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(54) METHOD FOR FABRIC FORMATION AND A DEVICE FOR CARRYING IT OUT

(57) The invention relates to a method of fabric formation in which from a set of threads is formed a shed, through which is inserted a second set of threads, whereupon the inserted thread arrives at the fell of the formed fabric. At least two equivalent sets of threads mounted in an equivalent manner on equivalent carriers are used for forming fabric, whereby alternately a shed is formed by the individual sets of threads and alternately a thread of a corresponding set is inserted through the shed as a weft thread so that each of the threads of one set of threads is inserted in one particular weaving cycle through the shed, which is formed by the threads of another set of threads, and this inserted thread of one set of threads is used in at least one following weaving cycle as a shedding thread for forming a shed by the threads of this set of threads and for inserting one or more threads of at least one other set of threads, whereby the threads of all the sets of threads together form the binding points of the fabric being formed.

A device for fabric formation which comprises at least two sets of threads, whereby it further comprises a shed forming device and a weft insertion device and also comprises a beating-up device and a take-up and winding device of fabric. All the sets of threads are mounted in an equivalent manner on equivalent carriers, each carrier being aligned with a insertion device of a corresponding set of threads, whereby each set of threads is aligned with means for fixing the ends of the picked threads of each set of threads and means for regulating the tension of the inserted threads of each set of threads and also means fo forming shed by the inserted threads of another set of threads.

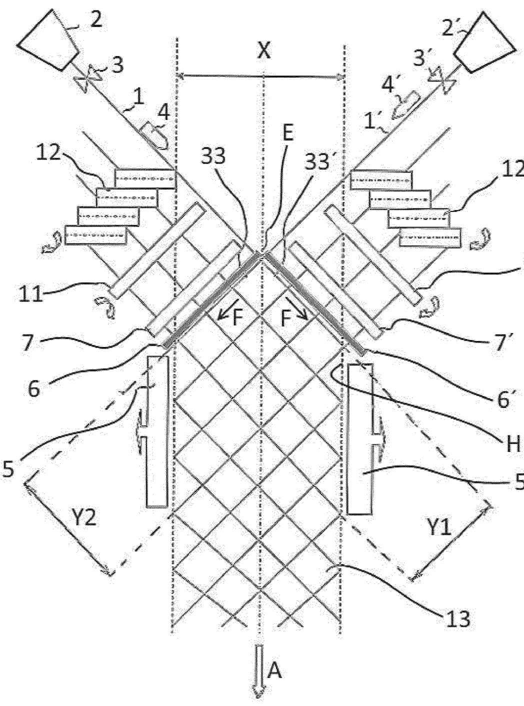

Fig. 1

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Description

Technical field

[0001] The invention relates to a method for fabric formation in which from a set of parallel threads is formed a shed, through which another set of threads is inserted, whereupon the inserted thread arrives at the fell of the formed fabric.

[0002] The invention also relates to a device for fabric formation which comprises at least two sets of threads, whereby it further comprises a shed-forming device and a weft insertion device, whereby it also comprises a beating-up mechanism, a take-up mechanism, a let-off motion and winding device of fabric.

Background art

[0003] There are numerous known methods of producing fabric (weaving) and devices for carrying them out, i.e. for weaving.

[0004] The known methods and devices use two fundamentally different sets of threads for forming fabric, when one set consists of warp threads and the other consists of weft threads. However, there are large differences between warp threads and weft threads in terms of their dimensions, especially their length, the weight of the reserve on the weaving machine, e.g. differences between the weight of a bobbin for depositing a weft thread and the weight of a warp beam for depositing warp threads, differences between kinematic and dynamic parameters, which manifest themselves on the thread during fabric formation, influencing particularly the movement speed, stop motion, beating up, etc., and, last but not least, there are differences in economic parameters, especially in the cost of the preparation of each set of threads, i.e. the cost of preparing a weft thread and the cost of preparing a warp beam with warp threads.

[0005] Existing methods and devices used for fabric production have a set of warp threads arranged on a warp beam or on a bobbin creel, whereas the set of weft threads is arranged as a single thread wound on a bobbin of a required calibre. It is noted that from the economic point of view, preparation of textile material, i.e. preparation of warp beams or bobbin creels with a set of warp threads and preparation of bobbins with a continuous thread wound for wefts (with a weft thread) for weaving represents the highest sum in the structure of the production cost per unit of produced fabric. Particularly expensive is the process of warping and sizing. Also production cost, or more specifically, depreciation expenses of the weaving machine, is another important part of production cost per unit of produced fabric, whereby the production cost of the machines is unfavourably influenced especially by the price of warp beams and by the cost of their installation into the frame of the weaving machine.

[0006] The theory of weaving describes the basic contradiction between the required "balance" of the importance of warp and weft threads with regard to the mechanical as well as performance characteristics of the finished fabric and the "imbalance" of warp and weft threads in the phases of fabric formation (creation, production), whereby this imbalance of warp and weft threads follows from the very essence of the methods and devices used and known for fabric formation.

[0007] The imbalance of warp and weft threads is caused by the difference in the behaviour of a set of warp threads and a set of weft threads during fabric formation, the basic difference being in the number of warp threads and the number of weft threads, which are simultaneously involved in the process of weaving. From the side of the warp, i.e. warp threads, there are always all the threads of this set involved, while from the side of weft, i.e. weft threads, there is always only one thread. Therefore, from the equation of continuity follow differences between the speed of the movement of warp threads and the speed of the movement of weft threads, which results in different resistance, inertial and impact forces which act on the individual threads of each set and cause different deformations of the threads of the individual sets, etc. Different behaviour of the weft and warp threads complicates simultaneous and balanced control of the forces in both sets of threads, which is necessary for both the machine performance and the quality of the fabric, and sometimes even makes the control impossible. Last but not least, different behaviour of the weft and warp threads causes different costs of techno-economic parameters of preparatory operations necessary for the preparation of the weft and warp threads.

[0008] The above-mentioned phenomena and their negative or limiting impact on the technology of the weaving machines and methods of weaving (fabric formation) have been the subject of many research studies over the past years, which resulted in the construction of multi-shed weaving machines. The concept of multi-shed weaving machines is based on the assumption that a higher number of installed shedding systems reduces the above-mentioned discrepancy between the number of warp threads and the number of weft threads and technological progress in terms of weaving should be ensured by increasing the performance of the weaving machine, which corresponds to a multiple of the performance of individual insertion systems of a multi-shed weaving machine and the number of simultaneously performed insertion operations on a multi-shed weaving machine. Nevertheless, experience shows that merely increasing the number of insertion systems which are substantially taken over from one-shed weaving machines, means that during the introduction of these new insertion systems into a new environment of a multi-shed weaving machine, new, so far unknown and considerably more complex interactions with the other systems of multi-shed weaving machines occur, which on the contrary leads to the reduction in basic functions and parameters when using these known insertion systems. Consequently, the more insertion systems will be installed on the machine, the greater necessity (and apparently with a progressive effect) to reduce the mean speed of the insertion operation and its quality, which has a major effect on the performance and therefore on the productivity of the machine. For these reasons, multi-shed weaving machines have never achieved the assumed massive increase in the performance of the weaving process and therefore have never been able to occupy a corresponding position in the market for weaving machines, because mere increasing the number of inserting systems on the weaving machine with a system of warp threads, as it has been so far used and perceived, i.e. with one fixed set of warp threads, is not reasonable, nor does it provide a solution to the above-mentioned conflict and discrepancy.

[0009] The aim of the invention is to propose a method of weaving and a device for carrying it out, by which the disadvantages of the background art would be eliminated or at least reduced.

