June 3, 1947. F. V. CLARKE 2,421,539

LOOM REVERSING MECHANISM

Filed Oct. 12, 1944 2 Sheets-Sheet 1

Fig. 1.

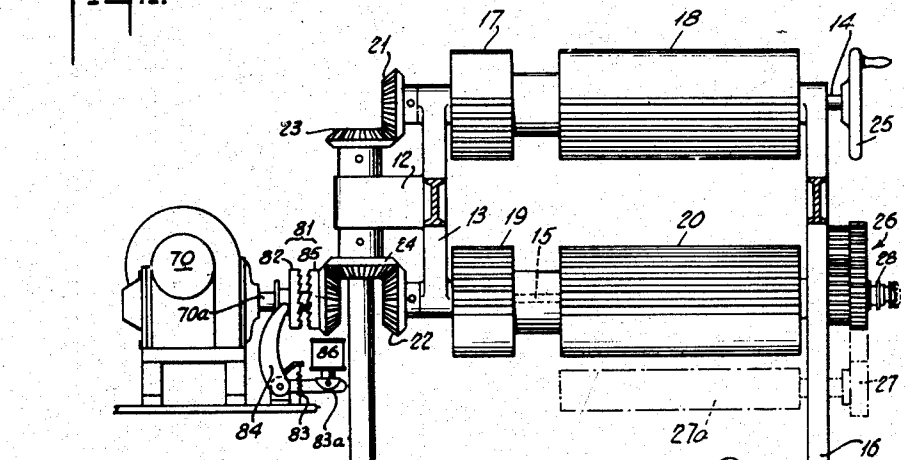


Fig. 1a.

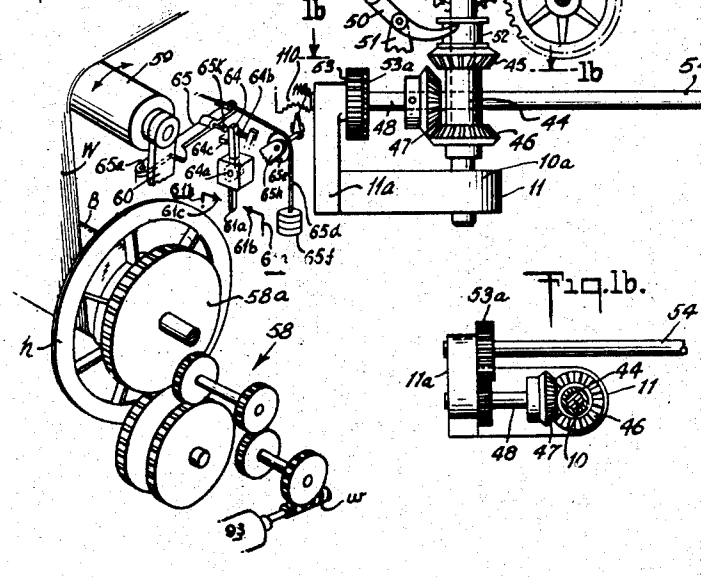


Fig. 1b.

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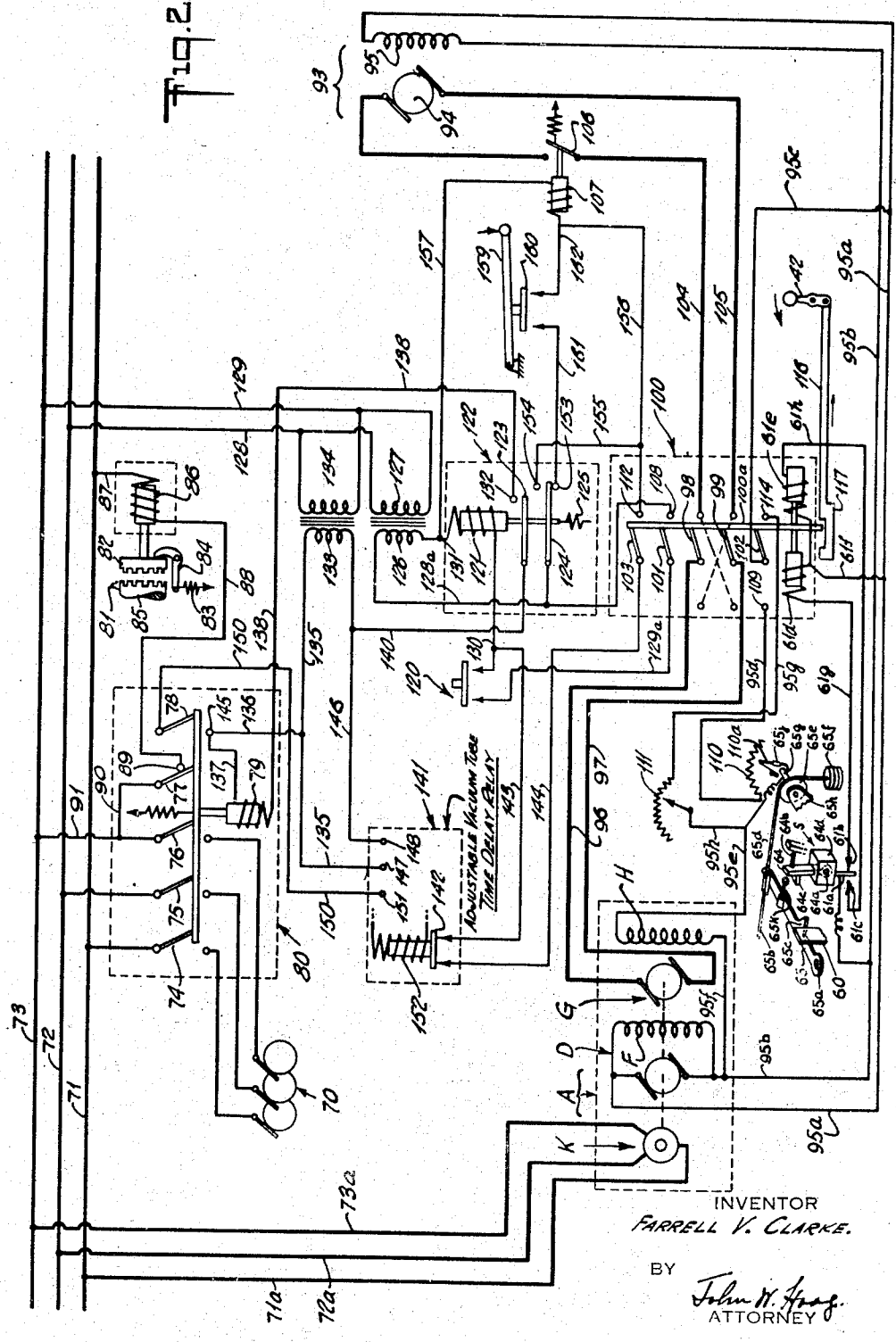
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June 3, 1947. F. V. CLARKE 2,421,539

