March 19, 1940. A. H. ADAMS 2,194,271

TEXTILE FABRIC

Original Filed Aug. 16, 1934 5 Sheets-Sheet 1

Fig. 1.

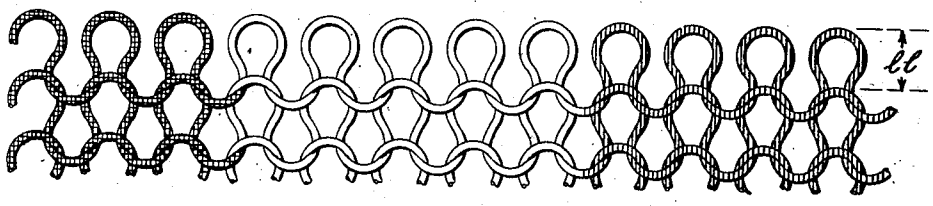


Fig. 2.

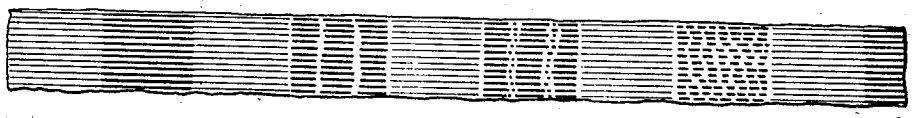


Fig. 3.

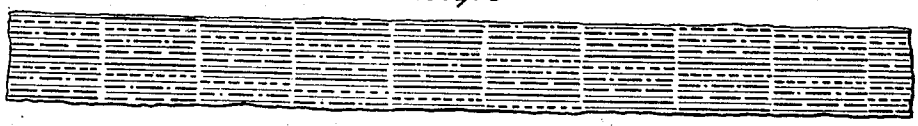


Fig. 4.

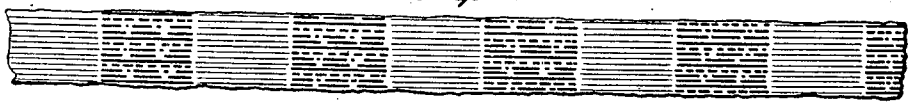
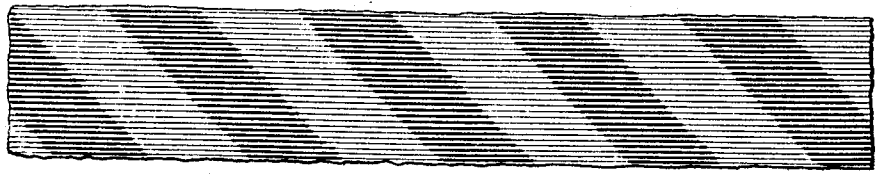


Fig. 5.



Fig. 6.



Inventor

Arthur H. Adams

Attorney

March 19, 1940. A. H. ADAMS 2,194,271

TEXTILE FABRIC

Original Filed Aug. 16, 1934 5 Sheets-Sheet 2

Fig. 7.

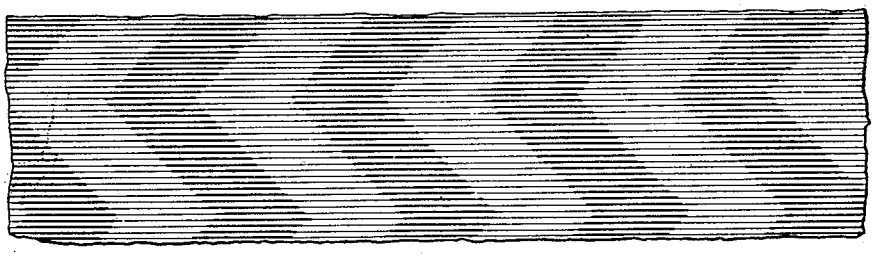


Fig. 8.

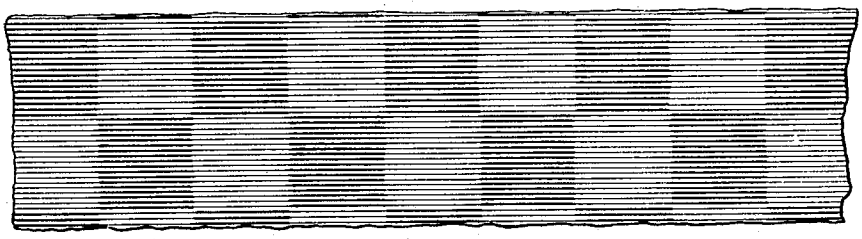


Fig. 9.

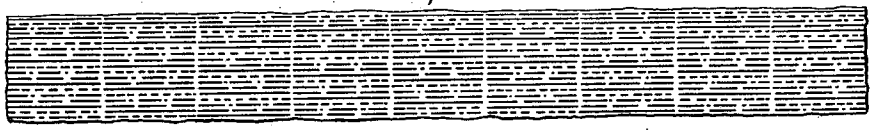


Fig. 10.

