May 17, 1932. J. SIRMAY 1,858,469

CIRCULAR KNITTING MACHINE

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Fig. 1,

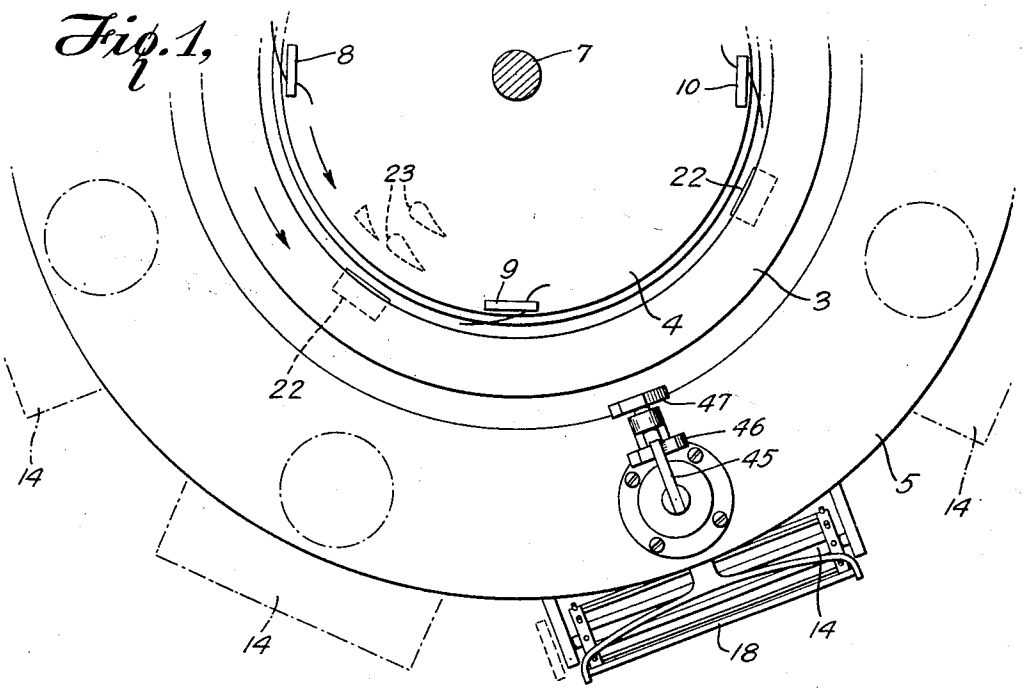
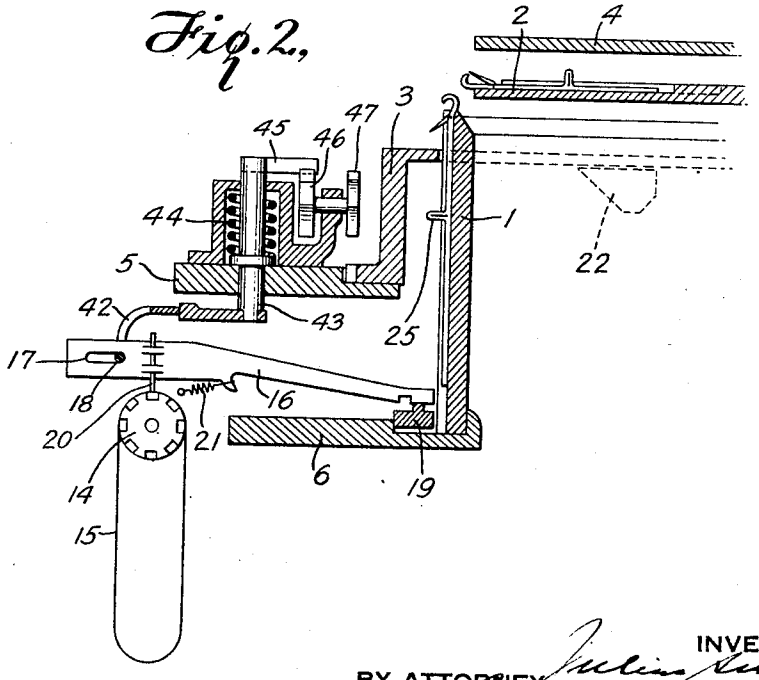


Fig. 2,



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Fig. 3,

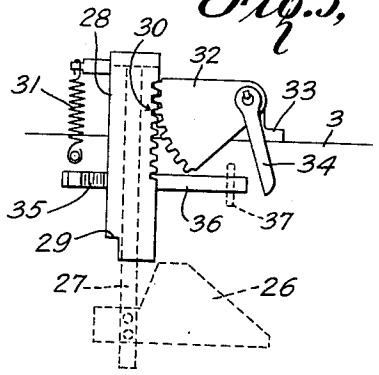


Fig. 4,

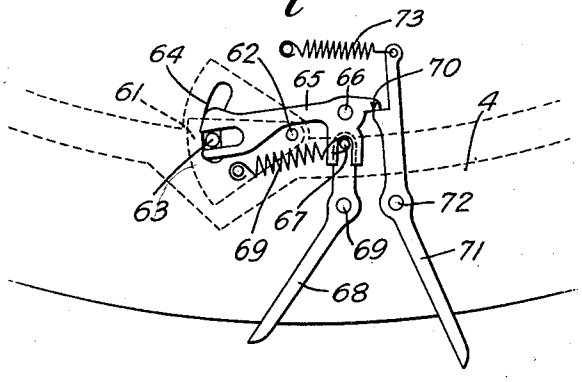


Fig. 5,

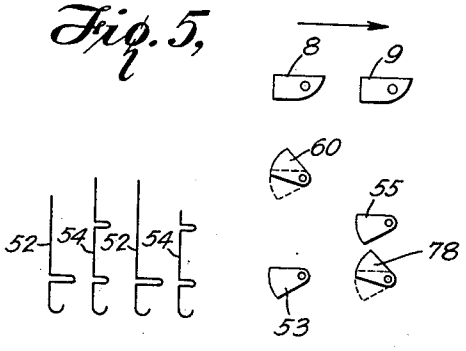
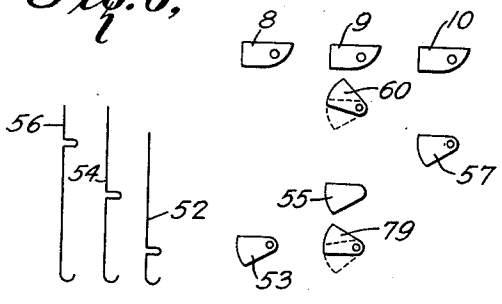


