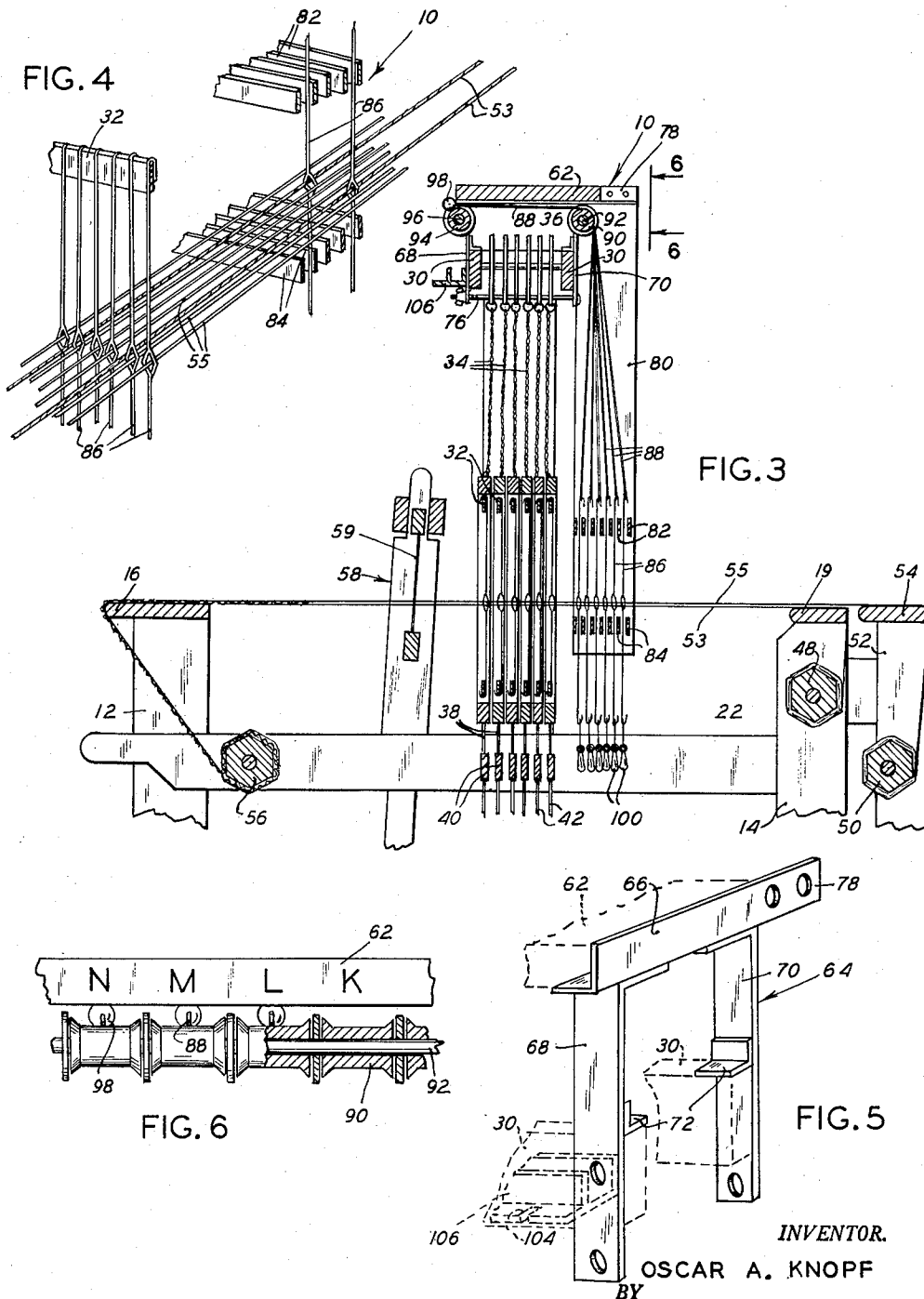


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MULTIPLE HARNESS ATTACHMENT FOR A LOOM

Filed March 31, 1958

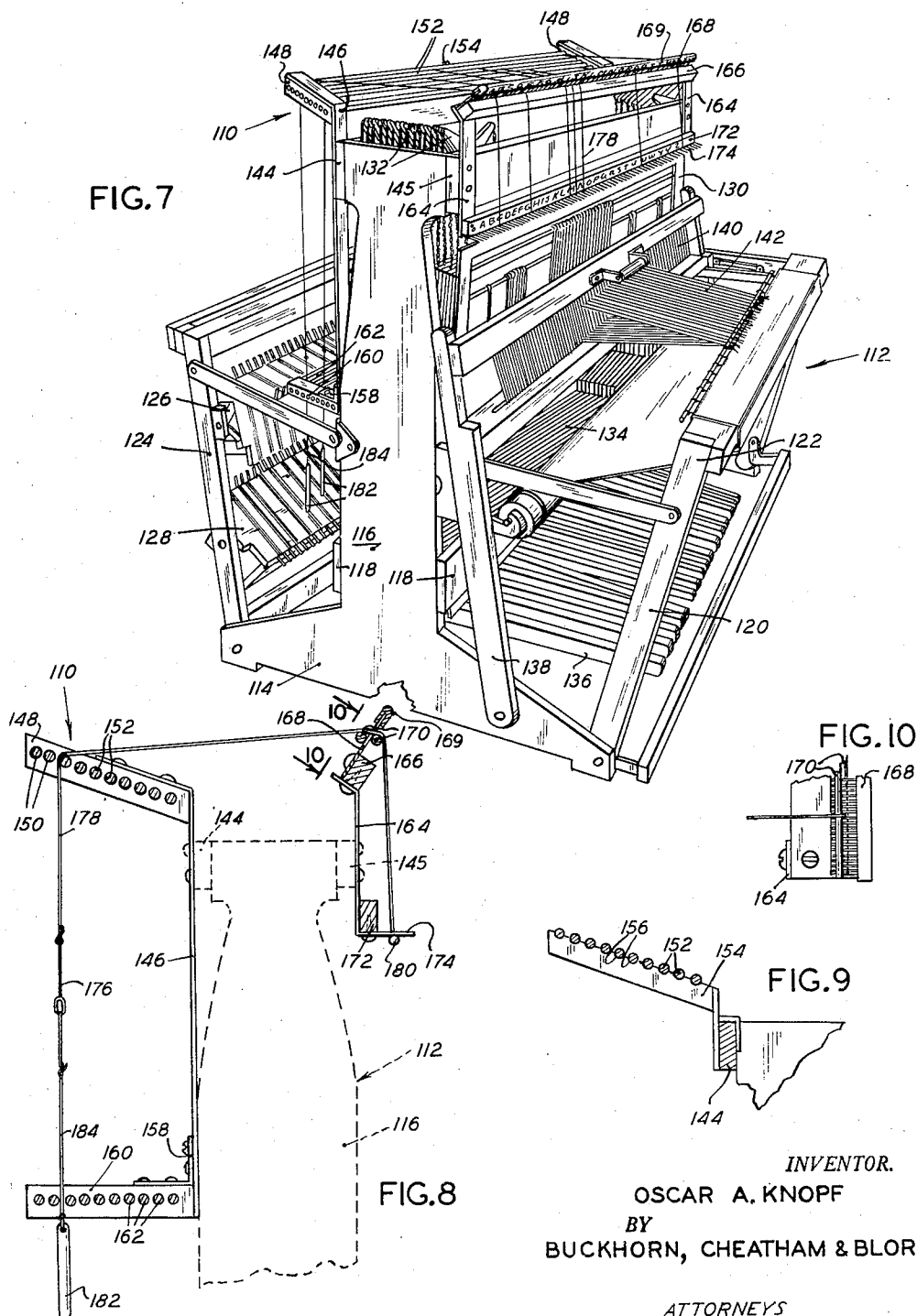
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ATTORNEYS