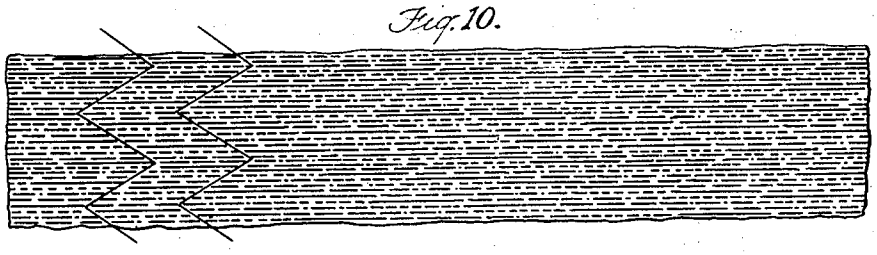




Fig. 11.



Fig. 12.



Fig. 13.

Inventor
Arthur H. Adams

Attorney

March 19, 1940. A. H. ADAMS 2,194,271

TEXTILE FABRIC

Original Filed Aug. 16, 1934 5 Sheets-Sheet 3

Fig. 14.

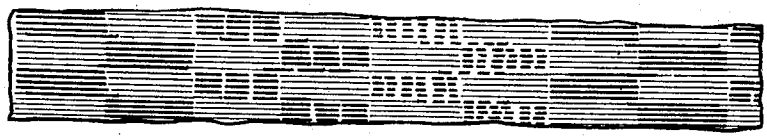


Fig. 15.

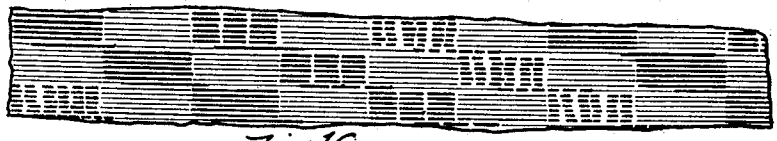


Fig. 16.

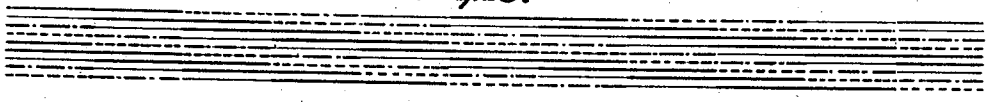


Fig. 17.

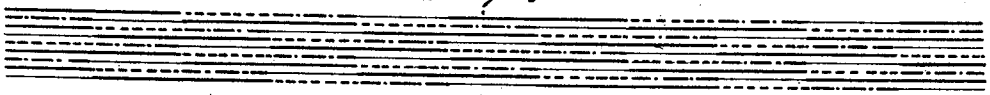


Fig. 18.

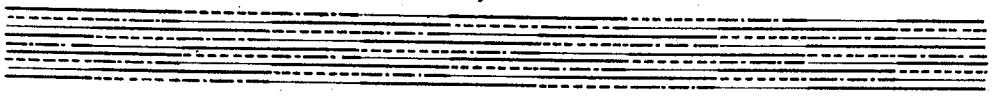


Fig. 19.

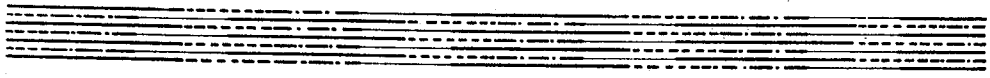


Fig. 20.

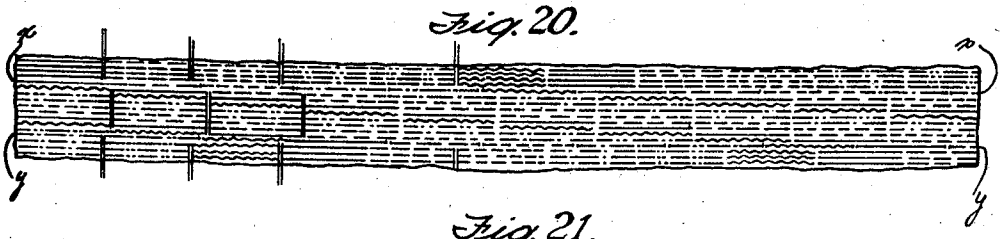
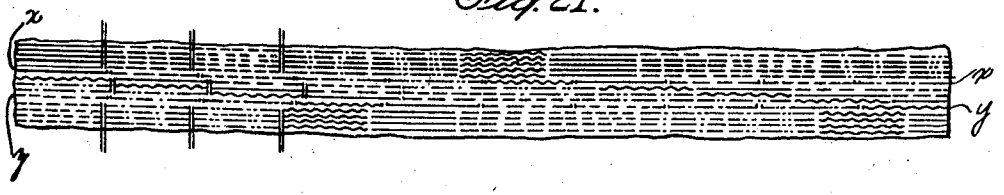


Fig. 21.



Inventor
Arthur H. Adams

Attorney

March 19, 1940. A. H. ADAMS 2,194,271

TEXTILE FABRIC

Original Filed Aug. 16, 1934 5 Sheets-Sheet 4

Fig. 22.

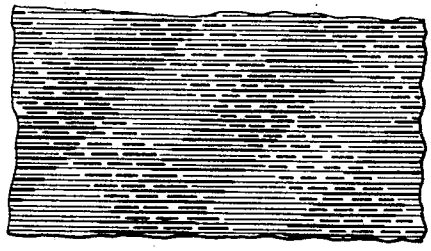


Fig. 23.



