Feb. 2, 1954 W. D. IDE 2,667,769

PATTERN MEANS FOR CIRCULAR KNITTING MACHINES AND METHOD OF OPERATING SAME

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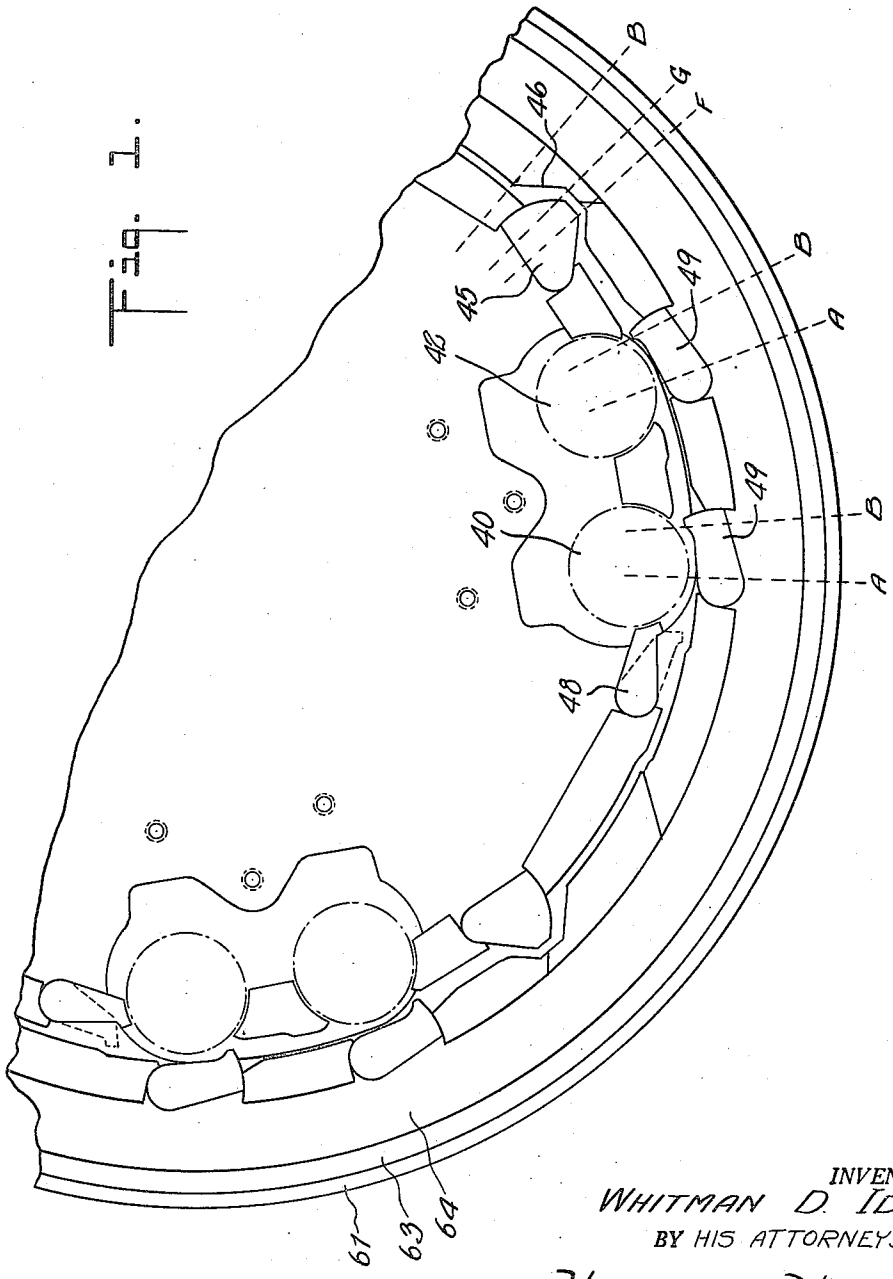
Fig. 1.



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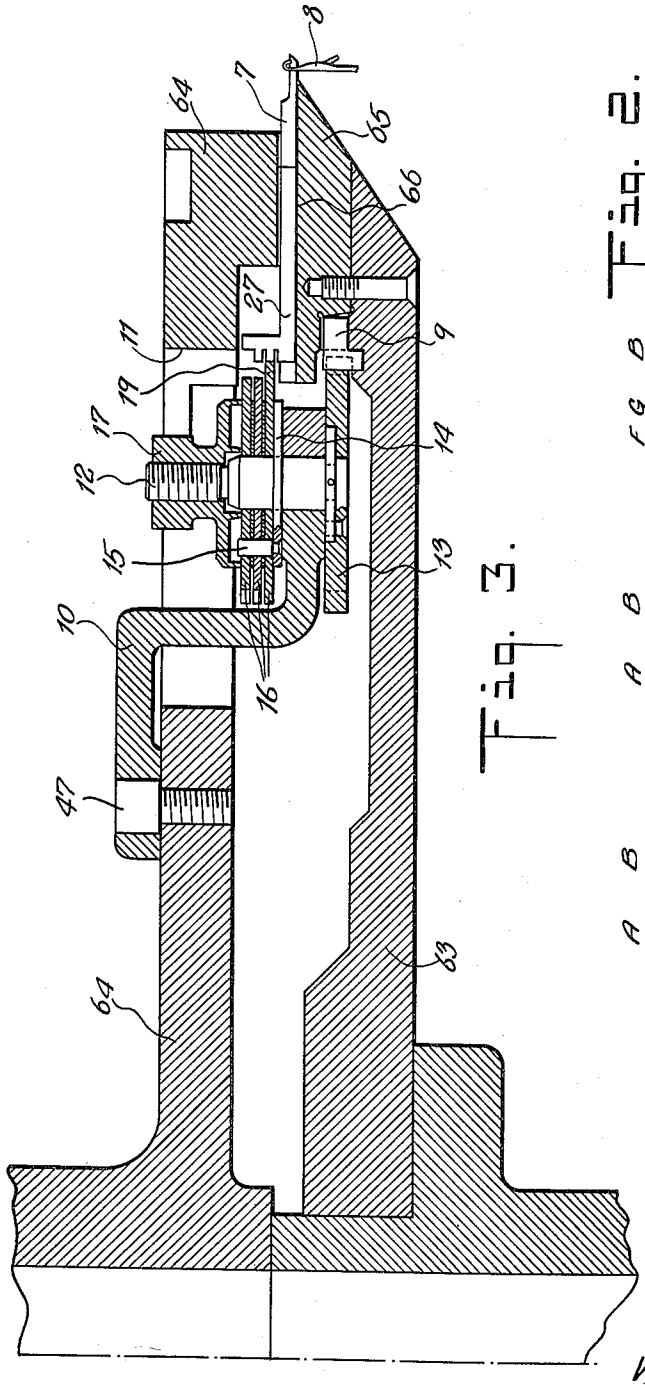

Fig. 3.

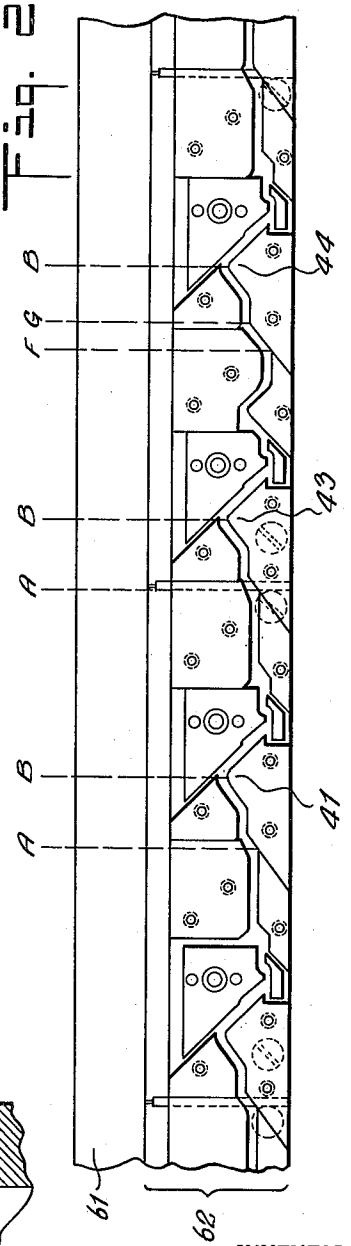

Fig. 2.

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Fig. 4.

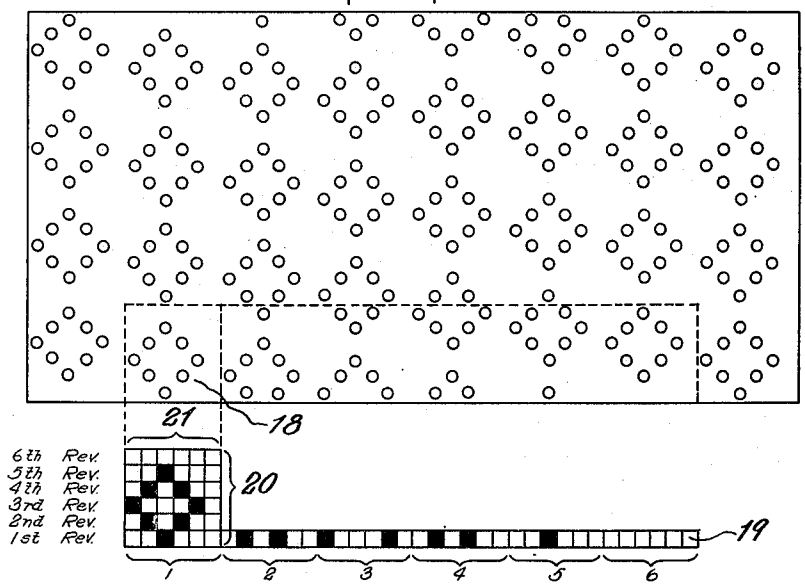
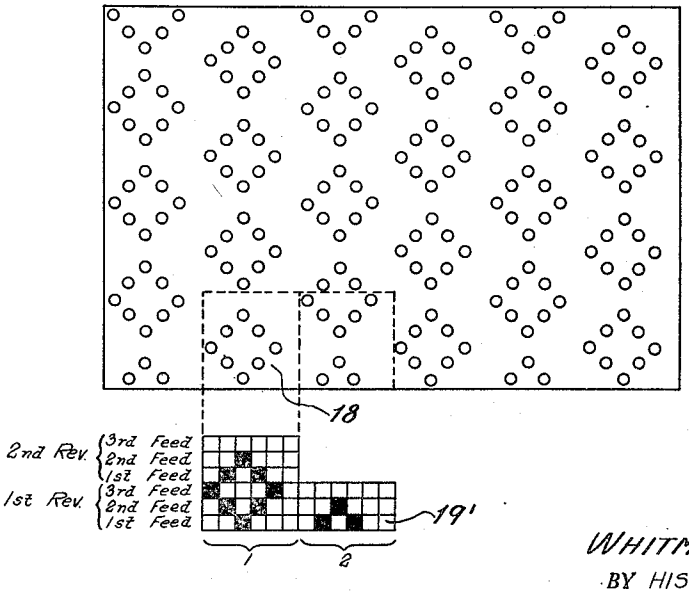


Fig. 5.