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Filed Oct. 12, 1944 2 Sheets-Sheet 2

Fig. 2.



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LOOM REVERSING MECHANISM

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Application October 12, 1944, Serial No. 558,314

21 Claims. (Cl. 139—1)

1

This invention relates to a loom construction and control means for certain loom parts and operations. The invention includes power driven means for backing up certain loom parts and means for relating this movement with positive warp beam drive means.

Heretofore in the operation of a loom, when one or more filling threads broke, it has been necessary for the loom attendant to disconnect the main loom drive connection to the cloth roll and the head motion including the means for controlling the weaving pattern, thereby reversing the drive connection between said cloth roll and the head motion, and, after reversing the pattern chain, to manually actuate the head motion to let-off the cloth roll, and to retract the pattern control means, and also to manually rewind the warp beam to take up slack in the warp and to condition the warp to receive one or more new filling threads to replace the broken thread or threads. These manual operations were arduous, due in part to the position of the handwheel for operating the head motion, and the accuracy of these manual adjustments depended for control entirely upon the skill and experience of the loom attendant who was without any dependable measure of how far the warp needed to be taken up on the warp beam in order that a tension substantially equal to that maintained on the warp threads during preceding and following portions of the weaving operation would be maintained during the replacing of the broken filling threads.

Accordingly an object of the invention is to provide an improved method and means for driving the head motion, so related to means for driving the warp beam in reverse that a tension substantially uniform with that existing prior to the breaking of the filling threads will be provided during the backing up of the warp and replacement of the broken filling threads.

Another object of the invention is to provide non-manual means for reversing the loom head to obviate the necessity of performing this operation manually.

Another object of the invention is to provide power drive means for driving a loom head to reverse the pattern chain and cloth roll and control means for limiting the said reverse action.

Another object of the invention is to provide control means whereby the loom head drive may be utilized to retract the pattern chain and to let off woven cloth and whereby means for taking up the warp to compensate for said letting off of woven cloth and to maintain the warp tension

2

within a desired range, may be related and called into action.

Other objects of the invention will be in part obvious or in part pointed out hereinafter.

The invention accordingly consists in the features of construction, combinations of elements, arrangements of parts, and in the several steps and relation and order of each of said steps to one or more of the others thereof, all as will be pointed out in the following description, and the scope of the application of which will be indicated in the following claims.

The invention will best be understood if the following description is read in connection with the drawings, which show a practical embodiment of the invention, and in which,

Figure 1 is a side elevation of a portion of a loom showing the head motion cylinders and drive means therefor;

Figure 1*a* is a detail view in perspective showing a loom warp beam, having independent drive means, and indicating the warp, a whip roll, and an electric switch controlled by the position of the whip roll;

Figure 1*b* is a detail plan view taken on the line 1ᵇ—1ᵇ of Figure 1.

Figure 2 is a diagrammatic and schematic representation of an electrical circuit arrangement showing diagrammatically the relation of the electrical control features to the schematically represented mechanical features of the entire system of control.

As shown in Figure 1 a vertical drive shaft 10 for the head of a loom, is supported at its lower end in a bearing 10ᵃ provided by an horizontal bracket arm 11. Shaft 10 adjacent its upper end is supported in a bearing provided by the bracket 12 extending from the loom frame member 13, which also provides bearings for one end of shafts 14 and 15, which are arranged one above the other, and which are supported at their other ends respectively, in bearings provided in loom frame member 16. Affixed on shaft 14 is a box cylinder gear 17, and a harness cylinder gear 18. Similarly supported on shaft 15 is a bottom box cylinder gear 19, and a bottom harness cylinder gear 20. At the inner ends of shafts 14 and 15 respectively are bevel gears 21 and 22 which mesh with gears 23 and 24 respectively, fixed to shaft 10 adjacent its upper end, to rotate the chain cylinder gears 17 and 19 and the head motion cylinder gears 18 and 20.