Fig. 24.

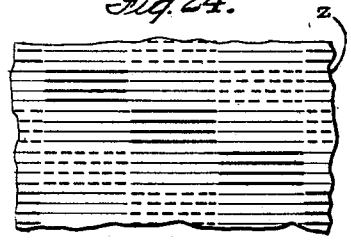




Fig. 25.

Fig. 26.

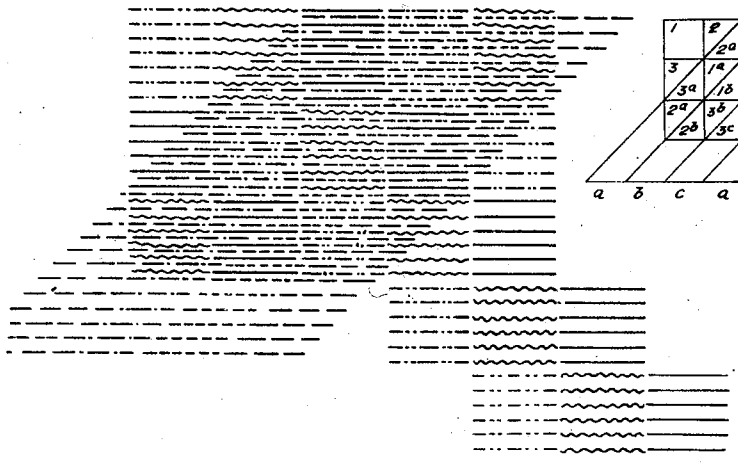
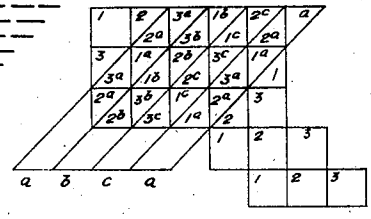


Fig. 27.



Inventor

Arthur H. Adams

Attorney

March 19, 1940. A. H. ADAMS 2,194,271

TEXTILE FABRIC

Original Filed Aug. 16, 1934 5 Sheets-Sheet 5

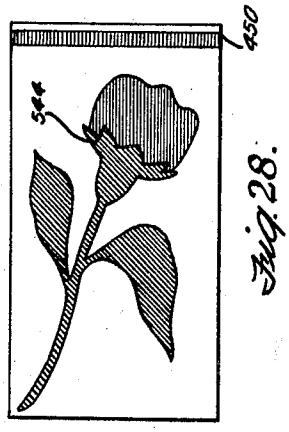


Fig. 28.

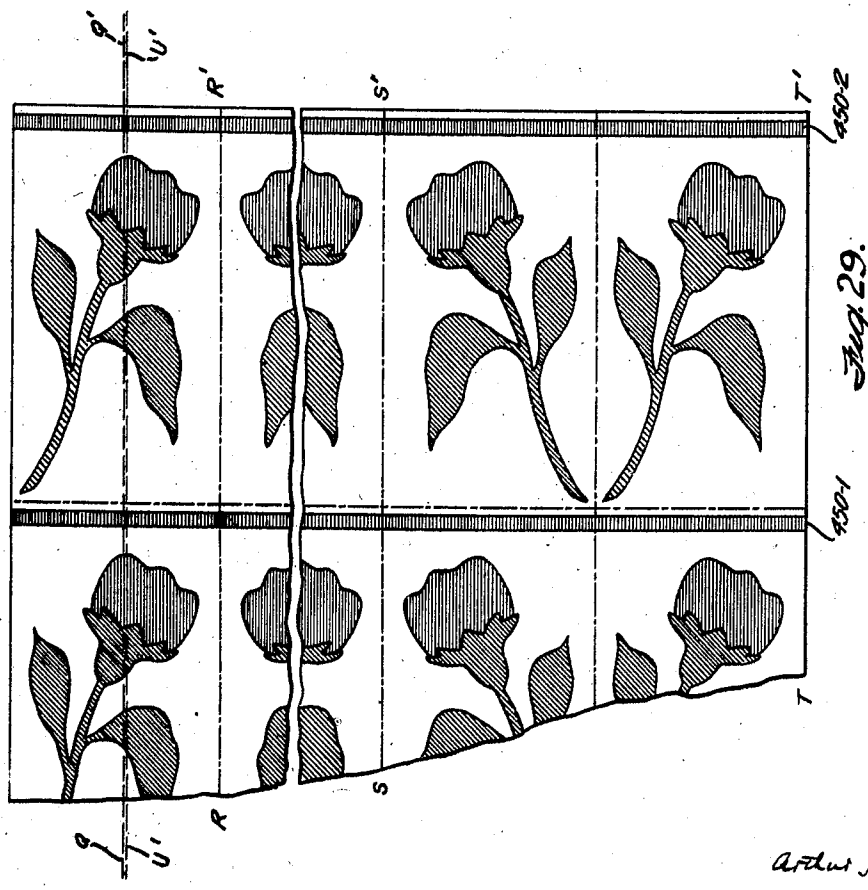


Fig. 29.

