June 30, 1931. H. E. HOUSEMAN 1,811,849

PROCESS OF KNITTING PLATED FABRIC

Original Filed April 20, 1928 4 Sheets-Sheet 1

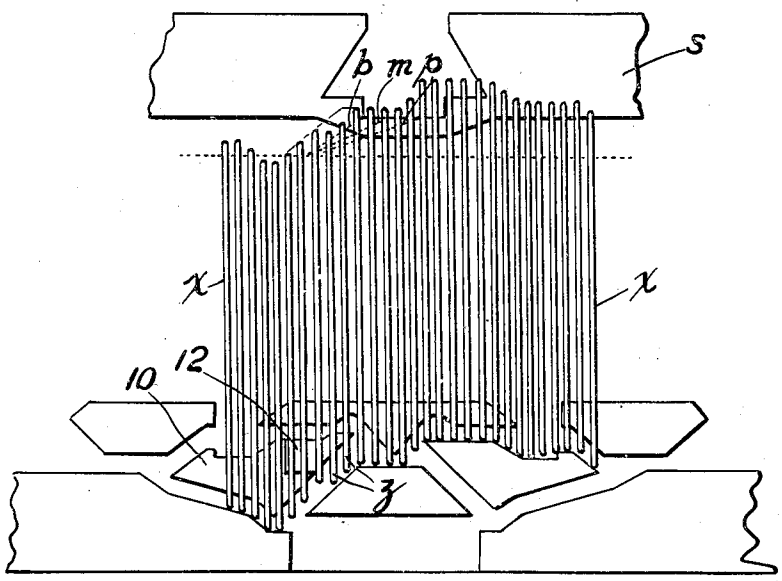



FIG. 1.

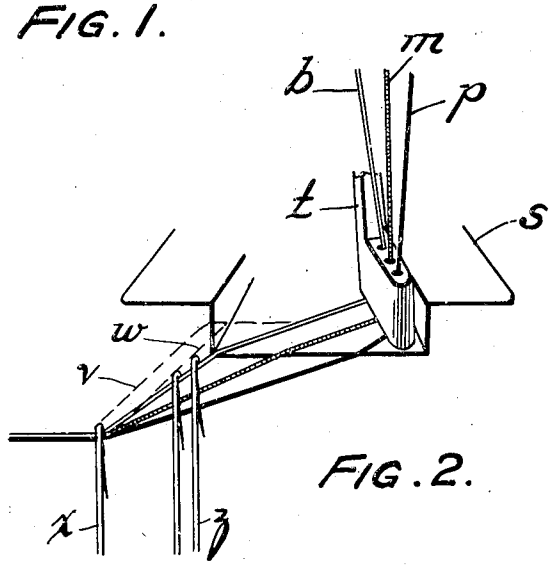



FIG. 2.

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PROCESS OF KNITTING PLATED FABRIC

Original Filed April 20, 1928 4 Sheets-Sheet 2

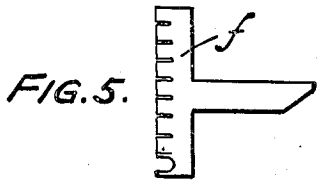



FIG. 5.

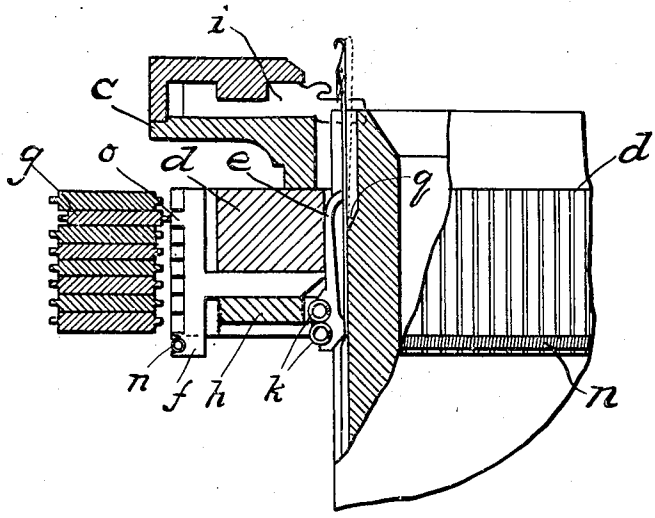



FIG. 3.