Fixed at the front end of shaft 14 is a hand wheel 25, by which, according to previously prevailing practice, the head of the loom has been

manually driven to reverse the weaving action when required, as for replacing broken filling threads or to level the harnesses when warp ends are broken. It will be noted that the hand wheel 25 is positioned high up at the top of the loom structure and it is thus difficult for many operators, and particularly women, to reach the hand wheel 25 and rotate it for driving the head motion.

Shown at the front end of shaft 15 is a train of gears indicated generally by the numeral 26, which controls the direction of drive of pattern chain driving gear 27. Said system of gears is controlled by key 28 which for forward drive is in the full line position shown in Figure 1. When key 28 is in reverse position, as shown in dotted lines in Figure 1, the pattern chain is set to move rearwardly, as for the replacing of broken filling threads.

Shaft 10 is driven for normal forward drive of the loom head from main loom shaft 29, having thereon gear 30 which meshes with teeth 31 cut in the periphery of bevel gear 32, which in turn meshes with bevel gear 33, mounted so that it is freely rotatable on shaft 10, and having a collar 34 provided with the bores 35 engageable by pins 36, carried by the clutch member 37 splined to shaft 10. Clutch member 37 is provided with a groove 38 which receives the forked end of lever arm 39 which is mounted on fixed pivot 39 and is attached to, and moves with, link 40. The position of link 40 is controlled by slideable rod 116, having at its front end a shifting lever 42, pivoted to the loom frame 16 and connected as at 43 to rod 116. In Figure 1 shifting lever 42 is shown in its rear position with clutch 37 disengaged from the forward drive means of shaft 10. In this position of clutch 37, sliding collar 44, the position of which is controlled by the position of clutch 37, will be in its upper position, and gear C will be driven to let off cloth from the cloth take-up roll. Sliding collar 44 is splined on shaft 10 and comprises the upper bevel gear 45 and the lower bevel gear 46, spaced apart a distance slightly greater than the diameter of the bevel gear 47 mounted on shaft 48, which is supported at one end in a bearing provided in vertical bracket arm 11a. Which of gears 45 or 46 is meshed with gear 47 depends upon whether clutch 37 is in its upper or lower position, as sliding collar 44 moves in unison with clutch member 37 and is interconnected therewith through pivoted lever arm 39, link 49, and arm 50 mounted on fixed pivot 51, the forked end of which engages in groove 52.

Also mounted on shaft 48 is a gear 53 which drives a gear 53a, meshed at the rear of said gear 53 and which is attached to shaft 54 on which there is a worm 55 which engages and drives the gear C of the cloth take-up roll. At the forward extremity of shaft 54 a hand wheel 56 is shown by which, according to prior art practice, gear C may be manually rotated in reverse to let off cloth from said cloth take-up roll, as for backing up the warp to replace a broken filling thread, and also according to prior art practice warp beam B, shown in Figure 1*a*, is manually rotated to take up the warp.

For backing up the warp in this way it was necessary for the operator, after first shifting lever 42, to disconnect upright shaft 10 from its driving means by disconnecting clutch 37 from driving gear 33, and after shifting key 28 to effect reversal of the pattern chain drive, to reach up to hand wheel 25 and rotate it manually a sufficient distance to move the warp and pattern chain backward into position for the substitution of the broken filling thread or threads, and to then manually rotate warp beam B, and hand wheel 56 if necessary, to back up the warp and to take up the slack in the warp caused by the backing up of the warp, before replacing the broken threads. Not only was it difficult for a short operator, particularly in the case of women, to reach and rotate hand wheel 25, but it was also necessary for the operator to go behind the loom and manually rotate warp beam B in reverse as by grasping the heads *h* of the warp beam, until, in the operator's judgment, the slack in the warp, caused by the backing up of the warp, was taken up and the tension which the warp had before the breaking of the filling thread or threads, was restored. The control of the warp tension was thus subject to the personal equation and was dependent upon the guess or "hunch" of the operator. Since failure on the part of the operator to restore a warp tension to that which existed prior to the breaking of the filling thread or threads results in non-uniform weaving during replacing of the filling threads, thus lessening the quality of the cloth, it has heretofore been necessary to have experienced operators in attendance upon looms during their operation. By my invention means are provided for driving the loom head to reverse the weaving action by non-manual means, and preferably for a predetermined amount, and for relating the control means therefor to warp tension control means, such for example as the means set forth in co-pending application Serial No. 558,313, filed October 12, 1944, whereby the tension of the warp may be continuously and automatically controlled during rearward movement of the warp, thus eliminating the aforesaid manual operation, and the personal equation in the tensioning of the warp, with the result that a higher and more uniform quality of cloth is obtainable, even with loom attendants not necessarily experienced in weaving.