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MULTIPLE HARNESS ATTACHMENT FOR A LOOM

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MULTIPLE HARNESS ATTACHMENT FOR A LOOM

Oscar A. Knopf, Winston, Oreg.

Application March 31, 1958, Serial No. 725,272

12 Claims. (Cl. 139—29)

This application is a continuation in part of my copending application Serial No. 654,810, filed April 24, 1957, now abandoned. The invention relates to a multiple harness attachment for a loom and more particularly to an attachment which may be easily installed upon or removed from a conventional hand loom and by which substantially any desired pattern not limited to pattern blocks can be produced as part of or independently of the weave of the cloth, the attachment being capable of producing patterns in which the detail can be small as an individual loop of a single weft or warp thread brought to a surface of the cloth being woven. The invention also relates to an improved heddle and heddle frame arrangement for the main heddles of the loom which is particularly useful with the attachment of the present invention.

Hand looms for pattern weaving are usually draw looms and, in general, such looms include a plurality of main heddle frames mounted in a castle structure and also a plurality of auxiliary or supplemental heddle frames positioned behind the main heddle frames. The main heddle frames are selectively raised through lams by a plurality of pedals and the auxiliary heddle frames are elevated by pull cords extending over the top of the castle structure into reach of the operator of the loom. The number of auxiliary heddle frames is limited by space requirements such that patterns woven on the loom are, in general, limited to the weaving of pattern blocks of substantial size so that fine detail in the pattern cannot be produced in a loom of reasonable size.

On the contrary, the attachment of the present invention enables either individual auxiliary heddles or any desired combination of such heddles to be elevated or lowered at any one time so as to produce substantially any desired pattern in substantially any detail desired. Thus by employing the auxiliary heddles to raise warps not controlled by the main heddle frames and elevating an individual auxiliary heddle or a selected group of such heddles, an individual warp or selected group of warps can be brought to the upper surface of the cloth being woven for any desired pick and such warps may be of some distinctive color or be of a distinctive type of yarn or cord. On the other hand, by elevating all of the auxiliary heddles except an individual auxiliary heddle or a selected group of such heddles, the weft of a given pick can be brought to the upper surface of the cloth being woven and the weft of such pick may be of any desired color or type to form the desired pattern. Similarly, any desired portion of a warp or weft can be brought to the lower surface of the cloth. Instead of employing all of the auxiliary heddles to independently control warps not controlled by the main heddle frames, a part or all of the warps controlled by the auxiliary heddles may also be controlled by the main heddle frames. This is made possible by employing the improved heddles of the present invention, which heddles also enable an improved heddle frame operating arrangement to be employed by which patterns or weaves normally requiring a much larger number of heddle frames

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can be produced. The weave or texture of the cloth being woven is, in general, set by the treadle sequence for the successive picks and by the connections of the pedals through the lams to the various heddle frames of the main heddle frame structure. The present attachment, however, enables the loom to be set up to produce a very wide variety of patterns either as part of the weave of the cloth or superimposed upon the weave of the cloth and such attachment requires much less space than the more limited auxiliary heddle frames of conventional draw looms.

It is therefore an object of the present invention to provide an improved attachment for hand looms by which a greater variety of patterns and greater detail of such patterns can be produced in such looms.

Another object of the invention is to provide an attachment for hand looms enabling the production of substantially any desired pattern, which attachment may be readily installed on conventional hand looms and removed therefrom.

Another object of the invention is to provide an attachment for hand looms which enables the operator thereof to elevate individual heddles forming part of the attachment or to elevate substantially any desired combination of such heddles so as to produce a desired pattern on either the upper surface or the lower surface of the cloth being woven or on both surfaces of such cloth, either by distinctive warp threads upon the surface of the cloth or distinctive weft threads upon such surface.

Another object of the invention is to provide an improved heddle and heddle frame arrangement by which patterns or weaves normally requiring a much larger number of main heddle frames can be produced.

A further object of the invention is to provide an improved attachment for hand looms by which the pattern woven into or superimposed upon either or both surfaces of the cloth may be varied in substantially any desired manner as the weave progresses in order to produce any desired pattern in substantially any weave or detail desired.

