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Description

5 IMPROVED PILE FABRIC, METHODS AND CIRCULAR
KNITTING MACHINES WITH IMPROVED PILE ELEMENTS
FOR MANUFACTURING AFORESAID

BACKGROUND OF THE INVENTION

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1. Field of the Invention

15 An improved knit pile fabric, the methods therefor and
circular knitting machinery with improved pile elements
for manufacturing the improved knit pile fabric.

2. Description of the Prior Art

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Knitted pile fabrics are generally composed of ground
yarns forming a ground fabric in different constructions
to which pile yarns, forming protruding pile loops, are
meshed.

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In the overwhelming majority of proposals for knitting
pile fabrics, the knitting of the base or ground fabric
and the forming of pile loops is realized simultaneously
by knitting the ground yarn and the pile yarn together
30 into all stitches of each of the complete courses.

With exception of the proposal described in the German
Patent No. 671 333 thereby exclusively one pile yarn is
knitted together with one ground yarn to stitches. If the
35 ground fabric is knitted into plain single jersey courses

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a pattern is exclusively obtained by selecting the pile elements for pile forming or plating (non-pile forming) or forming pile loops of different length (for example as described in the German Patent No. 656 588, British
5 Patent No. 462.662, US-Patent No. 3,477,255). Colored patterns are produced by feeding different pile yarns to a sequence of succeeding feeders and knitting pile loops in one of the feeders in a predetermined section and meanwhile the other courses in this portion are composed
10 of plated stitches. As a result, the pile density is reduced according to the number of courses knitted in a sequence, so that for a sufficient pile density the sequence of different pile yarns is limited usually to two.

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Based on the foregoing described method for pile knitting the number of pile yarns in a complete course is only increaseable by knitting a predetermined number of sectional courses in a sequence of at least two feeders
20 after which the complete course is realized. Such methods are described in the proposals according to the US-Patent 2,710,527; 4,409,800; German Patents 1 153 482; 1 585 051; in which ground yarn and pile yarn floats will spread over the wales knitted from alternative pile and
25 ground yarn. The manufacturing of patterned pile fabrics according to this proposal is limited by the floats of the ground yarns which will also project from the fabric if they spread over more than three wales whereby they may be cut off in the required shearing operation after
30 knitting to remove the float portions of the pile yarns and making the pattern visible.

To avoid longer floats from the ground yarn when knitting partial sections of a fabric, it is proposed, according
35 to European Patent No. 0 043 135 (corresponding to

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- US-Patent No. 4,633,683) to arrange the ground yarn between the knitting sections in a lay-in (accordion-type) structure. In a further proposal, referenced European Patent No. 0 072 425, the non--
- 5 knitting, respectively non-pile forming yarns are tied into the ground fabric in a lay-in structure, so that this fabric is usable after knitting in the looped construction too.
- 10 Lay-in portions of yarns incorporated into the ground fabric will widen the fabric width and will reduce also the course density and therefore also the pile density and the elasticity of the fabric.
- 15 To overcome such limitations a number of proposals over the last fifteen years have been made to knit at least two pile forming yarns into a ground fabric from one ground yarn. To avoid the handicaps of the method referred in the German Patent No. 671 333, resulting from
- 20 the required exact adjustment of the yarn carrier for feeding a first pile yarn to a first group of needles and arranging thereafter this first pile yarn in the backs of the needles of a second group of needles, whereby an unverifiable tensioning of the first pile yarn
- 25 (especially according to the provided pile length, yarn friction, alteration of the needles etc.) must be accepted; it is proposed to provide subsequent sections of ground and pile yarn feeders in which at least the pile yarns are sinked or prelooped to sectional pile loop
- 30 portions which are knit in a final section of a knitting sequence together with a ground yarn to a complete course. Methods for manufacturing this type of fabric are described in the US Patent Nos. 4,612,784; 4,989,421; 5,167,133; European Patent Publications No. 0 335 618;

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0 594 187; 0 629 727; German Patent Publications No. 40 33 735; 41 29 845; 195 05 646.

As referred in these publications, the ground yarn will
5 knit exclusively with one of at least two pile yarns in
sectionally predetermined and alternating pile areas, so
that the pile yarns excluded from pile knitting will
spread or float over the pile portions from alternative
pile yarns. Therefore it is supposed that these floats
10 are removed by a shearing process subsequent to knitting.
Resulting from this exclusively velour-type fabrics can
be produced while an increased shearing loss, according
to the number of pile yarns per course, must be accepted.

15 To reduce the percentage of pile yarns in the fabric,
respectively using courser pile yarns without increasing
the portion of pile yarns in the fabric, it is provided
in some proposals to mesh the pile yarns into the fabric
by tucking.

20 Analogous to the above-mentioned proposals it is
proposed, according to the proposal of European Patent
Publication No. 0 484 692, to sink or pre-loop on at
least two succeeding pile yarn feeders, alternatively,
25 sectional pile loops and clearing these pile loops from
the needle latches in the final ground yarn feeder, so
that the pile loops are meshed into the ground fabric by
tucking. The overspreading pile yarn portions must be
also removed by shearing as referred before.

30 It is noted that pile fabrics incorporating the pile
yarns by tucking are also described according to the
proposals of US Patent Nos. 4,043,151; 4,409,800;
European Patent Nos. 0 422 917; and British Patent No.
35 830,219.

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To avoid floats from the pile yarns spreading over pile sections from alternative pile yarns it is proposed, in the German Patent Publication No. 27 04 295, to knit two
5 pile yarns in subsequent feeders in alternate wales to a continuous lay-in construction where, in each feeder, predetermined pile elements draw out pile loops. Both pile yarns are meshed into a plain course of the ground fabric.

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With this proposal it is exclusively possible to knit two pile yarns into a course without floats from the pile yarns so that the fabric can be used with the original loop structure or with severed pile loops with a reduced
15 shearing loss. The disadvantage of this proposal is that only two pile yarns can be meshed or incorporated into a ground fabric when a sufficient pile density will be obtained and the pile yarns are meshed to the base fabric exclusively by tucking, which will reduce the stitch
20 density.

SUMMARY OF THE INVENTION

25 With the foregoing in mind it is the object of the present invention to create a knitted pile fabric comprising courses from which only the pile loops of at least two pile yarns will protrude so that this fabric with the looped structure can be used as well as the pile
30 loops can be severed in the knitting machine to avoid a high shearing loss and to increase the quality of the velour-type surface of the fabric.

A further object is that the meshing of the pile yarns to
35 the ground fabric is realized in different fabric

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constructions so that the fabric can be adapted to required conditions.

5 A further object is that the pile loops arranged in a course can be drawn to different lengths.

10 A further object is that the pile yarns are generally not sinked (prelooped) prior to their knitting or incorporation into the ground fabric so that prelooping is avoided.

BRIEF DESCRIPTION OF THE INVENTION

15 The general objects of the present invention are obtained by manufacturing pile fabrics on circular knitting machines having at least two cooperating beds, one supporting respective movable knitting needles, which will mesh across a complete course together
20 simultaneously at least two pile yarns to or into the fabric continuously, and supporting in the other bed hooked pile elements that move transversely in cooperation to and between the knitting needles, engaging one of the pile yarns and drawing out pile loops from at
25 least two pile yarns between succeeding wales, respectively, thereby forming pattern areas.

According to this concept the pile yarns can be knitted to stitches as well as being meshed in a lay-in structure
30 into a ground fabric.

When the pile yarns are knitted to stitches at least one of the pile yarns is alternatively knit into ground yarn portions, with regular sinker loops, while the other pile
35 yarn is drawn to pile loops (elongated sinker loops).

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Consequently the alternating ground yarn portions of the pile yarns will substitute for a specific ground yarn for knitting the ground fabric.

- 5 Ground yarns are required for knitting a ground fabric if pile yarns are incorporated therein in a lay-in structure, but such a ground fabric can also contain pile yarns so that a patterned pile fabric from more than three pile yarns per course, with a high pile density can
10 be prepared.

For manufacturing velour-like fabrics the present invention enables the severing of pile loops in the knitting machine preferably in association with the
15 proposals according to US Patent No. 4,592,212, and the further improvement of German Patent Application 195 18 490, so that an increased shearing loss is avoided and pile material can be saved by knitting shorter pile loops.

20 Manufacturing pile fabrics with pile loops severed in the knitting machine will require a circular knitting machine with a dial, a cylinder and a sinker ring according to the requirements described in the above referred
25 documents.

In contrast to this for manufacturing looped pile fabrics, which are applicable in the knitted loop structure or can be finished into a velour-type fabric,
30 the circular knitting machine will have two cooperating beds in which the knitting needles can be arranged alternatively in one of the beds and the pile elements in the other. By different positions in the loop-forming action pile loops of different length in each course can
35 be provided.

