ABSTRACT: A fabric is woven of warp threads crossing integral and sectional weft threads which alternate. The integral weft threads extend across the entire fabric and are inserted by first weft inserting means, while each sectional weft thread includes a plurality of aligned double weft elements which are inserted into warp shed sections, respectively, by a plurality of weft inserting needles, and preferably tied by a knitting needle.
Fig. 2.
Fig. 3.
Fig. 13.
Fig. 19.
FABRIC HAVING INTEGRAL AND SECTIONAL WEFT THREADS, AND LOOM FOR MAKING THE SAME

REFERENCE TO A RELATED APPLICATION

An application directed to related subject matter is being simultaneously filed by Jisa et al.

BACKGROUND OF THE INVENTION

Conventional woven fabrics have weft threads extending in one piece across the entire width of the fabric, and are inserted into corresponding warp sheds. Specific looms are known for making ribbons or bands in which the width of the fabric is so narrow that the weft thread can be inserted from one side of the narrow fabric by a reciprocating weft inserting needle in the form of a double weft element which is tied on the other side of the narrow fabric by a tying knitting needle.

SUMMARY OF THE INVENTION

It is one object of the invention to provide a new woven fabric which can be manufactured at high speed.

Another object of the invention is to provide woven fabric having a novel pattern which makes it suitable for use for apparel and for decorative purposes.

Another object of the invention is to manufacture a pile fabric such as terry cloth at low cost.

Another object of the invention is to provide a fabric with a stripe pattern extending in the warp direction and being formed by loops.

Another object of the invention is to provide a loom for weaving fabrics according to the invention.

Another object of the invention is to provide a loom in which integral weft threads are inserted by pneumatic means, and double weft elements, which alternate with the integral weft threads, are respectively inserted by reciprocating weft inserting needles.

With these objects in view, a fabric according to the invention is generally characterized in that the weft threads thereof are interwoven alternately with at least one integral weft and at least one sectional double weft. Each sectional double weft preferably consists of a series of aligned double weft elements each of which has two parallel weft sections crossing with at least two warp threads, an end loop connecting the weft sections, and a connecting loop extending from the other end of the weft elements. The end loops either project out of the fabric, or are lying flat on the surface thereof. One weft section or leg of each double weft element extends in the form of a connecting loop over at least one integral and/or sectional weft into some of the subsequent double weft elements, while a connecting loop from the other weft section or leg of the same double weft element extends over at least one integral and/or sectional weft into some of the preceding double weft elements of the respective sectional weft. The end loops of the double weft elements are either knitted together to form a wale of s chain stitches, or remain free and are held only by the warp threads crossing the same. The wales, or the untied end loops either extend in warp direction, or along a zigzag line, or slanted to the warp and weft directions.

In one embodiment of the invention, the connecting link of one double weft element extends about the end loop of the adjacent double weft element of the same sectional weft, while a connecting loop extending from the other weft section or leg of the same double weft element, extends about the end loop of the double weft element of the preceding sectional weft of the adjacent fabric section, or passes below the free end loops. The end loops extend out of the fabric surface between the weft sections or legs of the double weft elements, or under the connecting loop of the adjacent double weft element of the same sectional weft. The double weft elements are either arranged oriented in the same direction so that all end loops are located on the same side, or oppositely oriented so that in the same fabric section, end loops and connecting loops alternate. In the case that the end loops of the double weft sections are located on the fabric surface, the end loops are connected to each other by knitting the same into chain stitches.

The fabric according to the invention can be manufactured from any natural or synthetic fiber converted into yarn, a low twist roving, ribbon, tape, twisted foil, thread, filament or the like.

A fabric according to the invention comprises a plurality of groups of warp threads; a series of integral weft threads having a length corresponding to the entire width of the fabric and being interwoven with the warp threads of the groups of warp threads; and sectional double weft threads forming the integral weft threads in the warp direction in a cyclical order, and preferably alternating with the same.

Each sectional double weft thread includes a plurality of double weft elements in the warp direction, the aligned double weft elements being, respectively, interwoven with the warp threads of the groups of warp threads so that longitudinal fabric sections extending in warp direction are formed by different groups of warp threads and by integral weft thread portion and double weft elements crossing the same. Successive double weft elements of each sectional double section are connected and formed of the same thread. It follows that in addition to the weft thread required for the integral weft threads extending across the entire fabric, an additional weft thread is required for each fabric section.

In a preferred embodiment of the invention, each double weft element includes a pair of first and second coextensive weft sections together interwoven with at least two warp threads of the respective group of warp threads in the respective fabric section, an end loop connecting the first and second weft sections at one end, and a connecting loop connecting the other end of the first weft section with the other end of the second weft section of the subsequent double weft element of the same fabric section. The connecting loops of the double weft elements of each fabric section are anchored in threads of the adjacent fabric section, and preferably pass under a warp thread and over an integral weft thread.

A loom according to the invention comprises heddle means for forming a warp shed including a plurality of warp shed sections of a plurality of groups of adjacent warp threads; first weft inserting means for inserting an integral weft thread into the warp shed over the entire transverse width of the warp threads; a plurality of second weft inserting means spaced from each other across the warp threads, said second weft inserting means being reciprocable for inserting double weft elements into the warp shed sections, respectively, whereby fabric sections are formed; operating means for operating the heddle means and the first and second weft inserting means in synchronism so that integral weft threads, and double weft threads composed of sectional double weft elements alternate in the woven fabric; and a plurality of tying knitting needles mounted for reciprocation between adjacent fabric sections and cooperating with the second weft inserting means, respectively, to hold in the respective warp shed section, double weft threads, after insertion by a forward stroke of the second weft inserting means, and during the return stroke of the same.