Fig. 6,



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Fig. 7,

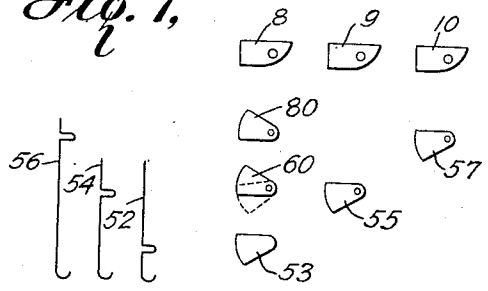


Fig. 8,

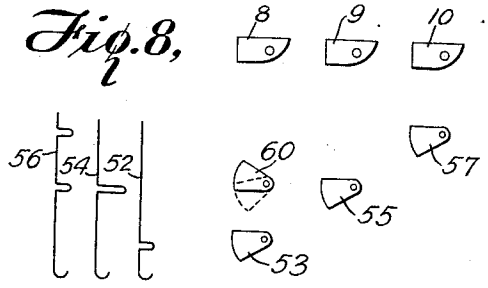


Fig. 9,

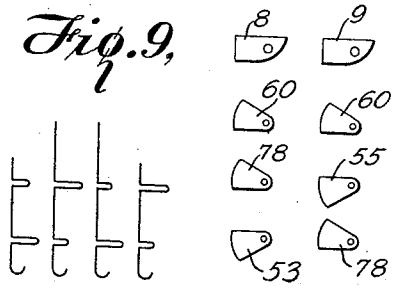
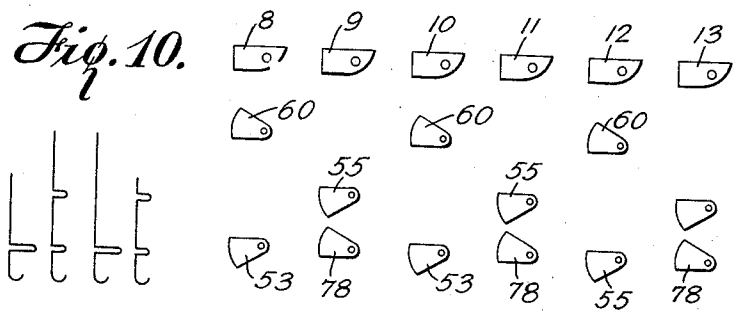


Fig. 10.



INVENTOR

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BY ATTORNEYS

Patented May 17, 1932

1,858,469

UNITED STATES PATENT OFFICE

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CIRCULAR KNITTING MACHINE

Application filed October 16, 1930. Serial No. 489,113.

My invention relates to circular rib or multi-needle-bank knitting machines so constructed or so provided with pattern mechanism that a pattern or other fancy effect can be produced on one side of the fabric (called the "face") by selectively knitting the same from two or more yarns; that is to say, by forming some of the stitches in individual rows appearing on the face of the fabric from one yarn, and forming the remainder from another or other yarns.

It is frequently desired that a fabric having such a fancy face, should have its opposite side or "back" knitted selectively from the various yarns also; but usually it is satisfactory to have this selective knitting at the back done in a more or less regular manner. So-called "twill backs" and/or "birdseye backs" are examples; for brevity, I herein call backs of this kind "fancy effect backs," since I believe that their greatest utility, if not their sole utility, is in connection with the knitting of pattern or other fancy effects on the face of fabrics. Furthermore, it is frequently desirable that machines capable of producing such fancy fabrics, should also be capable of producing plain fabrics alternately, at will, and particularly plain fabrics having different relations between the number of stitches in their faces and the number of stitches in their backs (or a single continuous plain fabric having a certain relation between the stitches in its back and the stitches in its face at one place, and another relation at another place). Plain fabrics such as 2:2 and 1:1 rib are examples. Of course, such plain fabrics require backs differing from the "fancy-effect back" of the fancy fabrics, and usually differing from each other.

An object of the present invention is to provide for the knitting of both fancy-effect and plain fabric backs, and an arrangement for this purpose wherein the change from one kind of back to another is readily made.

According to the present invention, I employ for the needles on which the backs are knitted, independently sliding needles differing among themselves in form (e. g., distinguished among themselves by having high and low butts, or long and short shanks, or some having one butt and others two butts, etc.) and a number of needle-projecting cams for more or less alternate use as hereinafter explained.

While the invention is applicable to multi-needle-bank machines of various kinds, for example to machines having their needles arranged in coaxial cylinders, as well as to dial and cylinder machines, as will become apparent, I believe it will be applied most often to dial and cylinder machines; that is to say, to machines in which (in each machine) the needles are arranged in a cylinder and a cooperating dial. I shall therefore describe the invention as applied to a dial and cylinder machines; from this application its application to other forms of machines will be understood. Furthermore, since in dial and cylinder machines the fancy face of the fabric is customarily produced on the cylinder needles, I have here illustrated a machine so constructed. It will be understood however that dial and cylinder machines can be so built that the fancy effect is produced on the dial needles and the back made on the cylinder needles, and hence when I use the term "cylinder" herein I include "dial" as an alternative, and vice versa, except when the contrary may appear.

In the accompanying drawings, Fig. 1, a plan view, and Fig. 2, a vertical section to illustrate particularly a pattern mechanism, show more or less diagrammatically sufficient of a dial and cylinder machine to enable the parts thereof concerned with the present invention to be identified. Fig. 3, an elevation, illustrates a known mounting for needle raising cams for cylinder needles and mechanism for moving the same to and from operative position at will. Fig. 4 also illustrates a known form of dial cam mounting and mechanism for shifting needle projecting cams for the dial needles to and from operative position at will. Figs. 5 to 10 illustrate diagrammatically various needle and cam arrangements for knitting the backs of fabrics, in accordance with my invention.

Referring first to Figs. 1 and 2: The stationary cylinder 1 and stationary dial 2 (con-