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The pile elements for manufacturing the pile fabrics according to the present invention are characterized by a hooked portion, in which the peak, 1p of the hook is advanced or staggered relative to the radius of the inner arc of the hook towards to the hook opening, so that a guiding ledge 1s, directed towards to the backs of the pile elements, is formed, which will support the correct feeding and disposition of the pile yarns. For severing of the pile loops the pile elements have a cutting ledge spaced from the hook in continuation of the stems (loop guiding portion), cooperating with cutting ledges of the cutting elements. Pile elements for manufacturing looped fabric structures in separated positions are additionally pivotable for controlling the pile yarns. This assures the unaffected movement of each pile yarn between feeding and pile forming (and velour-type fabrics with more than two pile yarns).

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BRIEF DESCRIPTION OF THE DRAWINGS

Other objects, features, and characteristics of the invention will become apparent upon consideration of the following description and the appended claims with reference to the accompanying drawings, all of which form a part of this specification and wherein like reference numerals represent corresponding parts in the various views.

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Fig. 1 to 5 are extracts of fabric constructions according to the present invention.

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Fig. 6 is a simplified schematic cross section of a circular knitting machine for manufacturing novel pile fabrics with cutting the loops in the machine.

- 5 Fig. 6a is an enlarged side view of a needle and a pile element actuated to engage a pile forming yarn.

Fig. 7 is a diagram showing the tracks of needles, pile and cutting elements in relation to each other for a
10 first embodiment knitting with two pile forming yarns.

Fig. 8a is a view from the top to the stitch forming section as marked with III/IV in Fig. 7.

- 15 Fig. 8b is a view from the front to the same section.

Fig. 9a is also a view from the top to this section, while

- 20 Fig. 9b is a front view with an alternative control of the pile elements to Fig. 8b.

Fig. 10 to 14 are detailed side views to the needles and pile elements in their relative position to each other
25 according to the positions indicated by V to IX in Fig. 7.

Fig. 15 to 21 are side views to each needle N1 to N7 of Fig. 8a and 8b in cooperation with the adjacent pile elements.

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Fig. 22 to 27 are the side views to the alternative control of pile elements cooperating with the needles N1 to N6 in Fig. 9a and 9b.

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Fig. 28a is a simplified schematic upper cross section of a circular knitting machine for manufacturing a novel pile fabric from three pile forming yarns and severing the pile loops in the knitting machine.

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Fig. 28b is the simplified schematic lower cross section to Fig. 28a showing the means for selecting the pile elements.

10 Fig. 29 is also a simplified schematic cross section of a knitting machine according to Fig. 28a, showing the pile elements after feeding the second pile yarn.

15 Fig. 30 is a diagram showing the trucks of needles, pile and cutting elements and butts of intermediate and control-jacks in relation to each other in order to manufacture a pile fabric from three pile yarns.

20 Fig. 31 to 34 are side views to the needles and pile elements arranged according to the positions indicated by XXVI to IXXX.

Fig. 35a is a view from the top to the stitch forming section indicated with XXX in Fig. 30.

25

Fig. 35b is a front view to the same section.

30 Fig. 36 to 39 are side views to each of the needles N13 to N16 in cooperation with the adjacent pile elements according to Fig. 35a and 35b.

Fig. 40 to 43 is a side view to the lower part of the pivotable pile element to demonstrate the control of the pile elements during the stitch forming section.

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Fig. 44 is a simplified schematic cross-section of a circular knitting machine for manufacturing loop pile fabrics.

5 Fig. 45 is a diagram illustrating the tracks of needles and pile elements of Fig. 44 in relation to each other for knitting a complete course in a further embodiment.

Fig. 46 to Fig. 52 are detailed positions of pile
10 elements and needles corresponding to the positions F1, F2 and section K in Fig. 45.

Fig. 53 is a further simplified schematic cross-section of a circular knitting machine for manufacturing loop
15 pile fabrics.

Fig. 54 is a diagram illustrating the tracks of needles and pile elements of Fig. 53 cooperating in knitting a complete course of a loop fabric.

20 Fig. 55 to 56 will illustrate the feeding positions of pile yarns according to the positions F11 and F12 in Fig. 54.

25 Fig. 57 is a diagram of the tracks of needles and pile elements for manufacturing a looped fabric from three pile yarns.

30 DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Fig. 1 illustrates a pile fabric characterized by alternating pile loops from the both pile yarns. Both courses are composed from first pile yarns A1, B1 and
35 second pile yarns A2, B2 alternatively forming pile loops

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(PA1, PA2), respectively, or regular sinker loops (SA1, SA2). Each sinker loop connects adjacent stitches, from which pile shanks from the same (pile) yarn will protrude, ensuring an improved W-nap tie-in of the pile shanks into the fabric whereby by the pile formation from two pile yarns the full pile density is realized. From the illustration it is also visible that an additional ground yarn is principally not required when the friction of the pile yarns to one another and when the stitch density is sufficient for providing solidity or tightness of the fabric from the regular sinker loops of the pile yarns.

According to the intentions of the fabric designer the pile loops PA1, PA2 of the pile yarns are arranged between the same wales, as shown, or can be staggered in subsequent courses in a desired cycle.

With the described advantage of the improved meshing of the pile loops this fabric is an advance in knitting plain pile fabrics.

In Fig. 2 a part of a patterned pile fabric from two pile yarns is shown and illustrates an alternate knitting of ground yarn portions and pile loop portion from each pile yarn. The first pile yarns C1, D1 are knit into regular sinker loops SC1 when the second pile yarns C2, D2 are drawn to pile loops PC2. Then, the first pile yarns C1, D1 are drawn into pile loops PC1 while the second pile yarns C2, D2 are knit into regular sinker loops SC2. If required the solidity of the fabric on the alternation of the pile forming from one to the other pile yarn is improved by feeding an additional ground yarn.

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A sufficient solidity or tightness of the fabric formed from two pile yarns is obtained when changing the pile forming from one pile yarn to the other pile yarn by forming a regular sinker loop SL from both pile yarns as shown in Fig 3 between the pile loop forming portions. Pile areas from first pile yarns E1, F1, G1 (PE1) are connected by a regular sinker loop SL from first and second pile yarn with the pile areas (PE2) from the second pile yarns E2, F2, G2.

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Fig. 4 illustrates a section of a fabric in which the courses are composed from three pile forming yarns. A first course is shown as being knit from yarns H1, H2 and H3, and a second course from yarns K1, K2 and K3. According to the sequence of one exemplary pattern, the pile loops (PH1, PH2, PH3) from one of the three pile yarns will alternate. The regular sinker loops are knitted from both other non loop forming yarns and will ensure a sufficiently solid fabric, thereby excluding generally, a specific ground yarn.

20

If more than three colors in one line of a pattern are provided it is necessary to distribute the different colors into two succeeding courses where, in each course, the pile forming is suspended when pile loops are arranged in the other course. This patterning is well known and the reduced pile density can be improved by an increased course-density and higher pile loops. Especially when velour-type fabrics are produced it is recommended to sever the pile loops in the machine as described.

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If the dial is equipped with at least two different needle groups, alternating with one another, fabrics according to the invention can be manufactured by a knit

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and miss base fabric construction in the same way as described. Such base fabric constructions are well known (for example from the additional US Patent Nos. 2,710,527 and 4,409,800). In contrast to the description of the
5 embodiments only one group of the needles is raised and the other group will miss. In the subsequent feeder the needle groups are alternatively raised for knitting according to a predetermined sequence, for example, according to the referred documents.

10

With two different groups of needles it is also practicable to mesh the pile yarns in a lay-in structure into the fabric. To obtain this structure alternate needles are raised into tuck position and after feeding
15 the pile forming yarns as described below in the embodiments, tucking the needles are retracted to knock over. The needles with the tucks of the pile yarns remain in the subsequent feeder in miss or idle position. Meanwhile the alternative needles are raised to a
20 clearing position and will knit, at least with a ground yarn, single threaded stitches. Thereafter, the floats of this ground yarn will tie in the previous tucked pile yarns into the fabric and will prevent movement of the pile yarns when the needles are raised in a subsequent
25 feeder.

A fabric of this type is illustrated in Fig. 5. The pile yarns L1 and L2 are meshed together into the ground fabric in a lay-in structure and pile loops (PL1, PL2)
30 from one of these yarns will be alternatively formed. The pile yarns L1 and L2 are then tied into the fabric with the floats FG2 of ground yarn G1 knitted in alternate wales to stitches. Subsequently, the pile yarns M1 and M2 will be tucked in these wales and ground yarn Gm is knit
35 subsequently in the alternative wales, by clearing the



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tucks of pile yarns L1 and L2 from these needles, and meshing in the tucks of pile yarns M1 and M2. To the stitches of ground yarn Gm the tucks of pile yarns N1 and N2 are arranged, which are tied in into the fabric from
5 ground yarn Gn.