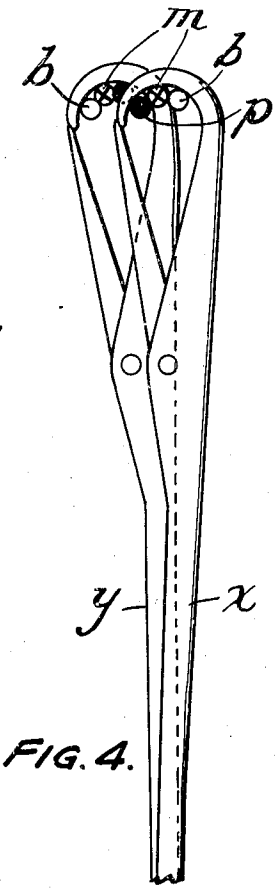



FIG. 4.

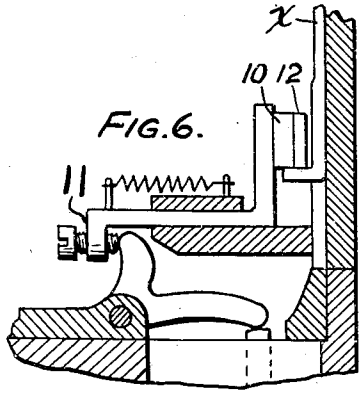



FIG. 6.

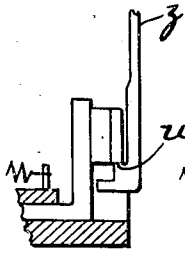



FIG. 7.

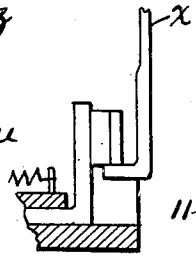



FIG. 8.

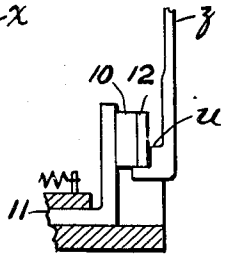



FIG. 9.

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PROCESS OF KNITTING PLATED FABRIC

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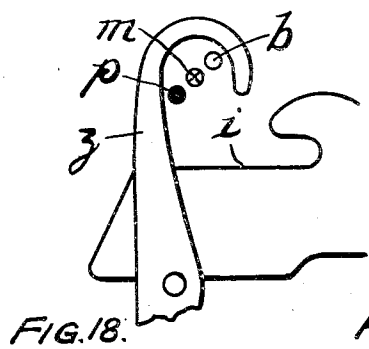


FIG. 18.

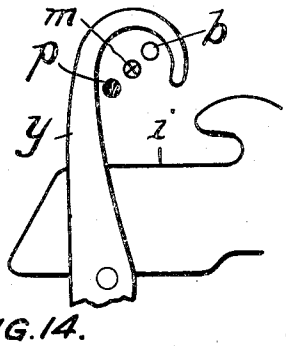


FIG. 14.

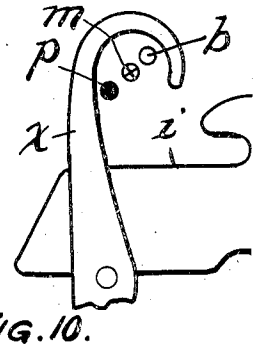
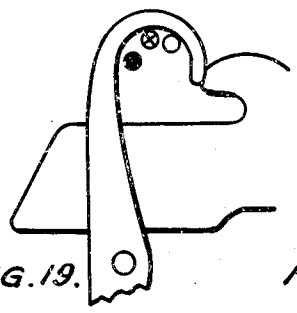


FIG. 10.


FIG. 19.

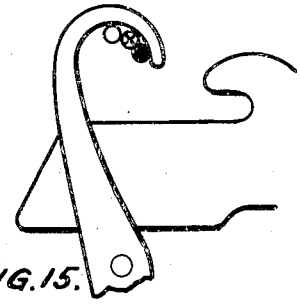

FIG. 15.


FIG. 11.

