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(54) Shed-forming mechanism for jacquard machines

(57) The invention relates to a shed-forming mechanism for a jacquard machine, such as namely a three or multiple-position open-shed jacquard machine, which comprises:

hook elements (1,2) serving for lifting the warp threads of a weaving device, provided with one or more elastic selection elements (3-6), such as namely spring elements with at least two spring legs,
one or more sets of upward and downward moving knives (7-10) on to which the hook elements (1,2) can hook on, and
selector means (St,Sm) which can act on the elastic selection elements (3-6) in order selectively to allow the hook elements (1,2) to hook on to the knives (7-10) or not,
whereby the selector means (St,Sm) for acting on the elastic selection elements (3-6) consist of push selectors, such as namely mechanical, electromechanical or piezoelectric push selectors.

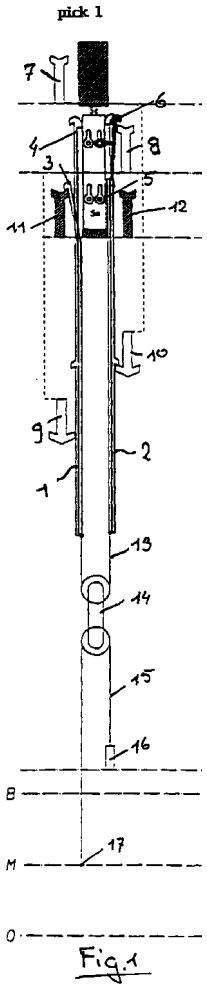

Fig.1

EP 0 982 419 A2

Description

[0001] The invention relates to a shed-forming mechanism for open-shed jacquard machines.
With such a mechanism the warp threads of the weaving machine are operated according to the open-shed principle in order to implement weaving according to a jacquard pattern.

[0002] Shed-forming mechanisms are in themselves known for two or multiple-position open-shed jacquard machines, whereby the warp threads are operated via hook elements which by means of elastic selection elements, under influence of for example electromagnetic selector means, can be hooked on to upward and downward moving knives, while the hook elements operate the warp threads either via a tackle element (shed-forming device with tackle mechanism) or for example via a heddle (tackleless shed-forming mechanism).

[0003] Thus namely from the Belgian patent publication no. 1 009 047 (corresponding to the American patent specification 5.671.784) a three-position open-shed jacquard machine is known. This jacquard machine implements the three-position open-shed with a set of upper and a set of lower lifting knives, two complementary hooks interconnected by a tackle cord to a tackle element. The complementary hooks are selected by two selection elements located one above the other in one and the same plane. The three positions are therefore implemented within the partition of one selection element.

[0004] Those known shed-forming mechanisms however comprise a number of disadvantages.

[0005] Firstly the long legs of the hooks are pressed sideways by the upper lifting knives with their descent before the selection can take place. When the electromagnetic coil is not energised the long hooks have to spring back sufficiently fast in order to hook on to the projecting edge of the lifting knives. The springing back of the hooks is determined by the spring force which the hooks can develop and the inertia of the hooks. Making the spring stiffness of the hooks greater results in more electric power having to be supplied to the electromagnets in order to hold the hooks away from the lifting knives when engagement of the hooks by the lifting knives has to be prevented. Furthermore because of this the mass inertia of the hook is also increased.

[0006] Secondly the second, lower electromagnets have to attract the short legs of the hooks whereby the magnetic circuit is made over two layers of material: that of the short and the long legs. Moreover the magnetic flux flows through both steel strips of the hooks: more electric power will therefore be required in order to make the short hook bend because loss of flux occurs in the second material layer.

[0007] Thirdly in the short legs of the hooks a recess has to be provided in order to attach the hooks to a projection. This signifies that the minimum utilisable partition in width direction of the hooks has to be sufficiently great in order to attach these recesses for a reasonable width of the projection.
Fourthly, through the hooking-on of the short legs on to the projection on the frame of the electromagnetic coil, the load of the hook is transferred to the housing of the electromagnetic coil. This housing must therefore be constructed sufficiently rigid in order to be able to bear the mechanical load.

[0008] Through the arrangement of the hooks and their corresponding knife systems this jacquard device furthermore takes up a relatively large space in height. The construction height must be correspondingly high enough in order to limit the angle of incidence of the harness cord in the arcade plank to 60° in order to counteract harness wear and tear through friction.

[0009] The purpose of this invention is to provide a shed-forming mechanism for jacquard machines that excludes the disadvantages of the known mechanisms.

[0010] For that purpose according to the invention a shed-forming mechanism is presented which comprises:

- hook elements serving for lifting the warp threads of a weaving device, provided with one or more elastic selection elements,
- one or more sets of upward and downward moving knives on to which the hook elements can hook on, and
- selector means which can act on the elastic selection elements in order selectively to allow the hook elements to hook on to the knives or not,
- whereby selector means for acting on the elastic selection elements consist of push selectors.

The elastic selection elements on the hook elements preferably consist of spring elements.

[0011] According to a preferred embodiment of the invention each spring element comprises at least two spring legs whereby in each case one push selector is provided in order to be able to act on one spring leg.

[0012] By utilising push selectors in such a situation in place of pull selectors such a push selector will act on each leg of each complementary hook in order to push the hook towards the lifting knife or holding knife. In this manner the engagement or the hooking-on to a stationary knife is positively performed: i.e. energising the selector leads to bending of a leg of the hook. The selection and the speed of the selection is determined by the force and operating speed of the push selector itself.

[0013] By providing a stationary holding knife between the movable lifting knives in order to hold the hook in the middle position, which is the selection position, no mechanical load is transferred from the hook to the selection housing. The electronic components therefore experience no mechanical load from the hooks.

[0014] With a first, upper selector the long leg of the hook is pushed on to its corresponding first, upper lifting

knife, when the hook has to go to the top position, and with a second, lower selector the shorter leg is pushed on to a stationary knife grating in order to hold the hook in the middle. When the hook has to go to the bottom position no selector is activated. The advantages are proportionate: for the top or middle position in each case only one push selector of the two has to be energised. Because of this less electric power is required for performing the selections.

[0015] The push selectors which according to the invention are used for acting on the elastic selection elements preferably consist of mechanical, electromechanical, piezoelectric selector means, or similar.

[0016] The shed-forming mechanism according to the invention, with push selectors as selection means for acting on the elastic selection elements, can very suitably be utilised for two or multiple-position open-shed jacquard machines.

[0017] Utilisation for three-position open-shed jacquard machines forms a preferred embodiment of the invention.