As is well known a lay-in structure enables the engagement of courser yarns so that a high pile density is obtained.

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In addition to the above described fabric, the stitches of the ground fabric can be knit at least from two pile forming yarns as described in the embodiments throughout. In this way fabrics with more than three different yarns
15 in one line or course are arranged without a reduction of the pile density.

The lay-in structure of the pile yarns can be incorporated into a plain course from all needles when
20 the dial-needles cooperate with holding sinkers as proposed, for example, in the German Patent Publication 27 04 295.

The illustrations according to Fig. 1 to 5 and the
25 description to them provide an impression of the wide range of fabric constructions which can be created by the application of the present invention.

Turning now to the apparatus, the simplified cross
30 section of a circular knitting machine in Fig. 6 shows an arrangement of needles N in a dial D and pile elements 1 in a cylinder C. The pile elements 1 are collectively actuated by their butt 1b or individually by control
jacks 3 in the form of two arm levers with a butt 3a on
35 the upper portion and a butt 3b on the lower portion. The

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control jacks 3 are arranged in a recessed portion of the pile elements 1 and are positioned by known patterning devices from a reset position, in which all upper butts are depressed to the cylinder and all butts 3b are protruding from them individually to a selecting position with an opposite arrangement of the butts 3a and 3b. Each protruding butt is controllable by cooperating cams as later described according to Fig. 7.

10 The needles 1 in the dial D are actuated collectively all together by cams to knit a plain fabric or in at least two groups in a predetermined different knitting cycle for knitting basic ground fabric structures. Needle control and cams are well known by persons skilled in the art.

For severing the pile loops movable cutting elements 2 are arranged in a sinker ring S which is mounted to the cylinder or is separately arranged and driven synchronously with the cylinder and dial.

As is visible in Fig. 6a an inclined knitting ledge Dk, cooperating with the needle hooks of needles N, is provided on the dial to improve the regular plating of the yarns. The pile elements 1 are characterized by a hook at the top end with a peak 1p advanced or staggered forward relative to the center of the arc of the hook towards neb 1n. From peak 1p a positioning ledge 1s is inclined toward the dial, opposite to the hook opening, and will support the separation of the pile forming yarns. Pile loops can be drawn out from the arcs of the hooks or the stem portion Pk of the pile elements.

The pile elements 1 have a sharpened cutting ledge 1c along the lower part of the stems and to sever pile loops

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ledge 1c is positioned opposite cutting ledge 2c of cutting element 2. Arrangement of the cutting ledges 1c and 2c to one another and the procedure of severing the pile loops are described according to Figs. 2 and 3 of the earlier German Patent application 195 18 490.4, respectively, US-A2-4,592,212 which are herewith fully incorporated by way of reference for further details.

10 Movement of the needles N to produce a plain fabric is shown in Fig. 7 with the pile elements 1 knitting alternately with one of two pile yarns and the cutting elements 2. According to the tracks of these elements the cams therefore are shaped.

15 Needles 1 are controlled according to track NT to a clearing position. At this time all pile elements are retracted according to track 1T in position to straighten out the previous knitted pile loops so that their stitch portions (see Fig. 10), which may be enlarged by the
20 latch clearing movement of the needles, are retracted and tighten around the needle stems to obtain a clear stitch side of the fabric. Thereafter, all pile elements 1 are raised to a cutting position, and the needles N are retracted to a feeding position. Nearby to the approach
25 of the pile elements 1 in cutting position the cutting elements 2 are actuated according to track 2T to the center of the machine, thereby performing a scissor-like severing of such pile loops which are previously arranged in-between the cutting ledges 1c and 2c (position VI
30 respectively Fig. 11) by permanent knitting. The cutting action is terminated in position VII of Fig. 7, and as shown in Fig. 12 where the cutting ledge 2c has passed cutting ledge 1c of the pile element. Thereafter, the cutting elements 2 are retracted to their idle position.
35 Simultaneously to the stretching action of the pile loops

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(position V in Fig. 7) the control jacks 3 will be positioned in a reset position by depressing butts 3a into the cylinder. Subsequently, the control jacks 3 are actuated from a mechanical or electronic selecting device individually to a selected position. Patterning controls corresponding to the above description are known, for example, from the documents DE-A1-23 64 138 or DE-A1 24 47 427.

10 Shortly before the end of the retraction of cutting elements 2 into an idle position, the pile elements predetermined to miss the first pile yarn are retracted, according to track P2 by cams acting on butts 3a, below the cheeks of the needles (position VIII in Fig. 7). At
15 this time, shown also in Fig. 13, a first pile yarn T1 is fed to the pile elements located in feeding position according track P1, whereafter these pile elements are retracted to an intermediate position as shown in Fig. 14 (position IX in Fig. 7) in which the hooks of the pile
20 elements will control the engaged pile yarn T1, unaffected by this movement to the stitch forming action above the needle cheeks.

Also at position IX of Fig. 7 a second pile yarn T2, and
25 if provided a ground yarn G, is fed (Fig. 14).

Immediately with the feeding of the second pile yarn T2 the needles N start their retraction for stitch forming action.

30 The movement of pile elements simultaneously with the stitch forming action of the needles is performed, in one way, corresponding with the tracks P1, P2 and 1T of Fig. 7, as shown in more detail in Figs. 8a and 8b, or on the
35 other hand corresponding to tracks P11 and P12 in Fig. 7,

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as shown in dash lines and illustrated in detail in Figs. 9a and 9b.

Referring now to the Figs. 8a and 8b the second pile yarn
5 T2 is engaged by the needle hooks and drawn to the dial. Shortly before the pile yarn T2 approaches pile elements 1, pile elements predetermined to engage the second pile yarn T2 are raised corresponding to track P2. Such
10 predetermined pile elements will be either all previous ones which have missed the first pile yarn T1 or, in respect to an additional selection, at least a part of them. In Fig. 8b pile element 1/1 will start raising for engaging the second pile yarn T2; pile element 1/3 is already positioned to do this.

15 Starting out from Fig. 15 a pile element raising for engaging the second pile yarn T2 (1/1 in dash lines) will penetrate with their peaks 1p in front of the first pile yarn T1 through the needle line. By this action the
20 positioning ledge 1s will shift pile yarn T1 onto the back of the raising pile such as elements 1/3 as shown in Fig. 16, according to the arrangement of the relevant needles and pile elements in Figs. 8a and 8b.

25 At the same time the pile elements which have engaged the first pile yarn T1 (1/2; 1/4 in Figs. 8a and 8b) are slightly retracted to avoid an engagement of the second pile yarn T2 (Fig. 17) and to assure that pile yarn T2 can slide overhead of the retracted pile elements (such
30 as 1/4 shown in Fig. 18) thereby controlling the position of first pile yarn T1.

When the needles have passed the pile elements (subsequent from needle N5 in Fig. 8a) the tracks P1 and
35 P2 are united to track 1T and needles and pile elements

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are collectively retracted for stitch and pile forming (see, Figs. 19, 20 and 21).

With the retracting of the pile elements 1 for pile forming it is possible to adjust the pile length according to the retracted position. On the other hand by the retraction of the pile elements into the pile forming position the relevant pile yarn is controlled to the inside of the needle hooks (see Fig. 19) and a reverse plating effect will result.

To obtain a regular plating the pile elements are actuated corresponding to the tracks P11 and P12, which will continue tracks P1 and P2 when the needles have passed the pile elements (see, Fig. 7, and Figs. 9a and 9b).

Referring to Figs. 9a and 9b the needles N1 - N8 are actuated identically as in Figs. 8a and 8b. In contrast to the previous arrangement, the pile elements 1/11 - 1/18 are controlled in alternative positions from pile elements 1/1 - 1/8 in Fig. 8b, to illustrate the different effects, with pile elements 1/11, 1/13, 1/15 and 1/17 positioned to engage the first pile yarn T1. Generally, the treatment of the pile yarns and their separation is identical to that described above.

When the second pile yarn T2 approaches the pile elements with needle N1 (Fig. 22) pile element 1/12 starts to raise for engaging the second pile yarn T2. Thereby the peak of this pile element will penetrate through the needles in front of the first pile yarn T1 and will shift this pile yarn T1 with the positioning ledge 1s onto the back of pile element 1/12. The position of pile element 1/13, this element controlling the first pile yarn T1 in

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its hook, is slightly retracted (as shown in Fig. 23) so that the second pile yarn T2 is prevented from entering the hook of pile element 1/13.

5 The position of pile element 1/14 is arranged to engage the second pile yarn T2 (Fig. 24) while according to Fig. 25 the hook of needle N4 passes the pile elements by which the second pile yarn T2 is drawn into the hook of pile element 1/14 and is controlled overhead of the pile
10 element 1/15 which has engaged the first pile yarn T1.