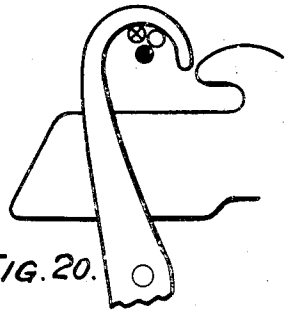
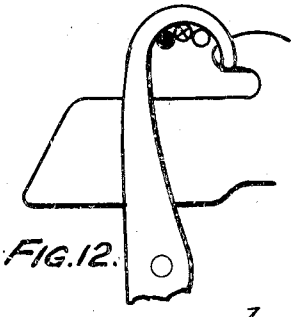

FIG. 20.


FIG. 16.


FIG. 12.

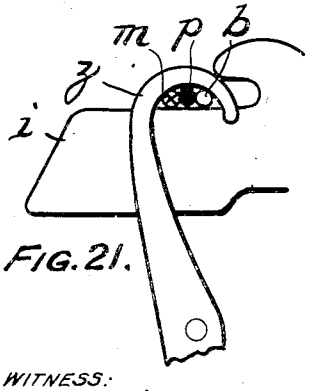


FIG. 21.

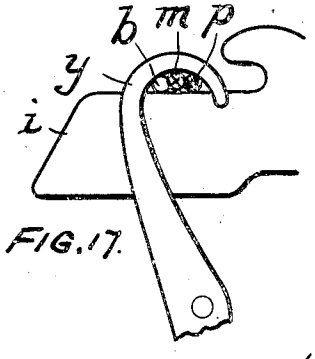


FIG. 17.

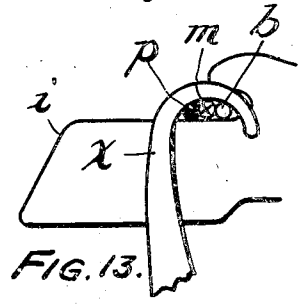


FIG. 13.

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PROCESS OF KNITTING PLATED FABRIC

Original Filed April 20, 1928 4 Sheets-Sheet 4

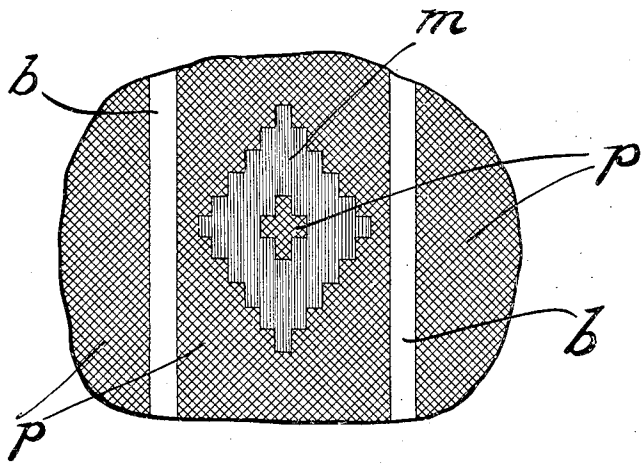



FIG. 22.

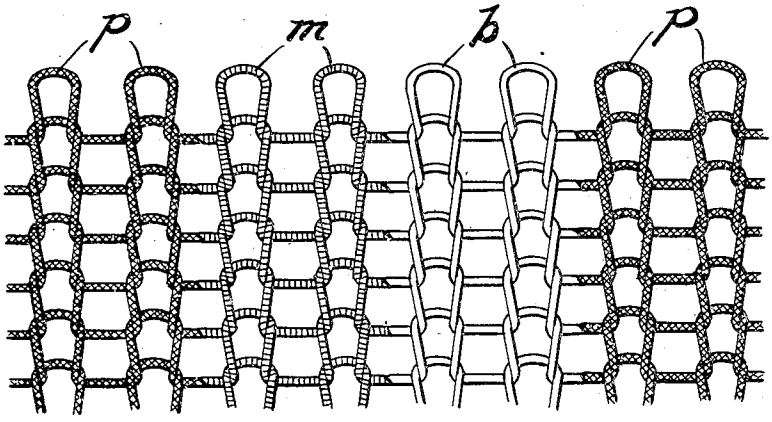



FIG. 23.

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WITNESS:

R. F. R. Kitchel.

Patented June 30, 1931 1,811,849

# UNITED STATES PATENT OFFICE

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## PROCESS OF KNITTING PLATED FABRIC

Original application filed April 20, 1928, Serial No. 271,428. Divided and this application filed February 12, 1929. Serial No. 339,327.

