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This invention relates to knitting machines and methods, and particularly to knitting mechanisms and procedures adapted for use in the production of design fabrics and to certain correlated inventions and discoveries appertaining thereto.

An object of the invention is the provision of simple and readily constructed mechanisms which are adapted for the production of fabrics embodying various of a large number of attractive designs.

A more specific object is the provision of improved mechanism for the production of design fabrics by beard needles.

Another object is the provision of improved means for the selective control of auxiliary knitting elements such as sinkers, dial needles, and other auxiliary elements of various types.

Another object is the provision of improved means for selectively operating needles or other knitting elements.

A further object is the provision of mechanisms adapted for use with fine-gage machines.

Still another object is the provision of simple and effective procedures whereby various feature or design fabrics may be formed with particular ease and efficiency.

An additional object is the provision of improved elements utilizable for knitting operations. Other objects of the invention will in part be obvious and will in part appear hereinafter.

The invention accordingly comprises the features of construction, combinations of elements and arrangement of parts and the several steps and the relation and order of one or more such steps with respect to each of the others thereof, all of which will be exemplified hereinafter and the scope of the application of which will be indicated in the claims.

For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed description taken in connection with the accompanying drawings, in which:

Figure 1 is a small scale diagrammatic plan view of a knitting machine embodying the invention;

Fig. 2 is an enlarged vertical section along the line 2—2 of Fig. 1;

Fig. 3 is a greatly enlarged somewhat diagrammatic horizontal section along the line 3—3 of Fig. 2;

Fig. 4 is a somewhat diagrammatic side view illustrating a manner of operation;

Fig. 5 is a downwardly extended view similar to Fig. 2 on an enlarged scale and illustrating certain operative positions;

Fig. 6 is a similar view illustrating other operative positions;

Fig. 7 is a view of a portion of Fig. 4 on a larger scale;

Fig. 8 is a detail view showing two types of needles and pressers utilized;

Fig. 9 is a somewhat diagrammatic side view of the needles and sinkers;

Fig. 10 is a detail horizontal section along the line 10—10 of Fig. 5;

Fig. 11 is a diagrammatic view of the mechanism of Fig. 7, looking outwardly;

Fig. 12 is a view similar to the upper portion of Fig. 5 showing a simpler form of construction;

Fig. 13 is a vertical sectional view of a modified form of construction;

Fig. 14 is a somewhat diagrammatic side view of the needles and sinkers of Fig. 13;

Figs. 15 and 16 are views similar to Figs. 4 and 9 respectively, showing another modification;

Fig. 17 is a view similar to Fig. 12 showing another modification;

Fig. 18 is a similar view showing another modification;

Fig. 19 is a similar view showing another modification;

Figs. 20 and 21 are views similar to Figs. 10 and 7 respectively, showing another modification; and

Fig. 22 is a fragmentary view similar to Fig. 4, showing a supplemental arrangement.

The production of design fabrics on beard needle machines has always involved the use of complicated operating means. Moreover in many instances such means have so been constructed that their use was unsatisfactory from a practical standpoint due to tendencies toward breakage of the more fragile parts. Furthermore, it has been difficult to construct operating mechanisms so that they will be adapted for design formation on fine-gage machines, wherein as many as twenty to forty needles an inch are often utilized. While various suggestions toward overcoming one or another of the foregoing difficulties have been made, the fact remains that latch needles are still commonly relied on for the practical production of design fabrics. Furthermore, in order to adapt the usual beard needle knitting machine to produce design fabrics, it has been considered necessary to utilize needle-selecting means, and independent presser-selecting means. Moreover, in the use of both beard needles and latch needles,
there are many instances wherein the operations of sinkers, of needles positioned differently from the main needles, or of other auxiliary knitting elements should be controlled in accordance with the manner in which the main needles are controlled; but where such control has been effected, it has ordinarily been brought about by a duplication of control mechanisms, which added greatly to the complication and expense of the operation and the machine and which lacked the desired positiveness of operation, and which were in many instances unadapted for use in fine-gage machines.

Again there have been distinct limitations in the selection of needles or other knitting elements to perform design operations, due to lack of positiveness of control and due to unsatisfactory formation of the parts.

With the foregoing and other considerations in view, the present invention in various of its aspects contemplates the provision of a simple and effective procedure and of simple and effective means so arranged that there is a minimum tendency toward breakage of parts, whereby beard needles may be so manipulated as to produce any of a wide variety of design fabrics, including tuck-stitch fabric, well-stitch fabric, and "interlock" fabric such as those disclosed in my Patents Nos. 1,541,230 and 1,728,293, among others; and also contemplates the provision of improved means whereby sinkers, auxiliary needles, and other auxiliary knitting elements may be effectively controlled in response to a selective needle movement without duplication of selecting means for the production of a wide variety of stitch manipulations, including those above indicated; and furthermore contemplates the provision of especially positive and effective means for the production of design fabric, particularly in the case of fine-gage machines. Likewise the invention contemplates the provision of improved knitting methods.

Among the features of the invention are the provision of mechanism including beard needles and including also beard pressers which are operated as a result of the operation of the needles, the provision of simple mechanism whereby auxiliary knitting elements may be selectively controlled, and more particularly may be controlled in response to the operation of the needle-controlling means; the provision of selecting means which operates in a particularly positive manner; the avoidance of complicated operating means; and the provision of mechanism which will operate with certainty and effectiveness even when the needles are very closely spaced.

In accordance with the invention, there may be provided beard pressers which are operated directly by the needles or by certain ones thereof, or by elements which act on such needles, so that the operation of a beard presser or a plurality of beard needles will be dependent upon the operation of a particular needle. In accordance with the invention also there may be provided means which are utilizable in a beard needle machine, a latch needle, or other type of machine to operate auxiliary knitting elements selectively in any of a variety of desirable ways in accordance with the operation of the means which actuates the needle or other main knitting element, and in a direct and simple manner.