stituting the beds of the two banks of needles employed in this machine), the rotating cam cylinder 3, dial cam cap 4, the vertical post 7 supporting the dial and dial cap and the upper and lower stationary bed plates 5 and 6 on which the foregoing are mounted, will be recognized, as will also the independently sliding latch needles shown in the cylinder and dial. The cam cylinder 3 and dial cap 4 rotate synchronously of course. For the purpose of illustrating the fact that the machine is a multiple yarn machine (adapted to feed a number of yarns simultaneously but separately, that is to say, for separate knitting by the needles) three yarn guides 8, 9 and 10 are illustrated, each supplying one yarn to the cylinder and dial needles; it will be understood from what follows however that a greater or lesser number of yarns (and feeds) may be used. It can be assumed too that each feed includes a stitch cam or stitch cams 23 on the dial cap 4 to retract all projected dial needles as each feed passes. So far as the present invention is concerned, broadly speaking, any kind of mechanism can be used to direct the knitting of the fancy-effect face of the fabrics, so long as it is of the sort which causes the needles of the face-forming bank to be knitted on selectively from the different yarns as the desired fancy-effect may require; that is to say, in individual rows of the stitches appearing on the face of the fabric, cause some of the stitches to be knit from one yarn and the remainder to be knit from another or other yarns. Also this pattern mechanism (including in the term "pattern mechanism" any and all kinds of mechanisms acting in the manner described) can be applied to either the cylinder needles or the dial needles as before pointed out. For the purpose of illustrating the invention, I have here shown a machine which has a pattern mechanism (Fig. 2) of a well known true-jacquard type, and this pattern mechanism is applied to the cylinder needles. Briefly describing the pattern mechanism here shown: It consists of a plurality of pattern drums 14, distributed around the needle cylinder, each carrying a pattern 15 controlling a group of needle raising levers 16. There may be, say, one of these levers 16 for each of the cylinder needles, and each of the cylinder needles, if not long enough, may be provided with an extension or jack reaching down to its lever 16. The outer end of each lever is slotted at 17, and the supporting rods 18 for the outer ends of the levers (one rod for the levers of each drum) pass through the slots of the respective groups; the inner ends of the levers rest on a second cam cylinder 19, or section of the cam cylinder, which is rotated synchronously with the cam cylinder or cam cylinder section 3. In their normal at rest positions (shown in Fig. 2) these levers 16 do not quite reach underneath their respective needles. The cam cylinder or cam cylinder section 19 can be assumed to be provided with a needle-raising cam in each of the feeds (yarns) of the machine; these cams engage the inner ends of the levers 16 however, rather than the cylinder needles directly. Each of the pattern drums 14 is slotted lengthwise, and the distance between each two adjacent slots represents one step in the rotation of the drum. The pattern drums are turned step by step successively, each being turned one step (for example, by known mechanism, not illustrated) shortly before each of the feeds reaches the group of levers 16 which that pattern drum controls; wherever this brings a perforation in the corresponding pattern 15 underneath the feeder 20 of one of the levers 16, that feeler falls into the drum slot below the perforation and consequently the lever is, by further or continuous turning of its drum 14, pushed in underneath its cylinder needle, so that the stitch cam on the cam cylinder 19 of the approaching feed can raise that or those levers 16 whose feelers find perforations and thereby raise the corresponding needles to (for example) clearing position; where however a feeler 20 finds no perforation in the pattern 15 below it at the time, the lever 16 carrying that feeler remains in the outer position illustrated in Fig. 2, so that the passing needle-raising cam on the cam cylinder 19, while raising that or those levers 16, does not raise the corresponding needles, and hence the needles corresponding to the levers 16 whose feelers 20 find no perforations in their pattern 15 at the time, do not knit as that feed passes. The cam cylinder or cam cylinder section 3 can be assumed to carry a stitch cam 22 in each feed for retracting the cylinder needles to complete the stitches in the customary manner. At the various passes of the various feeds, the cylinder needles knit selectively therefore, (in the making of fancy fabrics at least), each needle knitting a complete stitch as and when the feeler of the lever 16 below it finds a perforation in its pattern 15. As each feed passes beyond levers 16 that have been moved inwardly as described, and consequently the inner ends of those levers 16 fall again toward their position in Fig. 2, those levers are returned longitudinally to their position illustrated in Fig. 2; this may be done by known mechanism; for example, by or with the assistance of the individual lever springs 21. It will be observed of course that the pattern mechanism is capable of knitting rows of face stitches each of which is made up entirely of stitches of one yarn; and in certain fancy effects rows of face stitches each of which consists entirely of stitches of one yarn may be intermixed with rows of face stitches in each of which some stitches are made from one yarn

and the remainder are made from another or other yarns.

The knitting of the faces of the fancy fabrics is done with the aid of the pattern mechanism as will be understood from the foregoing. In the knitting of plain fabrics, or a considerable length of plain fabrics (when the cylinder needles cast-off and take on yarn in a more or less regular manner), the pattern mechanism can be employed to direct the operations of the cylinder needles also; or in the alternative (and this will generally be found preferable), mechanism such as employed on machines adapted to make plain fabric only, can be substituted for the pattern mechanism. For example, in the machine illustrated, the cam cylinder 3 can be provided with needle raising cams, say one in each feed, movable into and out of operative position with respect to the needle butts 25; and, for example by the use of high and low butt needles in the cylinder and by the use of cams of different thicknesses (the thick cams engageable with the low butts as well as the high butts, and the thin cams engageable only with the high butts), the cylinder needles can be made to stitch in different regular orders as needed in the production of the different plain fabrics desired, as will be understood. Mechanisms of various types can be employed for shifting these needle-raising cams into and out of operating position; the known mechanism illustrated in Fig. 3 is illustrative. With this mechanism, each needle raising cam 26 is carried on a vertically sliding rod 27 mounted in the cam cylinder 3, and above the top of the cam cylinder each of these rods is fastened to a downwardly extending head 28 projecting over the side of the cam cylinder 3 and provided with a shoulder 29 and gear teeth 30. A spring 31, anchored to the side of the cam cylinder 3, tends to pull down each head 28, and thereby the respective needle-raising cam 26, to the lower or inoperative position of the latter. To raise the cam 26 to its operative position, a toothed sector 32, carried on a bracket 33 mounted on the cam cylinder 3, meshes with the teeth 30 and has keyed to it a finger 34. By turning this finger 34 in a clockwise direction (Fig. 3) the corresponding needle-raising cam 26 is raised, and as the latter reaches its operative position, the head 35 of a lever 36 hinged at 37 in the side of the cam cylinder 3 (and spring pressed outwardly) snaps under the shoulder 29 of the head 28, and thus serves to hold the cam 26 in its upper or operating position, against the thrust of the needle butts on the cam and the pull of spring 31, until the head 35 of lever 36 is again knocked back from underneath the shoulder. It can be assumed that each of the cylinder needle-raising cams 26 is provided with such a mechanism, so that they are independently movable at will into and out of operating position. Obviously the fingers 34 and holding levers 35—36 can be operated by hand, or automatically by suitable control mechanism on the machine. When, as here, the pattern mechanism needs to be or can be held out of operation while plain fabric is being made, various kinds of mechanisms can be employed to put the pattern mechanism into and out of operation. To some extent, the nature will depend on the kind of pattern mechanism employed of course. Various mechanisms are known for discontinuing the operation of such pattern mechanisms as that shown in Fig. 2; for illustrative purposes, I have shown one wherein each of the lever-carrying rods 18 is mounted in a bracket 42 carried by an individual rod 43 sliding through the bed plate 5 and normally spring pressed downwardly (by 44) into the position illustrated in Fig. 2 wherein the feelers 20 are in engagement with patterns 15; by raising one of the rods 43 however, the corresponding lever carrying rod 18 can be raised so high that the feelers 20 of the levers 16 it carries are raised entirely out of contact with their pattern 15. The corresponding pattern section is thereby put out of action. To thus raise and lower the various rods 43 of the machine shown, it can be assumed that each is provided with a head 45 engageable with an individual star wheel 46 keyed to the same short shaft as a second individual star wheel 47; it is apparent that by turning any of the star wheels 47 until one of the points of its associated star wheel 46 is thrust underneath its head 45, the corresponding rod 43 can be raised and the corresponding section of the pattern mechanism put out of operation; while by turning the same star wheels another step, or until a notch of star wheel 46 comes underneath its associated head 45, the corresponding lever-carrying rod 18 is dropped again and the pattern mechanism section thereby returned to operation. As with respect to the needle-raising cams 26, the pattern mechanism sections may be put into and out of operation by hand, or automatically by known mechanism.