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PATTERN MEANS FOR CIRCULAR KNITTING MACHINES AND METHOD OF OPERATING SAME

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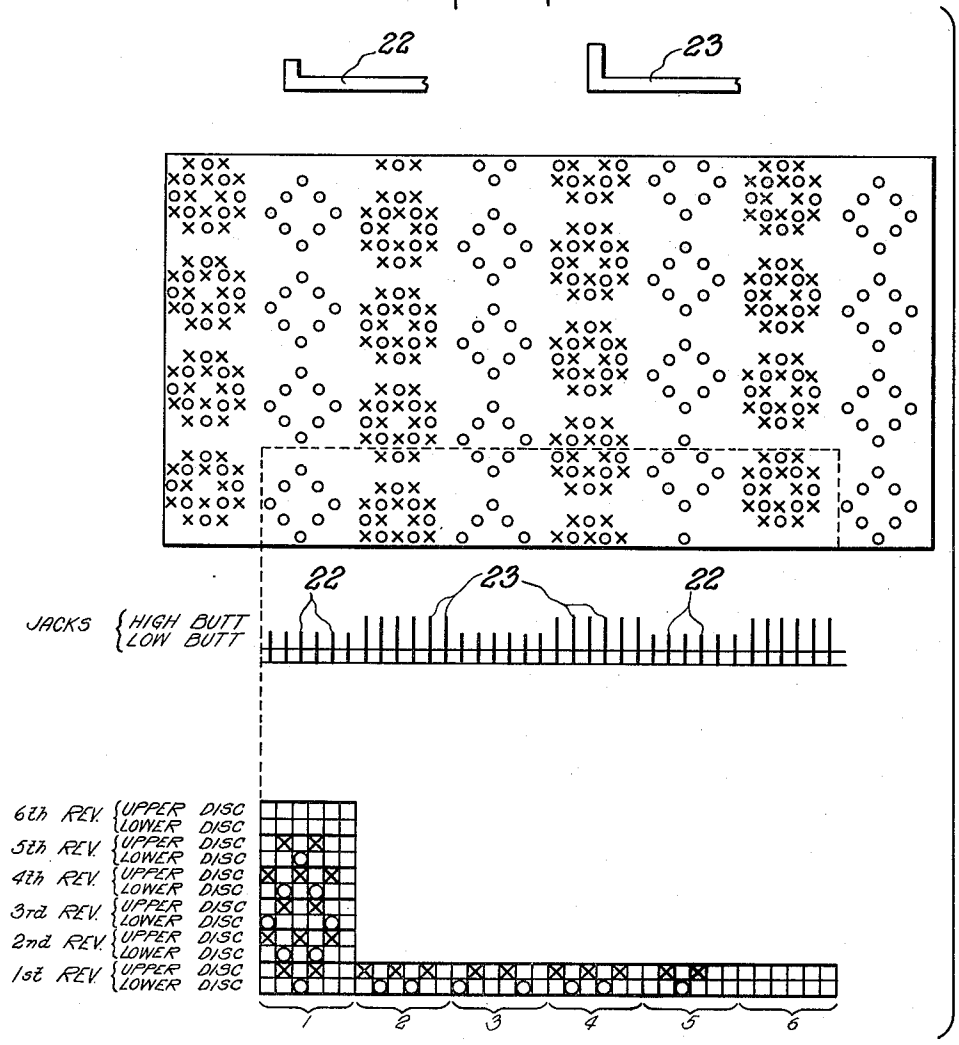
Fig. 6.



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PATTERN MEANS FOR CIRCULAR KNITTING MACHINES AND METHOD OF OPERATING SAME

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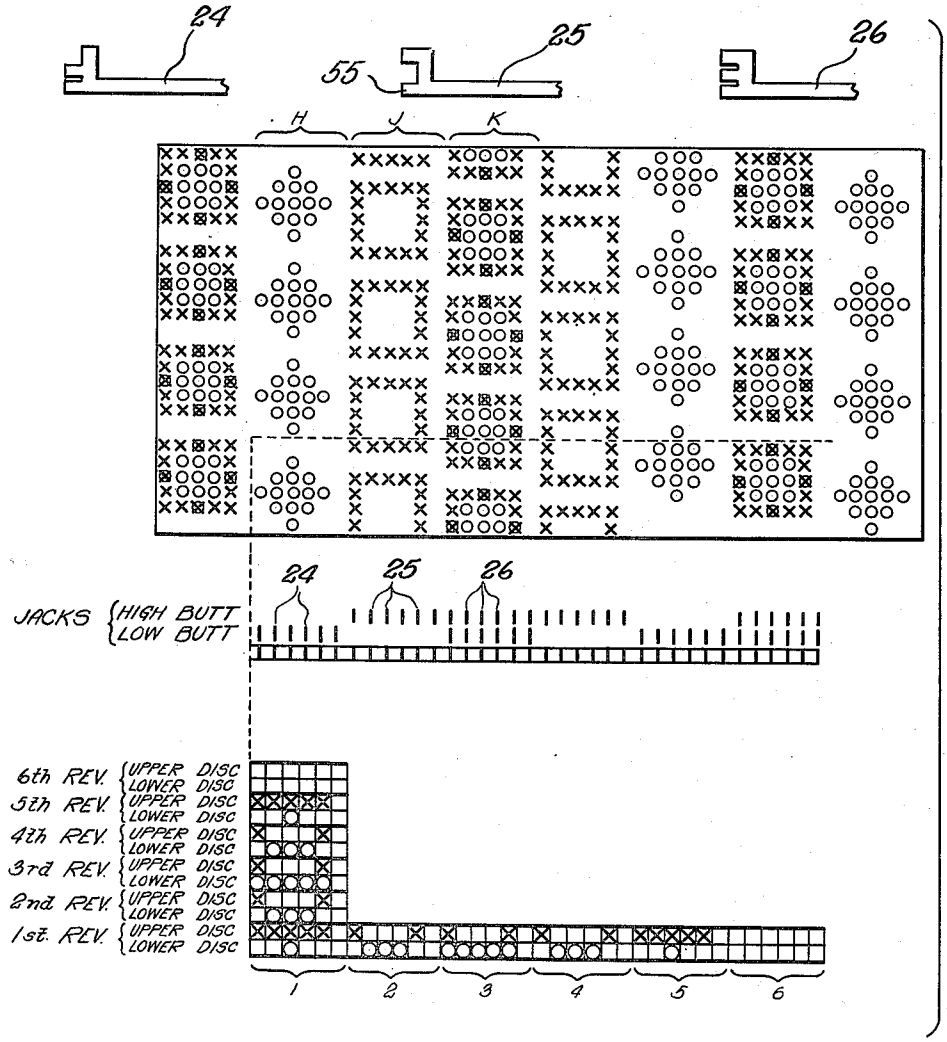
Fig. 2.



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PATTERN MEANS FOR CIRCULAR KNITTING MACHINES AND METHOD OF OPERATING SAME