By means of the invention there may be produced fabrics of many desirable types including those disclosed in my Patent Nos. 1,541,230, 1,728,293, 1,817,199, 1,831,964, 1,981,057 and 2,002,271.

In one manner of carrying out the invention, beard needles may be selectively placed on only two levels and caused to manipulate the yarn differently when all of a plurality of adjacent needles are on one level than when only certain of said plurality are on the same level. This may be accomplished by pressing the beards of the needles during their retraction only when the particular needles have all been advanced. Such a procedure is highly effective in the formation of interlock or double interlock fabric (as described in my Patents 1,541,230 and 1,728,293) in a particularly simple manner. All that is necessary is to advance a plurality of adjacent beard needles to a yarn-receiving level to receive yarn, to retract the same, and to press their beards while being retracted at certain stages; and to place only alternate or otherwise spaced ones of said needles on a yarn-receiving level to receive yarn, and to retract them without pressing their beards.

The utilization of mechanism such as contemplated by the invention enables the production of a wide variety of design fabrics, including those above indicated, on a beard needle machine, and also enables a large number of desirable variations in knitting operations to be obtained with ease and certainty.

While the invention is exemplified as embodied in a circular knitting machine having a rotatable needle cylinder, it will be understood that the bed on which the needles or other controlled elements are carried may be of any desired shape or form and may be stationary or movable as desired. If the bed is movable, actuating means carried on a stationary support will be utilized, whereas if the bed is stationary actuating means which rotate about or otherwise move past the bed in manners well known in the art may be utilized.

The particular mechanism exemplified in Figs. 1–11 embodies a stationary annulus 24, carrying cams, pattern members and other actuating mechanism, and a rotatable bed 28 of cylindrical form providing about its periphery a series of vertical slots 26 which may if desired be very closely spaced, as for example 30 or more to the inch. In each of a multiplicity of these slots, and ordinarily all of them, there is disposed for vertical sliding movement a needle 27. As will be seen, the cylindrical bed and the actuating mechanism are mounted for relative movement in a direction extending longitudinally (in this case circumferentially) of the bed, and the needles are mounted for movement in a direction extending longitudinally of the needles but laterally of the bed. Each of the needles is formed with a spring beard 38 of the usual type adapted to be pressed inwardly for knitting. As exemplified, vertically slideable beard pressers 39 are provided in the slots for this purpose. As will be understood, when a beard presser is operative, the beard of a needle which has just received a new yarn while in an advanced position may be pressed by the beard presser upon its retraction, so that a body yarn lying upon the needle will ride over the beard and against a loop to be knitted; whereas, when the beard presser is not operative, the body yarn will slide under the beard and be held therein along with the newly received yarn. The beard pressers in the present instance are arranged to be moved towardly by a cam 30 to press the beards thereof.
During the retraction of the needles when they are in an advanced position, but to ride beneath the cam 30 when they are not in an advanced position. In order to prevent the presser from being pulled downwardly by the friction of the needle-beard 45 and other action, the presser is formed with a projection 31 adapted to extend over the cam 30. The pressers are retained within the slots 27 by means of an annular spring 33 which fits in a recess 34 in the outer edge of the presser. The recess 34 is longitudinally extended to the desired sliding movement of the presser, the shoulders at the top and bottom of the recess acting to provide positive limits to the longitudinal movement of the pressers. Each presser is provided with a portion 35 which is held against its needle to retain the upper portion of the needle shank against the rear wall of its slot under the influence of the retaining spring 33. As will be seen, the portion 35 is so formed as to permit the presser to rock upon it as a pivot at such portions of the operation as may be desirable for the production of the desired appearance of the finished product. In order to facilitate the production of design fabric, such for instance, as interlock fabric, there are utilized two types of needles as indicated at 27a and 27b (see Fig. 8), these being arranged in alternation in the present instance; and two types of beard pressers 28a and 28b are associated with the needles 27a and 27b, respectively. The beard pressers 27a and 27b of each pair are united by a pin 37. The beard presser 28a extends downwardly and has a lower surface 38 which is adapted to be engaged by a surface 39 on the needle 27a toward the end of the advancing movement of the needle. The presser 28b is shorter and is advanced only as a unit with the presser 28a. Accordingly, when one (27a) of the pair of needles with which the pair of beard pressers is associated is advanced, the presser will be advanced; whereas when the other (27b) of the needles is advanced, the beard pressers will not be actuated. Thus a highly desirable selective control may be effected and needles may be permitted to receive a yarn and knit, or receive a yarn without knitting, as desired for the production of an "interlock" fabric as described, for instance, in my Patents Nos. 1,541,230 and 1,728,293 (and 1,728,294), or of weft-stitch, tuck-stitch, or other design fabrics.

While needles constructed and operated in any desired manner may be utilized for the positioning of beard pressers in accordance with the invention, the needles 27a are exemplified as constructed and operated in a manner such that needle operation is facilitated and made particularly positive. This feature of the invention is applicable to both beard and latch needles and to other knitting elements wherein similar problems apply. As exemplified, the needles 27a are provided with lower ends 40 which are movable inwardly so as to pivot at a point 41, and the shape of the needle 27a is narrowed at 42 permit bending at this point during the inward movement, the top of the needles being held fully within the slot by the portions 35 of the pressers. Selection of the needles 27a before each yarn feed at which selection is desired is obtained by the rotary pattern member 44, having selectively disposed about its periphery a multiplicity of actuators 45 which are removably held between plates 46 and 46', as will be seen from Figs. 5 and 10. Whenever there is an actuator member 45 this will engage the end 48 of the needle during the relative movement of the needle bed and the actuator mechanism and the actuator member will press the end inwardly.