The integral weft threads are first cut to the proper size, and then inserted into the partly open warp shed by a pneumatic nozzle, while all sectional double weft elements of the same fabric section are made of the same weft thread so that a weft thread is additionally required for each fabric section.

The arrangement of the present invention permits not only all kinds of patterns of the fabrics, but also a wide variety of color effects.

The patterning of fabrics according to the invention can be influenced by the following conditions:

1. The arrangement of the double weft elements in each sectional weft.
2. The general arrangement of the double weft elements in the fabric.
3. The color patterns of the integral and sectional wefts relative to the warp threads.
4. The weave of the fabric.
5. The final treatment of the fabric.

The following table indicates a number of possible variations and modifications of fabrics according to the invention.
MODIFIED LOOP ARRANGEMENTS FOR THE DOUBLE WEFTS

Double weft elements are:
Oriented in the same direction;
Or oriented in opposite directions.

End loops of double weft elements are:
Knitted in a wale of chain stitches.
Connecting preceding and subsequent end loops.
Connecting preceding and subsequent end loops over at least one:
Integral weft;
Sectional double weft.
Not knitted to each other and form:
Free pile loops;
A pile after shearing.

Connecting loops and end loops of double weft elements are disposed:
Under the same warp thread;
Under different warp threads.

Connecting loops of double weft elements extend:
Into the double weft elements of preceding and subsequent double wefts;
And also over at least one subsequent:
Integral weft;
Sectional double weft.

Position of connecting loop relative to adjacent end loop:
Connecting loop extends about end loop;
Connecting loop extends under end loop.

Position of connecting loop relative to warp thread:
Connecting loop interfaces warp thread:
By extending into preceding and subsequent sectional double wefts;
And also over at least one:
Integral weft;
Sectional double weft.
Connecting loop does not interlace the warp thread.

Generally speaking, the loops of the sectional double weft element may be arranged to form stripes, zigzag lines, or slanted rows, and portions of the double weft elements of adjacent fabric sections may overlap, or be spaced from each other. Other patterning can be obtained by omitting some of the double weft elements, or by providing integral and sectional wefts in an irregular sequence.

The manner in which the double weft elements and end loops of the same are arranged within a single sectional weft can vary the pattern to a great extent, particularly in warp direction.

Various warp and weft patterning effects, as well as relief warp patterns, can be obtained by using warp threads having different thickness, texture, material, or color, or by differently tensioning the sectional and integral wefts.

A fabric according to the invention can be patterned in many ways to provide effects which are not feasible when standard weaving techniques are used to produce conventional fabrics.

A broad range of structural and color patterning is particularly suitable for weaving fabrics for apparel, beach garments, dust cloths, terrycloth, table cloths, and decorative materials, elastic fabrics, industrial fabrics, wrappings and packaging material and the like.

Relief warp and weft pattern effects are particularly suitable for decorative fabrics and upholstery covers.

Pile fabric with plain or shorn free loops are particularly suitable for the production of beach garments, terrycloth, and dust cloths.

Color patterning of the sectional weft can either be uniform within the entire area of the fabric, or be warp wise; zigzag-shaped, slanted, or irregular.

A different kind of color patterns can be produced by inserting into a particular fabric section variously colored or different thick wefts by means of two or more weft inserting needles cooperating with the same group of warp threads. The thus inserted double weft elements may be oriented in the same direction, or oriented in opposite directions.

Unbound end loops of sectional double weft elements produce either a loop covered surface, or a pile, if the loops are cut.

The end loops of the double weft elements can be pulled out on the same side of the fabric, or on both sides of the same. In the former case, the back of the fabric is plain, and the weave and appearance thereof is not distinguishable from a standard woven cloth.

Fabrics according to the invention permit any finishing process, such as napping, printing, or coating.

The specific fabrics according to the present invention which will be described hereinafter by way of example, only fabrics having a plain weave are described. It is, however, to be understood that any other cam controlled, dobby, or Jacquard operational method may be used in accordance with the intended use.

The sectional double weft elements of adjacent fabric sections can be interlaced and connected with each other in a suitable binding by a tying needle, and can be anchored on integral weft threads, warp threads, or loops of aligned double weft elements.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a schematic plan view illustrating a fabric according to a first embodiment of the invention;
FIG. 2 is a fragmentary schematic plan view illustrating a second embodiment of the invention;
FIG. 3 is a fragmentary plan view illustrating a third embodiment of the invention;
FIG. 4 is a schematic and diagrammatic plan view illustrating a fourth embodiment of the invention;
FIG. 5 is a schematic fragmentary plan view illustrating a fifth embodiment of the invention;
FIG. 6 is a schematic fragmentary plan view illustrating a sixth embodiment of the invention;
FIG. 7 is a fragmentary schematic plan view illustrating a seventh embodiment of the invention;
FIG. 8 is a schematic diagrammatic plan view illustrating the embodiment of FIG. 7.