Other objects and advantages of the invention will appear in the following description of the preferred embodiment of the invention shown in the attached drawings of which:

Fig. 1 is an isometric view of the front and side of a hand loom with one form of the attachment of the present invention in position thereon;

Fig. 2 is a similar isometric view on an enlarged scale of the attachment of Fig. 1 removed from the loom;

Fig. 3 is a central vertical section on an enlarged scale through the upper portion of the loom of Fig. 1 with the attachment of Figs. 1 and 2 in place;

Fig. 4 is a detailed, fragmentary, isometric view on a still larger scale showing the relative location of the main heddle frames and of the auxiliary heddles of the attachment of Figs. 1 to 3;

Fig. 5 is an isometric view on a still larger scale of one of the brackets for securing the attachment of Figs. 1 to 3 to the loom and supporting the various portions of the attachment;

Fig. 6 is a fragmentary back view of the upper back portion of the attachment of Figs. 1 to 3;

Fig. 7 is a perspective view showing the front and side of another form of hand loom having a modified form of attachment in accordance with the present invention;

Fig. 8 is a vertical cross section through the attachment of Fig. 7 taken longitudinally of the loom and showing the castle of the loom in dotted lines;

Fig. 9 is a fragmentary vertical cross section through the upper rear portion of the castle of the loom on a plane parallel to the plane of the section of Fig. 8;

Fig. 10 is a fragmentary plan view showing a front corner of the front portion of the attachment of Fig. 7 looking in the direction of the arrows 10—10 of Fig. 8;

Fig. 11 is a side elevation of the improved heddle of the present invention on an enlarged scale;

Fig. 12 is a diagrammatic view on an enlarged scale illustrating possible positions of main and auxiliary heddles controlling a single warp;

Fig. 13 is a view similar to Fig. 12 illustrating other positions of the heddles;

Fig. 14 is another view similar to Fig. 12 illustrating another position of the heddles;

Fig. 15 is another view similar to Fig. 12 illustrating still another position of the heddles;

Fig. 16 is a diagrammatic view on a small scale illustrating a possible arrangement of the heddles of Figs. 11 in a plurality of heddle frames;

Fig. 17 is a diagrammatic view illustrating a possible connection of the treadles to the heddle frames of Fig. 16; and

Fig. 18 is a diagrammatic view illustrating a possible manner of threading warp through auxiliary heddles and main heddles.

In the drawings, an attachment 10 in accordance with the present invention is shown separately in Fig. 2 and in place on the loom in Figs. 1 and 3. The loom may be of any known or suitable construction, the particular loom shown in Fig. 1 being of the type usually employed for counterbalance heddle frame operation in which one main heddle frame is raised while another is lowered to form a shed but which loom has been converted to "jack" loom operation in which selected main heddle frames are raised only to form the shed. Such loom has a frame including front uprights 12 and rear uprights 14 connected together by front cross members 16 and 18, rear cross members 19 and 20, and upper and lower side frame members 22 and 24, respectively. The loom is provided with a conventional castle structure 26 having upright side members 28 mounted upon the upper side frame members 22 and also having cross members 30 connecting the tops of the side members 28. A plurality of heddle frames 32 are supported in the castle structure by chains 34 at each side of the castle structure. The chains are connected between the ends of the heddle frames 32 and the inner ends of heddle lifting arms 36 in the form of bell cranks journaled on pivot members extending between the cross members 30 of the castle structure. Such heddle lifting arms have their other ends connected by means of cords 38 to lams 40 shown in Fig. 3, the lams 40 extending laterally across the loom below the heddle frames 32 and being selectively connected by cords 42 to any one or more of pedals 44 (Fig. 1) pivotally supported upon a sub frame 46 connected to the front lower cross member 18. It will be understood that there are a pair of heddle lifting arms 36 and a lam 40 associated with each heddle frame 32.

The particular loom selected is shown as having six heddle frames and also as having two separate warp drums 48 and 50, the warp drum 48 being journaled in the upright frame members 14 and the warp drum 50 being journaled in another pair of upright side members 52 spaced rearwardly of the upright members 14. The loom may thereby be threaded with separate sets of warps, the cross member 19 constituting a thread beam for the warp 53 from the drum 48 and another cross member 54 extending between the upright members 52 constituting a thread beam for the warp 55 from the drum 50. The drum 50 is usually referred to as the ratchet drum and in conventional looms will ordinarily have a ratchet mechanism (not shown) for controllably releasing the drum for rotation. The drum 48 is usually referred to as the brake drum and in a conventional loom will ordinarily have a brake mechanism (not shown) for applying adjustable tension to the warps being drawn therefrom. The cloth woven in the loom passes over the front

upper cross member 16 which functions as a breast beam and is wound upon a cloth drum 56 journaled in the side members 22. The loom also includes a conventional batten or beater mechanism 58 provided with a reed 59 through which the warp passes and which batten is pivoted at 60 to the lower side members 24.

The attachment of the present invention includes an upper cross member 62 secured at each of its ends to a bracket member 64 shown most clearly in Fig. 5 as having an upper member 66 extending longitudinally of the loom and two downwardly extending loom engaging members 68 and 70. The loom engaging members 68 and 70 each have inwardly directed portions 72 which engage and rest upon the top surfaces respectively of the cross members 30 of the castle structure 26. The brackets 64 are clamped in position by means of bolts 76, shown most clearly in Fig. 3.

The upper member 66 of each bracket 64 has a rearwardly extending portion 78 (Figs. 2 and 5) to which is secured a downwardly extending heddle guide supporting member 80. The members 80 form supports for upper guide bars 82 and also for lower guide bars 84. The bars 82 and 84 extend laterally of the loom and the bars in each set of bars are spaced from each other in a direction longitudinally of the loom to provide slots in which auxiliary heddles 86 are guided. Any desired number of guide bars 82 and 84 may be provided and any desired number of auxiliary heddles 86 may be positioned in appropriate slots between the guide bars. Such auxiliary heddles may be attached to pull cords 88 at their upper ends, the cords 88 extending upwardly and over a series of small pulleys or spools 90 which are journaled for rotation about a common axis provided by a shaft 92 extending laterally of the loom and secured to the downwardly extending member 70 of the bracket 64. The cords 88 are then directed forwardly and over a set of similar pulleys 94 journaled on a shaft 96 secured to the downwardly directed member 68 of the bracket 64. The pulleys 90 and 94 constitute a plurality of cord guides adjacent the top portion of the attachment for receiving the heddle raising cords. The cords 88 terminate in enlarged beads 98 and the pulleys 94 are sufficiently close to the top member 62 of the attachment 10 that the beads 98 are held from rearward motion underneath the top 62. This positions the heddles 86 in the position shown in Fig. 3, such heddles being held in their downward positions by means of weights 100. As indicated in Figs. 1 and 2, individual heddles 86 may be connected to individual cords 88 or if desired, small harnesses 102 may be employed to connect any selected group of heddles to a single cord 88. It will be apparent that any desired number of harnesses, such as the harnesses 102, may be employed and that various numbers of heddles may be connected to a single cord 88 by such a harness. As indicated in Fig. 2, several cords having beads 98 may be trained over a single pulley 94 and it will be apparent that such several cords may be trained over a single pulley 90. Pulling the cords 88 by means of the beads 98 raises individual heddles 86 or groups of such heddles attached thereto and such heddles can be held in raised position by engaging the ends of the respective cords in notches 104 on a cross bar 106 positioned below the pulleys 94 and having its ends secured to the members 68 of the brackets 64. The beads 98 engage below the bar 106 to hold the ends of the cords with the respective heddle in the raised position. Thus each of the cords have one end attached to a heddle or groups of heddles and the notches 104 in cross bar 106 constitute holding means for the other ends of the heddle cords.