The rotary pattern member, in the present instance, is in the form of a circular wheel having slots 47 in which the actuators 45 are held and which may receive the ends 40 of the needles to drive the needle during the relative movement of the needle bed and the actuator mechanism. The wheel may be gear-driven, if desired. A cam 48 is provided to assure that the ends 40 will be in an outward position when the wheel 44 operates. As will be seen, the needles 27b do not extend downwardly to the portion of the machine where the pattern wheel 44 is operative, and a single pattern wheel may, accordingly, be utilized to make the selections even in a fine-gage machine. Each of the ends 40 on the needles 27a 45 carries a butt 46 which, as exemplified, is shaped in a particular manner, the construction being claimed in my co-pending application, Serial No. 75,784, filed April 26, 1906. This butt, when the end is in its normal outward position, is engaged by a cam 49 to advance the needle a desired distance. The butts 48' and the cam 49 preferably have outwardly-sloping cooperating surfaces to insure against slipping.

The needles 27a and 27b are formed, respectively, with main butts 50a and 50b adapted to be engaged by a cam 51. The cam 51 has a lower surface 52 which is adapted to partially advance the needles to a position where the bits 48' on the needles 27a will be engaged by the cam 49 if their ends 40 are not pressed inwardly, and which are adapted to advance the needles to a point for further selective action. It is to be noted that the butts 50a are shorter than the butts 50b and are pointed as indicated at 53. The cam 51 is formed with a slot 54 adapted to receive the butts 50a which ride up the surface 52 to the slot. However, the cam 49 is steeper than the cam 51, so that when a butt 48' is engaged by the cam 49 the needles will be moved rapidly upwardly and will clear the slot 54, as will be clear from Figs. 4, 7, and 11. The butts 50a and 50b of the needles 27b are so long that they will clear the slot. Those needles 27a whose butts enter the slot 54 will be drawn downwardly by an inclined portion 55 of the slot, whereas the needles 27b and those needles 27a which are held by the pattern wheel and acted on by the cam 49, will ride upwardly on an upper portion 56 of the surface of the cam 51. Accordingly, as the needles leave the cam 51, all of the needles 27b will be in an advanced position and certain of the needles 27a will be in an advanced position, while others of the needles 27a will be in a retracted position.

Those of the needles 27a which are advanced, will advance their pressers and one adjacent presser, so that in the sections a and c, Fig. 4, all the pressers will be advanced. Yet in the sections b and d all the pressers will be retracted. Thus the needles in the sections a and c will receive a yarn and knit, whereas in the sections b and d the needles 27b will receive the yarn without knitting and the needles 27a will pass the yarn, thus providing for a slubbed interlock fabric, or, when the positioning of the needles or some of the needles in the sections a and b 70 or c and d are reversed at the next yarn feed, for the production of an interlock fabric. By means of the usual stitch-cam, such as shown at 57, the needles are retracted to a position indicated in Figs. 2 and 8 after reception of 75
yarn from a yarn-carrier 58, the retracting being sufficient so that the needles whose beards are pressed will cast loops. A cam 59 is provided to restore the needles. As will be apparent, the butts 48 are unaffected by these cams.

The beard preservers are retracted by a cam 60 acting against butts 61 on the beard preservers. The selecting action of cam 49 may be eliminated at such portions of the operation as may be desirable for the production of the desired designs. This may be accomplished by mounting the cam on a rod 62 carrying an arm 63 which is held against a pattern chain 64 by means of a spring 65. Protuberances 66 on the pattern chain will move the arm 63 to withdraw the cam 49 from operative position. When the cam is thus withdrawn, no knitting will occur, but the needles 27b will continue to catch the yarn so that gathered effects may be produced. As will be apparent, needles which are similar to the needles 27, except that their yarn-manipulating points carry a latch, rather than a beard, may be advantageously used in many instances, and needle-operating mechanism of the character indicated may readily be utilized to actuate these or other suitable types of knitting elements in accordance with this feature of the invention. As will also be apparent, certain of the subsidiary features may be utilized in machines wherein the needles are all of the same type.

There are many instances where a different sinker operation will be required in different parts of the fabric as when different manipulations of a yarn are desired in parts of a fabric where the knitting of a certain yarn occurs and in parts where this yarn is unknitted, or when a yarn is to be knitted tightly and loosely in different parts of the fabric, or when some other variation is desired. In the embodiment exemplified in Figs. 1–11, there is provided an arrangement whereby an auxiliary yarn may be formed into hanging loops, such for instance as used in tailoring at the same time as a main yarn is knitted, but where the hanging loops will not be formed where the main yarn is unknitted. In the particular arrangement exemplified the yarn carrier 58 is formed to feed a main yarn 67 and a supplemental yarn 68, and adjacent to each needle there is provided a main sinker 69 and a supplemental sinker 70. Pins 37 connecting the preservers are extended beyond one of the preservers, as indicated at 71, so that they may enter notches 72 on a pair of supplemental sinkers 70. The main sinkers 69 are cut away to provide notches 73 to permit reception and movement of the pins. A cam 74 acts on the lower end of the preservers to swing them outwardly during their upward movement so that the pins 37 and their extensions will enter the notches 72. The sinkers 69 and 70 are normally manipulated by butts 74' and 75 fitting into a sinker cam groove 76 of the usual type, as indicated in Fig. 3.