It is known to knit plated fabric, that is, fabric which is formed of a backing or body yarn and a facing or plating yarn, by feeding these two yarns under different tension simultaneously to the needles; the plating yarn appearing on the face of the fabric, while the backing yarn is concealed. It is also known to produce striped and figured effects and designs by causing the two yarns knit by certain of the needles to be reversed in position so that the body yarn will appear on the face of the fabric knit by these needles, while the plating yarn is concealed. In an application filed by Wilbur L. Houseman July 29, 1927, Serial No. 209,383, mechanism for producing this reverse plating is set forth. Such mechanism comprises pressers, rotatable with the needles, which are actuated by non-rotatable cams to bend selected needles inward out of their normal knitting plane, thereby reversing the normal positions of the threads in those needles, so that the body or backing yarn will, in the wales formed by such needles, appear on the face of the fabric, producing a striped effect. This mechanism is hereinafter particularly described. Automatic pattern-controlled mechanism for actuating such cams in such manner as to actuate needles at will and produce any desired design is known in the art.

Known means for reverse plating wherein all the needles in all the courses engage the threads and knit them into the fabric are limited to the production, in plated fabric, of two-color effects. Not only have three-color effects, involving the knitting into the fabric by all the needles in all the courses, not been contemplated, but known mechanism, if applied to three threads, would merely reverse the positions of these threads, bringing the normal face yarn, or so-called plating yarn, to the back and the backing yarn to the front, leaving the middle yarn in the middle and therefore producing only a two-color effect.

The object of the present invention is to produce plated knitted fabrics having three-color effects, such as striped fabrics or fabrics with designs of various configurations, such stripes or designs being formed by causing any one of the three threads to appear on the face of the fabric along any wale in all the courses or in selected wales along any course, while the other two threads, although knit into the fabric, are concealed by the yarn appearing on the face of the fabric.

My invention comprises not only the process herein described and claimed, but also the novel fabric itself, which latter, however, forms the subject-matter of an application, Serial No. 271,428, filed April 20, 1928, Patent No. 1,745,620, of which this application is a division.

The process may be carried out in different ways. In the preferred way of carrying out the new process the three threads are fed simultaneously to a circle of knitting needles. A relatively strong tension is imposed on one of the threads, say the plating thread, so that normally it will appear on the face of the fabric. A medium tension is imposed on another thread, which may be called the middle thread, so that normally it will appear in the middle of the fabric directly under, and concealed by, the plating thread. No tension, or a relatively slight tension, is imposed on the third, or backing, thread, so that normally it will appear on the back of the fabric and be concealed by the other two threads. The lines along which the respective threads are made to approach the circle of needles are so positioned that if the hook end of a needle is bent inward out of its normal knitting plane it will so engage and act on the threads as to reverse their positions so as to cause the backing thread to appear on the face of the fabric and the plating thread on the back of the fabric; and are also so positioned that if the needle hook is caused to prematurely engage the backing thread and middle thread and is then bent inward, the middle thread will appear on the face of the fabric.

The exact mode of operation which is effected when the preferred way, just briefly described, of practicing my process is applied to the production of the new fabric will be better understood by reference to the follow-

ing description in connection with the accompanying drawings, in which—

Fig. 1 is a diagram of a series of needles, the yarn feed and the needle actuating cams, constituting part of the mechanism which it is preferred to use.

Fig. 2 is a diagram of part of Fig. 1, enlarged, showing also the normal path of a needle in its downward yarn-engaging movement and the path of a needle when it is prematurely moved down into yarn-engaging position.

Fig. 3 is an elevational view, mainly in section, of a part of a needle cylinder and of the means for selectively pressing back needles to produce, in the hooks thereof, the arrangement of threads shown in Fig. 17 or Fig. 21.

Fig. 4 is a detail view of the upper ends of two needles, one in normal position and the other bent back.

Fig. 5 is a detail view of one of the needle presser actuating jacks of Fig. 3.

Figs. 6, 7, 8 and 9 are diagrams showing the stitch cam and needles actuated thereby; Fig. 6 also showing the means for moving the stitch cam into and out of operative position to actuate certain threads in the manner shown in Figs. 18–21.

Figs. 10–13 are diagrams showing the operation of a needle on the three threads in normal plating.

Figs. 14–17 are diagrams showing the operation of a needle on the three threads to effect a reverse plating that will bring the backing yarn on the face of the fabric.