FIG. 9 is a fragmentary perspective view illustrating the forming means in an open position;
FIG. 10 is a fragmentary perspective view illustrating the forming means of FIG. 9 in another position;
FIG. 11 is a fragmentary perspective view illustrating the weft inserting needles and the tying knitting needles of the apparatus of the invention;
FIG. 12 is a fragmentary perspective view illustrating the forming means of FIG. 9 in still a further position;
FIG. 13 is a side elevation illustrating a loom according to the invention;
FIG. 14 is a fragmentary plan view illustrating operating means for the weft inserting means and tying needles of the loom;
FIG. 15 is a fragmentary elevation, partially in section illustrating the apparatus of FIG. 14;
FIGS. 16, 17 and 18 are fragmentary schematic views illustrating successive positions of a pneumatic weft inserting device for inserting an integral weft into the entire warp shed of the fabric; and
FIG. 19 is a fragmentary view on an enlarged scale, illustrating the detail of the nozzle for inserting the integral wefts.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings, and more particularly to FIG. 1, a fabric according to this embodiment of the invention
comprises equidistant warp threads 3, crossed by integral wefts 1, and sectional wefts 2 which alternate with each other, but may follow each other in any selected cyclical sequence. While the integral wefts 1 have a length corresponding to the total width of the fabric, the sectional wefts 2 are composed of aligned sectional double weft elements 4, each of which includes two consecutive and preferably parallel weft sections 5 and 6, an end loop 7 connecting the respective weft sections 5 and 6, and a connecting loop connecting the other end of one weft section 5 with the weft section 6 of the following sectional double weft element 4. A connecting loop 8 is connected with the weft sections 5 and 6 of each sectional double weft element 4, and connected with the preceding and subsequent double weft elements 4, but for descriptive purposes it is easier to assume that a connecting loop 8 connects each weft section 5 with weft section 6 of the subsequent double weft elements 4. In relation to one sectional weft 2, the sectional wefts 2b and 2c precede the same, and the sectional weft 2a follow the same. In each sectional weft, the aligned double weft elements 4 may be connected with each other as shown in FIG. 1, or even spaced from each other as will be explained with reference to FIG. 5.

The end loop 7 of each double weft element 4 projects out of the fabric in the manner of a pile loop, while the pair of weft sections 5 and 6 passes alternately above and below the warp threads 3 to form longitudinal fabric sections B and A which are integral due to the interweaving of the integral wefts 1 with warp threads 3. However, in accordance with the invention, each fabric section A, B also includes sectional wefts 2 whose end loops are interconnected. A portion 10 of the warp thread 3a which extends between two adjacent fabric sections, is a holding portion for the respective end loop 7. Another portion 11 of the warp thread 3a where connecting loop 8 is reversed, is designated as reversing portion 11. Each connecting portion 8 passes under the reversing portion 11 and above the integral weft thread 1 crossing the same so that the left end of the respective double weft element 4 is secured. However, it is not absolutely necessary that the reversing and holding portions are provided on the same warp thread 3a, as shown in FIG. 1, and in FIG. 5, the holding portion 10, and the reversing portion 11 are provided on different warp threads. The end loops 7 are connected by chain stitches, and form a wale in the region of the warp thread 3a between two adjacent fabric sections A and B.

While the fabric sections A and B overlap in the embodiment of FIG. 1, they are spaced from each other in the embodiment of FIG. 5. Each of the longitudinal fabric sections A, B is produced by one or several weft inserting needles of the type used in ribbon looms. If only a single weft inserting needle is used, only a single weft thread is used for each longitudinal fabric section A or B and forms successive double weft elements 4 in the respective fabric section. If two weft inserting needles are used for inserting the double weft elements in each fabric section, threads of two different colors can be used for double weft sections alternating in the respective fabric section. FIG. 1 shows one complete fabric section B, with the complete double weft elements 4 including connecting loops 7 and end loops 8. Fabric sections A adjacent fabric section B, only partly shown, and it will be understood that the double weft elements of the two adjacent fabric sections A are constructed in the manner illustrated and described with reference to fabric section B. FIGS. 2, 3, 5, 6, and 7, which also illustrate only portions of the fabric sections, will be understood in the same manner.

The several embodiments of fabrics according to the present invention will be described hereinafter, but it may be noted that the embodiments of the invention have certain novel and unobvious features in common, although they vary in other respects.

In accordance with the invention, the warp threads 3 are interwoven alternately, or at least cyclically, with integral wefts 1, and sectional wefts 2 which comprise a series of aligned double weft elements 4 which are knitted to each other in a manner different from the integral connection of the integral wefts 1. The weft sections or legs 5, 6 of each double weft element 4 extend over at least two warp threads 3, being interwoven with the same. The end loops 7 of double weft elements 4 may extend out of the fabric surface in the form of pile loops, or may be knitted to lie flat on the surface of the fabric.

Only the weft sections or legs 5 and 6 form a weave with warp threads 3, whereas end loop 7 of the warp threads 3. Weft sections or legs 5 and 6 always pass together above or below the respective warp threads and constitute therefore a double weft. However, in a different binding, the binding of the weft 5, 6 of a double weft element 4 is different in at least one binding point from the binding of the preceding or subsequent integral weft in the region of the weft sections 5, 6 of the section A, B.

The integral wefts 1 and the sectional wefts 2 alternate regularly, or between two integral continuous weft 1, a plurality, for example 3 or 5 sectional double weft 2 may be arranged. Depending on the pattern, between two sectional double wefts 2, more than one different binding integral wefts 1 may be provided. The number of sectional wefts 2 and alternately binding integral wefts 1 depends on the pattern requirements, or on the desired strength of the fabric. A further characteristic of the fabric according to the invention is that the weft section 5 of each double weft element 4 is connected across at least one integral weft 1 with the weft section 6 of the successive double weft element 4, from which follows that the weft section 6 of each double weft element 4 is connected by a connecting loop 8 with the weft section 5 of the preceding double weft element 4 across an integral weft 1. For example, connecting loop 8 at the end of weft section 5 of sectional weft 2 is connected with weft section 6 of weft element 4 in sectional weft 22, while the connecting loop 8 connects with weft section 6 of weft section 22 is connected with weft section 5 of the preceding sectional weft 2b, each connecting loop passing under a warp thread 3a and above an intermediate integral weft 1. Connecting loops 8 connect preceding and subsequent double weft elements 4 of the same fabric section, for example fabric section B, crossing one integral weft 1 in the embodiment of FIG. 1. However, in the fabric illustrated in FIG. 8, connecting loop 8 extends to the double weft elements 4 of the same fabric section B over three wefts, of which the two outer wefts are integral wefts 1, and the intermediate weft is a sectional double weft.