So much for a circular rib machine to which the present invention is applicable. Referring now to the remaining figures: Each of Figs. 5 to 10 shows an aggregate of such back-forming needles as are suitable, in cooperation with the cams respectively shown, to form some one set of fabric backs. In each figure however, only about as many needles have been shown as are needed to explain the invention; in any machine, the back-forming needles will be composed of, or at least include, a plurality of one of these aggregates, or a plurality of some other aggregate assembled on the principles here disclosed if, for example, some set of fabric

backs other than those herein mentioned is desired. For the needles on which the "backs" of the fabrics are formed (here, for illustrative purposes, assumed to be the dial needles) I propose to employ independently sliding needles as before stated, and independently sliding needles differing among themselves in form so as to be projectable to or toward clearing position (e. g. to positions where the loops fall behind the needle latches) by a number of cams as here described. Each feed will include a stitch cam (not shown) to retract all the projected needles. as will be understood. To project the back-forming needles I provide, first, cams in number at least equal to the number of lots into which it is necessary to divide the back-forming needles in order to produce the particular selective knitting at the "back" and the particular "fancy-effect back" desired; these cams I mount in different races or at different distances from the edge of the bed in which the back-forming needles are carried (here the dial 3); and these cams I allocate to different yarns (e. g., place in different feeds). These first-mentioned cams are used for making the fancy-effect back. The needles of each of the lots into which it is necessary to divide the back-forming needles in order to obtain the desired fancy-effect back are provided with butts engageable by one of these cams, so that each of these cams can project the needles of one of these lots to or toward clearing position. Thus, referring first to Fig. 5 wherein it is assumed that the fancy-effect back desired requires that alternate back-forming needles knit at each feed (and hence the back-forming needles are to be divided into two lots), cams 53 and 55 constitute these fancy-effect cams, the needles 52 composing one of the lots are provided with butts engageable by came 53 so that this cam 53 can project the needles of this lot 52 to or toward clearing position at the proper times to knit from the yarn from yarn guide 8, and the needles 54 composing the second lot are provided with butts for engagement with the cam 55 which is located farther away from the edge of the dial than the cam 53 and is so located angularly that it projects its needles 54 to or toward their clearing positions at proper times to knit from the yarn from yarn guide 9. When the dial needles are to be divided into more than two lots for the formation of the fancy-effect back, another fancy-effect cam 57 (Fig. 6) is located still farther away from the edge of the dial, and the needles 56 of the third lot are provided with butts for engagement by this third fancy-effect cam 57 so as to be projected thereby at the proper times to knit from a third yarn, say the yarn from yarn guide 10; and so on. In Fig. 5 it will be observed that needles in addition to the needles 52 have butts at the same distance from their hooks as the needles 52; the purpose of this possible arrangement is explained hereafter; it is sufficient for the present to point out that the butts of the needles 52 are high butts, whereas the butts of the needles 54 lying in the same race are low butts, and the cams 53 are thin cams, whereby the latter are able to project only the needles 52; they pass over adjacent butts of needles 54 without engaging them.

To these first-mentioned cams employed for making the fancy-effect back, I add at least one more cam 60 to project back-forming needles when one (here called the first) of the desired plain fabrics is being knitted. When the back-forming needles are divided into two lots for the formation of the fancy-effect back, I mount this cam 60 in a race, or at a distance from the edge of the back-forming needle bed, different from that at which any of the first-mentioned or fancy-effect cams (at least of the same cam group) are mounted; thus for example, in Fig. 5 cam 60 is located farther from the edge of the dial than even cam 55. In other words, I provide the back-forming needles with at least three needle-projecting cams, mounted at not less than three different distances from the edge of their bed. When the back-forming needles are divided into more than two lots for the formation of the fancy-effect back, this cam 60 for the first plain fabric can also be mounted at a distance from the edge of the needle bed different from that of any of the fancy-effect cams of the same cam group as shown for example in Fig. 6; but when the back-forming needles are divided into three or more fancy-effect lots, the first plain-fabric cam 60 can usually be located at the same distance from the bed edge as one of the fancy-effect cams 53, 55, 57, etc., as shown for example in Fig. 7, where it will be observed that cam 60 is located at the same distance from the edge of the needle bed (in the same race, as it were) as cam 55. As a matter of fact, needle-projecting cams in three races or at three different distances from the edge of the bed of the back-forming needles, are enough to produce all the different backs that I seem to find knitters ordinarily require at present. This added cam 60 (and each of them, if there be more than one) is so located as to project its needles to or toward clearing position at the proper times to knit from some one of the yarns of the machine; usually however I place it in about the same angular position (around the axis of the machine) as one of the first mentioned or fancy-effect cams, that is to say, allocate it to the same yarn or yarn guide or place it in the same feed as one of the fancy-effect cams, as illustrated in Fig. 5 for example; in that figure it will be observed that this first plain-fabric cam 60 is so placed that the needles it projects

can knit from the same yarn guide 8 as the needles projected by the fancy-effect cam 53; each cam 60 can be located in a different angular position from that of any of the fancy-effect cams however, and each can have its own individual yarn guide. All the needles of the back-forming bank which are to knit in forming the back of this first of the plain fabrics may be provided with butts engageable by the plain fabric cam 60, as illustrated in Fig. 5 for example; it being assumed in Fig. 5 that the first plain-fabric desired is such as requires the back-forming needles to knit in pairs (two knitting and the next two being skipped) two needles of the aggregate (there the middle two) are provided with extra long shanks to engage with the cam 60. Fig. 6 is also illustrative of this correlation between the first plain-fabric cam 60 and the needles. Incidentally, it will be noted from Figs. 5 and 6 that for brevity I use the phrase "needle butt" herein as including the end of a needle shank engaging a cam. Alternative to knitting all the needles needed for the first plain fabric by means of the plain fabric cam 60 (see Fig. 7, for example): When the needles required for this plain fabric include all the needles of one of the lots into which the back-forming needles are divided for the purposes of making the fancy-effect back (lot 52 in Fig. 7), the plain-fabric cam 60 can be placed in the same angular position as the fancy-effect cam provided for that lot (cam 53 in Fig. 7), and only so many of the needles of the other lot or lots as are needed for this first plain-fabric (some or all of 54 for example) need then have butts engageable by the plain-fabric cam; in such a case, both the plain-fabric cam and the adjacent fancy-effect cam (53) are then employed in the making of the first plain fabric. Incidentally (see Fig. 7 again), when the back for this first plain fabric requires the knitting of all the needles of two of the fancy-effect lots (all of 52 and all of 54, for example), allocation of the plain-fabric cam 60 in the same angular position as the fancy-effect cam (53) provided for one of these lots (52), and further, the location if this cam 60 in the same race or at the same distance from the edge of the needle bed as the fancy-effect cam (55) serving the other lot (54) avoids the necessity for providing (some, at least, of the) needles with extra butts solely for the production of the first plain fabric, as will be apparent from Fig. 7. Fig. 8 illustrates another possible arrangement when the first plain fabric includes all the needles of one of the lots (54) into which the back-forming needles are divided for the purpose of making the fancy-effect back: Here the butts on the needles 54 are high butts, and their coacting fancy-effect cam 55 is a thin cam; that is to say, cam 55 is thick enough to engage the high butts of needles 54 but is so thin as to pass over lower butts, such as those shown on needles 56, without touching the latter; the plain-fabric cam 60 is placed at the same distance from the edge of the needle bank as the cam 55, and is made thick enough to engage both high and low butts; then such of the needles (here some or all of 56) are needed in addition to needles 54 to produce the back for the first desired plain fabric, are provided with low butts; obviously when only cams 53, 55 and 57 are in operation (cam 60 out of action) the desired fancy-effect back will be produced; on the other hand, when the cams 53, 55 and 57 are out of action and cam 60 is working, all the needles 54 will knit and such of needles 56 as are provided with low butts in the same race will knit also.

