, and arms 798; and swings the toggle rod 799 carried thereby through a short arc, as between the ends of the slot 799a in the web of an intermediate decker arm 787, Figure 36. No such slot is required in the end arms 787 because rod 799 does not extend through them, Figure 46. A corresponding swing is imparted simultaneously to the several arms 800 and their nut assemblies 785 at all operative positions of the latter along screw shaft 786 to vary to angular position of said decker points 782 mounted at the outer end of arms 784 which rock with said nut assemblies 785.

Decker synchronized with other devices

It will be apparent that synchronization of movements of the decker actuating devices with certain parts of the machine is effected through the conjoint operation thereof by said shaft 274. For example, decker shaft 274 not only actuates said cams 764 and 765, Figure 36, but also the cams 768 which operate the push-out bar 775; the cams 273, Figure 50, which maintain the cam assembly in operation for the earlier and slower "in" motion of push-in bar 195; and the cams 766 which arrest operation of the rear push-in bar 191 when the edge needles are being advanced in the decking cycle toward loop delivering position by push-in bar 195. And the devices actuated by the cams above noted are synchronized with the mechanism for arresting knitting by common connection thereof with drive shaft 6.

The decking devices and controls, as above described, are of relatively simple construction well adapted to operate with other automatic mechanisms as part of a full automatic flat links knitting machine. An advantage of the devices whereby the decker points are maintained at their proper positions in relation to the needles to be decked from is that they operate positively and accurately. Further, they combine effectively with devices for imparting to and fro and up and down movement of the decker points and insure precision in lifting the stitch loops and placing them on other needles.

Decker points

The decker points 782 are of the construction shown in Figures 46B and 46C. Each comprises a shank with a butt 812 at one end and opposed tapered resilient tips or spring arms 813 extending from the other end and forming a longitudinal slot between them. The outer end portions of said arms are disposed at an angle to the inner or base portions thereof and are also directed inwardly toward each other to close the outer end of said slot. Said closed end is offset from the base portions of said tips.

Ordinarily, when the selected needles are moved in decking toward the rear bed to the position of initial engagement with the decker points, the last formed stitch loops resting under the needle latches of said needles are intercepted by portions of the rear bed comb. As the needle hook of one of these loop bearing needles continues to move into its rear bed slot, the arrested loop engages the needle latch and deflects it to open position, after which said loop slides past the free end of the latch and rests upon a portion of the needle shank. As shown in Figure 72, when the decker point reaches needle engaging position, it is moved downwardly and readily engages the needle hook in the slot between said tips 813 regardless of whether the latch is down, i. e. closed, or rocked back to open position. As the needle returns into the front bed and the hook thereof passes ends of a portion of the front bed comb, the latch closes down over the ends of said tips (Figure 73). The needle is then further withdrawn into the front bed to its retracted or neutral position leaving the stitch loop suspended on the decker point.

Thereafter, the decker point with said loop suspended thereon is moved to a new position opposite a needle upon which the loop is to be deposited. For this purpose, the decker point moves downwardly over the exposed hook of said needle in such a manner that the ends of tips 813 thereof come behind said hook. In so doing, said tips are spread apart to pass the latch if the latch happens to be down.

The decker point constructed as above described permits positive and rapid actuation of the needles and points both in removing loops from needles and in placing removed loops on other needles, since it is not essential to operation of the points that the latches be open or closed when the needles are in loop delivering or loop receiving position in relation to said points.

Pattern control

Further objects of the present invention have been to provide an improvement in pattern change control mechanism for knitting machines; to provide such control mechanism capable of being operated from a continuous pattern band or the like; to provide means whereby a pattern band or sheet of relatively short length may be effectively employed to repeat the effect of its pattern features thus avoiding the need for a relatively or unduly long strip or band with all the pattern change indicia arranged in the actual sequence of their occurrence in knitting; and to provide pattern change control mechanism which shall be positive and dependable for automatically controlling operation of all the instrumentalities employed in producing a wide range of knitted products. More specific aspects of the above mentioned improvements are separately claimed in my co-pending application Serial No. 530,770 filed herewith.

Operation of an automatic multiple knitting machine, such as that illustrated generally in Figure 1, is conveniently regulated by pattern change control devices of which details of one embodiment are shown more clearly in Figures 11 to 20 inclusive.

In that embodiment, a pattern sheet of suitable material, as paper, is perforated at predetermined places to effect, with other instrumentalities including a cooperating pattern chain, different operating results in predetermined timed relation and thus cause the machine to automatically knit a product or plurality of products incorporating desired characteristics of design, construction and size.

Pattern sheet

Said pattern sheet, here shown in the form of an endless band, presents in effect a plurality of parallel longitudinally extending zones arranged one after another across the band and

each corresponding to some function or set of instrumentalities as to which operating changes occur to effect various pattern modifications. Said band also presents in effect a plurality of transversely disposed sections each comprising laterally adjacent portions of all of said zones and each supplying all the pattern change indicia, as perforations, effective in a single pattern change cycle.

Perforations made at predetermined places in said band are co-related with devices, including a set of feelers, for controlling the different operating mechanisms, as racking, thread change, narrowing and widening, etc. Accordingly, in a typical pattern band, as 553, Figure 12, the location of one or more perforations, as 693, 736a etc., in one zone or another determines which operative function or instrumentality is to be changed. The location of such perforations in one section or another not only determines which of the several operational changes shall become effective in the same given course; but also, in part, determines the timing or order of occurrence of said changes in relation to others effective in different courses, this timing being modified by operation of the pattern chain to be described.

As seen in Figures 12, 13, 13A and 13B, the pattern band 553 of paper, or other suitable material, is supported over a portion of the periphery of a hollow drum 554 provided with radially extending pins 555 for engaging parallel rows of opposed drive perforations 556, Figure 12, arranged at the opposite edge portions of said band. Each pair of opposed drive perforations 556, in effect, also marks the median line of one of said transverse change sections of said band 553.

The relative locations of the perforations in each pattern change entry or record on the band depend on the extent and/or direction of movement desired from the devices controlled by said perforations when the change section containing said entry is brought by rotation of said drum 554 into operative pattern change controlling relation thereto.

Pattern drum

Said pattern perforations in band 553, when at zenith or operative control position, are in register with suitably spaced holes 557 which extend through the peripheral wall of said drum 554, Figures 13 and 13A, and permit the passage of feeler pins through said perforations. Said holes 557 are provided in sets of three or other suitable number for each feeler or for each zone of the band 553. Said sets are disposed in a transversely extending group across drum 554 for each change position thereof. One such complete group of sets of holes 557 is shown in detail, Figure 13A, to illustrate the arrangement here described. In the embodiment shown in Figure 13, there are twelve such equi-angularly spaced groups, one for each of the twelve stopping or change positions of drum 554 which are 30° apart. Each such group consists of a transverse middle row of radially directed holes and, at each side thereof, a parallel row of holes, the central axes of which are parallel with the central axes of the radially directed holes.

Control of rotation of pattern drum

Suitable devices cooperating with drum 554 control the time and extent of its rotation to bring one or another of said groups of holes 557 therein into registering relation with the pattern perforations, as 693, Figure 13A, in one or another of the transverse sections of pattern band 553 and into operative relation to certain selecting devices, including suitable feelers of which portions engage with said holes and said perforations when the latter are in register.

Drum actuating pawls

Drum 554 is mounted on a shaft 558 and rotated through an index wheel 559, clockwise or counterclockwise and at times depending on the operation of actuating and controlling devices cooperating in a predetermined manner with said band 553 and said drum 554. Thus, index wheel 559 is actuated at predetermined occasions if desired to rotate drum 554 clockwise, Figure 13, by means of an upper or clockwise pawl 560; and at other predetermined occasions to rotate said drum counterclockwise, Figure 13, by means of a lower or counterclockwise pawl 561. Said pawls 560 and 561 are bifurcated at their index wheel engaging ends to form, respectively, a long finger 560a, a short finger 560b, and a long finger 561a, and a short finger 561b.

Means are provided for selectively adjusting the angular position of said drum rotating pawls so that a short finger thereof will engage and actuate the index wheel 559 to rotate it and drum 554 one notch, 30°; or, so that a long finger and a short finger thereof will together rotate said drum two notches, or a total of 60°. This feature permits frequently repeated use of any section of the pattern sheet and, to that extent, renders the selective control mechanism more effectively elastic. Accordingly, to produce an article of a given pattern, the number of pattern determining sections and, therefore, the length of the pattern band employed is reduced to a minimum.

Pattern chain for drum control

Devices for selectively adjusting the angular position of said pawls 560 and 561 in preparation for controlling the direction and extent of rotation of the drum 554 include a sprocket 562 on a shaft 563 and a suitable pattern control chain mounted to advance with rotation of said sprocket 563, counterclockwise, as seen in Figure 13.