In contrast to the control of the pile elements corresponding to Fig. 8a and 8b, in the present embodiment the pile elements which have engaged the
15 second pile yarn T2 remain in their raised position to which the other pile elements are now actuated by track P11 in Fig. 9b).

According to Fig. 26 pile element 1/15 starts to raise up
20 to the position of pile element 1/16 which has engaged the second pile yarn T2. All pile elements which are not designated to engage the second pile yarn T2 are raised to a collective position with all other pile elements (Fig. 27) in which the pile loops from the pile yarns are
25 drawn out along the longitudinal axis of the needles. This occurs when the hooks of the needles have passed the pile elements according to track NT. By this action the looping portions of the pile yarns contact first the innermost position of the needle hooks while non-pile
30 forming portions of the pile yarns will contact the knitting ledge Dk of the dial which will arrange these portions inside of the needle hooks for regular plating.

As is visible from the top views of Fig. 8a and 9a, the
35 needles N6 to N8 will knit stitches from both pile

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forming yarns whereby regular sinker loops (representing a ground fabric portion) from one of the yarns on the dial ledge Dk are arranged, when the other yarn is drawn out to pile loops, on the selected pile element.

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A fabric construction resulting from the above described procedure is characterized by full pile density, with each stitch having a protruding pile, and an increased solidity of the meshed pile in which the pile shanks of a
10 pile forming yarn are protruding from adjacent stitches connected by a regular sinker loop as evident from the arrangement of the yarns in Fig. 8a and 9a between the needles N6 to N8. (and illustrated also in Fig. 1)

15 As is also evident from Fig. 8a and Fig. 9a only in the illustrated arrangement of alternately pile forming from two yarns, the first pile yarn is arranged at most in a section of three needles (N2 to N4) in a wave-like manner in front of and, respectively, behind the pile elements.
20 The therefrom resulting tensioning of the first pile yarn for knitting and pile forming is negligible and is nullified by each other selection or alteration of the needles.

25 At least theoretically, under this condition a ground fabric knitted from a specific ground yarn is not required. In practice, a pile fabric exclusively manufactured from two pile yarns, in which the alternation from a portion of pile loops of one yarn to a
30 portion from the other yarn is realized by a stitch from which each pile yarn is protruding with a pile shank, may not have the required solidity or tightness especially when arranged corresponding to the above described embodiment.

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To improve the solidity or tightness of such a fabric use of a specific ground yarn is recommended. In patterned pile fabrics an additional ground yarn is not required, when on the alternation of different pile sections at least one sinker loop from both pile yarns is provided which will ensure a sufficient solidity of the fabric. (as illustrated in Fig. 3)

Again it is demonstratively indicated that the separation of the pile yarns for loop forming and the unaffected feeding of the yarns to the pile forming action is the essential part of this invention.

Resulting from the foregoing description of fabric construction it is obvious that in knitting with three pile yarns restrictions in respect to the solidity or tightness of the fabric are avoided. (as illustrated in Fig. 4)

When knitting with three pile forming yarns the procedure of handling the second and third pile forming yarn is identical according to the treatment of first and second pile forming yarn in the above described embodiment. Therefore, it is required that the first pile yarn is arranged in a way in which it is not affected from the actions of pile elements engaging the second and third pile forming yarn.

The requirements for an unaffected movement of the first pile yarn from the feeding to the stitch and pile forming actions is visible from Figs. 28a and 29. The upper portion of pivotable pile element 11/I is moved or rocked with the first pile yarn T11 towards the dial D so that pile yarn T11 will move behind the backs of all those

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pile elements 11/II remaining in vertical or unrocked position.

Referring to Fig. 28a and 28b the pile element 11 is
5 linked with an intermediate jack 4, with neb 4m arranged in a recess of the pile element 11. The intermediate jacks 4 are actuated collectively by butt 4b or individually from control jacks 5 which are arranged and acting with butts 5a and 5b corresponding to the
10 foregoing embodiment.

The nebs 11h and 11k of the pile element 11 cooperate with the neb 4n on the intermediate jack 4, respectively, with guiding cam Ch.

15

Fig. 30 illustrates the movement of the needles by track TN (seen from the top) and the horizontal (rocking) movement of the pile elements in the tracks Tp1 (pivoted or rocked) and Tp/A (vertical).

20

Also from the top the movement of cutting elements is shown and their track is indicated by 2t.

From the front are shown in Fig. 30 the tracks of pile
25 elements 11, and the intermediate and control jacks (4 and 5).

Track 11T represents the movement of the pile elements 11 and is divided, corresponding to the process, into the
30 tracks 11Ta, 11T1, 11T2 and 11T3. The track of the butts 4b of the intermediate jack 4 is shown in the tracks T4, T4a, T4/1, T4/2 and T4/3.

The butts 5a of the control jacks 5 are moving according
35 to tracks TA, TA/1, TA/2 and TA/3, corresponding to an

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opposite disposition of the butts 5b which are moving according to tracks TB and TBa. Full lines on tracks TA or TB represent projecting butts, dash lines representing depressed butts which are moving indirectly by movements
5 actuated on the other butt or from butt 4b of the intermediate jack 4.

The knitting process in this embodiment starts identically with the above described process. The needles
10 are raised to the clearing position and the pile elements are retracted to tensioning the pile loops (compare Fig. 10). Thereafter, the needles are retracted to a feeding position and the pile elements are raised to a cutting position (compare Fig. 11) in which they will remain
15 nearby to the end of the cutting action (compare Fig. 12) of the cutting elements.

Simultaneously to the cutting action the control jacks 5 are reset and divided. A cam acting now on butts 5b will
20 retract also intermediate jack 4 and the corresponding pile elements 11 to an idle position according to the tracks TBa, T4a and 11Ta in which the peaks of the pile elements 11 are arranged in line or below the cheeks of the needles N (Fig. 31) while the other pile elements 11
25 are controlled or locked in a feeding position (track 11T1) to engage a first pile yarn T11 which is fed in position XXVI of Fig. 30 and shown also in Fig. 31.

After feeding yarn T11 the raised pile elements 11 are
30 retracted on butts 4b to an intermediate position according to tracks T4/1 and 11T1. By this action, as well as in the foregoing retraction of all pile elements missing the first pile yarn T11 (e.g. 11/II, the nebs 11h of the pile element and nebs 4n of the intermediate jacks
35 4 remain separated from one another and therefore are not

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linked together, as is shown by the dashed lines of intermediate jacks 4 in Figs. 28a and 29. By raising the previously retracted intermediate jacks 4 (T4a) the nebs 4n will overlap and engage the nebs 11h of the cooperating pile elements (missing the first pile yarn T11) as shown in full lines in Fig. 28a and 29 and will control and hold such elements further on in a vertical position (11/II).

- 10 Simultaneously with the retraction of the pile elements with the first pile yarn the control jacks are reset and divided for subsequent action.

When the pile elements, with the engaged pile yarn T11, have nearly approached their intermediate position according to position XXVII in Fig. 30, the cutting elements 2 are slightly moved towards to the dial. The compression of the cutting elements 2 against the pile elements 11 pivots the pile elements 11 which have engaged the first pile yarn T11, and which are not controlled at this time in a vertical position by the overlapping nebs 11h and 4n, also towards to the dial (e.g. pile element 11/I in Fig. 28a), so that the first pile yarn T11 can move unaffected to the pile forming and knitting action between upright and pivoted pile elements (Fig. 32).

Subsequently predetermined pile elements 11/II raised by a cam acting on butts 5a according to tracks TA/2, T4/2 and 11T2 into a feeding position (position XXVII in Fig. 30) and after feeding a second pile yarn T12 (Fig. 33) these predetermined pile elements 11/II retracted to an intermediate position by a cam acting on the butts 11b of the pile elements so that the overlapping arrangement of nebs 4n and 11h remains for example, as discussed

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previously for pile element 11/II in Fig. 28. Additionally, the holding cam Ch will cover neb 11k of the pile elements 11/II which have not engaged the first pile yarn T11 (see Fig. 29). As illustrated in Figs. 29 and 34 the first and second pile yarns T11, T12 are separated and can move to the knitting and pile forming action unaffected by the previous actions.

Simultaneously with the retraction of the pile elements which have engaged the second pile yarn T12, the control jacks 5 are reset and divided for engaging a third pile yarn T13. The pile yarn T13 is fed immediately prior to the retraction of the needles N at position IXXX in Fig. 30 so that the pile yarn T13 is quickly engaged by the needle hooks and controlled towards the dial.

The pile forming and knitting action is illustrated in detail corresponding to section XXX, in Fig. 30, in Fig. 35a where the needles and pile elements are shown from the top, and in Fig. 35b where the same portion is shown from the front. Additional side views of needles N13 to N16, that are cooperating with the pile elements, are shown in Fig. 36 to 39.

