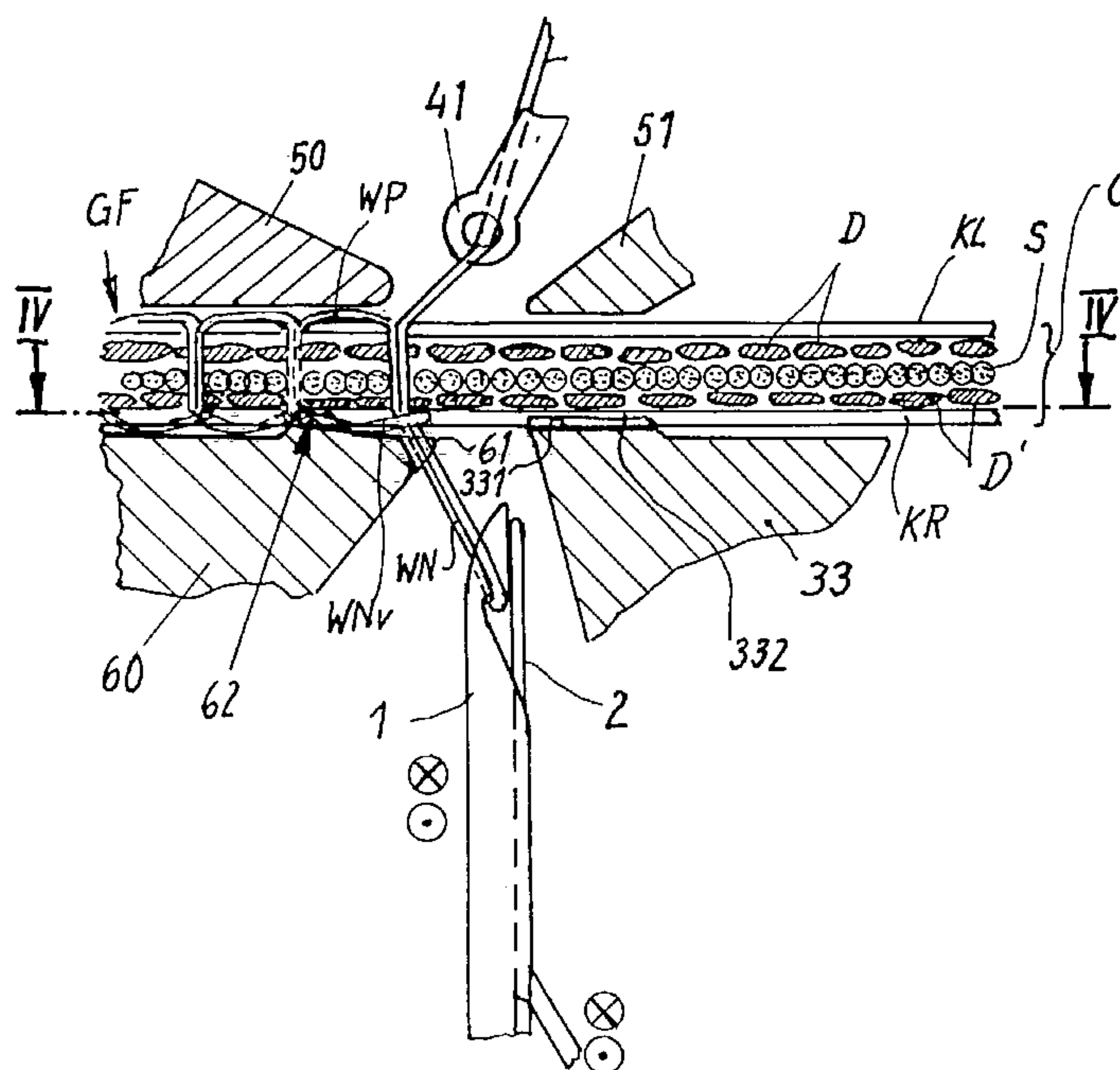




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(54) Titre : PROCEDE ET UNITE DE PRODUCTION D'UNE STRUCTURE DE FILS OU DE FIBRES MULTICOUCHE, PREFIXEE
 (54) Title: METHOD AND SYSTEM FOR PRODUCING A MULTI-LAYER, PRE-FIXED THREAD OR FIBRE ARRANGEMENT



(57) Abrégé/Abstract:

The invention relates to a method and a system for producing a multi-layer thread or fibre arrangement (GF) which is pre-fixed by means of a loop structure and is used as a strip-type semi-finished product for reinforcing elements consisting of plastic or resin. Said fibre arrangement (GF) comprises layers consisting of stationary weft yarns (K) and layers consisting of thread or fibre warps (S, D, D') which are stretched between conveyor chains in such a way that they are oriented in different directions. The aim of the invention is to reduce the costs and the required surface mass, simultaneously maintaining defined, required flexural strength. To this end, the method is designed in such a way that the stationary weft layer (KR) consisting of fibre or thread warps and oriented parallel to the working direction is located directly adjacent to the needle loops (WN) of the loop structure, and needle loops (WNV) of the loop structure cross the threads or fibres of the stationary weft layer, in the knock-over phase, before the knitting needles (1) penetrate the thread arrangement (G) in order to create a successive row of loops.

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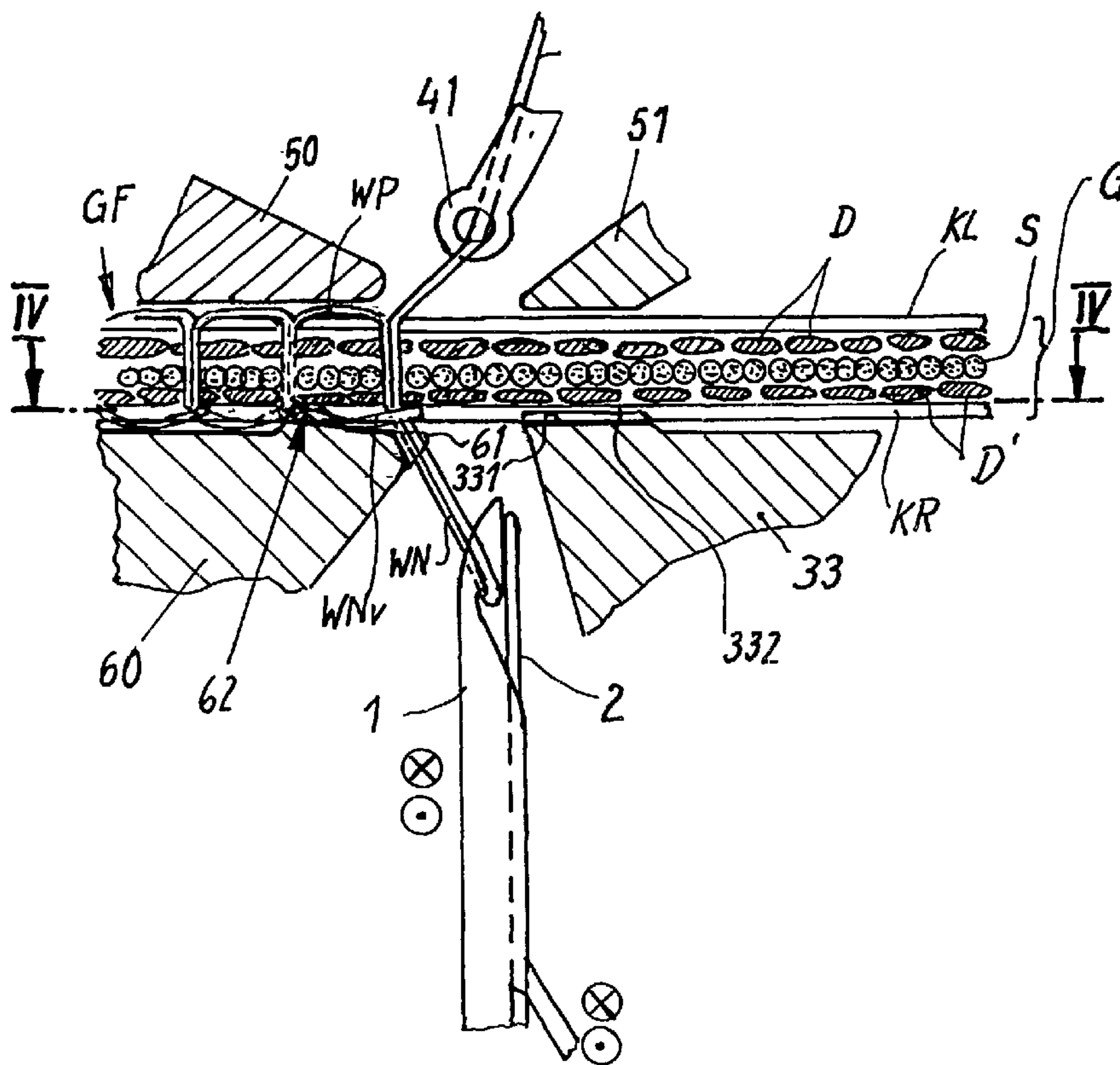
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(54) Title: METHOD AND SYSTEM FOR PRODUCING A MULTI-LAYER, PRE-FIXED THREAD OR FIBRE ARRANGEMENT

(54) Bezeichnung: VERFAHREN UND ANLAGE ZUR HERSTELLUNG EINES MEHRSCICHTIGEN, VORFIXIERTEN FADEN- ODER FASERGELEGES



(57) Abstract: The invention relates to a method and a system for producing a multi-layer thread or fibre arrangement (GF) which is pre-fixed by means of a loop structure and is used as a strip-type semi-finished product for reinforcing elements consisting of plastic or resin. Said fibre arrangement (GF) comprises layers consisting of stationary weft yarns (K) and layers consisting of thread or fibre warps (S, D, D') which are stretched between conveyor chains in such a way that they are oriented in different directions. The aim of the invention is to reduce the costs and the required surface mass, simultaneously maintaining defined, required flexural strength. To this end, the method is designed in such a way that the stationary weft layer (KR) consisting of fibre or thread warps and oriented parallel to the working direction is located directly adjacent to the needle loops (WN) of the loop structure, and needle loops (WNV) of the loop structure cross the threads or fibres of the stationary weft layer, in the knock-over phase, before the

knitting needles (1) penetrate the thread arrangement (G) in order to create a successive row of loops.