[0018] The shed-forming mechanism according to the invention can moreover very suitably be utilised for example for: a two-position open-shed jacquard machine in which two complementary hooks are interconnected by a tackle cord that via a tackle element serves for lifting a warp thread of the weaving machine, or for a tackleless two-position open-shed jacquard machine in which the hook elements are connected to a heddle element with which a warp thread of the weaving device can be lifted.

[0019] According to a further preferred embodiment of the invention when utilised for three or multiple-position open-shed jacquard machines, in addition to the one or more sets of upward and downward moving knives at least one or more stationary holding knives are provided in order to hold the hook in an intermediate position.

[0020] In an embodiment of the invention for three or multiple-position open-shed jacquard machines, provided with spring elements with at least two spring legs, the shed-forming mechanism according to the invention can furthermore be provided with a guide for preventing the hook on the longer spring leg from falling off the knife with a downward movement of the knife.

[0021] The characteristics and distinctive features of the invention, and the operation thereof are further explained below with reference to the attached drawings which show a number of preferred embodiments of the invention. It should be noted that the specific aspects of these embodiments are only described as preferred examples of what is intended in the scope of the above general specification of the invention, and may in no way be interpreted as a restriction on the scope of the invention as such and as expressed in the following claims.

[0022] In these drawings:

Figure 1: is a representation of the respective positions of the hook elements, selection elements and selector means of a shed-forming device according to the invention for a three-position open-shed jacquard machine, represented in a starting position for a first pick position, with shed formation in middle position;

Figures 2 up to and including 4: are a representation of the positions of the hook elements, selection elements and selector means, represented in three possible situations for a second pick position, with shed formation respectively in top, middle and bottom position, starting from the situation according to figure 1;

Figure 5: is a representation of the positions of the hook elements, selection elements and selector means, represented in a starting position for a second pick position, with shed formation in middle position;

Figures 6 up to and including 8: are a representation of the positions of the hook elements, selection elements and selector means, represented in three possible situations for a first pick position, with shed formation respectively in top, middle and bottom position, starting from the situation according to figure 5;

Figures 9 up to and including 11: are a simplified schematic representation of a set of (right) hook elements, selection elements and selector means of a shed-forming mechanism according to the invention, in an embodiment according to figures 1 up to and including 8, with shed formation respectively in bottom, middle and top position, for a first pick position (in solid line) and for a second pick position (in dotted line), respectively;

Figures 12 and 13: are a schematic representation of the various transition possibilities between the respective state and position situations for a three-position shed-forming mechanism according to the invention;

Figures 14 up to and including 16: are a schematic representation (analogous to figures 9 up to and including 12) of the hook elements, selection elements and selector means of an alternative embodiment of a shed-forming mechanism according to the invention;

Figures 17 and 18: are respectively a front and rear view in perspective of two different embodiments or the complementary elastic selection elements (spring hooks) for a three-position shed-forming mechanism according to the invention;

Figures 14 up to and including 16: are schematic representations of various embodiments of push selectors for a shed-forming mechanism according to the invention, in electromagnetic embodiments (figures 19 - 21 and 23 - 27) and in piezoelectric embodiment (figure 22).

[0023] The shed-forming device according to the invention depicted in figure 1 comprises:

two complementary hooks ("hook elements") (1) and (2), each provided with hook springs ("selection elements") with two spring legs (one long and one short) (3), (4) respectively (5), (6); two sets of electromagnetic top, respectively bottom push selectors ("selector means") (St) and Sb);
two sets of, top and respectively bottom, upward and downward moving knives (7), (8), respectively (9), (10);
a set of stationary holding knives (11) and (12); and
a cord (13), whose respective extremities are attached to the two complementary hooks (1), (2), and which is connected via a tackle (14) to a tackle cord (15) which is connected by one of its extremities to a fixed part (16) of the device and by its other extremity (17) to a harness cord of the weaving device for lifting a warp thread.

[0024] In figure 1 the situation is presented for a first pick position (left top knife in top dead position) of a shed-forming device for a three-position open-shed jacquard machine, with shed formation in middle position.

[0025] In figures 2 - 4 the situations are shown such as those, with a following pick position (second pick position), which can be reached from the starting position from figure 1, namely the situations with shed formation respectively in top, middle and bottom position.

[0026] In figures 1 - 4 the height levels of the top, middle and bottom position of the extremity (17) of the tackle cord of the shed-forming device connected to the harness cord are respectively indicated by (B), (M) and (O), and the height levels of the shed-formation by (h).

[0027] In figure 2, where more specifically the situation with the long spring leg (6) is shown in the top position, the operation of the guiding element (18) is clarified. Because of the presence of the guide (18) the hook is prevented from falling on to the spring leg (18) of the knife (8) with a downward movement of that knife.
With a downward movement of the hooks which rest on a descending knife, the hook can indeed, in case of insufficient pre-tensioning of the drawback spring in the harness, temporarily leave the knife and the guide (18) has to prevent the hook from falling off the knife.

[0028] In an analogous manner as for figure 1 discussed above, in figure 5 the situation is represented for a second pick position (left top knife in bottom dead position) of a shed-forming device for a three-position open-shed jacquard machine, with shed formation in middle position; in figures 6 - 8, analogous to figures 2 - 6, the situations are shown such as those with a following pick position (second pick position) which can be reached from the starting position from figure 5, namely the situations with shed formation respectively in top, middle and bottom position.

[0029] In figure 1 the activated position of the right top push selector (St) and the corresponding position of the longer spring leg (6) are indicated highlighted in black, while in figure 5 the activated position of the right bottom push selector (Sm) and the corresponding position of the shorter spring leg (5) are shown highlighted in black.

[0030] Because of the arrangement of the knives as represented in figures 1 up to and including 8 the height of the jacquard machine can be reduced for one and the same lifting height stated as purpose. The hook rests on the underlying knife gratings with a nose which rests on a projection on the underside of the lifting knives. The upper knives take the hooks further upwards on a supporting surface which is located on top of the lifting knives.

[0031] As push selector any mechanical, electromechanical or piezoelectric element can be used that is capable of pushing a flexible hook on to the lifting knives or stationary knives.

[0032] The operation of the selection elements and selector means is further explained on the basis of figures 9 up to and including 13: in figures 9 - 11 the right-hand set of hook elements, selection elements and selector means of the mechanism according to figures 1 up to and including 8 are shown schematically, with shed formation respectively in bottom (figure 9), middle (figure 10) and top position (figure 11), respectively for a first pick position (in solid line, left in each figure) and for a second pick position (in dotted line, right in each figure);
figures 12 and 13 show the transition diagram to and from the various situations which are depicted in figures 9 - 11.