In accordance with my invention I provide means including control means, such as are included in the electric circuit illustrated in Figure 2, and later described in detail, to control a source of power, preferably an electric motor, to drive the head motion to reverse the weaving action and to back up the warp, preferably exactly the distance required to replace a broken filling thread, all in relation to direction and speed of drive of the warp beam. In the specific embodiment of the invention disclosed herein I provide motor 70 and an electric control circuit which is placed in appropriate condition to drive the head motion and to be controlled by a push button 120, by the actuation of a switch 100, desirably operated by shift lever 42 as by the rear end of link or sliding rod 116 actuated by shift lever 42, so that when clutch 37 is disengaged, by operation of lever 42, from the main loom drive means, switch 100 is simultaneously actuated to condition certain circuits. The electric motor 70 is provided to turn the head motion through an electro-magnetically controlled clutch, generally indicated in Figure 1 in its entirety by the reference character 81 and having a movable clutch member 82 slideably mounted on motor drive shaft 70a, biased in any suitable way as by spring 83 and lever arm 84, toward and into engagement with the companion clutch member 85, which as illustrated consists of a clutch face on the rear side of a bevel gear. The movable clutch member 82 is held out of engagement with companion clutch member 85 during forward opera-

tion of the loom head by an electro-magnet or solenoid whose winding 86 is energized as will be described, and whose plunger core is joined to lever 84 by arm 83a. Clutch member 85 is in engagement with bevel gear 24 to drive shaft 10 in reverse when clutch 81 is closed and motor 70 is operating.

The head-motion motor 70 is conveniently an alternating current motor such as a three-phase motor, receiving current from a main three-phase line or circuit (Figure 2) comprising conductors 71, 72, and 73 to which the motor may be connected by switch blades 74, 75, and 76 of a composite switch which, in the illustrative circuit and arrangement, preferably has two other switch blades 77 and 78, all arranged so that when the circuit of switch blades 74, 75, and 76 is open, the circuit controlled by switch blade 77 is closed and the circuit controlled by switch blade 78 is open. This composite switch is preferably of the remote controlled type and hence and illustratively is provided with a winding 79 having a suitable armature or solenoid core so connected to the switch blade structure that the latter is operated to close the motor circuit upon energization of the winding 79, a reverse actuation of the switch occurring upon de-energization of the winding 79. For convenience this relay-operated switch is generally indicated in its entirety by the reference character 80.

Power to turn the head-motion is delivered as earlier above-described through the electromagnetically controlled clutch 81 whose parts are schematically shown in Figure 2 as having the movable clutch member 82 biased in any suitable way as by a spring 83 and lever 84 toward and into engagement with the companion clutch member 85 but which may be held out of engagement with the companion clutch member 85 by a solenoid 86 whose winding receives energy from one phase, such as phase 71—73 of the power circuit, through the switch blade 77 of the main relay switch 80. The circuit for this purpose extends from conductor 71, conductor 87, winding of solenoid 86, conductor 88, switch contact 89, switch blade 77 (closed, when the main switch 80 is open, thus to hold the clutch 81 disconnected), and then by way of conductors 90 and 91 to the other conductor 73 of the phase 71—73. In the normal operation of the loom, clutch members 82 and 85 are out of engagement, main switch 80 is open, and hence motor 70 is at rest.

During such normal operation of the loom, the warp beam B is driven controllably, as is later described, by the motor 93 by suitable gearing as is indicated in Figure 1*a*, such gearing including a worm *w*, reduction gearing 58 and bull gear 58a connected with the beam B. The beam drive, being through the worm *w*, may thus be self-locking or irreversible to prevent the beam B, by its momentum, from overriding the drive of the motor 93. Warp drive motor 93 drives the beam B in warp let-off direction at a speed which is controlled, preferably by the whip roll 59 (Figure 1*a*) so as to maintain substantial constancy of tension of the warp W as the operation of the loom proceeds but provision is also made for reversing the drive of motor 93, during this normal operation of the loom, to drive the beam B in take-off direction, and according to certain features of my invention, I make use of this reversal of the drive of the warp beam B by the motor 93 to take up the warp W during the interval of time that motor 70 drives the head-motion to reverse the weaving action.

The warp-drive motor, indicated in the diagram by the reference character 93, is preferably arranged for control of its speed and direction of drive and conveniently is a direct current motor comprising an armature 94, and a field winding 95. Field winding 95 is preferably arranged to be energized at constant voltage from any suitable source of direct current, for example, a direct-current generator D which may be driven by a motor K energized from and connected to the three-phase power circuit 71, 72, 73, by conductors 71a, 72a and 73a; motor K also drives a direct-current generator G. Motor and generators may comprise a so-called motor amplidyne unit diagrammatically indicated at A.

Generator D is connected to the field winding 95 by conductors 95a and 95b, supplying motor 93 with fixed excitation. Motor armature 94 is connected to direct-current generator G by lines 96 and 97 and by lines 104, 105, through switch blades 98 and 99 of a movable switch structure designated as a whole by the reference character 100. Switch 100 comprises also switch blades 101, 102 and 103 for purposes later described. With respect to switch blades 98 and 99, the switch structure 100 is of the double throw type, having its two pairs of contacts cross connected as indicated to function to reverse the direction of current flow from the generator G to the armature 95 through conductors 104 and 105, in one of which is included an electromagnetically controlled switch 106, the control winding 107 of which is arranged in any suitable way to close the switch upon energization of the winding 107 and open it upon de-energization of the winding.