Figs. 18–21 are diagrams showing the operation of a needle on the three threads to effect a reverse plating that will bring the middle yarn on the face of the fabric.

Fig. 22 is a face view of a plated fabric, exhibiting a typical or conventional three-color design, which may be produced by my process.

Fig. 23 is a diagram, enlarged, of a small section of a plated fabric which may be produced by my process, with the three different threads on the face in different parts thereof.

In order to illustrate one of several different ways of carrying out my new process, let it be assumed that, in the knitting of normal plated fabric, three differently colored threads are fed simultaneously toward a common point in the circle of needles. One possible arrangement of threads is shown in Figs. 1 and 2. The paths of the threads so converge that the backing thread extends at the steepest angle of approach and the plating thread at the flattest angle of approach. The backing thread *b* may be assumed to be be under relatively light or no tension. The middle thread *m* may be assumed to be under a medium tension. The plating thread *p* may be assumed to be under a strong tension. Needles *x*, in their downward movement, follow the regular path, marked *v* in Fig. 2. In accordance with the well understood principles governing the operation of plating, the three threads are knit into the fabric in the order *p*, *m*, *b*, as shown in Figs. 10–13, so that the plating thread appears on the face of the fabric and the backing thread on the back of the fabric. In the last named figures, Fig. 10 shows, in cross-section, the relative positions of the threads just before they are engaged by the needle hook; and Figs. 11, 12 and 13 show successively lower positions of the needle hook as the threads are drawn down thereby. An adjacent sinker or web holder *i* is also shown in successive positions which it occupies during the downward movement of the needle. The sinkers perform only the function usually performed in knitting and in the specific embodiment of the process herein set forth do not act cooperatively to determine the relative positions of the threads.

In order to make the backing thread appear on the face of the fabric, the hook end of a needle is pushed back (inward toward the center of the circle of needles), as shown in Figs. 15, 16 and 17, causing the hook to so engage the threads that they are rolled around and their order reversed, as may be understood by comparing Figs. 14 and 15, so that the threads knit into the fabric in the order *b*, *m*, *p*; the backing thread therefore appearing on the face of the fabric and the plating thread on the back of the fabric. This inward movement occurs just prior to the engagement of the needle with thread *b*; or at any rate prior to engagement with thread *m*. The needle shown in Figs. 14–17 is, for convenience of description, marked *y*; although it will be understood that the same needle in one course of knitting may move down in its normal plane and in another course of knitting may have its hook deflected.

In order to make the middle thread appear on the face of the fabric, a needle is caused to move down prematurely (in the path marked *w*, Fig. 2) so as to engage the middle yarn and the backing yarn while they are in their normal relation (see Fig. 19) and is then deflected so as to cause the plating yarn to roll under the middle yarn (see Fig. 20) and position itself between the middle yarn and the backing yarn (see Fig. 21). The deflection occurs at the same time in the cycle as the deflection mentioned above; but since the needle has moved down prematurely, both threads *b* and *m* have been engaged prior thereto. For convenience, this needle is marked *z*, although it will be understood that the same needle in one course of knitting may move down at a normal point in a normal plane, as in Figs. 10–13; in another course of knitting may move down at a normal point and have its hook deflected, as in Figs. 14–17,

and in another course of knitting may move down prematurely and also have its hook deflected, as in Figs. 18–21.

In order to produce three-color figured effects, it is necessary (in carrying out the process on a circular knitting machine in the described illustrative way) to provide means for selectively bending back selected needles for a predetermined number of courses and to prematurely move down into knitting position selected needles for a predetermined number of courses.

In order to selectively bend back needles it is preferred to utilize the mechanism disclosed and claimed in the said Wilbur L. Houseman application, Serial No. 209,393, shown herein in Figs. 3, 4 and 5.

Vertically slidable in slots of the revolving needle cylinder are the needles, which are movable up and down in a normal knitting wave by cams operating in the usual way. Fastened to the needle cylinder is the sinker dial *c*, which carries the sinkers or web holders *i*, which cooperate with the needles in the usual manner to form the stitches.