[0033] In figure 12 and 13 for every possible transition the activation of the selectors is indicated by the number 1, while the non-activation is indicated by the number 0.

[0034] From figure 12 it can for example thus be read off that in order from the "bottom" position in pick 1 (figure 9, left) to reach the "bottom" position in pick 2 (figure 9, right) both selectors must not be activated (St=0 and Sm=0); in order from that same starting position in pick 2 to reach the "middle" position (figure 10, right), respectively the "top" position, the selector St must not be activated and the selector Sm must be (St=0 and Sm=1), respectively the selector St must be and the selector Sm must not be (St=1 and Sm=0).

[0035] Analogous indications are read off from figure 12 for the transition from the "middle" and "top" positions in first pick (left in figure 12) to the respective "bottom", "middle" and "top" positions in second pick (right in figure 12), and from figure 13 for the transition from the "bottom", "middle" and "top" positions in second pick

(right in figure 13) to the respective "bottom", "middle" and "top" positions in first pick (left in figure 13).

[0036] In figures 14 up to and including 16 an alternative embodiment of a shed-forming mechanism according to the invention is schematically shown (in analogous manner as for figures 9 up to and including 12), whereby permanent magnets (20), (21) are provided on the hook elements (5), (6) and whereby the bending of the hooks is achieved by electromagnetic repulsion by the selector means (Mm) and Mt).

[0037] The transition diagram to and from the various situations which are depicted in figures 14 - 16, is shown by the same figures 12 and 13 as discussed above.

[0038] Figures 17 and 18 show front and rear views of two different embodiments or complementary elastic selection elements (spring hooks) for a three-position shed-forming mechanism according to the invention, with a long spring leg (6) and a short spring leg (5), and with a top suspension hook (24), a middle suspension hook (23) and a bottom suspension hook (22).

[0039] Figures 19 up to and including 27 finally show schematic representations of various embodiments of push selectors for a shed-forming mechanism according to the invention, in electromagnetic embodiments (figures 19 - 21 and 23 - 27) and in piezoelectric embodiment (figure 22).

Claims

1. Shed-forming mechanism for a jacquard machine, comprising

hook elements serving for lifting the warp threads of a weaving device, provided with one or more elastic selection elements,
one or more sets of upward and downward moving knives on to which the hook elements can hook on, and
selector means which can act on the elastic selection elements in order selectively to allow the hook elements to hook on to the knives or not,
characterised in that the aforementioned elastic selection elements consist of spring elements **and that** the aforementioned selector means for acting on the elastic selection elements consist of push selectors, whereby in each case one individual push selector is provided in order to be able to act on one spring element.

2. Shed-forming mechanism according to claim 1, **characterised in that** each spring element comprises at least two spring legs.

3. Shed-forming mechanism according to one of the preceding claims, **characterised in that** the aforementioned push selectors for acting on the elastic selection elements are selected from mechanical, electromechanical and piezoelectric selector means.

4. Shed-forming mechanism according to one of the preceding claims, **characterised in that** the aforementioned push selectors for acting on the elastic selection elements consist of piezoelectric selection means.

5. Shed-forming mechanism according to one of the preceding claims, **characterised in that** the aforementioned push selectors are utilised with a three or multiple-position open-shed jacquard machine.

6. Shed-forming mechanism according to claim 5, **characterised in that** the aforementioned push selectors are utilised with a three-position open-shed jacquard machine.

7. Shed-forming mechanism according to one of the preceding claims, **characterised in that** the aforementioned push selectors are utilised with an open-shed jacquard machine whereby two complementary hooks are interconnected by a tackle cord that via a tackle element serves for lifting a warp thread of the weaving machine.

8. Shed-forming mechanism according to one of the claims 1 - 6, **characterised in that** the aforementioned push selectors are utilised with a tackleless open-shed jacquard machine whereby the hook elements are connected to a heddle element with which a warp thread of the weaving device can be lifted.

9. Shed-forming mechanism according to one of the preceding claims for a three or multiple-position open-shed jacquard machine, **characterised in that** in addition to the one or more sets of upward and downward moving knives at least one or more stationary holding knives are provided in order to hold the hook in an intermediate position.

10. Shed-forming mechanism according to one of the preceding claims for a three or multiple-position open-shed jacquard machine, provided with spring elements with at least two spring legs, **characterised in that** furthermore a guide is provided for preventing the hook on the longer spring leg from falling off the knife with a downward movement of the knife.