The butts 74 on the main sinkers 69 are of the same extent as the width of the cam groove, but the butts on the supplemental sinkers 70 are of less extent so that these sinkers may be independently moved. The notches 73 in the sinkers are of sufficient extent so that in the present in stance these sinkers will not be effected by a movement of the preservers which will cause a desired inward movement of the supplemental sinkers. A cam 71 is provided to act on those preservers which have been advanced to move them inwardly directly after the passage of the yarn carrier and the inward movement of the cam sinkers by the cam groove. In operation whenever the preservers are advanced by the action of the needles 27a the preservers will be swung by the cam 74 so that their pins 37 will enter the notches 72 at the end of their advancing movement. After the receipt of a yarn by the needles the cam 71 will move the preservers inwardly to advance the supplemental sinkers 70. In order to free the sinkers from the preservers so that these parts may thereafter be independently controlled, there is provided a cam 121 which draws the preservers downwardly just enough so as to move the pins out of the notches. It is to be observed that the needles and preservers are advanced somewhat more than would otherwise be necessary in order to allow for this slight retracting movement. This retracting movement may be very slight, but is exaggerated in the drawings for the sake of clarity. The sinkers should be so formed, as with 20 bends, or should be so set in the sinker slots, that the frictional resistance will be sufficient to prevent the immediate withdrawal of the supplemental sinkers after the removal of the pins from the notches. After this retracting movement, the retraction of the needles by the stitch cam, the operation of the preservers by the cam 30, the withdrawal of the sinkers by the cam groove, and the final retraction of the preservers by the cam 50 may be carried out in a manner which 30 will be readily apparent.

Preferably the preservers are formed with holes 29 for the reception of the pins and the pins are frictionally set in these holes so as to permit pins of different lengths to be pressed through the 35 holes of one or more preservers as desired.

It will be appreciated that the supplemental sinkers may be omitted throughout the machine or at desired portions of the machine in accordance with the requirements of a particular case. 40

As will be apparent, while the provision of this sinker control feature is advantageous in many instances, it may readily be omitted without affecting the advantages attained by the other features of the invention. For example, there is shown in Fig. 12 a desirable simple form of construction which may be similar in every respect to that shown in Figs. 1–11 except that the pins, as indicated at 37c, are disposed at a lower point of the preservers, and the supplemental sinkers, as well as the cam 71 and the main sinkers 69c are omitted. The needle-operated preservers may be made shorter and the cam 78 may be omitted. This arrangement has a wide utility in the many fields in which no supplemental control is desired. The pins may be set at any desired point.

There are many instances in which compactness of mechanism and simplicity of operation are of less importance than flexibility of the operation and variability in the stitch production. In such instances it is desirable that each needle be independently controlled. For this purpose there may be utilized a construction such as exemplified in Figs. 13 and 14 wherein a series of 66 similar bead needles 21d are provided on a bed 26d. Each needle is provided with an independent actuating presser 29d at the rear end 25c, except that it is not connected with any other presser. The construction may be such that the pressers will not affect the sinkers, a sinker arrangement such as utilized in Figs. 1–11 may be utilized, or other suitable arrangement may be provided. In the particular construction exemplified, the pressers are formed with holes 29d and 75
short pins 31d are provided in the holes of certain of the pressers. The main sinkers 86d are provided with notches 87 for the reception of these pins, and presser-operating cams 14d, 74d, 55d, 31d are provided. The cam groove 16d is provided with an additional recess 83 to permit the movement of the sinkers under the influence of the cam 17d. In the exemplified embodiment, those pressers which are formed with pins 37d, as at the left-hand side of Fig. 14, are to be provided for a looser knit, whereas those pressers which are not provided with pins, as at the right-hand side of Fig. 14, do not actuate the sinkers even when the pressers are advanced, so as to provide a tighter knit at those portions of the fabric knit by needles equipped with pinless pressers. As above indicated, all of the pressers, or none of them, may be provided with pins, or any other suitable arrangement may be utilized. Likewise pressers may be arranged in units, only one presser of the unit being actuable by its needle, as hereinafter advanced, for example.

As exemplified, the needles 21d are actuated by a mechanism such as shown in my co-pending application, Serial No. 720,321, filed April 17, 1934, now Patent No. 2,025,463 comprising rockers 84 individual to the needles. Each of the rockers 85 has a plurality of stepped cam-engaging surfaces 85 and 86 at its lower end adapted to cooperate with the cam 87 to advance the rocker and the needle. If the rocker is in the position shown by dotted lines, neither surface will be engaged and the rocker will not be moved. If the rocker is in the position shown in full lines, the surface 85 will be engaged and the rocker will be moved enough to partially advance the needle. If the rocker is in the position shown in dot and dash lines, the surface 86 will be engaged and the rocker will be moved enough to fully advance the needle. Only in the latter case will the presser be advanced sufficiently to be engaged by the cam 80, whereas a yarn will be received by the needle whether it is in a partially advanced or in a fully advanced position. Thus the needle will knit and the sinker 83d will be advanced by the presser only when a needle is fully advanced. In order to set the rockers, they may all be swung to the position shown in dotted lines, as by a suitable cam 87, and then actuated by a pattern wheel 88 wherein actuators are selectively disposed in slots 89 and 90. As exemplified these slots are provided in two rows to facilitate operation in fine-gauge machines, the slots being staggered so that an actuator in an upper slot will swing one rocker and an actuator in a lower slot will swing a Successive rocker. Actuators 81 and 82 of different lengths are provided, the shorter actuators being provided where a rocker is to be swung to a position shown in full lines and the longer actuators being provided where a rocker is to be swung to the position shown in dot and dash lines. If the actuator is provided, the rocker will remain in the position provided. The pattern wheel is driven by means of a gear 93 meshing with the rockers.

