

[54] JACQUARD MECHANISM

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[58] Field of Search 66/25, 50 R, 75; 310/26, 310/8.5, 8.6; 139/55, 59, 65, 68

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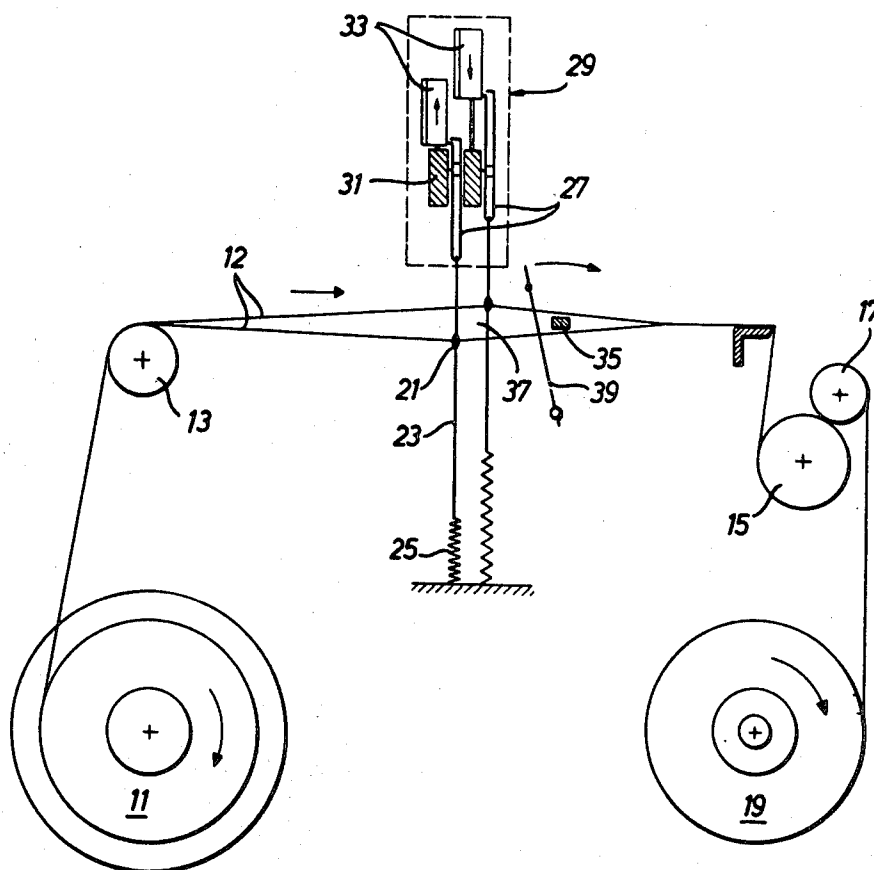
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[57] ABSTRACT

The weaving machine is provided with control elements which are flexed or moved between one of two positions by magnetic, electrical or thermal forces as to program the movement of the healds in forming a shed. The use of jacquard cards to interdict or to permit dropping of jacquard needles connected to the healds can thus be eliminated. The control elements are used in single-lift and in double-lift jacquard mechanism.

34 Claims, 11 Drawing Figures



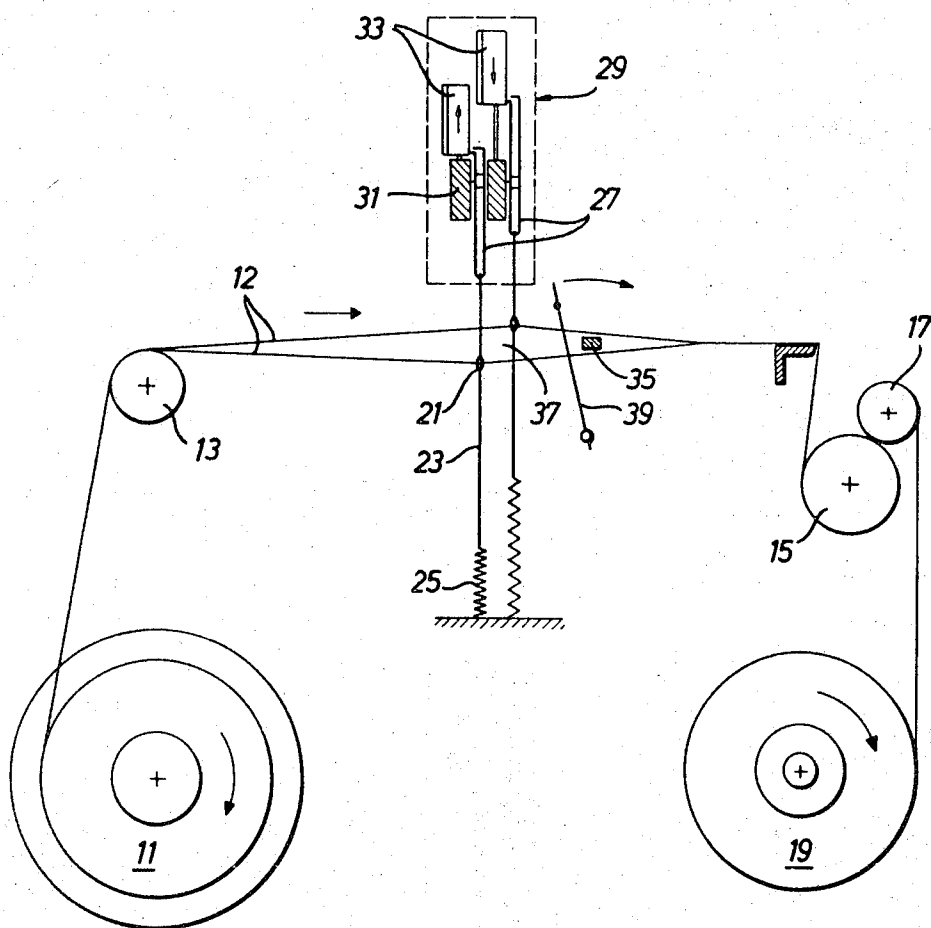
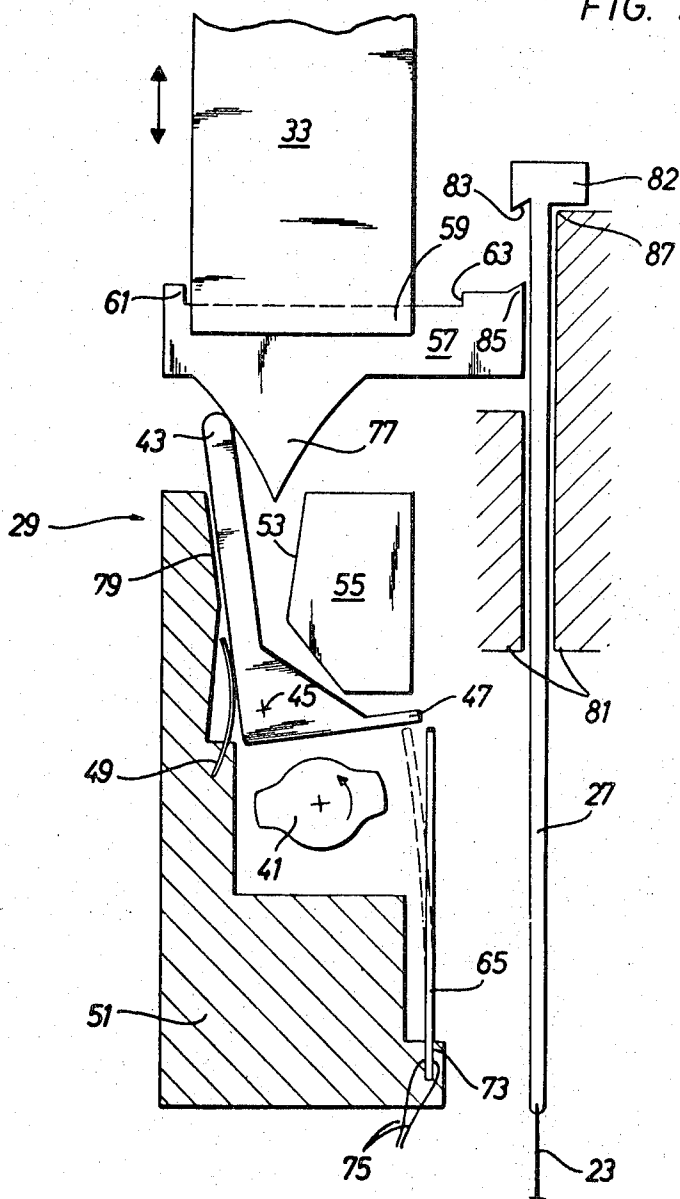