With the switch structure 100 thrown to the left, motor 93 operates in forward direction to let off the warp and switch blades 101 and 103 hold later-described circuits open since they are out of contact with the switch contacts 108 and 112 while auxiliary switch blade 102 is brought into engagement with fixed contact 109, thus completing through the latter a circuit for energizing the field winding F' of the generator G and in which circuit provision is made to vary or control the amount of excitation supplied to the field winding in order thus to vary or control the energy supplied to motor armature 94 and correspondingly to vary its speed of drive. This I prefer to do by way of a rheostat 110 controlled by the whip-roll as is later described and included in the circuit of generator field F to thereby vary the speed of the motor 93 and the rate at which it drives the warp beam in forward or let-off direction. Preferably, I also provide a rheostat 111 by which the speed of drive in reverse or warp take-up direction may be manually controlled or set, and arrange the two rheostats so that either is made effective according to the position of switch 100. The resultant selective shifting of the two speed controls or rheostats I furthermore co-relate, as is later described, with the control and drive of head-motion motor 70.

With switch 100 thrown to the left, for forward or let-off drive, a rheostat-controlled circuit will be seen to extend from the generator D, conductor 95a, conductor 95c, switch blade 102, contact 109, conductor 95d, whip-roll controlled rheostat or variable resistance 110, conductor 95e, generator field H, and then by conductor 95f back to the other terminal of the generator D.

If, however, the switch 100 is thrown to the right for warp take up drive, the current flow from generator G to the armature 94 is reversed to reverse the direction of drive of the motor

93 and hence of the warp beam; at the same time switch blade 102 is thrown out of engagement with fixed contact 109, thus to remove whip-roll responsive rheostat 110 from the circuit of field winding 95, and into engagement with contact 114, to substitute hand rheostat 111 for rheostat 110. Generator field H is energized in the same direction as before, through a circuit that extends from the generator D, conductor 95^a, conductor 95^c, switch blade 102, contact 114, conductor 95^g, manual rheostat 111, conductor 95^h, conductor 95^e, field winding H, and by way of conductor 95^f back to the excitor generator D.

Considering now the specific or preferred form of control of speed and direction of drive of the warp beam in response to changes in tension and reach of the warp W, I prefer to employ the system and arrangement disclosed in the above-mentioned co-pending application to which reference may be made for its specific details of construction and operation but in Figure 2 I have schematically and diagrammatically shown how I bring that system and arrangement of control into co-acting relationship with the head-motion motor drive and other controls and in both Figures 1*a* and 2 I have indicated the mechanical arrangement whereby direction and speed of control of the warp drive motor 93 may be controlled by the whip-roll.

Thus the whip-roll 59 is mounted for movement toward or away from the head-motion or lay of the loom, conveniently by rotatably supporting it in the upper ends of laterally spaced arms 60 (only one of which is shown) which are suitably pivoted at their lower ends in any suitable way as indicated in Figure 1*a*. It is over the whip-roll 59 that the warp threads W are led from the beam B, through the loom head to the loom take-up roll. Adjacent each end of the whip-roll 59 are bell cranks 65 (only one of which is shown) pivoted as at 65^a to swing in substantially a horizontal plane, the long arms of the cranks being parallel and joined for movement together by a tie rod 65^b.

Suitable means are provided to cause the bell cranks 65 to swing or move about their pivots in response to changes in position of the whip-roll 59 toward or away from the loom head, and for this purpose the bell cranks 65 may each have a transverse or short arm 65^c constructed to have the two spaced arms 60 bear respectively against them under the tension of the warp threads W. The tension of the latter may be approximately determined by setting or determining the resistance which the bell cranks 65 offer against movement by whip-roll supporting arms 60, such as by a chain 65^d connected to the cranks 65 and running over a sprocket 65^e and having a weight 65^f on its end. Sprocket 65^e is fixed to a spindle or shaft 65^g rotatably supported in suitable bearings in an arm 65^h and having at its end suitable lost motion connection, indicated at 65^j, with the arm 110^a of the rheostat 110. Thereby changes in tension of the warp W, effect change in rotary position of the sprocket 65^e and its shaft 65^g, and also of the position of the rheostat arm 110^a. The weight 65^f is variable or adjustable in any suitable way.

With switch 100 actuated to the left in Figure 2, for warp let-off drive of the beam B, the speed of the motor armature 94 of warp drive motor 93 to drive the beam in let-off direction, is determined, during normal operation of the loom, by the position of the whip-roll 59 within a certain range of movement of the whip-roll toward or away from the lay of the loom and thus the speed of drive of the warp beam in let-off direction is varied so as to maintain substantially constant tension of the warp threads W and also to compensate for diminishing diameter of the warp mass on the beam B.

Since it is desirable at times during normal operation of the loom, and in coaction with the just-described speed variation in the drive of the motor 93 in warp let-off direction, provision is made, preferably in the manner described and claimed in the aforesaid co-pending application, to cause the whip-roll, when conditions arise to move it rearward (to the left in Figure 1*a*, to effect reversal of the motor 93 and thus cause the warp beam B to be driven in take-up direction and thus cause restoration of the position of the whip-roll within that range of its movements toward or away from the lay of the loom again to function to control the speed of the warp drive motor 93 in let-off direction.

Such an arrangement may comprise a laterally projecting arm 65^k adjustably carried by crank 65, preferably in any suitable way, as by threading the member 65^k in the crank 65, so that the extent to which the member 65^k projects from the crank 65 may be adjusted.