In order that the back for the first plain-fabric and the back for the fancy fabric may be made alternately at will by means of such cams as those described with reference to Fig. 5 and the subsequent figures: The plain-fabric cam 60 (and all of them, if there are more than one), is so mounted as to be movable into and out of action at will. By having this first-plain-fabric cam 60 (or all of them, if there be more than one) out of action, the back-forming needles are left free for projection by the fancy-effect cams 53, 55, 57 (and the others, if there be more of them). In general, I also mount all these fancy-effect cams in such a manner that they too can be moved into and out of action. The only exception is when the desired first plain-fabric back requires all the needles of some one of the fancy-effect lots to knit, and the first-plain-fabric cam 60 is located in the same angular position as the fancy-effect cam serving that lot. Fig. 6 is illustrative; in that figure it is assumed that the desired first plain-fabric requires the knitting of all the needles 54 (as well as some or all of needles 56), and cam 60 is allocated to the same yarn guide 9 as the fancy-effect cam 55. In such an arrangement the fancy-effect cam 55 need not be movable into and out of action, but can be left in action at all times, unless the knitting needed to produce the back for the second or another plain-fabric requires that this cam 55 be out of action when this second or another plain-fabric is being made. Fig. 7 is also illustrative of the same situation; in this figure, since only needles 54 have butts engageable with plain-fabric cam 60, the cam 60 and cam 53 must be used together in order to make the back for the first plain fabric. However, even when the arrangement is such that one (or more) of the fancy-effect cams can be left in action so far as some set of fabrics is concerned, I usually mount them all for movement into or out of action, since to do so enlarges the capabilities of the machine at least potentially, either

with or without the addition of cams other than those mentioned herein.

The manner in which the movable back-forming cams are mounted for movement into and out of action is not concerned with the present invention, and various movable mountings are known. Likewise the present invention is not concerned with any particular mechanism for moving these cams to and from operating position except that I prefer that the mechanism be such that they are independently movable, and various mechanisms for this purpose also are known. Should the backs of the fabrics be made on cylinder needles, Fig. 3 will serve as illustrative of a suitable mounting of and operating mechanism for each of the movable cams of Fig. 5 and the subsequent figures. Where the backs are knitted on dial needles (as is assumed in the machine shown in Figs. 1 and 2), Fig. 4 is illustrative of a suitable mounting and cam-operating mechanism. In Fig. 4, the cam 61 may be any one of the cams mentioned in connection with Figs. 5 and the subsequent figures; this is hinged at 62 on a pin carried in the dial cap 4. A pin 63 projecting upwardly from the cam 61 through an arcuate slot 64 in the dial cap, stands in a slot of a lever 65 hinged to the dial cap at 66 and provided with a second slot into which extends a pin 67 of a finger lever 68 hinged at 69 to and above the dial cap. A spring 69 anchored to the dial cap and fastened to pin 67 tends to turn these two levers in such a direction as to retract the cam 67 to its inoperative position. A shoulder 70 on the lever 65 is engageable by a shoulder on a second finger lever 71 hinged to the dial cap at 72, and which is pulled by its spring 73 toward the engaging position illustrated in Fig. 4. When the shoulders are engaged at 70, it is obvious that finger lever 71 holds cam 61 in operating position. Usually finger levers 68 and 71 were placed at different levels, and extend beyond the edge of the dial cap for ready access as will be understood. The operation of this mechanism is rather apparent; a slight turn of finger lever 71 clockwise releases its engagement with lever 65 at shoulder 70, thereby permitting spring 69 to retract the cam to inoperative position; this movement also turns finger lever 68 counter-clockwise to a corresponding extent. Return of the lever 68 clockwise returns all the parts to their positions illustrated in this figure. The levers 68 and 71 can be shifted manually, or automatically by mechanism on the knitting machine as will be understood.

For knitting the back of a second and/or the last of the desired plain fabrics, I provide mechanism additional to the cams per se hereinbefore described. Where the first plain-fabric cam 60 occupies the same angular position around the axis of the knitting machine as one of the fancy-effect cams, and the second desired fabric is such that its back can be knitted by the joint and simultaneous action of this cam 60 and the adjacent fancy-effect cam (occupying the same angular position), such mounting and control of these two cams that they can be moved into and out of action independently of each other is all that is absolutely essential to the production of the second plain-fabric. Fig. 8 contains an example; it is there assumed that the second plain-fabric requires the knitting of all the back-forming needles from one yarn (or from each of a number of yarns); and cam 60 is a thick cam, cam 55 is thin, needles 54 have high butts and (it can be assumed, all) needles 56 have low butts; hence by the simultaneous use of 60 and 53, all the needles are made to knit from the yarn from guide 8 when the second plain fabric is required. In such cases the mountings of these cams (e. g. 60 and 53 in Fig. 8), or the mountings and the mechanism for shifting them whereby they are independently movable to and from operating positions (for example, mechanisms of Fig. 3 or Fig. 4), constitutes mechanism in addition to the cams per se whereby the back for the second plain fabric is produceable. Usually, however, for knitting the back of the second or another plain fabric, I provide an additional cam or cams, that is to say a cam or cams additional to those already mentioned; in such a case, the added cam (or cams), and the operating mechanism therefor, if any, can be regarded as constituting the mechanism additional to the previously described cams whereby the another plain fabric is made. For brevity I herein call such a cam the second plain fabric cam. It can be located at still another distance from the edge of the needle-bed (i. e., at a distance different from that of cams 60, 53, 55, 57, etc., described), but consonant with the idea before expressed that cams at three distances are ordinarily sufficient (three cam races, as it were) I usually locate it at the same distance from the bed-edge as one of the cams previously described. This second plain-fabric cam can be allocated to its own individual yarn guide, but usually and preferably I place it in substantially the same angular position around the axis of the machine as one of the fancy-effect cams. Fig. 5 is an example; here a second plain-fabric cam 78 is allocated to the yarn guide 9 and is placed at the same distance from the edge of the needle bed as the fancy-effect cam 53. As with respect to the plain-fabric cam 60, all the back forming needles to be knitted by this second plain-fabric cam (or cams) can have butts engageable by the latter, and where this second plain-fabric cam (or cams) 78 is placed at the same distance from the edge of the needle bed (in the same race, as it were) as one of the cams previously mentioned, I make the previously mentioned cam in the

same race thick and the added second-plain-fabric cam 78 thin, or vice versa, and I distinguish between the needles to be knit by these two cams by the use of high and low butts as the construction of the backs of the two fabrics to be produced by these two (or more) cams of this race may require. Fig. 5 is also illustrative of this; fancy-effect cam 53 is a thin cam and the second plain-fabric cam 78 is thick; the needles 52 to be projected by 53 in the making of the fancy-effect back are provided with high butts, which alone are engageable by 53; and the needles additional to 52 to be projected by the second plain-fabric cam 78 (here all the needles 54) are given low butts at the same distance from the needle ends as the high butts on 52; as a consequence cam 53 projects only needles 52, while cam 78 projects needles 52 and needles 54 also. Alternative (in some instances) to providing all the back-forming needles of the second plain fabric with butts engageable by the second plain-fabric cam, this second plain-fabric cam can be allocated to the same yarn (or yarn guide) as one or more of the cams previously mentioned, and only those needles additional to the needles projectable by the last mentioned cam may be provided with butts engageable by the second plain-fabric cam. Fig. 6 is illustrative of this; here the second plain-fabric cam 79 is allocated to yarn guide 9 to which the first plain-fabric cam 60 is also allocated, and only needles 52 have butts engageable by cam 79; by the joint and simultaneous use of cams 60 and 79, all the back-forming needles are made to knit from the yarn from guide 9. In Fig. 7, either the cam 80 or cam 60 can be regarded as a second plain-fabric cam, and the other is then the first plain-fabric cam, for by the joint use of either 80 and 53, or 60 and 53, two adjacent needles are made to knit from one yarn and each third needle skips, while by having all three cams 53, 60 and 80 in action simultaneously, all the back-forming needles are made to knit from the yarn from guide 8. The second and/or last plain-fabric cam (or cams), of which 78, 79 and 80 are representative, is (or are) mounted for movement into and out of operating position, and may be provided with mechanism for operating it, that is to say, for moving it to and from operating position; as with respect to the cams previously mentioned, Figs. 3 and 4 are representative of suitable mountings and operating mechanisms for such additional cams, Fig. 3 when the back is formed on cylinder needles and Fig. 4 when the back is formed on dial needles.