Inventor
Arthur H. Adams

Attorney

Patented Mar. 19, 1940 2,194,271

UNITED STATES PATENT OFFICE

2,194,271

TEXTILE FABRIC

Arthur H. Adams, Yonkers, N. Y.; Edith R. Adams, executrix of said Arthur H. Adams, deceased, assignor to Herman Epstein, Newark, N. J.

Original application August 16, 1934, Serial No. 740,075. Divided and this application May 13, 1935, Serial No. 21,156

1 Claim. (Cl. 66—169)

This invention relates to new and useful improvements in the ornamentation of fabrics produced from polychrome yarns by knitting or other well known methods of the textile art.

The present case is a division of my application Serial No. 740,075, filed August 16, 1934.

By a polychrome yarn is here meant a filament having sequentially in its length a plurality of differently colored stretches. The linear pattern may be repeated very frequently or in comparatively short lengths, or the pattern may be very long, such as to form a considerable area of fabric before repeating itself fully. A long repeat may, of course, contain stretches of short repeats.

By proper control of the placement in a fabric of yarns of the class of short patterns (these will usually be so short as to repeat one or more times in a cycle of the machine—i. e., in one "course" of a knitter, in one "pick" of a loom, etc.), a vast number of new geometric and color effects can be produced in fabrics. Furthermore, reliably uniform mixed and random effects can be produced by means of polychrome yarns. Heretofore practically all fabric ornamentation has been by changing the stitch or fabric structure or by alternating the use of two or more yarns of different solid colors.

Fabrics have been produced by hand weaving using yarns colored beforehand in appropriate spacings and tints. By laborious manual adjusting of such yarns or threads both in the warp and filler, irregular crude patterns could be produced. One example of this is the Japanese spotted tissue, known also as "Kasuri."

It will be noted that fabric ornamentation of this sort involves no change in the weave or structure of the fabric as it does in all applications of the jacquard. The simplest and sheerest weaves and knitted structures may be used. This polychrome yarn method of fabric ornamentation gives equally clear color effects on both sides of the fabric and there are no wasteful or unsightly stretches of unnecessary threads on the back side.

The art of printing in color on sheer muslins and the like comes the nearest in results to this new art of any now practiced save the above mentioned handicraft art. However, the effects attainable are not the same since prints are never full colored and presentable on the back of the fabric. The outlines of the figures in prints are very hard and mechanical, being independent of the threads or stitches of the fabric. The whole knitting art to which this new art of ornamentation is particularly adapted yields fabrics to which printing cannot be applied because they stretch too easily, are too thick and too resilient.

In contrast, by my invention knitted patterns can be produced which have a prearranged artistic regularity or softness of outline more pleasing than prints or even the best product of the jacquard.

Heretofore in knitting the range of patterns and effects obtainable by mingling and changing yarns was relatively limited. In weaving we deal with a large number of yarns particularly in the warp and a tremendous range of ornamentation is possible by varying the colors of these warp yarns and varying their interweavings. In knitting, preferably a single yarn is used and by the very structure of knitted fabrics this yarn may not be changed too often. A considerable range of ornamentation is now practicable in knitters by various devices for dropping or varying the stitches, doubling or otherwise changing the yarn, introducing jacquard type pattern controls, etc. Nevertheless, knitted goods as heretofore produced were inherently restricted in ornamentation when compared to woven goods. My polychrome ornamentation therefore greatly enriches the knitting art. By the very nature of this invention involving the accurate positioning in the fabric of the colored yarns used, it is well adapted to cooperate with the various pattern knitting devices. If a knitter is equipped, for instance, with means to produce a diagonal or zig-zag double stitch line or a ladder or open stitch effect it may be synchronized with the colored yarn feed of this invention so as to cooperate with the pattern wheel or stitch control in use, whereby the figures or shapes in the fabric structure may coincide with shapes or outlines of the color.

Any figure or representation, however complex, can be reduced to or embodied in a linear pattern. Suppose, for example, that a spray of flowers in three colors be stenciled on a plain woven or knit fabric. Let this fabric be then unraveled. The long unraveled yarn will then exhibit a certain definite sequence and extent of the three colors. If it were replaced in the fabric, millimeter per millimeter, just as it originally lay, the original figure, a three colored spray of flowers, would be recreated.

By this invention, such "long repeats" or long yarn patterns are also made possible, and the exact and planned building thereof of fabrics ornamented with figures. Means are shown to print such long patterns from a control sheet.

One object of the present invention is the production of ornamental two dimensional patterns in fabrics by the prior production of suitable linear color patterns on filaments and by the planned positioning of these linear patterns in the fabric being formed.

Another object is the production of planned figures and effects in knit goods by the accurate control of the rate of use of plannedly colored yarns.

Another object is the positive and reproducible generation in knit goods of mixed or random effects from parti-colored yarns of known linear pattern without those occasional and objectionable striped or insufficiently random areas that result when the yarn use rate is not constantly controlled in relation to the linear pattern thereof.

Another object is the production of cyclically varying effects such as wave patterns and zig-zag effects, in knit goods by cyclic variations in the feed of parti-colored yarns.