Arm 65^k is arranged in any suitable manner to actuate a snap switch mechanism generally indicated by the reference character S and provided with a movable contactor 61^a which is in engagement with either of two contacts 61^b and 61^c for correspondingly energizing either winding 61^d or winding 61^e of electro-magnets or solenoids whose armatures or cores are suitably connected mechanically to the switch 100 to actuate the latter either toward the left (for forward drive of the warp drive motor 93) or to the right (for reverse of the warp drive motor 93). The circuit arrangements are as shown in Figure 2, deriving electrical energy from the generator D.

Thus, contactor 61^a may be connected to one side of the generator D circuit, as to the conductor 95^b, a conductor 61^f connects two terminals of the windings 61^d and 61^e to the other side of conductors 95^a of the generator D circuit, conductor 61^g connects winding 61^d to contact 61^b and a conductor 61^h connects the other terminal of winding 61^e to contact 61^c.

The switch structure S has an operating member 64 positioned in the path of horizontal oscillating movement of the member 65^k; member 64 is suitably mounted as at 64^a for pivoting movement and is biased by a spring 64^b toward and against a stop 64^c, and is connected, through any suitable spring-toggle mechanism diagrammatically represented or indicated at 64^d, to the contactor 61^a so that contactor 61^a is snapped over from one contact (61^b or 61^c) to the other only after the operating member 64, under the joint action of actuating member 65^k and the spring 64^b, passes the mid-point of its arc of swing, usually corresponding to vertical or upright position of the part 64.

With actuator 65^k out of engagement with the operator 64, spring 64^b holds the member 64 against the stop 64^c and hence at the extreme left-hand position away from its mid-position or vertical position, and thus contactor 61^a is held in contact with contact 61^b to maintain winding 61^d energized and thus maintain forward direction of drive of the warp beam motor 93 but under the speed control by the rheostat 110 as above described, so long as the range of

back and forth movement of the whip-roll 59 relates the actuator 65k to the switch operator 64 so that it is out of engagement with the part 64 or, if in engagement with it, positions the member 64, against the bias of spring 64b, to the left of the vertical mid-position of operator 64.

However, should conditions arise where the whip-roll 59 moves rearwardly beyond the range just-mentioned, and this can happen when the loom has been idle for substantial periods of time, or also due to other conditions which can arise during the normal operation of the loom, the actuator 65k moves in clockwise direction (Figures 1a and 2) to move the pivoted operator 64 to the right beyond its mid-position, thus snapping the contactor 61a away from contact 61b and into engagement with contact 61c, thus de-energizing winding 61d and energizing winding 61e to actuate switch 100 to the right and thus reverse the drive of warp drive motor 93.

Beam B is thus driven in reverse direction, but preferably at normal speed inasmuch as whip-roll responsive rheostat 110 is cut out of the speed control circuit at switch blade 102 and contact 109, and rheostat 111 is substituted for it by switch blade 102 engaging switch contact 114 to place it in a circuit earlier above-described. Rheostat 111 may be manually set to give the motor 93 the desired rate of drive of the warp beam in take-up direction.

As the warp beam B thus takes up warp, the reach of warp threads W, from the warp beam over the whip-roll to the loom head, is thereby shortened up and the whip-roll 59 is thereby moved toward the right in Figure 1a until it has reached a position where, through crank 65, actuator 65k recedes or moves to the left sufficiently to bring the operator 64, biased by spring 64b, into its left-hand range of swinging movement and thus snap over the contactor 61a to de-energize switch winding 61e and energize switch winding 61d to thereby actuate switch 100 to restore the forward drive of warp motor 93 and to substitute the whip-roll responsive rheostat 110 for the manual rheostat 111.

The lost motion connection 65j and the snap-over mechanism 64d of switch S insure smoothness of operation of the mechanism. The loss motion connection 65j takes part in avoiding hunting in that certain minor shifts in the back and forth movement of the whip-roll 59 are not communicated to the rheostat and thus what would otherwise be very numerous back and forth readjustments, in minute increments, between whip-roll and motor speed can thus be avoided. The snap-over switch mechanism and the relationship between the operator 64 and the actuator 65k function in a generally similar manner, it being noted that the operator 64 may be contacted by the actuator 65k and by it give back and forth movements, throughout each of the two ranges of pivoting movement of the member 64 to either side of its vertical mid-position, without moving the contactor 61a, excepting at or about the mid-position.

Considering now the controls for effecting drive of the head-motion to reverse the weaving action and the inter-relationship thereof to the control by the whip-roll of the speed and direction of drive of the warp beam, it is first to be noted that, for such drive of the head-motion, the reversely moving warp W should be taken up; here I preferably utilize the warp beam B and arrange it to be driven in take-up direction. Hence I preferably

utilize the reverse drive of the warp beam by motor 93, under the control of switch 100. For this purpose, and as earlier above noted, the cloth take-up roll is arranged to be driven in cloth let-off direction, under the control of shifting lever 42 which can be actuated to position clutch 37 (Figure 1) to disconnect or interrupt the take-up drive from shaft 10 and to position sliding collar 44 in its upper position so that gear C can be driven for cloth let off from shaft 10 which is now to be driven by head-motion motor 70, provided that clutch 81 is actuated to couple motor 70 to complete the drive of the shaft 10.