As will be apparent, rocker mechanism such as described may be utilized to move the needle and presser to two positions in both of which the presser will operate to cause knitting, but in one of which the presser will be advanced sufficiently to operate a sinker and in the other of which will not be advanced sufficiently to operate a sinker. In the construction shown in Figs 1-11, the needles shown at 21a and 27b are alternated to facilitate the actuation thereof by a pattern wheel of the type shown as for use in fine-gauge machines. In instances, however, where the gage is coarser or where a pattern wheel may be of finer gage, or where other selecting means, such for instance as a pattern wheel similar to the pattern wheel 88, may be utilized, needles of the character shown at 21c and 27c may be arranged in any desired manner. In Figs. 15 and 16, there is shown an arrangement adapted for production of interlock fabric wherein the unknit yarn may float back of two wales, and where other variations may be formed. The operation will be readily apparent from these figures, the needles 21c and 37b being arranged as indicated, and a pin 37 running in each instance from a presser 29u, in one direction or the other, to a presser 29b. The pattern wheel in this instance will be formed with slots so arranged that wherever a needle 27u occurs, it may be pressed by an actuator.

As will be apparent, if, for example, two or more needles 27b with associated pressers 29b are provided between successive needles 21c with associated pressers 29u, and the two or more pressers 29b connected, as by a pin 31, to a single presser 29u, three or more pressers may be actuated as a single unit by one needle of a group, when desired.

Pressers may be arranged to operate in response to the needle movement in a variety of manners. For example, instead of being arranged as above exemplified, they may be arranged as indicated in Fig. 17 wherein the pressers 29c are disposed for pivotal movement on a retaining spring 84. In this instance, the needles 27c are mounted on a bed 25 and may be operated by mechanism such as above described in any other suitable manner. Pairs or groups of pressers may be worked by only one needle of a pair or group, or independent pressers may be individually worked. If independent pressers are utilized, each needle is provided with a projection 85 which bears against a surface 96 on the presser to swing it into the path of a cam 97 whereby it is held in bed pressing position during the retraction of the needle. If pressers are operating in units as described, the projections 88 will be formed only on those needles which are designed to cause the presser operation.

As above disclosed, the invention may be utilized for the control of auxiliary knitting elements whether or not the main needles are beam needles. For example, in Fig. 18 there is exemplified a construction wherein latch needles 27f are provided in the slots of the needle bed 25f. Control elements 29f, which may be operated by the needles, as for example in the manner in which the pressers 29u or the pressers 29d are operated, are provided. These may be operated in units of two or more, or individually as desired, and are arranged to operate sinkers 69f by means of pins 37f entering notches 100 in the sinkers. These sinkers are of a character commonly used for the production of hanging loops or toweling, and are arranged with a portion 101f adapted to be projected between yarns 101n and 101p in the well known manner so that when the needle is retracted the yarn 101n will be drawn over the portion 101m and the longer loop than the yarn 101p. As will be apparent to those skilled in the art, the sinkers will be retained in position during a proper portion of the retraction of the needles. When a 75...
control element 29 is advanced, so that the pin 31f enters the notch 108, the control element 29 is engaged with cam 77f so as to move it from the full line position to the dotted line position to project one or more sinkers, depending upon the extent of the pin 31f. When, however, a control element is not advanced sufficiently for the pin to enter the notch, or when a control element carries no pin, a sinker will not be moved. Thus variable effects may be produced. The control elements may be so arranged that their pins will only enter the notches when the needles have been advanced to casting level, and will not enter the notches when the needles are slanted to a "tucking" level; or they may be arranged to enter the notches when the needles which exercise the control are at one of two casting levels to which they may be advanced. A selective operation of the needles may be effected in any desired manner, as for instance any of the manners and by any of the mechanism herein exemplified, or in a manner and by mechanism such as exemplified in my co-pending application, Serial No. 720,921, now Patent No. 2,025,463 hereinafore referred to, or by other suitable mechanism, to obtain the desired effect.

In instances wherein it is desired to omit the special sinker operation, or the beard pressing operation, or both, during certain portions of the operation of the machine, any of the cams 71, 80, etc., may be made adjustable, so that they may be rendered inoperative either manually or by automatic means. In Fig. 18, there is exemplified an arrangement wherein the cam 77f is mounted on a rod 110f which may be operated by mechanism which includes a pattern wheel and which is similar to the mechanism for operating the rod 62 for the control of the cam 41.

Various other types of auxiliary knitting elements may be similarly operated in accordance with the invention. In Fig. 19, there are shown needles 27g which may be of a character shown in Figs. 1-11 and operated by similar mechanism, or may be of other character and otherwise operated. As exemplified, the needles are mounted on the bed 28g and are provided with butts 102 which, as the needles are advanced, move a lever 103 upwardly. This lever 103 is pivoted upon a member 104 which is adjustable mounted as indicated and carries at an outer end an operating arm 105. Each operating arm 105 carries the end of the shank of a dial needle 107 in a fork 108. Each dial needle is provided with a butt 109 which when the arm 105 and the dial needle are in an elevated position, will be engaged by the cam 110 to advance the dial needle for knitting. Cams 111 are provided to raise the operating arms and the dial needles prior to the operation of the needles 27g. Accordingly, when a cylinder needle 27g is advanced after the passage of the cam 111, it will raise the left-hand end of the lever 103 and lower its right-hand end together with the arm 105 and the dial needle 107. In this situation, the needle 27g will be operative and the needle 107 inoperative. When, however, a needle 27g is not advanced after the passage of a cam 111, the arm 105 and the dial needle 107 will remain in an elevated position, the butt 109 of the needle 107 will not be engaged by the cam 110 and the needle 107 will be advanced, so that this needle, rather than the needle 27g will be operative.