Principle of the invention

[0010] The goal of the invention is achieved by a method of weaving, whose advantage consists in the use of at least two equivalent sets of threads which are arranged in an equivalent manner on equivalent carriers, whereby alternately a shed is formed by the individual sets of threads and alternately a thread of the corrresponding set is inserted through the shed as a weft thread so that each of the threads of one set of threads is inserted through the shed in one particular weaving cycle, whereby the shed is formed by the threads of another set of threads and this inserted thread of one set of threads is used at least in one following weaving cycle as a shedding thread for forming a shed by this set of threads and after insertion of one or more threads of at least one other set of threads, whereby the threads of all the sets of threads together create the binding points of the fabric to be formed.

[0011] The principle of the device for performing the method according to the invention consists in that all the sets of threads are arranged in an equivalent manner on equivalent carriers, each of the carriers being aligned with a insertion device of a corresponding set of threads, whereby each set of threads is aligned with means for fixing the ends of the inserted threads of each set of threads and with means for regulating the tension of the inserted threads of each set of threads and also with means for forming a shed by the inserted threads of another set of threads.

[0012] The advantage of the solution according to this invention is not only a higher productivity of weaving, but also improved uniformity of the characteristics of the formed fabric, since both "weft" and "warp" threads may be of the same (comparable, equivalent) character, and during fabric formation pass through the same (comparable, equivalent) conditions and the same (comparable, equivalent) working operations. Another advantage of this invention is eliminating the necessity of using the warp, as it is known from current weaving machines, including eliminating the costs and manufacturing operations necessary for the preparation of warp threads on the warp beam, i.e. eliminating the costly preparation of the warp beam for the weaving process which is nowadays necessary, as well as eliminating the necessity of using the warp beam frame and other related elements on the weaving machine.

Description of drawings

[0013] The invention is schematically represented in the enclosed drawings, where Fig. 1 shows a plan view of the arrangement of fabric formation according to the invention, Fig. 2 illustrates a side view of the configuration of the means for guiding threads and realization of beating-up, shed-forming means, means for compensating the forces, thread tension regulating means and means for capturing threads, Fig. 3 is an axonometric illustration of an example of embodiment of a device for the implementation of the invention with a pneumatic insertion device, Fig. 4 is an axonometric illustration of an example of embodiment of a device for changing the position of both inserted threads, Fig. 5 shows a side view of an example of embodiment of a rotary weaving reed and relay nozzles for supporting the insertion operation and Fig. 6 is an axonometric illustration of an example of embodiment of a rotary weaving reed with a insertion channel and helical gliders.

Specific description

[0014] The invention is based on a method of weaving (fabric formation) in at least two equivalent (comparable), ideally two completely identical, sets of threads are used. In the initial stage of fabric formation, i.e. before insertion of the thread through a shed, these sets of threads are mounted in a manner which is equivalent (comparable), ideally completely identical, on equivalent (comparable), ideally completely identical, supply packages. Thus, each set of threads is during the process of fabric forming completely and gradually formed by taking off and inserting individual threads from a corresponding carrier and their parallel inserting into the shed formed by the threads of another set of threads. A typical carrier of each set of threads is a supply package of a insertion mechanism of the weaving machine, on which is wound ideally (in the best case) a single thread by several orders larger than the machine width, or, more specifically, the width of the formed fabric, and from which during the weaving process according to this invention gradually (by cutting) are separated linear portions, which are formed by the individual threads of a particular set of threads, as will be described below. The threads of each set of threads are either the same or "similar" or they are even totally different - both with respect to dimensions and materials, as well as from the point of view of other possible parameters of the threads. Dimensional, material and other characteristics (parameters) of the threads of the individual sets of threads are determined by the required parameters of the fabric to be formed.

[0015] It is obvious that the individual sets of threads from which fabric **13** is formed by the method according to the invention, are arranged towards each other under a specific angle corresponding to the angle enclosed by the threads of the fabric being formed.

[0016] For further description, it will be taken into account that the carrier of each set of threads is a thread supply package of an insertion mechanism, which is aligned with each thread supply package, i.e. with each set of threads.

[0017] The individual threads of each set of threads are alternately inserted from the thread supply package of each set of threads to a weaving zone, i.e. the zone in which fabric is formed, whereby, alternately, by each set of threads a shed is formed and alternately the thread of this set is inserted as a weft thread through the shed formed by another set of threads. The process takes place in such a manner that each of the threads of one set of threads inserted in one particular weaving cycle through the shed formed by the previously inserted threads of another set of threads is used at least in one following weaving cycle as a shedding thread for forming a shed by this set of threads and for inserting one or more threads of at least one following set of threads, whereby the threads of all the sets of threads together create the binding points of the fabric being formed.

[0018] This means that the threads of all the sets equally contribute to creating the binding points of the formed fabric, since each thread of each set of threads is used once as a weft thread and subsequently it is used at least once, but usually several times in a row, as a warp thread for forming a shed for inserting a thread of another set of threads. This inserted thread of another set of threads then, at least in one following weaving cycle, again becomes a warp thread, or, more precisely, one of the warp threads, for forming a shed for inserting another thread of another set of threads. Consequently, in the case of using two sets of threads, weaving cycles regularly alternate, when in one cycle a thread from the first set of threads is inserted into the shed formed by the previously inserted threads of the second set of threads and in the subsequent weaving cycle a thread from the second set of threads is inserted into the shed formed by the previously inserted threads of the first set of threads. Thus, in each set of threads, the insertion operation and shed formation regularly alternates with shed formation by each set of threads, which thus contribute to fabric formation in an equivalent (comparable) manner - ideally, in a completely identical manner - are also equally loaded, exposed to forces, speeds, etc.

[0019] As has been suggested above, a thread of one set of threads is inserted into the shed formed by threads from another set of threads inserted in the previous weaving cycles. In other words, this means that a thread of one set of threads inserted in one weaving cycle as weft, becomes in at least one subsequent weaving cycle a warp thread, or, more specifically, one of the warp threads, for forming a shed for inserting a thread (weft) from another set of threads and this other thread then in at least one subsequent weaving step becomes a warp thread for forming a shed for inserting a thread (weft) from the following (or previous) set of threads. To control the lateral movement of the individual threads of each set of threads, i.e. to form a shed by the previously inserted threads of a corresponding set of threads, a required number of means for shed formation is used, the number being determined mainly by the number of threads which are actively involved in forming fabric of a desired width, as will become obvious from the following text and drawings.

[0020] The solution according to the invention is based on using at least two sets of threads, which are in an ideal case fully identical, i.e. from the point of view of weaving technology, they have a "format" of threads (quality, length, carrier, etc.) complying with the selected technology of inserting threads (weft), i.e. the selected technology of thread insertion (weft insertion) into a shed. Also, the sets of threads meet the requirements of the formed fabric in terms of the quality and parameters of the fabric being formed. All the sets of threads are situated on the machine frame in a manner which is typical of the selected technology of insertion, e.g. in a manner known in current insertion devices.

[0021] As indicated above, the individual sets of threads form with each other a specific angle which depends on what angle of the crossing of the threads is required in the formed fabric. This angle can be described, e.g., as an angle between the longitudinal axes of thread inserters (weft inserters), an angle between the longitudinal axes of threads, etc. For example, in order to form a classical orthogonal fabric by the method according to the invention, it is sufficient to use two sets of threads, which form an angle of 90° and which are arranged according to the invention perpendicularly to each other in the machine frame.

[0022] The actual process of fabric formation according to the invention, i.e. weaving, starts with the process of the so-called weaving-in, when the individual threads of the individual sets of threads are gradually and alternately inserted in the weaving zone, whereby gradually from the centre of the width of the formed fabric, binding points are created between the threads of the individual sets of threads across the full width of the formed fabric. As soon as the binding points are created across the full width of the formed fabric, the process of weaving-in is stopped and is followed by the process of fabric formation across the full width.