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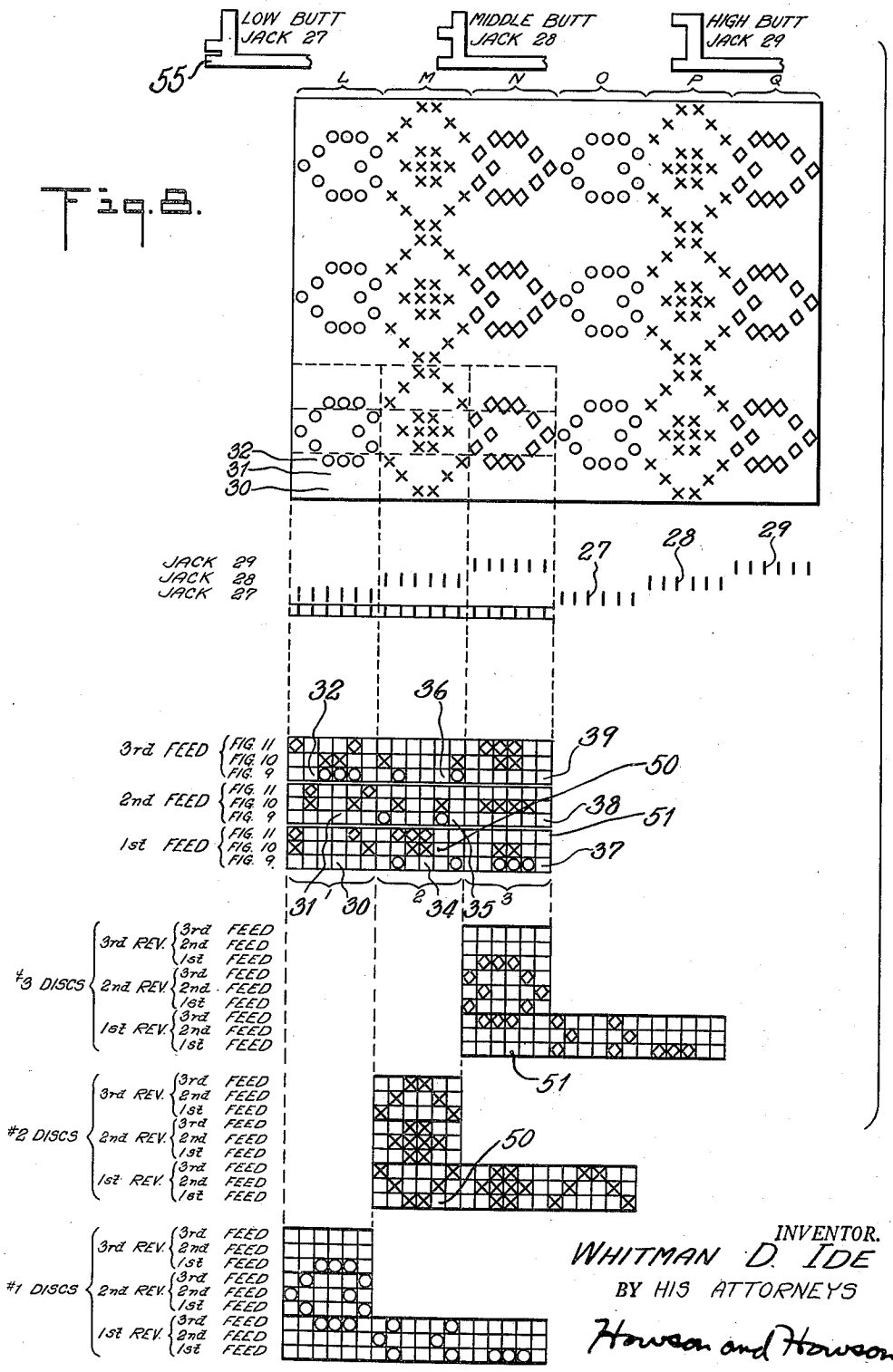
Fig. 8.



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PATTERN MEANS FOR CIRCULAR KNITTING MACHINES
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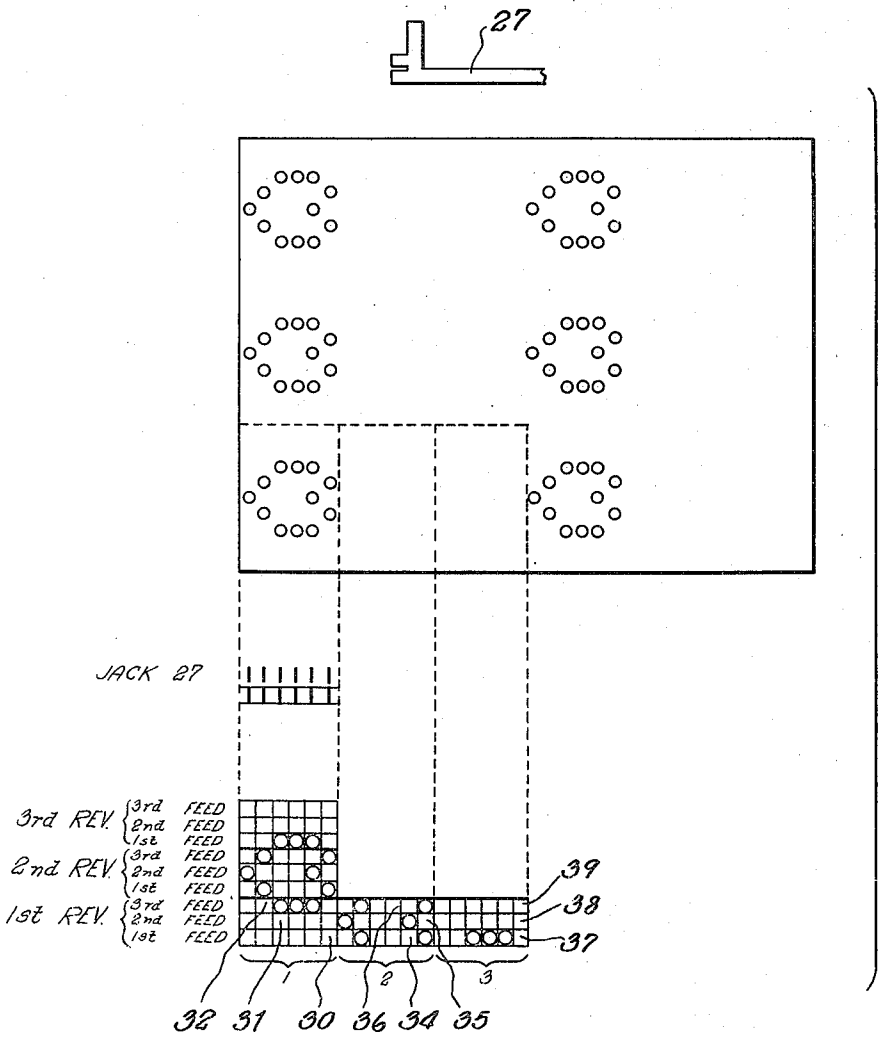

Fig. 9.

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PATTERN MEANS FOR CIRCULAR KNITTING MACHINES AND METHOD OF OPERATING SAME
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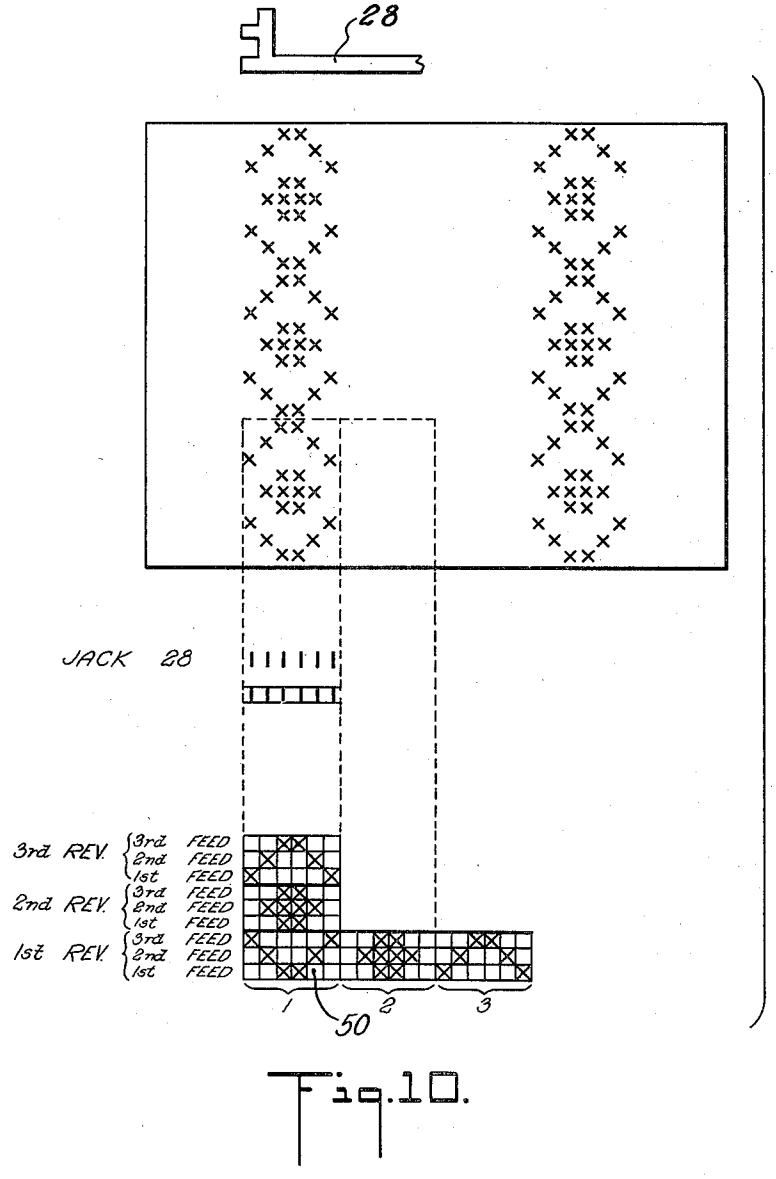

Fig. 10.

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PATTERN MEANS FOR CIRCULAR KNITTING MACHINES AND METHOD OF OPERATING SAME

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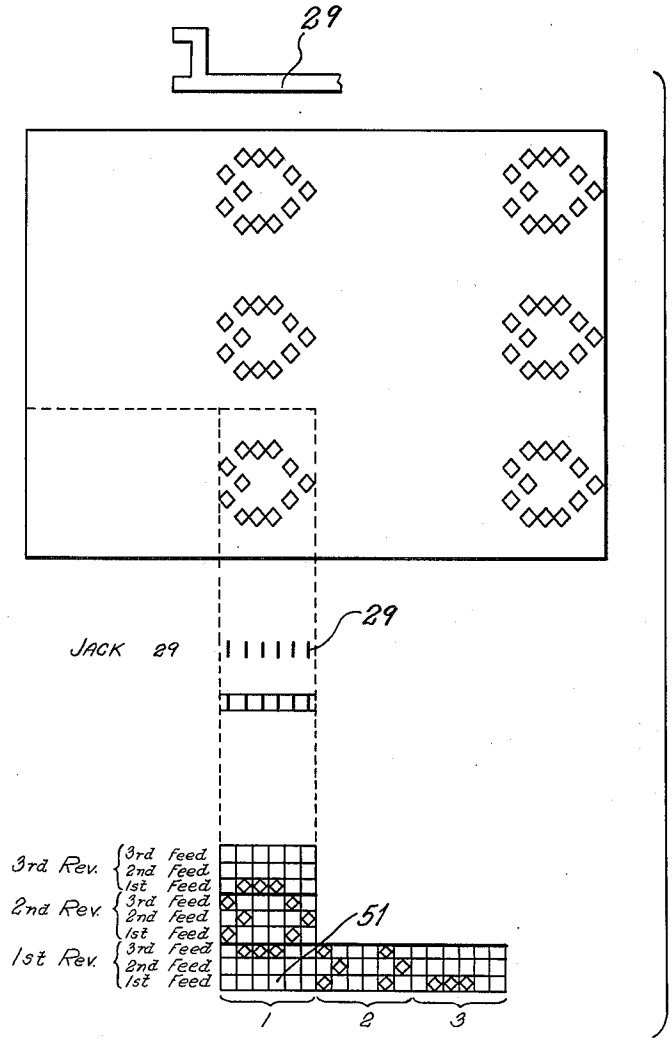

Fig. 11.