Below the sinker dial *c* is a slotted jack dial *d*, which is attached to the sinker dial. Pressers *e* are placed in the needle cylinder slots after the needles have been inserted and are held in place by the two spring bands *k*. These pressers are so shaped that they bear against the needles at the extreme upper ends of the pressers and also at points opposite the spring bands *k*. The needle cylinder slots are of greater than normal depth at their upper ends, forming shoulder *q*. The needles are unsupported above these shoulders, which act as fulcrums when needles are pushed back by the upper ends of pressers *e*. The jack dial *d* has slots corresponding in number with the slots in the needle cylinder. At intervals and in groups in accordance with a pattern which is to be formed in the knitted fabric, jacks *f* are inserted in the dial slots. These jacks are held lightly in contact with their corresponding needle pressers *e* by a spring band *n*.

A threaded clamp ring *h* holds the jacks in their proper vertical position. The jacks are formed with slots on their rear ends so that sections may be broken out in different places leaving butts *o*, which may be in any one of eight different vertical positions. If desired, there may be two or more butts on a jack. The one illustrated in Fig. 5 has butts in all eight positions, whereas the one shown in Fig. 3 has a butt in only the second highest position.

The eight cams *g* for operating butts *o* in the eight different positions do not revolve and may be moved into or out of the path of the respective butts *o* of jacks *f*, each of the eight different cams being in alignment with one of the corresponding eight butt locations on the jacks.

When one or more of the eight cams *g* are moved and held in the path of the jacks *f* having butts *o* corresponding to the vertical positions of such cams, these jacks will be pushed inward and will in turn rock the corresponding pushers *e*, thereby springing the corresponding needles at the fulcrum point *q*, causing their hooked ends to be bent back out of line with the adjacent unpushed needles in the normal knitting plane.

In order to prematurely move down into knitting position selected needles, it is preferred to use the mechanism disclosed in my Patents Nos. 1,631,816 and 1,631,817, a part of which is shown herein in Figs. 6–9.

In Fig. 1 an arcuate group of needles *x*, *z*, vertically slidable in the needle cylinder, is shown in operative relation with the three threads *b*, *m*, *p*, which are fed from a yarn carrier *t* (Fig. 2) that is projected into the throat of the latch ring *s*. In the same figure is shown a group of cams, which are constructed in the usual way except that the stitch cam 10 is specially constructed and is operable radially by being carried on a radially movable slide 11 (see Fig. 6). The stitch cam is widened, at its upper forward corner, to provide a part 12 overhanging the inner side of the cam. The part 12, which is in effect a supplemental cam, has a cam face aligning with the regular cam face of cam 10.

The needles *x* (see Figs. 6 and 8), which may be designated regular needles, are of ordinary construction with the usual butts. The needles *z* (see Figs. 7 and 9), which may be designated special needles, are of the same construction except that they are provided with shoulders *u*.

If the stitch cam is moved out, as shown in Figs. 8 and 9, the cam 12 is not in line of travel of the shoulders *u*, and all the needles are operated, in the regular way, by the engagement of their butts with the cam 12, and all the needles are operated at the same point in the circumference of the needle cylinder; and the needles that are not deflected inward engage all three threads in the manner shown in Fig. 11, while the needles that are deflected inward as hereinbefore described engage all three threads in the manner shown in Fig. 15. When, however, the stitch cam is moved in, as shown in Figs. 6 and 7, the supplemental cam 12 is in line of travel of the shoulders *u* of the special needles *z*, and the special needles will move down, at a point, in the circumference of the needle cylinder, in advance of the point at which the regular needles *x* are moved down and at such point as to engage and act on the threads (if the needles *z* are deflected inward as hereinbefore described) in the manner shown in Figs. 19–21.

In my said Patents 1,631,816 and 1,631,817, the means above described for prematurely depressing needles is so arranged as to cause prematurely depressed needles to escape en-

gagement with one of the threads. In the present case the height of the shoulder *u* is reduced so as to cause the premature downward movement of the needles to be somewhat delayed so that they will not escape engagement with any of the threads.

In the said Patents 1,631,816 and 1,631,817, the needles in the front half, and the needles in the rear half, of the machine are shown as differently constructed and the stitch cam is shown as movable into several different radial positions, in order that the special needles may be operated as regular needles in knitting the heel and toe. Means for selectively depressing needles for any desired number of courses is known. Means adapted to selectively bend back the hook ends of needles for any desired number of courses is known. By means of this mechanism, or other mechanism that may be devised, the process may be so practiced as to produce an infinite varety of three-color figured effects in plated knitted hosiery; but the use of such mechanism is unnecessary to such execution of the described process as will produce the three-color plated fabric described; nor is the use of the mechanism herein particularly described necessary to the execution of the new process.