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(57) Zusammenfassung: Die Erfindung betrifft ein Verfahren und eine Anlage zur Herstellung eines mehrschichtigen, mittels Maschenverbund vorfixierten Faden- oder Fasergeleges (GF), das als bandförmiges Halbzeug zur Armierung von Teilen aus Kunststoff oder Harzen dient, wobei das Fadengelege (GF) Schichten aus Stehschussfäden (K) und Schichten aus Faden- oder Faserscharen (S, D, D') besitzt, die zwischen Transportketten unterschiedlich ausgerichtet gespannt sind. Mit dem Ziel der Reduzierung der Kosten und der Verringerung der notwendigen Flächenmasse bei einer bestimmten, geforderten Biegesteifigkeit wird das Verfahren so gestaltet, dass die parallel zur Arbeitsrichtung ausgerichtete Stehschussschicht (KR) aus Faser- oder Fadenscharen den Nadelmaschen (WN) des Maschenverbundes unmittelbar benachbart angeordnet wird und dass Nadelmaschen (WNv) des Maschenverbundes in der Abschlagphase die Fäden oder Fasern der Stehschussschicht kreuzen, bevor die Wirknadeln (1) zum Zwecke der Ausbildung einer folgenden Maschenreihe wieder in das Fadengelege (G) eindringen.

PCT/DE02/04647

5 **“Method and Apparatus for Producing a Multistratum,
Preset Thread- or Fiber Fabric”**

10 The invention relates to a method and a system for producing a multistratum,
preset thread- or fiber fabric that is used as a ribbon-shaped semi-finished product
for reinforcing parts made of plastic or resins and that in the individual strata
comprises thread- or fiber sheets, each of which are oriented differently, whereby
in at least one of the strata – a stationary weft – thread- or fiber sheets are oriented
largely parallel to the working direction, whereby at least one of the strata
comprises thread- or fiber sheets that are stretched between rows of hooks of
conveyor chains on both sides of a laying arrangement for producing the thread
15 fabric, whereby the thread- or fiber fabric is supplied to a warp knitting machine
at the speed of the aforesaid transport chains and there – stretched between the
transport chains – is preset by means of a system of loops and whereby needle
loops and plate loops of the system of loops enclose threads or fibers of all strata
of the thread- or fiber fabric.

20 In the production of multistratum, pre-consolidated thread fabrics that are
impregnated or cast-in with resin or plastic in a subsequent process and finally
cured in a pre-selected shape into semi-finished products for various final

products, the exterior thread- or fiber layer is in many respects determinant for the properties or employment of the semi-finished product.

Especially for ribbon-shape workpieces, flexural resistance transverse to their longitudinal axis to a great extent determines how they can be used. This is particularly true for aircraft skins and ship hulls. In this case there is the additional challenge of making the semi-finished products light and cost-effective.

Another determining feature is the visual surface of such a structure. It is generally desirable that the surface adapts to the structure of the future product or does not interfere therewith.

Thread fabrics of this type are generally preset on the warp knitting machine using the so-called stitch bonding method. In known warp knitting machines, so-called stationary weft threads that extend across lengthy segments exclusively in the working direction of the warp knitting machine cannot be inserted on the right-hand side of the knitted fabric.

On such machines, the only thread- or fiber fabrics that can be compressed and preset are those that have diagonal or transversely laid thread- or fiber strata on their lower side, the right-hand side of the knitted fabric. Such thread- or fiber systems can be stretched between conveyor chains and guided in the cast-off plane to the loop formation site of a warp knitting machine with no problem.

For assuring symmetrical stability under load of the reinforcing thread fabric, the fabric structure is generally designed approximately symmetrical. One stratum or a plurality of strata of thread sheets that are inclined at different angles to the

working direction is/are added to a center layer of weft threads thereabove and therebelow.

For assuring relatively high flexural resistance of the semi-finished product transverse to the working direction, the exterior stratum is designed with a very small angle – generally 30° – to the working direction of the thread fabric.

However, this requires extremely long laying arrangements for producing these fiber fabrics. At an angle of inclination of 30° relative to the working direction and a warp knitting machine with a working width of more than 100 inches, the laying arrangement with three laying apparatus is already more than 10 meters long.

The conveyor chains that stretch and transport the thread fabric are subject to high wear. Laying apparatus with large dimensions are expensive and require constant maintenance.

The following documents define the state of the art in this field:

US patent 3,761,345 provides originally used systems and methods for producing the cited thread- or fiber fabric. In each case, the lower-most thread layer or stratum is provided with primarily transversely-oriented thread- or fiber sheets that are stretched between the conveyor chains.

Most of the other thread layers are laid cross-wise or in a zigzag pattern so that there are numerous areas on the thread fabric that have different thicknesses.

To avoid the visually unsatisfactory surface, fiber snippings are applied to the left-hand side of the thread fabric and bound thereto in the knitting process. A second

knitting process is required for covering the right-hand side of the knitted fabric with the same type of fiber snippings.

In accordance with US 4,325,999, thread- or fiber sheets are placed only parallel to one another to counter areas in the thread sheet that have different thicknesses.

5 For attaining particularly high rigidity relative to bending transverse to the longitudinal direction, at least two strata that have straight threads parallel to one another and that are inclined only 30° to the working direction were added to the knitted fabric/thread fabric. Such a form for the thread fabric is not suitable
10 either, as already mentioned, for satisfying the user requirements as defined in the foregoing.

With enlarging the working width of the thread fabric to more than 100 inches (=2.52 m) and with the increasing desire for a greater number of thread- or fiber strata, it became increasingly difficult to supply the produced thread fabric in a stable manner between the conveyor chains of a warp knitting machine

15 In accordance with DE 198 52 281 A1, positioned below the laying apparatus and between the transport chains is a continuous conveyor belt, the upper run of which was supported from below. However, the dimensions of the conveyor belt made it necessary to reliably guide the thread fabric from the moved conveyor belt across an open distance to the cast-off plane of the warp knitting machine. The diagonal
20 lower thread layer was used for this, as well.

For additionally assuring guidance in the transition from the moved to the frame-fixed guide, in one exemplary embodiment continuous guide wires were used

together with the conveyor belt, and these could be guided through the spaces of the needles in the cast-off plane without their being tied up therein. These continuous guide wires could be guided back to the entry of the laying arrangement and onto the conveyor belt. Such guide wires and guiding them are
5 extremely expensive and solve only the last-cited problem.

It can therefore be assumed that the thread fabrics that reinforce large surface area, flat, ribbon-shape semi-finished products have a structure such as that illustrated and described in DE 33 04 345 C2 and DE 33 43 048 A1. The required flexural stiffness in one direction is primarily provided by a single stationary thread system
10 or at most by two stationary thread systems.

All other diagonal thread systems contribute only as more or less elastic members in a limited manner to increasing the flexural resistance in the cited direction. For one skilled in the art, it is clearly evident that thread fabrics embodied in this
15 manner are only somewhat stable against bending transverse to the longitudinal direction of the semi-finished product. Generally additional reinforcing elements are added for assuring a predetermined flexural stability, but this increases mass and raises costs.

The object of the present invention is to suggest a method and a system for producing a multistratum preset thread- or fiber fabric that makes it possible to
20 arrange optimally effective reinforcing elements as far as possible from the neutral bending line for assuring the necessary flexural stability of thread- or fiber-reinforced semi-finished products and makes it possible to use to the greatest extent possible existing elements or elements that are low in mass for setting on the thread- or fiber fabric.

This object is achieved by claim 1 in a surprisingly simple manner. With the arrangement of a stationary weft stratum that is immediately adjacent to the needle loops of the system of loops, and with an orientation of the needle loops crossing the stationary wefts on the right-hand side of the system of loops, the stationary weft stratum is held reliably and in a stable manner on the entire preset thread fabric.

First of all, it is possible to insert stationary weft threads in a stable manner on the right-hand side of the system of loops. The preconsolidated thread fabric when used alone can be stored for the interim with no folds by rolling it. If stationary weft thread systems are arranged on both exterior sides of the thread fabric, high flexural resistance is obtained in the final state.

The designer of a semi-finished product is provided the opportunity to insert between the stationary thread systems any desired strata that meet the requirements, that can provide a certain distance between stationary thread strata, and that can effect additional reinforcing in secondary directions.

Frequently less compact fiber or non-woven fabric elements can provide reinforcing in secondary directions. These fiber or non-woven fabric elements generally have less mass and are easier to produce and supply. The arrangement of the visible fiber or thread strata symmetrical to the longitudinal direction in many cases makes additional measures unnecessary in terms of the structure of the surface.

The profiled embodiment of the support surfaces on the cast-off elements also then assures adequate lateral setting of the thread fabric, if no cast-off elements on the exit sites of the needle loops from the thread fabric set these transverse to the working direction. The stationary wefts that are under the greatest lateral load due to the displacement of the needle loops are set by the projecting profiles. Upward creeping is effectively prevented by the thread fabric situated thereover.

By further modifying the method with claim 2, with a limited needle bar displacement it is possible to keep the required modifications to the previous method in a limited frame and to provide high functionality in the method. By avoiding cast-off elements that engage in the spaces between the needles, the needle displacement process is realized largely with no risk in the cast-off phase. The absence of knock-over bits in the area of the needle plane permits high working speeds for the warp knitting machine and permits the use of crank-controlled needle drives. The required gauge accuracy for laying the working threads into the needle hooks can be assured in the usual gauges.

The object set forth can also be achieved while avoiding a needle bar displacement using the modification of the method in accordance with claim 3. In this case, the displacement that effects the crossing of needle loops and stationary weft threads is provided by the cast-off bar. The guide elements for the laterally displaceable cast-off generally capture only the threads of the stationary weft stratum. The thread strata situated thereover, which are transversely oriented, are prevented from displacement by their position and by the tension produced between the conveyor chains.