[0023] As has been stated above, the process of weaving-in proceeds in such a manner that in the first weaving cycles of the weaving process, the threads of each set of threads are alternately inserted by means of their insertion devices from their supply packages in the weaving zone, whereby the threads of the individual sets of threads are inserted in the weaving zone in a mutually intersecting manner, which means that the threads of the individual systems of threads, after being inserted, are crossing each other. The mutual position of the individual crossing threads of each set of threads, i.e. whether in the process of weaving-in a particular thread of one set of threads is above or under a corresponding thread of another set of threads, is determined either by a specific phase (time) displacement of individual weft threads in the individual sets of threads, i.e. inserting one thread after another, or it depends on the use of a device for changing the position of the inserted threads at the point of crossing - the so-called siding, as will be described further on, or already at this stage one of the shed-forming devices described hereinafter is applied, creating the upper and lower parts of the shed by the particular threads of a particular set of threads.

[0024] After each insertion of a thread, the particular inserted thread of the particular set of threads is in the insertion position (inserted "weft") in the formed fabric. Subsequently, the particular thread moves from the insertion position to a beat-up position, whereby this movement is realized by using suitable means, e.g. by one of the known means, e.g. by the spur of the inserter or by a weaving reed, etc. In the beat-up position, the particular thread is further acted on by a beating-up means, by which the particular thread is moved from the beat-up position to the fell of the formed fabric.

[0025] Following the insertion of a thread of a particular set of threads into the weaving zone, or, in other words, into the shed, both ends of the inserted thread are fixed, whereupon the regulator of tension and position starts to act upon the thread, which consequently straightens, thus allowing controlled and regulated movement of the particular thread through the weaving machine, as will be described further on. For example, the front end of the inserted thread (seen according to the direction of the thread movement during insertion is captured by a fixing device, e.g. a pneumatic device (underpressure, suction, etc.), or a mechanical device (nippers, additional threads with leno weave, etc.), while the rear end of the particular thread is guided into the regulator of the tension and position of threads and simultaneously, or shortly thereafter, the rear end of the particular thread is separated, e.g. cut off, from the thread reserve on the corresponding thread supply package. The regulator of tension and position controls (determines) the position of the thread and also, in cooperation with the fabric take-up mechanism, controls the tension and further movement of the individual inserted threads of each thread subsystem in direction **A** of the fabric take-up.

[0026] In the following weaving cycle, after being inserted, each inserted thread of each set of threads is moved due to the cooperation of the fabric take-up mechanism and the regulators of the tension and position of the threads from its beat-up position by a distance corresponding to the sett of the formed fabric, whereby this thread is still straight between the fixing device of the front end and the regulators of the tension and position of threads. During the above-mentioned moving by a distance equivalent to the fabric density, the particular thread is set into contact with the shed-forming means, which are aligned with a corresponding set of threads in the area between the fell of the formed fabric and the regulators of the tension and position of this set of threads. Thus, this particular thread may be raised, thereby forming the upper branch of the shed, or it may remain in the original position, in which it forms the lower shed branch. Lowering the threads of the lower shed branch under their basic level is also possible, e.g. in order to enlarge the shed opening, but in the basic embodiment it appears unnecessary or even less effective. In this weaving cycle, which follows immediately after the weaving cycle in which the particular thread of a particular set of threads was inserted as weft into the weaving zone (shed), the particular inserted thread turns from weft into a warp thread, which is now used for forming a shed for inserting another thread of another set of threads.

[0027] In this cycle of the weaving (weaving-in) process, when a shed is formed, a thread is inserted from another set of threads as weft, wherein this thread forms a binding point of the fabric at the point where it crosses the previously inserted threads of the previous set of threads, by which the shed is now being created. These binding points are formed according to a desired pattern of the formed fabric, i.e. in harmony with the formed shed in each weaving cycle (in each step of the weaving cycle). During the process of weaving-in, these weaving cycles alternate (are repeated) for the individual sets of threads until the binding points between the alternately inserted threads of the individual sets of threads on both fells of the newly formed fabric are created, whereby the process of weaving-in is considered as terminated, while the process of weaving across the full width of the fabric continues.

[0028] As a consequence, all the sets of threads which are involved in fabric formation according to this invention are mutually equivalent (comparable), ideally, they are fully identical, and so the process can be described as weaving by means of equivalent (comparable) sets of threads, when each set substantially forms a thread subsystem, and together the thread subsystems form a thread system of the fabric being formed.

[0029] The weaving process according to this invention is characterized by the fact that in the formed fabric having a width **X,** the binding points are formed on the individual threads of each set of threads on the length $\mathbf{Y_i, Y_2 .... Y_n}$, which is smaller than the total width **X** of the formed fabric, but in the sum of the threads of the individual sets of threads, the binding points are formed on the total length $\mathbf{Y} = \mathbf{Y_1 + Y_2}$, which is greater than the width **X** of the formed fabric. In the case of two sets of threads disposed to each other at an angle of 90°, the length of the threads on which the binding points are formed corresponds to the value $Y = \sqrt{2} \cdot X$.

[0030] The formed fabric is taken-up in direction **A** of the longitudinal axis of the fabric by an unillustrated take-up mechanism with a regulated drive, and, if necessary, it is wound on an unillustrated cloth beam.

[0031] An example of embodiment of a device according to the invention for two sets of threads **1, 1',** forming an angle of 90° with each other, provided with a gripper inserting (picking) device **4**, **4'** is schematically represented in Fig. 1.

[0032] Both sets of threads 1 and **1'** are located on identical supply packages **2, 2'** (packages of the insertion device), which are mounted on the machine frame. The axes of the packages **2**, **2'** form an angle of 90°. Each package is aligned with a measuring device **14** of the thread **1**, **1'** (weft measuring device) and a insertion device (mechanism), in this case a gripper insertion device **4, 4'**, in another case with a shuttle inserting device, in the example of Fig. 3 with a pneumatic insertion device etc., which means that each set of threads has its own insertion device (mechanism).

[0033] Each set of threads in direction **A** of the formed fabric take-up is behind each insertion device aligned with means for holding already inserted threads **1, 1'** as well as and shed-forming means.The means for holding the inserted threads **1, 1'** comprise fixing means **5, 5'** of the front ends of the inserted threads **1, 1',** whereby the rear ends of the inserted threads **1, 1'** are aligned with the regulators **12, 12'** of the tension and position of the threads **1, 1'.** The fixing means **5, 5'** and the regulators **12, 12'** of the tension and position of the inserted threads **1, 1'** of a particular set of threads are arranged on opposite sides of the formed fabric, i.e. the fabric being formed lies between them.

[0034] Between the formed fabric and the regulators **12, 12'** of the tension and position of the inserted threads **1, 1'** of each set of threads are arranged hereinafter described means **7, 7', 8, 8', 9, 9', 10, 10', 11, 11'** for dividing already inserted threads **1, 1'** into the shed branches, shed-forming means, beating-up means of presently inserted threads **1, 1'** to the fell of the formed fabric on the side of a corresponding set of threads and means for compensating for the forces induced in the threads **1, 1'** by the shedding device **7, 7'.**

[0035] Fig. 2 illustrates an embodiment with a shuttle inserting (picking) device, which comprises a shuttle **20** with a thread **1, 1'** reserve of a particular set of threads (constituting a thread supply package), whereby the shuttle **20** is mounted on a movable part of a linear motor **22** and the thread unwound from the shuttle **20** is gradually moved to the beat-up position during the movement of the shuttle **20** through the shed by means of a spur **21** mounted on the shuttle **20.** To ensure the correct position of the threads **1, 1'** in relation to the elements of the shedding device **7, 8, 9,** and, consequently, to ensure the right function of the shedding device **7,** a device for separating the threads **1, 1'** before forming a shed is used, i.e. for separating the threads into individual branches of the shed. In the illustrated example of embodiment, this mechanism for separating the threads **1, 1'** before forming a shed comprises a rotary harness board **10, 10'** with helical gliders, whose pitch corresponds to the sett of the threads **1, 1'** of the formed fabric, i.e. is identical to the density of the threads **1, 1'** of the formed fabric.

