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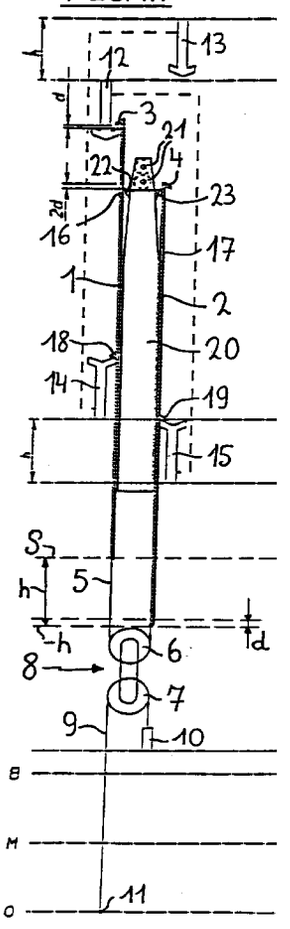
(54) Three-position open-shed jacquard machine

(57) Three-position open-shed jacquard machine, comprising a system (5, 8, 9) with two hooks (1), (2) for lifting warp threads, two first knives (12), (13) which are movable up and down in phase opposition, and which in a carry zone in the vicinity of their bottom dead centre can carry along a respective hook (1), (2) from a selection height (S), a control element (20) for taking the hooks (1), (2) into a carry position and into a non-carry position, two second knives (14), (15) which are movable up and down in phase opposition, and which in the vicinity of their top dead centre can carry along a respective hook (1), (2) from the selection height (S), while the first (12), (13) and second knife (14), (15) interacting with the same hook (1), (2) are movable in phase opposition, and each hook (1), (2) taken into a non-carry position can be retained by retaining means (22), (23), and in which the control element (20) can be operated to take each hook (1), (2) into a non-carry position during an upward movement of its first knife (12), (13), so that the hook (1), (2) does not remain retained by a retaining means (22), (23), but is carried along by its downward moving second knife (14), (15).

FIG.1A



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Description

The present invention relates to a three-position open-shed jacquard machine, comprising:

- a system with two interacting hooks for lifting at least one warp thread on a weaving loom,
- two first knives which are movable up and down in phase opposition, and which in a carry zone in the vicinity of their bottom dead centre can carry along a respective hook, and
- a control element, by means of which the respective hooks at the selection height can be taken into a carry position and into a non-carry position relative to their first knife.

In the case of such a jacquard machine each system with two interacting hooks can take at least one warp thread to three different heights - hereinafter called positions. After each half movement cycle of the knives - which is whenever one of the knives is situated in its top dead centre - one or more weft threads on the weaving loom are inserted into the shed formed between the warp threads. The insertion of one or more weft threads is hereinafter called a shot. In the case of a three-position open-shed jacquard machine the three positions of the warp threads can be achieved for each shot. This means that a warp thread which is situated in a first position for a particular shot can either remain in said first position or be taken to the second position or to the third position for the next shot.

European Patent 0,399,930 discloses a three-position open-shed jacquard machine. In the case of this jacquard machine, in order to make the three positions possible, it is necessary to have a system with two sets of interacting hooks disposed adjacent to each other. The interacting hooks of each set are interconnected by means of a lifter cord. Each lifter cord is passed under a top lifter roller of a respective lifter element. Another lifter cord is immovably fixed by one end and is then passed over a bottom lifter roller of one lifter element, under a reversing roller which is immovably fixed lower down than the lifter elements on a fixed part of the jacquard machine, and over a bottom lifter roller of the other lifter element. The other end of said lifter cord is connected to a harness cord for lifting at least one warp thread. Through a suitable selection of the hooks, said warp thread can be taken as desired into one of three possible positions for each shot. A control element is necessary for each set of interacting hooks, in order to be able to make the desired selection.

Due to the fact that two adjacent sets of interacting hooks, two adjacent control elements, two lifter elements and a reversing roller are provided for each system, this jacquard machine takes up twice the amount of space as a two-position open-shed jacquard machine. Besides, this jacquard machine works out to be fairly expensive.

German Patent No. 4,101,778 discloses two three-position jacquard machines, with the characteristics indicated in the first paragraph of this description. Each system for lifting at least one warp thread to three different positions comprises two interacting hooks, one control element, and one lifter element.

In the case of a first jacquard machine from this patent one of the knives is provided with a carrier flange at two different heights, so that each hook can be carried along either by the top carrier flange or by the bottom carrier flange of a knife. When a knife is situated in its bottom dead centre, the top carrier flange is situated approximately at the level of the bent-over top end of a hook situated at the selection height.

At the moment when the bottom carrier flange is situated at the level of the bent-over top end of a hook, said knife is already moving at full speed to its top dead centre. When a hook has been selected to be carried along by the bottom carrier flange, said hook is carried along with a jerk by the knife from a stationary position at the selection height. This causes irregular running of the jacquard machine.

In the case of the second jacquard machine from this patent, the two knives have only one carrier flange. However, one of the two knives is connected to a transmission system in such a way that in its bottom dead centre it goes to the same height as the other knife, but in its top dead centre it is not lifted as high as the other knife.

The disadvantage of this jacquard machine lies mainly in the fact that a complex and expensive transmission system is required.

The object of this invention is to provide a three-position open-shed jacquard machine which does not have the disadvantages indicated above.

This object is achieved according to this invention by each of two embodiments of a three-position open-shed jacquard machine having the characteristics indicated in the first paragraph of this description.

Both embodiments comprise two second knives which are movable up and down in phase opposition, and which in the vicinity of their top dead centre can carry along a respective hook from the selection height, while the first and second knife interacting with the same hook are movable in phase opposition.

In the case of the first embodiment, retaining means are provided for retaining each hook taken into the non-carry position in the vicinity of the selection height, and the control element can be operated to retain each hook in the non-carry position during an upward movement of its first knife until its first knife is situated outside the carry zone, and subsequently to take the hook into the carry position, so that the hook is carried along by its downward moving second knife.

In the case of the second embodiment, retaining means are provided for retaining each hook taken into a first non-carry position in the vicinity of the selection height, and each hook at the selection height can be

taken into three different positions by its control element:

- the abovementioned carry position, in which the hook can be carried along by its first knife,
- the abovementioned first non-carry position, in which the hook is retained by a retaining means,
- a second non-carry position, in which the hook is not retained by a retaining means, so that the hook can be carried along by its second knife.

The disadvantages of the jacquard machine known from the abovementioned European patent have consequently been eliminated. Only one set of two interacting hooks is required per system for lifting one or more warp threads, only one lifter element is necessary (as explained below), and only one control element is needed. Furthermore, no reversing roller is required.

On the one hand, the jacquard machines according to this invention take up only half the amount of space as the jacquard machine according to European Patent No. 0,399,930. On the other hand, this jacquard machine is also much less expensive and less complex than the jacquard machine known from this European patent.

The disadvantages of the jacquard machine described in German Patent No. 4,101,778 are also eliminated with the jacquard machine according to this invention.

In the case of the jacquard machines according to this invention, a hook can be carried along from the selection height by a first knife if said knife is situated approximately in the bottom dead centre, and by a second knife if said knife is situated approximately in the top dead centre. In these positions the speed of said knives is still relatively low, so that a hook can be carried along from a stationary position in a smooth and virtually jerk-free manner by its first and its second knife.

Moreover, these jacquard machines do not require an expensive and complex transmission system.

The way in which the jacquard machines according to this invention work is explained in what follows. In order to illustrate how the warp threads can be taken into three different positions for each shot, said jacquard machines are assumed to be provided with one of the possible systems for lifting at least one warp thread. The characteristics of this system are as follows: This system comprises one lifter element with a top and a bottom lifter roller, while a first lifter cord, which connects the two interacting hooks, is passed under the top lifter roller, and while a second lifter cord is attached by one end in a fixed point, is passed over the bottom lifter roller, and is connected by the other end to a harness cord, for lifting one or more warp threads.

The explanation which follows therefore also demonstrates that the jacquard machines can operate with only one lifter element per system.

In the case of the first embodiment of the jacquard machine according to this invention, a hook situated at the selection height can be moved into two different positions: a carry position, in which the hook can be carried along by its first knife, and a non-carry position, in which the hook cannot be carried along by its first knife and is in interaction with its retaining element, in order to be retained in the vicinity of the selection height.