FIG. 1

FIG. 2



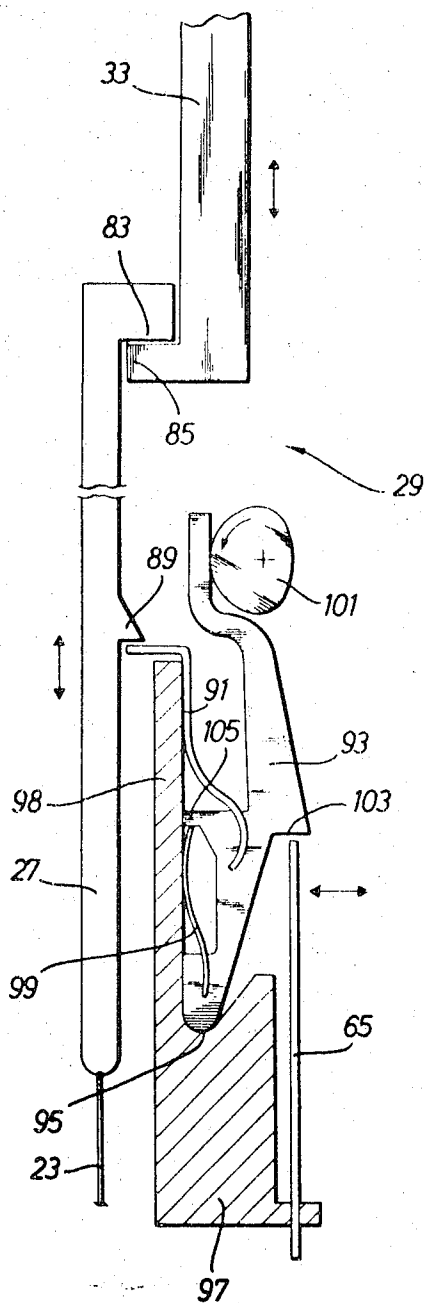


FIG. 3

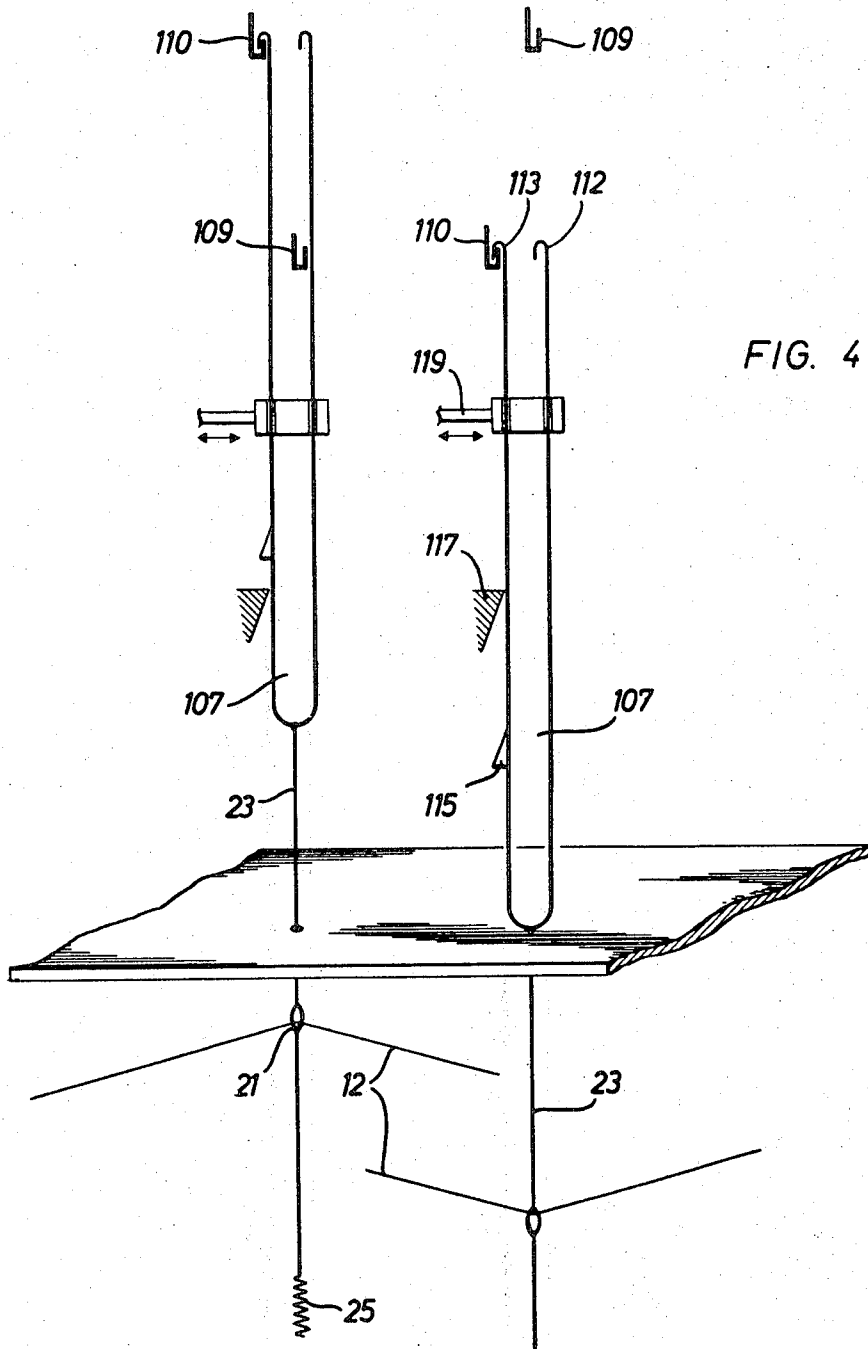
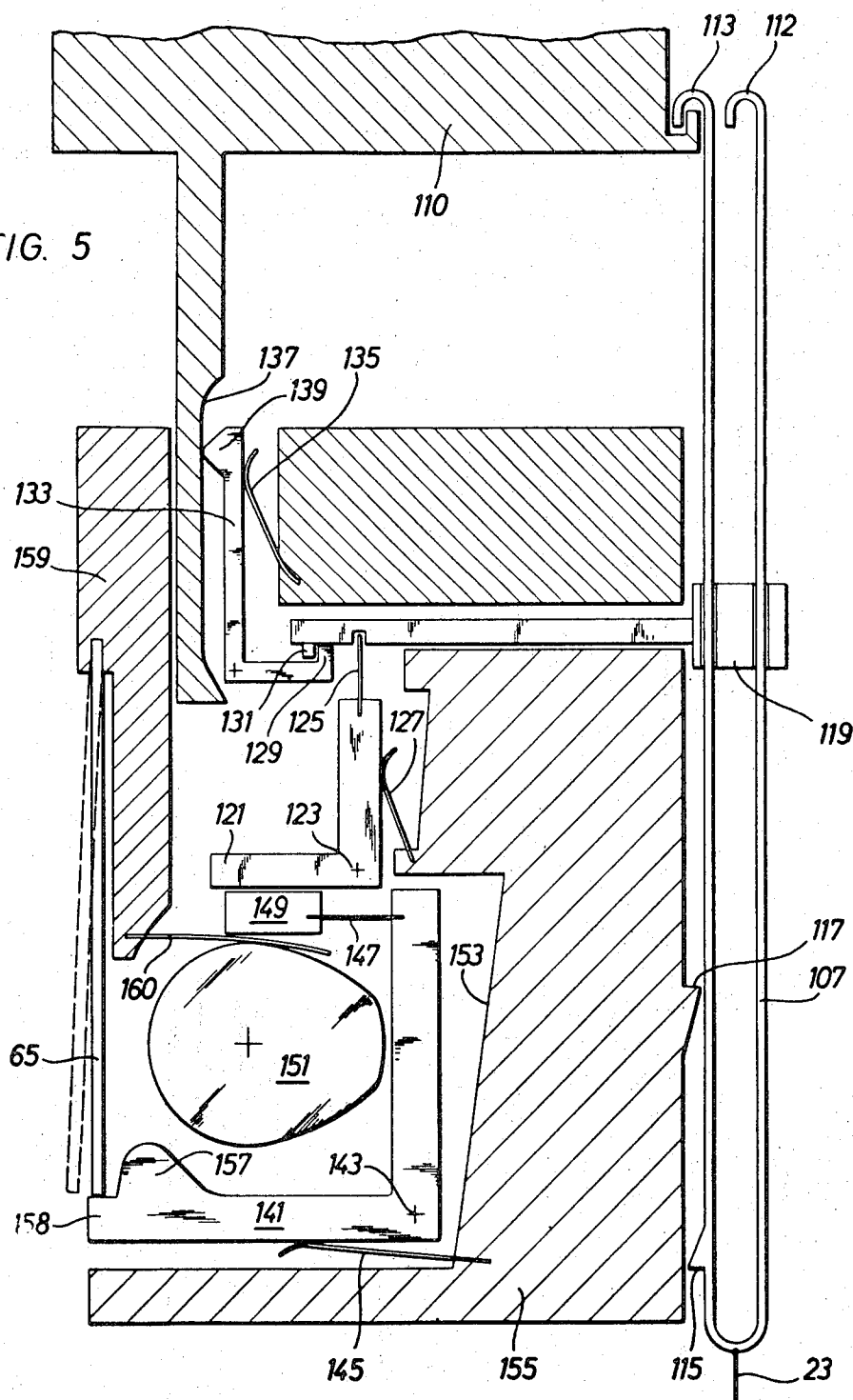
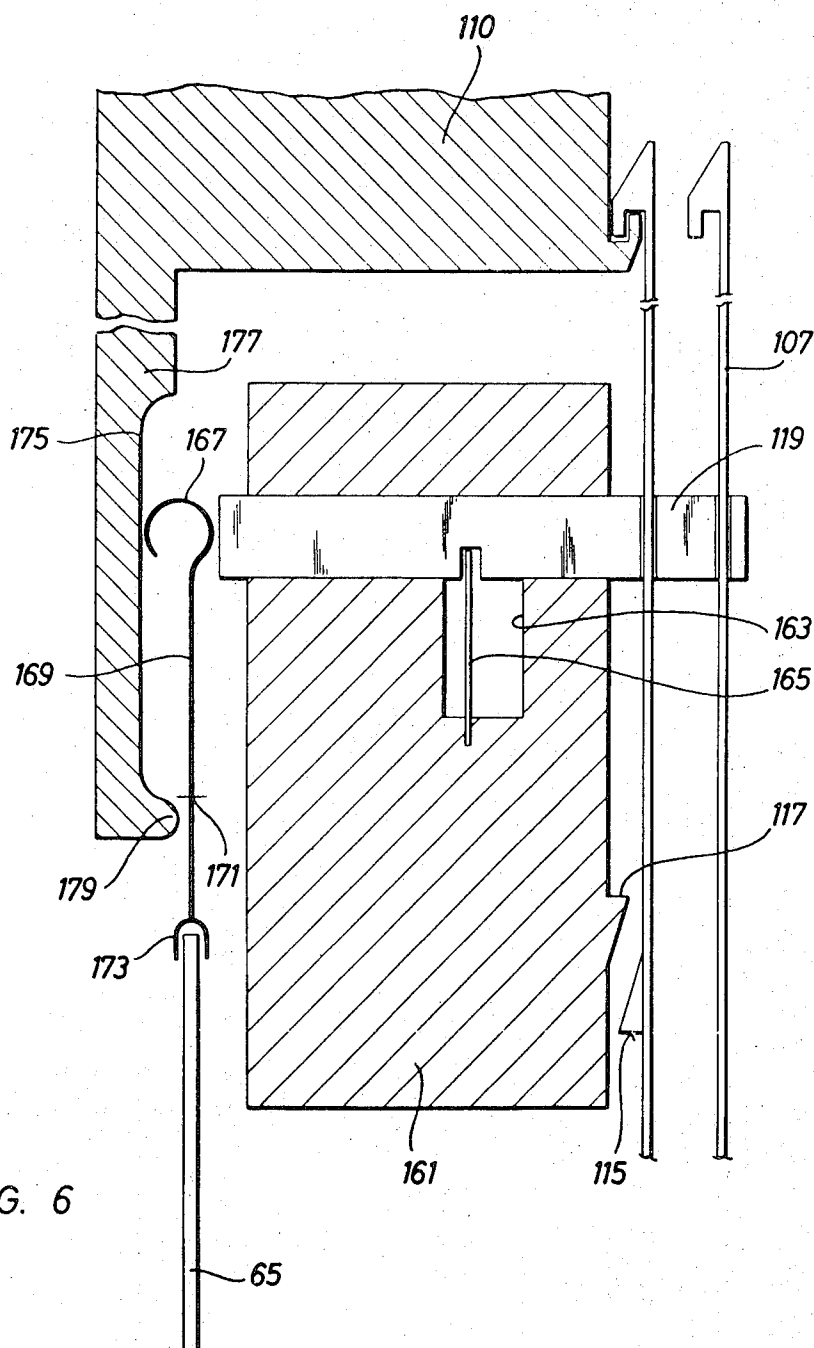