[0036] Fig. 3 illustrates a pneumatic insertion device with a main nozzle **15, 15'** for each set of threads. In addition, in this example of embodiment the main nozzles **15, 15'** are mounted reciprocatingly swingingly on a movable holder **27,** which contributes to extending the insertion time and also enables the above-mentioned transport of the inserted threads **1, 1'** from the insertion position to the beat-up position. In the section of insertion between the main nozzle **15, 15'** and point **E,** which is the point of intersection of the pathways of the insertion device of the individual sets of threads, is located an auxiliary channel **16, 16'** for guiding each of the threads **1, 1'** at the initial stage of the insertion operation before they enter the weaving zone. The auxiliary channel **16, 16'** does not have any external interactions with the threads **1, 1'** and serves either only to direct the air field during the insertion operation (passive confuser) or it is provided with not represented auxiliary insertion elements (nozzles) to support the speed profile of the inserted threads **1, 1'** during the insertion operation (active confuser). The auxiliary channel **16, 16'** is provided along its entire length with an unthreading groove **25** for the inserted threads **1, 1',** which are captured after being inserted by the fixing means **5** of the front ends of the inserted threads **1, 1'** and by the regulator **12, 12'** of the thread tension and movement.

[0037] In the embodiment of Fig. 3, the auxiliary channel **16, 16'** is stationary.

[0038] In the embodiment of Fig. 4, the auxiliary channel **16, 16'** is designed as an output member of a mechanism with an oscillating (reciprocating) movement, whose displacement law corresponds to that of the main nozzle **15, 15',** which oscillates on the movable holder **27** in order to extend the time limit for the realization of the insertion operation and move the thread **1, 1'** which is being inserted from the insertion position to the beat-up position.

[0039] Figs. 4 II and 4 III illustrate the so-called siding **18** for realizing the change of the mutual position of the individual inserted threads **1, 1'** of the individual sets of threads, i.e. above each other/under each other, by means of a mechanical device. In the case of the pneumatic insertion of threads **1, 1'** through a shed in Figs. 3 and 4, the siding **18** enables to change the mutual position of the mouths of the auxiliary channels **16, 16',** which are aligned with the outlet of the main nozzle **15, 15'** before the threads **1, 1'** enter the insertion channel **23** of the rotary weaving reed **17, 17'.** The insertion channel **23,** illustrated in Figs. 5 a 6, is described further on. Each rotary weaving reed **17, 17'** is in the illustrated example of embodiment arranged in the weaving zone in the direction of the inserted thread **1, 1** of one set of threads **1, 1'** and, at the same time, is arranged transversely to the other set of threads.

[0040] The siding **18** is, for example, realized by means of a reversible movable (swinging) mounting of the auxiliary channel **16, 16',** e.g. on a movable holder **37, 37',** which is rotatably mounted on the machine frame on a pin **38, 38'** and is driven by an unillustrated mechanism.

[0041] Figs. 4 I to 4 III show three possible mutual positions of the outlets of both auxiliary channels **16, 16',** wherein in Fig. 4I they are arranged in one plane, in Fig. 4 II the left auxiliary channel **16** is arranged under the right auxiliary channel **16'** and in Fig. 4 III the left auxiliary channel **16** is arranged above the right auxiliary channel **16'.**

[0042] The above-described regulators **12, 12'** of the tension and position of the inserted threads **1, 1'** substantially constitute a device for fixing and transporting the rear ends of the inserted threads **1, 1'** and comprise in the illustrated example of embodiment several pairs of regulatory rollers rolling away from each other, rotating around their longitudinal axis, which is perpendicular to direction **A** of the take-up of the formed fabric, and, as a result, the rotation axis of the regulator rollers is parallel with the longitudinal axis of an unillustrated mechanism for the take-up of the formed fabric. The regulator rollers are coupled to an unillustrated drive which is coupled to an unillustrated control device, which ensures the required angular velocity of the rotation of the regulator rollers and the required torque of the regulator rollers. Between the regulators **12, 12'** and a corresponding thread supply package **2, 2'** of each thread subsystem are arranged scissors **3, 3'** for cutting the inserted threads **1, 1'** and creating the rear end of the inserted threads **1, 1'.** In an unillustrated example of embodiment, the regulators **12, 12'** are composed also of other technical means, which enable to keep the rear ends of the threads **1, 1'** straight and at the same time allow their movement in direction **A** of the take-up of the formed fabric.

[0043] The above-mentioned fixing device **5, 5'** of the front ends of the inserted threads **1, 1'** of each thread subsystem is in an example of embodiment formed by a suction nozzle, which sucks in the front ends of the inserted threads **1, 1',** by which means it holds them taut, while allowing the movement of the threads **1, 1'** in direction **A** of the take-up of the formed fabric. In yet another, unillustrated, example of embodiment the fixing device **5, 5'** is formed by a device for the formation of a leno selvage, a gripper device etc., these means, however, always hold the inserted threads **1, 1'** taut, while allowing the movement of the threads **1, 1'** in direction **A** of the take-up of the formed fabric.

[0044] The above-mentioned shedding device **7, 7'** of each set of threads comprises in the example of embodiment of Fig. 3. a set of needles **34** mounted on actuators **35,** where the needles **34** are disposed in the direction of each set of threads **1, 1'** in the weaving zone in the harness board **8.** In the embodiment according to Fig. 2, the shedding device **7, 7'** comprises actuators **9, 9',** which are disposed in the stationary harness board **8, 8',** whereby each of the actuators **9, 9'** comprises a needle **34** for raising the corresponding thread **1, 1'.**

[0045] During fabric formation the individual threads **1, 1'** of each set of threads move above the harness board **8, 8'** which is aligned with them, and in each weaving cycle a particular thread **1, 1'** is in contact with another thread **34** for thread rasing. The raised threads **1, 1'** form an upper branch of the shed, whereby the lower branch of the shed is formed by the threads **1, 1',** which have not been raised, i.e. the threads left in the lower position. The actuators **9, 9', 35** in an unillustrated example of embodiment are based on the principle of an electromagnet or other linear drives. For forming fabric with a higher density it is advantageous to use a cascade arrangement of the actuators **9, 9', 35.**

[0046] To ensure the correct position of the threads **1, 1'** with respect to the elements of the shedding device **7, 7'** and, consequently, to ensure the right function of the shedding device **7, 7'** it is possible to use the above-mentioned means for separating the threads **1, 1'** before forming a shed, i.e. for separating the threads **1, 1'** into the individual branches of the shed. In the example of embodiment of Fig. 2, this device for separating the threads **1, 1'** before forming a shed is composed of a rotary harness board **10, 10'** with helical gliders, whose pitch corresponds to the density of the threads **1, 1'** of the formed fabric, i.e. is basically identical to the density of threads **1, 1'** of the formed fabric. In the embodiment according to Figs. 3, 5 and 6, this device for separating the threads **1, 1'** before forming a shed is composed of helical gliders directly on the rotary weaving reed **17, 17',** which is substantially an equivalent to the above-mentioned rotary harness board **10, 10'** with beating-up means.