For use in connection with a given pattern sheet or band, said chain is made up to include in proper order different forms of a conventional type of link, such for example as those shown in Figures 14 to 18 inclusive. Figure 14 illustrates a plain link 564; Figure 15, a low lug link 565 having a low lug 565a extending laterally to the left; Figure 16, a low lug link 566 having a low lug 566a extending laterally to the right; Figure 17, a high lug link 567 having a high lug 567a extending laterally to the left; and Figure 18, a high lug link 568 having a high lug 568a extending laterally to the right.

When a chain, comprising links like those above described, is advanced by sprocket 562 to bring said links one after another into operative position in relation to parts to be described, the plain links 564 so positioned cause no rotation of drum 554; the right lug links 566 and 568 cooperating with the upper pawl 560 cause drum 554 to rotate clockwise, Figure 13; the left lug links 565 and 567 cooperating with the lower pawl 561 cause drum 554 to rotate counterclockwise, Figure 13. The low lug links 565 and 566 cause one notch, 30°, (i. e. on index wheel 559)

rotation of drum 554; and the high lug links 567 and 568 cause a two notch, 60°, rotation of drum 554.

Each of the links employed in forming the pattern chain has a hook portion 564a which is releasably interlocked with a cross piece 564b of another link when the chain is assembled. Thus, the same links may be used repeatedly in assembling different pattern chains.

Upper drum pawl

The upper pawl 560 which rotates index wheel 559 and drum 554 clockwise, Figure 13, is mounted on a stud shaft 569 carried at an upper portion of a reciprocatable bracket 570 which is moved periodically toward and away from drum 554 by means to be described. Pawl 560 carries at one side a roller 571 which rides on the upper edge of an upper pawl positioning lever 572 secured at one end of a rock shaft 573, and normally biased toward neutral position by a spring 572a, Figure 13.

An arm 574, secured at the opposite end of said rock shaft 573 has a roller 575 at its outer end in position to ride yieldingly on the right side, Figure 11, of the periphery of the hub of sprocket 562. With a plain link 564, or a left lug link 565 or 567, at zenith position on sprocket 562 and with said roller 575 riding on the hub thereof at the right of said link, the free end of the positioning lever 572, through arm 574 and rock shaft 573, is tilted to "up," or neutral position. This raises the inner end of upper pawl 560 sufficiently for its terminal fingers to clear the index wheel 559 on the next periodic thrust of bracket 570 toward said index wheel; and no rotation of drum 554 is effected through arm 574 and lever 572.

If a right lug link, as 566 (low) or 568 (high) shall have reached zenith or operative position on sprocket 562 so that a right lug, as 566a or 568b is interposed between the hub of said sprocket and said roller 575, arm 574 is tilted clockwise, Figure 13; and the free end of positioning arm 572 is thereby lowered to one or another of its two operative positions.

If the interposed right lug is low, as 566a, Figure 13, upper pawl 560 will thereby be tilted to such position in relation to index wheel 559 that, on the next periodic advance of bracket 570 and the consequent endwise thrust of pawl 560, the end of short finger 560b of the latter will engage a tooth, as 559a, of index wheel 559 and rotate said wheel one notch, 30°, clockwise. If a high lug, as 568a is operative, pawl 560 is tilted farther than before and, at the next periodic endwise thrust thereof, index wheel 559 and consequently drum 554 will be rotated two notches, or 60°, of which the first notch, or 30°, is effected by long finger 560a engaging tooth 559a, and the next notch, or an additional 30°, by short finger 560b engaging tooth 559b.

Lower drum pawl

The lower pawl 561 pivoted at 576 on said bracket 570 has a roller 577 riding on the upper edge of a lower pawl positioning and guiding lever 578 secured on a rock shaft 579 journaled in a portion of the frame of the machine. Said lever is rocked to and from different angular positions by means including an arm 580 which is loosely mounted on said rock shaft 579, Figure 13, adjacent to an upwardly extending arm portion 578a, Figure 13A, of said lever 578 and connected thereto by a spring 581.

An upper end portion of said arm 580 is constantly engaged by the depending end of an arm 582, dotted, Figure 13, secured to a sleeve 583 loose on rock shaft 573, Figure 13B. An arm 584, Figure 11, having a roller 585 at its outer end is also secured to sleeve 583, Figure 13B. Roller 585 is positioned to engage and ride on the periphery of that portion of the hub of sprocket 562 at the left of the sprocket teeth, Figure 11, or upon any left lug of a chain link at zenith position thereon.

When a plain link or a right lug link is at zenith position on sprocket 562, arm 584 is in down, or "neutral" position, i. e. as shown in Figure 13. The depending arm 582 thereby maintains lower lever 578 in the down or neutral position shown. Therefore, on the next periodic thrust of bracket 570 toward drum 554, both fingers of pawl 561 will clear the teeth of index wheel 559; and drum 554 is not rotated through arm 584 and lever 578.

If, in the advance of the pattern chain, a left lug link 565 or 567 reaches operative (zenith) position, a low lug 565a or a high lug 567a, as the case may be, will be interposed between said hub of the sprocket and said roller 585. The effect of the resulting tilting of arm 584 is transmitted through arm 582, arm 580, and spring 581, to lever 578 and thence to pawl 561. If a low lug 565a is operating, the pawl 561 will be raised, and therewith short finger 561b to operative position opposite a tooth 559c of index wheel 559; and, on the next periodic inward thrust of bracket 570, short finger will rotate said wheel 30° counterclockwise. If a high lug 567a is operating, long finger 561a of pawl 561 will engage said tooth 559c of index wheel 559 and advance said wheel and drum 554 30° counterclockwise; and short finger 561b will engage the next succeeding tooth 559d of said index wheel and rotate said wheel and drum 554 another or additional 30° counterclockwise.

Drive for pattern chain and sprocket

The periodically reciprocatable bracket 570 previously referred to and upon which pawls 560 and 561 are pivotally mounted is secured to and extends downwardly from an outer end portion of a sliding pawl carrier bar 586, Figures 11 and 20, periodically reciprocated endwise by a cam 587 on main shaft 6. Said cam 587 engages cam rollers 588 and 589 journaled at one side of an inner end portion of carrier bar 586. The effect of one cycle of operation of cam 587 on said carrier bar 586 and connected devices in relation to movement of the stitch cams of the stitch cam operating cam 76, Figure 5, in one course, as left to right, Figure 1, is illustrated in Figure 75.

A pawl 590, Figure 20, is pivoted to an outer end portion of carrier bar 586 at 591, and with its free end movable into and out of position to engage the teeth of an index wheel 592 on the sprocket shaft 563. Means are provided whereby said pawl 590 is periodically advanced by endwise thrusts of carrier bar 586 sufficiently to rotate index wheel 592 and therefore sprocket 562 one notch, 30°, counterclockwise, Figure 20, during each complete rotation or cycle of main shaft 6. However, whether or not such rotation of said sprocket 562 takes place during a given cycle of main shaft 6 depends on the angular position of pawl 590 when carrier bar 586 is advanced by cam 587, i. e. whether the free end of said pawl 590 is in down or up position by operation of devices to be described.

Control for chain and sprocket drive

As shown in Figure 20, pawl 590 on bar 586 is provided with a roller 593 journaled on a laterally extending stud 594. The periphery of said roller rides on the laterally extending flange portion 595 of an arm 596 secured at one end of a rock shaft 597, Figure 11. A detent arm 598, Figure 13, is secured to and extends upwardly from the other end of said rock shaft 597. Said pawl 590 is biased toward operative position in relation to index wheel 592 and the free end of said detent arm 598 is biased toward and bears against a stop lug 599 extending laterally from an outer end portion of a slidable bar 600. This bias is produced by the weight of free end portions of said arm 596 and of pawl 590 which bears thereon and causes said arm 596 and pawl 590 to swing downwardly when arm 598 is released by outward endwise movement of said slide bar 600 which carries stop lug 599 outwardly, left Figure 13, under circumstances to be described.

Pattern chain control slide bar and feeler

Means for controlling endwise pawl releasing movement of said slide bar 600 include a laterally extending stop lug 601 thereon, Figure 11, positioned to be intercepted by a detent 602 at the upper end of a vertically slidable chain control feeler 603, Figure 13C, when the latter is in "up" position, as shown in Figure 13. With detent 602 intercepting lug 601, said feeler 603 thus prevents the previously described outward or pawl releasing movement of slide bar 600. Means are provided for dropping said feeler to release pawl 590 and for thereafter returning said feeler and said pawl to "up" position.