FIG. 5





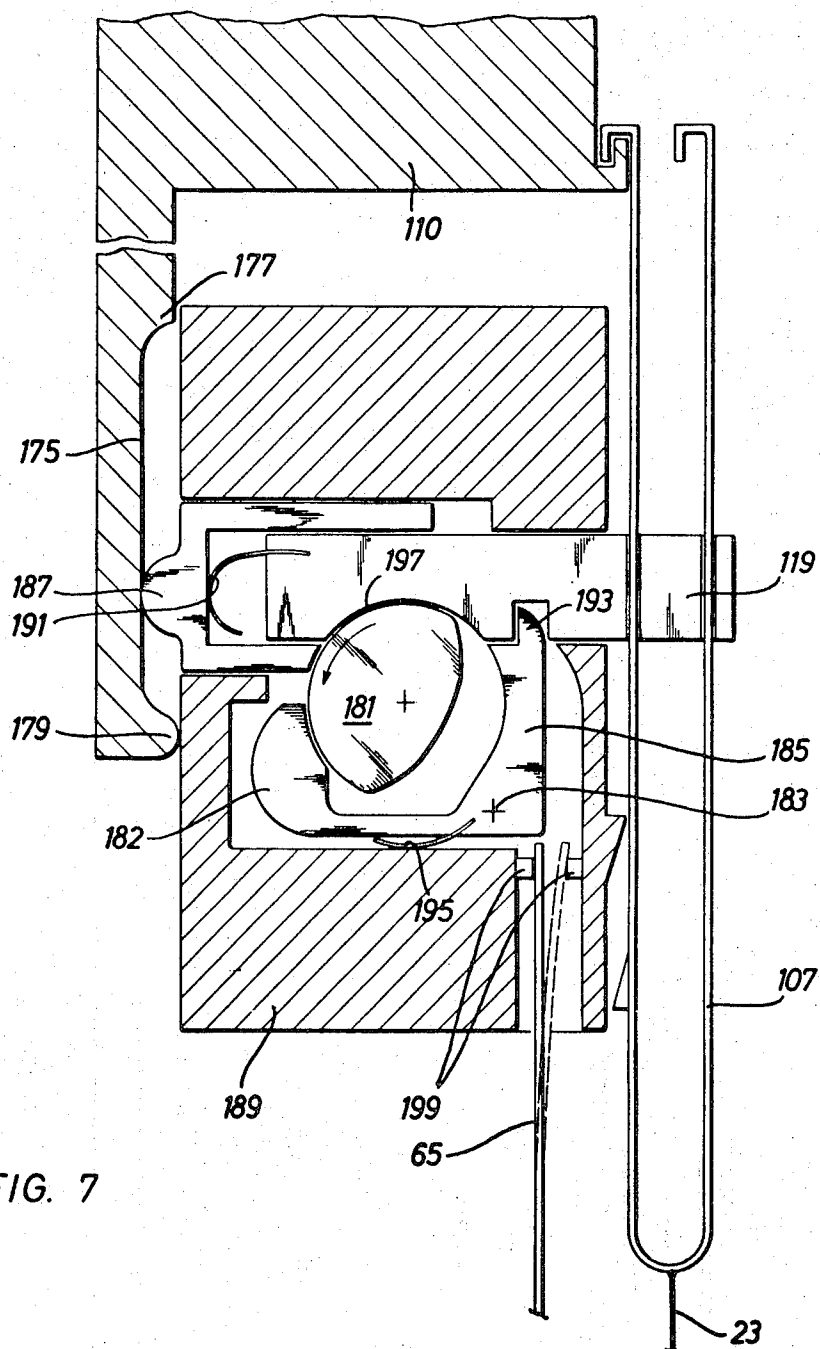


FIG. 7

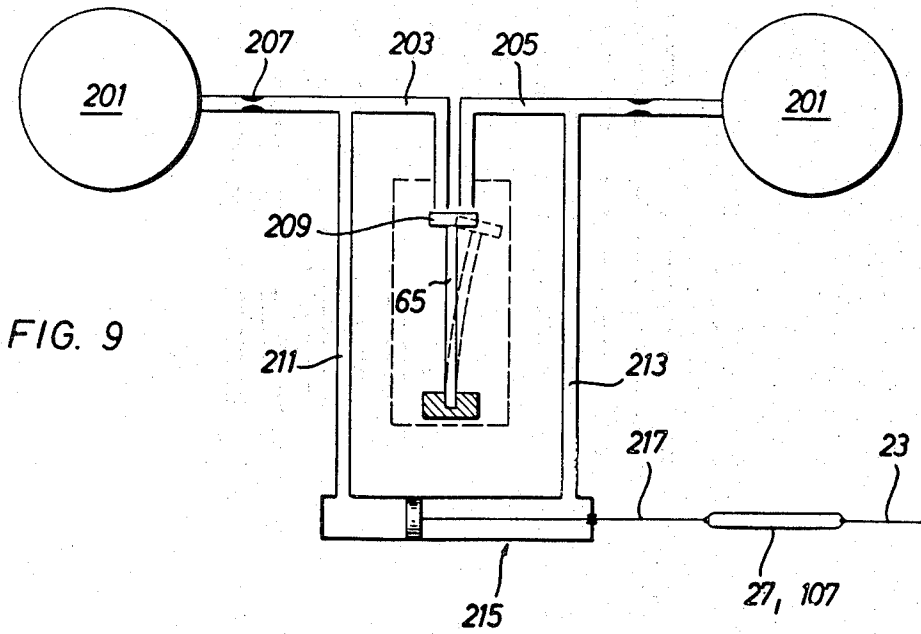
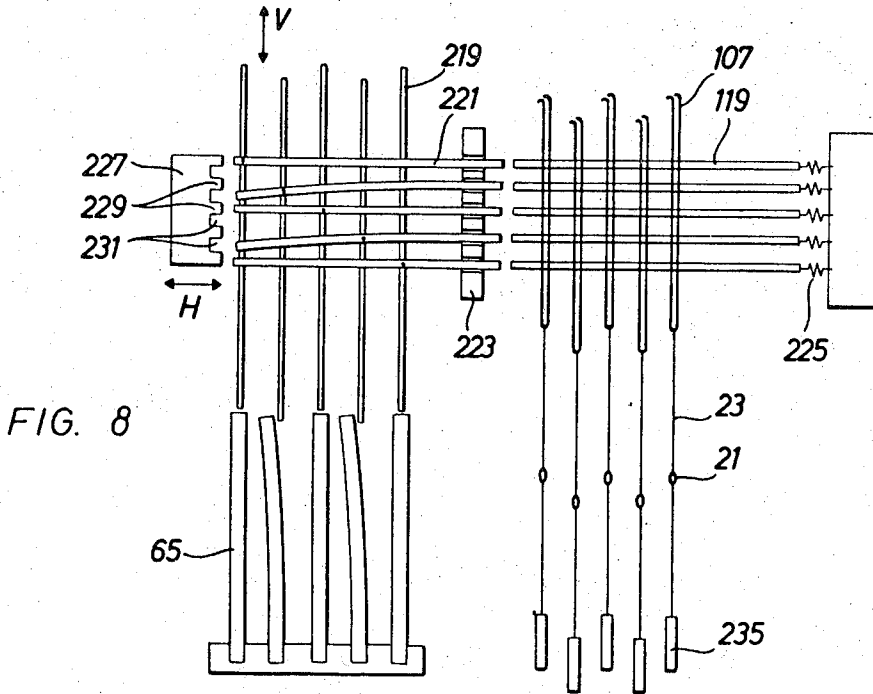


FIG. 10

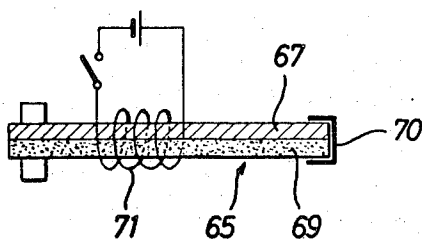
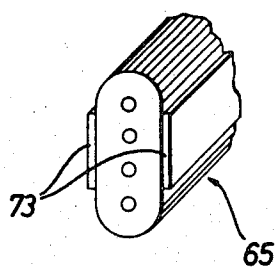


FIG. 11



JACQUARD MECHANISM

This invention relates to a jacquard mechanism particularly for weaving machines.

In previously proposed jacquard mechanisms, for example, for looms, harness cords are fixed to hooks (or lifting wires), healds are fixed to the harness cords and warp yarns are drawn through heald eyes or mails. In order to form a shed, selected hooks are first brought by suitable means, for example, control rods (jacquard needles), into a position in which, unlike the other hooks, they are within or out of range of one or more draw knives. The draw knives have served to raise or lower all the selected or unselected hooks respectively for shedding. Usually, each hook has one associated control rod and each control rod has means, such as a perforation or solid area in a jacquard card, for selecting the hooks to be raised or lowered. A hook, for example, may remain within range of the associated draw knife whenever the control rod associated with this hook enters a perforation in the jacquard card, but may be pushed out of range of the draw knife whenever the jacquard card does not contain a perforation for the associated control rod.

In other previously proposed forms of jacquard mechanisms, each control rod may be operated by an auxiliary rod (preliminary needle) to which a "dropper" is fixed. The dropper either enters a perforation in a jacquard card or is obstructed by a solid area of the card, so that, for example, the associated auxiliary rod is or is not moved out of a normal position, as the case may be. If the auxiliary rods are then pushed forwards towards the control rods, only those hooks associated with a perforation in the jacquard card, for example, remain within range of the draw knife.

The two above-mentioned selection procedures differ in that, in one case, the perforations or solid areas in the jacquard card produce motion of the control rods directly whereas, in the other case, they only effect a particular positioning of the droppers, since the control rods are displaced by way of the auxiliary rods by other means, for example, a pressure plate.

The use of jacquard cards to select the hooks puts a considerable limitation on the pattern repeat. For example, looms with several thousand warps would need cards with an equal number of perforations or solid areas. This, however, would be uneconomical.

Another disadvantage of such previously proposed jacquard mechanisms is that they must be relatively high above the loom and must be provided with a harness. Otherwise, the harness cords cannot be connected to a plurality of healds in order to produce small repeats.

In order to overcome the above disadvantages, it has been proposed to control the selection of the hooks by electromagnetic systems which are energized in accordance with the pattern. Such electromagnetically controlled jacquard mechanisms have the advantage that, instead of using jacquard cards, any program carrier can be used to generate the required electrical signals. However, it has been difficult so far to reduce the bulk, the large total currents, the heat generated by the electromagnets, and/or their mutual electromagnetic effect to the necessary extent.

Accordingly, it is an object of the invention to provide a jacquard mechanism which eliminates the need for jacquard cards and is electrically controlled.