When the first knife of a hook situated at the selection height is situated in the bottom dead centre (in which case the second knife of that hook is situated in the top dead centre), it can be ensured that after completion of the next half movement cycle of the knives said hook moves according to the selected option into one of the following situations:

a) is taken upwards by its first knife, by moving the hook into the carry position while the first knife is situated in the carry zone;
b) is retained in the vicinity of the selection height, by taking the hook into the non-carry position and retaining it in that position;
c) is taken down by its second knife, by moving the hook into the non-carry position until the first knife is situated outside the carry zone, and subsequently taking the hook into the carry position. The hook is in interaction with its retaining element for a relatively short period and cannot be carried along by the first knife. This interaction is ended by subsequently taking the hook into the carry position. The hook therefore can no longer be retained by the retaining element, and can also no longer be carried along by its first knife, since said knife is situated outside the carry zone. This hook is consequently carried along by its second knife.

In the case of the second embodiment, a hook situated at the selection height can likewise be taken into the abovementioned situations a), b), c) during the half movement cycle of the knives concerned, by taking the hook into the carry position, into the, first non-carry position, and into the second non-carry position respectively.

Due to the fact that the hook can be moved into three different positions, situation c) can be reached without making the hook interact with its retaining element.

If the first and the second knives perform an up and down movement over a height (h), then a hook in situation a) is at a height (+h) above the selection height, in situation b) is in the vicinity of the selection height, and in situation c) is at the height (-h) below the selection height.

A hook carried along by a first knife is taken to the selection height when said first knife is situated in its bottom dead centre. A hook carried along by a second knife is taken to the selection height when said second knife is situated in its top dead centre.

Let us now look at a left-hand and a right-hand interacting hook in the situation for a first shot, in which their first knives are in the top and in the bottom dead

centre respectively. The second knives interacting with these respective first knives are then situated in the bottom dead centre and in the top dead centre respectively, in view of their movement in phase opposition to the first knives. The left-hand hook can be in one of the situations a), b) or c), while the right-hand hook can be situated only at the selection height. A different position of the warp threads is obtained for each of these three possibilities:

An "Up" position when the left-hand hook is in situation a), at height (+h), and the right-hand hook is at the selection height, a "Middle" position when the left-hand hook is in situation b), at the selection height, and the right-hand hook is at the selection height, and a "Down" position when the left-hand hook is in situation c), at the height (-h), and the right-hand hook is at the selection height.

In the "Middle" position the warp threads are a height (h) lower down relative to the "Up" position. For the left-hand hook in situation b) is a height (h) lower down than in situation a), so that the end of the second lifter cord connected to the harness cord is likewise situated a height (h) lower down.

In the "Down" position the warp threads are a height (2h) lower down relative to the "Up" position. For the left-hand hook in situation c) is a height (2h) lower down than in situation a), so that the end of the second lifter cord connected to the harness cord is likewise situated a height (2h) lower down.

Let us now look at the situation for a subsequent, second shot, in which the knives of the left-hand and the right-hand hook are situated in the bottom and in the top dead centre respectively. The second knives interacting with these respective first knives are then situated in the top and in the bottom dead centre respectively, in view of their movement in phase opposition to the first knives.

If the left-hand hook was in situation a) - at the height (+h) - for the first shot, then during the half movement cycle of the knives between the first and the second shot it is taken by its first knife to the selection height.

If the left-hand hook was in situation b) - at the selection height - for the first shot, then during the half movement cycle of the knives concerned (between the first and the second shot) it cannot be moved either by its first knife or by its second knife. The left-hand hook is thus still in situation b) for the second shot.

If the left-hand hook was in situation c) - at the height (-h) - for the first shot, then during the half movement cycle of the knives concerned it is taken by its second knife to the selection height (S).

The right-hand hook, which was at the selection height for the first shot, can be taken according to the selected option into one of the situations a), b) or c) (see above) during the half movement cycle of the knives concerned (between the first and the second shot).

For the second shot three different positions of the warp threads can consequently also be obtained:

- "Up" position, when the left-hand hook is at the selection height and the right-hand hook is at the height (+h)
- "Middle" position, when both hooks are at the selection height
- "Down" position, when the left-hand hook is at the selection height and the right-hand hook is at the height (-h).

It follows from this that for each shot one hook in each case is taken to the selection height (S), while the other hook can be taken according to the selected option into one of the situations a), b) or c), so that for the warp threads, irrespective of which of the three positions they are situated in for a first shot, any of the three positions can be achieved for a subsequent shot.

The first embodiment of the jacquard machine according to this invention is preferably provided with retaining means, in order to retain each hook taken into the non-carry position at a retention height lower down than the selection height, while each hook taken into the non-carry position at the selection height is in interaction with its retaining element, and in that position is movable downwards until it is at the retention height, so that said hook can be supported by its downward moving second knife at least until its upward moving first knife has left the carry zone.

In order to ensure that a hook situated at the selection height is carried along by its downward moving second knife, as described above, the hook must be taken into the non-carry position for the time needed by the first knife to leave the carry zone, and must subsequently be taken into the carry position, in order to ensure that the hook does not remain retained by its retaining element.

However, during the time needed by the first knife to leave the carry zone, the second knife moves downwards, so that there is a possibility that at the moment when the hook is placed in the carry position this second knife will no longer be at the ideal height for carrying along the hook in a jerk-free manner from the selection height. This problem is solved by the preferred embodiment of the jacquard machine (first embodiment) according to this invention described in the previous paragraph.

The problem described in the previous paragraph is solved in a particularly simple and effective way if each hook is provided with a retaining opening, while two projections disposed at a fixed height are provided, which projections can be situated in the retaining opening of a respective hook, in order to retain said hook at a retention height lower down than the selection height, while each projection goes into the retaining opening of a respective hook through said hook at the selection height being taken into the non-carry position, and each hook which has been taken into the non-carry position, with a projection in its retaining opening, is movable from the selection height to the retention height, so that said hook can be supported by its downward moving

second knife at least until its upward moving first knife has left the carry zone.

The height of the retaining opening of each hook is in this case preferably such that the vertical play of the projection provided for said hook in the retaining opening is at least equal to the distance between the selection height and the retention height of the hook.

Such a hook is retained at the retention height through the fact that the hook rests with the top edge of its retaining opening on the top side of a projection. Taking this hook at the selection height into the non-carry position causes the projection to move into the bottom of the retaining opening, while there is a free space between the top side of the projection and the top edge of the retaining opening (a vertical play), and the hook - supported by its second knife - can move downwards until it is at the retention height. In this case the second knife can support the hook at least until its upward moving first knife has left the carry zone.

In a preferred embodiment of this jacquard machine, each second knife in its top dead centre can carry along a respective hook from the selection height, while the carry zone of each first knife extends above the bottom dead centre of said first knife over a distance which is less than the distance between the selection height and the retention height of the hook interacting with said first knife.

An upward moving first knife consequently leaves the carry zone before the hook interacting with said first knife - supported by its downward moving second knife - has reached the retention height. The hook can consequently be taken smoothly (for example, without friction of the projection against the top edge of the retaining opening) into the carry position, in order to be carried along by its second knife.

This also makes it possible to provide the top side of the projections with an upward projecting edge, in order to prevent a hook retained at the retention height from slipping off the projection. Therefore, once the hook is at the retention height, it can no longer be taken from the non-carry position to the carry position. In order to ensure that a hook is carried along by its second knife, the hook must consequently be taken to the carry position before it has reached the retention height.

The carry zone of each first knife preferably extends from above the bottom dead centre of said first knife over a distance which is less than half the distance between the selection height and the retention height of the hook interacting with said first knife.

In an especially preferred embodiment, the control element of this jacquard machine is provided with means for exerting an electromagnetic force on the hooks.

By switching on and switching off the abovementioned means, each hook situated at the selection height can be taken into two different positions: the carry position and the non-carry position. The control element is preferably designed in such a way that each hook can also be taken from the non-carry position to the carry position at any height between the selection height and the retention height.