Needles such as shown in Figs. 1-11 or other knitting elements may be readily operated in a variety of different manners, the lower ends of the needles being differently formed in certain cases. In Figs. 20 and 21, there is shown an arrangement wherein the needles which operate the pressers, as indicated at 27aa, are formed with long butts 112 of the usual type and wherein the other needles as indicated at 27bb are formed with long butts 113 of the usual type. In the exemplified mechanism, there is provided a thin cam 114 disposed outwardly of the cylinder and arranged to advance the long butt needles, but to pass the short butt needles.

The short butt needles 27aa are formed with resilient lower ends. Beyond the cam 114 there is provided a cam 115 adapted to raise the short butt needles but permitting these to be selectively pressed behind it. For the latter purpose there is provided a pattern wheel 116 which is obliquely disposed in the present instance and arranged to selectively press the butts of the short butt needles to cause them to ride beyond the cam 115. Accordingly these short butt needles which are engaged by actuators 117 on the pattern wheel will move behind the cam 115, whereas those which enter empty slots on the pattern wheel will ride up the surface of the cam 115. As will be seen, the pattern wheel is juxtaposed with this cam surface. In order to facilitate the movement of the needles or of the cam, as the case may be, the rear of the cam 115 is recessed as at 118 to permit the lower ends of the needles to spring outwardly after they have passed the operative surfaces of the cam.

In various instances, it is desirable that all of the needles be placed in a retracted position during certain periods of operation, or that all the needles be in a fully advanced position, or that none of the needles be in a fully advanced position during certain periods, and that there is exemplified in Fig. 22 a construction wherein adjustable cams 119 and 120 are provided between the cam 51 and the yarn feed and stitch cam 57. By the adjustment of the cam 119 to the dotted line position, all of the needles 27 may be fully advanced regardles of the operation of the pattern wheel 44. By the adjustment of the cam 120 to the dotted line position, all of the needles 27 may be placed in a retracted position and by the adjustment of this cam to the position shown in dot and dash lines, those needles which have been advanced by the cam 51 may be partially retracted if desired. The cams 119 and 120 may be manually operated, or may be operated automatically in any well known or suitable manner, as for instance, by pattern chain arrangements of the nature indicated in Fig. 5.

Certain subject matter disclosed but not claimed herein has been claimed in my copending application Serial No. 76,754, filed April 28, 1936, now issued as Patent No. 2,124,304, dated July 19, 1938.

Since certain changes in the construction set forth and in the carrying out of the above method, which embody the invention, may be made without departing from its scope, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

The invention claimed is:

1. Knitting mechanism comprising a bed and actuator means, said bed and said actuator means being relatively movable, a series of beard needles on said bed, a series of auxiliary knitting elements on said bed, a series of beard pressers.
individual to said needles, means to selectively position the needles, means to position the beard pressers in accordance with the positioning of at least certain of said needles, means to operate the beard pressers in accordance with the positioning of the beard pressers, and means to operate said auxiliary knitting elements in accordance with the positioning of the beard pressers.

2. Knitting mechanism comprising a bed and actuator means, said bed and said actuator means being relatively movable, a series of beard needles on said bed, means to selectively place needles at two levels of said bed, said actuator means to position said needles when placed at one of said levels to pass a yarn carrier without receiving yarn and to cause certain needles when placed at the other of said levels to receive a yarn and knit or to receive yarn without knitting depending on whether or not associated ones of said certain of said needles are placed at said other of said levels.

3. Knitting mechanism comprising a bed and actuator means, said bed and said actuator means being relatively movable, a direction longitudinal of said bed, a series of beard needles on said bed, a beard presser unit movable substantially laterally, said beard presser unit having a plurality of adjacent needles, and means to move said unit in response to the operation of a given one of said needles.

4. Knitting mechanism comprising a bed and actuator means, said bed and said actuator means being relatively movable, a series of beard needles on said bed, a series of beard pressers, means to impart longitudinal selective movement to said needles, means to impart longitudinal movement to the beard pressers in accordance with the movement of only certain ones of the selected needles, and means to operate only those beard pressers which have been moved longitudinally.

5. Knitting mechanism comprising a bed and actuator means, said bed and said actuator means being relatively movable, a series of slots in said bed, a plurality of needles movable longitudinally in said slots, a series of control elements for said auxiliary knitting elements, a series of control elements for said auxiliary knitting elements, said control elements being individual to and adapted to be engaged by at least certain of said needles and being movable to operate said needles in accordance with the operation of said auxiliary knitting elements.

6. The method of forming a design fabric embodying a plurality of yarns which comprises selectively placing needles on only two levels and causing certain of a plurality of adjacent needles to be moved and causing all of said pluralities of adjacent needles to be moved, but not to knit when certain other of said pluralities of adjacent needles are at the other of said levels, no yarn being received by those of said pluralities of adjacent needles which are not moved, and causing all of said pluralities of adjacent needles to receive yarn and to knit when all of said pluralities of adjacent needles are placed at said one of said levels.

7. The method of forming a design fabric which comprises selectively placing a series of needles on one or another of two levels, selectively positioning beard pressers on one or another of two levels, controlling the positioning of the beard pressers in accordance with the placing of only particular ones of the needles at one of said levels but not in accordance with the placing of others of the needles at said one of said levels, and operating the needles in accordance with the positioning of the beard pressers.

8. Knitting mechanism comprising a bed and actuator means, said bed and said actuator means being relatively movable, a series of beard needles on said bed, a series of beard pressers for pressing the beards of said needles, each beard presser comprising a beard pressing portion and shank portion, each shank portion being formed with a longitudinally extended recess in the outer edge thereof, presser retaining means extending thru said recesses, means to selectively impart longitudinal movement to said pressers to position the same, cam means to operate the positioned pressers, and means to prevent escape of the pressers from the cam means.