At its lower end, said feeler 603, has a feeler pin 603*a*. Between its ends is an inwardly extending re-setting lug 607, arranged to be engaged by a feeler resetting bar 608, Figure 13, which, when in "up" position, holds said feeler pin 603*a* above pattern band 553, and when in down position, permits said pin 603*a* to drop through a chain control perforation 609 if one is presented.

In operation, the chain control perforations, as 609 in pattern band 553, Figure 12, are brought one at a time in predetermined sequence as required, between said chain control feeler pin 603*a* and one of the holes 557 in the drum 554, so that said feeler pin 603*a* can engage and drop through one of said perforations. This occurs as resetting bar 608, controlled by cam 613, Figure 20, is lowered, line *b*, Figure 75. At that time, the inner push bar 617, Figure 11, is in its extended dwell position, broken line, Figure 13, thereby holding bar 600 retracted and lug 601 thereon at one side of detent 602.

If no chain control perforation 609 is at zenith position when bar 608 is dropped, the lower end of chain control feeler pin 603*a* merely drops against and onto the web of the pattern band. Thereupon inner push bar 617 moves toward outer push bar 685, line *c*, Figure 75. Slide bar 600 cannot advance because stop 601 thereon is intercepted by detent 602 on feeler 603. This condition is illustrated by the dotted line X in Figure 75.

However, when feeler 603 is dropped the full distance, as when a chain control perforation 609 is at zenith position, detent 602 thereon is thus displaced downwardly and out of the path of outward movement of stop lug 601 on slide bar 600. Said slide bar 600 thereupon slides endwise to the left, Figure 13, (line *d*, Figure 75) impelled by the weight of arm 596 and pawl 590, as above noted. With the resulting rocking movement of shaft 597, the outer end of flange 595 of said arm 596 and the free end of pawl 590 swing downwardly.

In this lowered position, the free end of said pawl 590 is moved forward, left Figure 20, with the next periodic forward movement of carrier bar 586, line *e*, Figure 75, to engage and rotate said chain driving index wheel 592 one notch. This brings the next link of the pattern chain into operative (zenith) position on the sprocket 562 and thereby determines the extent and direction of the next rotation, if any, of drum 554 and equivalent movement of pattern band 553 supported thereon.

The rotation of drum 554 and advance of the pattern sheet, if any, occurs on the next stroke (right, Figure 13), line *a*, Figure 75, of said carrier bar 586 which carries with it the depending bracket 570 and the previously described drum actuating pawls 560 and 561. But before that stroke and in the preceding cycle, slide bar 600 has been returned, line *g*, Figure 75 to retracted (inoperative or neutral) position by outward movement of inner push bar 617, line *f*, Figure 75, (to the right, Figure 13) and feeler 603 has been restored by bar 608 to its "up" (inoperative or neutral position), line *h* Figure 75.

Returning slide bar to neutral

Devices for effecting the return movement of slide bar 600, line *g*, Figure 75, and the lifting of pawl 590 therewith and for holding the same in neutral or retracted position include a lug 616 at the inner end, right, Figure 13, of said bar 600 and means for engaging and pushing said lug.

For this purpose, and for another purpose to be described, the inner transversely extending push bar 617 is mounted at the inner ends of spaced lower rack bars 618 and 618*a* slidably supported in the frame and each having a series of upwardly exposed teeth at its outer end. Said rack bars 618 and 618*a* are periodically reciprocated endwise by rotation of pinions 619 and 619*a* secured on a shaft 620, Figures 11 and 19, which also carries another pinion 621. The latter engages and is driven by the teeth of a curved rack 622 mounted at the outer end of a rocker arm 623 pivoted at 624.

A cam roller 625 is pivoted at an inner end portion of said rocker arm 623 and in position to ride on the periphery of cam 610 on main shaft 6. Another cam roller 626 is pivoted at the lower end of a depending branch of rocker arm 623 and in position to ride on the periphery of cam 611 on said shaft 6, Figure 19.

Cams 610 and 611, as indicated by the arrow on the latter in Figure 19, rotate clockwise with main shaft 6. With said cams disposed as shown in said figure, lower rack bars 618 and 618*a* and inner push bar 617 carried thereon occupy substantially the relative positions shown in solid lines, Figure 13, said lower rack bars being then approximately at their outermost limit of travel. Upon further rotation of main shaft 6, cam 611 causes arm 623 to swing upwardly and thus to rotate shaft 620 counterclockwise, Figures 13 and 19. This drives lower rack bars 618 and 618*a* and inner cross bar 617, inwardly (right, Figure 13) with a rear edge portion of the latter bearing against lug 616 of slide bar 600. At the end of this movement, line *f*, Figure 75, stop 601 on slide bar 600 has moved beyond the vertical path of detent 602 on feeler 603 which is now returned to "up" or locking position, line *h*, Figure 75. This is closely followed by the rotation, if any in the next cycle, of drum 554 effected in the manner

heretofore described by one of the pawls 560 and 561 and devices connected therewith.

Returning chain control feeler to neutral

The lifting or return of chain control feeler 603, line *h*, Figure 75, to the initial position wherein it may block slide bar 600 against forward endwise movement (i. e. when no chain control perforation comes to zenith position) and thus hold pawl 590 inoperative is effected by means including said raising bar 608 secured on shaft 612 which is periodically rocked by operation of a cam 613 through an arm 614 secured to said shaft 612 and having a cam roller 615, Figures 11 and 20. Thus, when the arm lifting portion of cam 613 engages said roller 615, shaft 612 is rocked and thereby swings an outer edge portion of raising bar 608 upwardly against resetting lug 607 on the chain control feeler 603 and simultaneously against similar lugs 607 on other or pattern control or change feelers to be described, line *h*, Figure 75.

Operation of control links

An outer transverse push bar 685, Figure 13, which, with inner transverse push bar 617, cooperates with the various stop or control links as hereinafter more specifically described, is carried between and actuated by spaced parallel upper sliding rack bars 687 and 687*a* which engage and are driven by said pinions 619 and 619*a* on shaft 620. Thus, when said pinions are rotated by cams 610 and 611, as previously indicated, to operate inner push bar 617, outer push bar 685 periodically reciprocates simultaneously and coextensively with said inner push bar 617 but in opposite directions, to and from the relative positions thereof shown in full lines in Figure 13.

The periodic movement of inner push bar 617 as said bar and outer push bar 685 are moved away from each other, line *f*, Figure 75, by cam 611, is employed to effect the return movement of slide bar 600 above referred to.

The periodic reciprocal movement of said bars toward each other, effected by cam 610, line *c*, Figure 75, which follows dropping of the pattern change feelers 689, Figure 13D, line *b*, Figure 75, effects endwise positioning movement of variously shaped control links, as 805, Figure 13, under certain conditions to selectively control the direction and extent of movement of pattern change devices operatively connected thereto.

Pattern change feelers

An outer end portion of each pattern control link rests freely on the top end of one of said vertically adjustable pattern change feelers 689 and is conditioned for subsequent movement to and from different pattern control positions by vertical adjustment of its supporting feeler.

In the embodiment shown, Figure 13D, each of said link conditioning or pattern change feelers 689 comprises a flat body portion having three downwardly extending feeler pins 604, 605 and 606, or more or less depending on the number of changes required. These pins are of different lengths, as 604 long, 605 medium, and 606 short, and cooperate with perforations in the pattern band to determine the several different operative control positions taken by said feelers. The position taken by any feeler in each pattern change operation depends on whether the pattern sheet brings one, two, three or other number of perforations into register with the pins of said feeler.

Said pattern change feelers 689 and chain control feeler 603, are mounted to slide vertically in slots 690 formed in a guide member 691 positioned above the drum 554, Figures 13 and 13B; and are retained in said slots by a face plate 692. Means including said raising bar 608 and connected devices are provided for dropping all of said feelers simultaneously toward the pattern sheet and for simultaneously raising said feelers therefrom.

The several control links conditioned by said feelers 689 are formed with variously arranged pairs of cooperating stops. Each pair consists of one of a series of one or more stepped or offset vertically disposed outer faces and one of a series of one or more cooperatively arranged inner faces. An outer face of one pair is adapted to be selectively engaged by said outer cross bar 685, and the corresponding inner face of said pair, by inner cross bar 617, each time said bars are moved toward each other, line *c*, Figure 75. If the free end of any one or more of said links has been raised or lowered from its previous condition, said movement of bars 617 and 685 toward each other will move the corresponding control link or links endwise to a different control position.

Where a control link is provided with two pairs of stops or faces representing two control positions, as one neutral and one operative, for example, the corresponding link conditioning feeler need be equipped to take only one lower or operative change position, i. e. with only one feeler pin. In the form shown, however, the pattern change feelers 689 are adapted to provide three different conditioning positions, i. e. one for each pin of different length.