According to track TA/3 selected control jacks 5 with the cooperating intermediate jacks 4 and pile elements 11/II are raised from their idle position to an engaging position as illustrated by pile element 11/3 in Fig. 35a, 35b and 36. By this movement the second pile yarn T12 is arranged on the back of raised pile element 11/3 and will stay on the back of pile element 11/3 for a distance or space of preferably up to three needle positions. If the pile elements are provided to alternatively engage the second (T12) and third (T13) pile yarns, the second pile yarn T12 is arranged in a wave-like manner as described

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in earlier embodiments. (as illustrated in Fig. 8a, respectively 9a with pile yarn T1)

At the same time pile elements with the first pile yarn
5 T11 and second pile yarn T12 are slightly retracted (for
example, pile elements 11/4 and 11/5 in Fig. 35b, 36, 37,
and 38) so that the yarn portions of pile yarn T13 not
engaged by pile elements will pass with the needle hooks
overhead of these slightly retracted pile elements as is
10 shown for pile element 11/5 in Fig. 35b. Also, yarn
portions by pile yarn T12 not engaged from pile elements
will pass with the needle hooks overhead of pile elements
which have engaged the first pile yarn T11.

15 When the needle hooks have retracted towards the dial and
passed the pile elements, the pile elements with the
first pile yarn T11 (pile element 11/6 in Fig. 35a, 35b
and 38) are pivoted back into a vertical position by cam
Cp (Fig. 40, 41, 42) and are supported by an outward
20 movement of the cutting elements (see track Tpl in Fig.
30). Simultaneously, the pile elements which have not
engaged the third pile yarn T13 are raised by the butts
of the pile elements 11, so that pile forming is realized
along the longitudinal axis of the needles to perform a
25 correct or regular plating.

It is self-evident from the first embodiment that the
pile elements can also be retracted for pile forming by
which a reverse plating will result. (see Fig. 8b)

30

The movement of pivoted or rocked pile elements which
have engaged the first pile yarn back to a vertical
position is illustrated in Fig. 40 to 43.

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The retracting of pile element 11/I along path 11T1 respectively 11T2 which engaged the first pile yarn T11 in section XXX of Fig. 30, is realized by retracting cam Cr, acting on the protruding ledge 11r of the pile element (Fig. 29). Pile elements 11/II, which have engaged the second pile yarn T12 or will miss all pile yarns, are retracted by butts 5b (Fig. 30) via path Tbm in Fig. 30. They are controlled in vertical position by holding cam Ch (Fig. 40, 41), cooperating with neb 11k (Fig. 41).

Simultaneously with the raising of previously retracted pile elements 11/I and 11/II by raising cam C1, shown in Fig. 41, 42 acting on butt 4b, as a presser cam Cp will act on the protruding parts of the pivoted pile elements 11/I (Figs. 40-42), so that they are rocked back into a vertical position when the stitch forming action is initiated in which all pile elements 11 are controlled by cam Cg (Fig. 43).

From the description of all embodiments above it is obvious that the present invention provides an excellent approach for manufacturing velour-type fabrics by association of the proposals for severing pile loops according to EP-A2-0 082 538, resp. US A2 4,592,212 and German patent application 195 18 490.4.

Nevertheless pile fabrics with regular loop structure can also be manufactured. This is realized by additional use of well known proposals.

As known from different methods, looped pile fabrics according to the invention are realized by arranging a latch on the above described pile elements. The latches are opened on the beginning of a knitting cycle and

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thereafter in an additional section the pile elements are raised, the pile loops are cleared from the latches and, after retraction of the pile elements, the pile loops are cleared from the pile elements (note, for example, German
5 Patent Application 27 04 295).

To avoid additional movement of the pile elements for clearing pile loops it is also possible to use pile elements with hooks positioned toward the dial, for
10 example, as proposed in US-Patent 4,043,151. For realization of the present invention such elements must be modified and improved as described in the following embodiments.

15 As illustrated in the simplified cross-section of a circular knitting machine in Fig. 44 hooked pile elements 21 are arranged in the cylinder C. As shown by pile elements 21, the pile forming hooks are characterized by a peak 21p advanced on staggered towards the dial in
20 relationship to the inner arc of the hook to support the dividing and control of the pile yarns and by an inclined positioning ledge 21s that slopes away from the dial and extends from the peak 21p opposite to the hook opening. The pile elements 21 have on their inner side, facing the
25 file, a recess R cooperating with a neb 22n of intermediate jacks 22, which can actuate the pile elements in a longitudinal direction in association with a selection arrangement analogous to the illustration and description of the previous embodiment.

30 The complete arrangement of pile elements 21, intermediate jacks 22 and control jacks, similar to 5 in Fig. 28b, is collectively controllable by butt 21b of the pile element which is additionally pivotable by butt 21d
35 when cooperating with a presser cam PC.

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The arrangement of the needles N and their movement for knitting a complete course is accomplished in a manner analogous to that described for the previous embodiments.

5

In Fig. 45 the required movements of needles N and pile elements 21 for knitting a plain course with pile loops alternatively from two pile yarns is illustrated. The needles N move along track Tn, from the right to the left, while pile elements 21 move according to tracks P21, P21a and P21b, respectively.

When the needles N are raised to a clearing position the pile elements 21 are arranged in an idle position. Immediately with the clearing of the stitches from the latches a stretching out of the previous knitted pile loops can be realized. Simultaneously with this action the control jacks are reset and divided.

20 The needles N are now retracted to a feeding position and all those pile elements 21 predetermined or selected to engage one of the two pile yarns are raised to a feeding position as indicated in Fig. 45 as position F1 in which pile yarn T21 is fed (Fig. 46).

25

Prior to the feeding position of T21 the control jacks of the raised pile elements and the raised intermediate jacks, are divided so that predetermined pile elements 21 for engaging the first pile yarn T21 are retracted along path P21a to an intermediate position as shown in Fig. 44. The upper end of the remaining pile elements 21r are simultaneously pivoted or rocked outward away from the dial by the action of presser cam PC operation on butts 21d (Fig. 44).

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According to Fig. 47 the second pile yarn T22 is fed to the pivoted or rocked pile elements 21r, corresponding to position F2 in Fig. 45, whereafter also these pile elements are retracted, preferably by butts 21b (track P21b in Fig. 45), to an intermediate position as shown in Fig. 48. As illustrated therein the second pile yarn T22 is correctly arranged at the backs of the pile elements 22 which are controlling the first pile yarn T21, which is exactly separated from the second pile yarn T22 by the pivotal movement of the predetermined pile elements 21r.

Following the positioning of the pile elements with the second pile yarn T22 the knitting and pile forming action according to section K in Fig. 45 is initiated by retracting the needles N into the dial (Fig. 49). Thereby the pivoted position of pile elements 21r with the second pile yarn T22 is nullified, that is the pivoted pile element 21r is rocked back to a vertical condition to a pile element 21 position (Fig. 50), and a slight retraction of the pile elements 21 will assure that yarn portions of pile yarn T22, designated to knit a regular ground fabric portion, can pass overhead of the pile elements 21 controlling the first pile yarn T21 (as is demonstrated in Fig. 51). In cooperation with the stitch forming the pile loops alternatively from one of the pile yarns T21 resp. T22 are drawn out (Fig. 52).

The pile elements can be actuated in the pile forming process according to various requirements in different variations.

When the length of the loops is adjusted by the retraction of the pile elements 21 on butts 21b, or comparable butts on the intermediate jacks, the position of the retracting cam will specify a uniform loop length.

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The same will happen if simultaneously with the loop forming action a presser cam will pivot the pile elements to a predetermined rocked position.

5 The retraction of the pile elements via the cooperating intermediate and control jacks enables in addition to the alternate pile forming from two pile yarns, for example T21 and T22 the adjustment of the pile loops to two different lengths.

10

According to the above description the selection of the pile elements for retracting pile elements with a first pile yarn T21 will remain also for the loop forming action. With a different position of the retracting cams acting on the butts 5a or 5b of the control jacks 5 the loop length of each loop yarn is individually adjustable.

15

If different loop lengths from both pile yarns are requested subsequent to the retraction of pile elements with the first pile yarn 21, the control jacks must be reset and divided according to the predetermined length of the loops, which are realized by the different position of the retracting cams acting on the butts of the control jacks.

20

25

An alternative to the foregoing described embodiment is illustrated in the arrangement of pile elements and intermediate jacks in Fig. 53 and their movements according to Fig. 54.

30

Adjacent to a hooked portion 31h of the lower end of pile elements 31 a recess is formed in which a hooked portion 32h of an intermediate jack 32 can be located. The neck 32n of the intermediate jack 32 is acting in an enlarged recess of the pile element 31, which can be actuated on

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butts 31b and pivoted by butts 31d when cooperating with a presser cam as described in the foregoing embodiment before.