For fixing coarse thread fabrics with a system of loops with large gauge distances, it is of course also possible to provide the cast-off by needle-shaped or tube-

shaped cast-off elements that are oriented in the cast-off direction and that entirely or partially pass through the needle spaces. For coarse thread fabrics, the working speed of the warp knitting machine is lower. Collisions between these needle-shaped cast-off elements and the knitting needles are nearly impossible.

5 It has proved useful to provide the cited stationary weft stratum in accordance with claim 4 on the right-hand side of the knitted fabric as the first stratum of the thread fabric and then to build up the thread fabric on this stratum and finally to guide the finished fabric into the cast-off plane.

10 Incorporating a stratum made of stationary weft threads in accordance with claim 5 assures the theoretically highest flexural resistance of the semi-finished product in a definable manner.

Modifications to the method in accordance with claims 6 through 8 lead to thread fabrics of different quality that can be selected depending on the demands placed on the semi-finished product.

15 The system for producing a pre-consolidated thread- or fiber fabric in accordance with claim 9 makes possible the manner of working described with respect to claim 1, claim 2, and claim 4 with the most simple possible operation.

20 The system in accordance with claim 10 realizes the method in accordance with claim 1 in the modification in accordance with claim 3. Naturally, in this system work is performed with needle bars that do not perform any displacement. Without defining a specific claim, it is noted that a combination of claims 9 and 10 is still completely in the range of the present invention.

The invention shall be explained in greater detail in the following using exemplary embodiments.

The drawings illustrates:

- 5 Fig. 1 a section through the loop formation site of a warp knitting machine for consolidating a thread fabric, whereby the needle bar, the slide bar, and a part of the cast-off bar perform a lateral displacement movement;
- Fig. 2 is a section in the plane of the thread fabric above the bottom stationary weft stratum in the region of the cast-off plane along the line II – II in Fig. 1;
- 10 Fig. 3 is an enlarged detail from the loop formation site of a warp knitting machine with a modified cast-off design without knock-over bits in the needle spaces;
- Fig. 4 is a section along the line IV – IV in Fig. 3;
- 15 Fig. 5 is a schematic longitudinal section through the system for producing a preset thread- or fiber fabric;
- Fig. 6 is a simplified top view of Fig. 5;
- Fig. 7 is a longitudinal section of a modified system;
- Fig. 8 is a top view of Fig. 7;
- 20 Fig. 9 is a perspective elevation of a thread fabric, the right-hand side of which is set with a system of needle loops and the left-hand side of which is set with a combined weft fiber/system of thread loops;
- Fig. 10 is a section through the loop formation zone with a laterally displaceable cast-off arrangement for the lower-most stationary thread stratum; and
- 25 Fig. 11 is a section along the line XII – XII in Fig. 10, parallel to the lower-most thread- or fiber layer.

The section of a loop formation site of a warp knitting machine illustrated in Fig. 1 is constructed according to the principle of stitch bonding. The vertically arranged knitting needles 1, which are embodied here as slide needles with sliders 2, have at their head a tip that can upwardly penetrate the thread fabric from below at any desired site.

The knitting needle bar 10 and thus also the slide bar 20 are laterally displaceable in the cast-off phase, that is, when their needle tip is located below the thread fabric G and below the cast-off element 3. The thread fabric G is guided in the cast-off plane by the lateral conveyor chains (not shown) and by cast-off means 3. These cast-off means 3 are held on the side of the needle face in the cast-off bar 30 using conventional clamping plates 31.

The cast-off means 3, whose shaft is embodied with limited elasticity, can be caught immediately in front of the needle face at a support surface 301 of the cast-off bar 30.

When producing strong thread fabric G, it is useful to catch the cast-off elements 3 behind the back of the knitting needle 1 again, as well. The support bar 32 can take on this task at A. This support bar 32 in addition has at its side facing the needle plane gauge-appropriate guide projections 321 that can guide laterally at a distance that remains the same under the cast-off plane of the shafts of the knitting needles 1.

This guide for the knitting needles 1 can receive a portion of the lateral forces that the just-formed needle loops WN exert during displacement onto the hooks of the displaceable knitting needles 1. At its top side, the fiber fabric G, GF is secured

against vertical lifting by holders 50 and 51. Allocated to the knitting needle 1 are preferably two guide bars 41, 42 that can supply knitting threads W in a different manner in tricot- or fringe laying.

5 The thread fabric G in this case comprises a central weft thread layer S, two adjacent diagonal thread layers D, D' above and below this weft thread layer S, a lower stationary weft layer KR and an upper stationary weft layer KL. The upper stationary weft layer KL is supplied by a corresponding stationary thread guide 43, but not until the area of the loop formation site.

10 Fig. 2 illustrates a phase in which the tips of the knitting needles 1, after the needle loop displacement below the cast-off plane, re-penetrate into the thread fabric G. The cast-off elements 3 arranged between the needle spaces pass through the thread- or fiber sheet KR and guide the thread fabric G using their sliding contact with the lower diagonal thread layer D'

15 The laterally displaced needle loops W_{Nv} grab these cast-off elements 3 from below and also the fibers of the stationary thread stratum KR that are guided between these cast-off elements 3. When the knitted ware continues, the displaced needle loops W_{Nv} are pulled downward by the free ends of the cast-off elements 3.

20 This embodiment has particular advantages when the thread fabric is to be preset in a coarser gauge. The risk of the tips of the knitting needles 1 colliding with the cast-off elements is then relatively low.

With the embodiment of the cast-off in accordance with Fig. 3, the goal is to perform pre-consolidation of the thread fabric with a system of loops that is less

fine and with shorter stitch lengths. For avoiding collisions between the knitting needles 1 and the cast-off elements 3, the lower stationary weft threads or fibers KR guide the thread fabric G across the plane of motion of the knitting needles 1.

5 For avoiding deflection of the thread fabric G during the cast-off motion, a first support bar 33 with a fiber divider 332 and a support surface 331 are fixedly arranged immediately in front of the needle plane (plane of the knitting needles 1) on the side of the needle face.

10 A second support bar is situated immediately behind the back of the row of knitting needles 1; we can also call it the cast-off bar 60. This cast-off bar 60 also has guide profiles that engage between stationary threads or fibers KR of the thread fabric G. A cast-off nose 61 holds the exit site of the needle loop WN from the preceding stitch hole whenever the knitting needles 1 are laterally displaced in the cast-off position.

15 This embodiment has the advantage that only the thread fabric G that can be easily penetrated by the knitting needles 1 at any desired site is located in the movement plane of the knitting needles 1. Collisions that can occur due to different tensions in the needle loops WNv or WN are therefore prevented. The thread fabric G itself in this case is constructed the same as that which was described with regard to Fig. 1.

20 Fig. 4 is a section along the plane IV – IV in Fig. 3. This section is from immediately above the lower-most stationary thread or stationary fiber stratum KR. Fig. 4 is intended to illustrate how the profiles 332, 62, 61 are embodied and arranged on the support bar 33 and the cast-off bar 60 so that they can correctly perform their casting-off function and their lateral guiding function with respect to

the stationary fibers or stationary threads KR and the displaced needle loops
WNV.

The fiber sheet KR coming from the right in Fig. 2 is guided on the support bar 33
from below by the support surface 331 near the plane of motion of the knitting
5 needles 1.

Attached to the support bar 33 immediately in the plane in which the needles poke
into the thread fabric G are fiber dividers 332 that press the fiber stratum KR into
the spaces between the knitting needles 1. Their upper edge guides the diagonal
thread or fiber sections D'. Their length should be selected such that two
10 successive diagonal threads D' are supported by the fiber dividers 332. Arranged
immediately behind the knitting needles 1 is the cast-off bar 60, which guides
from below the fiber stratum KR that has already been bound in. Provided behind
each of the knitting needles 1 are guide profiles 62 for the lower thread- or fiber
stratum KR, which guide the thread fabric G in the spaces that the fiber dividers
15 332 have prepared.

With their upper surfaces these guide profiles 62 also simultaneously support at
least two threads of the diagonal thread stratum D. The so-called cast-off noses
61, which can be situated laterally behind each needle shaft, hold in the cast-off
position the feet of the needle loops WNV against the displacement movement of
20 the knitting needles 1 at the preceding position and in this manner effectively
prevent the thread- or fiber fabric G from displacing particularly into the center
area of the thread fabric. In addition, the fiber- or thread fabric is fixed laterally
externally by the conventional conveyor chains 8, 8'.

Fig. 5 demonstrates the type of production of the thread fabric G for performing the present invention. The laying arrangement 7 is arranged in the area of the upper run of the conveyor chains 8, 8'. Situated in the laying area below the plane of the upper run is a continuous conveyor belt 81 that supports the thread fabric G from below in the phase of its production between the conveyor chains 8, 8'. A guide plate 82 assures the exact position of the upper run of this conveyor belt 81.

As the first stratum, the lowermost stationary thread stratum KR is fed as the thread sheet via the thread supply apparatus 71 onto this conveyor belt 81, the upper run of which moves synchronously with the conveyor chains 8, 8', in the direction of the warp knitting machine with its knitting needle bar 10. The first diagonal thread layer D' is applied to this first thread stratum KR by means of the thread laying apparatus 76. The following weft laying apparatus 73 stretches a thread sheet S between the two conveyor chains 8, 8' before another thread laying apparatus 77 lays the diagonal thread layer D about the hooks of the conveyor chains 8, 8'. The uppermost stationary weft layer KL is applied to the thread fabric G as the last thread sheet using the thread supply apparatus 75.

The thread fabric G assembled in this manner is pre-consolidated in the warp knitting machine by means of a knitting needle bar 10, which is a component of the loop formation zone. See Figures 1 and 3. The knitting needle bar 10 forms a system of loops from plate loops WP and offset needle loops WNV. The offset needle loops WNV hold the lower stationary thread layer KR on the thread fabric G, while the plate loops WP, provided in tricot lay, enclose the upper stationary thread layers KL.