In the case of the second embodiment of the jacquard machine according to this invention described above, each hook is preferably provided with a magnetized element, while the control element is provided with means which can be operated in such a way that they exert a magnetic force of attraction and a magnetic force of repulsion on the respective magnetized elements, in order to take a hook situated at the selection height into two different positions, while the third position can be achieved by not operating the abovementioned means, so that no magnetic force is exerted.

In a most preferred embodiment of this jacquard machine (second embodiment), each hook is taken into the carry position under the influence of a magnetic force of repulsion, and is taken into the first non-carry position under the influence of a magnetic force of attraction, while the hook is in the second non-carry position when no magnetic force is exerted on the hook.

The characteristics and the operation of the jacquard machines according to this invention are illustrated further in the detailed description which follows of one of their possible embodiments. In this description reference will be made to the drawings appended hereto.

Figures 1A to 4E relate to the first embodiment of the jacquard machine.

Figures 1A to 1C show diagrammatically the first and second knives, a control element, and two interacting hooks in interaction with a system for lifting warp threads on a weaving loom. The respective figures represent successive situations during a half movement cycle of the knives, where a hook is carried along by its first knife from the selection height.

Figures 2A to 2B show the same device in successive situations, where a hook is carried along by its second knife from the selection height.

Figures 3A to 3D show the same device in successive situations, where a hook is retained at the retention height.

Figures 4A to 4D show in detail the control element and the top part of one hook of the same device in successive situations, where a hook at the selection height is placed in such a way that it can be carried along by its second knife.

Figure 4E shows in detail the control element and the top part of one hook of the same device, in a situation in which said hook is retained at the retention height.

Figures 5A to 8C relate to the second embodiment of the jacquard machine.

Figures 5A to 5C show diagrammatically the first and second knives, a control element and two interacting hooks in interaction with a system for lifting warp threads on a weaving loom. The respective figures each show a different situation of this device for a first shot, a different position of the warp threads being obtained in each case.

Figures 6A to 6C show different situations of the same device for a second shot, a different position of the warp threads being obtained in each case.

Figures 7A to 7C show in detail the control element and the top part of one hook of the same device, in the second non-carry position, the carry position and the first non-carry position respectively.

Figures 8A to 8C show the same as the respective Figures 7A to 7C, but for an alternative embodiment of the control element and the hooks.

The first embodiment of the jacquard machine according to this invention (see Figures 1A to 4E) comprises two hooks (1), (2) made of a flexible material, with a top end (3), (4) which is bent over downwards.

One of the ends of a first lifter cord (5) is attached at the bottom end of each hook (1), (2). This first lifter cord (5) is passed under the top lifter roller (6) of a lifter element (8). A second lifter cord (9) is attached by one end to a fixed part (10) of the jacquard machine, is passed over the bottom lifter roller (7) of the lifter element (8), and is connected by the other end (11) to a harness cord (not shown in the figures) for lifting warp threads on a weaving loom.

Said jacquard machine also comprises two first knives (12), (13) which by means of a drive unit are movable vertically up and down in phase opposition to each other, and two second knives (14), (15) which are disposed below a respective first knife (12), (13), and by means of a drive unit are movable vertically up and down in phase opposition to each other (the drive units are not shown in the figures).

The drive of the knives (12), (13), (14), (15) is such that the first (12), (13) and second knives (14), (15), which are situated above one another, move in phase opposition to each other.

The first (12), (13) and second knives (14), (15) move up and down over the same height (h), while each second knife (14), (15) in its top dead centre is situated lower down than the height which the upper first knife (12), (13) reaches when it is situated in its bottom dead centre.

Each hook (1), (2) is provided with a retaining opening (16), (17) and with a laterally projecting supporting lug (18), (19).

The jacquard machine also comprises a control element (20), disposed at a fixed height and having two coils (21) for exerting an electromagnetic force of attraction on the hooks (1), (2). A projection (22), (23) is provided in the vicinity of said coils (21), on either side of the control element (20). The control element (20) is disposed between the two vertical planes in which the knives (12), (13), (14), (15) move up and down.

The two interacting hooks (1), (2) are provided on either side of the control element (20), in such a way that each hook can rest with its supporting lug (18), (19) on a second knife (14), (15). When a second knife (14), (15) is situated in its top dead centre, the hook (1), (2) supported by said second knife (14), (15) is at the selection height (S).

A hook (1), (2) situated at the selection height (S) is situated with its top end (3), (4) above the carrier flange of a first knife (12), (13) situated in the bottom dead centre, so that the hook (1), (2) can be carried along by said first knife and is situated with its retaining opening (16), (17) opposite a projection (22), (23).

When an electric current is passed through the wires of the coils (21), a magnetic force of attraction is exerted on a hook (1), (2) situated at the selection height (S), with the result that the top part of said hook (1), (2) bends towards the control element (20), and a projection (22), (23) goes into the retaining opening (16), (17) of said hook (1), (2). In that position - called the non-carry position - the top end (3), (4) of the hook (1), (2) goes outside the range of the carrier flange of its first knife (12), (13), so that the hook (1), (2) cannot be carried along by said first knife (12), (13).

When the operation of the control element (20) is ended, the hook (1), (2) springs back to its straight position, in which case the projection (22), (23) leaves the retaining opening (16), (17), and the top end (3), (4) of the hook (1), (2) goes back within the range of the carrier flange of its first knife (12), (13). This position is called the carry position.

In Figure 1A the left-hand hook (1) is situated in the carry position and is supported by its second knife (14) at the selection height (S). There is a vertical distance (d) between the top end (3) of this hook (1) and the carrier flange of the first knife (12) interacting therewith, which first knife is in its bottom dead centre. The top side of the projection (22) is situated a vertical distance (2d) lower than the top edge of the retaining opening (16), the last-mentioned vertical distance (2d) being virtually twice that of the first-mentioned vertical distance (d).

Figure 1B shows the situation at the moment when the left-hand first knife (12) and the right-hand second knife (15) have been moved up over the first-mentioned vertical distance (d). In the meantime, the left-hand second knife (14) and the right-hand first knife (13) have been moved down over the same distance (d). In that situation the left-hand hook (1) is situated at the selection height (S), while it rests with its top end (3) on the carrier flange of its first knife (12), and while the supporting lug (18) of the hook (1) is situated the same vertical distance (d) higher than the carrier flange of its second knife (14).

Figure 1C shows the situation at the moment when the left-hand first knife (12) and the right-hand second knife (15) are situated in their top dead centre. The right-hand first knife (13) and the left-hand second knife (14) are then situated in their bottom dead centre. The left-hand hook (1) has now been taken by its first knife (12) to the height (+h).

In Figures 1A to 1C the right-hand hook (2) in each case rests with its supporting lug (19) on the carrier flange of the right-hand second knife (15), so that said hook (2) is situated at the height (-h), at the height (-h) and at the selection height (S), respectively.

The various possible positions of the end (11) of the second lifter cord (9) which correspond to the "Up", "Middle" and "Down" positions are indicated in the figures by the letters B, M and O respectively. In the situations of Figures 1A and 1B the warp threads are situated in the "Down" position. In the situation of Figure 1C the warp threads are a height (2h) higher, in the "Up" position, since hook (1) has been taken up over a distance (h) and hook (2) is in the selection position (S).

Figure 2A shows the same situation as that of Figure 1A. Figures 2A to 2D show the successive situations (with the same half movement cycle of the knives (12, 13, 14, 15) as in Figures 1A to 1D) when the left-hand hook (1) is carried along by its downward moving second knife (14).

The moment the left-hand first knife (12) is situated in its bottom dead centre, the control element (20) is operated, in order to take the left-hand hook (1) into the non-carry position (Figure 2B). The moment the left-hand first knife (12) has been moved up over the distance (d), the operation of the control element (20) is stopped (Figure 2C). The left-hand hook (1) has been taken down at that moment over a height (d) by its second knife (14), so that the top side of the projection (22) is situated only a vertical distance (d) below the top edge of the retaining opening (16). Due to the fact that the top side of the projection (22) is not yet situated against the top edge of the retaining opening (22), the hook (1) is not impeded when springing back to the carry position.