During normal operation of the loom, warp drive motor 93 operates in forward or let-off direction of drive, under speed control, through the rheostat 110, by the whip-roll, excepting for such relatively infrequent and in any case short intervals of time during which the snap-over switch mechanism S is actuated for take-up drive of the warp beam by the motor 93; when conditions arise where reverse drive of the weaving action is needed, therefore, switch 100 will usually be found in its position to the left and hence for forward or let-off drive by motor 93 of the warp beam. I therefore provide for the actuation of the switch 100 from its left-hand position in Figure 2 to its right-hand position, in response to actuation of the shifting lever 42, and this may be done mechanically through a loss motion connection diagrammatically indicated in Figure 2 which permits actuation of switch 100 under the control of the windings 61d and 61e so long as shifting lever 42 is not actuated for reversing the weaving action but which throws and holds the switch 100 to the right in response to shifting of shifting lever into position to reverse the weaving action drive.

Thus, a mechanical linkage 116, actuated by or from the shifting lever 42, may have a lost motion connection 117 analogous to a pin and slot connection with the contactor bar 100a of the switch 100 so that when the shifting lever 42 is in the position shown in Figure 2, switch bar 100a may be actuated by the windings 61d and 61e into either of its positions to the left or right but upon actuation of the shifting lever 42 in counterclockwise direction, the lost motion connection picks up the contactor bar 100a of the switch and moves it from its left-hand or forward switch position to its right-hand or reverse switch position. Such actuation of the switch 100 thus changes the motor connections so that the direction of drive of motor 93 is reversed and also, at contact 109, the motor is freed from speed control by the whip-roll rheostat 110 for which manual rheostat 111 is substituted as will now be clear.

In the above consideration of the control of speed and direction of drive of the warp beam motor 93, during normal operation of the loom, switch 106 remains closed, being under the control of the loom starting lever 159 which is shown in stopping position in Figure 2 but which during normal loom operation is in starting or running position in which a contactor 160 controlled or actuated by the lever 159 is in closed position in a circuit to maintain energized the winding 107 of switch 106 and thus to keep the switch 106 closed. This energizing circuit and related circuits are described in detail later on.

Such actuation of the switch 100, however, also closes a circuit at contact 108 by switch blade 101 and in that circuit is included the above-mentioned push button switch 120, and also the winding 121 of a relay switch generally indicated

by the reference character 122 and which is constructed in any suitable way to have two movable contactors 123 and 124 arranged in any suitable way to be moved upwardly as seen in the diagram upon energization of the winding 121 and to be moved downwardly, as by a spring 125, upon de-energization of the winding. Energy for energizing the winding 121 may be derived from a suitable step-down transformer 126—127 whose high voltage winding may be connected as by conductors 128 and 129 to one of the phases 72—73 of the main power line and whose low voltage winding 126, giving a voltage on the order of 12 volts, is thus available for energizing the winding 121 of the relay switch 122.

Closure of push button switch 120 energizes the relay-switch winding 121 through a circuit which extends from transformer winding 126, conductor 128a, switch contact 108, switch blade 101 (in closed position), conductor 129a, switch 120, conductor 130, winding 121, and then by conductor 131 back to the other side of transformer winding 126. The energization of relay switch winding 121, with resultant actuation of the relay switch itself, sets into motion a number of instrumentalities, including the actuation of the switch 80 to start the drive of head-motion motor 70 and the actuation of clutch 81 into driving relationship, all as is about to be described, but it is at this point noted that these instrumentalities cannot be set into action, as by accidental actuation of the push button switch 120, during normal operation of the loom, for during the latter switch 100, as above noted, is in its left-hand position for forward or let-off drive of the warp drive motor 93, at controlled speed, and in such position of switch 100 the just-described circuit in which is included push button switch 120 is open at switch contact 108 and switch blade 101 (in open position). Accordingly it will be seen that shift lever 42 must first be actuated to disconnect the main loom drive from shaft 10 of the head-motion, and that actuation of shift lever 42 moves switch 100 to the right, thus closing the above-described push button circuit at contact 108 and switch blade 101; thus start of the head-motion motor drive, by the push button control 120, is permitted only after the just-mentioned parts of the loom have been conditioned for reverse drive of the weaving action.

Energization of winding 121 actuates relay switch 122, the contactor 123 of which is moved into engagement with a contact 132 and thus closes a circuit to the winding 79 of the switch 80 which controls the operation of head-motion motor 70 and certain other devices. The energizing of circuit for winding 79 includes a low voltage winding 133 (illustratively 110 volts) of a step-down transformer whose high voltage winding 134 is connected by conductors 128—129 to one phase of the main power circuit; from winding 133, the energizing circuit for winding 79 proceeds by way of conductor 135, conductor 136, conductor 137, winding 79, conductor 138, contact 132 of relay switch 122, contactor 123, and by way of conductor 140 back to the other side of winding 133.

Switch 80 is thus moved to close the circuit to the motor 70 by switch blades 74, 75, and 76, thus starting the motor 70, and at the same time the circuit of winding of clutch solenoid 86 is broken by switch blade 77 so that movable clutch member 82 is moved by the spring 83 into engagement with the companion clutch member 85, so that motor 70 can drive the head-motion to reverse the weaving action but this drive is preferably to be only of selectable or predetermined extent, such as for example only one turn of the head-motion, and accordingly a suitable timing mechanism is brought into action to interrupt the just-described drive by the motor 70 at the desired point. Such timing mechanism may be of any suitable or desired form and preferably is arranged to cause actuation of the switch 80 in opening direction, thus to halt the drive of head-motion motor 70 and also to again energize winding of clutch solenoid 86 to hold clutch 81 in disengaged position. Conveniently, therefore, the timing mechanism is arranged to de-energize winding 79 of the switch 80, after the lapse of the desired time interval.