In threading the loom illustrated, the warp from one of the warp drums, for example, the warp 55 from the drum 50 may be passed through the eyes in selected heddles supported in the heddle frames 32, whereas the warp from the other warp drum, such as the warp drum 48, may be passed through the eyes in the heddles 86.

All of the warp will then be passed through the reed of the beater 58 and over the breast beam 16 to the cloth drum 56.

In weaving cloth upon the loom illustrated, with the attachment of the present invention thereon, the weave or texture of the cloth will be determined by the order of the operation of the pedals 44 to raise selected heddle frames 32 and thus raise selected warps 55 while leaving selected warps 55 in the lower positions. Raising of such selected warps will form a shed through which a shuttle (not shown) will be passed. After each pick the batten 53 is moved toward the front of the loom in a conventional manner to compact the weft threads against each other and form the cloth. The attachment of the present invention is employed to produce a pattern at or upon a surface of the cloth and to accomplish this on the upper surface with warp threads, selected heddles or groups of heddles 86 are raised by the pull cords 88 to raise selected warps 53 passing through such heddles 86 in order to bring such warps to the upper surface of the cloth. Such warps may be of distinctive color or of a distinctive material to form the pattern. Alternatively, a weft pattern may be formed on the upper surface by raising all of the heddles 86 except certain selected ones of such heddles so as to bring to the upper surface selected portions only of a weft thread. In such cases, the particular weft may be of a distinctive color or a distinctive type of thread. For forming patterns upon the lower surface, auxiliary heddles are operated in a manner which is the reverse of that just described. It will be apparent that the weave will have to be such as to provide tying or stitching threads for long floats of either warp or weft on the upper surface of the cloth.

When forming a pattern from the warps passing through the heddles 86, a large number of warps of different colors or of different types may be employed, since a large number of heddles 86 can be accommodated in the guides formed by the bars 82 and 84. By using a large number of small harnesses, such as the harnesses 102, the block patterns of conventional hand looms may be easily produced and by employing a large number of individual heddles 86 connected to separate cords 88, it is possible to produce on the surface of the cloth a design in which the detail may be as fine as that produced by the bringing of a selected auxiliary warp to the surface over one weft thread only. The same order of detail can be produced with patterns formed with the weft.

As a specific example, a loom having the attachment of the present invention may be employed for the weaving of multiply fabrics having a pattern on both surfaces. Thus a five-ply fabric, suitable for a rug, can be woven by employing two main heddle frames to produce a tabby weave in which small warp threads are rather widely spaced and in which the warp threads extend over alternate pairs of weft threads on each surface and also entirely through the fabric. Four layers of auxiliary warps controlled by the auxiliary heddles may extend straight through the fabric to divide the five plies. By manipulation of the auxiliary heddles to raise selected auxiliary warp threads or groups thereof, any desired portion of any selected weft thread may be buried within the fabric to form a part of an inner ply or may be brought to either surface to form a part of a surface ply and thus form part of a desired pattern on such surface. Portions of one or more other weft threads are employed to fill in or complete the pattern on the surface when the selected weft thread, referred to above, is buried in the cloth, the portions of such other weft not appearing on the surface also being buried in the cloth. However, a loom with the attachment of the present invention may be employed to weave fabrics of any desired numbers of plies including a single ply fabric and, as indicated above, the pattern may be superimposed upon a surface of any desired weave or type of cloth instead of forming an integral part of a ply of a single or multiple ply cloth.

In weaving on a loom with the attachment of the present invention, a design is usually first constructed on squared paper and the columns of the squares will ordinarily be assigned indicia, such as numbers or letters, and in order to enable such design to be worked out upon a loom, the pulleys 94 may likewise be assigned corresponding indicia. For example, the pulleys 94 may be identified by letters 108 (Fig. 2) on the front of the upper cross member 62 of the attachment. The notches 104 in the cross bar 106 for holding the ends of the cords 88 may likewise be correspondingly lettered in order to assist in keeping track of the cords. Similarly, the pulleys 90 at the back of the attachment may be correspondingly lettered as shown in Fig. 6 as an aid in threading the loom in the first instance.

In order to show sufficient detail in the drawings, the loom illustrated is shown as being provided with a much lesser number of main heddle frames and a much lesser number of auxiliary heddles and pull cords than would be found in large looms and it will be understood that a large number of pulleys may be employed, for example, twice the number of letters in the alphabet, in which case it is convenient to letter the pulleys both ways from the center of the loom. Furthermore, the present attachment may be employed with looms having a single warp drum or only one of the two warp drums need be employed, in which case part of the warp will be passed through selected heddles 86 and a part of the warp will be passed through selected heddles in the heddle frames 32. It will, of course, be apparent that the upper warp 55 in the loom shown may be passed through the heddles 86 while the lower warp 53 may be passed through the heddles in the heddle frames 32.