In Fig. 6, which illustrates a top view of the system in accordance with Fig. 5, only the upper thread strata of the thread fabric G are shown. In the section outward to the right, we see the stationary thread stratum KR. Following thereover is the first diagonal thread layer D'. Then the stationary thread stratum S, the second diagonal thread layer D, and finally the upper thread layer made of stationary thread KL are laid. The finished, preset thread fabric GF is indicated after the row of knitting needles 1.

Fig. 7 illustrates another system for producing a pre-consolidated multistratum thread and/or fiber fabric GF. The basic structure of the system – relative to guiding and conveying the thread fabric – corresponds to that which was described with regard to Fig. 5.

As the first stratum, the lower stationary thread stratum KR is laid for stationary threads onto the conveyor belt 81 by means of the thread supply apparatus 71. This thread supply apparatus 71 is followed by a non-woven fabric supply apparatus 72, which applies across the entire width a more or less voluminous non-woven fabric VR with fiber structures in different directions. A sheet of weft threads S oriented at a right angle to the working direction is stretched onto this non-woven fabric VR between the conveyor chains 8, 8' by means of a weft laying apparatus 73'. A second stratum of non-woven fabric VL is then laid upon these weft threads S by means of a non-woven fabric supply apparatus, before a thread supply apparatus 75 for stationary weft threads applies the upper stationary thread layer KL and finishes the thread fabric G'.

Such a design of the laying arrangement 7' has the advantage that a substantial portion of the volume of the thread fabric GF' – illustrated in Fig. 9 – does not

have to be filled using expensive threads. The stability of the thread fabric GF' in the main directions – chain and weft – is defined by pre-laid thread systems KR, KL, S, while the secondary directions are covered by the non-woven fabric strata VR, VL, which largely determine the distance between the threads or fibers in the main directions.

Fig. 9 illustrates the thread fabric GF produced with the cited system. The lower side of Fig. 9 illustrates the type of binding of the lower-most thread stratum KR to the thread fabric GF by means of offset needle loops WNV from the system of loops.

Fig. 8 illustrates the laying arrangement 7' in Fig. 7, this time from a top view. It can be seen that the length of the laying arrangement 7' in this embodiment is clearly less than that of laying arrangement 7, which was described with respect to Fig. 5 and Fig. 6.

Figures 10 and 11 illustrate another variant for binding the lowermost thread or fiber stratum, which is oriented in the working direction and is set by the needle loops WN of the system of loops. The structure and manner in which the loop formation apparatus works corresponds to the most essential elements in Fig. 1.

The knitting needles 1 of the needle bar 10 and the closing wires 2 of the closing wire bar 20 are not laterally displaced in the cast-off phase – just like the support and guide bar 32'. It is also useful in this case to guide the row of needles 1 to the side, maintaining the same spacing, below the cast-off plane using the support and guide elements 32'.

At the beginning of the casting-off process, the needle loop caught in the needle head is still oriented in the working direction. For attaining a position crossing one of the stationary threads KR between the needle loop WN and the stationary threads, the lowermost stratum of the thread fabric KR' is designed laterally
5 displaceable by the displaceable guide profile of the cast-off element 3'.

In the phase of casting off the needle bar 10, the cast-off element 3' of the cast-off bar 30' laterally displaces the fibers or threads of the lowermost stratum KR' of the thread fabric G by approximately one needle gauge, so that a section of the fibers separated from the sheet is displaced across the needle loop leg. Only the
10 lowermost thread or fiber stratum KR' is displaced by this process and reliably set on the system of loops.

The deflection of the stationary threads or stationary fibers KR during the production of the system of loops, as it is indicated in Fig. 12, is removed after the system of loops is finished. An equalized tension is set at which the stationary
15 threads or stationary fibers KR' are oriented nearly straight in the working direction.

Furthermore, in the method it seldom occurs that all of the fibers or thread parts in each row of loops cross the leg of the needle loop. However, the connection to the other layers of the thread fabric G is sufficiently secure in one area across a
20 plurality of loop rows that the thread fabric GF can be cast-in during a subsequent process and can set in the final shape.

Legend

| | | |
|----|---------|---|
| | 1 | Knitting needle/slide needle |
| | 10 | Knitting needle bar or slide needle bar |
| | 2 | Closing wire, slider |
| 5 | 20 | Closing wire bar, slider bar |
| | 3, 3' | Cast-off element |
| | 30, 30' | Cast-off bar |
| | 301 | Support surface |
| | 31, 31' | Clamping bar |
| 10 | 32, 32' | Support and guide bar |
| | 321 | Guide projections |
| | 33 | Support bar |
| | 331 | Support surface |
| | 332 | Fiber divider |
| 15 | 41 | Working thread guide (guide bar) |
| | 42 | Working thread guide (guide bar) |
| | 43 | Stationary thread guide |
| | 50 | Counter bar |
| | 51 | Counter bar |
| 20 | 6 | Knock-over bits |
| | 60 | Cast-off bar |
| | 61 | Cast-off nose |
| | 62 | Guide profile |
| | 7, 7' | Laying arrangement |
| 25 | 71 | Thread supply apparatus (for stationary weft) |
| | 72 | Non-woven fabric supply apparatus |

| | | |
|----|---------|--|
| | 73, 73' | Weft laying apparatus |
| | 74 | Non-woven fabric apparatus |
| | 75 | Thread guide apparatus (for stationary weft threads) |
| | 76 | Thread laying apparatus (diagonal - 1) |
| 5 | 77 | Thread laying apparatus (diagonal - 2) |
| | 8, 8' | Conveyor chains |
| | 81 | Conveyor belt |
| | 82 | Guide plate |
| | D, D' | Diagonal thread layer |
| 10 | G, G' | Thread fabric, fabric |
| | GF, GF' | Thread fabric, pre-consolidated |
| | (K) | Stationary thread, reinforcing element |
| | KL | Stationary thread, reinforcing element (left-hand side of knitted fabric) |
| 15 | KR, KR' | Stationary thread, reinforcing element (right-hand side of knitted fabric) |
| | KRT | Fiber strand, divided, bound |
| | S | Stationary threads, stationary thread layer |
| | W | Working threads |
| | WP | Plate loop |
| 20 | WN | Needle loop |
| | WNv | Needle loop, displaced |
| | V L | Non-woven fabric, reinforcing element |
| | VR | Non-woven fabric, reinforcing element |

**“Method and Apparatus for Producing a Multistratum,
Preset Thread- or Fiber Fabric”**

5 **Patent Claims [AS AMENDED UNDER ARTICLE 19]**

1. Method for producing a multistratum, preset thread- or fiber fabric
- that is used as a ribbon-shaped semi-finished product for reinforcing parts made of plastic or resins
 - and that in the individual strata comprises thread- or fiber sheets, each of
- 10 which are oriented differently,
- whereby in at least one of said strata – a stationary weft stratum – thread- or fiber sheets are oriented largely parallel to the working direction;
 - whereby at least one of said strata comprises thread- or fiber sheets that are stretched between rows of hooks of conveyor chains on both sides of a
- 15 laying arrangement for producing said thread fabric;
- whereby said thread- or fiber fabric is supplied to a warp knitting machine at the speed of the aforesaid transport chains and there – stretched between said transport chains – is preset by means of system of loops; and,
 - whereby needle loops and plate loops of the system of loops enclose threads
- 20 or fibers of all strata of said thread- or fiber fabric

characterized

in that said stationary weft stratum made of fiber- or thread sheets and oriented largely parallel to the working direction is arranged as lowermost stationary weft stratum (KR) immediately adjacent to the needle loops (WN)

25 of the system of loops;

in that the threads or fibers of said lowermost stationary weft stratum (KR) of said thread fabric (G) are guided laterally by means of profiled guide surfaces (301; 331; 332; 60, 61, 62), in the take-off direction, of cast-off elements (3, 3', 6); and,

5 in that the legs of said needle loops (WN) of the system of loops and the threads or fibers of the aforesaid stationary weft stratum in the cast-off phase cross one another due to a relative mutual displacement of the needle loops and/or the stationary weft threads to the previous binding site before the knitting needles (1) penetrate said thread fabric (G) again for the purpose of forming a
10 subsequent row of loops.

2. Method in accordance with claim 1, characterized

in that the part of said thread fabric (G) situated above said lowermost stationary weft stratum is laterally guided in the working area of said knitting needles (1) at least by means of conveyor chains (8, 8');

15 in that the threads of said lowermost stationary weft stratum that are stretched in the working direction (KR) – supported in front of the needle face and behind the back of the needle using said cast-off elements (3, 3', 6) against the cast-off pressure and the displacement of said needle loops (WN) – guide the thread fabric in the cast-off plane across the needle plane;

20 in that said needle loops (WN), guided by laterally displaceable knitting needles (1), after crossing over threads or fibers of said lowermost stationary weft stratum (KR) are deposited and cast-off using said needle loops (WN) of the subsequent loop row.

3. Method in accordance with claim 1, characterized

in that said cast-off elements (3, 3', 6) are laterally displaced by at least one gauge during the cast-off phase, and,

in that said needle loops (WN), guided by non-laterally displaceable knitting needles (1'), after the displacing of the threads or fibers of said lowermost stationary weft stratum (KR) are deposited and cast-off using said needle
5 loops (WN) of the subsequent loop row.

4. Method in accordance with claim 1, characterized

in that the threads or fibers of the aforesaid stationary weft stratum (KR) are guided into the cast-off plane of the warp knitting machine as lowermost
10 stratum of said thread fabric (G) deposited first on a moving conveyor belt (81).

5. Method in accordance with claim 1, characterized

in that stationary weft threads or fibers (KL) are also supplied in the upper-most stratum of the thread or fiber fabric (G, G'), and,

15 in that the working thread guide (41, 42) is embodied with even pattern notation or in counter notation to the displacement of the needle bar tricot laying.

6. Method in accordance with claim 5, characterized

in that arranged between said upper-most and said lower-most stratum made of stationary weft threads (KL, KR) are at least two diagonal thread strata (D, D') and a stratum that is arranged between said diagonal strata and that is at a
20 right-angle to the working direction of said running thread or fiber sheets (S).