While I herein describe the "second plain fabric" as one in which the back requires the knitting of all the back-forming needles at one feed (or at each of a number of feeds) it will be apparent that my invention is not so limited. Also, while I have thus far illustrated and described my invention with reference to comparatively simple arrangements, it will be apparent to those skilled in this art that arrangements more efficient than those illustrated can be built up on the principles here laid down. For example, the arrangement of Fig. 5 permits the machine to be operated as a two-feed machine when pattern fabrics are being made, but when any one of the plain fabrics is being made, the machine can operate as only a single feed machine. By duplicating plain-fabric cams and appropriately changing the arrangement of the butts or the needles, plain fabric can be made on multiple-feeds also. For example, in Fig. 9 cam 60 is duplicated in both feeds; likewise cam 78 is duplicated at both feeds; the butts of the needles 54 running in the race containing cam 55 are made high butts, and low butts in the same race are provided on the needles 52; cam 55 is a thin cam like cam 53, and both cams 78 are thick; otherwise the arrangement is like that of Fig. 5, but the result of the changes is that the machine can be operated as a multifeed machine while making the plain fabrics as well as when making the pattern fabric, with a corresponding increase in the yardage per day. Again, I have so far described my invention as applied to machines having respectively the least number of feeds with which it is possible to produce those particular fabric-backs which, for illustrative purposes, I have assumed to be desired. A greater number of feeds may be employed however; and when a machine having a greater number of feeds is desired, I usually, for greater all-around efficiency, make the number of feeds a multiple of that number which is required to produce the desired fancy-effect back; thus when the desired fancy-effect back requires the knitting of alternate needles (Fig. 5) I usually provide the machine with four feeds, or six feeds, or eight feeds, etc., and make the cams of each two adjacent feeds like the cams of the next two adjacent feeds; obviously other numbers of feeds and other cam arrangements can be employed however if desired, or for special purposes. Incidentally, I regard fancy-effect backs produced by knitting alternate needles (Fig. 5) as preferable. Fig. 10 illustrates my preferred application of the embodiment of Fig. 5 to a six feed machine; the numerals 8, 9, 10, 11, 12 and 13 point to the yarn guides; the operation with the arrangement of this figure will be understood when it is observed that the needles and cams have the same reference characters as in Fig. 5, and when it is remembered that cams 53 are thin cams (engageable with only the long butts of needles 52) and that cams 78 are thick (and hence engageable with butts of both 52 and 54). If the two feeds represented by the yarn guides 12 and 13 and their associated cams are dis-

regarded, Fig. 10 will also illustrate the preferred application of my invention to a four feed machine.

Obviously my invention is not limited to the embodiments illustrated; indeed, so many embodiments of my invention are possible that it is impossible to illustrate them all. Incidentally, it will be observed that with any given array of cams, the stitching can be changed by substituting an array of needles having another arrangement of their butts. Furthermore, cams additional to those described can be applied to a machine embodying my invention to serve other purposes, as will be understood.

Still further, in describing various cams of the back-forming needles as mounted at "different distances from the edge" of their needle bed, I accurately describe the arrangement where the back is knitted on one bank of needles. However, in a knitting machine having its needles mounted in more than two banks, and where the back is knitted by the needles of more than one of the banks, various of the cams operating back-forming needles here described as mounted at different distances from the bed edge may be mounted at equal distances from the edges of the respective beds supporting the needles they respectively operate. Such machines are unusual however, and the manner in which the present invention can be applied to them will be understood by those skilled in this art. It will suffice therefore to point out that the claims hereinafter are intended to be construed broadly enough to include the application of the present invention to such machines. And still further, I have hereinbefore referred to various of the cams as projecting the needles "to or toward" their clearing positions. Usually I actually use the needle projecting cams illustrated to project the needles to their clearing positions; but an obvious departure from this practice (as will be understood) is to use the cams discussed above to project their respective needles only part way toward their clearing positions, say to a tuck position, where they are within the reach of further cams which will serve to carry the partly-projected needles forward to the complete clearing positions. I intend herein to cover both of these forms.

Finally, it will be observed that the claims hereafter frequently define the invention in a form incorporating, or specifically mentioning, only the least number of cams capable of performing the functions of which the structures of the respective claims are capable. It will be understood that I intend them to include arrangements wherein cams additional to those specifically mentioned are included.

I claim:

1. In a circular multi-needle-bed knitting machine having yarn-feeding means including means for feeding simultaneously a plurality of yarns separately, pattern mechanism to cause the needles on which the face of the fabric is knitted to knit from said plurality of yarns selectively, a plurality of fancy-effect needle-projecting cams for the needles on which the back of the fabric is knitted, said cams being mounted at different distances from the edge of the bed for said back-forming needles and being allocated to different yarns of said plurality of simultaneously-fed yarns, and at least one plain-fabric needle-projecting cam, for the needles on which the back of the fabric is knitted, so placed as to cause needles projected by it to knit from one of the yarns of the knitting machine and being movable into and out of operating position, said fancy effect and plain fabric cams together being located at more than two different distances from the edge of the bed for said back-forming needles, and at least those of said fancy-effect needle-projecting cams other than any that may be so placed as to cause needles projected thereby to knit from the same yarn as needles projected by a plain-fabric cam being movable into and out of operating position.

2. In a circular multi-needle-bed knitting machine having yarn-feeding means including means for feeding simultaneously a plurality of yarns separately, pattern mechanism to cause the needles on which the face of the fabric is knitted to knit from said plurality of yarns selectively, a plurality of fancy-effect needle-projecting cams for the needles on which the back of the fabric is knitted, said cams being mounted at different distances from the edge of the bed for said back-forming needles and being allocated to different yarns of said plurality of simultaneously-fed yarns, and at least one plain-fabric needle-projecting cam, for the needles on which the back of the fabric is knitted, so placed as to cause needles projected by it to knit from one of the yarns of the knitting machine and being movable into and out of operating position, said fancy effect and plain fabric cams together being located at more than two different distances from the edge of the bed for said back-forming needles and all of said fancy-effect cams being movable into and out of operating position.