[0047] The above-mentioned means for the compensation for the forces induced in the threads **1, 1'** of each set of threads by the shedding device **7, 7'** consist in the illustrated embodiments of at least one compensator **11, 11'** for each set of threads. In the example of embodiment shown in Figs. 2 and 3, the compensator **11, 11'** is made as a known passive compensator, which is connected to the machine frame by a spring. In an unillustrated example of embodiment, the compensator **11, 11'** consists of an active compensator with a motion mechanism connected to a drive. In another unillustrated example of embodiment, the compensator **11, 11'** is composed of another suitable means capable of compensating for the forces induced by the shedding device **7, 7'** in the threads **1, 1'.**

[0048] The beating-up means of the threads **1, 1'** to the fell of the formed fabric are in the illustrated embodiments composed of a rotary weaving reed **17, 17'** aligned to each set of threads **1, 1'** In the example of embodiment of Figs. 5 and 6, the rotary weaving reed **17, 17'** is along its entire length provided with a insertion channel **23,** through which a particular thread is inserted **1, 1'** into the shed formed by the previously inserted threads of another set of threads. The insertion channel **23** is in the illustrated example of embodiment aligned with relay nozzles

19 to support the insertion operation, whereby the relay nozzles 19 are in the illustrated example of embodiment mounted on a bracket 28, which is reciprocatingly swingingly mounted on the machine frame, and so the relay nozzles 19 perform an oscillating (reciprocatingly swinging) movement into the insertion channel 23 and out of the insertion channel 23. To obtain the required time period for inserting the thread 1, 1' through the insertion channel 23, the illustrated insertion channel 23 is either extended along the circumference of the rotary weaving reed 17 (extended in contrast to the classical weaving machines according to the background art), i.e. it has a greater angle of opening the lateral walls of the insertion channel 23, or the angular speed of the rotary weaving reed 17, 17' is adjusted and, in case of need, also stopping of the rotary weaving reed 17, 17' in a certain time interval of the weaving cycle is applied. As indicated above, the rotary weaving reed 17, 17' is provided with helical guide gliders 24 for dividing the threads 1, 1', whereby these gliders are connected to the insertion channel 23 and cooperate with it. The pitch of the helical guide gliders 24 is equal to the pitch of the threads 1, 1' in the formed fabric and so the threads 1, 1' in each weaving cycle move due to the action of the gliders 24 of the rotary weaving reed 17, 17' in direction **F** obliquely to the edge of the fabric by a defined distance corresponding to the sett of the formed fabric and the size of the shift of the fabric in direction **A** of the take-up is determined by the angle between both sets of threads 1, 1'.

[0049] The beating-up means of the rotary weaving reed 17, 17' are in an example of embodiment formed by a beat-up dent 26, whose shape is such that the required size Δ of the beat-up pulse 32 is achieved, as is shown in Fig. 5. The width φ of the beat-up nose 26 of the rotary weaving reed 17, 17' determines the phase (time) shift of the beating-up of the threads 1, 1' of both sets of threads. Simultaneous beating-up of the threads 1, 1' of both thread subsystems is impossible because of mutual impermeability of the masses of both rotary weaving reeds 17, 17', whose dedendum circle 30 must not overlap into the beat-up strips under the fell 33 of the formed fabric.

[0050] Fabric formation on the device according to exemplary embodiments is carried out in such a manner that in the first weaving cycle of the weaving process, in the so-called process of weaving-in, from the supply packages 2, 2' always one thread 1, 1' at a time is taken off and inserted into the insertion zone. Both threads 1, 1' cross each other at point **E**, thus creating the first binding point. After inserting both threads 1, 1' into the insertion position, each of the inserted threads 1, 1' is taken to the beat-up position, namely by the movement of the inserted threads 1, 1' in direction **F**. Simultaneously with the transport of each thread 1, 1' to the beat-up position, the threads 1, 1' are guided by their front ends to the fixing device 5, 5', whereas by their rear ends they are guided to the regulators 12, 12' and separated from the thread supply package 2, 2'. Subsequently, the regulators 12, 12' carry the threads 1, 1' during the process of fabric formation and keep the threads 1, 1' straight together with the fixing devices 5, 5' **of** the front ends of the threads 1, 1'.

[0051] After inserting a thread into the shed and after the beating-up of the threads 1, 1' to the fell of the formed fabric, the front ends of the inserted and beaten-up threads 1, 1' are fixed in the fixing device 5, 5', whereas the rear ends of the inserted threads 1, 1' are, from the point of view of the direction of the insertion of each of the threads 1, 1', are transferred and held by the regulator 12, 12', as indicated above, and are cut off from the supply package 2, 2' by means of a suitable device, e.g. by scissors 3, 3'.

[0052] The threads 1, 1' are carried by the regulators 12, 12' by being guided initially between the first pair of the regulatory rollers and gradually, as other inserted threads 1, 1' move in direction **A** of the fabric take-up, they are handed on to the following pairs of the regulator rollers, which are arranged in direction **A** behind the first pair of the regulator rollers, i.e. substantially along the formed fabric. The regulator rollers, along with an unillustrated drive of an unillustrated fabric take-up, fulfill the function of regulating the forces acting in the threads 1, 1'. The regulator rollers are provided with frictional surface having a required friction coefficient and are pushed to each other by a spring, or hydraulically or pneumatically, to avoid slippage between the threads 1, 1'. The regulator rollers are coupled to a servo drive, which ensures their required angular speed and torque. The number of pairs (sections) of the regulator rollers and their width is such that the distance of the threads 1, 1' from the beat-up point 33 (the fabric fell) to the regulator rollers is approximately the same during the whole process of weaving, when the formed binding points on the thread 1, 1' spread from the position of the first binding point **E** as far as to the selvage of the fabric, by which means the same stiffness of the threads 1, 1' is achieved and thereby also the same value of the beating-up force in the whole process.

[0053] Direction **A** of the take-up of the formed fabric and the speed of the movement of the formed fabric can be defined by two components, whereby one of them is in the direction of the longitudinal axis of the inserted thread 1, 1', i.e. in the direction of insertion, and enables to define the delivery of the thread length for forming the binding points of the formed fabric, while the other component of the movement of the threads 1, 1' is in a direction perpendicular to the longitudinal axis of the thread 1, 1' and enables to define the speed of the movement of the threads 1, 1' in direction **F** of the sett of the formed fabric.

[0054] In each following weaving cycle the threads 1,1' already inserted move in direction **A** of the fabric take-up in such a manner that they move in direction **F** by a distance corresponding to the density of the fabric, by which means the already inserted threads 1, 1' of each set of threads get into contact with the individual means of the shedding device **7** for forming a shed, and, as a result, the inserted threads **1, 1'** of one set of threads become warp threads for another set of threads for at least one subsequent weaving cycle.

[0055] In another cycle one thread **1, 1'** from each thread subsystem is inserted into the insertion zone and the shed in a similar manner. These threads **1, 1'** cross each other again, forming a binding point together as well as with the other threads **1', 1'** of the opposite set of threads, which have been inserted in the previous weaving cycle and which are currently involved in forming the shed. These threads **1, 1'** are simultaneously shifted in direction **A** of the fabric take-up by the regulators **12, 12'** at a controlled angular velocity.