It is another object of the invention to provide a jacquard mechanism which is of simple compact construction.

It is another object of the invention to provide an electronically operated jacquard mechanism which uses relatively small electrical currents.

It is another object of the invention to reduce the heat generated within an electromagnetic jacquard mechanism.

Briefly, the invention provides a jacquard mechanism for a weaving machine in which a plurality of lifting hooks are raised or lowered in a predetermined pattern depending on the position of control elements which are movable from one position to another without performing any substantial work so as to prevent or permit raising, or lowering, or the hooks as the case may be by any suitable means. These control elements are such that their shape changes from one condition to another when heat or an electric or magnetic field is applied to the elements, the change in condition taking place substantially without work being performed by the elements, and reverts to the original condition when the heat or field is removed.

In one embodiment, the jacquard mechanism includes a plurality of lifting hooks, means for raising and lowering the hooks, control elements, means for sensing the condition of the control elements and means for initiating selection of the hook or hooks to be raised or lowered in dependence upon such sensing. The means used to sense the condition of the control elements is preferably a mechanical or pneumatic means.

The invention has considerable advantages. A very substantial advantage is that jacquard cards are no longer required since each individual warp thread can have its own hook selected in accordance with the pattern, with no disadvantages as regards the patterning. Another advantage is that the jacquard mechanism as a whole is much more compact and can be placed just above the loom even if each warp has its own hook, thus improving visibility in the weaving shed. Also, no harness is required.

The control elements may, for example, be multilayered electro- or magnetostrictive materials or, in particular, the various natural or synthetic piezoelectric crystals, piezoelectric ceramic substances being particularly suitable. Endurance tests have shown multilayered piezoelectric control elements made from certain alkaline-earth titanates to be suitable, giving deflections of a few millimeters if clamped at one end. Control elements may also be made, for example, from barium titanate, lead barium titanate and lead zirconate titanate, that is, from compounds generally termed ceramic oxides. Other known materials are "trilaminar piezoelectric oxides" having two ceramic layers and an intermediate metal layer to increase their mechanical strength. Also, "multimorph" elements produced in one piece by extrusion can be used.

The control elements are definable as "active flexural swinging elements" which can be bent or activated by applying, e.g. an electrical or magnetic field without using additional devices such as mechanical or electromagnetic devices. The term "freely swinging" is intended to mean that bending takes place with zero work, that is, the control elements perform no work or a negligible amount of work in bending. The control elements are further non-load bearing, that is, the elements are not intended to take any appreciable load

since they generally consist of a brittle material. The elements are intended to be used as regulator elements and not for the execution and mechanical initiation of the action of motion or for blocking motion.