3. In a circular multi-needle-bed knitting machine having yarn-feeding means including means for feeding simultaneously a plurality of yarns separately, pattern mechanism to cause the needles on which the face of the fabric is knitted to knit from said plurality of yarns selectively, a plurality of fancy-effect needle-projecting cams for the needles on which the back of the fabric is knitted, said cams being mounted at different distances from the edge of the bed for said back-

forming needles and being allocated to different yarns of said plurality of simultaneously-fed yarns, and at least one plain-fabric needle-projecting cam, for needles on which the back of the fabric is knitted, mounted in substantially the same angular position as one of said fancy-effect cams and being movable into and out of operating position, said fancy-effect and plain-fabric cams together being located at more than two different distances from the edge of the bed for said back-forming needles, and at least all of said fancy-effect needle-projecting cams other than such as are located in substantially the same angular position as said one plain-fabric cam being movable into and out of operating position.

4. In a circular multi-needle-bed knitting machine having yarn-feeding means including means for feeding simultaneously a plurality of yarns separately, pattern mechanism to cause the needles on which the face of the fabric is knitted to knit from said plurality of yarns selected, two fancy-effect needle-projecting cams for the needles on which the back of the fabric is knitted, said cams being mounted at two different distances from the edge of the bed for said back-forming needles and being allocated to two different yarns of said plurality of simultaneously-fed yarns, and at least one plain-fabric needle-projecting cam, for the needles on which the back of the fabric is knitted, so placed as to cause needles projected by it to knit from one of the yarns of the knitting machine and being movable into and out of operating position and being located at a third distance from the edge of the bed for said back-forming needles, and at least one of said fancy-effect needle-projecting cams, being movable into and out of operating position.

5. In a circular multi-needle-bed knitting machine having yarn-feeding means including means for feeding simultaneously a plurality of yarns separately, pattern mechanism to cause the needles on which the face of the fabric is knitted to knit from said plurality of yarns selectively, three fancy-effect needle-projecting cams for the needles on which the back of the fabric is knitted, said cams being mounted at three different distances from the edge of the bed for said back-forming needles and being allocated to different yarns of said plurality of simultaneously-fed yarn, and at least one for the fabric needle-projecting cam, for the needles on which the back of the fabric is knitted, so placed as to cause needles projected by it to knit from one of the yarns of the knitting machine and being movable into and out of operating position and being located at substantially the same distance from the edge of the bed for said back-forming needles as one of the first mentioned cams, and at least such of said fancy-effect needle-projecting cams, other than any that may be placed in substantially the same angular position as a said plain fabric needle-projecting cam, being movable into and out of operating position.

6. In a circular multi-needle bed knitting machine having yarn-feeding means including means for feeding simultaneously a plurality of yarns separately, pattern mechanism to cause the needles on which the face of the fabric is knitted to knit from said plurality of yarns selectively, a plurality of fancy-effect needle-projecting cams for the needles on which the back of the fabric is knitted, said cams being mounted at different distances from the edge of the bed for said back-forming needles and being allocated to different yarns of said plurality of simultaneously fed yarns, and at least one plain fabric needle-projecting cam, for the needles on which the back of the fabric is knitted, so placed as to cause needles projected by it to knit from one of the yarns of the knitting machine and being movable into and out of operating position, said fancy-effect and plain fabric cams together being located at three different distances from the edge of the bed for said back-forming needles, and at least such of said fancy-effect needle-projecting cams as have an angular position different from that of said plain fabric needle-projecting cam being movable into and out of operating position.

7. In a circular multi-needle-bed knitting machine having yarn-feeding means including means for feeding simultaneously a plurality of yarns separately, pattern mechanism to cause the needles on which the face of the fabric is knitted to knit from said plurality of yarns selectively, a plurality of fancy-effect needle-projecting cams for the needles on which the back of the fabric is knitted, said cams being mounted at different distances from the edge of the bed for said back-forming needles and being allocated to different yarns of said plurality of simultaneously-fed yarns, at least one plain-fabric needle-projecting cam, for the needles on which the back of the fabric is knitted, so placed as to cause needles projected by it to knit from one of the yarns of the knitting machine and being movable into and out of operating position, said fancy-effect and plain-fabric cams together being located at more than two different distances from the edge of the bed for said back-forming needles, and at least those of said fancy-effect needle-projecting cams other than any that may be so placed as to cause needles projected thereby to knit from the same yarn as needles projected by a plain-fabric cam being movable into and out of operating position, and mechanism additional to the afore-

mentioned cams per se for the knitting of another plain fabric.

8. In a circular multi-needle-bed knitting machine having yarn-feeding means including means for feeding simultaneously a plurality of yarns separately, pattern mechanism to cause the needles on which the face of the fabric is knitted to knit from said plurality of yarns selectively, a plurality of fancy-effect needle-projecting cams for the needles on which the back of the fabric is knitted, said cams being mounted at different distances from the edge of the bed for said back-forming needles and being allocated to different yarns of said plurality, at least one plain fabric needle projecting cam, for the needles on which the back of the fabric is knitted, so placed as to cause needles protected by it to knit from the same yarn as needles projected by one of the first mentioned cams, said fancy-effect and plain fabric cams together being located at more than two different distances from the edge of the bed for said back-forming needles, and all of said fancy-effect and plain fabric cams being movable into and out of operating position and said one plain fabric cam and the said fancy-effect cam the needles of which can knit from the same yarn as the needles projected by said plain fabric cam being movable into and out of operating position independently of each other, and each independently of the remainder of said fancy-effect needle-projecting cams.

9. In a circular multi-needle-bed knitting machine having yarn-feeding means including means for feeding simultaneously a plurality of yarns separately, pattern mechanism to cause the needles on which the face of the fabric is knitted to knit from said plurality of yarns selectively, a plurality of fancy-effect needle-projecting cams for the needles on which the back of the fabric is knitted, said cams being mounted at different distances from the edge of the bed for said back-forming needles and being allocated to different yarns of said plurality of simultaneously-fed yarns, at least one plain-fabric needle-projecting cam, for the needles on which the back of the fabric is knitted, so placed as to cause needles projected by it to knit from one of the yarns of the knitting machine and being movable into and out of operating position, said fancy-effect and plain-fabric cams together being located at more than two different distances from the edge of the bed for said back-forming needles, and at least such of said fancy-effect needle projecting cams other than any that may occupy substantially the same angular position as said plain fabric cam being movable into and out of operating position, and at least one further plain fabric needle projecting cam, for the needles on which the back of the fabric is knitted, so placed as to cause needles projected by it to knit from one of the yarns of the knitting machine and being movable into and out of operating position.

10. The subject matter of claim 9 characterized by the fact that the cam last mentioned therein is placed at the same distance from the edge of the bed for the back-forming needles as one of the cams previously mentioned in the claim.

11. The subject matter of claim 9 characterized by the fact that the cam last mentioned therein occupies substantially the same angular position as one of the cams previously mentioned in the claim.

12. The subject matter of claim 9 characterized by the fact that the cam last mentioned therein occupies substantially the same angular position as one of the fancy-effect needle-projecting cams mentioned therein.