In said Patent No. 1,631,817 a preferred, but more complicated, type of stitch cam is disclosed.

A section of fabric knit in accordance with the herein described process is shown in Fig. 23, the drawing being made with the stitches far looser and far more open than in the actual fabric in order to more clearly illustrate its structure. In the first two and the last two wales the plating yarn appears on the face. In the third and fourth wales the middle yarn appears on the face. In the fifth and sixth wales the backing yarn appears on the face.

Having now fully described my invention, what I claim and desire to protect by Letters Patent is—

1. The process of producing on a knitting machine a plated knitted fabric which comprises feeding three threads toward the needles, imposing such differential tension on the threads as to cause one thread to normally appear on the face, and the other threads respectively in the center, and on the back, of the fabric in plated relation, manipulating threads engaged by certain needles to bring a second thread on the face, and the other threads respectively in the center, and on the back, of the fabric in plated relation, and manipulating threads engaged by other needles to bring a third thread on the face, and the other threads respectively in the center, and on the back, of the fabric in plated relation.

2. The process of producing on a knitting machine a plated knitted fabric which comprises feeding three threads toward the needles in different paths and so manipulating them as to cause one thread to normally appear on the face and the other threads respectively in the center and on the back of the fabric, deflecting the hook ends of certain needles to cause them to engage all three threads and reverse the order in which they appear in the fabric, and prematurely moving down and also deflecting other needles to cause them to engage all three threads and bring on the face of the fabric the thread which normally appears in the center.

3. In the process of producing on a knitting machine a plated knitted fabric, feeding three threads toward the needles, imparting to certain needles, while they are traversing a definite arc of the circle of travel of the needles, the downward movement required to cause them to engage all three threads and form loops in which one thread is on the face in parts of the fabric, imparting similar downward three thread engaging movement to certain needles relatively prematurely while they are traversing an earlier reached arc of the circle, and radially deflecting prematurely depressed needles to cause another thread to appear on the face in other parts of the fabric.

4. In the process of producing on a knitting machine a plated knitted fabric, feeding three threads toward the needles, imparting to certain needles, while they are traversing a definite arc of the circle of travel of the needles, the downward movement required to cause them to engage all three threads and form loops in which one thread is on the face in parts of the fabric, imparting similar downward three thread engaging movement to certain needles relatively prematurely while they are traversing an earlier reached arc of the circle, and radially deflecting needles whose downward movement occurs during the traverse of each of said arcs to cause each of the other threads to appear on the face of the fabric in other and different parts thereof.

5. In the process of producing on a knitting machine a plated knitted fabric, feeding three threads toward the needles, imparting to certain needles the downward movement required to cause them to engage all three threads and form loops while they are traversing a definite arc of the circle of travel of the needles, so manipulating the threads as to cause one thread to normally appear on the face, and the other threads respectively in the center and on the back of the fabric, when the downward movement of the needles occurs during the traverse of said arc, imparting similar three thread engaging movement to certain other needles prematurely while they are traversing an earlier reached arc of said circle to cause them to prematurely engage one of the threads, and radially

deflecting certain needles whose downward movement occurs during the traverse of each arc and thereby causing the needles traversing the two arcs to bring one or the other of said other two threads on the face of the fabric.

6. The process of producing on a knitting machine a plated knitted fabric which comprises feeding three threads toward the needles, imposing such differential tension on the threads as to cause one thread to normally appear on the face, a second thread on the back, and a third thread in the center, of the fabric in plated relation, manipulating threads engaged by other needles to bring the second thread on the face, the first thread on the back, and the third thread in the center, of the fabric in plated relation, and manipulating threads engaged by other needles to bring the third thread on the face, the second thread on the back and the first thread in the center, of the fabric in plated relation.

7. The process of producing on a knitting machine a plated knitted fabric which comprises feeding three threads towards the needles in different paths, forming loops with certain needles including all three threads in which one thread overlies the second and third threads and the second thread overlies the third, displacing the relative positions of the threads at other needles and forming loops including all three threads in which the third thread overlies the second and first threads and the second thread overlies the first, and displacing the relative positions of the threads at other needles and forming loops including all three threads in which the second thread overlies the first and third threads and in which the first thread overlies the third.