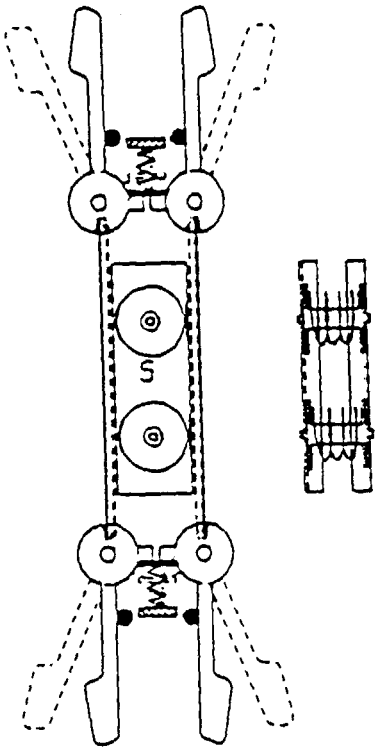

Fig. 25

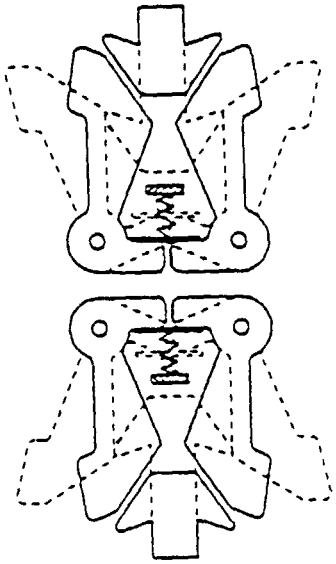

Fig. 26

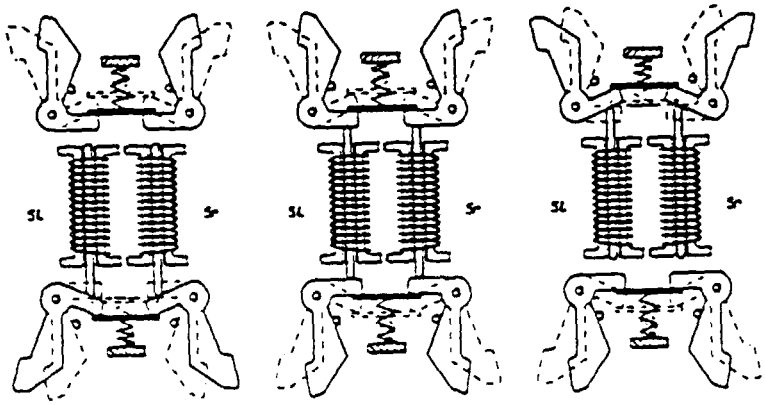

Fig. 27

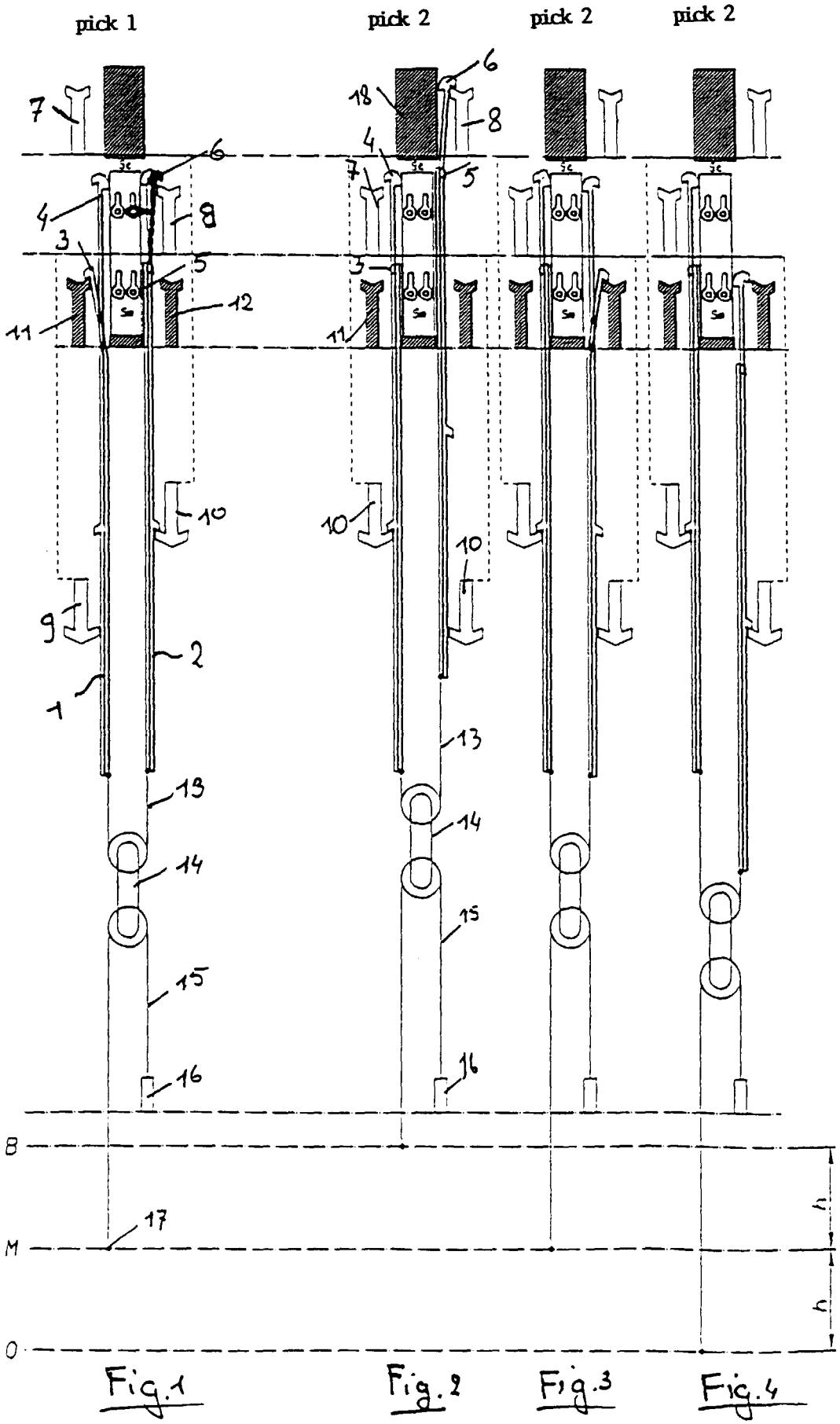

Fig.1 Fig.2 Fig.3 Fig.4