In accordance with the invention, the connecting loops 8 of the sectional wefts 2 extend into the preceding and subsequent sectional double wefts 2, if the double weft elements 4 are arranged oriented in the same direction, or extend into both the even numbered preceding and subsequent sectional double wefts 2, if the double weft elements 4 are arranged in a non-corresponding manner in the fabric, or if a system of more than one inserting needle is employed. The double weft elements 4 in each fabric sections may be oriented in the same direction, or oriented in opposite directions. In the former case, the end loops 7 of all double weft sections 4 are disposed on the same side of the double weft elements 4 and of the respective fabric section, as shown in FIG. 1. On the other hand, successive double weft elements 4 may be arranged alternately oriented in opposite directions so that the end loops 7 and connecting loops 8 are alternately provided on the same side of each fabric section, as shown, for example, in FIG. 7. The right end of the lowermost double weft element in FIG. 7 is formed by the end loop 7, while the next following double weft element of the sectional weft 2 ends on the same right side in connecting loops 8.

Depending on the arrangement of the double weft elements 4, the end loops 7 are knitted together between two adjacent fabric sections A and B. In the embodiment of FIG. 1, the end loops 7 of the double weft elements 4 of the same fabric section are in contact with each other and are knitted together in chain loops to form a wale.
In the fabric construction shown in FIG. 7, the end loops of alternate double weft elements 4 of two different adjacent fabric sections are knitted together in chain loops to form a wale. In the fabric construction of FIG. 6 the end loops 7 project out of the fabric from the holding portions 10 of the respective warp thread 3e, and are not knitted to each other at all, so that the end loops 7 loosely lie on the fabric and form stripes 12.

FIG. 1 illustrates a fabric which has a wale 9 consisting of end loops 7 of the same fabric section knitted together in chain stitches, whereas in the embodiment of FIG. 7, the wale 9 is composed of end loops 7 of double weft elements 4 of two different adjacent fabric sections knitted together in chain stitches. It will be seen that a connecting wale 9 can be produced of double weft elements 4 oriented in the same direction, or alternately oriented in opposite directions. Free end loops 7 may be provided with uniformly or oppositely oriented double weft elements 4.

The wales 9 may be arranged parallel to the warp threads, as shown in FIG. 1, in a zigzag pattern, as shown in FIG. 4, diagonally or slanted to the warp and weft threads, or irregular in accordance with a pattern.

By mutually looping connecting loops 8 and end loops 7 of the double weft elements of the sectional double wefts 2, the sectional double wefts may be made very conspicuous, or subdued on the front surface of the fabric, in accordance with the desired pattern. Further pattern effects may be obtained by suitably distributing the holding portions 10 of the end loops 7 of the double weft elements 4, as shown in FIGS. 1, 3, 5 and 6.

The stripes 12 of unbound end loops 7 may extend parallel to the warp direction, as shown in FIG. 6, or in zigzag shape, or slanted to the warp and weft directions. The connecting loops 8 are either laid about the end loops 7 of the corresponding aligned double weft element of the adjacent fabric section, or pass under the same. For example, the connecting loops of the fabric shown in FIG. 2 pass under the end loops 7 which form chain stitches.

Unbound end loops 7 project out of the fabric either between the weft sections 5 and 6 of the respective adjacent double weft element 4 of the same sectional double weft, as shown in FIG. 6, or under the connecting loop 8 of the respective adjacent double weft element 4 of the same sectional weft 2.

The fabric illustrated in FIG. 1 is constructed of integral wefts 1 and sectional double wefts 2 which are alternately woven into the warp threads 3. Each of the sectional double wefts 2 consists of a system of uniformly oriented aligned double weft elements 4. The two weft sections 5 and 6 of each double weft element 4 are treated like a single weft thread and form a plain weave with warp threads 3. The sectional double weft 2 are bound differently with respect to the preceding and the subsequent integral wefts 1 so that the binding points of the sectional double weft 2 with the warp threads, correspond with the binding points of the preceding and following integral weft 1. All double weft elements 4 of each fabric section B or A are formed by one weft thread so that a weft thread is provided for each fabric section, in addition to the integral weft threads 1 which pass through all fabric sections, and across the entire width of the fabric.

The end loops 7 of the double weft element 4 of each fabric section A or B, are knitted by a tying knitting needle to form the wale 9 parallel to the warp threads 3. Warp thread 3a which is located under the wale 9, always ties under the respective integral weft 1, and over the connecting loop 8. The connecting loop 8 passes about the end loop 7 of the weft element 4 of the adjacent fabric section in the same sectional double weft 2, and passes under the end loop 7 of the double weft element 4 of the preceding sectional double weft 2b of the adjacent fabric section A. Fabric sections A and B overlap in the fabric of FIG. 1, and the holding portions 10, and reversing portions 11 of adjacent aligned double weft elements 4 are located on the same warp thread 3a.

The fabric illustrated in FIG. 2 is different from the fabric illustrated in FIG. 1 inasmuch as the connecting loops 8 are not laid about the end loops 7, but pass under the same. A knitting needle forms a wale of chain stitches of end loops 7 so that the right ends of the respective double weft elements 4 of fabric section A are anchored in the warp threads 3.

A modification differs from the fabric construction of FIG. 1 inasmuch as the warp threads 3a bind always over the integral weft thread 1, and under the connecting loop 8. The loop links 8 of fabric section B are in this case not retained by the integral weft 1, but are laid about the end loops 7 of the weft element 4 of the adjacent section A.

The holding portions 10 and reversing portions 11 of the double weft elements 4 are in this case on the warp thread 3a, where the two fabric sections A and B overlap each other.

FIG. 3 illustrates a fabric in which a warp thread 3b provides the holding portions 10 for the end loops 7, and the reversing portions 11 for the connecting loops 8, and is disposed on the left of the warp thread 3a along which the wale of chain stitches formed by end loops 7 is formed.