- 5 The selective movements of the intermediate jacks 32 and pile elements 31 are controlled from an arrangement according to Fig. 28b. The upright pile elements 31 are raised selectively from their intermediate jacks 32 into a feeding position (illustrated in Fig. 53 in dashed
10 lines). Prior to the feeding of a first pile yarn T31 these elements are pivoted or rocked by a presser cam acting on butts 31d (track P31a Fig. 54) to position 31r prior to the retracting of the intermediate jacks, so that the hooks 32h of the intermediate jacks will hook
15 into the depressed hook portion 31h of pile elements 31r which are then retracted in this disposition, as illustrated in Fig. 53 in full lines, by the intermediate jacks.
- 20 Fig. 54 illustrates the movements of pile elements and needles for knitting a course of looped pile fabric with two pile yarns T31 and T32. Track Tn for the needles is identical with the needle movement in the foregoing embodiment set forth with reference to Fig. 45. When the
25 needles are raised to the clearing position the pile elements 31 are retracted according track P31 for tensioning the previous knitted pile loops. Thereafter, pile elements 31 are raised to an idle position simultaneously with the retracting of the needles N to a
30 feeding position. Previously, the control jacks 5 will have been reset and divided so that according to track P31a selected pile elements are raised to a feeding position.

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Simultaneously, the raising selected pile elements are pivoted or rocked (with their upper ends) outward, so that at position F11 a first pile yarn T31 is fed to the pivoted pile elements 31r (Fig. 55). As described above
5 the pile elements 31r will remain in the pivoted or rocked position when they are retracted to an intermediate position without the support of a presser cam since the hooks 32h remain hooked with the depressed hook portions 31h as explained above.

10

Prior to the retraction of the raised pile elements 31r, the control jacks remaining in an idle position may additionally be divided so that all or a part of the cooperating pile elements 31 are raised according to
15 track 31b in Fig. 54. It is obvious from Fig. 55 that pile yarn T31 is shifted from the backs of the raising pile elements 31 into the hooks of the retracting pile elements 31r (Fig. 56).

20 When the pile elements 31, moved according to track 31b, are in feeding position a second pile yarn T32 is fed into the hooks of such pile elements 31 in position F12 of Fig. 54. The raised pile elements 31 will control further on the pile yarn T31 on their backs in the hooks
25 of pile elements 31r (Fig. 56). Thereafter, pile elements 31 are retracted to an intermediate position (analogous to Fig. 48) and the knitting and pile forming action is initiated as described in the foregoing embodiment (Fig. 49 to 52). Thereby the pivoted position of pile elements
30 31r is nullified, that is they return to an unrocked or vertical position, by an adequate raising of the intermediate jacks 32.

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The manufacturing of loop structures from three pile yarns is performed when the both embodiments described before are joint together. This is illustrated in Fig.57.

- 5 To realize a looped pile fabric with three pile yarns principally an arrangement of needles and pile elements as illustrated in Fig. 53 is provided wherein the pile elements 31 are pivotable or rocked into a medium and front position by an adequate arrangement of the fulcrum.

10

- The knitting process as shown in Fig. 57 starts with the raising of the needles N according to track Tn into a clearing position in which the pile elements are cooperatively retracted to tension the previous knitted pile loops (track P41). Simultaneously, a selection is performed so that predetermined pile elements are raised and pivoted or rocked to a front position according to track P41a. At position F21 in Fig. 57 the first pile yarn T41 is fed to the relevant pile elements.
- 15
- 20 Thereafter, the intermediate jacks are retracted so that they will hook into the rocked pile elements (analogous to Fig. 53) and will position the cooperating pile elements with pile yarn T41 in an intermediate position.

- 25 Simultaneously, those unrocked or vertically positioned pile elements remaining in an idle position are raised to a feeding position or a selected part of such pile elements if a dividing is desired and will include all pile elements that engage the second or third pile yarn (T42, T43), respectively. To these raised pile elements, at position F22 in Fig. 57, the second pile yarn T42 is fed. A further selection will assure that only predetermined pile elements, provided for looping the second pile yarn T42, are retracted with the pile yarn
- 30
- 35 T42 to an intermediate position according to track P41b.

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At the same time a presser cam acting on a presser butt of the unrocked pile elements remaining in feeding position will pivot or rock these pile elements according to track P41c into a medium rocked position in which the third pile yarn T43 is fed, as indicated at position F23 in Fig. 57. Subsequently, these pile elements are also retracted to an intermediate position and the looping and knitting action is initiated in the same way as described before.

It will be clearly seen from all the described embodiments set out herein that the highest capacity in manufacturing pile fabrics according to the present invention is obtained when all needles in the dial are uniformly actuated for knitting.

It will be obvious to those persons skilled in the art that divergent to the described embodiments the pile yarns can be also be engaged by predetermined needles, preferably alternating, for example analogous to relevant proposals referred in the introduction of the present application.

As is generally known, it is necessary to arrange at least two groups of needles and to manipulate the groups of needles relative to one another according to a predetermined sequence of knitting stations.

If the pile yarns are knitted from predetermined (alternate) needles to stitches, the movement of the needles will be identical to the referred embodiments.

As is known in the art an inlaid structure of the pile yarns is obtained by raising the engaging needles to the

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tuck position, which is identical to and will substitute as the feeding position in the embodiments. Therefore, in contrast to the previous embodiments, when the needles have been raised to their clearing position, as shown by path Tn, the needles are raised to a tuck or feeding position and will remain in that position while the process, according to one of the embodiments, is performed. Thereafter, an additional knitting process is required to knit a ground fabric from at least a ground yarn. If the bed supporting the needles is additionally equipped with sinkers (according to German Patent Publication No. 27 04 295) all needles can be raised to a clearing position and will knit a complete course, otherwise the alternative needles suspended from the previous pile forming process are raised and after knitting stitches the floats, overlapping the tuck stitches of the pile yarns, will prevent the pile yarns from moving subsequently with the raising of the needles.

With the exception of the embodiments in which the pile loops are severed in the knitting machine (Fig. 6 to 43), in which the needles must be arranged in a dial and the pile elements in a cylinder, the arrangement of the needles and pile elements can be alternative in one of the two cooperating beds for knitting looped structures. If the needles are supported in a cylinder and the pile elements in the dial an additional adjustment of the pile length is enabled by alteration of the space between dial and cylinder.

An impression of such an arrangement is made by turning the drawings of Fig. 44, 46 to 53 and 55, 56 clockwise for 90°.

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While the invention has been described in connection with what are presently considered to be the most practical and preferred embodiments, it is to be understood that the invention is not to be limited to the disclosed
5 embodiments, but on the contrary, is intended to cover various modifications and equivalent arrangements included within the spirit and scope of the appended claims.

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WHAT IS CLAIMED IS:

1. A knitted pile fabric comprising courses composed of
5 at least two pile yarns forming pile loops
alternatively from a selected one of said at least
two pile yarns between the wales to which all of
said pile yarns are meshed together, so that the
pile yarns are also incorporated in the course when
10 they are excluded from pile forming.
2. The knitted pile fabric according to claim 1,
wherein the said at least two pile yarns of a course
are meshed into the fabric by knitting stitches in
15 all wales.
3. The knitted pile fabric according to claim 1,
wherein the pile yarns are meshed into the fabric by
knitting stitches in alternate wales.
- 20 4. The knitted pile fabric according to claim 1, 2 or
3, wherein in an alternating manner at least one of
said at least two pile yarns is formed into regular
sinker loops when the other of said at least two
25 pile yarns is formed into pile loops.
5. The knitted pile fabric according to claim 1, 2 or
3, wherein said at least two pile yarns are
collectively knit to form regular sinker loops (SL)
30 in predetermined wales.
6. The knitted pile fabric according to claim 1,
wherein said at least two pile yarns are tucked into
alternate wales of the fabric.