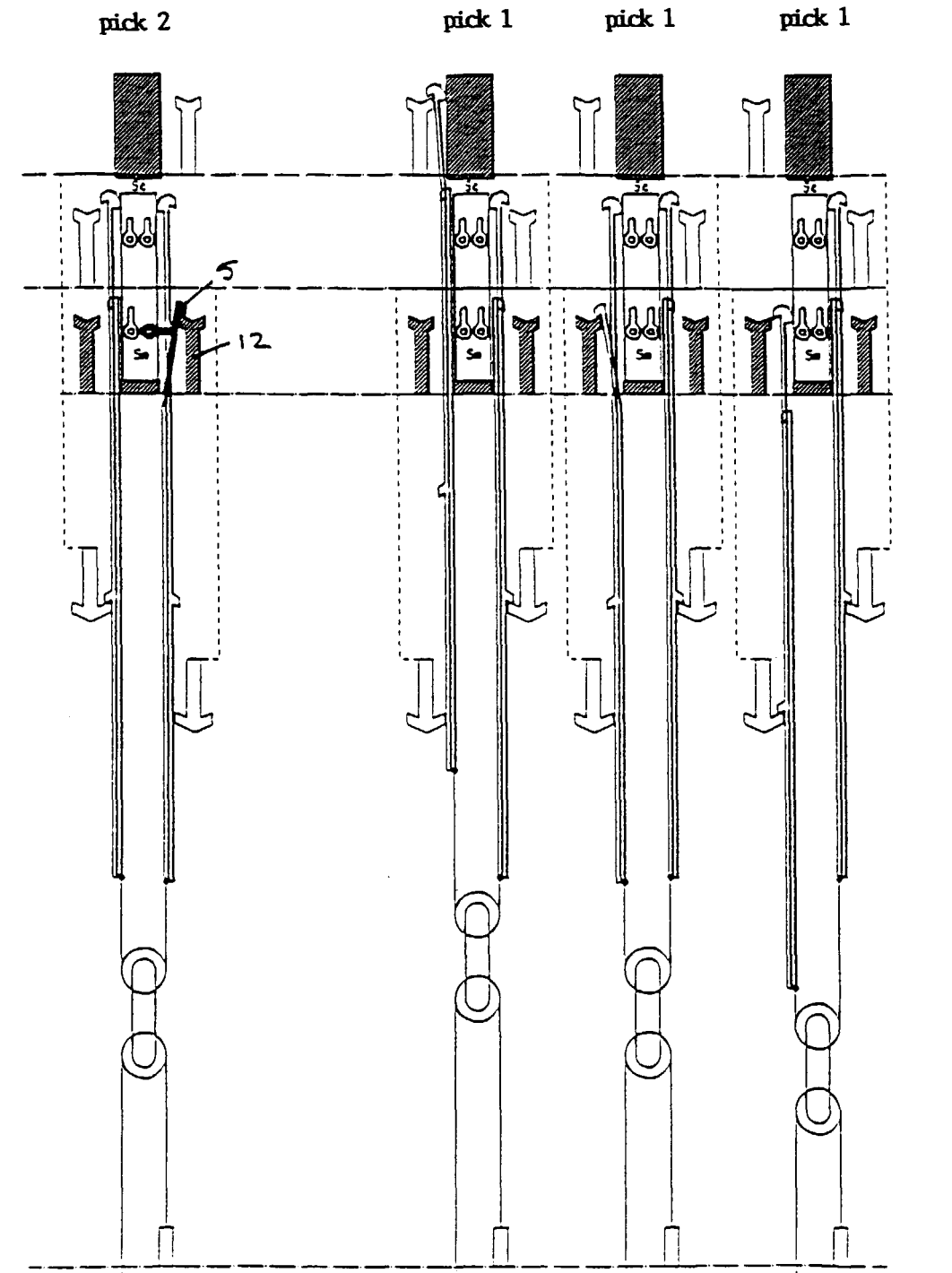

Fig.5 Fig.6 Fig.7 Fig.8

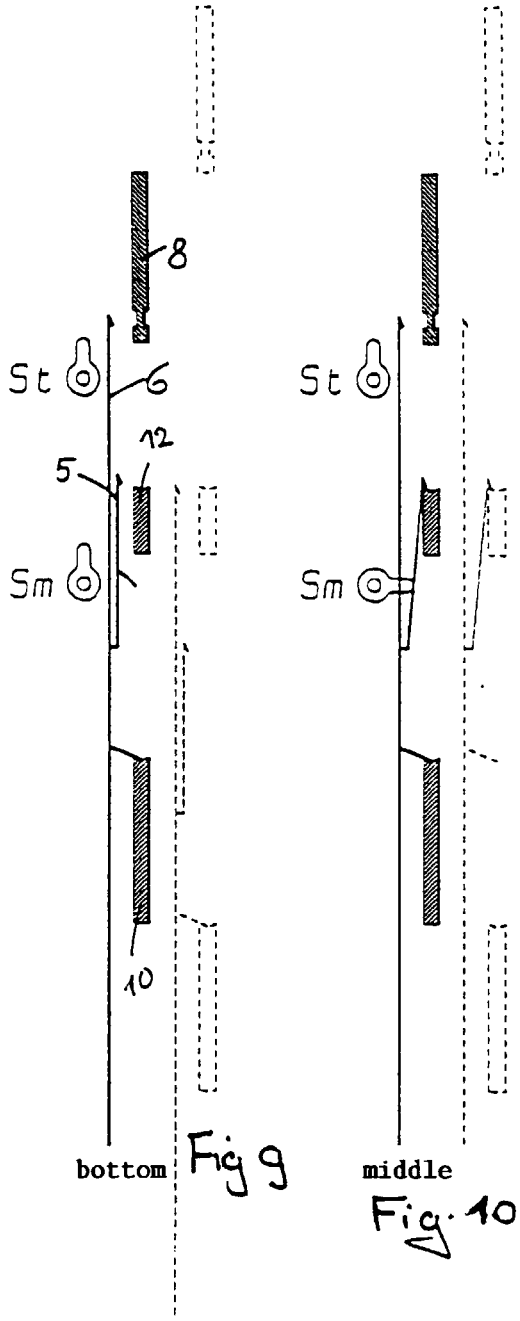

Fig 9

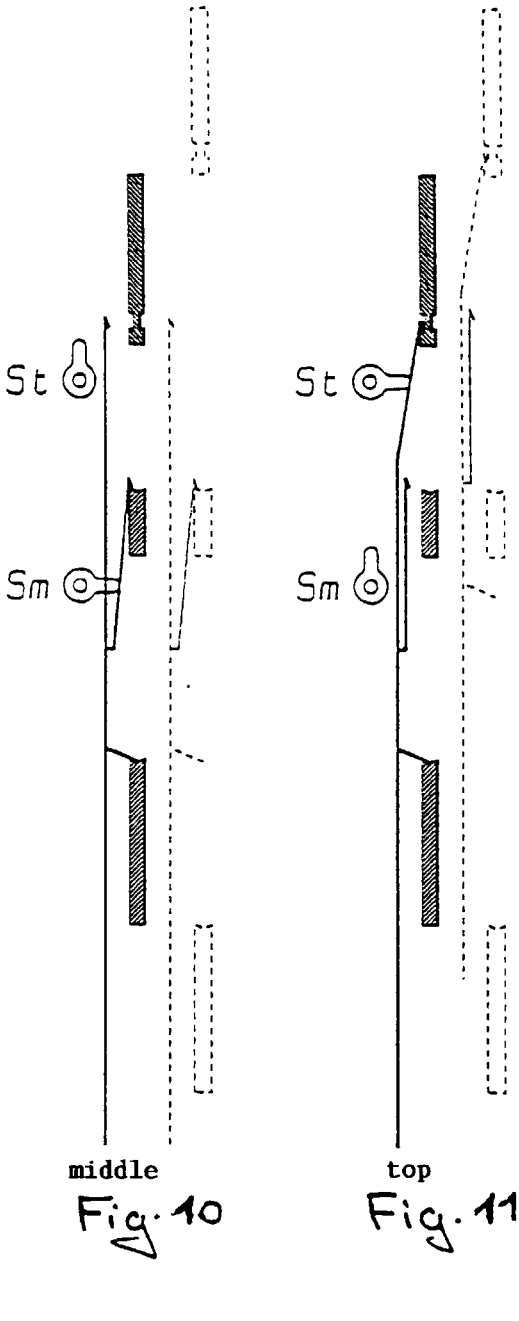

Fig. 10

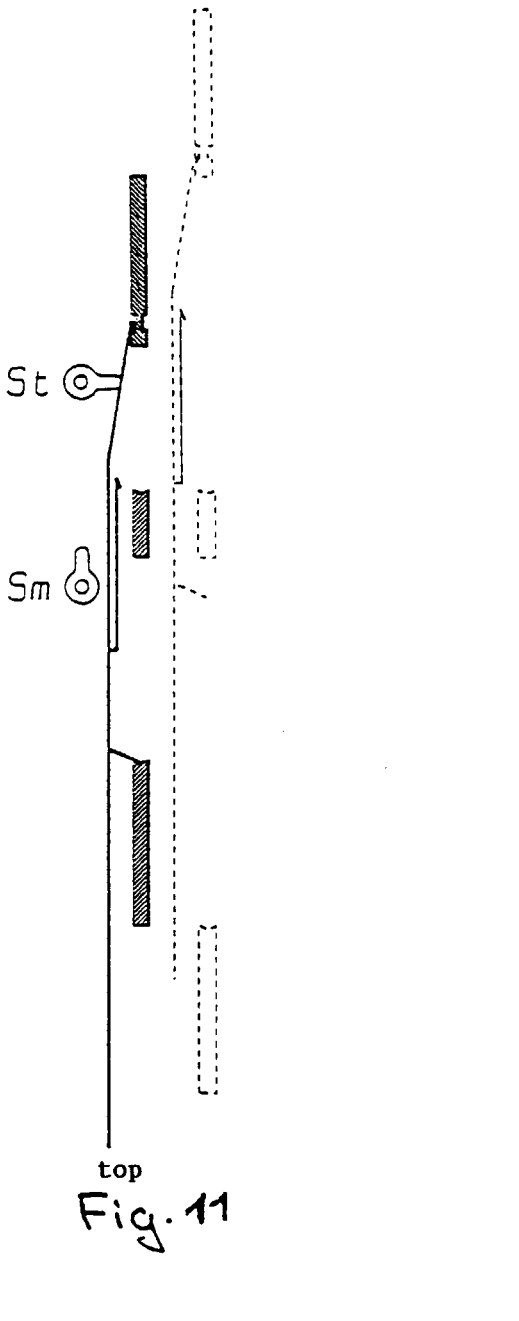

Fig. 11