These and other objects and advantages of the invention will become more apparent from the following detailed description and appended claims taken in conjunction with the accompanying drawings in which:

FIG. 1 diagrammatically illustrates the general construction of a loom having a jacquard mechanism according to the invention;

FIG. 2 illustrates a single-lift jacquard mechanism according to the invention;

FIG. 3 illustrates a modified single-lift jacquard mechanism according to the invention;

FIG. 4 illustrates a double-lift jacquard mechanism of known construction;

FIG. 5 illustrates a double-lift jacquard mechanism according to the invention;

FIG. 6 illustrates a modified double lift jacquard mechanism according to the invention;

FIG. 7 illustrates a further modified double-lift jacquard mechanism according to the invention;

FIG. 8 illustrates a dropper jacquard mechanism according to the invention;

FIG. 9 diagrammatically illustrates a pneumatic hook selection system for a jacquard mechanism according to the invention;

FIG. 10 illustrates a view of a control element according to the invention; and

FIG. 11 illustrates a part perspective view of a modified control element according to the invention.

Referring to FIG. 1, the loom comprises a warp beam 11 onto which the warp threads 12 are wound, various guide and tension rolls 13, 15 and 17, and a cloth beam 19 to draw off finished cloth. Each warp thread is drawn through a respective heald eye or mail 21 which is provided on a heald 23 attached by a spring 25 to a fixed part of the loom. Alternatively, weights may be provided on the ends of the healds instead of the springs 25. The other end of each heald 23 is fixed to a lifting hook (or wire) 27 belonging to a single lift jacquard mechanism 29, which has for each hook 27 a selector 31 and a reciprocable draw knife or drive beam 33. Before every pick of a shuttle 35, a shed 37 is formed in accordance with a pattern due to suitable co-operation between the hooks 27 and selectors 31. After each pick, a reed 39 beats the weft up into the fell as is known. Jacquard mechanisms also have harness cords (not shown) between the healds 23 and lifting hooks 27.

Referring to FIG. 2, wherein various parts have been omitted for the sake of clarity, the single-lift jacquard mechanism 29 is one in which the draw knives 33 are moved right up and down once per pick, sending a group of warp yarns 12 into the upper or lower shed each time in accordance with the pattern. As shown, the jacquard mechanism 29 includes a camshaft 41 provided with two cam lobes which extend over the operative width of the loom. The camshaft 41 carries out one half rotation during each complete upward and downward motion of the draw knives 33. Two cam lobes are chosen in order to reduce vibration during the running of the camshaft 41. A plurality of jacks or pushers 43, provided in the vicinity of the camshaft 41, are pivotably mounted at 45 and have respective projections 47. The jacks 43 are also biased onto an ob-

lique surface 53 of a fixed member 55 by means of respective springs 49 attached to a fixed part 51 of the jacquard mechanism 29.

The upper portions of the jacks 43 (as seen in FIG. 2) act on respective risers 57, each of which is displaceably mounted on a bearing rail 59 on a draw knife 33 with travel being restricted by limit stops 61, 63. The mounting of each bearing rail 59 on the draw knife 33 is such that the bearing rail 59 takes part in every upward and downward motion of the draw knife (see arrow).

The projection 47 of each jack 43 is arranged to sense the position of a respective control or flexing element 65. If made as a magnetostrictive element as shown in FIG. 10, the flexing element 65 comprises two strips 67, 69 which expand differently upon the application of a magnetic field, causing the flexing element 65 to bend. A protective cap 70 of wear-resistant material may be placed on the mechanically stressed end of the flexing element 65. The magnetic field may be generated by means of a coil 71, connected by a control switch to a battery as shown in FIG. 10 or to a control-signal-generating portion of a suitable program control device. If the flexing element 65 is a bimetal strip or an electrostrictive element, the strips 67, 69 are again of different materials and are directly connected to a battery by a control switch which causes the flexing element to bend due to the different thermal expansion or different electrostrictive properties of the strips. Alternatively, the flexing elements 65 may be piezoelectric elements as shown in FIG. 11, either multilayered or produced in one piece by extrusion. The latter elements generally have external electrodes 63 which are connected to a battery by suitable control switches when bending of the flexing element is desired.

Referring to FIG. 2, the flexing elements 65 are fixed to the stationary part 51 of the jacquard mechanism 29 and their electrodes 73 are provided with leads 75 which extend to a suitable power source.

In addition, each riser 57 acts on a hook 27, the bottom end of which is fixed to a heald 23. Thus, one hook 27, one riser 57, one jack 43 and one flexing element 65 are preferably associated with each heald 23. Further, the hooks 27 are guided in a fixed member 81 of the jacquard mechanism 29 and each has a heald 82 which carries a catch (or hook) 83 which cooperates with a corresponding catch 85 on the riser 57 when the riser has been moved to the right to the position shown in FIG. 2. Also, the riser 57 and the hooks 27 are positioned and dimensioned so that when a draw knife 33 moves downward from an uppermost position, the two engaging catches 83, 85, at first, remain engaged due to the weights or springs 25 (FIG. 1) fixed to the healds 23. Thereafter, the heads 82 of the hooks 27 come to bear on a projecting portion 87 of the member 81 before the draw knife 33 reaches its bottom position (shown in FIG. 2). As a result, the hooks 27 are disconnected from the risers 57 which can now be moved to the left as desired.

The jacquard mechanism 29 operates as follows.

When the camshaft 41 has turned through approximately 90° from the position shown in FIG. 2, all the jacks 43 are pressed by one cam lobe onto an oblique surface 79 of the stationary part 51, overcoming the influence of the respective springs 49. At the same time, the risers 57 have been lifted far enough by the draw knives 33 for their wedge-shaped portions 77 to be

above the upper ends of the jacks 43. When the jacks 43 are in this position, the projections 47 have pivoted out of range of the flexing elements 65, so that the flexing elements 65 can be brought into either of the positions shown by solid and broken lines in FIG. 2 by applying a suitable voltage, without these elements coming into contact with any other portion of the jacquard mechanism 29.

The selection of the hooks 27 which are to be raised or lowered before the next pick always takes place when the draw knife 33 has been raised high enough to bring the wedge-shaped portions 77 out of range of the jacks 43 and when, at the same time, the position of the camshaft 41 is such that one cam lobe is pressing all the jacks 43 onto the oblique surface 79. This is because all the flexing elements 65 are released by the projections 47 at this moment, and can be bent to the right or the left according to the pattern without having to overcome mechanical forces.

After the elements 65 have been moved appropriately in accordance with the pattern, the cam lobe slips off the jack projections 47 due to the continued rotation of the camshaft 41, so that some of the jacks have their projections 47 bearing on the elements 65 under the biasing force of the springs 49 while the remainder have their upper portions bearing on the oblique surfaces 53 of the fixed member 55. The draw knife 33 is then lowered, and the jacks engaging the elements 65 therefore act on the wedge-shaped portions 77 to slide selected risers 57 into the right-hand position, whereas the jacks 43 bearing on the oblique surface 53 act on the wedge-shaped portions 77 of their risers 57 as to pull the risers over to the left. The entire selection operation is therefore completely independent of the position previously occupied by the risers 57, that is, completely independent of which hooks 27 were previously raised.

On completion of the selection operation, the draw knife 33 is raised again so that only the catches 85 belonging to the risers 57 in the right-hand position engage in the catches 83 and raise the associated hooks 27. When the hooks so raised have brought the warps connected thereto into the upper shed, the next pick and the next selection operation can take place. This has the advantage that the next selection operation can take place as soon as the wedge-shaped portions 77 have moved beyond the jack ends, that is, long before the next pick, since selection, which takes place by means of the camshaft 41 and flexing element 65, is then independent of the position of the draw knife. Relatively long intervals of time are therefore available for the operation of the elements 65.

Referring to FIG. 3, wherein like reference characters indicate like parts as above, instead of selecting warps to be raised, the single-lift jacquard mechanism can select the warps which are brought to the lower shed by means of the hooks 27 while the remaining warps remain in the upper shed. To this end, catches 89 are provided on the hooks 27 to cooperate with springs 91 so that when the springs 91 are in the position shown, the hooks 27 can move upwards if desired, whereas downward movement is prevented because the catch 89 bears on the spring 91. Each spring 91 is fixed at one end to a jack 93 which is pivotally mounted at the bottom 95 of a recess in a fixed portion 97 of the jacquard mechanism 29. In addition, a spring 99 bears on an element 98 of the portion 97 and is fixed at one

end to the jack 93 and urges the upper end of the jack 93 onto a camshaft 101.