[0056] The absolute movement of the threads **1, 1'** is realized in direction **A** of threads, wherein in the illustrated the fabric take-up and follows the fabric selvage. In relation to the fell of the formed fabric, which has a pointed shape according to the number of the used sets example of embodiment with a pair of mutually perpendicular thread subsystems, the fell of the formed fabric forms with the selvage of the formed fabric an angle of 45°, which means that during weaving-in, when the number of threads **1, 1'** in the fabric is growing, and the binding points are formed gradually in a direction from point **E,** which marks the first binding point at the centre point of the fabric, towards the selvage of the fabric at a relative speed $\mathbf{v_{REL}=v_{TAKE\text{-}UP}\cdot\sqrt{2}}$. As a result, in each following weaving cycle more and more binding points are being formed, i.e. the number of the binding points is growing arithmetically. After inserting a sufficient number of threads **1, 1'** of all the sets of threads and after forming a binding point on both fells of the fabric, the process of weaving-in is terminated and in the following process of weaving binding points are already formed simultaneously always along the entire length of one part of the pointed fell of the fabric, i.e. in the illustrated example of embodiment in the section marked by points **E** and **G** and in the section marked by points **E** and **H.**

[0057] In each following weaving cycle the inserted threads **1, 1'** move in the gliders **24** of the rotary weaving reed **17, 17'** from point **E** in direction **A** of the fabric take-up, wherein in direction **F** obliquely to the selvage of the formed fabric they move by a distance corresponding to the density of the formed fabric. Thus, in each weaving cycle a shed for inserting the threads 1, **1'** of another set of threads is formed by the previously inserted threads **1, 1'** of one set of threads and in the following weaving cycle from the threads **1, 1'** of this other set of threads is formed a shed for inserting the threads **1, 1'** of the preceding sets of threads. The compensation for the forces induced by the shed, the fabric take-up and regulation of the forces can be performed by known devices and methods.

List of references

[0058]

1,1'	threads of the individual sets of threads
2,2'	packages (thread supply packages) of the individual sets of threads
3,3'	scissors
4,4'	gripper inserter of weft
5,5'	fixing device
6,6'	beating-up zone
7,7'	shedding device
8,8'	stationary harness board
9,9'	actuators
10,10'	rotary harness board
11,11'	compensator of the forces actuated by the shed
12,12'	regulator
13	fabric
14, 14'	thread measuring device (weft thread measuring device)
15,15'	main nozzle
16,16'	auxilliary channel
17,17'	rotary weaving reed
18	siding
19,19'	relay nozzles
20	shuttle
21	spur of the shuttle for the beating-up operation
22	drive of the gripper-linear motor
23	insertion channel
24	helical gliders of the rotary reed
25	unthreading groove
26	beat-up nose
27	movable holder of the main nozzle
28	movable beam of the relay nozzles
29	adendum circle of the reed
30	dedendum circle of the reed
31	width of the beat-up nose
32	beat-up pulse
33	fell of the fabric
34	needle
35	actuator
37	movable holder for the auxilliary channel
A	direction of the fabric take-up
B	direction of the axis of the fixing and transport mechanism
C	direction of the axis of the movement of the main nozzles
D	direction of the movement of the actuators of the shed
E	first binding point in the central section of the fabric width
F	direction of relative movement of threads at the fell of the fabric
H	last binding point at the fabric selvage

Claims

1. A method of forming fabric in which from a set of parallel threads is formed a shed through which another set of threads is inserted, whereupon the in-

serted thread arrives at the fell of the formed fabric, **characterized in that** at least two equivalent sets of threads are used, mounted in an equivalent manner on equivalent carriers, whereby by means of the individual sets of threads a shed is alternately formed and alternately a thread of the corresponding set is inserted through the shed as weft thread in such a manner that each of the threads of one set of threads is in one particular weaving cycle inserted through the shed, which is formed by the threads of another set of threads, and the thread of one set of threads thus inserted is used in at least one following cycle as a shedding thread for forming a shed by the threads of this set of threads and for inserting one or more threads of at least one following set of threads, whereby the threads of all the sets of threads together create the binding points of the formed fabric.

2. The method according to Claim 1, **characterized in that** at first the process of weaving-in is carried out, during which threads (1, 1') of all sets of threads are alternately inserted, whereby these threads (1, 1') together gradually create the binding points from the centre of the fabric (13) to the selvages of the fabric (13) and after the completion of the binding points formation on both selvages of the fabric (13), the fabric formation continues across the full width (X) of the fabric (13).

3. A device for fabric formation according to the preceding claims, which comprises at least two sets of threads, whereby it also comprises a device for forming a shed and for inserting weft and further comprises a beating-up device, a take-up mechanism and a winding device of fabric, **characterized in that** all the sets of threads are mounted in an equivalent manner on equivalent carriers, each of which is aligned with an insertion device of a corresponding set of threads, whereby each set of threads is aligned with means for fixing the ends of the inserted threads of each set of threads and means for regulation of the tension of the inserted threads of each set of threads, as well as means for forming a shed by the inserted threads of another set of threads.

4. The device according to Claim 3, **characterized in that** the insertion device is formed by a pneumatic insertion device.

5. The device according to Claim 3, **characterized in that** the insertion device is composed of an insertion device with a gripper inserter.

6. The device according to Claim 3, **characterized in that** the insertion device is composed of an insertion device with a shuttle inserter.

7. The device according to Claim 4, **characterized in that** behind each pneumatic insertion device is situated a rotary weaving reed (17, 17'), which is provided with a insertion channel (23) along its entire length.

8. The device according to Claim 3, **characterized in that** the shed-forming means are composed of a shedding device (7, 7') aligned with each set of threads (1, 1'), which comprises a harness board (8) arranged crosswise to a corresponding set of threads, whereby needles (34) are arranged on actuators (9, 9', 35) in the harness board (8).