Jacquard shaft operating and needle position selecting control

As seen in Figures 11C and 11D, the jacquard shaft and needle position control links 688 and 688*a* each have opposed sets of three outer and three inner stepped faces which, in the embodiment shown, provide the number of pairs of end faces or stops required to perform the functions hereinafter described. One or another of said pairs comes into operation depending on which, if either, of their supporting feelers is moved and to what position of vertical adjustment said feeler is brought by the pattern control devices. Both of said control links 688 and 688*a* are pivoted to one end of an arm 698 at 699. The other end of said arm is secured to the jacquard and profile and gathering bar control shaft 256, Figures 47 and 50, said shaft being thereby rotated to and from positions which determine five corresponding positions of the push arms 627 and 627, Figure 47. Said shaft 256 and other control shafts actuated or utilized in a similar manner, but for different operative effects, are mounted along with suitable friction or retaining devices to hold them releasably in the several angular positions to and from which they are rotated by selective operation of their respective control links.

It has previously been noted that each pattern change feeler, as 689, is provided with the feeler pins 604, 605, 606 of different lengths at its lower end to produce different control effects. Thus, if both the links 688 and 688*a* are initially in the "up" or neutral position shown in Figure 11C and if, on the next pattern change operation, the pattern sheet presents no perforation beneath either of the feelers which support said links,

when resetting bar 686 is dropped, line b, Figure 75, both said links remain in neutral or "up" position, Figure 11C. The next periodic motion, therefore, of the push bars 617 and 685 toward each other, line c, Figure 75, again brings bar 617 into engagement with rear face 701 of link 688a and bar 685 into engagement with front face 700b of link 688 and produces no movement of arm 698 from the assumed initial neutral position.

When two perforations, as 693, in pattern band 553 come between pins 604 and 605 of feeler 689, Figure 11D, and the corresponding holes 551 in drum 554, said feeler 689 which supports link 688a takes the intermediate lower position, as shown, with a corresponding conditioning or adjustment of the stop carrying end of said link. This brings outer face or stop 700 at the outer end of link 688a to operative position opposite the inner edge of outer push bar 685. Said bar, on its periodic return inwardly toward bar 617, line c, Figure 75, engages said stop 700 and thereby pushes links 688a and 688 endwise to the position shown in Figure 11D and effects corresponding angular movement of arm 698 and jacquard control shaft 256. The simultaneous periodic inward movement of inner push bar 617 brings its outer edge into engagement with inner faces 701b of 688a and 695b of 688 at the end of said endwise movement of said links.

A different angular position of arm 698 and consequently of shaft 256 is effected when, by reason of the incidence of suitably placed perforations in pattern sheet 553, link 688 is conditioned by its feeler to bring one of the stops or faces 695 or 695a opposite the outer edge of inner push bar 617.

In general, the arrangement of the pairs of stop faces on the several control links is such that the lever arms, as 698, controlled thereby may be deflected from any angular control position directly to any other angular control position. The same observation applies to control movements of the other links, lever arms, and control shafts hereinafter more specifically referred to.

Any deflection of jacquard control shaft 256 in either direction by said arm 698 starts operation of jacquard shaft 243, Figure 50. As seen in Figure 47, said jacquard control shaft 256 also actuates intermediate selective devices including the parts shown in Figure 47A. The portion 627 thereof is related to operation of the gathering bar 327 and the portion 628 to operation of the profile bars 277, Figure 41, through selector bar 502.

Control devices including the links 688 and 688a and other instrumentalities arranged and connected as above described provide a neutral angular position of arm 698 and two positions of angular adjustment at each side of neutral to produce, through jacquard control shaft 256, as many different operative control conditions.

Thread change control

The mechanism for thread change control, Figures 11A and 11B, provides for the neutral position of certain of its parts, as shown, and six operative positions reached by adjustment of said parts in one direction from their neutral position. For this purpose, an arm 702 is secured at one end to thread change control shaft 659, Figure 1A, which actuates rock shaft 183, and the devices connected thereto. Said arm 702 is moved to one or another of various angular control positions by endwise movement of a pair of control links comprising a long link 703 and a short link 704 pivotally connected to said arm 702 at 705. The neutral position of said links and arm 702, Figure 11A, is determined by the step face or stop 706 on long link 703 and the step face 707 on short link 704, when the feelers 689 supporting said links are both in raised position.

Shaft 659 also carries an arm 749, Figure 8, which controls rotation of shaft 169a through a clutch including the rolling key 748. Shaft 169a, Figure 1A, actuates shaft 169 through chain 682 and thus produces a forward and back movement of the latch carrying brackets 164 and 165, Figure 1, incident to each thread change operation.

Three of the six operative angular control positions of said arm 702 are determined by the inner stops or step faces 708, 708a and 708b on long link 703 and the other three by the inner stops or step faces 709, 709a, and 709b on short link 704. When one of said first three operative positions is required, short link 704 remains at the level shown in Figure 11A, while long link 703 is conditioned by its feeler 689 to bring the proper one of the step faces 708, 708a, 708b into line with the front edge of inner push bar 617. As said inner push bar 617 moves toward outer push bar 685, line c, Figure 75, and bears against the selected one of said step faces, the lever arm 702 is brought to the corresponding intermediate position. When one of the second three operative positions is required, short link 704 is dropped to a lower position with its feeler 689 thus bringing one of the step faces 709, 709a, 709b in line with the front edge of inner push bar 617. Long link 703, in such case, is also dropped to its lowest position to permit movement of its outer end beneath and past the edge of outer push bar 685 when inner push bar 617 moves toward said outer push bar 687, line c, Figure 75, and bears against a selected one of the step faces 709, 709a and 709b of short link 703.

Stitch length change control

As seen in Figures 3, 11F, 13 and 48, the stitch length control links 803 and 804 are adapted to rock shaft 119 through lever arm 119a to which both of said links are pivotally connected. Said links are of the same type as links 703 and 704, Figures 11A and 11B but provide an aggregate of five operative stops which produce one neutral position of shaft 119 and four operative positions all at one side of said neutral position. When shaft 119 is rocked to one or another of said four positions, it actuates the stitch length selecting devices shown in part in Figures 46 and 48 and including the vertical T bar 116 and connected mechanisms.

Selector bar control

In conditioning the control jacks as 293, Figure 41, for certain pattern changes, the selector bar 502, Figures 6, 41 and 42, is moved endwise to various positions to bring the lift lugs 281 thereof into and out of position beneath one or another of the sets of depending lugs 343, 344 on fashioning bar 341 or beneath one or another of the sets of depending lugs 280 on the profile bars 277. When in one of these positions, said selector bar 502 is lifted by operation of the push rod 509, Figures 41, 47 and 47B, and connected parts including link 624 and push members 627, 628 under conditions controlled by operation of the control links 688 and 688a previously described in connection with control of the operation of jacquard control shaft 256.

Automatic control of endwise positioning movement of said selector bar 502 is effected through

the control link 805, Figure 13, and control link 807, Figure 11G. As seen in Figure 13, link 805 is pivotally connected to a lever arm 806 on a shaft 537, and as seen in Figure 11G, link 807 is pivotally connected to a lever arm 541a on a shaft 541. Shaft 537 actuates the devices shown in Figure 35 and shaft 541 actuates those shown in Figure 34 to effect endwise movement of selector bar 502.

Each of said control links 805 and 807 has four steps which produce one neutral and three operative positions of each of said shafts 537 and 541, when said links are operated in connection with the feelers and push bars 617, 685, previously described.

Narrowing and quick return control in gusset forming

Control of narrowing and quick return from narrowing in gusset forming is effected by link 808, Figures 11, 11H and 13. Said link is connected to shaft 460 by lever 809 which actuates the control devices shown in part in Figures 4, 4D, 4E and 8. For this purpose, said link is provided with three pairs of step faces or stops of which the inner faces 808a, 808b and 808c cooperate with inner push bar 617 and the corresponding outer faces with the outer push bar 685 and the associated feeler devices, Figure 13. One pair of stops marks a neutral position; and the remaining two determine two different operative angular positions of shaft 460. One of said operative positions initiates narrowing; and the other starts the first half of the quick return which is completed by return of shaft 460 to neutral or initial angular position.

Decking control

Operation of the decking devices in the illustrated machine is controlled through link 810, Figures 11, 11I and 13, which is pivotally connected to lever arm 811 secured on decker control shaft 750. Rotation of said control shaft 750 effects operation of the decker shaft 274 and simultaneously arrests operation of the knitting cams. Connections for these purposes are shown in part in Figures 4, 4A, 4B and 4C.

Link 810 is provided with two pairs of step faces including respectively the outer faces 810a and the inner faces 810b, one pair of which, 810a produces the neutral positioning of decker control shaft 750 when link 810 is in "up" position and actuated by outer push bar 685 and the other of which produces operative movement and position thereof when said link is in "down" position and actuated by the inner push bar 617.