In the situation of Figure 2C the left-hand hook (1) can no longer be carried along by its first knife (12). For during the upward movement of the first knife (12) over the distance (d), the hook (1) moves downwards over the same distance (d), so that the relative movement of the hook (1) with respect to the first knife (12) is equal to 2d. On the other hand, the vertical distance between the top end (3) of the hook (1) and the carrier flange of the first knife (12) is only equal to d in the situation of Figure 2A.

The first knife (12) is thus already above its carry zone. Said carry zone (i.e. the path of a first knife on which said knife can carry along a hook (1), (2)) consequently extends above the bottom dead centre of the first knife (12) over a vertical distance which is less than d.

Figure 2D shows the situation when the left-hand first knife (12) has reached its top dead centre. The left-hand hook (1) at that moment has been taken by its second knife (14) to the height (-h). The right-hand hook (2) has been taken to the selection height (S) by its second knife (15). Through passing from the situation of Figure 2A to the situation of Figure 2D, the left-hand hook (1) has been taken a height (h) lower, while the right-hand hook has been taken upwards over the same height (h). The warp threads consequently remain in the same position, the "Down" position (O).

Figures 3A and 3B show the same situations as the respective Figures 2A and 2B. However, in the situation of Figure 3C (when the left-hand first knife (12) has left the carry zone) the control element (20) remains in operation, in order to retain the left-hand hook (1) in the non-carry position. This operation remains retained until the left-hand hook (1) has been moved downwards to the retention height (V). At that moment the operation of the control element can be ended, since the hook (1) is retained in the non-carry position by an upward projecting edge on the top side of the projection. When the left-hand knife (12) has reached its top dead centre (Figure 3D), the left-hand (1) and the right-hand hook (2) are situated at the retention height (V) and at the selection height (S) respectively. Through passing from the situation of Figure 3A to the situation of Figure 3D, the right-hand hook (2) has been taken a height (h) higher, while the left-hand hook (1) has remained at virtually the same height. The warp threads have consequently been taken a height (h) higher, to the "Middle" position.

The control element (20) and the top part of one of the hooks (2) are shown in detail in Figures 4A to 4E; in Figures 4A to 4D in the successive situations in which the control element (20) is operated, in order to have the hook (2) carried along by its second knife (15), and in Figure 4E in the situation in which the hook (2) is retained at the retention height (V).

The second embodiment of the jacquard machine according to this invention (see Figures 5A to 8C) likewise has two first knives (12), (13), two second knives (14), (15) and two interacting hooks (1), (2) connected to the same system (5, 8, 9) for lifting warp threads as that in the first embodiment.

Said hooks (1), (2) and knives (12), (13), (14), (15) are provided in such a way that they can interact in the same way as in the case of the first embodiment of the jacquard machine.

The second embodiment differs from the first in that the hooks (1), (2) along the edge of the control element (20) are provided with a permanent magnet (24), the magnetic north pole and south pole of which are situated opposite a bottom coil (25) and a top coil (26) respectively of the control element (20) when the hook is situated at the selection height (S). The control element (20) is also provided so that it can exert an electromagnetic force of attraction and an electromagnetic force of repulsion on the permanent magnet (24) of the hooks (1), (2) situated at the selection height (S).

By passing an electric current in one direction through the coil wires (see Figure 7C), a magnetic north pole is created by the top coil (26) and a magnetic south pole by the bottom coil (25). The north pole and the south pole of the control element (20) are thus situated opposite the south pole and the north pole respectively of a permanent magnet (24). A force of attraction is thus exerted on the permanent magnet (24), so that the hook (1), (2) bends towards the control element (20). As a result of this, a projection (22), (23) goes into the retaining opening (16), (17) of the hook (1), (2). The hook (1), (2) is thus situated in the first non-carry position.

By passing an electric current in the other direction through the coil wires (see Figure 7B), a magnetic south pole is created by the top coil (25) and a magnetic north pole by the bottom coil (26), so that a force of repulsion is exerted on the permanent magnet (24) of a hook (1), (2) situated at the selection height (S). As a result, the hook (1), (2) bends away from the control element (20), and its top end (3), (4) goes within the range of the first knife (12), (13) which is situated in its bottom dead centre and interacts with said hook (1), (2). The hook (1), (2) is thus situated in the carry position.

When no electric current is passed through the coil wires (see Figure 7A), no magnetic force is exerted on the permanent magnet (24) of a hook (1), (2) situated at the selection height (S), so that the hook (1), (2) is not bent. The knives (12), (13), (14), (15), the hooks (1), (2) and the control element (20) are disposed in such a way relative to each other that the top end (3), (4) of a hook (1), (2) in this situation is situated outside the range of its first knife (12), (13) when said knife is in the carry zone, and the projection (22), (23) is not situated in the retaining opening (16), (17). The hook (1), (2) is thus situated in the second non-carry position, and can be carried along by its second knife (14), (15).

The hooks (1), (2) in a variant embodiment (see Figures 8A to 8C) can also be provided with a permanent magnet (24), the magnetic north pole of which is situated at the side of the hook (1), (2) facing the control element (20), while the magnetic south pole is situated at the other side of the hook (1), (2). The coils (25), (26) are then provided next to each other on either side of the control element (20), so that each coil (25), (26) can be situated opposite the magnetic north pole of the permanent magnet (24) of one of the hooks (1), (2), if said hook (1), (2) has been taken to the selection height (S).

By creating a magnetic north pole with the coil (25), (26) situated opposite a hook (1), (2), a magnetic force of repulsion is exerted on the permanent magnet (24) of said hook (1), (2) (see Figure 8C), and by creating a magnetic south pole with said coil (25), (26), the permanent magnet (24) is attracted (see Figure 8B). The hook (1), (2) is situated in the carry position and in the first non-carry position respectively. When no electric current is passed through the coil wires, the hook (1), (2) goes into the second non-carry position (see Figure 8C).

Figures 5A to 5C show how for a first shot the three different positions (B, M, O) of the warp threads are achieved. In Figures 6A to 6C this is shown for a following shot. In each case one of the hooks (1), (2) is situated at the selection height (S), while the other hook (1), (2) is either taken to the height (-h) by its second knife (14), (15) or retained at the selection height (S) by a projection (22), (23), or is taken to the height (+h) by its first knife (12), (13). In this way the warp threads are taken into the respective positions "Down" (O), "Middle" (M) and "Up" (B). These three different positions (B, M, O) are achievable for each shot.

Claims

1. Three-position open-shed jacquard machine, comprising:

   - a system (5, 8, 9) with two interacting hooks (1), (2) for lifting at least one warp thread on a weaving loom,
   - two first knives (12), (13) which are movable up and down in phase opposition, and which in a carry zone in the vicinity of their bottom dead centre can carry along a respective hook (1), (2), and
   - a control element (20), by means of which the respective hooks (1), (2) at a selection height (S) can be taken into a carry position and into a non-carry position relative to their first knife (12), (13),

   characterized in that the jacquard machine comprises two second knives (14, 15) which are movable up and down in phase opposition, and which in the vicinity of their top dead centre can carry along a respective hook (1), (2) from the selection height (S), while the first (12), (13) and second knife (14), (15) interacting with the same, hook (1), (2) are movable in phase opposition; in that retaining means (22), (23) are provided in order to retain each hook (1), (2) taken into the non-carry position in the vicinity of the selection height (S); and in that the control element (20) can be operated to retain each hook (1), (2) in the non-carry position during an upward movement of its first knife (12), (13) until its first knife (12), (13) is situated outside the carry zone, and subsequently to take the hook (1), (2) into the carry position, so that the hook is carried along by its downward moving second knife (14), (15).

2. Three-position open-shed jacquard machine according to Claim 1, **characterized in that** the retaining means (22), (23) are provided in order to retain each hook (1), (2) taken into the non-carry position at a retention height (V) lower than the selection height (S); and in that each hook (1), (2) taken into the non-carry position at the selection height (S) is in interaction with its retaining element (22), (23), and in that position is movable downwards until it is at the retention height (V), so that the abovementioned hook (1), (2) can be supported by its downward moving second knife (14), (15) at least until its upward moving first knife (12), (13) has left the carry zone.