In general, after the loom has been threaded, the pedals 44 will be actuated in a definite sequence to form the basic weave. A shed will be formed upon the actuation of any pedal by lifting a portion of the warps passed through the heddles in the heddle frames 32. A shuttle containing a weft thread will then be passed through the shed at least once after each actuation of a pedal. The batten 58 will be appropriately actuated to compress the wefts into a cloth. Substantially independently of the basic weaving just described, individual warps or groups of warps controlled by the heddles 86 may be brought to the surface to form a pattern by raising the appropriate heddles 86 by the cords 88. Also selected portions of the weft being employed to form the basic weave or a special weft may be brought to the upper surface by raising all of the heddles 86 except a selected heddle or group of heddles to bring selected portions of a given weft to such surface. These operations will be reversed to form a pattern in the lower surface. A plurality of pull cords 88 may be trained over a single pulley 94, in which case the ends of the respective cords may be identified with different colored beads 98 and such colors may be employed upon the design sheet to differentiate between the various cords to be pulled to form the pattern.

The attachment of the present invention may be easily installed or removed at any time that warp is not present in the loom by merely attaching or detaching the brackets 64. This is accomplished by removing and re-installing the bolts 76. Also, the attachment may be left in place when weaving with the main heddles only without interfering with such weaving. Furthermore, by employing suitable brackets, the attachment may be adapted to various type of hand looms including those in which warp is raised only to form a shed, those in which warp is lowered only to form a shed or those in which a part of the warp is raised and another part lowered to form a shed. Thus, with the present attachment, the weaving capabilities of substantially any type of hand loom can be increased so that tapestries or other types of fabrics having detailed patterns can be woven.

A modified form of an attachment 110 in accordance

with the present invention is shown attached to a different type of loom 112 in Figs. 7 to 10, inclusive. The loom 112 includes base members 114 supporting upwardly extending castle members 116, the castle members being secured together by central cross members 118. A front frame structure 120 supporting a breast beam 122 is attached to the base members and castle members and a rear frame structure 124 supporting a pair of warp drums 126 and 128 as well as suitable thread beams, which are not shown in the drawing, is also attached to the base members and castle members. The loom is of standard construction and includes a plurality of heddle frames 130 which may be raised by rocker arms 132 pivoted in the castle structure and having one of their ends connected to the heddle frames by means of chains. The other ends of the rocker arms are connected by chains to lams 134 which are selectively connectable to treadles 136 so that any heddle frame 134 or any combination of such heddle frames can be raised by any treadle 136. The loom shown also includes a pivoted batten or beater 138 containing a reed 140 through which the warp 142 extends, one of the heddle frames 130 being shown as being raised to raise a portion of the warp and form a shed. The castle of the loom shown includes a pair of top cross members 144 and 145 extending between the upper ends of the castle members 116.

The attachment of Figs. 7 to 10 includes a pair of metal strap members 146 extending vertically along the rearward edge of each castle member 116 and rear surface of the rear cross member 144 so as to project somewhat above the top of such cross member 144. The upper ends of the metal strap members 146 are bent so as to incline upwardly and rearwardly and have secured to their lower surfaces a wooden block 148 having a plurality of holes 150 for receiving the ends of a plurality of cord guiding metal rods 152 extending between the wooden blocks 148 at the opposite ends of the castle structure. The rods 152 may be supported intermediate their ends by one or more spaced supplementary support members 154, one of which is shown most clearly in Fig. 9. Such support members may have a plurality of notches 156 in their upper surfaces in alignment with the holes 150 in the blocks 148 for receiving and supporting the rods 152 and the lower ends of such support members 154 may be secured to the rear cross member 144.

The lower end of the metal member 146 has secured thereto by means of an angle bracket 158 a second wooden block 160 having holes therein for receiving the ends of parallel heddle guiding metal rods 162, such metal rods also extending parallel to cross member 144 to thus extend laterally of the loom. Both the metal rods 152 and the metal rods 162 are spaced from each other laterally of such rods. The rods 162 are all positioned in the same horizontal plane but the rods 152 are positioned so that they are progressively higher in a direction toward the rear of the loom.

The attachment of Figs. 7 to 10 also includes metal members 164 secured to the upper front cross member 145 of the castle structure so as to extend vertically. The upper end of each of the members 164 is bent so as to be inclined upwardly and rearwardly and has secured thereto the end of a cross member 166 extending between the two metal members 164 above the cross member 145. The cross member 166 has a comb 168 secured to its upper and rearward surface so as to project upwardly and forwardly of the loom. As shown in Fig. 8, the comb 168 has a pair of cord guide rods 170 suitably secured to its upper and lower surfaces and has a notched member 169 covering the exposed ends of the comb elements. The forward lower surface of the member 169 may be provided with suitable indices, such as the letters of the alphabet, so as to indicate various sections of the comb 168.

The lower ends of the metal members 164 terminate somewhat below the cross member 145 and have secured thereto another cross member 172 similar to the cross member 166. The cross member 172 extends between the two metal members 164 and has secured to its lower surface another comb 174 which projects forwardly from the cross member and is positioned in a horizontal plane. The various elements of the attachment thus far described form supports and guides for auxiliary heddles 176 and for the heddle raising cords attached thereto. Thus a heddle raising cord 178 is secured to the upper end of each heddle or groups of heddles 176 and extends upwardly over one of the rods 152 and then forwardly over the rods 170. When a heddle 176 is in raised position, the forward portion of the corresponding cord 178 extends downwardly through the comb 174. The cords 178 terminate in enlarged portions or knobs 180 which engage under the comb 174. By pulling forward on a cord 178, such cord can be released from the comb 174 to lower the heddle 176 to a position in which the knob 180 engages the comb 168. A thin weight or lingo 182 is attached to the lower end of each heddle 176 or groups of heddles by a suitable cord 184 which extends downwardly from the lower end of such heddle. The auxiliary heddles 176 may each be attached to a separate cord 178 or as described with reference to the attachment of Figs. 1 to 6, any desired combination of small individual harnesses may be attached to a single cord 178 to enable the raising and lowering of a plurality of auxiliary heddles 176 by a single cord 178. In any case, such heddles are guided between the rods 162.

The loom of Figs. 7 to 10 including the attachments shown therein, may be employed in any manner exactly similar to that described with reference to Figs. 1 to 6. The attachment of Figs. 7 to 10 has provision for a larger number of auxiliary heddles and operating cords therefor and is of simpler and lighter construction than the attachment of Figs. 1 to 6.