Widening and narrowing control in fashioning

Operation of the widening and narrowing devices, such for example as those parts thereof shown in Figure 21 and including shafts 369 and 375 and slide bar 403 are controlled through link 802, Figures 11, 11J and 13. Said link is connected to rotate upright shaft 406 which in turn operates the gate carrying slide bar 403, Figure 21.

The neutral and three operative positions of said slide bar 403 are produced by pairs of step faces including the inner step faces 802a, 802b, 802c and 802d respectively and the corresponding outer faces on link 802, Figure 11J. One or another of said pairs is engaged by inner push bar 617 or by outer push bar 685 when the latter periodically move toward each other, line c, Figure 75, as previously described.

Racking control

As seen in Figures 4, 11, 11E and 13, automatic control of racking is effected through control or stop link 736 which is connected to rack control shaft 732 by lever arm 737, Figure 13. The connections by which racking is effected including link 734, finger 724, Figure 4A and shaft 725 and operation of the stitch cams is simultaneously arrested through arm 738, bell crank 739, and clutch including key 742, Figure 7, by rotation of said shaft 732 are shown in part in Figures 4A, 4C and 7.

Control link 736 is provided with two pairs of step faces identified respectively by the outer step face 736b and the inner step face 736c. These provide one neutral and one operative position for said link when the latter is conditioned by the feelers and actuated by said push bars as previously described with other parts of the illustrated automatic control mechanism.

Operation of controls

The pattern sheet, as 553, Figure 12, is prepared in advance with perforations arranged to produce a given type and size of garment, or part thereof, or other article to be knitted. Also, a pattern chain having the proper number and sequence of the various types of chain links, Figures 14 to 18 inclusive, is prepared in advance for use with each such pattern sheet 553.

In operation, the chain driving sprocket 562 is actuated to advance the chain whenever a chain control perforation, as 609, is at the zenith position on drum 554. But said drum is rotated to move the pattern sheet and thus modify the effective pattern change setting only when a link lug is brought into operative position on the sprocket 562. Accordingly, where a given pattern change setting is to be repeated over a succession of courses, i. e. by holding the pattern sheet at a given change position, the corresponding section of chain is made up of the plain or filler links 564. These are advanced one after another, following a lug link, by rotation of said sprocket until a change is required. This is effected by another lug link interposed at the proper place in the chain and by which the drum is caused to rotate and thus move the pattern sheet into position to present the desired new section of pattern change perforations therein.

The sequence of operation of the several parts above described will be better understood by reference to Figure 75, wherein the graph *y* represents a half turn of the cam 76, Figure 5, which produces one stroke or knitting course, as left to right of the knitting cams. During the operation represented by said graph *y*, cams 587, 613, 610 and 611 on shaft 6 make a full turn.

As the parts actuated by cam 76 leave one dwell position marking the end of a preceding right to left course, for example, cam 587 actuates the bar 586, Figure 20, and connected parts in a direction to rotate the pattern drum and thus advance the pattern sheet, provided of course, that the last effective advance of the pattern chain has brought a lug link into zenith position. This movement of bar 586 is represented by the line *a* of Figure 75.

When the pattern drum reaches its new position by said thrust of bar 586, the chain control feeler 603 and the pattern change feelers 689 drop into any pattern sheet perforations presented between them and the drum. This drop is represented in effect by line *b* which also shows the

corresponding drop of resetting bar 608, Figure 13, controlled by cam 613, Figure 20.

As the pattern change feelers reach their several lowered positions, cam 610, Figure 19, operates to move the push bars 617 and 685 toward each other, line *c*, Figure 75, to the position shown in Figure 13. This effects pattern changing movement or adjustment of those of the several control shafts which are to be actuated to produce changes in the next knitting course.

If the chain control feeler 603 has dropped, either alone or with other feelers, line *b*, Figure 75, and as the bar 617 moves toward bar 685, line *c*, Figure 75, the slide bar 600 is released and moves outwardly line *d*, Figure 75, to drop the pawl 590, Figure 20. Bar 586 is now moved in the opposite direction, right Figure 20, line *e*, Figure 75, to advance the pattern chain on sprocket 562.

Bars 617 and 685 are now moved away from each other by cam 611, line *f*, Figure 75; and substantially simultaneously therewith, slide bar 600 is returned to retracted position by said bar 617, line *g*, Figure 75.

The illustrated cycle is completed by cam 613, Figure 20, which actuates resetting bar 608 to lift all of the dropped feelers above the pattern sheet, line *h*, Figure 75, which is now free to be advanced in the next cycle.

It will be understood that in any cycle wherein no perforation is presented by the pattern sheet between the chain control feeler 603 and the drum, slide bar 600 will not move in the course including the lines *d* and *g*, Figure 75, but will be held in retracted position during the period represented by the dotted line *x*, Figure 75. Accordingly, when under these conditions, cam 587 produces the regular periodic movement of bar 586 also represented by line *e*, the pattern chain will not be advanced. As a practical matter, the control is set up to present either a chain control perforation in the pattern sheet or a lug on the pattern chain for effective operation in each cycle. In other words, either the chain will move or the pattern sheet will be advanced, or both will occur in each cycle representing a single knitting course.

I claim:

1. In a knitting machine having a needle bed, needles and needle jacks mounted therein to slide between retracted and advanced positions, the combination of a plurality of stitch cams movable endwise of said needle bed to simultaneously actuate advanced needle jacks of a like number of groups of needles mounted in different portions of said needle bed, means operative independently of any movement of said stitch cams and arranged and adapted to move needle jacks in said groups from retracted position into advanced knitting position, and means for moving said several stitch cams to simultaneously traverse said different portions of said needle bed and impart stitch forming movement to said needle jacks and needles when the latter are in said advanced position.

2. In a knitting machine having a needle bed, needles and needle jacks mounted therein to slide between retracted and advanced positions, the combination of a plurality of stitch cams, means for reciprocating said stitch cams in unison lengthwise of said needle bed to simultaneously move needle jacks of a like number of groups of needles mounted in different portions of said needle bed from advanced position toward retracted position, and means operative independently of said stitch cam reciprocating means and in the direction of sliding movement of the needles for moving needle jacks in said groups from retracted position into said advanced position.

3. In a links-links knitting machine having a needle bed carrying needles and needle jacks, said needle jacks being slidable between retracted and advanced positions therein and having portions arranged and adapted to engage and disengage portions of said needles, the combination of a plurality of stitch cams, jack positioning means for moving said needle jacks from retracted position into one advanced position for straight knitting and into a different advanced position for links-links knitting, and means operative independently of said jack positioning means for reciprocating said stitch cams to traverse said needle bed and actuate said needle jacks when said needle jacks are in either of said advanced positions.

4. In a links-links knitting machine having a needle bed carrying needles and needle jacks, said needle jacks being slidable endwise between retracted and advanced positions therein and having portions arranged and adapted to engage and disengage portions of said needles, the combination of a plurality of stitch cams arranged and adapted to move said advanced jacks, means for advancing needle jacks from retracted position into different advanced positions, and means operative independently of said needle jack advancing means for moving said stitch cams to traverse portions of said needle bed and actuate said needle jacks and needles when said jacks are in any of said advanced positions.

5. In a knitting machine having a needle bed carrying needles and needle jacks, said needle jacks being slidable endwise therein and having portions arranged and adapted to engage and disengage portions of said needles, the combination of a stitch cam carrier, a plurality of stitch cams mounted in spaced relation on said stitch cam carrier and in operative relation, respectively, to portions of said needle bed carrying different groups of needles and needle jacks, means for reciprocating said stitch cam carrier in a path whereby said several stitch cams move simultaneously across portions of said several groups of needles and needle jacks to simultaneously actuate needle jacks and needles of said several groups, and means for moving said stitch cam carrier to and from different paths of reciprocating movement to control the length of stitches formed when said stitch cams actuate said needle jacks and needles.

6. In a knitting machine having a needle bed carrying needles and needle jacks, said jacks being slidable therein and having portions arranged and adapted to engage and disengage portions of said needles, the combination of a stitch cam carrier, a stitch cam mounted on said stitch cam carrier in operative relation to said needle jacks, means for reciprocating said stitch cam carrier, and means for moving said stitch cam carrier to and from different paths of reciprocating movement to control the length of stitches formed when said stitch cam actuates said needle jacks and thereby said needles.

7. In a knitting machine having a needle bed carrying needles and needle jacks, said jacks being slidable therein and having portions arranged and adapted to engage and disengage portions of said needles, the combination of a stitch cam carrier having a stitch cam thereon arranged and adapted to actuate said needle jacks, means for reciprocating said carrier, a thread carrier sup-

port having a thread carrier fixed thereon, means differentially movable in relation to said stitch cam carrier reciprocating means for reciprocating said thread carrier support and said thread carrier thereon in synchronized relation with part of the reciprocating movement of said carrier and the stitch cams thereon, and means for varying the extent of reciprocating movement of said thread carrier support.