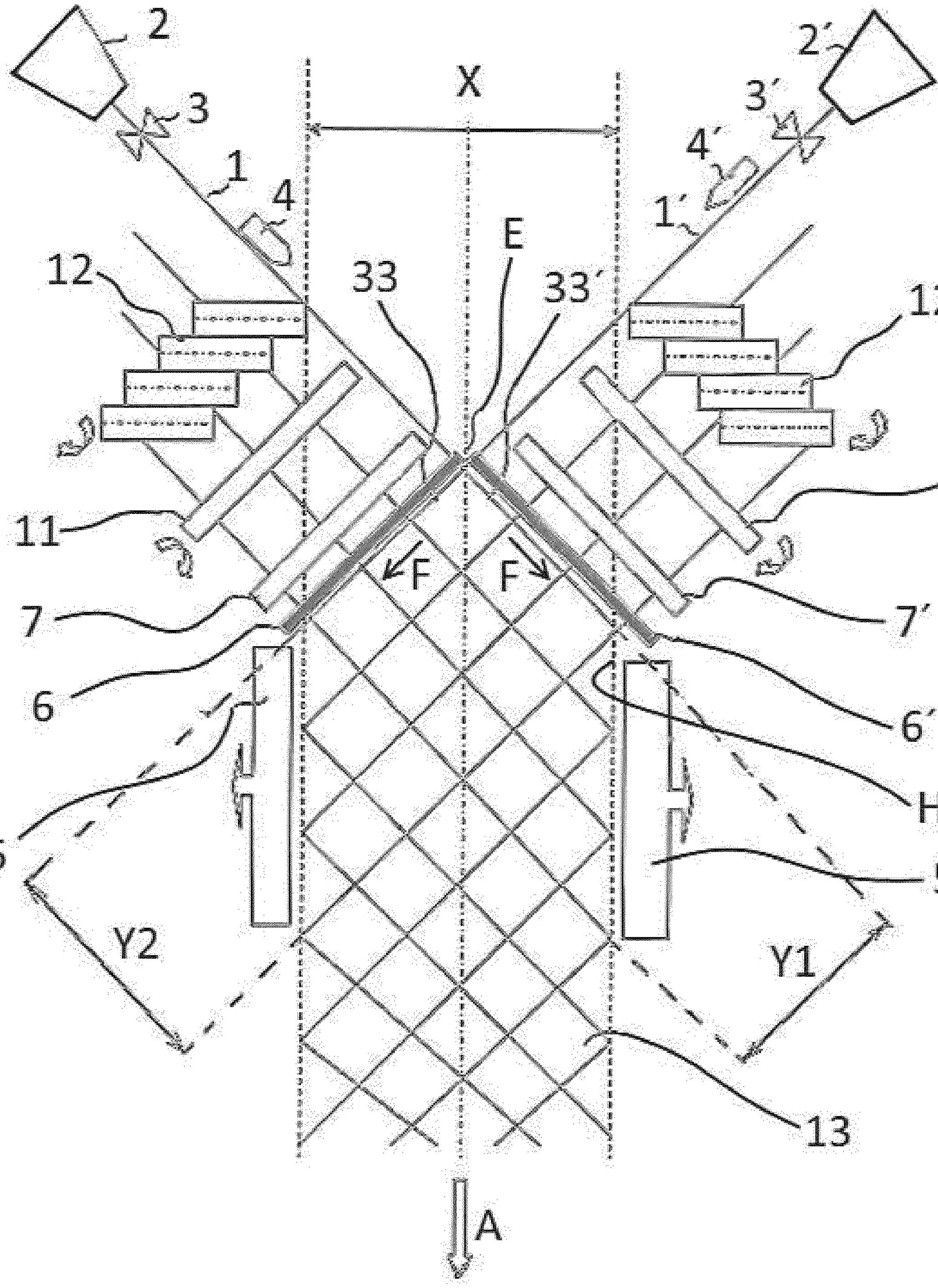


Fig. 1

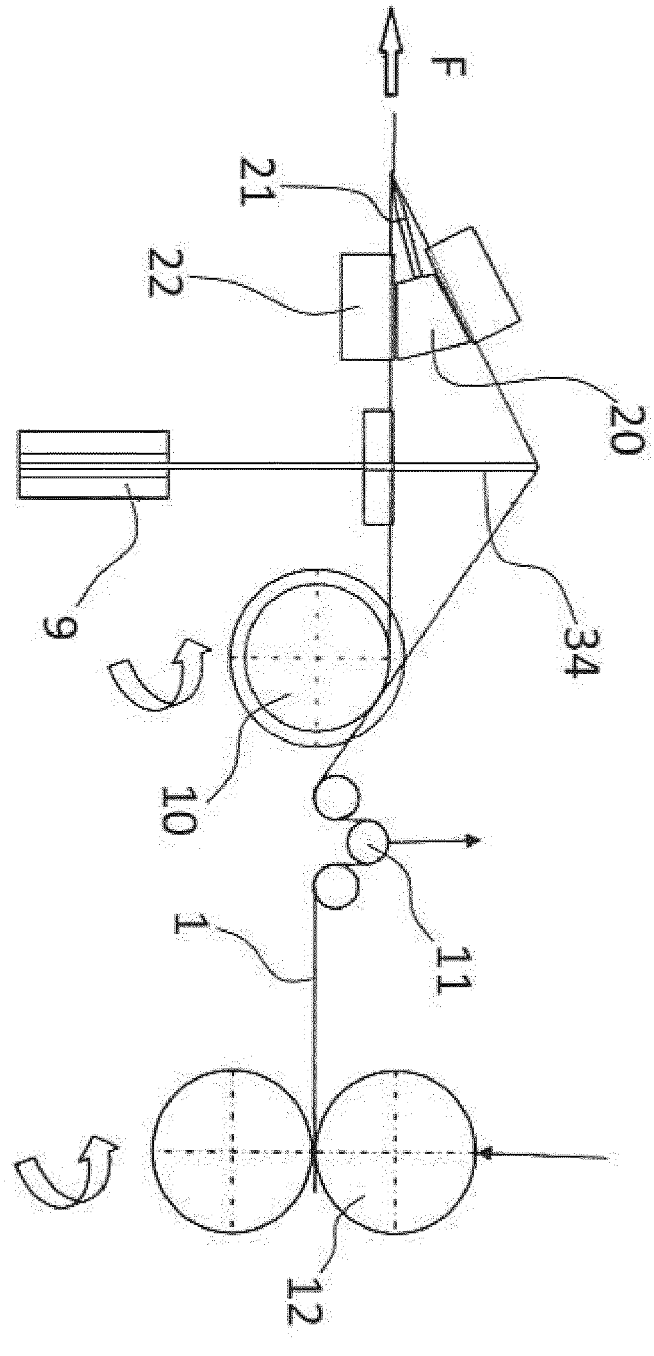
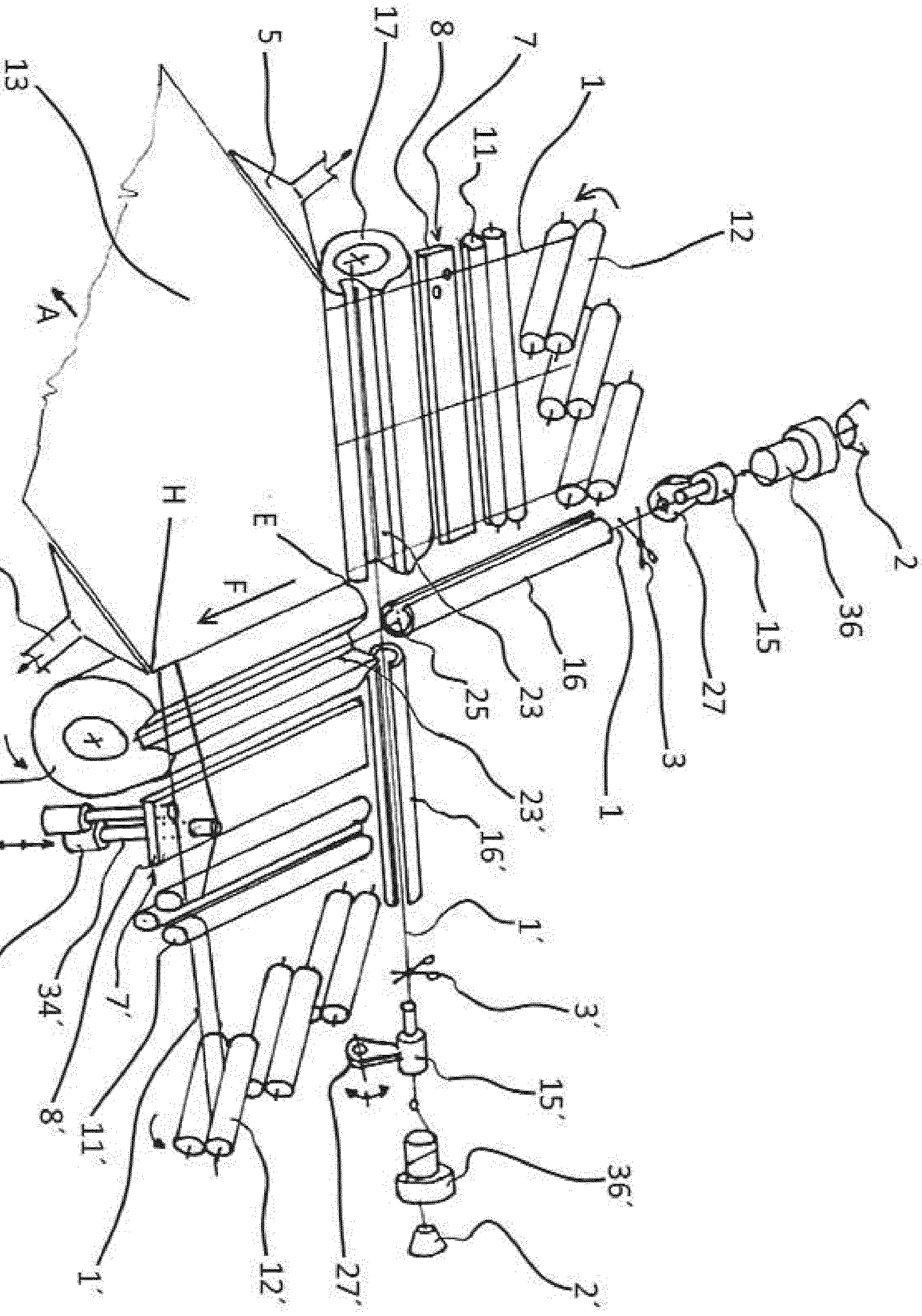