Another object is the control by linear color patterns of the color phase between a portion of polychrome yarn being laid into a fabric and a portion previously laid in, whereby colored yarn portions are ornamentally juxtaposed.

By means of machines and systems disclosed in my parent application, permitting only a non-cumulative deviation of the yarn pattern from the desired absolute relation or "phase," a fabric pattern outline (the edge of a stripe, for example) is obtained that has the following characteristics: it is statistically exact, straight if it should be straight, slanted or curved if it should be, zig-zag or stepped or broken, all mathematically true as planned. Yet the edge or outline of any figure or stripe is irregular or rapidly wavering. It is as though traced by a trembling hand but by a perfect eye.

This trembling or deviation of the line from the perfect or mean line is definitely limited. This limit is fixed by the frequency with which the automatic (e. g., photocell) check is made of the yarn position and by the amount of the individual corrections made in that position. "Is the yarn on time or ahead of time in relation to the machine?" is a question automatically answered at very frequent intervals. The more frequently this question is answered, the smaller each corrective retardation or "set back" of the yarn may be, and therefore the smaller the fluctuations about the perfect mean of the line of fabric stripes or patterns.

One very distinctive feature of this invention is this constant inspection, or checking up (by automatic means) of the position or "on timeness" of the yarn itself before it has entered the fabric. This checking is done while, as a matter of fact, there is still opportunity to correct a large part of any slight error found. This results in much more accurate placement of the colored spots in the fabric than can be had by any means whatsoever of watching the fabric patterns, as they form.

There is another advantage in this feature, relating to that class of fabric effects called random, which is one of the most important classes to be made of polychrome yarns. Owing to my provision of means for inspecting the yarn in time to do something at least practically corrective before the yarn is in final position in the fabric, random or "mixed" designs may be prearranged which have no shape or definite figures. The difficulty of controlling mixtures by inspection of the fabric is obvious since the desideratum is a fabric with no marked pattern or stripe, or at least having no areas of marked pattern. To inspect all the newly formed fabric continuously and rapidly so as to make sure that no marked patterns or stripes are forming anywhere and to determine quickly enough correct preventive action by such inspection would be well-nigh impossible. In fact, if "random" patterns were attempted by visual inspection of the fabric accompanied by manual corrections of the tension or feed of the yarn it would be practically impossible to expect an operator to determine whether the dissipation of any given incipient stripe requires speeding up or retarding of the yarn feed.

By purely visual inspection of the fabric patterns formed by polychrome yarns and by consequent manual adjustment of tension or of other determinants of rate of use of yarn, some knitters in the past have attempted to control fabric patterns.

The results, as regards accuracy, and range of fabric effects are not remotely comparable with those of this invention. The cost is very much higher due to the need of constant close attention.

The edge of a stripe, so made, may be said to wander rather than to tremble. The operator in these prior attempts was forced to wait until the yarn feed rate had already gained or lost enough to show a clearly visible trend away from normal in the stripe (or other fabric pattern) he was set to watch; only then could he decide whether to increase or decrease the tension or to change the stitch or the adjustment of the "sinkers" or to exercise other controls over the yarn feed rate. The operator's eye was the sole criterion of the correctness of the lines developing in the fabric, and their incorrectness had to be already irrevocable and plainly visible before he could begin to correct it. He would then usually over-correct it, with a consequent oscillating "wander" like the track of an inexperienced cyclist.

Only very crude and simple patterns, wide bold stripes, etc., could therefore be made by such posthumous correction methods, because the very big inherent wanderings would spoil the appearance of fine, delicate or intricate fabric patterns.

A considerable body of interesting ornamentation effects in knitted fabrics are shown and discussed, for the guidance of those who will practice this invention, and certain of the main types of polychrome-yarn-adorned fabrics are regarded as part of this invention since without it they have never and can never be made. One of these of particular interest, because of the kaleidoscopic effects obtainable, is the independent but synchronous control of two or more polychrome feeds. Thus two yarns of only three colors each, independently controlled may cause two sets of three stripes to cross, giving a maximum of nine blends or mixtures. These may be squares or oblongs, lozenges, triangles, crescents, arrows, and many other shapes.

In the drawings:

Figs. 1 to 29 inclusive illustrate a very few of the simpler fabric patterns or effects that can be produced on knitting machines having yarn timing controls of this invention. The effects of Figs. 1 to 26 inclusive and of Figs. 28 and 29 require to produce them a machine having only one yarn feed, although all of these patterns except Figs. 28 and 29, can be produced equally well and faster on other machines having sev-

eral independent yarn feeds, or on one with several feeds but a common control. These patterns may also all be produced by the photocell control of the yarn by its color, by the control utilizing differences in dielectric quality or by the use of "sized" points or mechanical markers on the yarns.

The patterns of Figs. 22, 25 and 26 require two independent yarn feeds. The patterns of Figs. 23 and 24 could be produced perfectly well by a single feed machine, or by one with independent feeds, but are shown particularly to illustrate certain kinds of effects to which the multi-feed single control type of machine is particularly adapted.