8. In a knitting machine, the combination of a needle bed, needle jacks and needles mounted therein, a stitch cam carrier, a stitch cam mounted thereon, means for reciprocating said stitch cam carrier and said stitch cam across said needle bed to effect stitch forming movement of said needle jacks and needles, a thread carrier, a thread carrier support arranged and adapted to support said thread carrier at a level above said stitch cam, and means differentially movable in relation to said stitch cam carrier reciprocating means for reciprocating said thread carrier support and said thread carrier in a horizontal path across said needle bed.

9. In a knitting machine, the combination of a needle bed, needle jacks and needles mounted therein, a stitch cam rod, a stitch cam mounted thereon, means for reciprocating said stitch cam rod endwise in a horizontal path across said needle bed to effect stitch forming movement of said needle jacks and needles, a thread carrier, a thread carrier supporting rod arranged and adapted to support said thread carrier at a level above said stitch cam, means for reciprocating said thread carrier supporting rod endwise in a horizontal path across said needle bed, and means for varying the extent of reciprocating movement of said thread carrier rod in relation to the extent of reciprocating movement of the stitch cam rod.

10. In a knitting machine, the combination of a needle bed, needle jacks and needles mounted therein, a stitch cam carrier, a stitch cam mounted thereon and arranged and adapted to effect stitch forming movement of said needle jacks and needles, a thread carrier supporting rod, a thread carrier mounted thereon in fixed relation thereto, widening and narrowing means cooperating with said needle jacks and arranged and adapted to vary the number thereof to be acted on by said stitch cam, means for reciprocating said stitch cam carrier, means differentially movable in relation to said stitch cam carrier reciprocating means for reciprocating said thread carrier supporting rod, and means operatively connected with said widening and narrowing means for varying the extent of reciprocating movement of said thread carrier supporting rod whereby the latter will have an increasing extent of movement in widening and a diminishing extent of movement in narrowing independently of the extent of reciprocating movement of the stitch cam carrier.

11. In a knitting machine having a needle bed carrying needles and needle jacks, said jacks being slidable endwise therein and having portions arranged and adapted to engage and disengage portions of said needles, the combination of a plurality of stitch cams arranged and adapted to move said needle jacks, means for reciprocating said several stitch cams simultaneously across portions of said needle bed carrying different groups of said needles and needle jacks to simultaneously actuate needle jacks and needles of said several groups, means for moving needle jacks in said groups to and from position to be actuated by said several stitch cams, a plurality of stitch transfer devices, means operatively connected with said needle jack moving means for actuating said transfer devices simultaneously to lift stitches from one or more needles in each group, and means for simultaneously moving said transfer devices to bring said lifted stitches in position to be deposited on another or other needles in each group.

12. In a knitting machine having a stitch cam carrier, a stitch cam mounted on said carrier, a thread carrier support and a thread carrier fixed thereon, the combination of means for reciprocating said stitch cam carrier and said thread carrier support respectively in synchronized relation, and means for effecting differential movement of said thread carrier support driving means in relation to said stitch cam carrier driving means to reverse the lead of said thread carrier in relation to said stitch cam between successive synchronized stitch forming movements of said stitch cam carrier and said thread carrier support, and means for varying the extent of said differential movement between said stitch cam carrier driving means and said thread carrier support driving means.

13. In a knitting machine having a stitch cam carrier, a stitch cam mounted on said carrier, a thread carrier support movable differentially in relation to the stitch cam carrier, a thread carrier mounted thereon and in fixed relation thereto, a brush support movable differentially in relation to said thread carrier support, and a brush mounted thereon and in fixed relation thereto, means for driving said stitch cam carrier, means for driving said thread carrier support and said brush support in synchronized relation with said stitch cam carrier driving means, and means cooperating with said stitch cam carrier driving means for effecting differential movement between said brush support and said thread carrier support to reverse the lead of said brush support in relation to said thread carrier between successive synchronized stitch forming movements of said stitch cam carrier, said thread carrier support and said brush support.

14. In a knitting machine having a stitch cam carrier, a stitch cam mounted on said carrier, a thread carrier support, a thread carrier mounted thereon and arranged in operative relation to said stitch cam, a brush support, and a brush mounted thereon and operatively arranged in relation to said thread carrier, the combination of means for reciprocating said stitch cam carrier, means for reciprocating said thread carrier support and said brush support in synchronized relation with said stitch cam carrier, and means cooperating with a portion of said stitch cam carrier reciprocating means and operatively connected to said brush support for effecting differential movement between said brush support and said thread carrier support to reverse the lead of said brush in relation to said thread carrier between successive stitch forming movements of said stitch cam carrier, said thread carrier support and said brush support.

15. In a knitting machine having a stitch cam carrier, a stitch cam thereon, a thread carrier support, a thread carrier thereon, a brush support, a brush thereon, means for actuating said stitch cam carrier, and means for actuating said thread carrier support and said brush support, the combination of means for effecting differential adjusting movement between said stitch cam carrier and said thread carrier support, and

means cooperating with said stitch cam carrier actuating means for effecting differential adjusting movement between said thread carrier support and said brush support.

16. In a knitting machine having a stitch cam actuating rod, a thread carrier actuating rod, a brush actuating rod, a driving arm for said stitch cam actuating rod, and a driving arm for said thread carrier actuating rod and said brush carrier actuating rod, the combination of a bracket fixed on said last mentioned driving arm and arranged and adapted to connect said thread carrier actuating rod thereto, a second bracket adjustably mounted on said last mentioned driving arm and arranged and adapted to connect said brush actuating rod thereto, and means operatively arranged between said second bracket and said first mentioned driving arm to effect adjusting movement between said adjustable bracket and said fixed bracket.

17. In a knitting machine having a stitch cam actuating rod, a thread carrier actuating rod, a brush actuating rod, a driving arm for said stitch cam actuating rod, and a driving arm for said thread carrier actuating rod and said brush carrier actuating rod, the combination of arm actuating means for effecting movement of said driving arms in unison over an intermediate part of their course and means for effecting differential movement of one of said arms in relation to the other of said arms at end parts of their course.

18. In a knitting machine having a stitch cam actuating rod, a thread carrier actuating rod, a brush actuating rod, a driving arm for said cam actuating rod, and a driving arm for said thread carrier actuating rod and said brush carrier actuating rod, the combination of arm actuating means for effecting movement of said arms in unison over an intermediate part of their course, means for effecting differential movement of one of said arms in relation to the other of said arms at end parts of their course, and means for varying the extent of movement in unison of said arms.

19. In a knitting machine having a front needle bed, a rear needle bed, a stitch cam carrier operatively related to each of said needle beds, a plurality of stitch cams mounted in spaced relation on each said cam carrier and in operative relation, respectively, to different portions of said needle beds, and means for reciprocating said stitch cam carriers to move said several stitch cams simultaneously across said different portions of the needle beds, the combination of spring tension biasing means operatively interposed between said stitch cam carriers to retain them yieldingly in spaced parallel relation, and means for varying the space between said cam carriers to control the length of stitches formed when said stitch cam carriers are reciprocated.

20. In a knitting machine having opposed needle beds one of which is movable longitudinally in relation to the other for racking, needle jacks and needles mounted to slide to and from working position in said beds, stitch cams and means for actuating the same to impart stitch forming movement to said needle jacks and needles, and means for selectively positioning the needle jacks in said other needle bed to effect narrowing and widening, the combination of a needle jack positioning bar having an edge portion arranged to engage needle jacks in the movable bed, means for periodically moving said needle jack positioning bar in a direction to move said needle jacks into working position in relation to the path of movement of a stitch cam, said edge portion being interrupted by an opening at least as great in extent as the racking movement of said longitudinally movable bed, and means cooperating with said needle jack positioning means in narrowing and widening for imparting longitudinal adjusting movement to said bar whereby said opening is maintained in effective operative position under all conditions of narrowing and widening.

21. In a knitting machine having opposed needle beds one of which is movable longitudinally in relation to the other for racking, a stitch cam operatively mounted in relation to each bed, and means for periodically reciprocating said stitch cams longitudinally of said beds, the combination of means for actuating said longitudinally movable needle bed, and means operatively connected therewith and with said stitch cam reciprocating means and arranged and adapted to arrest periodic operation of the latter during operation of said needle bed actuating means.