3. Three-position open-shed jacquard machine according to Claim 1, **characterized in that** each hook (1), (2) is provided with a retaining opening (16), (17); in that two projections (22), (23) disposed at a fixed height are provided, which projec-

tions can be situated in the retaining opening (16), (17) of a respective hook (1), (2), in order to retain said hook (1), (2) at a retention height (V) lower down than the selection height (S); in that each projection (22), (23) goes into the retaining opening (16), (17) of a respective hook (1), (2) through said hook at the selection height (S) being taken into the non-carry position; and in that each hook (1), (2) taken into the non-carry position, with a projection (22), (23) in its retaining opening (16), (17), is movable from the selection height (S) to the retention height (V), so that said hook can be supported by its downward moving second knife (14), (15), at least until its upward moving first knife (12), (13) has left the carry zone.

4. Three-position open-shed jacquard machine according to Claim 3, **characterized in that** the height of the retaining opening (16), (17) of each hook (1), (2) is such that the vertical play of the projection (22), (23) provided for said hook (1), (2) in the retaining opening (16), (17) is at least equal to the distance (2d) between the selection height (S) and the retention height (V) of the hook (1), 12).

5. Three-position open-shed jacquard machine according to one of Claims 2 to 4, **characterized in that** each second knife (14), (15) in its top dead centre can carry along a respective hook (1), (2) from the selection height (S), and in that the carry zone of each first knife (12), (13) extends above the bottom dead centre of said first knife over a distance which is less than the distance (2d) between the selection height (S) and the retention height (V) of the hook (1), (2) interacting with said first knife (12), (13).

6. Three-position open-shed jacquard machine according to one of Claims 2 to 4, **characterized in that** each second knife (14), (15) in its top dead centre can carry along a respective hook (1), (2) from the selection height (S), and in that the carry zone of each first knife (12), (13) extends above the bottom dead centre of said first knife over a distance which is less than half the distance (2d) between the selection height (S) and the retention height (V) of the hook interacting with said first knife (12), (13).

7. Three-position open-shed jacquard machine according to one of the preceding claims, **characterized in that** the control element (20) is provided with means (25), (26) for exerting an electromagnetic force on the hooks (1), (2).

8. Three-position open-shed jacquard machine, comprising:

- a system with two interacting hooks (1), (2) for lifting at least one warp thread on a weaving loom,
- two first knives (12), (13) which are movable up and down in phase opposition, and which in a carry zone in the vicinity of their bottom dead centre can carry along a respective hook (1), (2), and
- a control element (20), by means of which the respective hooks (1), (2) at a selection height (S) can be taken into a carry position and a non-carry position relative to their first knife (12), (13),

characterized in that the jacquard machine comprises two second knives (14, 15) which are movable up and down in phase opposition, and which in the vicinity of their top dead centre can carry along a respective hook (1), (2) from the selection height (S), while the first (12), (13) and second knife (14), (15) interacting with the same hook (1), (2) are movable in phase opposition; in that retaining means (22), (23) are provided in order to retain each hook (1), (2) taken into a first non-carry position in the vicinity of the selection height (S); and in that each hook (1), (2) at the selection height (S) can be taken into three different positions by the control element (20):

- the abovementioned carry position, in which the hook (1), (2) can be carried along by its first knife (12), (13),
- the abovementioned first non-carry position, in which the hook (1), (2) is retained by a retaining means (22), (23), and
- a second non-carry position, in which the hook (1), (2) is not retained by a retaining means (22), (23), so that the hook (1), (2) can be carried along by its second knife (14), (15).

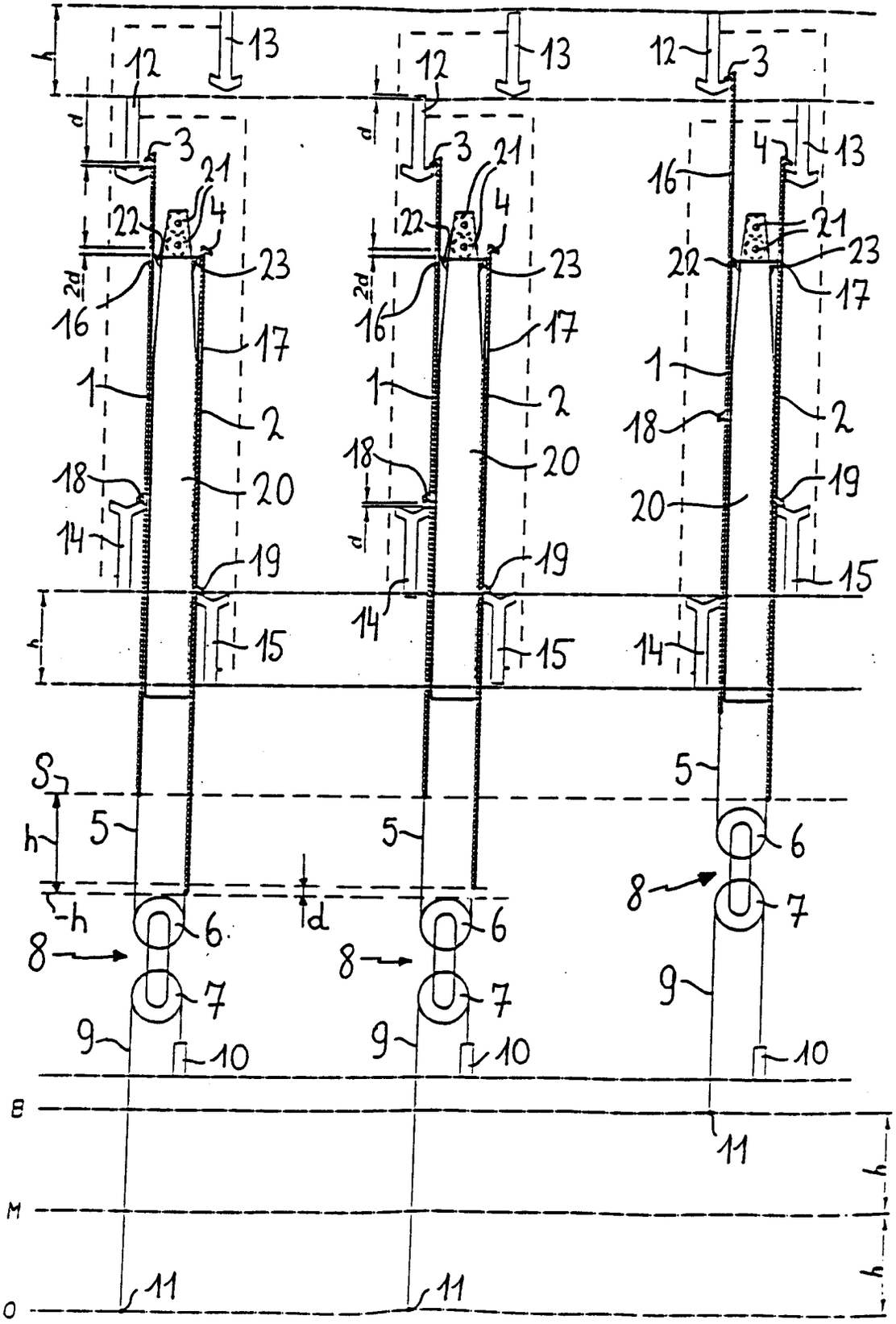
9. Three-position open-shed jacquard machine according to Claim 8, **characterized in that** each hook (1), (2) is provided with a magnetized element (24); in that the control element (20) is provided with means (25), (26) which can be operated in such a way that they exert a magnetic force of attraction and a magnetic force of repulsion on the respective magnetized elements (24), in order to take a hook (1), (2) situated at the selection height (S) into two different positions, while the third position can be achieved by not operating the abovementioned means (25), (26), so that no magnetic force is exerted.

10. Three-position open-shed jacquard machine according to Claim 9, **characterized in that** each hook (1), (2) is taken into the carry position under the influence of a magnetic force of repulsion, is taken into the first non-carry position under the

influence of a magnetic force of attraction, and is situated in the second non-carry position when no magnetic force is exerted on the hook (1), (2).

11. Three-position open-shed jacquard machine according to one of the preceding claims, **characterized in that** the system (5), (8), (9) for lifting at least one warp thread comprises a lifter element (8) with a first (6) and a second lifter roller (7), a first lifter cord (5), which is passed under the first lifter roller 16) and connects the two hooks (1), (2), and a second lifter cord (9), which is attached by one end in a fixed point (10), is passed over the second lifter roller (7), and at the other end (11) is provided with means for lifting one or more warp threads.