The auxiliary heddles 176 of Figs. 7 to 10 or the auxiliary heddles 86 of Figs. 1 to 6 may also be employed in conjunction with an improved type of main heddle 186 shown in Fig. 11 which has an elongated eye 188 adjacent one end of the heddle. One manner of using such heddles 186 is indicated in Figs. 12 to 15 in conjunction with the auxiliary heddles 176 of the attachment of the present invention. In such figures, heddles 186a having an elongated eye are shown with such eye at the top of the heddles and similar heddles 186b are shown with the elongated eye at the lower portion of the heddles. A warp 190 is shown as extending from a warp drum 192 through the eye of an auxiliary heddle 176 and through the eyes of the two heddles 186a and 186b and then through a beater 194 and over a breast beam 196 to a cloth drum 198. The heddles 176 are assumed to be connected in the same manner as the heddle 176 of Fig. 8 and the heddle 186a is assumed to be positioned in one of the rear heddle frames of the loom, while the heddle 186b is positioned in one of the front heddle frames of the loom. It will be understood that there will be a plurality of auxiliary heddles 176 and also that there will be a plurality of main heddles 186a and 186b in the various heddle frames. Each of the rear heddle frames will contain heddles 186a and each of the front heddle frames will contain heddles 186b. At least certain of the warps will extend through three heddles as shown in Figs. 12 to 15.

In the arrangement of heddles shown in the figures referred to, two of the heddles must be raised in order to raise the warp 190 to the upper position in the shed and one of these heddles must always be a heddle 186b. Thus raising the auxiliary heddle 176 as shown in dotted lines in Fig. 12 or raising the main heddle 186a as shown in full lines in Fig. 15, will not raise the warp 190 to the upper position in the shed as long as main heddle 186b is in the lower position shown in these figures. On the other hand, raising the main heddle 186b while both

the auxiliary heddle 176 and main heddle 186a are in their lower positions as shown in full lines in Fig. 13, also will not raise the warp 190 to its upper position in the shed. When the main heddle 186b is in its upper position, however, raising either the auxiliary heddle 176 as shown in dotted lines in Fig. 13 or the main heddle 186a as shown in full lines in Fig. 14, will raise the warp 190 to the upper position in the shed. It will be apparent that a combination of heddles rather than a plurality of heddles must be employed to raise any warp threaded through heddles in the manner illustrated in Figs. 12 to 15.

An example of an arrangement employing seven heddle frames 130 in an eight heddle frame loom to obtain the type of operation usually obtained with twelve heddle frames in a jack loom by using main heddles of the type shown in Figs. 11 to 15 is shown in Figs. 16 to 18. In Fig. 16, the first three heddle frames A, B and C are shown as being fitted with heddles 186b while the last four heddle frames E, F, G and H are fitted with heddles 186a. Heddle frames are usually present in looms in even numbers and for the purpose of the present example no heddles are shown in one heddle frame D, although such heddle frame may contain heddles for other purposes, such as assisting in forming a selvage. In Fig. 17, twelve treadles 136 are shown and labeled a to l, inclusive. The circular dots indicate possible connections between such treadles and the various heddle frames for a particular weaving operation. Thus heddle frames A, C, E and H are connected to treadle a, heddle frames B, C, G and H are connected to treadle b, etc. Fig. 18 illustrates a possible manner of threading warp 190 through auxiliary and main heddles using the arrangement of heddle frames and treadles of Figs. 16 and 17. The individual warp threads shown are labeled w1 to w15, inclusive. Only 15 warp threads are shown but, in general, a much greater number will be present. The auxiliary heddles 176, through which individual warp threads are threaded, are indicated by small squares. The individual heddles 186a in heddle frame E to H, inclusive, through which heddles such warp threads are threaded and which heddles have elongated eyes extending upwardly, are indicated by small circles. The individual heddles 186b in heddle frames A to C, inclusive, through which heddles such warp threads are also threaded and which heddles have elongated eyes extending downwardly, are indicated by small triangles. Each warp thread 190 extends through an auxiliary heddle and then through a heddle 186a in a rear heddle frame and a heddle 186b in a front heddle frame. Since there are four rear heddle frames and three front heddle frames in use, there are twelve possible different pairs of heddle frames made up of a front and rear heddle frame. Such twelve pairs correspond to the twelve treadles of Fig. 17. So far as the main heddles are concerned, warp thread w13 is threaded in the same manner as warp thread w1, warp thread w14 is threaded in the same manner as warp thread w2, etc. In other words, the arrangement repeats with each twelve warp threads.

It is apparent from Fig. 17 that depressing treadle a will lift heddle frames A, C, E and H. The lifting of heddle frames A and C will lift the heddles 186b contained therein and, as indicated in Fig. 18, will free for raising but will not raise a first group of warp threads containing threads w1, w3, w4, w6, w7, w9, w10, w12, w13, w15, etc. Lifting heddle frames E and H will raise heddles 186a contained therein and will attempt to raise a second group of warp threads containing threads w1, w4, w5, w8, w9, w12, w13, etc. Some of these are, however, held down by heddles 186b in heddle frame B which has not been raised. The warp threads actually raised to form the shed are those common to the two groups just given, namely, warp threads w1, w4, w9, w12, w13, etc. The remaining warp threads in the first group, namely, threads w3, w6, w7, w10, w15, etc., are, however, subject to being raised by the auxiliary

heddles 176 through which they are threaded. Such remaining warp threads have been freed by raising the heddles 186b through which they are threaded and the elongated upwardly extending eyes in the heddles 186a through which they are also threaded enable such threads to be raised by such auxiliary heddles. Control of the weaving can thus be effected by the auxiliary heddles in addition to the control effected by the treadles a to l inclusive.