7. Method in accordance with claim 5, characterized

in that at least two diagonal thread strata (D, D') are arranged between said upper-most and said-lower-most stratum made of stationary weft threads (KL, KR).

8. Method in accordance with claim 5, characterized

in that arranged between said upper-most stratum and said lower-most stratum

5 made of stationary weft threads are fiber strata (VL, VR) containing at least two tangle fibers and a stratum arranged between said two fiber strata (VL, VR) that is at a right-angle to said thread- or fiber sheets (S) running in the working direction.

9. System for producing a multistratum, preconsolidated thread- or fiber fabric

10 with a laying arrangement for producing a thread fabric between upper runs of conveyor chains equipped with hooks

- that has a thread supply apparatus or fiber supply apparatus for stationary weft threads, and

15 - that has at least one thread laying apparatus or fiber laying apparatus for thread- or fiber sheets to be stretched between said conveyor chains;

with a transport element arranged between said conveyor chains for supporting and moving said thread- or fiber fabric;

with a warp knitting machine, in particular a stitch bonding machine, the knitting needles of which transversely penetrate said thread- or fiber fabric in the cast-off plane in the loop formation zone; and,

20 with guide elements for said conveyor chains between said laying arrangement and said loop formation zone of said warp knitting machine,

for performing the method in accordance with claim 1, characterized

in that arranged in the entry area of said laying apparatus (7, 7') is a thread supply apparatus (71) for stationary weft threads that guides its sheet of stationary weft threads (KP) as the lowermost stratum of said thread- or fiber fabric;

25

in that, in addition to the lift drive, the knitting needle bar (10) is equipped with a displacement drive across at least one needle gauge;

in that a cast-off bar (30, 33) is arranged on the side of the needle face of the knitting needles (1) and in proximity thereto; and,

5 in that said cast-off bar (30,33) is equipped with guide elements (3, 332, 61, 62) for support against the cast-off direction and for lateral guidance of said thread- or fiber fabric (G) against the needle loop displacement.

10. System for producing a multistratum, preconsolidated thread- or fiber fabric with a laying arrangement for producing a thread fabric between upper runs of conveyor chains equipped with hook;

- that has a thread supply apparatus or fiber supply apparatus for stationary weft threads, and

- that has at least one thread laying apparatus or fiber laying apparatus for fiber sheets to be stretched between said conveyor chains;

15 with a transport element arranged between said conveyor chains for supporting and moving said thread- or fiber fabric;

with a warp knitting machine, in particular a stitch bonding machine, the knitting needles of which transversely penetrate said thread- or fiber fabric in the cast-off plane in the loop formation zone; and,

20 with guide elements for said conveyor chains between said laying arrangement and said loop formation zone of said warp knitting machine,

for performing the method in accordance with claim 1, characterized

in that arranged in the entry area of said laying apparatus (7, 7') is a thread supply apparatus (71) for stationary weft threads that guides its sheet of stationary weft threads (KP) as the lower-most stratum of said thread- or fiber fabric;

in that at least a part of the cast-off bar (30, 33) is arranged on the side of the
needle face of the knitting needles (1) and in proximity thereto; and,
in that the part of said cast-off bar (30,33) is equipped with guide elements (3,
332, 61, 62) for laterally guiding the thread- or fiber fabric (G) and is laterally
5 displaceable in the cast-off phase by at least one needle gauge.