Fig. 2


13
5
17
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23'
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12'
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Fig. 3

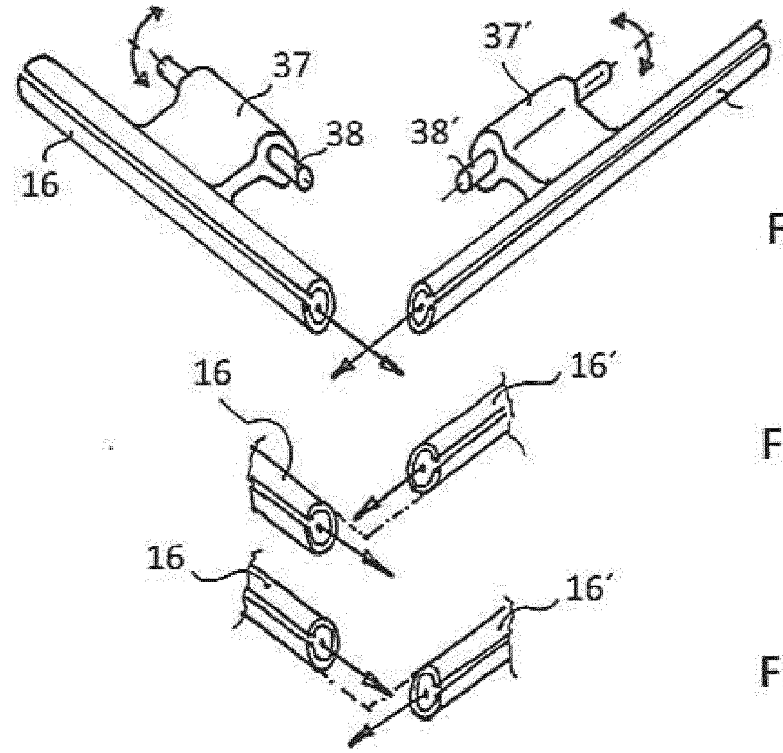

Fig. 4 I

Fig. 4 II

Fig. 4 III

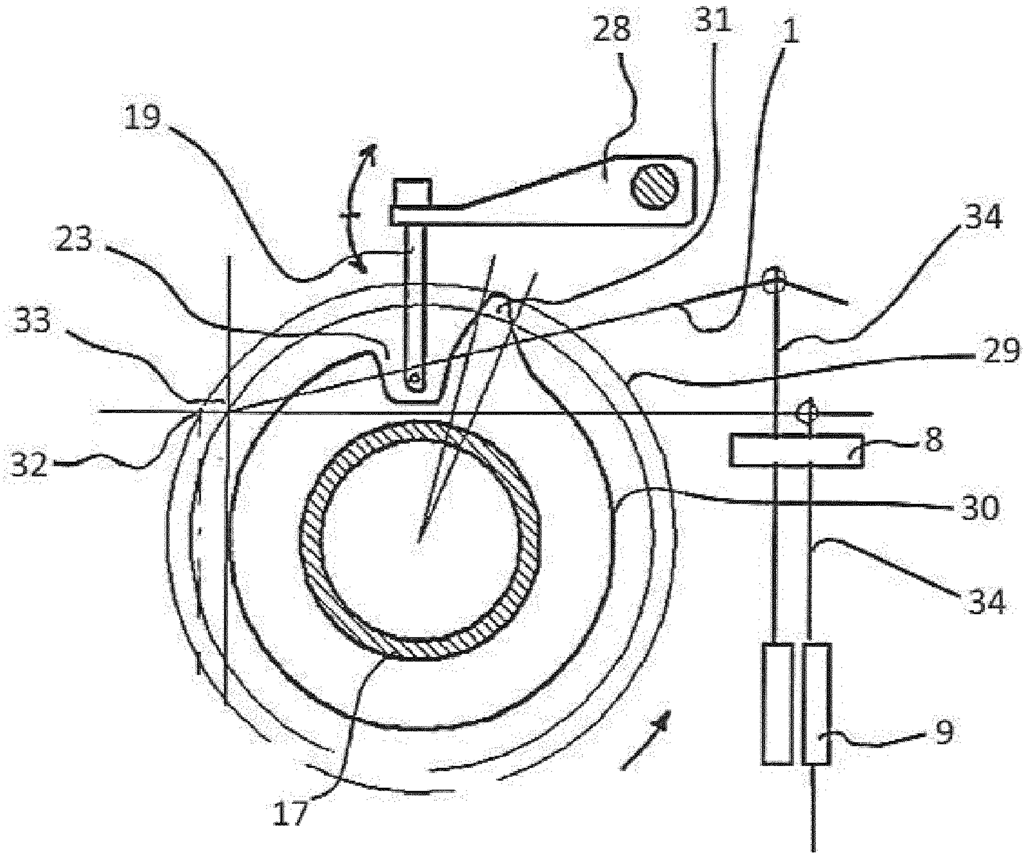

Fig. 5

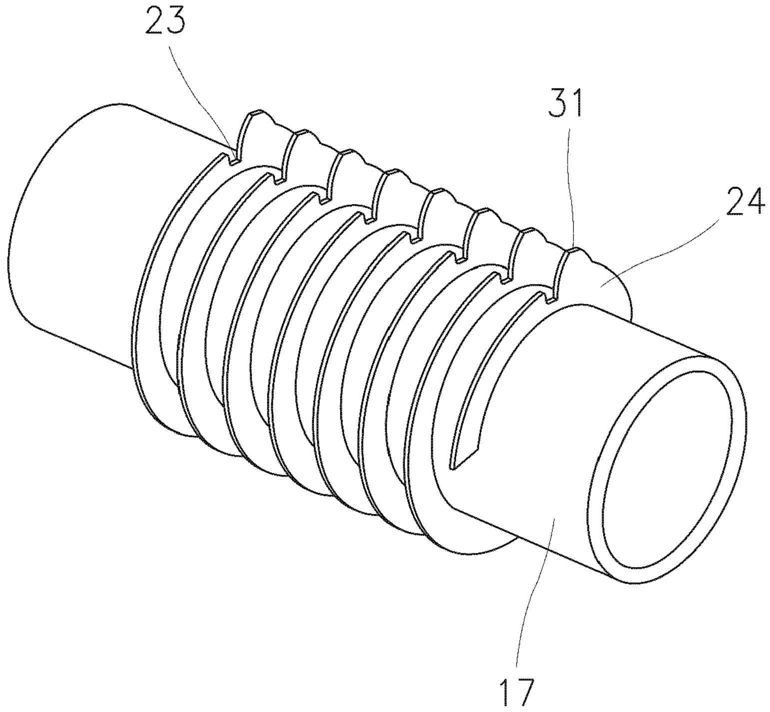

Fig.6