FIG. 4 illustrates schematically another fabric construction according to which the end loops 7 are knitted to form a zigzag-shaped wale 9. The connecting loops 8 pass under the end loops 7, similar to the fabric of FIG. 2. The holding portion 10 for end loops 7, and the reversing portions 11 for connecting loops 8 are alternately disposed on two different warp threads 3, and on several other warp threads 3. In a fabric woven in a plain weave, the holding portions 10 are distributed always to be located on every second warp thread 2 located, respectively, on the left and right of the respective wale 9. The two connecting loops 8 connected with the weft sections 5 and 6 of each double weft element 4, bind at the reversing point of the wale 9 within the reversing portion 11 symmetrically with respect to the holding portion 10 of the respective double weft section and of the same sectional double weft 2. With respect to the holding portion 10a which is disposed between the reversing points of the wale 9, connecting loops 8 bind identically but unsymmetrically.

FIG. 5 illustrates a fabric in which three warp threads are omitted between adjacent fabric sections A and B. End loops 7 of the double weft elements 4 of fabric section A are knitted together to form a wale of chain stitches 9 so that the right ends of the double weft elements 4 are secured in the weave.

The connecting loops 7 of the double weft element 4 of the fabric section B pass under a warp thread 3 and are anchored on integral weft threads 1. Evidently, the wale 9 is formed along a warp thread 3 which is different from the warp thread 3 which forms the edge of the fabric section B so that fabric sections A and B do not overlap.

As noted above, the end loops 8 of the fabric of FIG. 6 are free and not knitted together. The adjacent fabric sections A and B overlap each other in the region of the warp thread 3e which is located at the overlapping point of fabric portions A and B, and has holding portions 10 for the end loops 7, and reversing portions 11 for the connecting loops 8 of the respective double weft element 4. Each end loop 7 is located between two weft sections 5, 6 of the respective corresponding aligned double-weft element 4 of the adjacent fabric section B, and the free end loops produce a stripe effect forming a stripe 12 in longitudinal or warp direction.

A particular group of fabrics according to the invention are fabrics weft elements with end loops 7 and connecting loops 8 are not arranged oriented in the same direction, but alternately in opposite direction. Within each sectional double weft 2, the aligned double weft elements are alternately oriented in opposite directions.

For example, as shown in FIG. 7, the end loops 7 of the weft elements 4 of one fabric section A are alternately knitted together with the free end loops 7 of the double weft element 4 of the respective other fabric section B to form the wale 9 parallel to warp thread 3 and located between adjacent fabric sections A and B.
The connecting loops 8 of double weft elements 4 are connected with the preceding and subsequent double weft elements 4 of the same fabric section over two integral wefts between which the respective sectional double weft 2 is interposed. The holding portion 10 of warp threads 3 for the end loops 7, and the reversing portions 11 of the warp threads 3 for the connecting loops 8 are all provided on the same warp thread 3.

In the fabric illustrated in FIG. 8, the integral weft 1 alternates with the double weft elements 2, as described, and each sectional double weft 2 consists of a series or group of aligned double weft elements 4. The holding portions 10 for the loops 7 of the double weft elements 4 following each other, are staggered relative to each other alternately to the left and to the right, and extend over five warp threads 3. Both portions 10 and 11 are provided on the same warp thread 3 for holding the end loops 7 and reversing the connecting loops 8. Connecting loops 8 extend across two integral wefts 1 between an intermediate sectional double weft 2 is interposed. End loops 7 are knitted together to form a wale 9 of chain stitches.

The fabrics of the invention are made on a special loom which has, in addition to a conventional picking device for inserting the integral wefts 1 into the open warp sheds, and also with a plurality of weft inserting needles of the type used in ribbon looms for inserting sectional double wefts 2 into the adjacent fabric sections A and B. The apparatus further requires a plurality of tying knitting needles cooperating with the weft inserting needles for effecting anchoring of the double weft elements 4, and for forming the wales 9 of chain stitches formed of end loops 7.

The picking of the integral weft 1 across the entire warp shed can be accomplished by any conventional weft inserting mechanism, employing grippers, needles, shuttles, or pneumatically controlled weft inserting means.

The device for inserting the sectional double weft 7 includes a system of a plurality of weft inserting units each comprising at least one weft inserting needle for each fabric section, and a tying knitting needle cooperating with the same. The weft inserting needle is adapted to form a double weft element in the respective fabric section by using the same weft thread.

If more than one weft inserting means is used for each fabric section for the purpose of using several colored threads for the double weft elements 4 of each fabric section, the weft inserting needles alternately operate. During the alternating operation of two weft inserting needles having differently colored threads and inserting the same into the warp sheds of the same longitudinal fabric section, repeated differently colored double weft elements 4 are produced.

The tying needles between adjacent fabric sections are reciprocated in a plane substantially parallel to the fabric. Weft threads for each fabric section is wound off a stationary package, enters a duct in the respective weft inserting needle, and passes out of a guide eyelet at the end of the weft inserting needle. All weft inserting needles are driven from a common drive means and oscillate simultaneously in the same direction. The positions of the weft inserting needles are selected to be outside of the warps while the shed is closed, while entering the shed when the same is opened with the eyeflies of the inserting portions of the weft inserting needles leading. During the reciprocating movement of the weft inserting needles, the double weft elements are simultaneously inserted into the open sheds of the various fabric sections, and the loops of the double weft elements are engaged by the respective knitting needles which either knit the end loops 7 into a wale of chain stitches, or merely pull the end loops out of the fabric. In the first case, latch needles are used, and the reciprocating motion of the tying knitting needles is suitably synchronized with the oscillation of the weft inserting needles. In the latter case, it is necessary to employ bearded needles.