FIG.1A FIG.1B FIG.1C



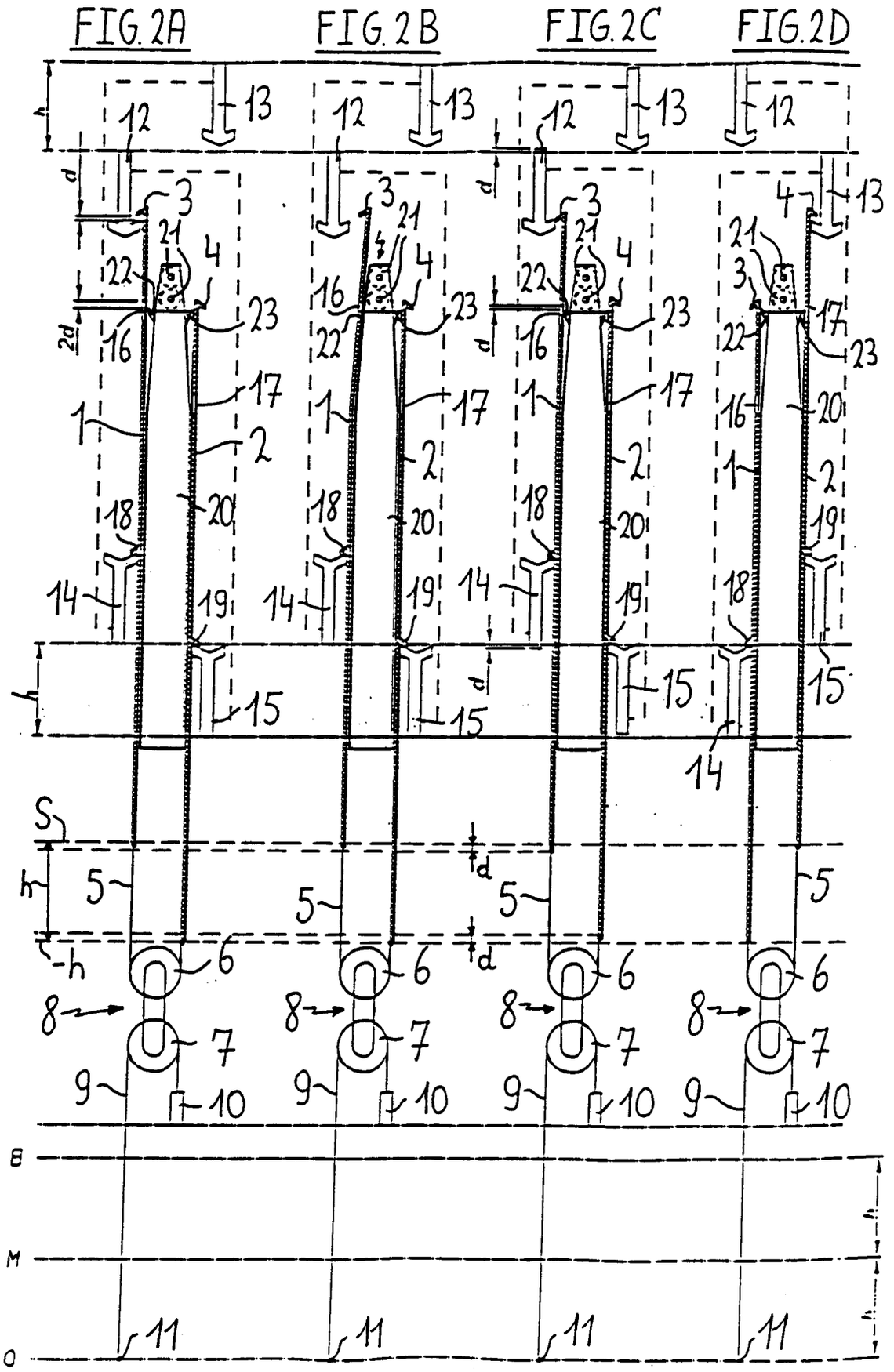
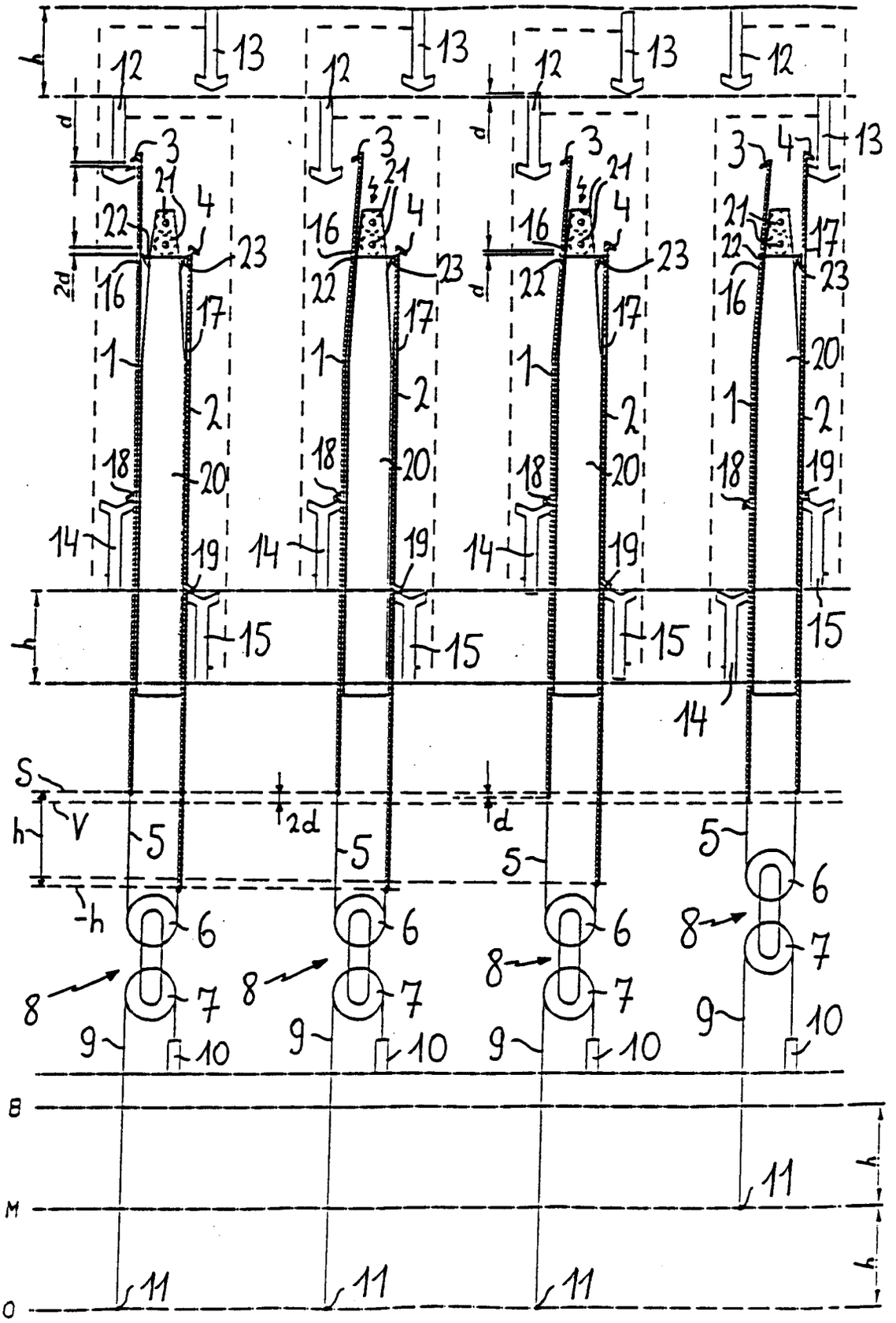