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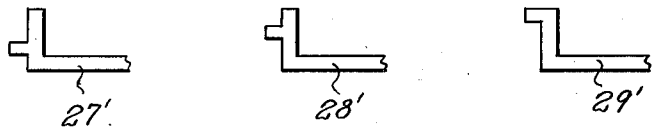
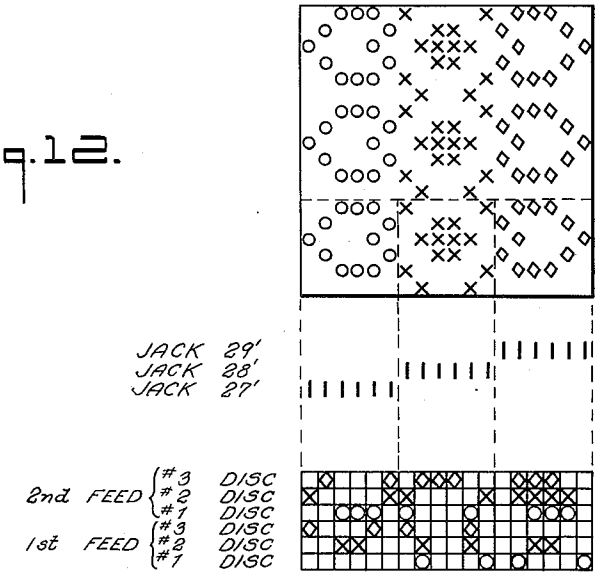
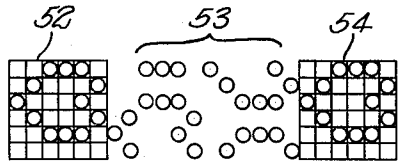


Fig. 12.





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Patented Feb. 2, 1954

2,667,769

UNITED STATES PATENT OFFICE

2,667,769

PATTERN MEANS FOR CIRCULAR KNITTING MACHINES AND METHOD OF OPERATING SAME

Whitman D. Ide, Laconia, N. H., assignor to Scott & Williams, Incorporated, Laconia, N. H., a corporation of Massachusetts

Application November 1, 1950, Serial No. 193,480

7 Claims. (Cl. 66—95)

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This invention relates to pattern means for circular knitting machines and method of operating same, and more particularly to means revolving in registry with the needle cylinder to select needles, jacks, or other knitting instrumentalities to produce designs in the knitted fabric. It has heretofore been known to have wheels carrying pattern indications revolving in timed relation with the needle cylinder or dial to apply their indications at the periphery of the cylinder or dial to needles, jacks, sinkers, and the like. The present invention belongs to such of this class of devices as apply a pattern on a wheel to the fabric progressively. These progressive devices make it possible to produce a large pattern from relatively small pattern means. This progression is achieved by having the wheel gain or lose in its relative position each revolution of the needle cylinder. One limitation of the progressive pattern system has been that the pattern is produced spirally, i. e., diagonally, on the fabric. Another disadvantage is that the types of patterns which can be produced are limited, since the pattern unit on the wheel is merely repeated without change around the fabric. It is the object of my invention to produce pattern means having the advantages of the progressive pattern system, without these disadvantages.

According to my invention the pattern means consist of one or more wheels, each composed of a plurality of superposed discs on a common axis, those discs having pattern indications on them. I provide operating butts at different heights on the knitting elements to cooperate with the selections indicated on the superposed discs. I provide special locating holes in the discs to simplify the assembly of the discs. I provide wheels at a plurality of selecting stations, i. e., at a plurality of knitting feeds on the machine, and I arrange the "fields" or units of pattern on the different discs and axes in a special manner. By these means I find it possible greatly to enlarge the pattern possibilities of the machine and, when desired, to completely eliminate the diagonal or slant effect of the pattern in the fabric. When it is desired to eliminate the slant effect, the number of units in the knitted pattern should equal the number of discs in each wheel and there should be butts in each successive pattern course in registry with a disc at a different level from the preceding field selection.

I will illustrate the invention applied to a stationary cylinder, independent needle, multiple feed Scott & Williams knitting machine adapted to make balbriggan fabric having two course eyelets therein made by the use of transfer jacks. The machine therefore has three knitting feeds to one selecting station. However, it should be understood that the invention is equally applicable to other special stitches or selective manipulation of knitting elements other than transfer jacks, and whether in dial or cylinder.

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In the drawings:

Fig. 1 is a plan view of a portion of a dial cap of a stationary needle cylinder Scott & Williams circular knitting machine built according to my invention, containing two pattern wheel selecting stations for making eyelet balbriggan fabric;

Fig. 2 is a development in elevation of needle cylinder knitting cams corresponding to part of the showing of the dial cap of Fig. 1; the lettered dash lines showing corresponding points in the knitting cycle in this and the preceding figure;

Fig. 3 is a view in vertical section through one side of the dial and dial cap of Fig. 1, taken on a line passing through one of my novel pattern wheels, showing a transfer jack moved outwardly by a projection on the bottom disc;

Fig. 4 is a diagram illustrating the layout of an ordinary progressive pattern of the prior art wherein the machine has one feed and one selecting station, the large diagram showing the diagonal character of the design in the fabric, while the graph at the bottom shows the pattern indications of the single disc of the single wheel, the six fields of the pattern wheel for producing that design as they lie successively on the disc, and, vertically, one of the pattern units produced in six revolutions of the machine by those same six fields;

Fig. 5 is a view similar to Fig. 4, showing the same design unit when produced on a three feed machine with three single disc pattern wheels of the prior art; while the graph at the bottom shows, horizontally, the first two fields of the single disc on each of the three wheels, and, vertically, the first pattern unit produced by the combined action of the three wheels in two revolutions of the machine;

Fig. 6 is a diagram similar to Fig. 4, showing a pattern which can be obtained by the employment of my invention on a single feed machine having one of my novel double disc wheels such as shown in Fig. 3, with high and low butt knitting elements arranged to give one selection from a single height of butt by itself or another from both butt heights together; the large diagram showing the appearance of the design in the finished fabric, the next portion showing the high and low butt layout of the jacks on the knitting

elements, and the bottom portions showing, horizontally, the pattern layout on the upper and lower discs for six successive fields and, vertically, the pattern selections available on the two discs in correspondence to their position in the fabric;

Fig. 7 is a diagram similar to Fig. 6, showing a pattern which can be produced in accordance with my invention on a single feed machine with a single double-disc wheel by the employment of two levels of frangible butts arranged to select from either disc alone or from the two together;

Fig. 8 is a series of diagrams showing the employment of my invention in a multi feed knitting machine having three pattern wheels each with three discs in association with three heights of independent frangible jack butts adapted to produce a basic pattern three fields wide from which slant has been entirely eliminated; the main oblong showing the design in the fabric, the diagram under it showing the arrangement of jack butts, the first graph under the jack butts showing the pattern indications on the assembled discs forming the wheels at the three feeds, the next graph showing the top No. 3 discs at each feed grouped together, the middle No. 2 discs for the three feeds grouped together and the bottom No. 1 discs of the three feeds grouped together, the discs being located under each bracket whose pattern they reproduce;

Figs. 9, 10 and 11 are diagrams of only the thirds of the basic pattern of Fig. 8 produced by the bottom, middle and top discs (i. e., Nos. 1, 2 and 3) respectively of the three feeds; the horizontal rows in the bottom graph in each view showing the pattern indications of three fields on the bottom discs No. 1 at the three feeds in Fig. 9, the middle discs No. 2 in Fig. 10, and the top discs No. 3 in Fig. 11; while the vertical arrangement of the pattern indications in these graphs each shows the indications effective to produce a different pattern unit in three revolutions of the machine;

Fig. 12 is a series of illustrations of a basic pattern stretching across three pattern units made according to my invention similarly to Figs. 8 to 11 but in which the machine employed has only two pattern wheels, each wheel still having three discs.

One of the more common systems of producing patterns in knitted fabric, more particularly circular knitted fabric, on multi-feed knitting machines, is by manipulation of selected knitting instrumentalities, such as needles, jacks, or sinkers. According to this system, a rotating means, such as a drum or a jacquard, is associated with the periphery of the revolving cylinder or dial of the knitting machine. This means has the same linear, i. e., peripheral, speed as the associated portions of the knitting elements and contains indications. The indications may be either butts or the absence of butts, spaced in registering relation to the associated knitting elements. Each projection is successively brought into registry with a specific knitting element, that element being given a special manipulation when a special stitch is desired. It will be obvious, of course, that if desired, these projections can be present where a regular stitch is desired, and absent where a pattern stitch is desired, if it is more convenient to set the machine in that manner. In the embodiments first shown in the drawings and description of the present application, however, the presence of the projection is used to produce the special stitch.

Heretofore one known way to manipulate the selected knitting elements for patterning was by means of a reproduction of the entire design on the drum in two dimensions exactly as it was to appear on the fabric. This involved a large mechanism. Such mechanisms are cumbersome and expensive and occupy a large amount of space on the machine.