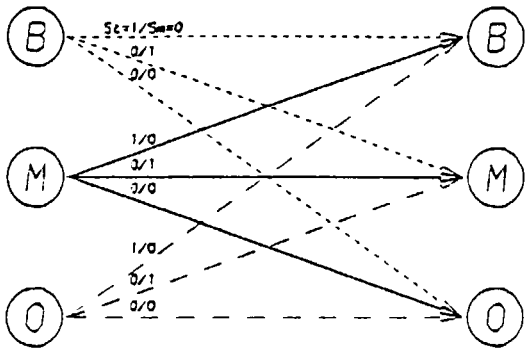

Fig. 12

pick 1 pick 2

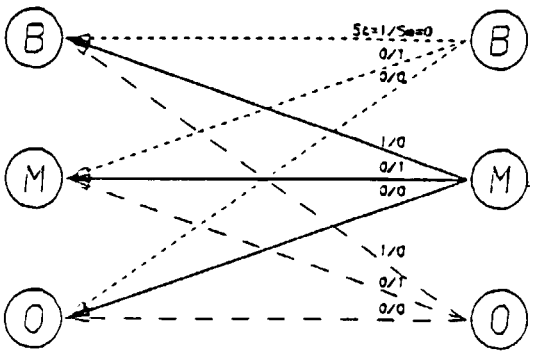

Fig. 13

pick 1 pick 2

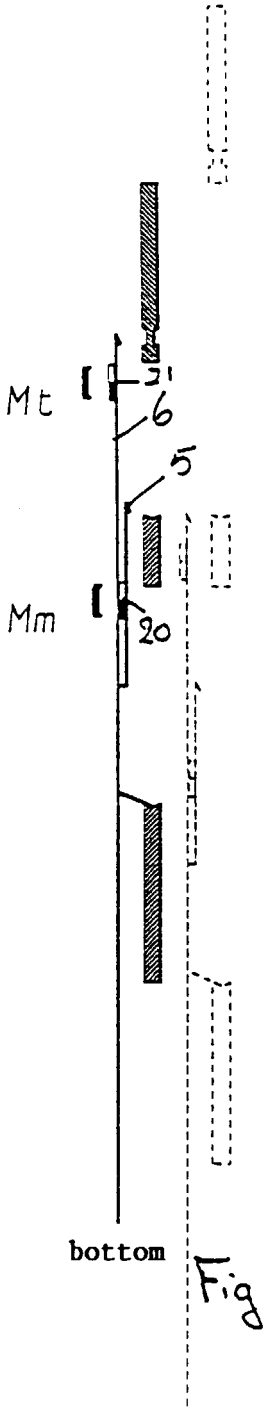

Fig. 14

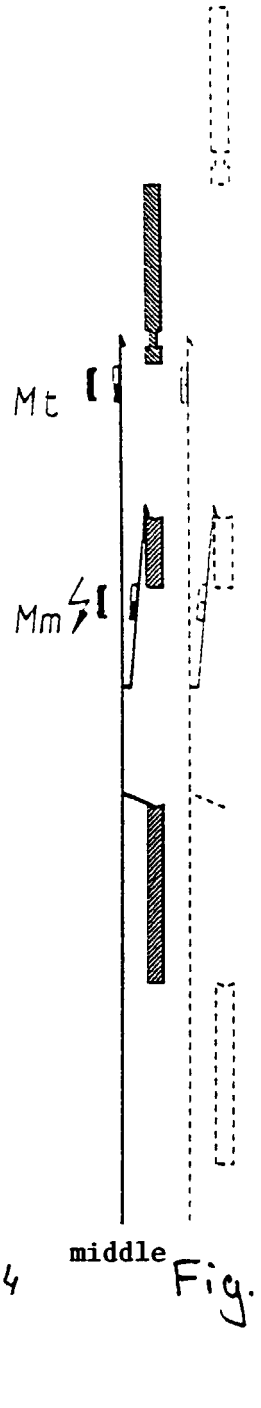

Fig. 15