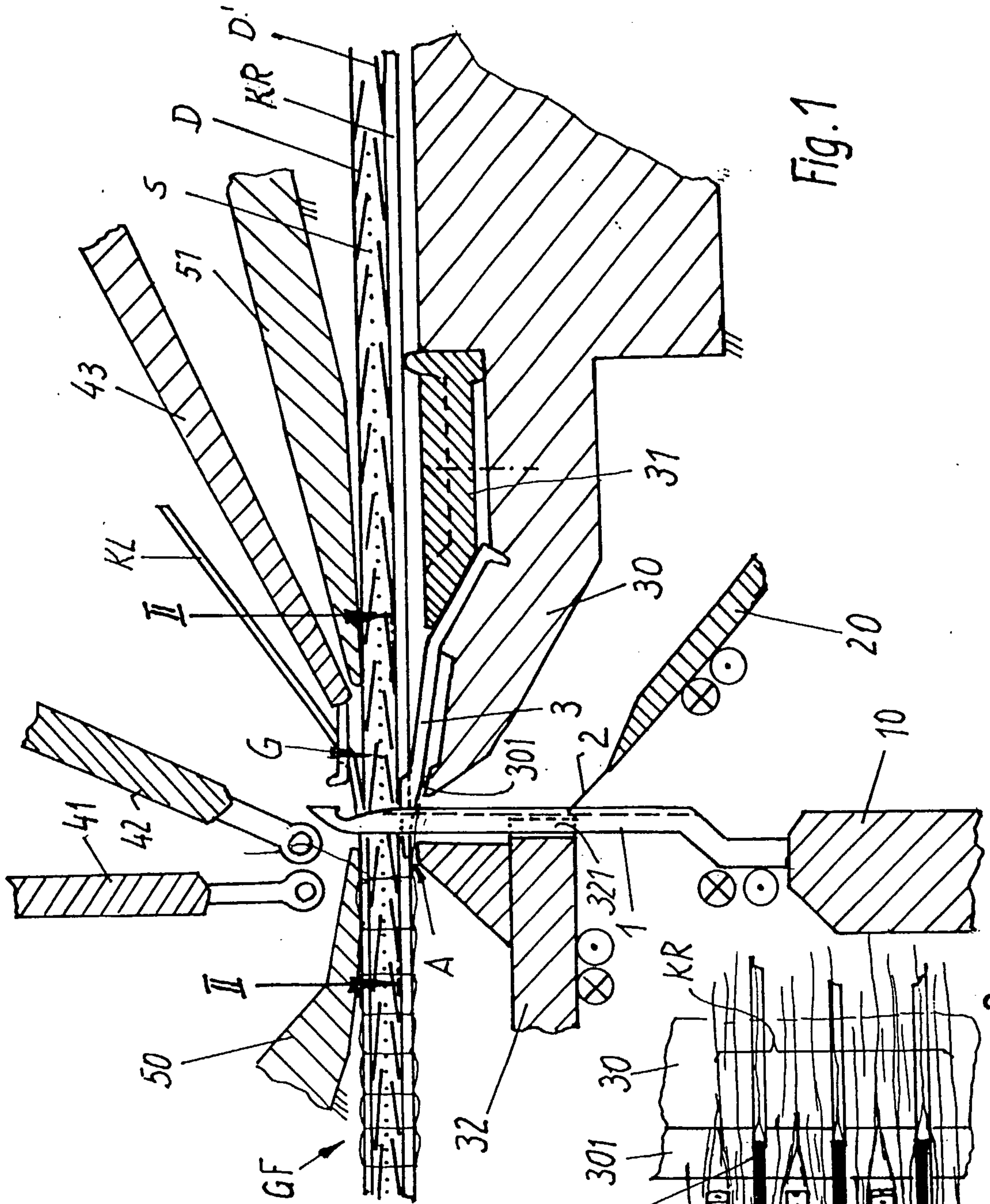


Fig. 1

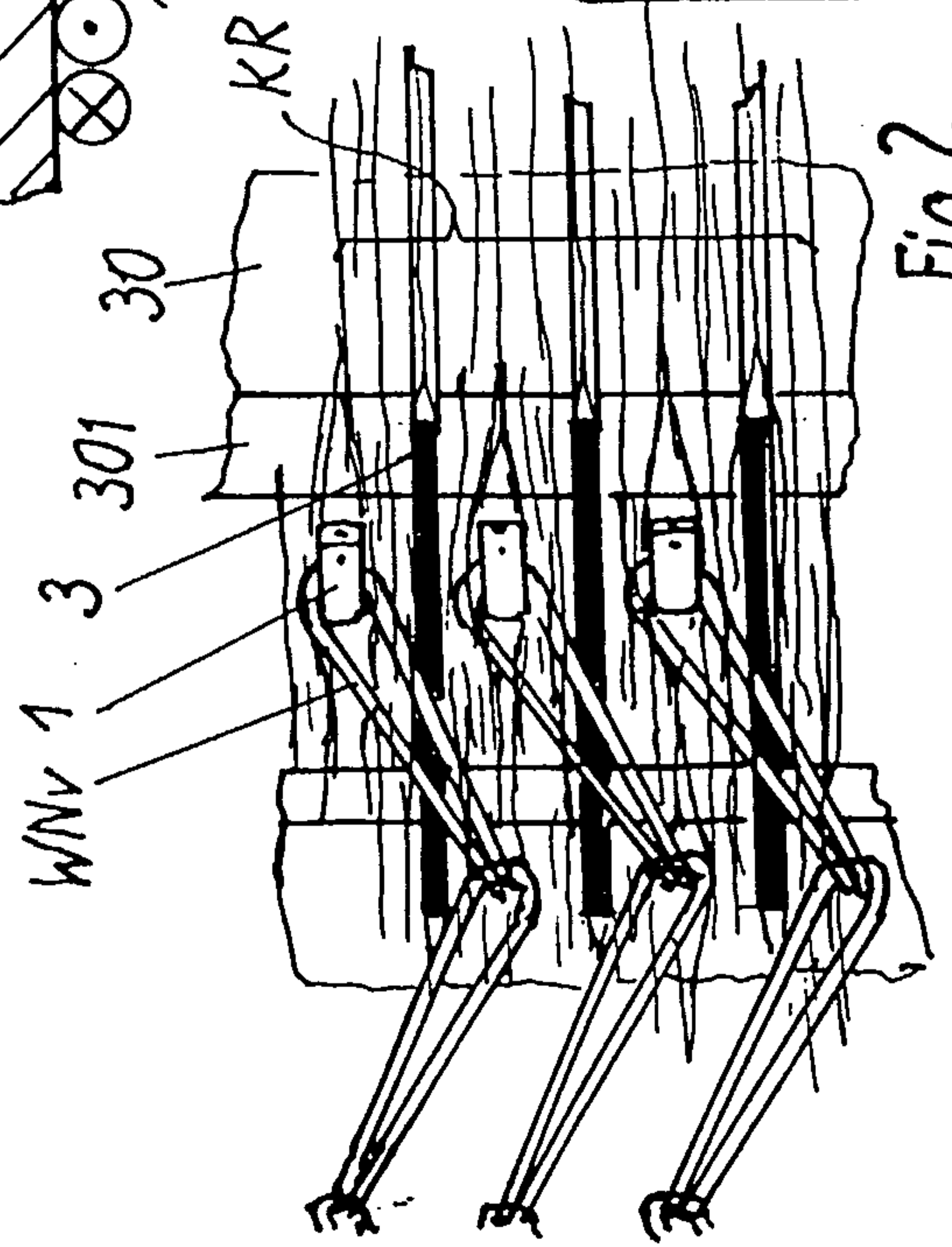


Fig. 2

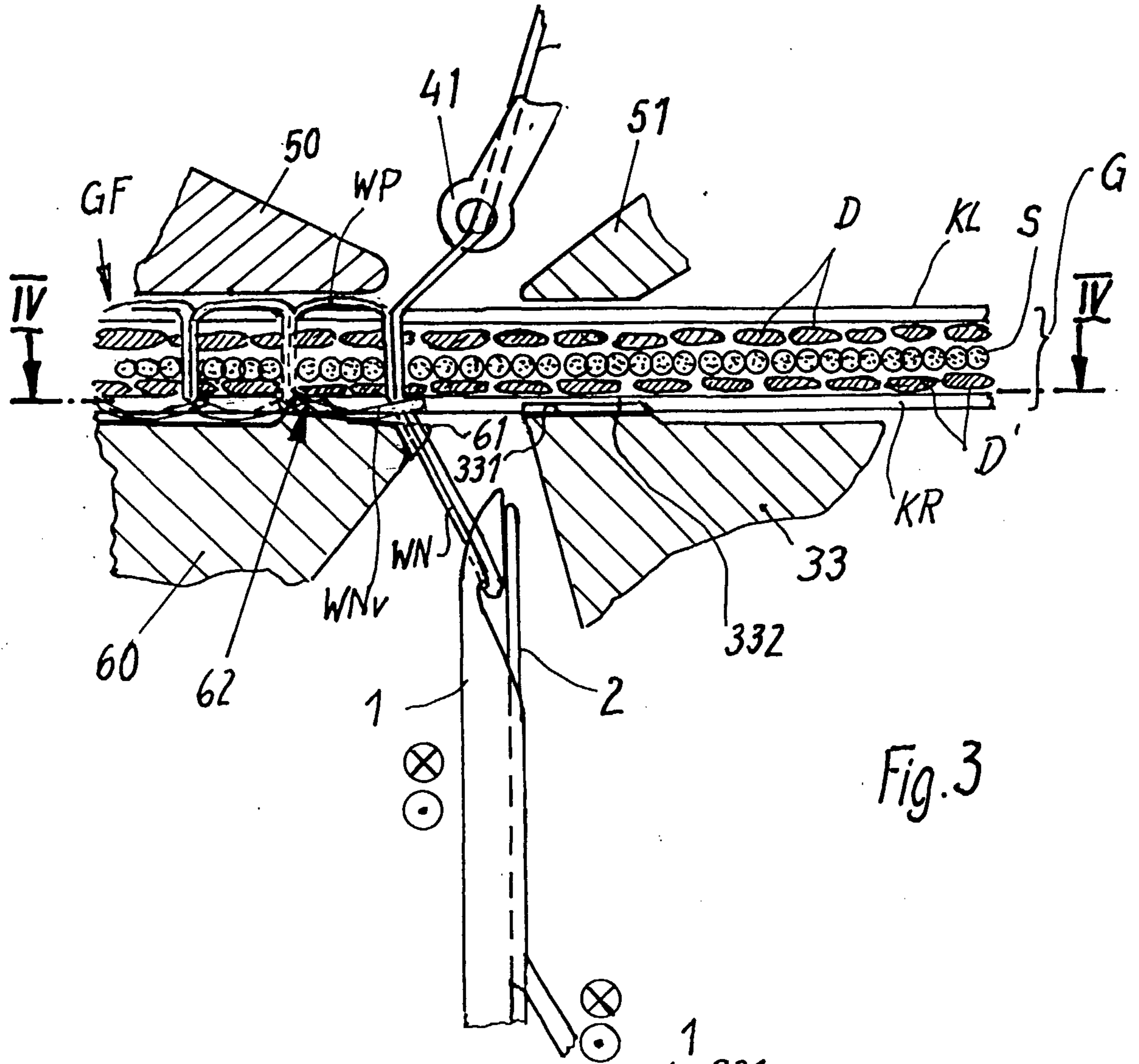


Fig. 3

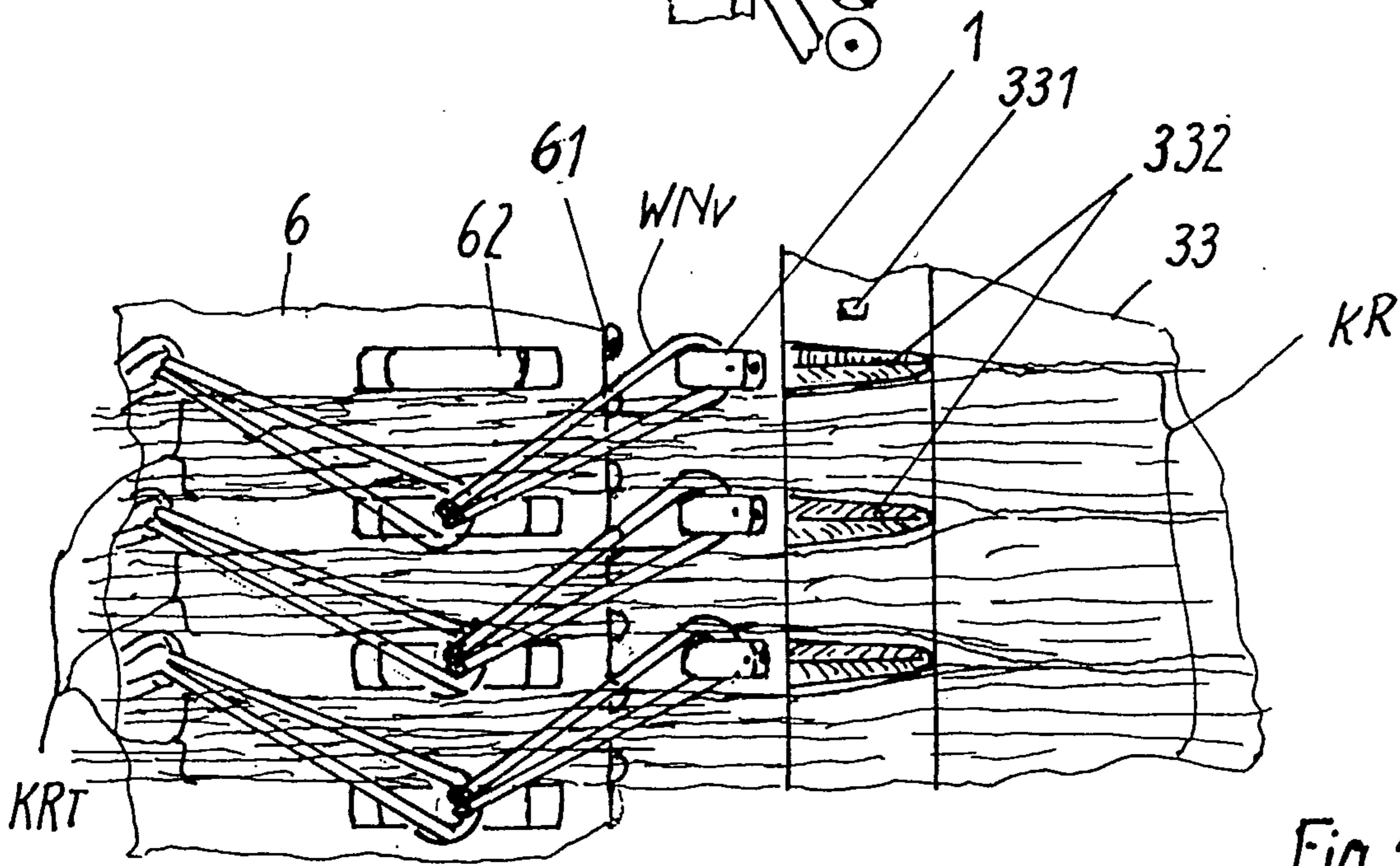