The "progressive" type of pattern system avoids these disadvantages. This system lays out the entire pattern in indications arranged in one dimension. According to this system, the needle or jack selections on successive courses basically are laid out in succession in one line on a pattern disc which, revolving in register with the knitting elements, reproduces the selections on the fabric. Normally, the disc makes several revolutions to each revolution of the knitting machine. However, it usually takes several revolutions of the machine to complete one set of pattern units vertically of the design. To complete the pattern units, the indications are applied to the fabric in a relation which is shogged on successive revolutions of the machine. To give this shogging, the parts are built so that one revolution of the machine does not equal an exact number of revolutions of the pattern wheel. Thus, at the end of one revolution of the knitting machine the pattern wheel will have advanced or dropped back a number of pattern indications, e. g., dial slots. The number of pattern indications by which the pattern wheel advances or retards relatively to the circle of knitting elements in one revolution of the machine should divide evenly into the total number of knitting elements. Unless this is true, the pattern design will not come back to its starting point in the fabric at desired intervals. In the trade the knitted design is considered as divided into areas, pattern units or "fields." Where I speak of "pattern unit," I refer to that portion of the fabric design which is one field wide and includes enough weft knit courses to complete one repeat of the design in that field. Each knitted course in such a pattern unit may be termed a "field course." The pattern wheel customarily progresses one or more fields forward or back with relation to the knitting elements for each revolution of the knitting machine. The number of knitting elements by which the wheel progresses each revolution of the knitting machine equals or is a multiple of the number of elements in one field or pattern unit.

This progression places the pattern indications of each course of each field of the design successively as part of adjacent knitted units of the design. Thus, if a disc revolves about four times to each revolution of the knitting machine, only one-fourth as many pattern indications are needed to produce a pattern around the fabric, and that reduced number of indications can repeat itself down the fabric an indefinite number of times.

However, the progressive system of patterning has the great disadvantage that the progression causes production of a slanting, spiral or diagonal arrangement of the pattern unit in the fabric. It is true, as shown in the prior art illustration of Fig. 5, that with certain arithmetic arrangements of the fields, feeds and pattern stations, it is possible to produce a slanting or staggered design which has certain horizontal effects in it. Even this does not completely eliminate the slanting effect; nor does it add to the patterning possibilities of the machine.

I have invented a progressive system in which

the diagonal or slanting effect is completely overcome while maintaining the advantages of the progressive system over the complete design drum systems above mentioned, or a jacquard.

The special stitch which will be used to illustrate my invention is the so-called "eyelet" balbriggan stitch made by transferring sinker wale loops to adjacent needles, as shown in the patent to Robert W. Scott, No. 846,430, dated March 5, 1907. These eyelets may be one or two course eyelets according to whether the transfer jacks are held out to receive yarn at one or two feeds. It will be obvious that the invention may also be used for other kinds of jacks or stitches, such, for example, as those shown in the Robert W. Scott Patent No. 834,763, dated October 30, 1903, or the Scott Patent No. 846,428, dated March 5, 1907. The invention can equally well be used to select needle control jacks or needles having butts designed to be moved away from the selecting wheels.

I will now describe such parts of the well-known Scott & Williams knitting machine suitable for this eyelet work as are necessary to an understanding of my invention. The machine has the usual revolving cam ring 61 containing a multiplicity of knitting cams 62. Associated in fixed relation with the stationary needle cylinder is a dial 63. There is a revolving dial cap 64 mounted above the dial carrying the pattern means of my invention.

As shown in Fig. 3, there is a ring 65 mounted on the dial at its periphery, having radial slots 66 in which are slidably mounted transfer jacks 7. Each jack is composed of two complemental parts—one having a left crimp and the other a right crimp, jointly forming an eye, as shown in the above-mentioned Scott Patent No. 846,430. In view of the fact that the stitch produced in the pattern example being described calls for a lateral transfer of the sinker wales of the stitches to adjacent needles, there is one transfer slot 66 in the dial for each two slots for the needles 8 in the needle cylinder. On the inner periphery of the ring 65 are small blades 9 mounted in a radial direction to serve as teeth and form an internal gear whose use will be hereinafter described.

There are one or more mounting brackets 10 screwed to the dial cap 64 and each projecting downwardly through an opening 11 in the cap to a position opposite the ring 65. Journalled in the lower end of each bracket 10 is a vertical shaft 12 forming part of one of my novel wheels. On the lower end of this shaft 12 is tightly fixed a horizontal gear wheel 13 adapted to mesh with the internal gear formed by the blades 9. Forming part of the vertical shaft 12 is a horizontal flange 14 lying on the upper face of the lower end of the bracket 10. This supports a registry or locating pin 15 at a position off center from the vertical shaft 12. I provide novel pattern discs 16 adapted to be mounted on the vertical shaft 12 as a common axis to keep the discs in axial registry with each other. The registry or locating pin 15 serves to locate the pattern discs angularly around the vertical shaft in proper spaced relation in the novel manner which will hereinafter be described. To clamp the plurality of novel discs together I provide a knurled nut 17 which screws on the upper end of the vertical shaft 12. By screwing this nut down, it grips the plurality of discs between itself and the flange 14 of the vertical shaft 12. The dial cap revolves, but the dial itself is stationary. Rotation of the discs thus mounted is caused by relative rotation between the dial cap and dial due to the blades 9 rotating the vertical shaft 12.

In Figs. 4 and 5 I have illustrated the prior art constructions. In Fig. 4 is shown a pattern which has been obtainable heretofore by using a single disc selecting wheel of the prior art in a single feed knitting machine. One complete unit of the pattern is shown at the bottom of the large oblong in Fig. 4 outlined by dash lines in the form of a square, marked with the reference character 18. It is six pattern courses in height and six pattern jacks in width. The outlined oblong shows the total length of the fields on the wheel. In this figure of the drawings the pattern wheel has thirty-six projections on it to operate the pattern jacks, these being spaced in exact registry with the consecutive jacks. The layout of the pattern indications on the disc of the wheel is shown on the entire bottom row 19. Each square horizontally represents a jack. This layout is divided into six fields, each corresponding to six transfer jacks. If the pattern were being made by stitches which had transfer jacks the same in number as the needles, then each field would correspond in width to six needles. It will be noted that the design occupies only the five left-hand jack spaces of the first field course of the bottom row 19 of the layout in this figure. However, the blank column 20, as well as the blank row 21 at the top of the pattern unit, must be considered as part of the pattern, being required to space the unit from the neighboring pattern units. The spiral or diagonal effect caused by the progressive nature of the system is as follows. Since the design is six jacks in width and the wheel's circumference covers thirty-six jacks, the jack-carrying dial of the machine has a total number of slots equal to thirty-six multiplied by a suitable number, say, for example, 10, with six jack slots added. This gives a total of three hundred sixty-six slots in the dial. The six extra slots mentioned could have been subtracted if preferred, this affecting only whether the diagonal effect will be a right-hand or a left-hand spiral.

During one revolution of the machine, the pattern wheel in such a setup with six slots added will rotate $10\frac{1}{16}$ times, so that on the second revolution of the machine the projections or indications shown in field 2 will register in the fabric on the wales controlled on the previous revolution by the indications of field 1. On the third revolution the jacks of field 3 will register in the fabric above field 2 of the second revolution, and so on until the design is completed at the end of the sixth revolution. Field 3 will form the third step and so on until an exact horizontal repeat occurs, at which time field 1 will follow field 6. Thus the diagonal effect shown in the large oblong of Fig. 4 will have been formed. It will be seen that it takes six courses to complete each unit of the pattern. In the graphs shown in the drawings the hollow squares represent those projections or indications on the pattern wheel which have been removed, and the black squares represent the locations where the projections have been left on and the transfer jacks will be projected.

In Fig. 5 I have shown a diagram of the arrangement of a progressive pattern of the prior art in which the design shown is a slanted or spiral design produced on a machine having three knitting feeds and a pattern wheel at each of the three feeds. In this case one complete pattern unit is the width of six transfer jacks, and the height of six pattern courses. Each wheel has a

single disc with twelve projections on it corresponding to twelve jacks of fields 1 and 2. It will be seen that in this particular case it takes only two revolutions of the needle cylinder to complete the pattern in the fabric instead of six as in the case of Fig. 4. The full row of pattern indications on the disc at the first feed is marked with the reference character 19'. Each field course or line of indications in the pattern of Fig. 5 is laid out to follow the field course below it and the three successive wheels each begins on a different field course in order that the fabric as it comes around to the three feeds may get successive field courses of the complete original pattern applied in direct rotation. Thus, as shown in Fig. 5, the first feed produces the bottom field course on the first revolution of the needle cylinder, while the second feed produces the second field course, and the third feed the third field course. Meanwhile, of course, the pattern wheel at the first feed has knit the fourth field course from the bottom of the adjacent design unit in the fabric, the second feed pattern wheel has knit the fifth field course, and the third feed pattern wheel has knit the blank field course for the top of the design. This blank field course is to produce space between the individual pattern unit and its neighbors above and below it in the knitted fabric, as in the case of Fig. 4. On the second revolution of the machine the pattern wheels will have been shogged the equivalent of one field and the pattern indications of the second field course on the discs will be reproduced in the first design unit in the fabric to complete the upper half of that first design unit in the fabric.

It will be seen that the three feeds of this machine and pattern produce sufficient slant or spiral in the pattern to cause every design to be in horizontal alignment with a similar design in the second column from it. In a sense the design can be considered partly symmetrical, having both horizontal and slant effects.

It will be noted that machines employing the progressive patterning system heretofore known can be considered as having a species of horizontal selectivity. According to my invention I provide variations in the design set up by the progressive circumferential position of the indications on the wheel, by adding vertical selectivity to the existing horizontal selectivity. The permutations in pattern obtainable in this way avoid the complexity and number of parts of the systems which have to lay out the entire pattern exactly as it appears in the fabric. I obtain a much greater range of patterning than the ordinary progressive machine with a much smaller number of parts and selections than the fully laid-out pattern systems. To obtain these variations or permutations I provide a plurality of pattern discs on a common axis in each pattern wheel and butts on the knitting elements at different levels to cooperate therewith. Preferably this selectivity is used in timed relation with the fields into which the indications on each disc are divided.