A flexing element 65 is fixed to the portion 97 below a projection 103 on the jack 93. This flexing element 65 can be bent back and forth freely whenever a lobe on the camshaft 101 urges a projection 105 of the jack 93 firmly onto the element 98. The catches 85 in this embodiment are on the draw knife 33 itself instead of one risers.

In operation, after a pick, selected hooks 27 are in the lower shed or lowered position whereas the others remain in the upper shed or raised position (FIG. 3) due to cooperation of their catches 89 with the springs 91. In order to carry out another selection operation, all the hooks 27 are raised by means of the draw knife 33 which is shown in its bottom dead-center position until the catches 89 are above the springs 91. Meanwhile, the lobe on the camshaft 101 bears on the upper ends of all the jacks 93 so that the projections 103 are moved out of the range of the elements 65. The elements 65 are then bent in accordance with the pattern. As the camshaft 101 continues to rotate, the lobe moves out of engagement with the ends of the jacks 93 so that the projections 103 of those jacks whose associated elements 65 take up the position shown in FIG. 3 bear on the elements 65. Those jacks 93 whose associated elements 65 have been pivoted out of range of the projections 103 have their upper ends pushed by the compression springs 99 onto the low portion of the camshaft 101. These jacks 93 are therefore pivoted so far to the right in FIG. 3 that their springs 91 move out of range of the projections 89.

After completion of this selection operation, the draw knife 33 is lowered again. As a result, the selected hooks 27 are pulled right down by the weights or springs 25 whereas the remaining hooks are held in a position corresponding to the upper shed by the springs 91. After the draw knife 33 has dropped, the next pick takes place.

Referring to FIG. 4, a conventional double-lift jacquard mechanism uses double hooks 107 to form a shed in accordance with a pattern. Such jacquard mechanisms, unlike single-lift jacquards, have two oppositely acting draw knives 109, 110 to control each hook, so that a pick can take place after every downward motion of one draw knife, and every upward motion of the other. The conventional double hooks 107 used, each comprises a metal strip bent into a U-shape, the upper end of which carries two hook members 112, 113 which cooperate with corresponding hook members on the draw knives 109, 110. Each hook 107 also has a catch 115 which can come to rest on a projection 117 during the downward movement of the hook 107 but which in no way impedes upward movement of the hook 107. In addition, each hook 107 is guided in a horizontally movable control rod 119. By suitably displacing this control rod 119, the catch 115 can be made, or not made, to come to rest on a projection 117 during the downward motion, and the hook members 112, 113 can be made, or not made, to engage with the hook members on the draw knives 109, 110 as the latter moves upward.

Jacquard mechanisms with double hooks of this type are also called open-shed jacquard mechanisms, since with such mechanisms the warp threads which are to remain raised (or lowered) for a plurality of successive

picks remain in the upper (lower) shed without being raised or lowered in the meantime.

Operation of such a mechanism is as follows.

If one of the draw knives is in the bottom dead-center position and the other in the top dead-center position, only the upper draw knife engages one of the hook members 112, 113 of the double hooks (cf. FIG. 2). At this time, another selection operation takes place, the control rod 119 being moved to the left or right in FIG. 4.

The following selection possibilities exist. If a double hook 107 is down and the draw knife 109 on the right in FIG. 4 is in the bottom dead-center position, the control rod 119 is moved to the right if the hook is to remain lowered, and to the left if the hook is to be raised when the right-hand draw knife 109 moves upwards. The same would apply, *mutatis mutandis*, if the left-hand draw knife 110 is in the bottom dead-center position instead of the right-hand draw knife. If a double hook is raised and is to remain raised, the control rod 119 must be in its left-hand position, since the catch 115 must engage the projection 117 the next time the associated draw knife moves downward. If a raised hook 107 is to be lowered, however, the control rod 119 is moved to the right so that the catch 115 moves away from the projection and the hook is pulled downwards by the springs 25 when the associated draw knife drops. While the control rod 119 is moving to the right the resilient double hooks are deflected, since they continue to be latched onto the associated draw knife in the upper shed.

Referring to FIG. 5, wherein like reference characters as above indicate like parts, in order to move the control rod 119 according to the position of a flexing element 65 controlled by a pattern, a lever 121 is pivotally mounted at 123 on a fixed part of the jacquard mechanism and is biased to the left as viewed by a spring 127 mounted in a fixed part 155 of the jacquard mechanism. The lever 121 carries a spring 125 which engages in a recess in the control rod 119. If the lever 121 has been pivoted into the position shown in FIG. 5, under the action of the spring 127, the control rod 119 is pulled far enough to the left for the catch 115 to run against the projection 117 on the fixed part 155 during the downward motion or for one of the hook members 112, 113 of the hooks 107 to engage on the corresponding draw knife during the upward motion. Only one draw knife 110 is shown since the other draw knife is outside the drawing shortly before the upper dead-center position is reached.

If the lever 121 is pivoted into its other position, overcoming the action of a spring 127, the control rod 119 is moved to the right so that the catch 115 cannot hit the projection 117, and engagement of a draw knife with either of the hook members 112, 113 is prevented.

The limit positions of the control rod 119 can be maintained by means of a hook-like detent 129, according to whether this detent lies to the right or to the left of a projection 131 on the control rod 119. This retaining action is cancelled if a pivotally mounted lever 133, to which the detent 129 is fixed, is pivoted against the action of a spring 135 mounted in the jacquard mechanism away from the projection 131. Pivoting of the lever 133 can be controlled by the draw knife 110, which for this purpose, carries a curved control surface 137 on which slides a projecting portion 139 of the

lever 133. The surface 137a is such that the lever 133 is pivoted to the right when the draw knife 110 is in the top or bottom dead-center positions and to the left when the draw knife 110 is between these two positions.

The position into which the lever 121 is pivoted is determined by the position of a jack 141 which is pivotally mounted at 143 on a fixed part of the jacquard mechanism so as to pivot against the action of a compression spring 145 mounted in the fixed part 155 and whose upper end carries a member 149 by way of a movable connection, for example, a flat spring 147. When the jack 141 is in the position shown in FIG. 5, the member 149 is between one end of the lever 121 and a continuously rotating camshaft 151 which extends over the entire width of the machine. If the jack 141 is pivoted to the right, so that the upper portion bears on an oblique surface 153 of the fixed part 155, the member 149 is drawn out of the operative range between the lever 121 and camshaft 151.

The position into which the jack 141 pivots depends partly on the position of the cam lobe and partly on the flexural condition of the flexing element 65. If the cam lobe runs onto a projection 157 on the jack 141, a projection 158 of the jack 141 is pushed down. At this moment, the flexing element 65, which is clamped into a fixed part 159 of the jacquard mechanism, can be bent into one of the two positions shown in FIG. 5. If the element 65 is bent into the position shown by broken lines, the jack 141 pivots (when the cam of the camshaft 151 slides off the projection 157) so that the upper end bears on the oblique surface 153 under the bias of the spring 145. When the cam subsequently moves past the lever 121, therefore, there is no effect.

However, if at the moment stated above, the element 65 is in the position shown by solid lines, the foot 158 of the jack 141 bears one bottom end of the element 65 as soon as the cam slides off the projection 157. The jack 141 therefore remains in the position shown in FIG. 5 so that the cam lobe of the camshaft 151 lifts the member 149 upon passing the lever 121. As a result, the lever 121 is pivoted contrary to the action of the spring 127 and tends to shift the control rod 119 to the right. In order to protect the flat spring 147, a sheet 160 may be provided between the member 149 and the camshaft 151 so that no tangential forces act on the member 149.

The double-lift jacquard mechanism described operates as follows.

If the draw knife 110 is in the upper or lower dead-center position, the control rod 119 can be moved since the lever 133 has been pivoted out of the way. At the same time, or even earlier, the flexing element 65 can be bent in accordance with the pattern, without having to overcome mechanical forces (since the projection 158 has been pivoted out of its range by the cam lobe of the camshaft 151). After bending, this condition is mechanically stored because the jack 141 takes up one of two pivoted positions. In accordance with the pivoted position, the camshaft 151, member 149, lever 121 and spring 125 set one of the two positions of the control rod 119. The position reached is then maintained by the lever 133 when the upward or downward motion begins, until the draw knife 110 is close to its next dead-center position.

The principal advantage of a selector mechanism of this kind is that during the subsequent motion of the

draw knife, the information concerning a particular position of the control rod 119, information originally sensed by the flexing element 65, is durably, mechanically stored by the lever 133, so that immediately after the information has been stored, the element 65 can be released for the next selection operation.