The loops formed simultaneously across the entire warp width are, or may be beaten up to the fell of the fabric by a reed, during or after the closing of the shed. In the event that grippers, needles or pneumatic picking devices are used for picking the integral wefts 1, the sectional weft picking interval is relatively shorter so that in this case an uneven slay motion can be utilized. For example, if the integral wefts 1 and sectional double weft 2 alternate, the slay motion should be decelerated during one revolution of the cam shaft, and accelerated during the following revolution.

For weaving the fabric according to the invention, a so-called half-shed, see FIG. 9, may be used where the heddle frames 13 consist of a comb of heddles 14.

During every, or every second, change of the shed, the weft is inserted, so that it is possible to insert the integral weft 1 into the shed across the entire width of the warp, and to insert the sectional double weft 2 into the following normal warp shed. As will be understood from FIGS. 9 and 10, the integral weft 1 can be inserted into the half-shed by movement in the direction of the warps, while the sectional double weft 2 can be inserted both into the half-shed shown in FIG. 9 and into the standard shed shown in FIG. 10.

For the insertion of the integral wefts 1 well known devices can be employed. For instance, the integral weft thread 1 is disposed in an auxiliary channel above and across the fabric to be formed, and the whole length of the integral warp section is transferred, for example pneumatically into the open half shed between the warp threads of the open shed, and beaten to the fabric edge.

Since the entire length of the integral weft thread 1 is inserted into the warp shed in one motion, the path of the integral warp from the preparatory channel to the beating line of the fabric is very short, and the stroke of the sectional weft inserting needles is also very small so that a great increase of the loom output can be obtained, as compared with standard looms, since the output does not depend upon the transverse width of the loom.

The weft inserting devices may reciprocate within a plane perpendicular to the warp, and the direction and length of this movement is synchronized with the operation of the loom so that the inserting needle can stop just before entering the shed.

A specific embodiment of an apparatus or loom for manufacturing the fabric according to the invention shown in FIG. 3, for example, is schematically illustrated in FIGS. 11 and 12.

The weft inserting needles 15 are supported on a forwardly located bar 16 to oscillate about pivots into and out of the warp sheds of adjacent narrow fabric sections, each of which includes a group of warp threads. Tying knitting needles 17 pass through bores in bar 16 and have end portions secured to another bar 18 through which the needles 17 are simultaneously reciprocated in axial direction. Each of the weft inserting needles 15 has a curved hollow arm 19 whose duct terminates in a guide eyelet 20. A weft thread for the respective fabric section is wound on package 22 and passes through the duct in the respective weft inserting means 15 to the eyelet 20 of the same.

A desired length of the integral weft thread 1 is inserted into the warp shed along the entire length of the loom, as will be explained hereinafter in greater detail. The entire integral weft thread 1 is moved into the open warp shed across the entire width of the loom. The tying needles 19 are shown to be latch needles provided with tongues and hooks. FIG. 11 illustrates the weft inserting needles 15 in a position of rest after insertion of a double weft element 4 into the respective warp shed of the associated fabric section. When the end loop 7 of the respective inserted double weft element 4 has been caught by the hook of needle 15 located on the right side of the respective fabric section, the weft needles 15 are returned to the initial starting position outside of the shed and on the left side of the needles is such that the warp shed contains two parallel weft sections 5 and 6 since the weft inserting needle 15 moves relative to the thread located in the duct of the same.

All double weft sections of the respective sectional double wefts 2 are thus simultaneously inserted into the respective
warp shed sections, whereupon the double weft sections are beaten up, while the end loops 8 are held by the latch needles 17. After the shed has been changed into a half open shed, another integral weft thread 1 having the same length as the width of the fabric, is inserted into all warp sheds of all fabric sections, whereupon the end loops 7 are knitted in chain stitches by needles 17 to form the wales 9. In the fabric thus woven, the integral wefts 1 and the sectional double wefts 2 alternate regularly.

In the manufacture of the fabrics shown in FIGS. 1 to 8, all double weft elements of the sectional double wefts 2 are inserted into the sheds of the fabric sections simultaneously. If, however, the weft inserting needles 15 are individually controlled, for instance by means of cards of a Jacquard frame, or by another pattern programming device, the simultaneous insertion of the double weft elements 4 of the sectional double wefts 2 can be accomplished in accordance with the desired pattern but in a certain selected part of the warp shed, forming thus a weave of the dobby, or Jacquard type.

The double weft elements 4 of the same fabric section A or B can be made of one or more threads. The double weft elements 4 can be inserted into the sheds in the warp direction, and may then be formed of threads supplied from the warp thread supply, and inserted into the shed simultaneously across the entire fabric width, or gradually, or in sections. All the embodiments of the fabrics can be obtained by adjusting the relative positions of the weft inserting needles and of the tying knitting needles 17.

The relative positions of the loop holding warp thread portion 10, and of the reversing warp thread portion 11 for the connecting loops 8 of two adjacent double weft elements 4 of the same sectional double weft 2, can be influenced by the selection of the distance or spacing between needle 15 and needle 17, in the weft direction.

The relative position between the end loop 7 and connecting loop 8 can be influenced by the position of the guide eyelet 20 in relation to the adjacent weft inserting needle 15. By adjusting the relative position as shown in FIG. 11, the weave according to FIG. 3 is obtained. In this case, the guide eyelet 20 of the weft inserting needle 15 is under the curved hollow inserting portion 9 of the adjacent weft inserting needle 15. In the opposite case, that is in the event that according to FIG. 11 the eyelet 20 of the weft inserting needle 15 is above the curved hollow weft inserting portion 19, the weave according to FIG. 5 is built, wherein the end loops 7 are surrounded by connecting links 8.

If two weft inserting needles for inserting double weft elements 4 in alternately opposedly oriented positions are used, the weave according to FIG. 7 is obtained.