In Fig. 6 my invention is shown embodied in a machine adapted to give one selection of knitting elements in one unit of the knitted fabric design and the combination of that selection with another selection in a second unit of the knitted design. It will be seen that this "one way" selectivity gives an increase in pattern possibilities and also makes it possible to have a design which is two fields wide. The design is produced by the use of one double disc wheel on a single feed knitting machine. The number of slots in the dial as well as the slant or diagonal effect of the resulting pattern are the same as in Fig. 4. As shown at the top of the figure, there are low butt jacks 22 and high butt jacks 23. In this particular illustration the jacks in the field designated in Fig. 6 of the drawings as field 1 are low butt jacks, and the jacks in field 2 are high butt jacks. This alternation continues throughout the six fields of the pattern wheel here illustrated. In the layout of the indications on the wheel at the bottom of the figure, the pattern indications on the lower disc are shown by circles, and the pattern indications of the upper disc are shown by x's. Since the butts on the jacks are at right angles to the indications on the discs, it will be seen that the high butt jacks 23 are actuated by pattern indications on either or both discs, while the low butt jacks 22 are selected only by the lower disc. It will be noted that the lower disc produces a diamond-shaped design, while the combination of the upper and lower discs produces an octagonal pattern unit. To assist in illustrating some of the novel effects obtainable by my invention, I call attention to the fact that the pattern indications of the lower disc in Fig. 6 produce the same pattern unit as the pattern disc in Figs. 4 and 5.

Fig. 7 is a view of a somewhat similar arrangement, but one in which different design units can be obtained in three successive fields by having the first field selected from one disc, the second field selected from the other disc, and the third field from a combination of the two discs. This gives "two way" selectivity at a single selecting station. In this case the design shown is three fields wide. It will be seen that the total design in Fig. 7 is more elaborate than the one in Fig. 6.

It is possible to obtain two way selectivity by using jacks having horizontal butts, i. e., butts which are parallel to the pattern indications on the disc. Thus, in this particular case by the use of frangible butts I have low butt jacks 24, high butt jacks 25 and double butt jacks 26. In this figure of the drawings the pattern units produced in the second, third and fourth columns of the design shown in the main oblong have been designated by brackets marked "H," "J" and "K." There is only one double disc pattern wheel required to make this design on a single feed machine. The lower disc is cut to produce the solid diamond pattern unit composed of the circles found under the brackets H and K, since the lower disc pattern indications register only with jacks having low butts 24. The upper disc controls the high butt jacks 25 and these jacks are used to produce the hollow square pattern unit shown by the x's appearing under brackets J and K. The upper disc as well as the lower disc actuates the double butt jacks 26. It will be seen that the pattern unit appearing under bracket K is a composite of pattern units H and J resulting from jacks 26 having both high and low butts. This, in effect, superposes the hollow square pattern unit of bracket J on the solid diamond pattern unit of bracket H to form the solid square pattern unit of bracket K. It will be noted that the double butt jacks 26 are actually operated by the indications on both the upper and lower discs where the x's appear over the circles in the drawing.

Another and preferred form of embodiment of my invention is shown in Fig. 8. This machine has three feeds for each selecting station. If the machine were producing two course eyelets it would have nine knitting feeds and three pattern

selecting stations. The pattern wheels drop back at each revolution of the machine, as before. Each pattern wheel has three superposed discs. The indications of the different discs are selected in a direction which progresses in the machine in a diagonal direction opposite to that of the normal walewise progression, whereby horizontal symmetrical effects are obtained in the knitted design. The complete elimination of slanting arrangements of units of the pattern in the finished fabric is one of the valuable capabilities of my machine. My invention completely eliminates such reproductions of the pattern units as normally appear in an unsymmetrical, i. e., slanting relation, in the finished fabric. In the case of a horizontally symmetrical pattern, the operating butts are successively opposite different superposed discs.

The pattern shown in Fig. 8 is produced by using three levels of frangible butts. The particular pattern illustrated is made without using two selecting butts on any of the jacks, but it will be obvious that different combinations of butts can be worked out, if desired, by adding jacks having butts in the first and second positions, in the second and third, and in the first and third positions. The bottom butts **55** shown in Figs. 7 and 8 relate to a nullifying cam which will be discussed later, and in the following discussion only the three regular selecting butts are referred to. As shown in Fig. 8, only three variations of jack selecting butts are employed, namely, the jacks **27** with butts opposite the lowermost or No. 1 disc, jacks **28** with butts opposite the middle or No. 2 disc, and jacks **29** with butts opposite the top or No. 3 disc. As in the case of Fig. 7, this Fig. 8 includes not only the showing of the jack butts, the oblong of the pattern design in the fabric and the layout of the pattern indications on the pattern wheels, but also the layout of the pattern indications on the discs for three field units of the design, namely, under the brackets L, M and N. The layout of the pattern indications on the pattern wheel is different in one important respect from that occurring in Figs. 6 and 7.

In the particular system shown in Fig. 8, each disc has eighteen frangible projections around its periphery, spaced to register with the transfer jacks, as heretofore. A disc drops back six jacks, i. e., one field, each revolution of the knitting machine, as in the previous case, and there are three hundred sixty-six jacks or jack slots in the dial of the machine. I prefer to leave the last six jacks out of their slots in the machine. It will therefore be seen that it takes twenty and one-third revolutions of the pattern wheel to equal each revolution of the dial.

As in the previous embodiments of my invention, the pattern layout at the bottom of the figure is based on having each space or square horizontally representing a transfer jack and each square vertically representing a weft course in the knitted fabric. However, in distinction to Figs. 6 and 7, the machine now has three pattern wheels and, in distinction to the prior art, the pattern indications available are operated in a vertically selective manner. This, of course, was impossible in the prior art, and in Figs. 6 and 7 either the upper or lower discs or both were used at each field of the pattern, as the exigencies of the pattern required. In this particular pattern, however, certain of the discs are entirely eliminated from action at each field of the pattern, as one of the necessary steps in producing a horizontally symmetrical pattern. The combination of vertical selectivity with horizontal selectivity in a progressive pattern system can, of course, be employed for other purposes, if desired. However, the arrangement of the order of active discs in the successive fields in a direction counter to the direction of progression of the fields on the fabric, taken in connection with the elimination of the reproduction of the pattern indications on the remaining discs on each wheel in each field, makes it possible by an adjusted placement of the indications to overcome all diagonal effects.

In Fig. 8 I have shown the finished pattern design and two vertical repeats of such of the pattern indications on the pattern wheels as are used to make the design. As already mentioned, the progressive nature of the pattern system is taken advantage of to give a progressive vertical selection by fields at each wheel from disc to disc. Thus, in the particular pattern design here shown, the portion of the pattern under any particular bracket L, M, N, O, P or Q is produced by using the normal horizontal progression to change the disc whose pattern indications are used to produce this particular pattern unit. Since the machine is a three feed pattern selecting machine, such a change occurs every three courses, and since it takes nine pattern courses to complete the pattern, it will be seen that a field of each of three discs at each of three selecting stations is used to produce each complete vertical repeat of the pattern covered by the dash outline under brackets L, M and N.

In Fig. 8 I have shown the fabric, the jack butts and the pattern indications resulting from all three levels of selection. In Figs. 9, 10 and 11 I have shown only the single field unit of the knitted design produced at one level of selection and the selecting means producing it. In Fig. 9 it is the three No. 1 discs at the three pattern wheels and the production of the knitted design unit under the bracket L in Fig. 8. In Fig. 10 it is the three No. 2 discs and the knitted design unit under the bracket M. Fig. 11 is the third field of the knitted design as shown under the bracket N, and the No. 3 discs etc. which produce it. It will be obvious from Figs. 9, 10 and 11 that only at every third field does any particular pattern unit appear in the fabric. By eliminating the reproductions of the pattern units which are staggered with relation to the first reproduction of the pattern unit in the fabric, i. e., by not using the second and third feeds at any one level and coordinating this properly with analogous arrangements at the second and third feeds, with proper allowance for the angular advancement and choice of initial pattern unit, I have found that the diagonal effect can be completely eliminated.

I will now set forth the coordination of fields and pattern indications of the various discs necessary to make the pattern unit under bracket L, and then the first repeat of that pattern unit in the knitted fabric under the bracket O. It should be noted that the pattern units under brackets L, M and N in Fig. 8 are different, so that in effect the basic pattern or design is three fields in width. Each pattern wheel carries one disc for each third of the pattern. These discs are superposed on each other on a common axis so that each wheel has a set of discs which between them cover the entire pattern of the three brackets. The patterns under brackets O, P and Q are repetitious of those under L, M and N.

The pattern jacks are arranged in this particular case so that the height of butt is changed with each field. It should be remembered that in view of the progressive nature of the pattern system, the butts opposite each field therefore change each three courses, i. e., each revolution of the knitting machine. The showings should be read from bottom to top.

In describing Fig. 8, I have referred to pattern feeds and pattern courses. If there are an equal number of pattern wheels and knitting feeds in the machine, it will be obvious that the sentences could have referred equally well to knitting feeds and knitting courses. However, when making two course eyelets by lateral transfer of sinker wales, as previously referred to, it takes three knitting feeds to each pattern selection. Thus, a machine to have three two-course eyelet pattern feeds would have nine knitting selections. In the case of the pattern of Figs. 8, 9 10 and 11, to make such a pattern the change from the pattern unit of one field to the pattern unit of the next field would occur every nine knitted courses and it would take twenty-seven knitted courses to complete the design. In using the word "design" I have reference to one repeat of the pattern covered by the dash outline under brackets L, M and N. I will now describe the machine as making such fabric.