22. In a knitting machine having opposed needle beds, one of which is movable longitudinally in relation to the other for racking, needle jacks and needles slidably mounted in said beds, a stitch cam movable longitudinally of each of said needle beds, and means for actuating said stitch cams to impart stitch forming movement to said needle jacks and needles, the combination of a needle jack positioning bar having an edge portion arranged to engage butt portions of the needle jacks in the movable bed, and means for reciprocating said bar to move said needle jacks into the path of movement of that one of said stitch cams which is movable longitudinally of the movable bed.

23. In a knitting machine having a needle bed needle jacks and needles mounted therein to slide between retracted and advanced positions, the combination of a plurality of stitch cams each mounted to effect a knitting stroke across a different portion of said needle bed, means operative independently of knitting movement of said stitch cams and between successive strokes thereof for moving needle jacks in said groups from retracted position into advanced position, means for conditioning portions of said needle jack moving means to vary the number of needle jacks moved thereby from retracted position to advanced position, and means for imparting a knitting stroke to said several cams to simultaneously traverse said different portions of said needle bed to impart stitch forming movement to said needle jacks when the latter are in advanced position.

24. In a knitting machine having a needle bed needle jacks and needles slidably mounted therein, and a plurality of stitch cams mounted to reciprocate above said needle bed, said stitch cams being spaced apart along the length of said needle bed whereby each said cam is operatively related to a separate group of said needle jacks and needles, the combination of means for moving needle jacks in said groups simultaneously from retracted idle position into advanced position in the path of movement of said respective stitch cams, means for conditioning a portion of said needle jack moving means to vary the number of needle jacks in each group to be moved from said idle position to advanced position by said needle jack moving means, means for removing stitch loops from one or more needles at end portions of each of said groups simultaneously, means operative in advance of operation

of said loop removing means to move said end needles and the needle jacks operatively associated therewith from retracted position into advanced position and into operative relation with said loop transferring means, and means for delivering said removed stitch loops simultaneously into operative engagement with other needles of said groups.

25. In a knitting machine having a needle bed needle jack and needles slidably mounted therein, and a plurality of stitch cams mounted to reciprocate above said needle bed, said stitch cams being spaced apart along the length of said needle bed whereby each said cam is operatively related to a separate group of said needle jacks and needles, the combination of means for moving needle jacks in said groups simultaneously from retracted idle position into advanced position in the path of movement of said respective stitch cams, means for conditioning a portion of said needle jack moving means to vary the number of needle jacks in each group to be moved from said idle position to advanced position by said needle jack moving means, means for removing stitch loops from one or more needles at each edge of each group simultaneously, and means for moving said removed loops into position to be simultaneously received upon needles positioned adjacent thereto.

26. In a knitting machine having a needle bed provided with grooves and needles slidably mounted in said grooves, the combination of a needle jack actuating cam having cam edges and a needle jack engaging bottom surface portion, needle jacks slidably positioned in said grooves and each having a needle engaging head, a butt arranged and adapted to engage said cam edge of said cam, a shoulder arranged and adapted to engage said bottom surface portion of said cam, and a shank between said head and said shoulder, a fixed needle jack retaining plate extending across portions of said grooves and spaced from the bottom surfaces thereof, means for moving said needle jacks from neutral to a position with their heads at one side of said retaining plate, their shoulders at the other side thereof, and said shanks beneath said plate, and means for moving said cam across said grooves to bring said bottom surface portion thereof into engagement with said shoulder and to bring said cam edge thereof into operative needle jack moving engagement with said butt to return each said needle jack toward neutral position.

27. In a knitting machine, having a needle bed having needle grooves and a plate arranged across end portions of said grooves, needle jacks slidably mounted in said grooves and each having a head portion, a shoulder portion, and a cam butt, means for advancing said needle jacks along said grooves in a direction and to an extent to bring said heads into a position beyond and out of engagement with said plate, the combination of a needle jack actuating cam mounted to reciprocate across said grooves and said needle jacks and having a needle jack actuating cam edge and a needle jack engaging bottom surface, and means for moving said cam transversely across said grooves and into engagement with said cam butts, said bottom surface of said cam being arranged and adapted during said transverse movement of said cam to bear on said shoulder portions of said needle jacks while said cam edge engages said cam butts and actuates said needle jacks to retract the heads thereof from said advanced position beyond said plate into position under and in engagement with said plate.

28. In a knitting machine having a needle bed, needles and needle jacks mounted therein to slide between idle and advanced positions, the combination of a plurality of stitch cams, needle jack positioning means movable in one direction to engage said needle jacks and move them from idle position to advanced position and movable in the opposite direction to disengage said needle jacks when they are in said advanced position, and stitch cam actuating means operative independently of said needle jack positioning means and arranged and adapted to move said stitch cams in a path to engage said needle jacks when they are in said advanced position and to move said needle jacks from said advanced position toward idle position.

29. In a knitting machine, the combination of a needle bed, push jacks having portions slidably mounted therein, a stitch cam carrier, a stitch cam mounted thereon, needles and needle jacks mounted to slide inwardly toward advanced position and outwardly toward idle position in said needle bed, and said needle jacks having butts arranged and adapted to be engaged by said stitch cam and end portions arranged and adapted to be engaged by said push jacks, means for moving said stitch cam carrier in a path to engage said stitch cam with the butts of said needle jacks when the latter are in advanced position and move the same outwardly, and reciprocatable means operative independently of said stitch cam carrier moving means and movable in one direction to move said push jacks endwise against end portions of said needle jacks to push said needle jacks into said advanced position and movable in the opposite direction to withdraw said push jacks away from engagement with said needle jacks when the latter are in said advanced position.

30. In a knitting machine having a needle bed and needles and needle jacks mounted therein, the combination of a needle jack positioning bar, means for actuating said bar to move the needle jacks from idle position into advanced position for knitting and into advanced position for decking, a stitch cam, means operative independently of said needle jack positioning bar for moving said stitch cam into engagement with said needle jacks when in advanced knitting position to return said needle jacks toward idle position, and a push-out bar operative independently of said needle jack positioning bar and movable into engagement with said needle jacks to return said needle jacks from advanced decking position toward idle position.

31. In a knitting machine having a needle bed carrying needles and needle jacks, the combination of a plurality of spaced interconnected stitch cams operatively arranged in relation to said needle bed, a stitch cam driving chain, a plurality of spaced interconnected thread carriers, a thread carrier driving chain arranged and adapted to actuate said thread carriers in synchronized relation with an intermediate portion of the movement of said stitch cams, and means operatively connected with said thread carrier driving chain to shift the operative position thereof and of the thread carriers in relation to the stitch cam driving chain and the stitch cams.

32. In a knitting machine having a needle bed carrying needles and needle jacks, the combination of a plurality of spaced interconnected stitch cams operatively arranged in relation to said needle bed, a stitch cam driving chain, a plurality of spaced interconnected thread carriers, a thread carrier driving chain arranged and adapted to actuate said thread carriers in synchronized rela-

tion with an intermediate portion of the movement of said stitch cams, means operatively connected with said thread carrier driving chain to shift the operative position thereof and of the thread carriers in relation to the stitch cam driving chain and the stitch cams, a plurality of spaced interconnected brushes operatively connected to said thread carrier driving means, and means operatively interposed between said thread carrier driving means and said stitch cam driving means and arranged and adapted to shift the position of said brushes in relation to said thread carriers.

33. In a knitting machine having a needle bed, needles and needle jacks, the combination of a stitch cam arranged and adapted to actuate said needle jacks, means for transferring stitches from certain of said needles to other of said needles, means for reciprocating said stitch cam, means for actuating said stitch transfer means toward and from the needles, means for moving said stitch transfer means laterally to bring the lifted stitches into position to be deposited on other needles, and means operative independently of said stitch cam reciprocating means for actuating said needle jacks to move said needles into knitting position and into position to cooperate with stitch lifting movement of said stitch transfer means.

34. In a knitting machine having a needle bed, a stitch cam carrier and a thread carrier support operatively related thereto, a stitch cam mounted on said stitch cam carrier, a thread carrier mounted on said thread carrier support, a drive chain actuating shaft having two driving sprockets mounted thereon, and means for rotating said shaft alternately in opposite directions, the combination of a stitch cam carrier drive chain having a portion disposed in operative driven engagement with one of said driving sprockets, a fixed idler sprocket engaging another portion of said chain, a thread carrier support drive chain having a portion disposed in operative driven engagement with the other of said driving sprockets, a fixed idler sprocket engaging another portion of said thread carrier drive chain, a sprocket carrier, a pair of idler sprockets mounted thereon and in engagement with portions of said thread carrier support drive chain between the driving sprocket and the fixed idler sprocket engaging said chain, and means for moving said sprocket carrier to vary the position of the idler sprockets thereon in relation to the thread carrier support drive chain.