9. Knitting mechanism comprising a bed and actuator means, said bed and said actuator means being relatively movable, a series of needles on said bed, said needles having yarn-manipulating portions, at least certain of said needles being provided with elongated shanks having inwardly movable ends, means providing for pivoting upon the bed during such inward movement, means to prevent outward movement of the yarn-manipulating portions, said shanks being narrowed at a point between said ends and said yarn-manipulating portions to permit bending when an end is swung in, means forming part of said actuator means to selectively press said ends inwardly, and means forming part of said actuator means to operate said needles in accordance with the operation of said selecting means.

10. Knitting mechanism comprising a bed and actuator means, said bed and said actuator means being relatively movable, a series of needles on said bed, said needles having yarn-manipulating portions, at least certain of said needles being provided with elongated shanks having inwardly movable ends, means providing for pivoting upon the bed during such inward movement, means to prevent outward movement of the yarn-manipulating portions, said shanks being narrowed at a point between said ends and said yarn-manipulating portions to permit bending when an end is swung in, rotary pattern mechanism forming part of said actuator means and arranged to selectively press the ends of the needles inwardly, and means forming part of said actuator mechanism to operate said needles in accordance with the operation of said rotary pattern mechanism.

11. Knitting mechanism comprising a bed and actuator means, said bed and said actuator means being relatively movable, a series of needles on said bed, said needles having yarn-manipulating portions, at least certain of said needles being provided with elongated shanks having inwardly movable ends, means providing for pivoting upon the bed during such inward movement, means to prevent outward movement of the yarn-manipulating portions, said shanks being narrowed at a point between said ends and said yarn-ma. 70 nipulating portions to permit bending when an end is swung in, means forming part of said actuator means to selectively press said ends inwardly, means forming part of said actuator means to operate said needles in accordance with
the operation of said selecting means, and means to render said operating means inoperative when desired.

12. Knitting mechanism comprising a bed and actuator means, said bed and said actuator means being relatively movable, a series of needles on said bed, said needles having a yarn-manipulating portion, at least certain of said needles being provided with an elongated integral shank having inwardly movable ends, means providing for pivoting upon the bed during inward movement, means to prevent outward movement of the yarn-manipulating portions, said shanks being arranged at a point between the said ends and said yarn manipulations portions to permit bending when an end is swung in, means forming a part of said actuator means to selectively press said ends inwardly, means forming a part of said actuator means to operate said needles in accordance with the operation of said selecting means, a series of control elements individual to said needles and operable thereby in accordance with the operation thereof, a series of auxiliary knitting elements, and means to actuate said control elements in accordance with the operation of the control elements by said knitting elements, said actuation of said control elements controlling the operation of said auxiliary knitting elements.

13. Knitting mechanism comprising a bed and actuator means, said bed and said actuator means being relatively movable, a series of knitting elements carried by said bed, certain of said knitting elements being of one length and others of said knitting elements being of another length, means forming part of said actuator means to move all of the knitting elements of one length and selected ones of the knitting elements of another length on said actuator, and means also forming part of said actuator means to select those knitting elements of said other length which are to be moved.

14. Knitting mechanism comprising a bed and actuator means, said bed and said actuator means being relatively movable, a series of bed needles carried by said bed, certain of said knitting elements being of one character and others of said knitting elements being of another character, means forming part of said actuator mechanism to advance all the needles of one character and to advance selected ones of the needles of another character, means forming part of said actuator mechanism to select which ones of said needles of another character are to be advanced, and means to cause a plurality of beard presses to be advanced when a needle of said other character is advanced but not to be advanced when a needle of said other character is unadvanced.

15. Knitting mechanism comprising a bed and actuator means, said bed and said actuator means being relatively movable, a series of knitting elements having butts of one character and other of the knitting elements having butts of another character, and a cam forming a part of said actuator mechanism and being formed with a cam surface and with guide means adapted to receive butts of one character when they move along said cam surface but not to receive butts of the other character when they move along said cam surface and to guide said butts of one character to a desired position.

16. Knitting mechanism comprising a bed and actuator means, said bed and said actuator means being relatively movable, a series of knitting elements on said bed, butts on said knitting elements, a cam having a cam surface adapted to engage said butts, a slot in said cam constituting an interruption in said surface and adapted to receive at least certain of said butts, and means to act on certain of said knitting elements to prevent their butts being received by said slot.

17. Knitting mechanism comprising a bed and actuator means, said bed and said actuator means being relatively movable, a series of knitting elements carried by said bed, said cam having an obliquely disposed operative surface in the path of relative movement of portions of at least certain of said knitting elements, and a pattern wheel rotating in a plane parallel to said surface in juxtaposition thereto and arranged to selectively press toward said bed said knitting elements out of the path of relative movement of said cam.

18. Knitting mechanism comprising a bed and actuator means, said bed and said actuator means being relatively movable, a series of knitting elements carried by said bed, a cam having an angularly disposed operative surface in the path of relative movement of portions of at least certain of said knitting elements, a pattern wheel disposed at an angle corresponding to the angle of said surface and in juxtaposition thereto and arranged to selectively press said knitting elements out of the path of relative movement of said cam, said cam having resilient means tending to hold said portions in the path of relative movement of said cam, said cam being extended in a direction adjacent to the surface of said cam, and resilient means to permit said portions to move freely past it after they have passed said surface.

19. Knitting mechanism comprising a bed and actuator means, said bed and said actuator means being relatively movable, a series of knitting elements carried by said bed, a plurality of beard-presser units movable substantially laterally of said bed and each containing a plurality of beard presses for pressing the beards of a group of needles, and means to move said units laterally, each with one of the needles of the group controlled thereby.