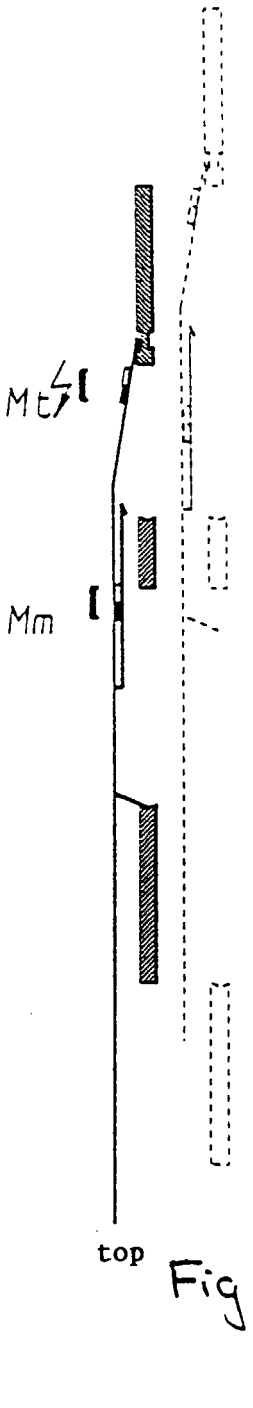

Fig. 16

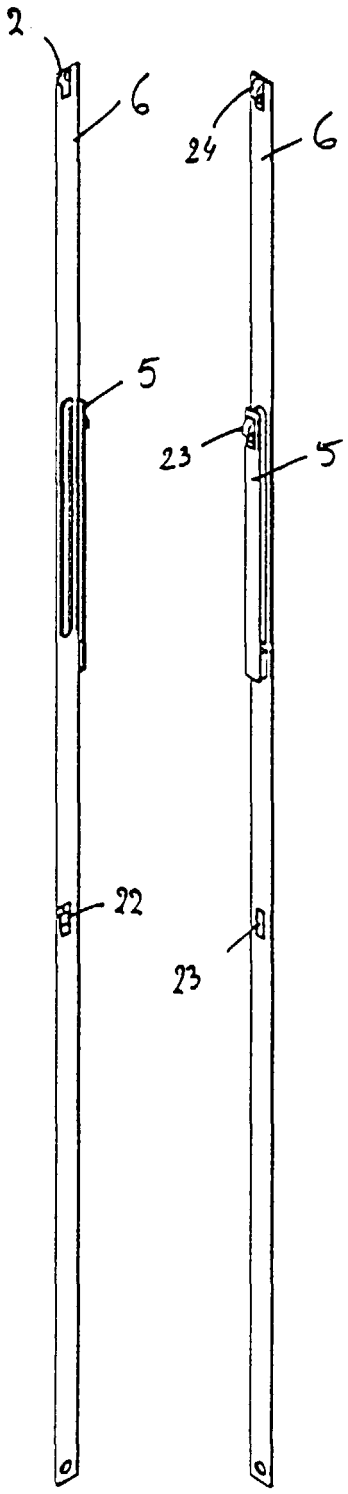

Fig.17

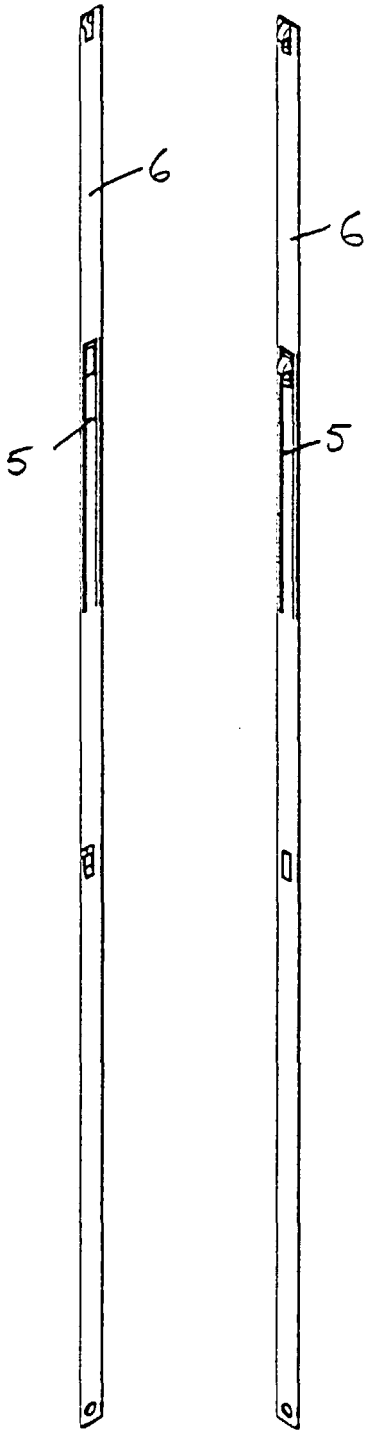

Fig.18

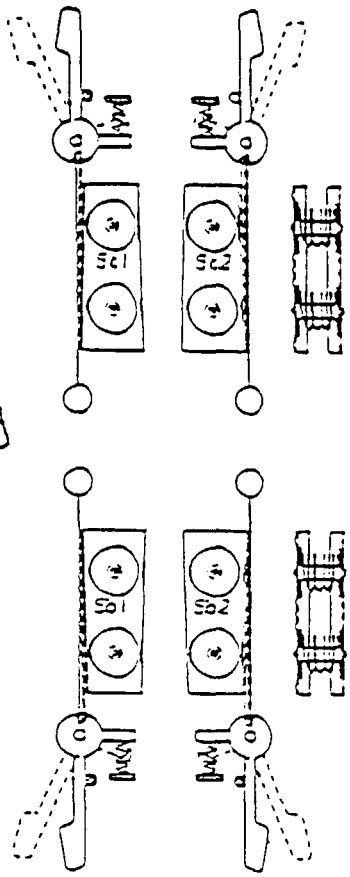

Fig.19

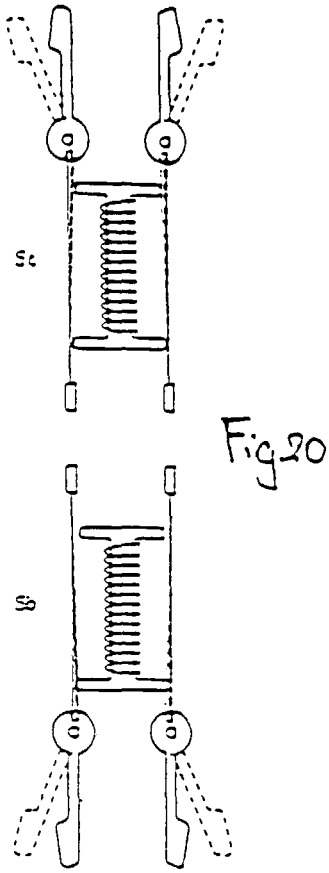