In a similar manner depressing treadle b of Fig. 17 lifts heddle frames B, C, G and H. Lifting heddle frames B and C, as shown in Fig. 18, frees warp threads w2, w3, w5, w6, w8, w9, w11, w12, w14, w15, etc., for raising. Lifting heddle frames G and H attempts to raise warp threads w3, w4, w7, w8, w11, w12, w15, etc. The warp threads actually raised are w3, w8, w11, w12, w15, etc. The warp threads subject to control by auxiliary heddles 176 are w2, w5, w6, w9, w14, etc. The action of the remaining treadles is apparent from the above. By depressing the treadles in a desired sequence and passing weft through the sheds thus formed and then actuating the beater, a basic weave is produced which weave can be modified by actuating the auxiliary heddles. In general, any desired number of rear heddle frames containing heddles 186a can be employed with any desired number of front heddle frames containing heddles 186b for different types of fabric and the number of possible combinations for controlling warp threads is the number of such rear warp frames times the number of such front warp frames.

The manner of employing the auxiliary heddles is not limited to the examples given above. Thus the warp threaded through such heddles can for certain patterns bypass the main heddles, or for other patterns can be threaded through the main heddles 186b only, or certain of the warp threads threaded through the auxiliary heddles can pass through the main heddles 186b while others of such warps do not. Even when each single warp thread passes through all three of an auxiliary heddle 176 and a main heddle 186a and a main heddle 186b, the auxiliary heddles can be employed to provide more than the number of combinations provided by the front and rear heddle frames employed. It will be apparent that the attachment of Figs. 7 to 10 including the auxiliary heddles 176 can also be employed with a loom of the type shown in Figs. 1 to 6 and in the manner described with reference to Figs. 1 to 6.

While I have described the preferred embodiment of my invention, it is to be understood that the details may be varied and that the scope of the invention is to be determined by the following claims.

I claim:

1. An attachment for a hand loom comprising top structure for positioning at the top portion of the castle structure of said loom, a heddle guide structure for positioning at the rear of said castle structure, said heddle guide structure providing a plurality of slots for receiving and guiding auxiliary heddles, a plurality of heddles positioned in said slots, a plurality of heddle raising cords each having one end attached to at least one of said heddles for movably supporting said heddles in said slots, a plurality of cord guides carried by said top structure for receiving said heddle raising cords, holding means for the other ends of said heddle cords for holding the ends of individual cords when said cords are pulled to raise the heddles attached thereto, and means for securing said attachment to said loom.

2. An attachment for a hand loom comprising a top structure for positioning at the top portion of the castle structure of said loom so as to extend laterally of said loom and side members extending downwardly from said top structure at the rear of said castle structure, heddle guide structure supported by said side members, said heddle guide structure including a plurality of bars extending laterally of said loom and spaced from each

other longitudinally of said loom to provide a plurality of slots for receiving and guiding heddles, a plurality of rear cord guides for heddle raising cords, said rear cord guides having cord guiding portions disposed laterally along said top portion above said heddle guides, a plurality of front cord guides for said cords having cord guiding portions disposed laterally along the front of said top portion, cord end holding means positioned below said front cord guides and having cord holding portions disposed laterally of said loom for holding the ends of individual heddle raising cords when said individual cords are pulled to raise heddles attached thereto, and means for securing said attachment to said castle structure.

3. An attachment for a hand loom comprising a top structure having a rear top portion positioned above and to the rear of the castle structure of said loom and extending laterally of said loom, and side members extending downwardly from said top structure at the rear of said castle structure, heddle guide structure supported by said side members, said heddle guide structure each including a plurality of bars extending between said side members and spaced from each other longitudinally of said loom to provide a plurality of slots for receiving and guiding heddles, a plurality of heddle raising cords each having an end attached to at least one heddle positioned in said slots, a plurality of rear cord guides carried by said rear top portion and having cord guide portions disposed laterally along said rear top portion above said heddle guides, a front cord guide structure having front cord guide portions disposed laterally along the top front of said castle structure, heddle cord end holding means positioned below said front cord guide portions and disposed laterally along the front of said castle structure for holding the ends of individual heddle raising cords when said individual cords are pulled to elevate heddles attached thereto, and means for securing said attachment to said castle structure.

4. An attachment for a hand loom comprising a top portion for positioning above the central portion of the castle structure of said loom, upper and lower heddle guides for positioning at the rear of said castle structure, said heddle guides each providing a plurality of slots for receiving and guiding auxiliary heddles, a plurality of heddles positioned in said slots, a plurality of heddle raising cords each having one end attached to at least one of said heddles for movably supporting said heddles in said slots, a plurality of cord guides adjacent said top portion for receiving said heddle raising cords, holding means for the other ends of said heddle cords for holding the ends of individual cords when said cords are pulled to raise the heddles attached thereto, and means for securing said attachment to said loom.

5. An attachment for a hand loom comprising an auxiliary frame including a top portion for positioning above the central portion of the castle structure of said loom so as to extend laterally of said loom and side members extending downwardly from said top portion at the rear of said castle structure, upper and lower heddle guides supported by said side members, said heddle guides each including a plurality of bars extending between said side members and spaced from each other longitudinally of said loom to provide a plurality of slots for receiving and guiding heddles, a plurality of cord guides for heddle raising cords, said cord guides being disposed laterally of each other along said top portion above said heddle guides, a plurality of cord guides for said cords disposed laterally along the front of said top portion, cord end holding means positioned below the last mentioned guides and disposed laterally of said loom for holding the ends of individual heddle raising cords when said individual cords are pulled to raise heddles attached thereto, and clamping means for attaching said auxiliary frame to said castle structure.

6. An attachment for a hand loom comprising an aux-

iliary frame including a top portion positioned above the central portion of the castle structure of said loom and extending laterally of said loom, and side members extending downwardly at the rear of said castle structure, upper and lower heddle guides supported by said side members, said heddle guides each including a plurality of bars extending between said side members and spaced from each other longitudinally of said loom to provide a plurality of slots for receiving and guiding heddles, a plurality of heddle raising cords each having an end attached to at least one heddle positioned in said slots, a plurality of rear cord guides secured to and disposed laterally of each other along the rear of said top portion above said heddle guides, a plurality of front cord guides disposed laterally of each other along the front of said top portion, said cords being supported in aligned guides of said front and rear guides, heddle cord end holding means positioned below said front cord guides and disposed laterally of each other for holding the ends of individual heddle raising cords when said individual cords are pulled to elevate heddles attached thereto, and clamping means for attaching said auxiliary frame to said castle structure.