Referring to FIG. 6, wherein like reference characters indicate like parts as above, the control rod 119 is mounted in fixed member 161 which also carries the projection 117 and a recess 163. Also, a return spring 165 is fixed to the member 161 to project through the recess 163 into a slot in the control rod 119. In addition, a control spring 169 is pivotally mounted on a fixed member of the jacquard mechanism at 171 to act via the top 167 thereof on one end of the control rod 119. The bottom end of the control spring 169 is pivoted by means of a cap 173 on a flexing element 65, the upper end of which can be bent perpendicularly to the plane of the drawing. The top 167 of the control spring 169 bears on a curved control surface 175, which is fixed to one draw knife and which carries two projections 177, 179 which are level with positions corresponding to the two dead-center positions of the draw knife 110.

This mechanism operates as follows.

If the draw knife 110 reaches its upper or lower dead-center position, the top 167 of the control spring 169 and, with the latter, the freely movable control rod 119 are moved to the right. If during the subsequent upward or downward movement of the draw knife 110, the top 167 of the control spring 169 slides back onto the recessed portion of the surface 175 between the projections 177, 179, the control rod 119 is brought back into its initial position by the return spring 165.

If the control rod 119 is not to be moved to the right, the control spring 169 is pivoted at right angles to the plane of the drawing by the element 65 at the moment of selection (that is, when the top 167 is at a point between the two projections 177, 179), with the result that the top 167 is no longer between the control rod 119 and control surface 175.

In order to keep the forces which the element 65 must apply in order to pivot the control spring 169 to a minimum, the spring 169 is mounted at 171 to have two arms of approximately equal weight while the top 167 touches neither the control surface 175 nor the end of the control rod 119 when between the two projections 177, 179. The control spring 169 is therefore arranged to be substantially "freely swinging", like the flexing element 65.

A prime advantage of this embodiment is that it does not require either a camshaft or a retaining mechanism. The times at which selection can take place and at which the information sensed by the flexing element is stored in the control rod 119 are determined solely by the length of the control surface 175 and projections 177, 179 in the direction of movement of the draw knife 110.

Referring to FIG. 7, the jacquard mechanism can alternatively be provided with a camshaft 181 which cooperates with one arm 182 of a jack 185, with a slider 187 and with the control rod 119. In this case, the jack 185 is pivotally mounted at 183 in the jacquard mechanism while the slider 187 slides in a guide in a fixed portion 189 of the mechanism and itself contains a guide for the control rod 119. In addition, a compression spring 191 is fixed to the control rod 119 and is pro-

vided between the end of the control rod 119 and the bottom of the guide in the slider 187. A projection on the left-hand end (as viewed) of the slider 187 slides along the control surface 175.

The control rod 119 also contains a slot in which a lug 193 on the right-hand arm of the jack 185 can engage in order to retain the control rod 119 in position. Below the right-hand arm of the jack 185 is a flexing element 65. When the element 65 is in the position shown by solid lines, the jack 185 is prevented from being pivoted by a compression spring 195 supported on the fixed member 189 of the jacquard mechanism.

Lastly, the control rod 119 contains a recess 197 in which the cam of the camshaft 181 can engage. This recess 197 is shaped so that the control rod 119, when in the right-hand limit position, can be pushed to the left into a left-hand limit position by the cam on the camshaft 181, which rotates continuously in the direction of the arrow.

This apparatus operates as follows.

As long as the projection on the slider 187 is at a point between the projections 177, 179 of the curved control surface 175, the cam lobe on the camshaft 181 bears partly on the control rod 119, partly on the slider 187 and partly on the left-hand arm 182 of the jack 185. The jack 185 is thus prevented from pivoting and the flexing element 65 can be bent without having to overcome any mechanical force. If, following arrival of an electrical control signal, the element 65 takes up the position shown by solid lines in FIG. 7, the jack 185 is prevented from pivoting by the compression spring 195 when the cam has released the control rod 119, slider 187 and jack 185. As a result, the control rod 119 is retained and prevented from moving to the right, due to engagement of the lug 193 in the slot. When the draw knife 110 has reached a dead-center position and the projection on the slider 187 runs onto one of the projections 177, 179, the control rod 119 remains in the left-hand limit position although the slider 187 is shifted to the right against the action of the spring 191.

After the weft has been picked, the projection on the slider 187 slides back onto the recessed portion of the control surface 175, so that another selection operation can begin.

Should the flexing element 65 be brought into the position shown by broken lines in FIG. 7, the jack 185 pivots when the cam slides off the left-hand arm 182, so that the lug 193 releases the control rod 119. When the slider 187 runs onto one of the projections 177, 179 as the draw knife 110 reaches the next dead-center position, not only the slider 187 but also the control rod 119 are moved into their right-hand limit positions, since, in this case, the spring 191 acts as a power transmission element. After picking, the control rod 119 is returned into the left-hand limit position by the cam of the camshaft 181, so that the lug 193 re-engages in the slot when the cam tilts the jack 185 upwards.

The embodiments described above relate to direct displacement of the control rods after mechanical sensing of the position of the flexing elements, as opposed to the sensing of jacquard cards. However, cases will now be described in which flexing elements are used where jacquard cards were previously sensed by means of droppers. This amounts to indirect control of the control rods.

In two possible ways of selecting the droppers, the droppers are controlled instead of the hooks 27 in the embodiments shown in FIGS. 2 and 3, and suitable intermediate members are provided in order to assign a given hook position to each of the two conditions of the droppers controlled in accordance with FIG. 2 or FIG. 3.

Referring to FIG. 8, a much simpler control system can be provided in which a conventional apparatus is provided with droppers 219, on each of which a resiliently bendable auxiliary rod 221 is pivotally mounted as shown. The auxiliary rods 221 are guided in at least one stationary guide 223 with one end of each auxiliary rod 221 being disposed opposite a control rod 119. Thus, if an auxiliary rod 221 is pushed to the right, the opposed control rod 119 is pushed to the right, overcoming the action of a compression spring 225. The auxiliary rods 221 are moved by a pressure plate 227, which has a surface facing the auxiliary rods 221 containing regularly alternating projections 229 or recesses 231 and which is movable as indicated by an arrow H. Under the influence of the droppers 219, which are mounted so as to be movable in the direction of an arrow V, the left-hand ends of the auxiliary rods 221, as viewed, can be moved out of their normal positions, in which they are opposite projections 229, into an inoperative position in which they are opposite recesses 231. Healds 23 and weights 235 are fixed to the hooks 107.

In operation, when the pressure plate 227 moves to the right, as viewed, only those auxiliary rods 221 which are in their normal position move selected control rods 119 so that the double hooks 107 associated therewith move, for example, into the upper shed position, whereas all the other hooks move into the lower shed position. When the pressure plate 227 then moves to the left, the compression springs 225 return all the control rods 119 and auxiliary rods 221 to the left.

In known jacquard mechanisms, the droppers 219 are controlled by jacquard cards advanced step by step, the cards being situated beneath the droppers 219 and having perforations and solid areas. Before the selection operation, all droppers are raised by a mechanism (not shown) and then left to themselves, so that they fall into perforations or onto solid areas of the jacquard card as a result of gravity or spring tension. A given position of the droppers 219 or, after the pressure plate 227 has moved forwards, a given position of the control rods 119, is therefore allocated to each perforation or solid area of the jacquard card. However, in the structure shown in FIG. 8, the position of the flexing element 65 is sensed by means of the droppers. An element 65 which has not been deflected, such as the first, third and fifth elements 65, as shown, therefore has the same effect as a solid area of the jacquard card, whereas an element 65 deflected according to the pattern, such as the second and fourth elements 65, as shown, corresponds to a perforation in the jacquard card.

In the embodiments previously described, the sensing of the flexing elements and the application of the forces required have been effected by entirely mechanical means. However, a simple electropneumatic program control device can be used instead for the hooks 27 or double hooks 107. To this end, as shown in FIG. 9, two pneumatic pressure reservoirs 201 feed two lines 203, 205 containing constrictions 207. Both lines 203, 205

end directly above a plate 209 which is fixed to a flexing element 65 and which is moved to the right or left by means of this element 65. Respective branches 211, 213 connected to the lines 203, 205 lead to the two inlets of a double-acting actuator 215 having a piston rod 217 fixed to a hook 27 or 107, a control rod 119 and/or a heald 23.

Operation of this apparatus is both simple and reliable, since the use of compressed air does not require particularly good seals and also, due to the nature of the weaving process, only low frequencies arise.

The position of the element 65 is sensed pneumatically in this case. If the plate 209 is exactly central beneath the outlets of the lines 203, 205, the pressure in the lines 211, 213 are equal. Any interference with the symmetry due to bending of the element 65, however, produces an excess pressure in one of the lines 211, 213, so that the piston rod 217 is moved to left or right. Since the forces required to move the hooks 27, 107 control rods 119 or healds 23 are small, extremely small actuators 215 can be used.