FIG. 2A
FIG. 2B
FIG. 2C
FIG. 2D
12
13
3
4
21
22
23
16
17
1
2
18
20
19
14
15
S
5
6
7
8
9
10
11
B
M
O

FIG.3A FIG.3B FIG.3C FIG.3D



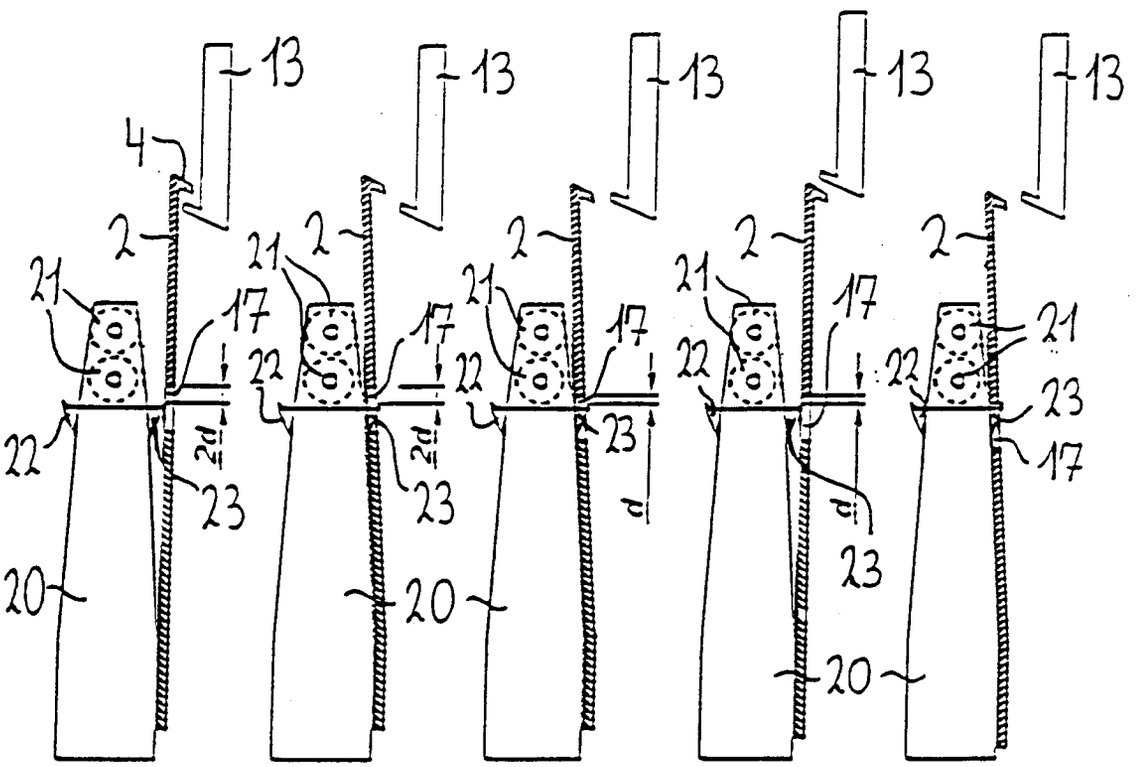


FIG.4A FIG.4B FIG.4C FIG.4D FIG.4E

FIG.5A FIG.5B FIG.5C

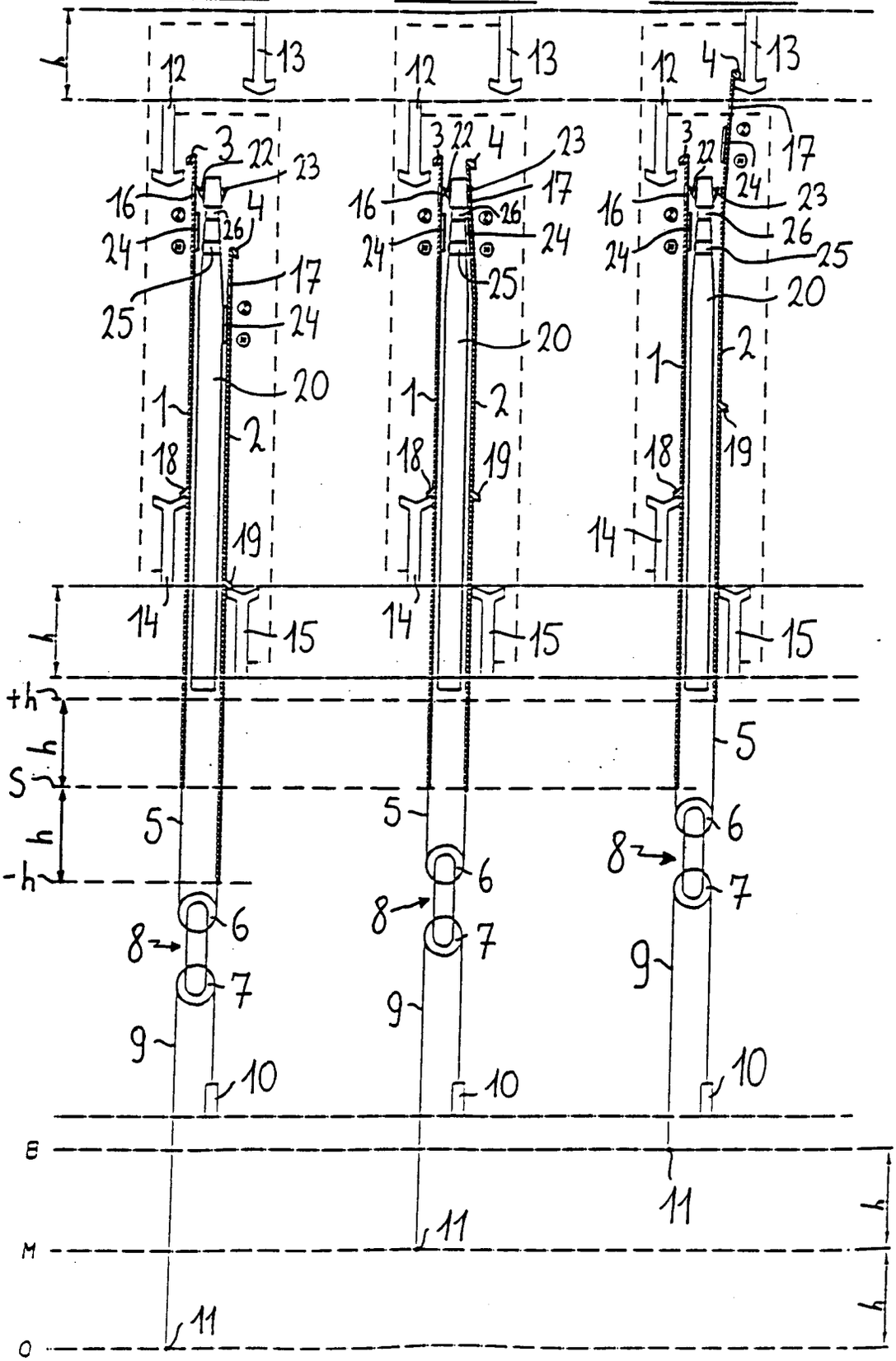
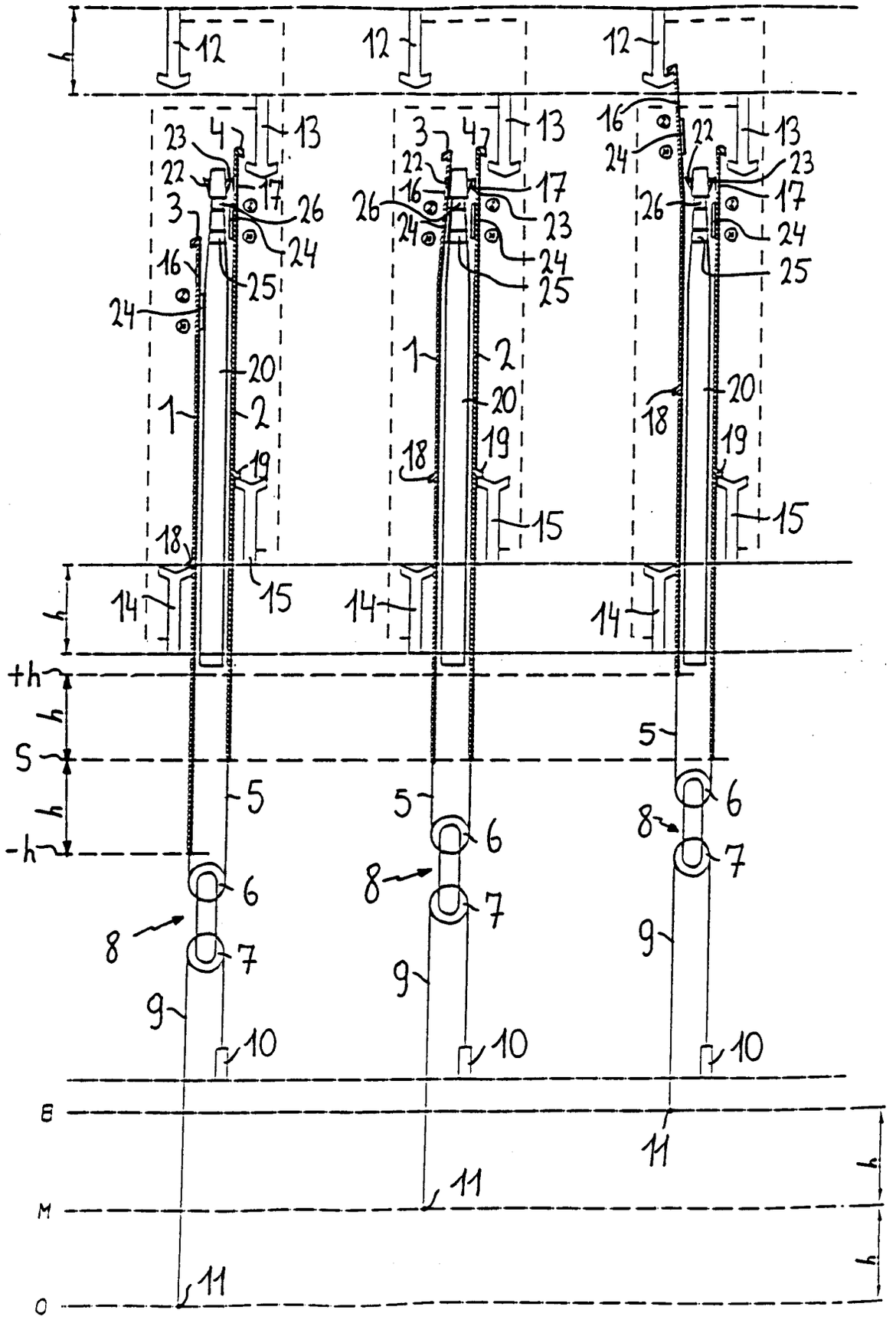