Before describing these figures in detail the following color code and understanding used in them may be noted. In Fig. 1 a couple of "courses" or rows of successive loops of the simplest or "plain jersey" type of knitting are shown greatly enlarged. Polychrome yarn is shown, and the change of color of any individual yarn can be noted in this figure. In all the other figures that whole portion of one such horizontal row of loops that is of one color is symbolized by a single line whose length represents the length of the one colored part of the course, and whose character (dotted, solid, wavy, etc.) represents the color. The line characters and colors thereby represented are:

Heavy full	=black
Light full	=white
Dotted	=orange
Broken or dash	=blue
Dash dot	=green
Dash double dot	=red
Wavy	=gray

These symbolized colors will be used in describing the figures, referring, e. g., to a "red" spot rather than to a "dash double dotted" stretch.

The assumption is further made that the upper courses are the older, i. e., that these patterns are built from the top down, and that the yarn of any given course is laid in from left to right.

Figs. 2, 3, 4 and 5 are vertical stripes made with the same yarn, colored, in equal length spots, black, white, blue, white, green, white, orange, white, (i. e., eight spots), and repeat. In Fig. 2 the feed is such that a whole number of these repeats goes into a complete course, thus the black spots of each course come under the black ones of the course preceding, and vertical solid color stripes are formed as shown.

In Fig. 3 the rate of yarn feed is slightly decreased, a negative "gain" from Fig. 2, so that the integral number of repeats per course is reduced by ⅛ of a repeat, or so that the yarn laid in per course is shorter by one spot length. The result is to bring the black spot of course 2 one length to the right of the black of course 1, etc., etc., so that each vertical stripe is found to be composed of all of the colors. This is a very good mixture or "heather." The vertical lines of separation points or color change points are quite visible in the drawing, but would be much less so in suit fabric.

Fig. 4 is constructed of this same yarn with a still larger negative gain over Fig. 2, a two-spot negative gain. This means that, compared with Fig. 2, the length of yarn that is fed per course is shorter by the length of two spots. This brings every black under the blue, every blue under the green, every green under the orange, and also brings all the whites together, so that we have alternating stripes of white and of mixed black, orange, green, blue. In the drawings, the appearance is not so different from that of Fig. 2, but in the colored goods it is very different.

Fig. 5 shows what the result is of a four-spot negative, or of a four-spot positive gain. The "repeat" being eight spots along it is a matter of convenience, in going from Fig. 2 to Fig. 5 whether the feed of the yarn will be decreased or increased to get the result of a "half pattern" or a "four-spot" displacement. It will be seen that the black and the green are aligned, the blue and orange, and the white and white, thus giving alternating and different vertical stripes of color, one of black, green mixture, the other of a blue, orange mixture, with plain white stripes between these stripes of color. Figs. 5 and 4 do not look at all alike in the fabric.

Fig. 6 using plain black and white spotted yarn is to illustrate the sloping effect of very slight changes in the rate of yarn feed. If the feed had been such as to place in one course an exactly integral number of pairs or "repeats" of black-white spots, there would have been black exactly under black and white exactly under white, just as at the left end of the Fig. 2 pattern. A negative gain, i. e., a decrease in the yarn fed per course, of the amount of one loop or stitch (11, Fig. 1), which in a 200-needle machine with one feed would be ½ of 1%, shifts the spots of each course laterally relative to the preceding an amount about equal to the height of each course, and produces a 45° slope of the stripes. In the Figs. 2 to 5 the increase or decrease of the feed rates used in each, by a mere ½ of 1% or so, would have imparted slopes in either direction to the plain or mixed color stripes described. Obviously, by means of the program device described, the designer may change about in one fabric, as frequently as he likes, between the plain color stripes of Fig. 2, the heather of Fig. 3, the white and four mixed color stripes of Fig. 4, and the white and two different mixture stripes of Fig. 5, and may at the same time without affecting the color mixtures change any or all of these colored stripes from vertical to right or to left hand slopes and back.

Fig. 7 illustrates the effect of alternatingly making the ½ of 1% gain of Fig. 6 positive and negative.

Fig. 8 still uses the same black and white yarn as Fig. 6 and applies a sudden positive gain, termed a shift because of its suddenness. The result is square checkers as shown when timed to make the stripes as long as they are wide between shifts. These one-spot shifts, or any half-spot or fractional spot shifts, or shifts of more than a spot, can be applied to the yarn of Figs. 2 to 5, producing checkers or stairs or broken stripes of any or of all these color mixtures. Other checkers or other discontinuity or "shift" patterns may also be sloped or zig-zagged.

Figs. 9 and 10, using a repeat of 4 equal spots of black, blue, green, orange, illustrate together the way in which a mixture or "heather" (which is really 4 contiguous vertical stripes all alike of all four colors mixed) may be treated to make the vertical alignment of the color change points less conspicuous. In Fig. 10 the pattern of Fig. 9 has been rather frequently zig-zagged. These zig-zags could be even finer and more irregular to good advantage, but the illustrative effect might suffer in that the lines would be hard to follow.

Figs. 11, 12 and 13 illustrate the color changes that a six-spot repeat allows. The repeat is black, blue, green, gray, orange, red. In Fig. 11, with integral repeats per course, there are these six colors in vertical stripes. In Fig. 12, applying a 2-spot negative gain to Fig. 11, we get two alternate stripes of black, orange, green mixed and of blue, red, gray mixed. In Fig. 13, by a three-spot gain we get three different stripes, respectively, of black and gray mixed, of blue and orange mixed, and of green and red mixed.