Fig.20

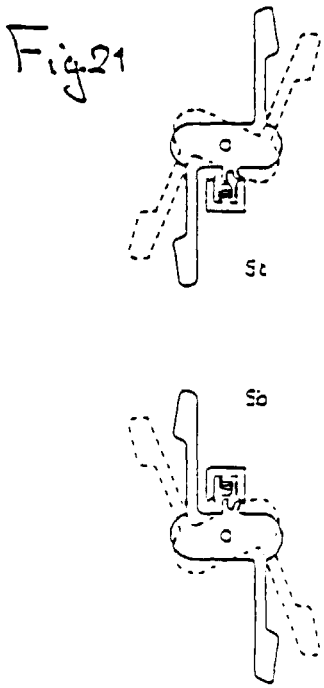

Fig.21

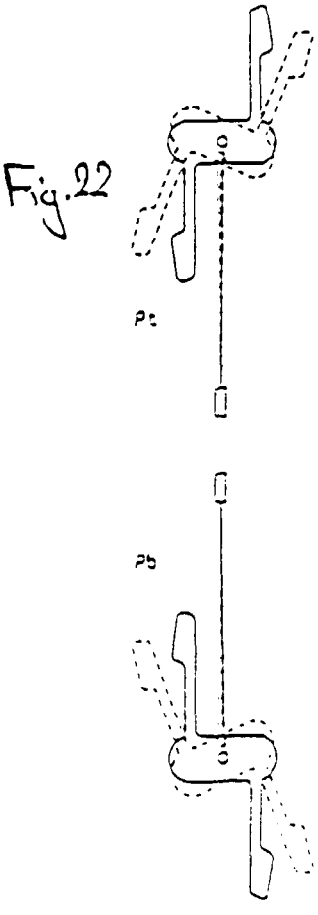

Fig.22

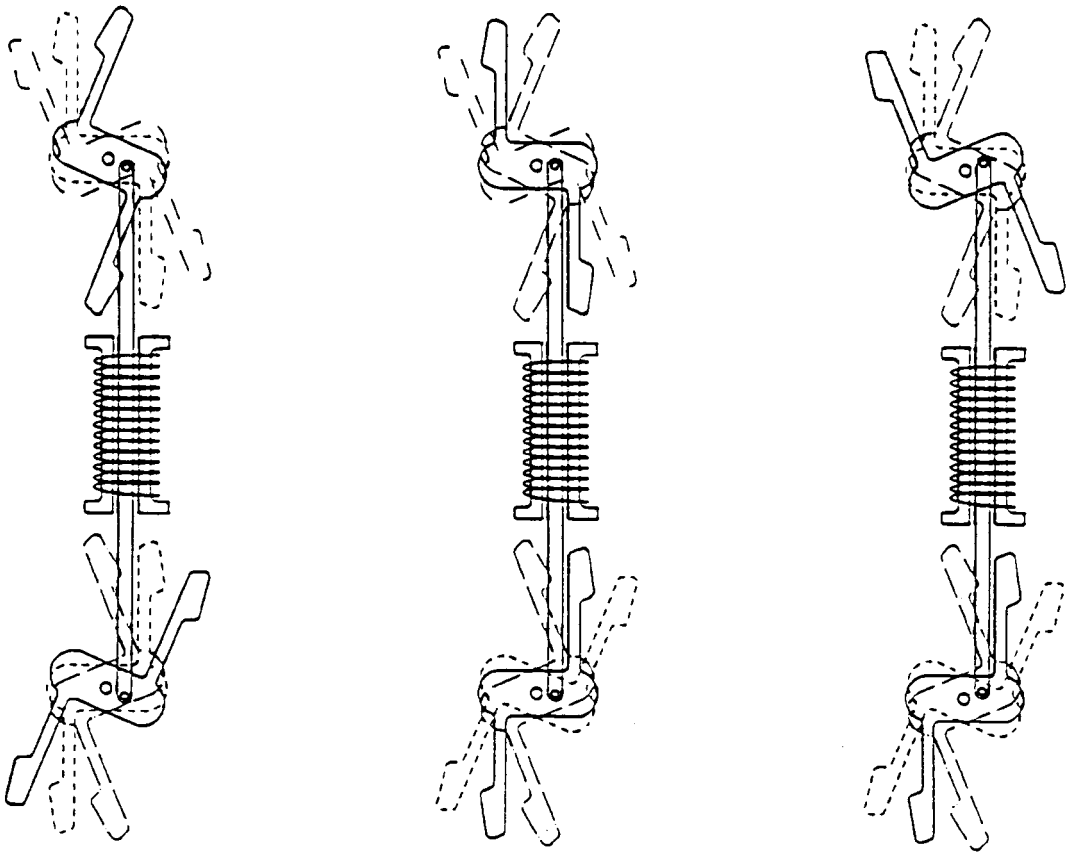

Fig. 23

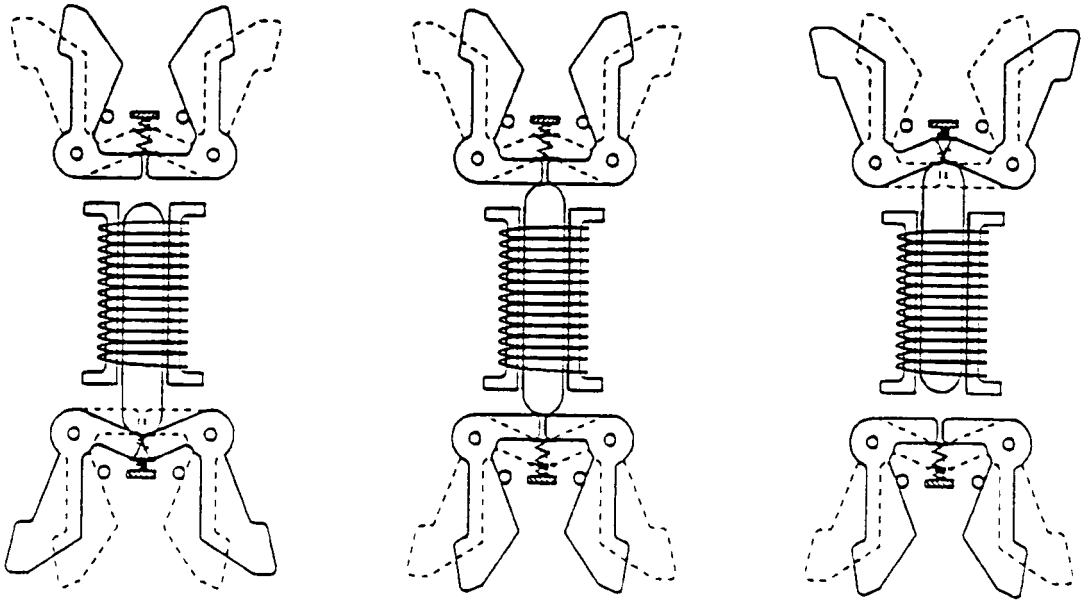

Fig. 24