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7. The knitted pile fabric according to claim 6 further including a base fabric knit from ground yarns.
- 5 8. The knitted pile fabric according to claim 7 wherein said ground yarns are knit into stitches in alternate wales.
- 10 9. The knitted pile fabric according to claim 7 wherein said ground yarns are knit into stitches in all wales.
- 15 10. The knitted pile fabric according to claim 8 or 9 wherein said base fabric further includes pile forming yarns.
- 20 11. A method for manufacturing a knitted pile fabric on a circular knitting machine which can sever pile loops and includes a circle of movable knitting needles each having a yarn engaging hook, a circle of pile elements each having a yarn engaging hook and a cutting ledge spaced from the pile element hook and a yarn supporting surface therebetween, the pile elements being movable transversely of and
- 25 between the needles and a circle of cutting elements each including a cutting ledge cooperating with a cutting ledge on the pile elements by a transverse movement of the cutting elements relative to the pile elements for severing the pile loops, said
- 30 method comprising the steps:
- a) actuating all pile elements to a cutting position and moving the cutting elements between the pile elements to and from a cutting position;
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- b) actuating the knitting needles into a feeding position;
- 5 c) actuating predetermined pile elements to a feeding position and the remaining pile elements to an idle position and feeding a first pile yarn to the pile elements positioned in a feeding position;
- 10 d) retracting the predetermined pile elements with the first pile yarn to an intermediate position;
- 15 e) feeding a second pile yarn to the knitting needles and retracting the knitting needles with the second pile yarn; and
- 20 f) simultaneously raising selected pile elements from an idle position to move their hooks above the hooks of the knitting needles to engage the second pile yarn;
- 25 g) retracting the pile elements with the engaged first pile yarn so that unengaged portions of the second pile yarn can pass over such retracted pile elements; and
- 30 h) retracting the knitting needles to a knock over position and retracting the pile elements to a pile forming position.

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12. A method for manufacturing a knitted pile fabric on a circular knitting machine which can sever pile loops and includes a circle of movable knitting needles, each having a yarn engaging hook, a circle of pile elements each with a yarn engaging hook and a cutting ledge spaced from the pile element hook and a yarn supporting surface therebetween, the pile elements being transversely movable of and between the needles, and a circle of cutting elements each having a cutting ledge cooperating with a cutting ledge provided on the pile elements for severing the pile loops by a transverse motion of the cutting elements between the pile elements, said method comprising the steps:
- a) raising all knitting needles to a feeding position actuating all pile elements to a cutting position and moving cutting elements to and from a cutting position;
 - b) actuating selected pile elements into a feeding position and the remainder of the pile elements into an idle position;
 - c) feeding a first pile yarn to the selected pile elements arranged at the feeding position;
 - d) retracting the selected pile elements together with the first pile yarn into an intermediate position and rocking the selected pile elements together with the first pile yarn inward toward the dial;

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- 5 e) raising predetermined pile elements from those retained at the idle position to a feeding position and feeding a second pile yarn to such pile elements raised into a feeding position;
- 10 f) retracting the predetermined pile elements together with the engaged second pile yarn to an intermediate position and thereafter feeding a third pile yarn to the knitting needles;
- 15 g) retracting the knitting needles together with the third pile yarn while simultaneously raising predetermined pile elements from the idle position with their hooks above the hooks of knitting needles to engage the third pile yarn;
- 20 h) partially retracting the pile elements which have engaged the first and second pile yarns so that unengaged portions of the second and third pile yarns can pass over the partially retracted pile elements; and
- 25 i) retracting the knitting needles to a knock over position and the pile elements to a pile forming position while simultaneously rocking those pile elements which have engaged the first pile yarn outwardly away from the dial back into a vertical position.
- 30 13. The method for manufacturing a pile fabric according to claim 11 or 12 wherein the pile elements are retracted for pile forming simultaneously to the stitch forming action of the knitting needles.

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14. A method for manufacturing a pile fabric according to claim 11 or 12 wherein the pile elements are positioned with a pile forming ledge between the needles for pile forming simultaneously to the stitch forming process.
15. A method for manufacturing a knitted looped pile fabric on a circular knitting machine having a circle of movable knitting needles and a circle of hooked pile elements movable transversely of and between the knitting needles, the method comprising the steps:
- a) raising the knitting needles to a feeding position and raising predetermined pile elements for pile forming from one of two pile yarns into a feeding position and controlling the remaining pile elements at an idle position;
 - b) feeding a first pile yarn to the pile elements arranged in the feeding position and subsequently retracting certain pile elements with the first pile yarn selected to knit pile loops from the first pile yarn into an intermediate position;
 - c) rocking those pile elements remaining in the feeding position outwardly from the dial and feeding a second pile yarn to such rocked pile elements;
 - d) retracting the rocked pile elements engaging the second pile yarn to an intermediate position;

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- 5 e) retracting the knitting needles and partially retracting the pile elements that have engaged the first pile yarn when the knitting needle hooks pass the pile elements so that unengaged portions of the second pile yarn can pass over such partially retracted pile elements which have engaged the first pile yarn and thereafter moving rocked pile elements back into a vertical, unrocked position; and
- 10 f) retracting the knitting needles to a knock over position and actuating the pile elements to a pile forming position.
- 15 16. A method for manufacturing a knitted looped pile fabric on a circular knitting machine having a circle of movable knitting needles and a circle of hooked pile elements movable transversely of and between said knitting needles, said method
- 20 comprising the steps:
- 25 a) raising knitting needles to a feeding position and raising pile elements selected to engage a first pile yarn into a feeding position;
- 30 b) rocking such pile elements outwardly from the dial and feeding a first pile yarn to such rocked pile elements;
- 35 c) retracting such rocked pile elements to an intermediate position and simultaneously with such retracting step selecting pile elements and raising the selected pile elements from an idle position to a feeding position and feeding a second pile yarn to such selected pile elements;

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- 5 d) thereafter retracting such pile elements with the second pile yarn from the feeding position to an intermediate position and then retracting the knitting needles;
- 10 e) partially retracting the pile elements immediately that have engaged at least the second pile yarn so that when the knitting needle hooks pass the pile elements the unengaged portions of the first pile yarn can pass overhead of the pile elements which have engaged the second pile yarn; and
- 15 f) retracting the needles into a cast off position and actuating the pile elements into a pile forming position.
- 20 17. The method for manufacturing a knitted looped pile fabric according to claim 15 or 16 wherein the pile elements are retracted for pile forming to a uniform position.
- 25 18. The method for manufacturing a knitted looped pile fabric according to claim 15 or 16 wherein the pile elements are retracted for pile forming to two different positions corresponding to their engagement of one of the pile yarns.
- 30 19. The method for manufacturing a knitted looped pile fabric according to claim 15 or 16 wherein the pile elements are additionally selected for retraction into two different pile forming positions.

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20. The method for manufacturing a knitted looped pile fabric according to claim 15 or 16 wherein the pile elements remain with their hooks in line with the needles for pile forming.
21. The method for manufacturing a knitted looped pile fabric according to claim 20 wherein the pile loops are rocked outwardly from the dial to a uniform pile forming position.
22. The method for manufacturing a knitted looped pile fabric according to claim 20, wherein a selected part of the pile elements are rocked outwardly from the dial to a second pile forming position.
23. The method for manufacturing a knitted looped pile fabric according to claim 20, wherein the rocked pile elements remaining their rocked position in the pile forming process.
24. A method for manufacturing a knitted looped pile fabric on a circular knitting machine having a circle of movable knitting needles and a circle of hooked pile elements movable transversely of and between said knitting needles, said method comprising the steps:
- a) raising knitting needles to a feeding position and raising selected pile elements for engaging a first pile yarn into feeding position;
 - b) rocking the raised pile elements to an outermost position away from the dial and feeding a first pile yarn to such rocked pile elements and

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thereafter retracting the rocked pile elements together with a first pile yarn to an intermediate position;

- 5 c) raising predetermined pile elements into a feeding position to engage a subsequently fed pile yarn;
- 10 d) feeding a second pile yarn to the pile elements raised into the feeding position and subsequently retracting certain ones of the pile elements with the engaged second pile yarn into an intermediate position;
- 15 e) rocking those pile elements remaining in a feeding position to a medium horizontal position and feeding a third pile yarn to such rocked pile elements;
- 20 f) retracting the pile elements from the feeding position into an intermediate position together with the third pile yarn;
- 25 g) retracting the knitting needles and partially retracting pile elements that have engaged one of the pile yarns a sufficient amount so that when knitting needle hooks pass the pile elements the unengaged portions of the first and third pile yarns will pass over those pile elements having engaged second and third pile yarns; and
- 30 h) retracting the knitting needles to a cast off position and actuating the pile elements to a pile forming position while simultaneously

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rocking the pile elements from their previously rocked positions back into a vertical position.

25. The method for manufacturing a knitted looped pile fabric according to claim 24 wherein the pile elements are retracted into a uniform pile forming position.
26. The method for manufacturing a knitted looped pile fabric according to claim 24 wherein the pile elements are positioned with their hooks in line with the knitting needles for pile forming.
27. The method for manufacturing a knitted looped pile fabric according to claim 26 wherein the pile elements are rocked outwardly from the dial into a uniform pile forming position.
28. The method for manufacturing a knitted pile fabric according to one of claims 11, 12, 15, 16 or 24 wherein all knitting needles are raised to a clearing position prior to their disposition in a feeding position.
29. The method for manufacturing a knitted pile fabric according to one of claims 11, 12, 15, 16 or 24 wherein alternate knitting needles are raised to a clearing position prior to their arrangement in a feeding position.
30. The method for manufacturing a knitted pile fabric according to claim 28 or 29, wherein the pile elements are retracted to a pile loop stretching position subsequent to a step of clearing of the loops from the latches of the knitting needles.