Fig. 4

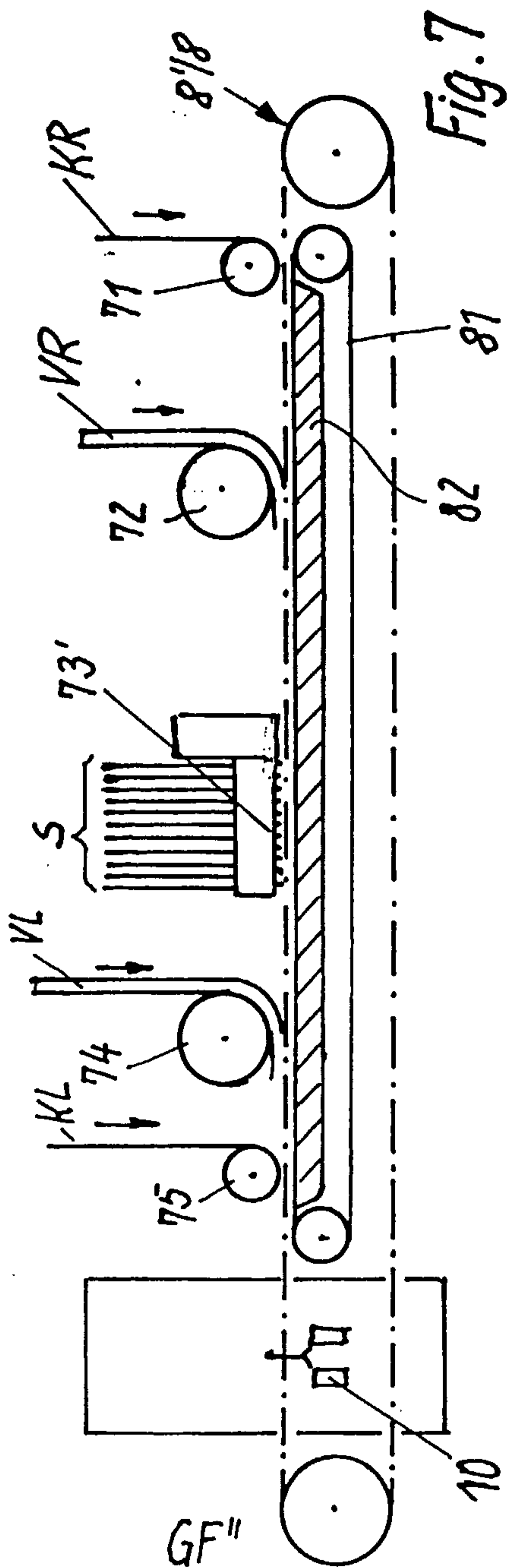


Fig. 7

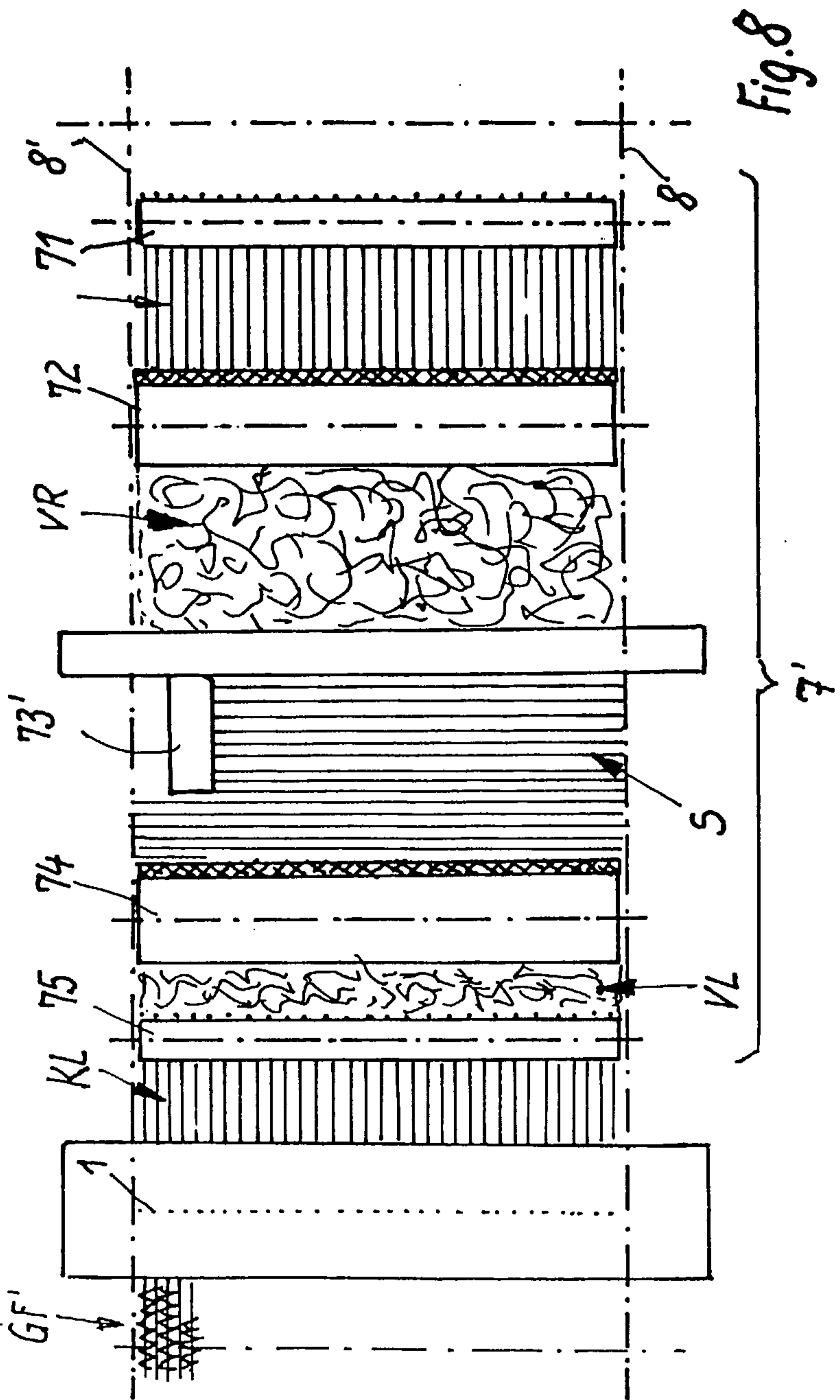


Fig. 8

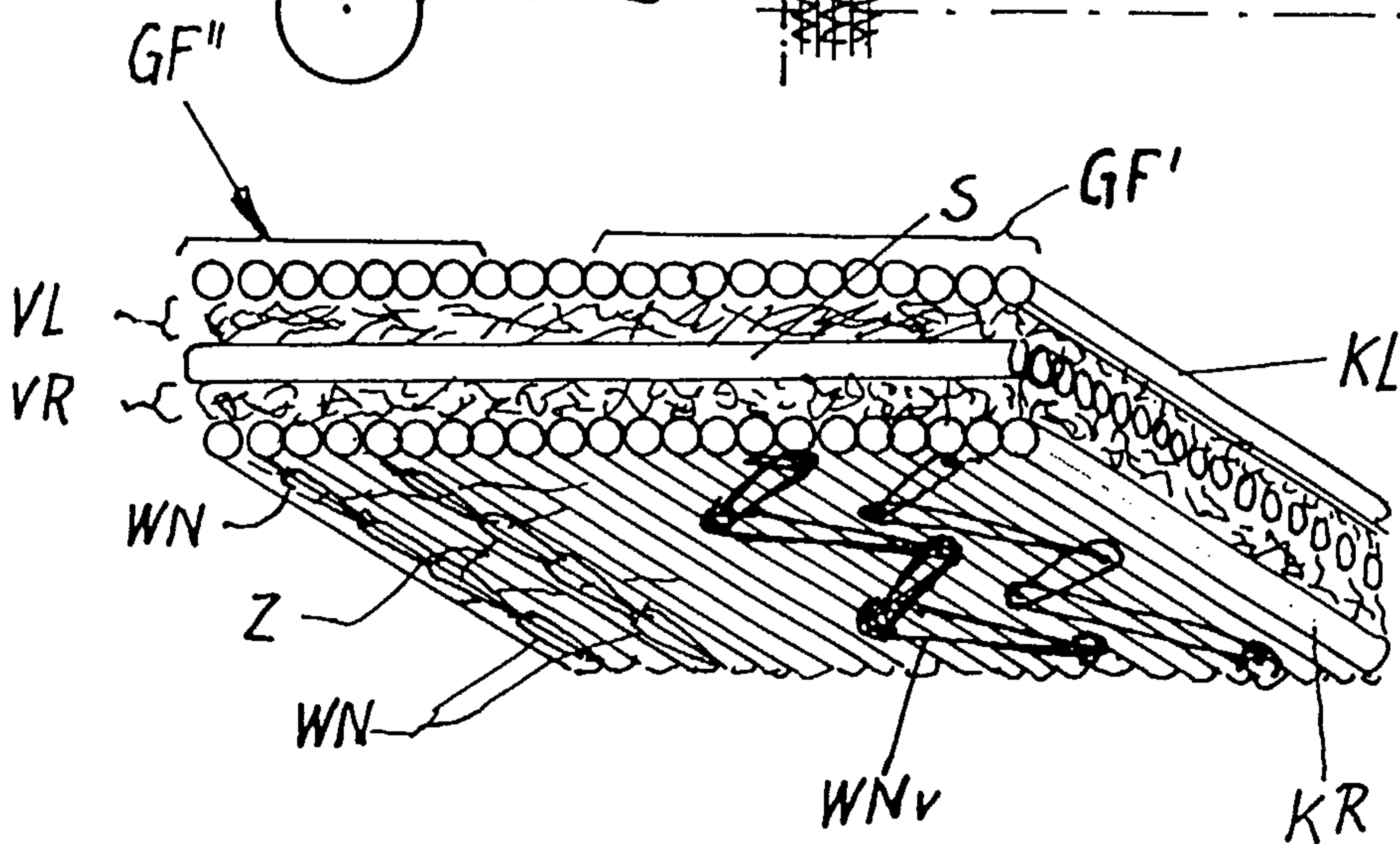
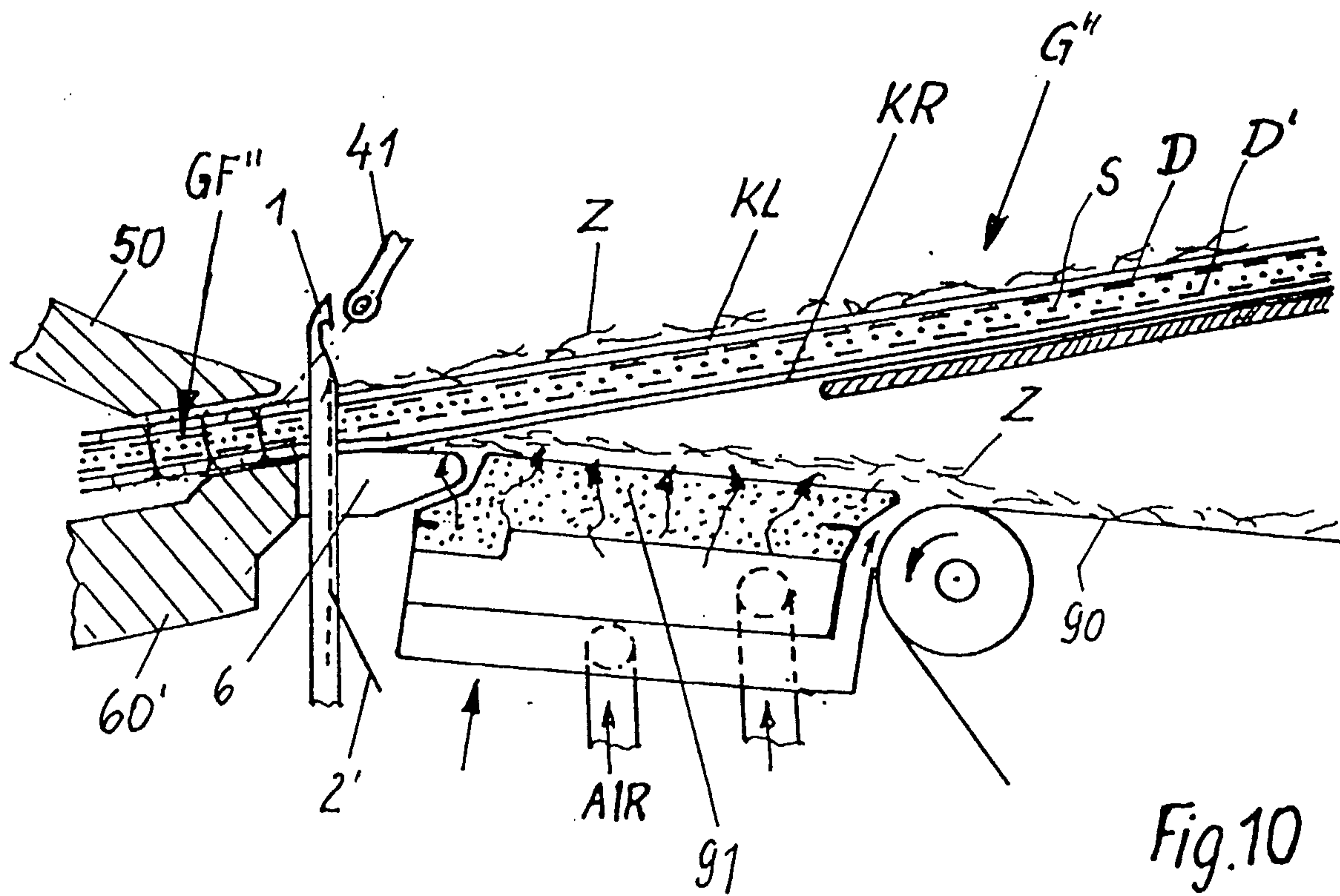