Other pneumatic devices, for example, single-acting actuators whose piston rods are connected to return springs or the like, may be substituted for the actuator 215.

The invention is not restricted to the embodiments described, which merely give an indication of the many control possibilities available when the control or flexing elements are used in jacquard mechanisms.

The compression springs described may be replaced with suitable draw springs or permanent magnets of suitable size. Also, the jacquard mechanism may be situated below the loom, or part may be above and part below the loom. The healds may be selected by pushing them instead of pulling, and all the hooks may be arranged in a plurality of planes, possibly nesting, instead of in one plane perpendicular to the warp threads.

It should be noted that there is no need to replace conventional jacquard cards by other data carriers when flexing elements are used. A further advantage of the invention is that traditional jacquard cards can be read by means of photoelectric cells or the like and their output signals can be fed to the flexing elements in order to have the flexing elements actuated in correspondence with the programmed pattern on the cards.

Operation of the flexing elements is no problem since relatively long intervals are always available for producing bending. A particular advantage of piezoelectric or piezoceramic flexing elements is their satisfactory storage properties, which permit the use of short-duration control signals which even after decay still give rise to the desired position.

Preferably, in order to prevent those flexing elements which have reached their selecting positions, but whose positions have not yet led to selection of the associated hooks, from swinging freely back if the machine is switched off or if the voltage fails, contact rails 199 (FIG. 7) are provided, on which the flexing elements bear in both their limit positions. Retaining voltages are applied automatically to these rails 199, if the machine is switched off or if the main battery fails, to maintain the information stored in the flexing elements until the machine or main battery is switched on again.

Lastly, the flexing elements can store information either by bending to either side of their normal positions

or by moving out of one deflected position into the opposite limit position. If necessary, moreover, they may receive resetting signals so that they resume their normal positions sooner.

What is claimed is:

1. A jacquard mechanism for weaving machines comprising a plurality of hooks;

non-load bearing control elements responsive to the of an electric field and a magnetic field to move from a first position to a second position for initiating selection of said hooks in a predetermined pattern for selective raising and lowering, said control elements being mounted for freely swinging and being active flexural swinging elements; and

means for raising and lowering said hooks, said means including means for mechanically sensing the position of one of said control elements, said latter means being movable into a selective one of two positions, one of said positions preventing selective raising or lowering of said hooks and the other of said positions allowing selective raising or lowering of said hooks.

2. A jacquard mechanism for a weaving machine comprising:

a plurality of lifting hooks;

means for raising and lowering said hooks;

non-load bearing control elements responsive to one of an electric field and a magnetic field to move from a first position to a second position without performing work, one of said positions being interposed in the path of said means to prevent raising or lowering of said hooks and the other position being spaced from said path to allow raising or lowering of said hooks;

sensing means for sensing the presence of said control elements in one of said positions; and

means for initiating selection of the hooks to be raised or lowered in response to said sensing means.

3. A jacquard mechanism as set forth in claim 2 wherein each control element is formed of a magnetostrictive substance.

4. A jacquard mechanism as set forth in claim 2 wherein each control element is formed of an electrostrictive substance.

5. A jacquard mechanism as set forth in claim 2 wherein each control element is formed of an extruded piezoceramic material.

6. A jacquard mechanism as set forth in claim 2 wherein each control element has an end cap of a wear resistant material thereon.

7. A jacquard mechanism as set forth in claim 2 wherein each control element is mounted in a cantilever manner.

8. A jacquard mechanism as set forth in claim 2 wherein said sensing means mechanically senses the presence of said control elements in said positions.

9. A jacquard mechanism as set forth in claim 2 wherein sensing means pneumatically senses the presence of said control elements in said positions.

10. A jacquard mechanism as set forth in claim 2 which further comprises a limiting means for selectively holding said control means in said positions during deactivation of said mechanism, said limiting means including a pair of oppositely disposed contact rails.

11. A jacquard mechanism as set forth in claim 2 wherein said sensing means includes a pivotally

mounted lever for pivoting into a selective position against a respective control element when in one of said positions and past said respective control element when in the other of said positions.

12. A jacquard mechanism as set forth in claim 11 wherein said sensing means further includes a rotatable cam shaft having a cam thereon for abutting and for pivoting each said lever away from said respective control element to permit flexing of said respective control element.

13. A jacquard mechanism as set forth in claim 11 wherein said mechanism is a single-lift mechanism.

14. A jacquard mechanism as set forth in claim 13 wherein said means for raising and lowering said hooks includes a draw knife for each control element and hook, said riser being displaceable perpendicularly of said draw knife and having a means at one end to engage a respective hook, said lever being slidably connected to said riser to move said riser relative to said draw knife towards and away from said respective hook.

15. A jacquard mechanism as set forth in claim 13 which further comprises a wedge-shaped portion on said riser in facing relation to said lever for movement of said lever on selective opposite sides thereof.

16. A jacquard mechanism as set forth in claim 11 which further comprises a spring fixed to said lever for movement into and out of the path of a respective hook in response to the position of a respective control element.

17. A jacquard mechanism as set forth in claim 11 wherein said mechanism is a double-lift mechanism.

18. A jacquard mechanism as set forth in claim 17 wherein said sensing means further includes a rotatable camshaft having a cam thereon for abutting and pivoting each said lever away from said respective control element to permit flexing of said respective control element and wherein said means for initiating selection includes a control rod connected to a respective hook and operatively connected to said camshaft for movement in response to rotation of said camshaft.

19. A jacquard mechanism as set forth in claim 18 wherein said means for initiating selection further includes a second pivotally mounted lever between said camshaft and said control rod, said second lever being connected to said control rod to move said control rod in response to pivoting thereof upon rotation of said camshaft.

20. A jacquard mechanism as set forth in claim 19 further comprising a member fixed to said rocking lever for movement therewith into and out of a position between said camshaft and said second lever to selectively prevent and permit pivoting of said second lever in response to rotation of said camshaft.

21. A jacquard mechanism as set forth in claim 19 which further includes a spring fixed to said second lever and disposed in a slot in said control rod to connect said second lever to said control rod.

22. A jacquard mechanism as set forth in claim 20 wherein said means for raising and lowering said hooks includes a movably mounted curved control surface and retaining means abutting said surface to retain said control rod in one of two limit positions thereof.

23. A jacquard mechanism as set forth in claim 22 wherein said control rod includes a detent and said retaining means includes a pivotally mounted lever having one end including a detent thereon disposed in

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abutment with said detent of said control rod to one side thereof.

24. A jacquard mechanism as set forth in claim 18 wherein said control rod includes a recess receiving said camshaft therein.

25. A jacquard mechanism as set forth in claim 24 which further includes a slider disposed on one end of said control rod, a compression spring between said one end of said control rod and said slider and wherein said means for raising and lowering said hooks includes a movably mounted curved control surface in abutment with said slider and wherein said lever includes a lug for reception in a recess of said control rod to prevent movement of said control rod with a respective control element in one of said positions during movement of said curved control surface.

26. A jacquard mechanism as set forth in claim 2 wherein said mechanism is a double lift mechanism having a displaceable control rod connected to a respective hook and to a respective control element.

27. A jacquard mechanism as set forth in claim 26 further comprising a pivotably mounted control spring selectively connected to a respective control element and selectively disposed adjacent said control rod for movement into and out of the path of said control rod, and means for selectively moving said control spring against said control rod when in said path to move said control rod.

28. A jacquard mechanism as set forth in claim 27 wherein said control spring is pivotably mounted to swing freely during movement of said respective control element.

29. A jacquard mechanism as set forth in claim 27 wherein said means for selectively moving said control

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spring includes a movably mounted curved control surface on said means for raising and lowering said hooks, said control spring includes a head between said surface and said control rod.

30. A jacquard mechanism as set forth in claim 29 which further includes a return spring for moving said control rod towards said control spring into a limit position.

31. A jacquard mechanism as set forth in claim 2 wherein said sensing means includes a plate fixed to a free end of a control element, a pair of pneumatic lines having outlets facing said plate, each line being responsive to movement of said plate to change the air pressure therein and connection means connected between said lines and said means for raising and lowering said hooks to actuate said latter means in response to a change in air pressure in said lines.

32. A jacquard mechanism as set forth in claim 31 wherein said connection means includes a branch connected to at least one of said pneumatic lines, and wherein said means for raising and lowering said hooks includes an actuator having a piston rod therein connected to said branch for movement of said piston rod in response to a change in pressure, said piston rod being connected to a respective hook.

33. A jacquard mechanism as set forth in claim 2 wherein said mechanism is a dropper type having a dropper disposed above a respective control element for movement into one of two positions in dependence upon the position of said respective control element.

34. A jacquard mechanism as set forth in claim 2 further comprising means for flexing said control elements from said first position to said second position.

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