Figs. 14 and 15 illustrate the effect of shifts made without the special sudden shifting means. It is perfectly possible to make checkers for example by speeding up or slowing down the feed drums sufficiently to make the desired one spot gain in a single course, and by thereafter reverting to the original rate of feed. These figures show the result. Fig. 14 starts with the feeding of an integral number of repeats per course of a black, white, blue, white, orange, white yarn. This gives vertical solid color stripes or blocks. The feed rate is increased, at the beginning of the fifth course visible in the figure, to feed one spot less per course, i. e., a one-spot negative gain is applied. The fifth course in Fig. 14 shows this transition, exaggerated for better understanding. By a negative gain the yarn is caused to go a trifle further. The first black spot of this transition course is seen a little displaced to the right versus the black of the course before. The rate of increase of this displacement is shown very greatly exaggerated, as the blue spot creeps even more to the right, the orange more yet, and the second black has almost gotten completely under the white. In the sixth course the feed rate reverts to the original integral number of repeats per course, and vertical blacks result until in the tenth course of one spot gain, but a positive one, is again applied only for the one course. It will be seen that the yarn goes less far and that the spots creep back to where they were at the top of the figure. The result is checkers of several colors, each row of blacks of one color being zig-zag or staggered corner to corner.

In Fig. 15 all the shifts are by negative gains, and the same phenomenon of a course of "creep" between each set of checkers is seen. The shifts all being one way each row of blocks of one color is corner to corner in one diagonal.

Figs. 16 to 19 illustrate some of the effects producible with yarns having spots not all of the same length. Here the yarn pattern or repeat in a five unit one, having black for two units of length, orange, green and white for the other three. Fig. 16 shows a rate of feed one unit short of an integral number of repeats per course. This is a mixture cut by marked very flat black diagonal right-slanting stripes. In Fig. 17 the feed is two units short of integral, and the result is a mixture dominated by flat left slanting vague stripes of black with orange and green interlarded. In Fig. 18 the feed is 3 units short of integral or 2 units over integral, and this is substantially the converse of Fig. 17, a mixture dominated by flat right slanting vague stripes of black with orange green interlarded. In Fig. 19 the feed is 2½ units over or under integral, and produces a set of soft or vague vertical stripes as follows: a strip one unit wide of black, green: a strip one-half unit wide of black, white; another of half unit wide or orange, white: another a half unit wide of orange, black; then repeat. With proper choice of colors and lengths some very beautiful effects can be obtained with yarn spots not equal in length.

Figs. 18 and 21 using a six equal spot repeat of black, blue, orange, green, red, gray, are drawn to show the "creeping" relationship between an integral feed (solid color stripes), and an integral plus one spot feed (heather) and the further fact that the number of courses of "heather" laid before resuming the integral or solid color rate of feed determines how the new solid color stripes will be lined up to those laid before the "heather." In Fig. 20 an integral feed is held until course x, when a negative one-spot gain is applied. This course x is the transition course, and the slow advance or creep of the spots to the right, past those of same color in the course above is noted. By the next course this creeping is completed and vertical stripes all alike of all six colors mixed are laid by a feed one spot less than integral. This is what we have called "heather," for the stripes are not visible as such, being all alike. Attention is called to the fact that if these "heather" stripes were visible individually they would be found not to line up at all with the solid color stripes above course x. There are, above x, an integral number, say n, of repeats in each course, or 6 n stripes. Below x there are only 6 $n-1$ stripes. Hence the vernier or creeping relation brought out, on purpose, by the double vertical lines.

When, in the ninth course after course x, the integral feed rate is resumed, in course y, as shown, the spots begin to shorten or creep to the left relative to the "heather" stripes, and by the next course after y the solid color integral feed rate is in full swing. The fact is to be particularly noted that, because it was just nine courses that were laid at a feed rate one spot less than integral, the solid color stripes below heather band x to y have crept to the right relative to the solid color stripes above this band by just nine spots. Of course a shift of nine spots looks and is identical, in the case of a 6-spot repeat, with a shift of 9—6—3 spots. In Fig. 21 the same points are to be noted, namely, the right hand creep as the spots are stretched out by the one spot slower feed applied in course x, the vernier relation of the "heather" stripes to the solid stripes above, the return or left-hand creep in course y as the faster feed is resumed, and the fact that four courses of this one-spot-less-than-integral feed shifted the new solid stripes four spots to the right (or two spots to the left) relative to the solid stripes above course x.

Fig. 22 is laid with two yarns with independent feeds, a black white yarn of equal spots, and a blue white ditto. The feed of the former is a very minute amount faster than will lay integral repeats per course. The feed of the latter is an equal amount slower.. The result is two interrelated system of stripes, a left sloping set of black white and a right sloping set of blue white stripes. This gives four different colored lozengers—black, white—white, black, blue—and blue, white.