The bottom or No. 1 disc on each wheel is effective whenever a jack with a bottom butt comes into contact with it, the middle or No. 2 disc affects jack butts at the middle level, while the top or No. 3 disc controls only jacks with butts at the top level. In the drawings the six jacks in a field all have the same kind of butt. Thus, there are six jacks **27** with bottom butts, followed by six jacks **28** with middle butts, and then six jacks **29** with top butts, all as indicated in Fig. 8. We will follow the action of one pattern for one revolution. At the first pattern wheel, the six bottom butt jacks **27** come opposite the No. 1 disc, but there are no pattern projections or indications, so that blank field course **30** is made (Figs. 8 and 9). As the dial cap continues to turn about the center axis of the machine, it carries the first pattern wheel along and the wheel rotates because gear wheel **13** is in contact with the blades **9**. This brings the next six jacks **28** into contact with the pattern wheel. These jacks correspond to the next field and they have No. 2 butts. They affect the next six eyelet stitches formed in this same knitted course after the blank field course **30**. As can be seen from Fig. 8 or Fig. 10, this must produce two eyelet stitches, side by side, from the third and fourth jacks. This is the field course marked **50** in the second pattern unit under bracket M. As the first pattern wheel continues to revolve, it presents the third field on the discs. At this point the third group of six jacks, namely, jacks **29** with top butts, contact the No. 3 disc. This is field course **51** on Figs. 8 and 11. It is blank, so no eyelets are produced. This is under bracket N. The pattern discs at the first wheel have now made one revolution, covering eighteen consecutive jacks all in one pattern course. In the meantime, the pattern wheels at the second and third feeds have been turning too. They have been cooperating in the patterning of the next two pattern courses. When the second feed and its pattern wheel reached the six jacks where the blank field course **30** of the first pattern unit was selected by the first wheel, the same group of six bottom butt jacks **27** were selected and the field course **31** resulted from the No. 1 disc at that feed. When the third feed came around to the same group of six bottom butt jacks **27**, they came into register with the No. 1 disc at the third feed, and field course **32** resulted. It will be noted that up to this point only bottom butt jacks have been opposite the pattern unit of bracket L, middle butt jacks **28** opposite bracket M and top butt jacks **29** opposite bracket N. The first three courses of the three pattern units have been made and the dial cap has caused one revolution of each pattern wheel.

The machine goes on turning, making additional reproductions of the first three courses of the three pattern units L, M and N, until the first pattern wheel has made twenty complete revolutions and impressed its pattern indications on three hundred sixty jacks. It then brings the indications of the first field of the No. 1 disc at the first feed opposite the last six jack slots in the machine. These slots are preferably empty, in which case no pattern stitches are made. However, the wheels advance one field just the same. This brings the second field of the three No. 1 discs in register with the first six jacks in the machine as the second revolution of the machine begins. The fabric wales corresponding to these first six jacks on the dial were given the indications of the first fields **30, 31** and **32** of the No. 1 discs at the first, second and third feeds respectively on the first revolution of the machine. The second and third fields on this disc were not effective on the first revolution of the machine. Now the first pattern wheel has dropped back one field with relation to the fabric in the machine. As they come around in their turn to the second revolution of the machine, the second and third pattern wheels have also dropped back. All the fields on the discs which on the first revolution of the machine were opposite the second pattern unit in the fabric are now opposite the first pattern unit. Similarly, those fields which were opposite the third pattern unit are now opposite the second, and those fields which were opposite the first pattern unit are now opposite the third.

The jacks opposite the pattern units in the fabric are unchanged, so they select from the discs in the same order that they did on the first revolution of the machine. The number of fields on each disc being equal to the number of levels of butts on the jacks, the beginning of the second revolution of the machine finds the bottommost butt jacks **27** reading the fourth field course **34** on the bottom disc at the first feed. This fourth field course of pattern unit bracket L is actually the second field on the disc (see Fig. 9). This field course **34** comes directly above field course **32** in the fabric. At the second and third feeds the same wales have the pattern indications of field courses **35** and **36** applied. On the third revolution of the machine, these wales of the fabric receive field courses **37, 38** and **39**. This completes the pattern unit under bracket L in Figs. 8 and 9. In the meantime, the three pattern wheels complete the pattern units under brackets M and N. Thus, the first reproduction of the three field designs is completed. The machine goes on to complete the other reproductions of the design around the fabric and then makes additional reproductions as more fabric is knit.

The first pattern indication field course of second and third pattern unit brackets M and N must be angularly offset one field and two, respectively, compared to the pattern indication

field courses for the first third of the pattern. This offsetting of the No. 2 and 3 discs can be seen in Figs. 10 and 11. It is possible to do this because of the use of a plurality of independent discs mounted on a common axis at each of a plurality of pattern stations. In other words, the middle or No. 2 disc of each wheel must begin its design six jacks beyond the bottom disc of Fig. 9, while the top or No. 3 disc for producing the third pattern unit under bracket N of Fig. 8 must begin its design six jacks beyond that of Fig. 10 and twelve jacks beyond that of Fig. 9. Since the discs illustrated have eighteen projections and I have chosen to have the jacks begin to produce the design under bracket L at a locating pin 15, the pattern indications to produce the pattern unit after bracket M begins 120° from the locating pin. The design under bracket N begins 240° from that same pin.

It would be quite confusing in preparing pattern wheels if in addition to all the other locating problems this angular allowance had to be considered. I therefore propose to use three equally spaced locating holes in each disc. In this way after the pattern indications have been prepared on the discs they may be stepped around at the time of assembly into a pattern wheel. The simplest way is to stamp a letter or identifying symbol opposite the locating hole to be placed on the pin 15, these symbols or registry indications therefore being placed at successively different holes on discs of different number. The operator then can begin placing his fields on the disc at the marked hole and know that the fields will be angularly allowed for in the proper manner. To assemble a wheel, the lower disc for the first feed is placed on the pin to align with the low butts of jacks 27 and a middle disc cut for the pattern under bracket M is placed on it to align with the middle butts of jacks 28 and a top disc cut for the part of the pattern under bracket N is placed on top to align with the high butts of jacks 29. The procedure is repeated in assembling the wheel for the second feed, using discs prepared as shown at the bottom of Fig. 3 as No. 1, No. 2 and No. 3 discs, marked "1st rev. 2nd feed." The third wheel is made from discs No. 1, No. 2 and No. 3, marked "1st rev. 3rd feed." It will be seen that it takes three disc fields vertically to produce one field course each revolution of the wheel. Thus, only one of the three discs on each pattern wheel is operating at a time, although all three are rotating.

The discs whose layouts are illustrated control jacks for the arrangement of quite simple designs which are only six jacks in width and involve only three pattern fields. In actual practice the discs usually would control jacks making designs having a minimum of twelve jacks in width for each field and the discs would be of sufficient circumference to pass at least four such groups before repeating horizontally. Such discs might have forty-eight projections and operate at four pattern fields, while the jacks would have four frangible butts.

Turning now to the production of eyelets on the machine shown in Figs. 1 and 2, a pattern wheel 40 is located just ahead of the first knitting feed 41 to project jacks wherever eyelets are desired, and the pattern indications on one of the discs will push any selected jack out as shown in Fig. 3, ahead of this first feed 41. The needles on either side of the jack draw a length of yarn over the jack and knit. The jack remains out and as it passes the second wheel position 42 at the second feed 43, a second length of yarn is drawn over it and the needles knit at the second feed. As the jack approaches the third feed 44, the jack is moved further out by a transfer cam 45, the needle hooks are moved up through the eyes of the jacks, the jacks are retracted by cam surface 46 and the sinker loops on them are thus cast off onto the needles at the third feed. This produces a two course eyelet. Only one pattern wheel is required to make a given kind of eyelet. If a single course eyelet is required, wheel 40 is placed in position 42 just prior to feed 43 where the operation of drawing yarn over the jacks occurs as described at feed 41 and before the next feed the jacks are pushed further out so that the eyes of the jacks are over the heads of the needles. The needles rise, the jacks retire and the loops are transferred onto the needles at the feed following the one where the loop was laid on the jacks. For a two course eyelet the jacks are selected a feed earlier and remain out far enough to catch loops at two courses.

When pattern wheels are used at more than one selection point the wheels are timed in the following manner. The locating holes are to be timed with relation to each other. A pattern disc 16 is placed on the vertical shaft 12 of the pattern wheel at the first selecting station in such manner that the proper locating hole is on the registry pin 15. The disc is then clamped on the shaft by the nut 17. The mounting bracket 10 is then loosened from the dial cap 64 by removing the screw 47, retracting the bracket slightly till the gear wheel 13 is out of mesh with the blades 9 on the ring 65. The wheel is then turned until the frangible pattern indication 19 directly in front of the locating hole is in position to move a jack. The bracket is then moved back till gear 13 meshes with the blades 9 and is secured in position by putting in screw 47. The jack aligned with the projection in front of the locating hole is then marked for identification and the machine turned till the wheel at the next selecting station is opposite the marked jack. This second wheel is turned to register with the marked jack, as described at the first selecting station. The machine is then turned till the marked jack is opposite the wheel at the third station and that wheel loosened, reset and tightened as before. Once all the wheels have thus been timed, the discs can be changed any number of times without having to reset the wheels.

In order to eliminate the diagonal effect it is essential that the number of knitted pattern units, i. e., the number of different pattern fields on a disc, be equal to the number of discs on a wheel. Any repetitions of the series of different pattern fields on a disc of course are not considered in this statement. In the embodiment of Figs. 8, 9, 10 and 11 the number of pattern units or fields, and the number of pattern wheels, are equal. It is not essential for elimination of the diagonal effect that the number of wheels equal the number of pattern units. Therefore, in Fig. 12 I have shown an embodiment illustrating how my invention can be used to produce a three field progressive pattern by means of two pattern feeds. In this embodiment each field contains six jacks and the machine completes a set of pattern units in three revolutions of the machine. The jacks 27', 28', 29' are, respectively, for the No. 1, 2 and 3 discs. The jacks are shown without any special butt 55 for nullifying cams as are

hereinafter described in connection with Fig. 8. The layout at the bottom of the figure shows, in the first square 52, the design unit of the first field; in the double blank 53, the reproductions of the first field which are omitted owing to the levels of the butts on the jacks 29' and 29''; and in square 54, the adjacent horizontal repeat of the design unit of the first field.