8. The process of producing on a knitting machine a plated knitted fabric which comprises feeding three threads towards the needles in different paths, forming loops with certain needles including all three threads in which one thread overlies the second and third threads and the second thread overlies the third, and displacing the relative positions of the threads at other needles and forming loops including all three threads in which the second thread overlies the first and third threads and in which the first thread overlies the third.

9. The process of producing on a knitting machine a plated knitted fabric which comprises feeding three threads towards the needles in different paths, forming loops with certain needles including all three threads in which one thread overlies the second and third threads and the second thread overlies the third, displacing the relative positions of the threads by other needles and forming loops including all three threads in which the third thread overlies the second and first threads and the second thread overlies the first, and displacing the relative positions of the threads by other needles and forming loops including all three threads in which the second thread overlies the first and third threads and in which the first thread overlies the third.

10. The process of producing on a knitting machine a plated knitted fabric which comprises feeding three threads towards the needles in different paths, forming loops with certain needles including all three threads in which one thread overlies the second and third threads and the second thread overlies the third, and displacing the relative positions of the threads by other needles and forming loops including all three threads in which the second thread overlies the first and third threads and in which the first thread overlies the third.

11. The process of producing on a knitting machine a plated knitted fabric which comprises feeding three threads towards the needles in different paths, forming loops with certain needles including all three threads in which one thread overlies the second and third threads and the second thread overlies the third, displacing the relative positions of the threads at other needles and forming loops including all three threads in which the third thread overlies the second and first threads and the second thread overlies the first, and displacing the relative positions of the threads at other needles and forming loops including all three threads in which the second thread overlies the other two threads.

12. The process of producing on a knitting machine a plated knitted fabric which comprises feeding three threads towards the needles in different paths one of the threads being closer to the shanks of the needles than the other two and the second thread being closer to the needles than the third, drawing the threads in such positions by certain needles to form loops including all three threads in which one thread overlies the second and third of said threads and the second thread overlies the third, displacing the three threads to bring the third thread closer to the shanks of the needles than the other two and the second thread closer than the first, drawing the threads in the last named positions by other needles to form loops including all three threads in which the third thread overlies the second and first threads and the second thread overlies the first, displacing the three threads to bring the second thread closer to the shanks of the needles than the other two threads, and drawing the threads in the last named positions by other needles to form loops including all three threads in which the second thread overlies the other two threads.

13. The process of producing on a knitting machine a plated knitted fabric which comprises feeding three threads towards the

needles in different paths one of the threads being closer to the shanks of the needles than the other two and the second thread being closer to the needles than the third, drawing the threads in such positions by certain needles to form loops including all three threads in which one thread overlies the second and third of said threads and the second thread overlies the third, displacing the three threads to bring the third threads closer to the shanks of the needles than the other two and the second thread closer than the first, drawing the threads in the last named positions by other needles to form loops including all three threads in which the third thread overlies the second and first threads and the second thread overlies the first, displacing the three threads to bring the second thread closer to the shanks of the needles than the other two threads, and the first thread closer than the third, and drawing the threads in the last named positions by other needles to form loops including all three threads in which the second thread overlies the other two threads and in which the first thread overlies the third.

14. The process of producing on a knitting machine a plated knitted fabric which comprises feeding three threads towards the needles in different paths one of the threads being closer to the shanks of the needles than the other two and the second thread being closer to the needles than the third, drawing the threads in such positions by certain needles to form loops including all three threads in which one thread overlies the second and third of said threads and the second thread overlies the third, displacing the three threads to bring the second thread closer to the shanks of the needles than the other two threads, and drawing the threads in the last named positions by other needles to form loops including all three threads in which the second thread overlies the other two threads.

15. The process of producing on a knitting machine a plated knitted fabric which comprises feeding three threads towards the needles in different paths one of the threads being closer to the shanks of the needles than the other two and the second thread being closer to the needles than the third, drawing the threads in such positions by certain needles to form loops including all three threads in which one thread overlies the second and third of said threads and the second thread overlies the third, displacing the three threads to bring the second thread closer to the shanks of the needles than the other two threads, and the first thread closer than the third, and drawing the threads in the last named positions by other needles to form loops including all three threads in which the second thread overlies the other two threads and in which the first thread overlies the third.

In testimony of which invention, I have hereunto set my hand, at Philadelphia, Pennsylvania, on this 7th day of February, 1929.

HAROLD E. HOUSEMAN.