Fig. 25 (postponing Figs. 23 and 24 for a moment), illustrates the interweaving of two patterns. The first is laid with a 3-spot red, gray, black repeat, in checkers or blocks formed by a half spot negative shift every six courses. The second is laid with a 3-spot blue green orange repeat, in blocks formed by a half spot positive shift every six courses. The two feeds are relatively so timed that the color change points of

both yarns coincide about their courses. The result, as the figure shows clearly, is a pattern showing a series of layers of blocks, each block 12 courses of yarn high and one spot wide, the blocks in each layer being staggered to those above and below. The colors of these blocks are $3\times3=9$. In one layer are: red, green; orange, gray; blue, black. In the next are: red, orange; blue, gray; black, green. In the next are: red, blue; gray, green; orange, black.

Fig. 26 pattern is laid with two interlarded yarns as follows: first a 3-spot—red, gray, black—repeat, fed integrally for 6 courses, then given a one spot negative shift: second, a 3-spot—blue, green, orange—repeat, fed integrally plus a positive sloping increment such that the stripe edges intersect the block corners of the first yarn. The result is a series of triangles, shown best in the diagram of Fig. 27. There are of course 9 mixed colors since there are three colors in each feed. These three examples give only a feeble idea of the almost infinite number of patterns of mixed colors and interesting geometric shapes that can be obtained with two independently controlled feeds of different yarns.

Fig. 23 shows a result obtained in a machine using a 4-end yarn from one supply and one feed. The yarn is a black, white, orange, white repeat. It is laid with integral feed, i. e., an integral number of repeats per course. But, by means of the adjustments between the four yarns that are possible in this machine, the second end is slightly negatively shifted (a little loop held out) relative to the first, the third is negatively shifted twice as much as the second, and the fourth three times as much. The fifth course is laid by the same yarn as the first. The sixth by the same as the second, etc.

Fig. 24 shows the result of laying the same yarn on the type machine with a feed one spot short of integral, and with the yarn ends displaced thus: The guide has been set to a stop which is so adjusted that it retards or negatively shifts the yarn of the first course or course 2 by ¾ of a spot (i. e., a loop equal to ¾ of the length of a yarn spot is held out). The yarn of the next course under Z is similarly negatively shifted, but only ½ spot, by its adjustable guides. The third course is shifted only ¼ spot. The fourth course not at all. The feed of one spot under integral brings the blocks corner to corner as shown.

Figs. 28 and 29 show a representation of a flower, in green and red, with a vertical stripe of red, on a background of a third color.

All of the fabric patterns so far described have been produced with yarn having what I have termed short patterns or short repeats. The flower of Fig. 28, clearly, requires a yarn colored in each course at different points and for different lengths. This yarn pattern will not be completed and will not exactly repeat itself after a fraction of a course, as do all the 2, 3, 4, 6 and 8 spot patterns above considered, but only after enough courses have been laid to complete the figure of the flower. Hence I have above termed yarns of this character "long pattern" yarns. The vertical stripe **450** shown is very convenient as providing a regularly recurring spot on the yarn, by which the photocells of the condenser device can determine its earliness or lateness and cause a magnet to make correction. If this stripe is not wanted, however, the yarn at these same recurring points may be touched during printing of the long pattern with a droplet of "size," and a suitable control unit and hook-up may replace the photocell unit circuit. As will easily be seen, in the laying of a "long pattern" yarn there will be no need for any feed changing means, nor for program means to govern such. A vastly simplified mechanism might be used. The machine need only be set to lay in each course a predetermined and integral number of times, that unit length of yarn (that greatest common devisor of the long pattern), the yarn length that will properly knit up between two figures or two stripes such as **450**—*1* and **450**—*a*. For brevity let me call this length a "long pattern unit." Its existence as a submultiple length of the long pattern is just as real if stripes **450**—*1*, **450**—**2**, etc., are left out of the design. The length of this "long pattern unit" determines the frequency with which the yarn timing is corrected. If, therefore, the figures are very large, and unless "sized" points are used, and used right through the body of the figures, as may be done, the yarn timing correction is less frequent and the outline of the figure is likely to be more irregular or dentelated. But there can, even then, be no cumulative error causing general distortion.

In Figs. 28 and 29 the "long pattern units" in any one course, e. g., in that course represented by broken line Q Q', are all alike. The long pattern might be complete when line R R' is reached: but it will be seen that it is very easy, in the printing mechanism whereby yarns are colored in any "long pattern," to reverse the whole pattern without additional mechanism, and this gives cheaply the added variety of mirror or reversed views in the fabric. Hence, in the example shown, the long pattern yarn is a piece long enough to knit all the course around the machine from course S S' to T T'. In case of breakage of a long pattern yarn the operator must either patch in a piece of properly colored yarn with two knots so as to bring the spacing between the control points (color spots for stripes, "sized" points or other members) to exactly what it was before the break, or must tie out one complete course. The latter is easier, and it will frequently cause insufficient distortion of the figure to be serious. The effect will be that of dropping out a thin slice of the figure such as that included between line Q Q' and line U U'.

Having thus fully described my invention what I claim is:

As a new article of manufacture, a knitted fabric containing a plurality of yarns each with longitudinal repeated color patterns, and in which colored yarn sections in successive courses bear a predetermined relation to one another.

ARTHUR H. ADAMS.