13. In a circular multi-needle-bed knitting machine having yarn-feeding means including means for feeding simultaneously a pluralityof yarns separately, pattern mechanism to cause the needles on which the face of the fabric is knitted to kit from said plurality of yarns selectively, a plurality of fancy-effect needle-projecting cams for the needles on which the back of the fabric is knitted, said cams being mounted at different distances from the edge of the bed for said back-forming needles and being allocated to different yarns of said plurality of simultaneously-fed yarns, at least one plain fabric needle-projecting cam, for the needles on which the back of the fabric is knitted, located in substantially the same angular position as one of said fancy-effect cams and being movable into and out of operating position, said fancy-effect and plain fabric cams together being located at three different distances from the edge of the bed for said back-forming needles, and at least those fancy effect cams other than the said fancy effect cam located in about the same angular position as said plain fabric cam being movable into and out of operating position, and at least one further plain fabric needle projecting cam, for the needles on which the back of the fabric is knitted, located in substantially the same angular position as one of the aforementioned cams and at substantially the same distance from the edge of said bed for the back-forming needles as one of the aforementioned cams, of the last mentioned fancy-effect cams, and the last mentioned plain fabric cam, one being thick and the other thin

14. In a circular multi-needle bed knitting machine having means means for feeding simultaneously a plurality of yarns separately, pattern mechanism to cause the needles on which the face of the fabric is knitted to knit from said plurality of yarns selectively, two

fancy-effect needle projecting-cams for the needles on which the back of the fabric is knitted, said cams being movable into and out of operating position and being mounted at two different distances from the edge of the bed for said back-forming needles and being allocated to two different yarns of said plurality of simultaneously fed yarns, a plain fabric needle-projecting cam for the needles on which the back of the fabric is knitted, located in substantially the same angular position as one of said fancy effect cams and at a third distance from the edge of the bed for said back-forming needles and being movable into and out of operating position, and a further plain fabric needle-projecting cam, for the needles on which the back of the fabric is knitted, located at substantially the same distance from the edge of the bed for the back-forming needles as the last mentioned fancy-effect cam and in substantially the same angular position as the other fancy-effect cam, said further plain fabric cam being a relatively thick cam and the fancy-effect cam located at substantially the same distance from the edge of the needle bed being a relatively thin cam, said further plain fabric cam being movable into and out of operating position.

15. In a circular multi-needle bed knitting machine having yarn feeding means including means for feeding simultaneously a plurality of yarns separately, pattern mechanism to cause the needles on which the face of the fabric is knitted to knit from said plurality of yarns selectively, a plurality of fancy-effect needle-projecting cams for the needles on which the back of the fabric is knitted, said cams being mounted at different distances from the edge of the bed for said back-forming needles and being allocated to different yarns of said plurality of simultaneously-fed yarns, at least one plain fabric needle-projecting cam, for the needles on which the back of the fabric is knitted, so placed as to cause needles projected by it to be knitted from one of the yarns of the knitting machine and being movable into and out of operating position, said fancy-effect and plain fabric cams together being located at more than two different distances from the edge of the bed of said back-forming needles, and at least those of said fancy-effect needle-projecting cams other than any that may occupy substantially the same angular position as said plain fabric cam being movable into and out of operating position, and independently sliding needles for knitting the back of the fabric, said needles being composed of a number of intermixed lots equal to the number of said fancy-effect needle-projecting cams, the needles of each lot being provided with butts engageable by one of said fancy-effect needle-projecting cams, and various of said needles having butts engageable by said plain fabric cams.

16. In a circular multi-needle-bed knitting machine having yarn-feeding means including means for feeding simultaneously a plurality of yarns separately, pattern mechanism to cause the needles on which the face of the fabric is knitted to knit from said plurality of yarns selectively, a plurality of fancy-effect needle-projecting cams for the needles on which the back of the fabric is knitted, said cams being mounted at different distances from the edge of the bed for said back-forming needles and being allocated to different yarns of said plurality of simultaneously-fed yarns, and at least one plain-fabric needle-projecting cam, for needles on which the back of the fabric is knitted, mounted in substantially the same angular position as one of said fancy-effect cams and being movable into and out of operating position, said fancy-effect and plain-fabric cams together being located at more than two different distances from the edge of the bed for said back-forming needles, and at least all of said fancy-effect needle-projecting cams other than the such as are located in substantially the same angular position as said one plain-fabric cam being movable into and out of operating position, and independently sliding needles for knitting the back of the fabric, said needles being composed of a plurality of intermixed lots equal in number to the number of said fancy-effect cams, the needles of each lot being provided with butts to engage with one of said fancy-effect cams, some of the needles having butts engageable with the said one plain fabric cam, and the said one plain fabric cam, and the fancy effect cam occupying the same angular position being operable simultaneously.

17. In a circular multi-needle-bed knitting machine having yarn-feeding means including means for feeding simultaneously a plurality of yarns separately, pattern mechanism to cause the needles on which the face of the fabric is knitted to knit from said plurality of yarns selectively, a plurality of fancy-effect needle-projecting cams for the needles on which the back of the fabric is knitted, said cams being mounted at different distances from the edge of the bed for said back-forming needles and being allocated to different yarns of said plurality of simultaneously-fed yarns, at least one plain-fabric needle-projecting cam, for the needles on which the back of the fabric is knitted, so placed as to cause needles projected by it to knit from one of the yarns of the knitting machine and being movable into and out of operating position, said fancy-effect and plain-fabric cams together being located at more than two different distances from the edge of the bed for said back-forming needles,

and at least such of said fancy-effect needle-projecting cams other than any that may occupy substantially the same angular position as said plain fabric cam being movable into and out of operating position, at least one further plain fabric needle-projecting cam, for the needles on which the back of the fabric is knitted, so placed as to cause needles projected by it to knit from one of the yarns of the knitting machine and being movable into and out of operating position, and independently sliding needles for knitting the back of the fabric, said needles being composed of a plurality of intermixed lots equal in number to the number of said fancy-effect cams, the needles of each lot being provided with butts for engagement with one of said fancy-effect cams, some of the needles having butts for engagement with the first mentioned plain fabric cam, and some of the needles having butts for engagement with the second mentioned plain fabric cam.

18. In a circular multi-needle-bed knitting machine having yarn-feeding means including means for feeding simultaneously a plurality of yarns separately, pattern mechanism to cause the needles on which the face of the fabric is knitted to knit from said plurality of yarns selectively, a plurality of fancy-effect needle-projecting cams for the needles on which the back of the fabric is knitted, said cams being mounted at different distances from the edge of the bed for said back-forming needles and being allocated to different yarns of said plurality of simultaneously fed-yarns, at least one plain fabric needle-projecting cam, for the needles on which the back of the fabric is knitted, located in substantially the same angular position as one of said fancy-effect cams and being movable into and out of operating position, said fancy-effect and plain fabric cams together being located at three different distances from the edge of the bed for said back-forming needles, and at least those fancy effect cams other than the said fancy-effect cam located in about the same angular position as said plain fabric cam being movable into and out of operating position, at least one further plain fabric needle-projecting cam, for the needles on which the back of the fabric is knitted, located in substantially the same angular position as one of the aforementioned cams and at substantially the same distance from the edge of said bed for the back-forming needles as one of the aforementioned cams, of the last mentioned fancy-effect cams and the last mentioned plain fabric cam, one being thick and the other thin, independently sliding needles for knitting the backs of the fabrics, said needles being composed of intermixed lots equal in number to the number of said fancy-effect cams, the needles of each lot being provided with butts for engagement by one of said fancy-effect cams, some of said needles having butts engageable by the first mentioned plain fabric cam, and some needles having long butts and others having short butts at the distance from the ends of the needles of those butts which are engageable with that fancy-effect cam which is at the same distance from the edge of the needle bed as the second mentioned plain-fabric cam.

In testimony whereof, I have signed this specification.

JULIUS SIRMAY.