20. Knitting mechanism comprising a bed and actuator means, said bed and said actuator means being relatively movable, a series of beard needles on said bed, a series of beard presses for pressing the beards of said needles, comprising a beard-pressing portion and shank portion, each shank portion being formed with a recess in the outer edge thereof, presser-retaining means extending into said recesses, said recesses being extended longitudinally a distance greater than the width of the presser-retaining means, and means to selectively impart longitudinal movement to said presses to position the same.

21. Knitting mechanism comprising a bed and actuator means, said bed and said actuator means being relatively movable, a series of beard needles on said bed, a series of beard presses for pressing the beards of said needles, means to selectively impart longitudinal movement to said presses to position the same, said cam means to operate the positioned presses, and means to adapt said cam means when the cam means operatively engage said presses to prevent escape of the presses from said cam means.

22. Knitting mechanism comprising a bed and actuator means, said bed and said actuator means being relatively movable, a series of knitting elements movable transversely of said bed, butts...
on said knitting elements, a yarn feed, a plurality of successive cam surfaces spaced in the direction of knitting element movement and adapted to engage said batts and arranged to be operative in positioning the needles in connection with the passage of said yarn feed, and means to cause the batts on certain knitting elements to be engaged by one of said cam surfaces after passing later with one or more batts of said cam surfaces, and to permit the batts of other of said knitting elements to pass from said one of said cam surfaces into the space between said cam surfaces without being engaged by said other of said cam surfaces.

23. Knitting mechanism comprising a bed and actuator means, said bed and said actuator means being relatively movable, a series of knitting elements carried by said bed, certain of said knitting elements being of one length and others of said knitting elements being of another length, means forming part of said actuator means to move all of the knitting elements of said length selected among the knitting elements of another length in a desired manner, means also forming part of said actuator means to select those knitting elements of said other length which are to be moved, and a series of control elements arranged in groups each group being adapted to be operated by one of said knitting elements of another length.

24. Knitting mechanism comprising a bed and actuator means, said bed and said actuator means being relatively movable, a series of beard needles carried by said bed, certain of said needles being of one length and others of said needles being of another length, a cam forming a part of said actuator means to advance all of the needles of one length a given extent and selected ones of the needles of another length a similar extent, and means also forming a part of said actuator means to select those needles of said other length which are to be moved.

25. Knitting mechanism comprising a series of longitudinally movable beard needles, a beard presser unit movable by and with only one of a plurality of said needles to beard-pressing position and adapted to press the beards of each of said plurality of said needles when so moved, and means imparting a beard-pressing action to said unit when in said position.

26. Knitting mechanism comprising a bed and actuator means, said bed and said actuator means being relatively movable, a series of beard needles mounted for sliding movement in a similar direction, means to cause the beard pressers to press the beards of the needles when in an advanced position, said beard pressers and said needles being so formed and arranged that a part of each of at least certain of said needles will bear against a part associated with one or more beard pressers to cause the associated beard presser or pressers to be advanced when the needle is advanced but that no parts of the needles will bear against the beard pressers to retract the same during the retraction of the needles, and means forming part of the actuating means to selectively control the operation of the needles to retract the same and to retract the advanced beard pressers.

27. Knitting mechanism comprising a bed and actuator means, said bed and said actuator means being relatively movable, a series of beard needles mounted for sliding movement on said bed in a given direction, a series of beard pressers mounted for sliding movement in a similar direction, means to cause the needle to retract the beards of the needles when in an advanced position, means forming part of said actuator mechanism to selectively advance said needles and to retract the same, means comprising mutually abutting portions on at least certain of the needles and at least certain of the beard pressers to cause the advance of one or more beard pressers when individual ones of at least certain of said needles are advanced, and means acting at a time other than the beard pressing operation to retract the advanced pressers.

28. Knitting mechanism comprising a bed, a series of instrumentalties movable on said bed, a series of main sinkers, auxiliary sinkers associated with at least certain individual ones of said main sinkers, means to selectively operate said instrumentalties, means to operate said main sinkers, and means responsive to the operation of said instrumentalties to selectively operate said auxiliary sinkers.

29. Knitting mechanism comprising a bed, a series of slots in said bed, a plurality of needles movable longitudinally in said slots, a series of sinkers, a series of control elements for said sinkers, said control elements being individual to and adapted to be engaged by at least certain of said needles and being movable to operative position directly thereby, means to selectively impart longitudinal movement to said needles, and means to selectively operate said sinkers in accordance with the positioning of said control elements, the last-mentioned means comprising means adapted to engage those control elements which have been moved to operative position and to cause the same to engage and operate said sinkers.

30. Knitting mechanism comprising a bed and actuator means, said bed and said actuator means being relatively movable, a series of slots in said bed, a plurality of beard needles movable longitudinally in said slots, a series of sinkers, a series of control elements for said sinkers, said control elements being individual to at least certain of said needles and being movable to operative position therewith, means to selectively impart longitudinal movement to said needles, and means to selectively operate said sinkers in accordance with the positioning of said control elements, said control elements being in the form of beard pressers.

31. Knitting mechanism comprising a bed and actuator means, said bed and said actuator means being relatively movable, a series of beard needles movable on said bed, means forming part of the actuator means to selectively control the operation of the needles, a series of auxiliary knitting elements extending at a substantial angle to said needle bed, a series of control elements individual to at least certain of said needles and individually responsive to the movement thereof, said control elements being adapted to control the actuation of said auxiliary knitting elements, and each of said control elements being adapted to be engaged by its needle during the movement thereof and to be moved directly thereby and being also adapted after being so moved to engage at least one of said auxiliary knitting elements to actuate the same, and means to operate said control elements after being so moved.