35. In a knitting machine having a needle bed, a stitch cam carrier and a thread carrier support operatively related thereto, a stitch cam mounted on said stitch cam carrier, a thread carrier mounted on said thread carrier support, a drive chain actuating shaft having two driving sprockets mounted thereon, and means for rotating said shaft alternately in opposite directions, the combination of a stitch cam carrier drive chain having a portion disposed in operative driven engagement with one of said driving sprockets, a fixed idler sprocket engaging another portion of said chain, a thread carrier support drive chain having a portion disposed in operative driven engagement with the other of said driving sprockets, a fixed idler sprocket engaging another portion of said thread carrier drive chain, a sprocket carrier rod mounted for reciprocating endwise movement, idler sprockets mounted in fixed spaced relation on said rod and in engagement with portions of said thread carrier support drive chain, and means for moving said rod periodically in synchronized relation with said means for rotating the drive chain actuating shaft to vary the position of the idler sprockets on said rod in relation to said thread carrier support drive chain.

36. In a knitting machine wherein a needle bed is provided with grooves having openings at inner edge portions of said bed, the combination of a stitch cam guiding and supporting member mounted above said bed and adjustable toward and away from said inner edge portions thereof, a stitch cam mounted on said member, means for imparting reciprocating stitch forming movement to said stitch cam in relation to said member and to said needle bed, means for biasing said member in one direction in relation to said inner edge portions of the needle bed, and means for moving said member in the opposite direction.

37. In a knitting machine wherein a needle bed is provided with grooves having openings at inner edge portions of said bed, the combination of a stitch cam guiding and supporting member mounted above said bed and adjustable toward and away from said inner edge portions thereof, a stitch cam mounted on said member, means for imparting reciprocating stitch forming movement to said stitch cam in relation to said member and to said bed, means for biasing said member in one direction in relation to said inner edge portions of the needle bed, means for moving said member in the opposite direction, and means for varying the extent of movement of said member in said opposite direction.

38. In a links-links knitting machine having opposed needle beds provided with grooves, a fixed plate above and extending across portions of the grooves in one of said needle beds, cam means mounted to slide above and across other portions of said grooves at one side of said plate, and means for reciprocating said cam means, the combination of needle jacks mounted to slide in said grooves between a retracted idle position and an advanced active position for links-links knitting, and each needle jack having a head arranged to be held in engagement with a needle by said fixed plate and a cam butt arranged and adapted to be engaged and disengaged by said cam means, said needle jacks, when in idle position, having their cam butts out of the path of movement of said cam means and their heads engaging said plate and, when in advanced active position for links-links knitting, having their cam butts in the path of movement of said cam means and their heads in position to be disengaged from said needles, and means operative independently of said cam reciprocating means for moving said needle jacks from retracted idle position to advanced links-links knitting position.

39. In a knitting machine having front and rear needle beds provided with grooves, needles, push jacks and tiltable needle jacks mounted to slide to and from stitch forming position in said grooves, the combination of a reciprocatable cam actuating rod for each needle bed, oppositely disposed cam means operatively connected to said rods and reciprocatable therewith across and above the grooves of said respective needle beds, said cam means having under surface portions positioned to bear downwardly on upper edge portions of said needle jacks and each having an end portion extending beyond the opposite end of the other, means for imparting reciprocating movement to said cam actuating rods, and means operative independently of said cam rod recip-

rocating means to advance said push jacks in a direction and to an extent sufficient to move said needle jacks into stitch forming position.

40. In a knitting machine having a needle bed, needle jacks and needles mounted therein to slide between retracted and advanced positions, a stitch cam mounted in operative relation to said needle bed, and means for actuating said stitch cam to engage and actuate said needle jacks when the latter are in advanced position, the combination of a push-in bar operative independently of said stitch cam actuating means, push jacks adjustably positioned in relation to said push-in bar and movable therewith to engage and push needle jacks from retracted to said advanced position, and means for conditioning said push-in jacks in relation to said push-in bar to vary the number of needle jacks moved thereby from retracted position to advanced position.

41. In a knitting machine having opposed needle beds, one of which is movable longitudinally in relation to the other for racking, needle jacks and needles mounted to slide to and from working position in said beds, and means for selectively positioning the needle jacks in said other needle bed to effect narrowing and widening, the combination of a push-in bar operatively related to said movable bed and having a longitudinally extending edge portion arranged to engage and move some of the needle jacks in the movable bed while others of said needle jacks remain unengaged and unmoved therein, means for periodically actuating said push-in bar in a direction to move said engaged needle jacks into active working position, and means cooperating with said needle jack positioning means in narrowing and widening for imparting longitudinal adjusting movement to said push-in bar whereby said edge portion thereof is maintained in effective operative position to engage and move some of said needle jacks in the longitudinally movable bed to active position under all conditions of narrowing and widening while others of said needle jacks in the longitudinally movable bed remain unengaged and unmoved to active position therein.

THOMAS S. HAYHURST.

Certificate of Correction

Patent No. 2,395,814. March 5, 1946.

THOMAS S. HAYHURST

It is hereby certified that errors appear in the printed specification of the above numbered patent requiring correction as follows: Page 1, second column, line 27, for "camparable" read *comparable*; page 17, first column, line 74, after "stroke" strike out "of the stitch"; page 21, second column, line 1, for "52C (while" read *52C, while*; line 72, for "fabric" read *fabrics*; page 22, first column, line 17, for "postions" read *positions*; page 28, second column, line 41, for "form" read *worm*; line 45, strike out "direction. This rotation of said worm" and insert *directions. A preferred mechanism for*; page 33, second column, line 8, for "in" before "effected" read *is*; page 37, first column, line 21, for "sroke" read *stroke*; page 38, first column, line 49, for "shaft 640" read *shaft 460*; page 45, second column, line 56, after "cams" insert *or*; page 47, second column, line 59, for "627" read *628*; page 53, first column line 10, claim 25, for "jack" read *jacks*; and that the said Letters Patent should be read with these corections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 28th day of May, A. D. 1946.

[SEAL]

LESLIE FRAZER,
First Assistant Commissioner of Patents.

rocating means to advance said push jacks in a direction and to an extent sufficient to move said needle jacks into stitch forming position.

40. In a knitting machine having a needle bed, needle jacks and needles mounted therein to slide between retracted and advanced positions, a stitch cam mounted in operative relation to said needle bed, and means for actuating said stitch cam to engage and actuate said needle jacks when the latter are in advanced position, the combination of a push-in bar operative independently of said stitch cam actuating means, push jacks adjustably positioned in relation to said push-in bar and movable therewith to engage and push needle jacks from retracted to said advanced position, and means for conditioning said push-in jacks in relation to said push-in bar to vary the number of needle jacks moved thereby from retracted position to advanced position.

41. In a knitting machine having opposed needle beds, one of which is movable longitudinally in relation to the other for racking, needle jacks and needles mounted to slide to and from working position in said beds, and means for selectively positioning the needle jacks in said other needle bed to effect narrowing and widening, the combination of a push-in bar operatively related to said movable bed and having a longitudinally extending edge portion arranged to engage and move some of the needle jacks in the movable bed while others of said needle jacks remain unengaged and unmoved therein, means for periodically actuating said push-in bar in a direction to move said engaged needle jacks into active working position, and means cooperating with said needle jack positioning means in narrowing and widening for imparting longitudinal adjusting movement to said push-in bar whereby said edge portion thereof is maintained in effective operative position to engage and move some of said needle jacks in the longitudinally movable bed to active position under all conditions of narrowing and widening while others of said needle jacks in the longitudinally movable bed remain unengaged and unmoved to active position therein.

THOMAS S. HAYHURST.

Certificate of Correction

Patent No. 2,395,814. March 5, 1946.

THOMAS S. HAYHURST

It is hereby certified that errors appear in the printed specification of the above numbered patent requiring correction as follows: Page 1, second column, line 27, for "camparable" read *comparable*; page 17, first column, line 74, after "stroke" strike out "of the stitch"; page 21, second column, line 1, for "52C (while" read *52C, while*; line 72, for "fabric" read *fabrics*; page 22, first column, line 17, for "postions" read *positions*; page 28, second column, line 41, for "form" read *worm*; line 45, strike out "direction. This rotation of said worm" and insert *directions. A preferred mechanism for*; page 33, second column, line 8, for "in" before "effected" read *is*; page 37, first column, line 21, for "sroke" read *stroke*; page 38, first column, line 49, for "shaft 640" read *shaft 460*; page 45, second column, line 56, after "cams" insert *or*; page 47, second column, line 59, for "627" read *628*; page 53, first column line 10, claim 25, for "jack" read *jacks*; and that the said Letters Patent should be read with these corections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 28th day of May, A. D. 1946.

[SEAL]

LESLIE FRAZER,
First Assistant Commissioner of Patents.