It is also possible to produce spaced designs by means of my novel construction. It might be noted that these designs may or may not be symmetrical, i. e., they may or may not have any diagonal or spiral effects. A simple example will be explained in connection with the machine of Figs. 8, 9, 10 and 11 in which there are three pattern selecting stations in the machine and three discs on each wheel. The pattern shown under the bracket L in the fabric part of these diagrams can be produced alone, omitting the pattern units after brackets M and N. It is also possible to produce in horizontally and vertically spaced relation in the fabric, a spaced design covering three fields of the pattern. Described broadly, the method of producing such single large designs in spaced relation in the fabric is as follows.

If the design is of such a nature that some of the jacks will not be needed at any time, those jacks are first removed from the machine. Then pattern selections of the remaining jacks which are not needed at any particular pattern selecting station at any particular revolution of a pattern wheel are nullified by means hereinafter described. We are producing the special stitches of the assembled group of fields necessary to produce one complete design and to nullify all field selections of immediately adjacent designs. It will be obvious, owing both to the horizontal progression of the pattern and to my novel vertical progression, that the fields which must be used will be activated intermittently at each of the pattern selecting stations and will be chosen from various disc levels. I therefore provide nullifying cams 49 at each pattern selecting station. Since nullification will be needed only at moments when no disc is active at the pattern station where selections are being nullified, the butts on the jacks and the nullifying cams can be so arranged that the nullifying cam at any pattern selecting station is effective on all the jacks passing that station. Additional pattern selections would be obtainable if the height of the cam and the butts on the jacks were arranged to give additional selectivity.

As already pointed out, the selections in successive fields on any given disc prior to my invention would have been adjacent courses in adjacent reproductions of a given pattern unit. My multiple height of discs with multiplicity of butt levels on the jacks enables the production of one pattern unit in combination with the elimination of adjacent pattern units. It is normally unnecessary to use nullifying cams to produce separated reproductions of a single design unless the design is large enough to cover more than one field. I will therefore confine my description of this phase of my invention to the production of a single, large design which is three pattern units in width and which is to be spaced horizontally and vertically from other reproductions of the design in the fabric. As already described in connection with Figs. 8 to 11, when the pattern design is three units, i. e., three fields, in width, two of the three pattern field courses presented at the same time are in effect nullified by the absence of butts on the jacks opposite the pattern indications on the disc.

However, I can provide means to eliminate the third pattern selection, say every other time, in order that the complete design may be omitted every other time, therefore producing the design only in spaced relation to itself. The above-mentioned removal from the machine of the individual pattern jacks which at no time have any part in the production of a pattern stitch, and the use of the nullifying cams 49, achieve this object of preventing recurrent reproductions of the complete design in the fabric.

As shown in Fig. 1, there is a jack projecting cam 48 just ahead of the first wheel at each pattern selecting station. When moved out to its operating position, this cam is adapted to project all jacks to take yarn, provided only that the jacks have butts at the level of the projecting cam. In addition, I provide a jack nullifying cam 49 associated with each pattern wheel. It will be noted that the butts on the pattern jack discs serve to project the jacks at the points marked "A" in Figs. 1 and 2. This point is located in the knitting cycle before the needles start to rise to take yarn. The nullifying cams are located at the points marked "B," at which time the needles are in their highest position just prior to drawing their stitch. It will therefore be seen that the nullifying cams cause withdrawal of jacks before they can take the yarn.

A single large design such as shown under the combined brackets L, M and N in Figure 8, may be readily produced by first removing all jacks 27, 28 and 29, except those in the proper location as illustrated, which would prevent any horizontal repeat. Next, the nullifying cams 49 corresponding to each selecting wheel may be rendered active to erase any selections made by the various rotating discs and thus no pattern would be produced. When the design was desired, nullifying cams 49 would be moved out of action and the wheels would begin producing the pattern. Upon its completion the nullifying cams would again become active and the resultant plain fabric continued as desired. It will be seen that designs may be separated horizontally, vertically, or both, by the proper spacing of jacks combined with the use of nullifying cams over desired numbers of courses. If the vertical separation is to extend for a lesser number of courses than the total number produced in one revolution of the machine, then only certain of the nullifying cams would be brought into action.

In describing this one single large design patterning system of my machine, I have assumed that the design consists of eyelets on a background of plain fabric. It is possible to reverse this setup, as above mentioned, and to have the design of plain stitches and the background of eyelets. In this case it is necessary to cut the discs, i. e., break butts on the discs in such a manner that the butts are broken off and the jack is not projected where the design is to appear. Where the design is not to appear, the butts should be left on in order that the jacks may be projected. In the case of the single large design system, this reversal of the design stitches would necessitate the following additional alterations in the manipulation of the machine. All the jacks would be left in the machine and would have to have special butts 55 (see Fig. 8) at the level of the projecting cams 48 in order that eyelet stitches may be made in all

wales before and after the design. When the design begins, the projecting cams would be retracted and the discs would control the projection of the jacks. One of the discs would be a solid one not considered a selecting disc and there would be butts at the level of this disc on all jacks except those in any one of the three fields adapted to produce the design unit shown under brackets L, M and N in the fabric portion of Fig. 8. When the design is completed, the projecting cams are again rendered active so that eyelets are made over the entire fabric. The result is that one or more symmetrical designs are made, the height of nine pattern courses and the width of eighteen consecutive jacks, without individual or relative slant, surrounded by fabric of eyelets.

It will be seen that by my invention patterns which are more elaborate as well as those without the usual slant can be produced.

I claim:

1. A circular knitting machine having a circle of independent knitting elements, a member carrying same, a plurality of feeds, and a plurality of relatively rotatable pattern wheels rotating at the same linear speed as the circle of elements and adapted to give individual elements differentiated pattern manipulation, each wheel having a plurality of superposed discs and each disc having peripheral pattern indications; the number of knitting elements in the circle being more or less than an even multiple of the number of pattern indications on any disc by a number evenly divisible into the total number of knitting elements, thereby making the pattern wheels progressive; in combination with the division of the indications for the pattern into units, there being a disc in each wheel for each different pattern unit, the indications for each unit being divided among the various wheels, and there being butts on the knitting elements adapted with the pattern indications to select only horizontally symmetrical pattern indications.

2. A circular knitting machine according to claim 1 in which operating butts are provided at different levels on the knitting elements in the member carrying same, so positioned that each level of butt contacts the pattern indications on the periphery of a different one of the superposed discs, whereby the horizontal selectivity of the progressive pattern system has combined with it vertical selectivity of fields.

3. A circular knitting machine having a circle of independent knitting elements, a member carrying same, and a plurality of relatively rotatable pattern wheels located about the circle adapted to select individual knitting elements therefrom, each wheel comprising a plurality of superposed discs on a common axis, the number of knitting elements in the circle being more or less than an even multiple of the number of pattern indications on a disc by a number which divides evenly into the number of knitting elements in the circle, whereby the pattern system is progressive; in combination with operating butts on the knitting elements, the butts being positioned to engage indications on a different disc from the adjacent butts in groups equal in number to the aforesaid divisor or a factor thereof, whereby selections from knitting elements equal in number to said divisor or a factor thereof are made periodically on different discs at each wheel to make a combined horizontally symmetrical pattern.

4. A circular knitting machine having a circle of independent knitting elements, a member carrying same, a plurality of knitting feeds and a relatively rotatable pattern wheel associated with each of a plurality of said feeds, the pattern wheels being adapted to be driven by the machine to give a progressive pattern design, each of said wheels being composed of a plurality of superposed discs mounted on a common axis and each having peripheral pattern indications, the periphery of each disc being divided equally into fields composed of a uniform number of indications, the number of superposed discs on each wheel and the number of operating butts on the knitting elements in a field being equal, the indications for the successive field courses being divided among the discs at the same level on the different wheels in rotation, and field course indications located one above the other on the superposed discs being for adjacent stitches in the design, in combination with operating butts on the knitting elements at the levels of the different discs, the operating butts for successive fields being successively opposite different superposed discs on successive revolutions of the machine in a vertical order which progresses in the machine in a diagonal direction opposite to that of the normal walewise progression, whereby only horizontally symmetrical effects are obtained in the knitted design.

5. A circular knitting machine having a circle of independent knitting elements, a member carrying same, a plurality of relatively rotatable knitting feeds and a plurality of pattern selecting stations associated therewith containing pattern wheels adapted to produce a pattern having units, each wheel being composed of a plurality of superposed discs on a common axis, each discs having peripheral pattern indications of only one pattern unit and different from the units of the other discs in that wheel, in combination with varied levels of operating butts on the knitting elements, the wheels operating progressively with relation to the circle of knitting elements, and the differentiations in the butt levels of the knitting elements being adapted to vary the discs with which the indications register, whereby only repeats of design units horizontal with relation to each other are selected.

6. In a method of operating a circular knitting machine having independent knitting elements with varied operating butts and a progressive pattern means in which there is a plurality of pattern wheels each consisting of a plurality of superposed selecting discs with peripheral pattern indications divided into fields corresponding to units of the pattern; the steps of causing the selection of knitting elements for patterning by contacting the butts of the knitting elements with the pattern indications, and varying at every unit of the pattern the disc from which pattern indications are taken by the butts of the knitting elements, the number of selecting discs equalling the number of pattern units, whereby slant in the pattern design due to the progressiveness of the pattern means is eliminated.

7. In a method according to claim 6 on a machine in which the indications for the successive courses of each unit of the pattern are divided among discs at the same level on the successive wheels, the steps of rotating the pattern wheels at the same linear speed as the circle of knitting elements, causing the butts of the elements to engage the pattern indications of the discs in repeated vertical succession changing at each field, and on each successive revolution of the machine causing the engagement of the pattern

indications by the butts to occur one or more fields ahead or back of the fields selected on the previous revolution in a direction opposite to that of the normal walewise progression; whereby the knitted pattern units are correctly completed and pattern units which would be in unsymmetrical position in the knitted fabric are not selected.

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