The weave shown in FIG. 8 is made by using two weft inserting needles 15, which are staggered to each other. By using the weave according to FIG. 8, which has the end loops 7 formed into a wale 2, or not tied at all, fabrics without the integral weft thread 1 can be manufactured. The strength of the fabric in the weft direction is assured in this case by staggering the double weft elements 4 in the weft direction.

Since in the fabrics according to the invention, the path of each weft inserting needle 15 is many times shorter than that of a shuttle in a standard loom, even at slow speed of the weft inserting needles, twice or even three times the picking rate of the most effective standard weaving looms is obtained.

Referring now to FIG. 13, the loom is supported on a frame 24 in whose lower part there are two warp beams 25 and 26 with brakes 27. Warp threads 3 withdrawn from the two warp beams 25, 26 are supplied symmetrical to the pair of comb-shaped heddle frames 29, 30 whose prongs penetrate each other, and which are secured to holders 31, 32, respectively, which are articulated to arms 33, 34 which are mounted for tilting movement on shafts 35, 36, respectively. Each holder 31, 32 is also pivotally connected with an angular follower lever 37, 38, respectively, which are mounted on shafts 39, 40, respectively for angular movement, each cam follower having a roller 41 cooperating with a cam 32, 43 which are secured to the main driving shaft 44. The shed forming mechanism is disposed between two sidewalls of the frame 24, of which only one sidewall 45 is shown in FIG. 13. The warp sheds 3 are alternately threaded into the eyes of the two heddles 29, 30, as best seen in FIG. 15. By operation of the heddle frames 29 and 30, the two sheds are opened and closed along the entire width of the loom.

Above the shed forming mechanism, a device 47 is provided for inserting wefts into the sheds, as best seen in FIGS. 14 and 15.

In this arrangement, no need be provided for beating the weft against the newly formed fell of the woven fabric, and the weft thread is tensioned by passing the warp threads through the shed of the warp shed.

The woven fabric 48 is taken up by means of a cloth roll 49, passes about a pressure roller 50, and is finally wound up on the cloth beam 51.

As explained above, the weft inserting device 47 for the sectional double wefts includes a plurality of weft inserting needles 15 and knitting latch needles 17.

The weft inserting needles 15 are journaled on pins 52 secured to a stationary bar 16. The knitting needles 17 are supported in another bar 18 and pass freely through openings 53 provided in the stationary bar 16, as best seen in FIG. 11. The weft inserting needles 15 have arms 54 provided with slots, in which pins 55 are respectively located. A control rod 56 carrying pins 55 is articulated with a connecting link 57 terminating in a cam follower roller 58 cooperating with a cam 59 fixed to a shaft 60, while connecting link 57 is articulated to a crank arm 61 pivotally mounted on a stationary pin 62. A spring 63 acts on the crank arm 61 to urge the follower roller 58 against cam 59.

Shaft 60 is driven by a transmission 64, 65 from a shaft 66 which is coupled through a transmission, not shown, with the main driving shaft 44. Cam 67 are secured to shaft 66 and control cam follower rollers 68 turnably mounted on brackets 69 on bar 18 which supports the knitting needles 17. Springs 70 acting on bar 18 assure the engagement of cams 67 by follower rollers 68.

Threads 21 respectively passing through the eyelets 20 of the weft inserting needles 15 are supplied over a system of guide rollers 71, 72 and 73 over a thread brake 76 from individual packages 22, roller 72 being yieldingly supported on an arm 74 biased by spring 75.

During the operation, cam 59 reciprocates control rod 56 so that the weft inserting means 15 perform reciprocating motions, and each weft inserting needles 15 inserts during the forward stroke one piece of the weft thread, and during the return stroke the second piece of the double weft thread into the respective shed section. The end loop 7 of each double weft element inserted by a weft inserting needle 15, is caught by the corresponding tying knitting needle 17, and held during the return stroke of the weft inserting means 15.

Below the heddle frames 29, 30 a device 77 for inserting integral weft threads 1 into the warp sheds, is shown in section in FIG. 13. A detail of the weft inserting device for the integral weft threads 1 is shown on an enlarged scale in FIG. 19.

On a bar 78 two symmetrically arranged channels 79, 80 are mounted and form a cavity with two slots 81, 82. Member 78 has a piston-shaped head which forms two cavities 79, 80 communicating with slots 81, 82, and two other cavities 85 and 86 slanted. Ducts 83, 84 respectively connect cavities 79, 86 and 80, 85. Cavities 85, 86 are connected to a source of compressed air, not shown, drawn into the half integral weft 1 inserted to a comb-shaped heddle after the preceding sectional weft 2 has been inserted by a plurality of weft inserting needles 15, as is best seen in FIGS. 9, 12 and 19. FIGS. 16, 17 and 18 show the device for inserting the integral weft 1 in greater detail. Each integral weft 1 is taken from a cross wound bobbins 87, and is guided to a weft measuring device over a through guide 88. The measuring device includes two columns 89, 90 operated to move opposite to each other and designed for measuring the correct required length of the integral weft corresponding
to the entire width of the warp shed. From the measuring device 89, 90, the integral weft 1 is guided over a thread guide 91 to a nozzle 92 of a standard pneumatically driving device which is known from conventional jet looms. The nozzle 92 communicates through a conduit 93 with a source of compressed air, not shown, and cooperates with the nozzle 77 described with reference to FIGS. 13 and 19.