7. An attachment for a hand loom comprising an auxiliary frame including a top portion positioned above the central portion of said castle structure and extending laterally of said loom and side members extending downwardly from said top portion at the rear of said castle structure, upper and lower heddle guides supported by said side members, said heddle guides each including a plurality of horizontal bars extending between said side members and horizontally spaced from each other longitudinally of said loom to provide a plurality of slots for receiving and guiding heddles, a plurality of heddles positioned in said slots, a plurality of heddle elevating cords each cord having an end attached to at least one of said heddles, a plurality of pulleys disposed laterally of each other along the rear of said top portion above said heddle guides, a plurality of pulleys disposed laterally of each other along the front of said top portion, said cords being trained over said pulleys, cord end holding means positioned below the last mentioned guides and disposed laterally of each other for holding the other ends of individual cords of said heddle raising cords when said individual cords are pulled to raise the heddle attached thereto, a bracket at each end of said top member and forming part of said auxiliary frame, and means for clamping said bracket to said castle structure.

8. An attachment for a hand loom having a plurality of heddle frames movable vertically in a castle structure forming part of said loom, said attachment including an auxiliary frame having a top portion to be positioned above the central portion of said castle structure so as to extend laterally of said loom and having a rear portion extending downwardly from said top portion at the rear of said castle portion, said downwardly extending portion including side members and upper and lower heddle guides supported by said side members, said heddle guides each including a plurality of bars extending between said side members and spaced from each other longitudinally of said loom to provide slots for receiving and guiding auxiliary heddles, a plurality of heddles positioned in said slots, a plurality of heddle raising cords each having one end attached to at least one of said heddles for supporting said heddles in said slots, a plurality of pulleys for said heddle raising cords secured to said auxiliary frame and disposed lateral of each other along the rear of said top portion with their axes in alignment with each other for receiving said heddle raising cords, a plurality of pulleys secured to said auxiliary frame and disposed laterally of each other along the front of said top portion with their axes in alignment with each other for also receiving said heddle elevating cords, holding means for the other ends of said cords positioned below the last mentioned pulleys and disposed laterally of each other of said loom for holding the ends of indi-

vidual cords when said cords are pulled to raise the heddles attached thereto, and clamping means for attaching said auxiliary frame to said castle structure.

9. An attachment for a hand loom having a plurality of heddle frames movable vertically in the castle structure of said loom, said attachment including an auxiliary frame having a top portion positioned above the central portion of said castle structure and extending laterally of said loom and having a rear portion extending downwardly from said top portion at the rear of said castle portion, said downwardly extending portion including side members and upper and lower heddle guides supported by said side members, said heddle guides each including a plurality of bars extending between said side members and spaced from each other longitudinally of said loom to provide slots for receiving and guiding auxiliary heddles, a plurality of heddles positioned in said slots, a plurality of heddle raising cords each having one end attached to at least one of said heddles for supporting said heddles in said slots, a plurality of pulleys for said heddle raising cords mounted on said auxiliary frame and disposed lateral of each other along the rear of said top portion with their axes in alignment with each other for receiving said cords, a plurality of pulleys mounted on said auxiliary frame and disposed laterally of each other along the front of said top portion with their axes in alignment with each other for also receiving said cords, holding means for the other ends of said cords mounted on said auxiliary frame and positioned below the last mentioned pulleys and disposed laterally of each other for holding the ends of individual cords when said cords are pulled to raise the heddles attached thereto, a bracket at each end of said top member of said auxiliary frame, said bracket having a top member extending longitudinally of said loom and secured to said top member and said side members and having downwardly extending portions for attachment to cross members of said castle structure, and clamping means for attaching said bracket to said castle structure.

10. An attachment for a hand loom comprising a rear top structure for positioning at the top and rear of the castle structure of said loom, a front top structure for positioning at the top and front of said castle structure and a heddle guide structure for positioning at the rear of said castle structure, said heddle guide structure having a plurality of bars extending laterally of said loom and spaced from each other longitudinally of said loom to provide a plurality of slots for receiving and guiding heddles, said rear top structure having a plurality of bars extending laterally of said loom above and to the rear of said castle structure and spaced from each other longitudinally and vertically of said loom to provide a plurality of rear cord guides above said heddle guide structure for heddle raising cords, said front top structure having front cord guides positioned above and in front of

said castle structure and forwardly of said rear cord guides, and cord holding means positioned below said front cord guides and in front of said castle structure for holding the ends of said heddle raising cords when said cords are pulled to raise heddles attached thereto.

11. A hand loom comprising a castle structure, a plurality of heddle frames mounted in said castle structure for vertical reciprocation and having main heddles therein to raise warp and form a shed when certain of said heddle frames are raised, treadles for selective attachment to said heddle frames for raising selected ones of said heddle frames, a heddle guide structure secured to the rear of said castle structure and providing a plurality of slots spaced longitudinally of said loom for guiding auxiliary heddles for vertical reciprocation, cord guide means secured to the top of said castle structure, heddle raising cords each having one end secured to at least one of said auxiliary heddles for raising said auxiliary heddles, said cords extending over said cord guide means to the front of said castle structure, and means on the front of said castle structure for holding the other ends of said cords when said cords are pulled to raise said auxiliary heddles.

12. A hand loom comprising a castle structure, a plurality of heddle frames mounted in said castle structure for vertical reciprocation and having main heddles therein to raise warp and form a shed when certain of said heddle frames are raised, treadles for selective attachment to said heddle frames for raising selected ones of said heddle frames, a heddle guide structure secured to the rear of said castle structure and providing a plurality of slots spaced longitudinally of said loom for guiding auxiliary heddles for vertical reciprocation, cord guide means secured to the top of said castle structure, heddle raising cords each having one end secured to at least one of said auxiliary heddles for raising said auxiliary heddles, said cords extending over said cord guide means to the front of said castle structure, and means on the front of said castle structure for holding the other ends of said cords when said cords are pulled to raise said auxiliary heddles, certain of said heddle frames having heddles therein provided with elongated eyes extending upwardly from said warp and other of said heddle frames having heddles therein provided with elongated eyes extending downwardly from said warp to provide for raising certain warp when two of said heddle frames are simultaneously raised or for raising certain warp when one of said heddle frames and certain of said auxiliary heddles are raised.

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