FIG.6A FIG.6B FIG.6C



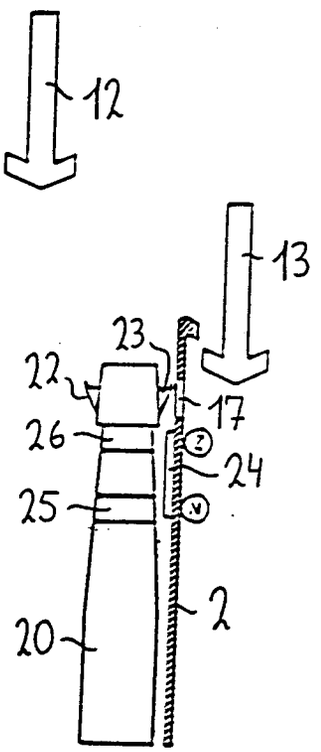


FIG.7A

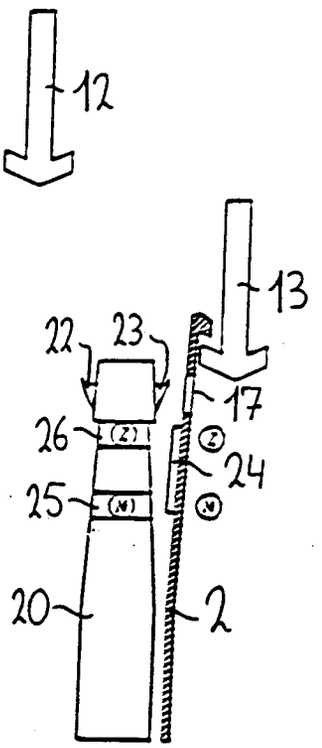


FIG.7B

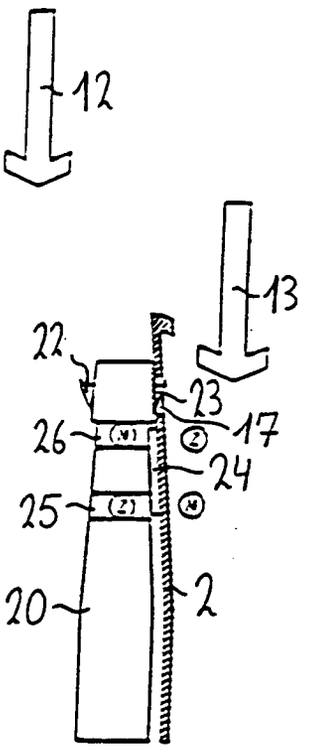


FIG.7C

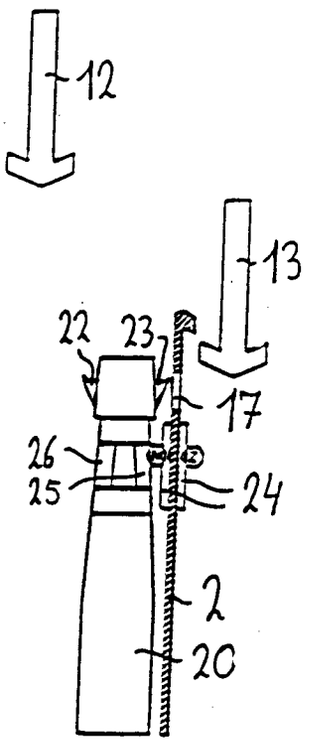


FIG.8A

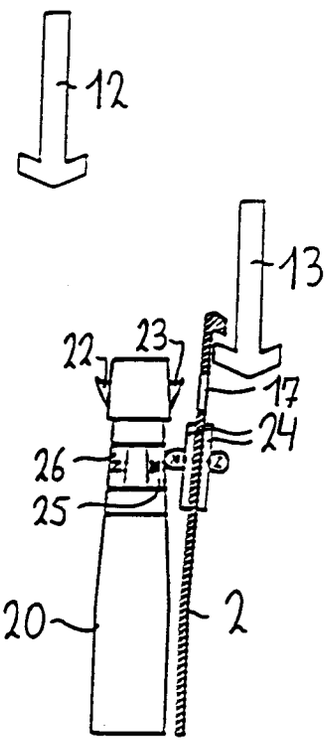


FIG.8B

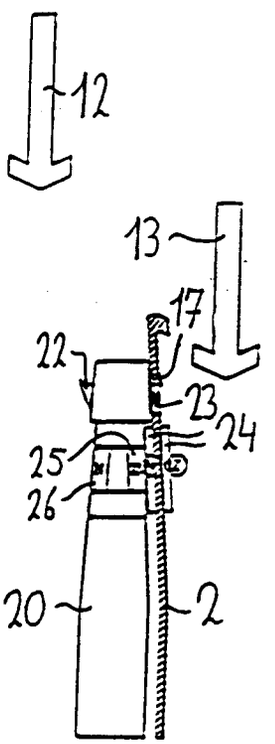


FIG.8C

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 96 20 0740

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	FR-A-2 287 539 (CARL ZANGS) * the whole document *	1,8	D03C3/12 D03C3/06 D03C3/20
A	FR-A-2 587 046 (TEXTIMA) * page 7, line 17 - page 8, line 34; figure 1 *	1-3,7-9	
A	EP-A-0 408 076 (VAN DE WIELE) * the whole document *	1-3,7-9, 11	
D,A	EP-A-0 399 930 (STAUBLI-VERDOL) * figures *	1,8	
A	FR-A-2 648 160 (TEXTIMA) * figures *	1,8	
A,D	DE-C-41 01 778 (OSKAR SCHLEICHER)		

TECHNICAL FIELDS SEARCHED (Int.Cl.6)

D03C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	28 June 1996	Rebiere, J-L

CATEGORY OF CITED DOCUMENTS

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L : document cited for other reasons

& : member of the same patent family, corresponding document

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