Fig. 9



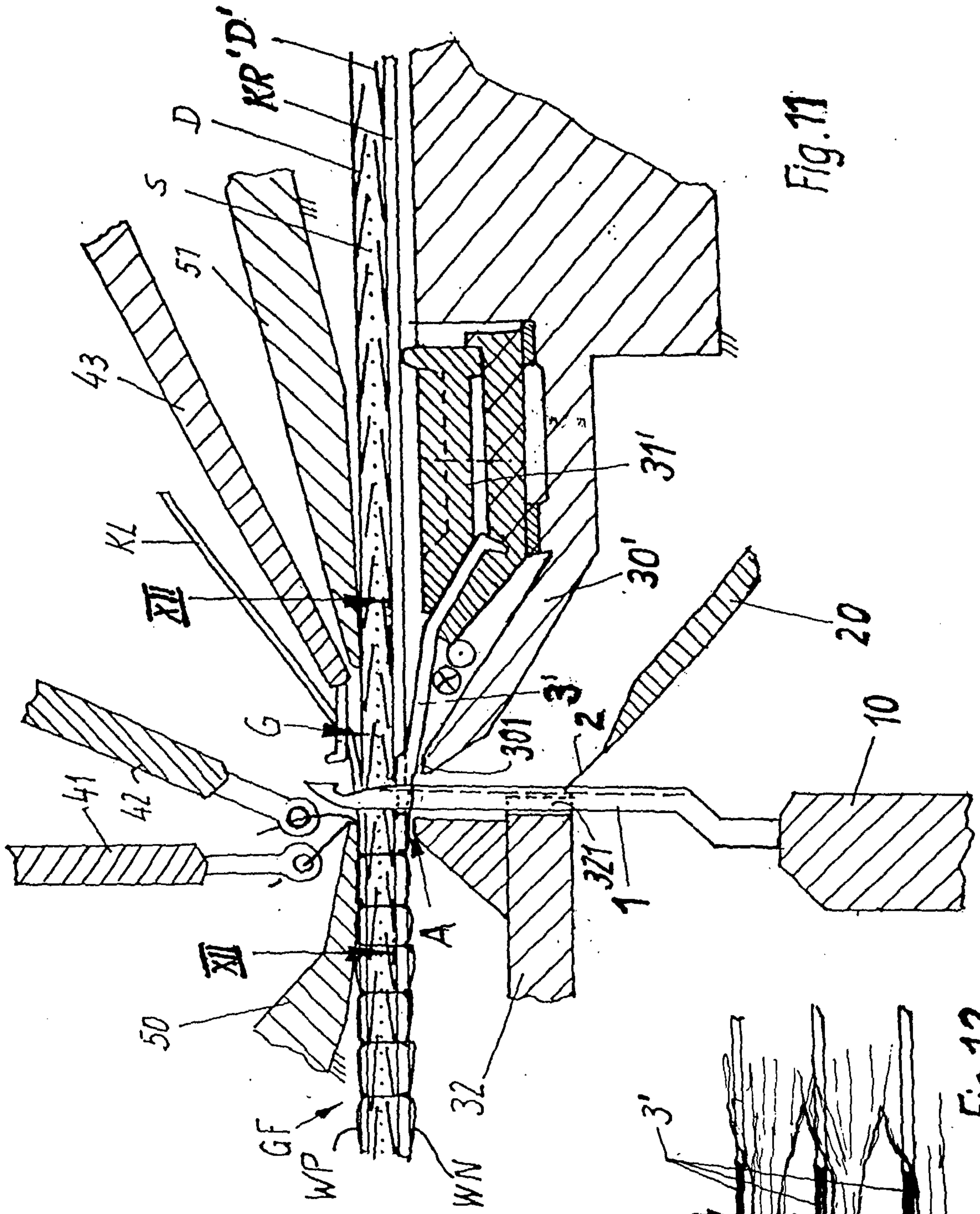


Fig. 11

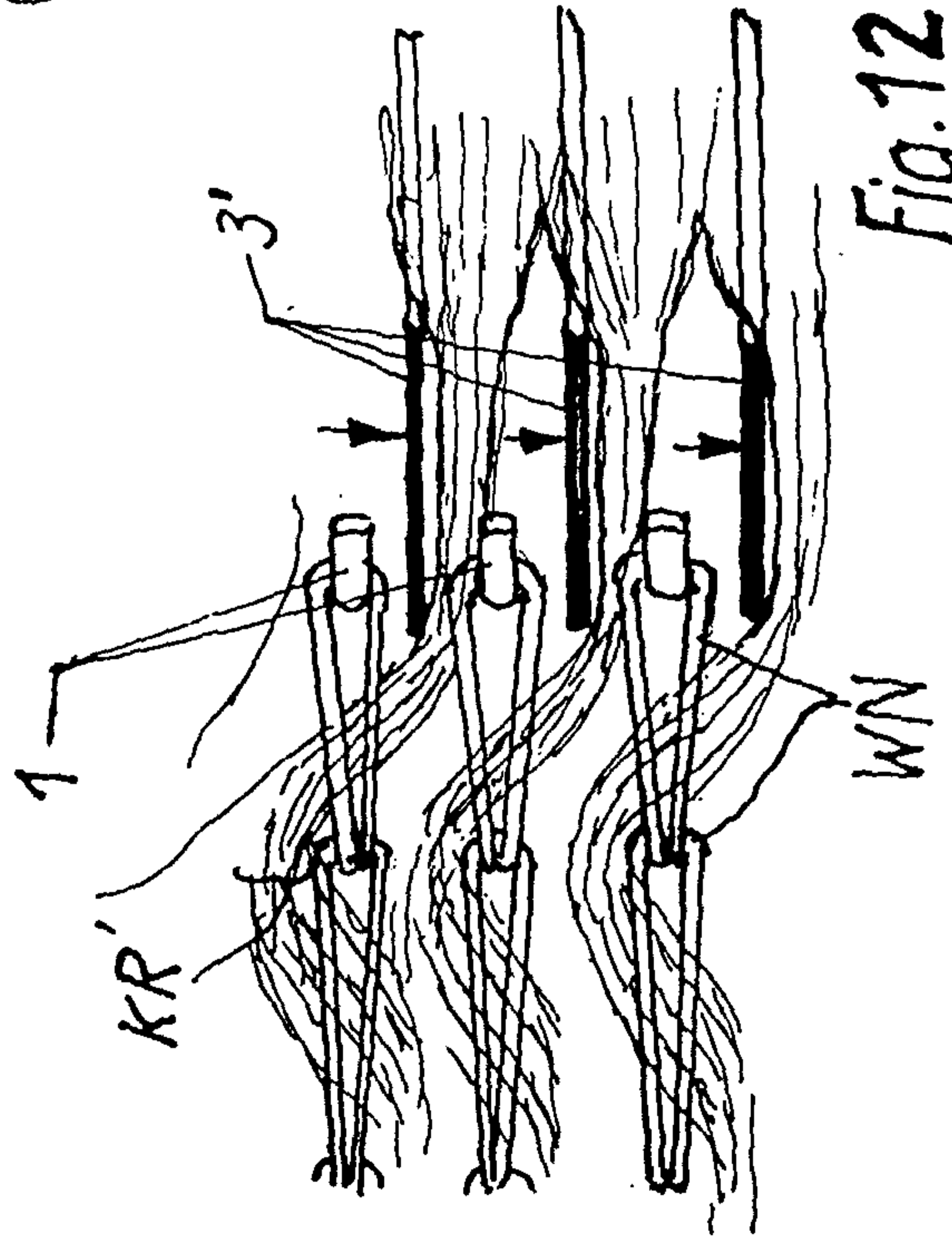


Fig. 12