After the required length of an integral weft 1 has been measured in the position of FIG. 16, the measuring combs 89, 90 are returned to their initial position, as shown in FIG. 17, and simultaneously pressure air is supplied through conduit 93 into the nozzle 92 to carry the integral weft thread 1 in the direction of the arrow 94 into the channel 79, see FIGS. 19 and 17. After the integral weft thread 1 has been inserted into channel 79, it is cut off by cutting means 95, as shown in FIG. 18, while pressure air is supplied through conduit 96 into chamber 86 of weft inserting nozzle 77 so that the air flows into the cavity 79 through ducts 84, and blows the integral weft thread 1 along its entire length out of slot 81 and into the open warp shed, as best seen in FIGS. 18 and 19. The integral weft 1 moves in the direction of the arrow 97 along its entire length so that all parts of the integral weft 1 simultaneously move into and into this warp shed. After the insertion of the integral weft 1 along the entire width of the loom into the half open warp shed, the shed is changed, and the weft thread 1 is secured by tensioning the warp threads. Thereupon, the sectional double weft 2 is inserted by the plurality of weft inserting needles into the respective warp shed sections to form the previously discussed double weft elements, end loops, as connecting loops, whereupon the shed is changed again and the next integral weft thread 1 is inserted.

FIG. 19 shows a weft inserting nozzle means 77 with two channels 79 and 80 and two chambers 85, 86. For high speed operation of the machine, a second integral weft is made ready during the time required for transporting a weft 1 into the half open warp, and its operation is carried out by a device identical to the device shown in FIGS. 16, 17 and 18. In this manner, integral weft threads 1 can be alternately inserted from chambers 79, 80 in rapid succession.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of sectional fabrics differing from the types described above.

While the invention has been illustrated and described as embodied in a fabric having alternating integral weft threads and sectional double weft elements in longitudinal fabric sections, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

What is claimed is new and desired to be protected by Letters Patent is set forth in the appended claims.

We claim:

1. A fabric comprising, in combination, a plurality of groups of warp threads; a series of integral weft threads having a length corresponding to the entire width of the fabric and being interwoven with said warp threads of said groups of warp threads; and sectional double weft threads following said integral weft threads in the warp direction in a cyclical order, each sectional double weft thread including a plurality of double weft elements aligned in the weft direction, said aligned double weft elements being, respectively, interwoven with the warp threads of said groups of warp threads so that longitudinal fabric sections extending in warp direction are formed by different groups of warp threads and by integral weft thread portions and double weft elements crossing the same, successive double weft elements of the same fabric section being connected and formed of the same thread.

2. A fabric as claimed in claim 1 wherein each double weft element includes a pair of first and second coextensive warp sections together interwoven with at least two warp threads of the respective group of warp threads in the respective fabric section, an end loop connecting the first and second warp sections at one end, and a connecting loop connecting the other end of said first warp section with the other end of the second warp section of the subsequent double weft element of the same fabric section; and wherein said connecting loops of the double weft elements of each fabric section are anchored in threads of an adjacent fabric section.

3. A fabric as claimed in claim 2 wherein each connecting loop extends over at least one integral weft thread and at least one sectional double weft element of the adjacent fabric section.

4. A fabric as claimed in claim 2 wherein said connecting loop of each double weft element of one double weft, is looped about the end loop of the adjacent aligned double weft element of the same double weft and is located partly above and partly below the same.

5. A fabric as claimed in claim 2 wherein said connecting loop passes under the one warp thread at which said fabric sections overlap, and over at least one integral weft thread which is located between the two double weft elements connected by the respective connecting loop.

6. A fabric as claimed in claim 2 wherein said end loop of a double weft element projects from said fabric between said warp sections of said one double weft element of said one double weft, but located in the adjacent fabric section.

7. A fabric as claimed in claim 2 wherein said end loop of a double weft element projects through said connecting loop of the aligned double weft element of the same double weft but located in the adjacent fabric section.

8. A fabric as claimed in claim 2 wherein said double weft elements of the same fabric section are uniformly oriented so that all end loops are located on one side of each fabric section, and all connecting loops are located on the other side of the respective fabric section.

9. A fabric as claimed in claim 2 wherein alternate double weft elements of the same fabric section are oppositely oriented so that end loops and connecting loops alternate on either side of the respective fabric section.

10. A fabric as claimed in claim 2 wherein said connecting loops of double weft elements of the same fabric section pass about the integral weft threads preceding the respective double weft threads, and pass under the end loops of the aligned double weft element located in the adjacent fabric section.

11. A fabric as claimed in claim 2 wherein said end loops of all said double weft elements are looped to form a wale of chain stitches extending along a warp thread.

12. A fabric as claimed in claim 2 wherein said end loops of successive double weft elements of a fabric section project from under different warp threads of the respective fabric section; wherein said connecting loops of aligned double weft elements of the adjacent fabric section are looped about said different warp threads, and over integral weft, respectively wherein said end loops are looped together to form a zigzag-shaped wale of chain stitches.

13. A fabric as claimed in claim 2 wherein two lateral warp threads on the sides of two groups of warp threads and of two adjacent fabric sections are spaced a multiple of the distance which the warp threads of each group are spaced from each other; wherein said connecting loops of said double weft elements of one of said fabric sections are looped about an integral weft thread adjacent the respective lateral warp thread; and wherein the continuous double weft elements of the adjacent fabric section are looped together to form a wale of chain stitches adjacent the other lateral warp thread whereby said adjacent fabric sections are connected only by said integral weft threads.

14. A fabric as claimed in claim 2 wherein said connecting loops of each double weft element of one fabric section are looped about the following integral weft thread adjacent one warp thread; and wherein the end loops of each double weft element of the adjacent fabric section freely project from under said one warp thread into the region of the weft sections of the respective double weft element of said one fabric sec-
15. A fabric as claimed in claim 2 wherein successive double weft elements of the same fabric section are alternately oppositely oriented; wherein aligned double weft elements located in adjacent fabric sections are oppositely oriented so that the end loop of each double weft element of each fabric section and the connecting loop of each aligned double weft element of the adjacent fabric section are both located between said fabric sections; and wherein said connecting loops are looped about a plurality of subsequent integral weft threads.