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31. The method for manufacturing a knitted pile fabric according to one of claims 11, 12, 15, 16 or 24 wherein alternate needles are raised to tuck position prior to feeding of the pile yarns, succeeded from feeders in which the needles are raised to clearing position for knitting a ground fabric from a ground yarn in a predetermined sequence.
32. The method for manufacturing a knitted pile fabric according to claim 31 wherein alternate knitting needles are raised into a tuck position prior to feeding of the pile yarns and, subsequent to the pile forming action, the remaining knitting needles are actuated for knitting a ground fabric from a ground yarn.
33. The method for manufacturing a knitted pile fabric according to claim 31 wherein alternate knitting needles are raised into a tuck position prior to feeding of the pile yarns and, subsequent to the pile forming action, all knitting needles are raised for knitting a ground fabric.
34. The method for manufacturing a knitted pile fabric according to claim 31 wherein alternate needles are raised in predetermined sequence for knitting a ground fabric.
35. The method for manufacturing a knitted pile fabric according to claim 31 wherein the ground fabric contains pile forming yarns.

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36. A circular knitting machine of the type having at least two cooperative beds adapted for movable disposition therein of circles of knitting needles and hooked pile elements, respectively, and arranged for respective movement of each said circle of knitting needles transversely of and between the other said circle of pile elements and having a plurality of knitting stations, said knitting machine further including:
- a) a plurality of knitting needles carried in one of said beds;
 - b) a plurality of hooked pile elements carried in the other of said beds, each of said pile element having a yarn engaging hook;
 - c) a pile yarn feed mechanism permitting a progressive feeding at least two pile yarns to said knitting needles and said pile elements;
 - d) a ground yarn feed mechanism permitting a feeding of a ground yarn to said needles;
 - e) a knitting needle and pile element actuating system permitting the progressive manipulation of said knitting needles and said pile elements to engage and manipulate the at least two pile yarns respectively, and a ground yarn, to knit a fabric with pile loops from the at least two pile yarns, and
 - f) a selecting mechanism to progressively manipulate said pile elements to engage alternatively one of

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said at least two pile yarns and forming pile loops from one of said at least two pile yarns.

37. The circular knitting machine as in claim 36 wherein
5 said pile elements are pivotally mounted so as to be laterally actuated into a rocked position.
38. The circular knitting machine as in claim 37 wherein
10 at least a part of said pile elements are rocked into different lateral positions to engage alternatively one of said at least two pile yarns.
39. The circular knitting machine as in claim 36 wherein
15 said circle of knitting needles is carried in a dial and said circle of said pile elements is carried in a cylinder.
40. The circular knitting machine as in claim 36 wherein
20 said circle of knitting needles is carried in a cylinder and said circle of said pile elements is carried in a dial.
41. The circular knitting machine as in claim 36 wherein
25 said circle of pile elements is hooked towards the bed of said circle of said knitting needles.
42. A circular knitting machine of the type having a
30 dial arranged therein, knitting needles disposed for respective movement to and between and transversely to hooked pile elements, each of said pile elements including a cutting ledge spaced from said hooks, said pile elements being arranged for respective
35 movement in a cylinder and having a sinker ring outside of the dial and the cylinder and spaced below the dial with sinker ring cutting elements

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therein each of which includes a cutting ledge, said
sinker ring cutting elements being arranged and
movable transversely with a spring contact by their
cutting ledges relative to said cutting ledges of
5 said pile elements for severing pile loops by a
respective movement therebetween, said knitting
machine having a plurality of knitting stations and
further including:

10 a) a plurality of pile yarn feeders progressively
feeding pile yarns to said pile elements and
knitting needles;

15 b) a ground yarn feeder progressively feeding ground
yarn to said knitting needles;

20 c) a cam structure to progressively manipulate said
knitting needles, said pile elements and said
sinker ring cutting elements so that at least two
pile yarns and the ground yarn are engaged to
knit a fabric with pile loops alternatively from
one of said at least two pile yarns;

25 d) a selecting mechanism to progressively manipulate
said pile elements to engage, in an alternating
manner, one of said at least two pile yarns, the
engaged pile yarn being formed into a pile loops,
and to retain the pile loops on said pile element
so that such pile loops become positioned between
30 the cutting ledges of said pile elements and said
sinker ring cutting elements; and

35 e) said cam structure moving said sinker cutting
elements transversely relative to said pile
elements and cooperate to sever the retained pile





loops thereby clearing such pile loops from said pile elements.

- 5 43. The circular knitting machine as in claim 42 wherein said pile elements are pivotally mounted so as to be laterally actuated into a rocked position.
- 10 44. The circular knitting machine as in claim 42 wherein said pile elements are positioned to engage the first pile yarn and then rocked toward to the dial when moved into an intermediate position and will be rocked back into vertical position simultaneously with the knitting action.
- 15 45. The circular knitting machine as in claim 42 wherein said circle of pile elements is hooked away from the bed of said circle of said knitting needles.
- 20 46. The circular knitting machine as in claim 36 or 42 wherein said knitting needle actuating system raises all of said needles to a clearing position prior to the feeding of the at least two pile yarns which are knitted to stitches in each wale.
- 25 47. The circular knitting machine as in claim 36 or 42 wherein said knitting needle actuating system moves alternating ones of said knitting needles to knit stitches from said pile yarns in a predetermined sequence.
- 30 48. The circular knitting machine as in claim 36 or 42 wherein said knitting needle actuating system moves alternate ones of said knitting needles to knit tuck stitches from said pile yarns and moves alternate
- 35 knitting needles in other knitting stations to the





clearing position to knit ground fabric from said ground yarn in a predetermined sequence.

49. The circular knitting machine as in claim 36 or 42
5 wherein said knitting needle actuating system moves alternate ones of said knitting needles to knit a ground fabric from said ground yarn and moves selected alternate knitting needles into a tucking position to receive and knit tuck stitches from the
10 at least two pile yarns in a predetermined sequence.
50. The circular knitting machine as in claim 36 or 42
15 wherein said knitting needle and pile element actuating system retracts said pile elements for uniform pile length simultaneously with the cast off movement of said knitting needles.
51. The circular knitting machine as in claim 36 or 42
20 wherein said pile elements include hook portions positioned in line to hook portions of said knitting needles simultaneously with the cast off movement of said knitting needles.
52. The circular knitting machine as in claim 36 or 42
25 wherein said pile elements actuating system moves selected one of said pile elements to two different pile engaging positions for engaging alternatively one of said at least two pile yarns.
- 30 53. The circular knitting machine as in claim 36 or 42 wherein said pile elements are manipulated to two different pile forming positions.

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54. A pile element comprised of a shank portion with a front side and a backside and having an upper end, said upper end including a hook portion defined between an interior arc shaped recess and an exterior surface, said exterior surface including a peak portion positioned to be offset from a center point of said interior arc shaped recess.
55. A pile element as in claim 54 wherein said exterior surface further includes a positioning ledge extending from said peak portion.
56. A pile element as in claim 55 wherein said positioning ledge is angled downwardly away from said peak position.
57. A pile element as in claim 54 wherein said hook portion includes a tip and said peak portion is offset toward said tip.
58. A pile element as in claim 54 wherein said pile element further includes a cutting edge on said shank portion positioned at a point spaced below said hook portion and directed in the same direction as said hook portion.
59. A pile element as in claim 58 further including a neb projecting outwardly from said shank portion in the same direction as said hook portion, said neb being spaced beyond said cutting edge and a raised portion extending along at least a portion of said shank portion beyond said neb.

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- 5 60. A pile element as in claim 54 wherein said pile element can be used in a cylinder of a knitting machine with said hook portion facing away from the cylinder.
- 10 61. A pile element as in claim 54 wherein said pile element can be used in a cylinder of a knitting machine with said-hook portion facing toward the cylinder.
- 15 62. A hooked pile element (1, 11, 21, 31) for knitting a pile fabric according to one of the claims 1 to 10 with a hooked portion at the upper end thereof for engaging a pile yarn and a butt (1b, 11b, 21b, 31b) on the front side for a uniform movement, characterized in that the peak of the hooked portion is positioned toward to the hook opening and staggered from the center of the inner arc of the
- 20 hook so forming an inclined positioning ledge from the peak to the backside of the hook opening.
- 25 63. A hooked pile element according to claim 62 wherein the hook opening is arranged to the front side of the pile element and a cutting ledge is arranged on the stem with sufficient space from the hook.
- 30 64. A hooked pile element according to claim 62 wherein the hook opening is arranged to the back side of the pile element.
- 35 65. A hooked pile element according to claim 63 or 64 wherein the pile element will have a fulcrum and ledges for a pivotal movement.

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