Illustratively and preferably, such mechanism may comprise a vacuum tube type of time delay relay diagrammatically indicated at 141 and it may be of any desired or suitable construction. Thus, it may include a contactor 142 normally in closed position and adapted to be actuated into open position only after the lapse of the desired time interval. The contactor 142, when thus actuated into open-circuit position, is to de-energize the winding 121 of the relay 122 and since the actuation of the push button switch 120 may be only momentary, provision is made for the actuation of a suitable holding switch to keep closed the circuit initially or momentarily closed by the push button itself. Such a holding switch is preferably provided in the construction of the relay switch 122, as by an additional contact 154 with which the contactor 124 engages upon initial energization of its winding 121 by the push button 120.

The resultant holding circuit preferably also includes the contactor 142 of the time relay 141 and the circuit extends from the transformer winding 126, conductor 131, winding 121, conductor 130, conductor 143, contactor 142 (in closed position), conductor 144, switch blade 103 of the double-throw switch 100, contact 112, conductor 155, contact 154, contactor 124, and by way of conductor 128a back to the other side of the transformer winding 126. Inclusion of contact 112 and switch blade 103 of the switch 100 in this holding circuit also insures against possible closure of that circuit during normal operation of the loom in forward direction, with the warp beam motor 93 driving the warp beam in let-off direction under the variable speed control of the whip-roll controlled rheostat 110, switch 100 being in its position to the left and thus interrupting this holding circuit at contact 112; this same arrangement, furthermore, is made to function, as is later described, also to insure against energization of this holding circuit when certain other parts are operated.

With the energization of relay winding 121 thus maintained, the circuit of main switch winding 79 is also held closed, at contactor 123 and contact 132 of the relay switch 122. The initial actuation of the switch 80 by winding 79 also closes a circuit at contact 145 to energize the vacuum tube circuit within the relay 141 to effect actuation in opening direction of the contactor 142 after the lapse of the desired time interval. Energization of the vacuum tube time delay relay 141 is achieved from the 110 volt transformer winding 133 which is connected by conductors 135 and 146 to binding posts 147 and 148 to supply the vacuum tube circuit with suitable high voltage, the initiation or starting of the vacuum tube circuit to effect the running of the desired time

interval being effected by the closure at switch blade 78 and contact 145 of a line which extends from one side of the transformer winding 133, then conductor 135, conductor 136, switch contact 145, switch blade 78, conductor 150, to binding post 151 of the time delay device 141.

The internal vacuum tube arrangements and circuits are not shown in the diagram, excepting the diagrammatic indication at 152 of a suitable winding or windings to actuate the switch contactor 142, since the vacuum tube circuit arrangement is per se not my invention and may take any suitable or known form, it being sufficient to point out simply that winding 152 is energized to move the contactor 142 into open-circuit position after the lapse of the desired time interval, the vacuum tube circuits including, in known manner, such elements or factors, preferably adjustable so as to vary the time delay period, as resistances, inductances, and condensers such that, for example, the leakage of current through a condenser takes place at such a low rate as to effect, by suitable means or arrangements, energization of the winding 152 to open the contactor 142 only after the desired time integral has elapsed.

When that happens, winding 121 of relay switch 122 is deenergized, opening the circuit of main switch winding 79 at the contactor 123 and fixed contact 132, thus restoring the various parts controlled by the main switch 80 to their initial positions.

When relay switch 122 is actuated, upon energization of its winding 121, as above-described, the movement of contactor 124 of relay switch 122 disengages it from a fixed contact 153 and brings it into contact with the above-noted fixed contact 154, thus also closing a circuit to winding 107 of the switch 106 in the circuit of the warp drive motor 93. The resultant actuation of switch member 106 into closed position starts the warp-drive motor 93 which operates in reverse direction in as much as switch 100 is thrown to the right. The speed of drive in reverse direction may be manually set by hand rheostat 111. Since warp drive motor switch 106—107 and switch 80 of the head-motion motor 70 are both actuated in response to actuation of the relay switch 122 which in turn is actuated into starting position by the push button switch 120, the pattern chain and the cloth take-up roll and the warp beam B are thus driven in reverse direction. This reverse drive is initiated by the operator, in the manner above-described, when for example it is necessary to replace a broken filling thread; the warp beam motor 93 thus takes up the warp threads and maintains tension on them that is appropriate for and during the reverse travel of the warp threads through the loom head, and in step with the let-off of the cloth from the cloth take-up roll, the speed of drive of the warp drive motor 93 for this purpose being manually controllable or capable of being set by the rheostat 111 which is brought into the speed control circuit by the movement of switch 100 into its right-hand position in which it is held locked by the shift lever 42 when the latter was initially actuated to condition various of the loom parts for reverse drive.

Usually, the breakage of a thread, as is well known, automatically stops the entire drive of the loom whose controls are well known and therefore not shown but include a loom starting lever 159 which is tripped into stopping position when a condition like a broken thread automatically stops the loom drive. In Figure 2 I have shown the starting lever 159 in tripped or stopping position. Accordingly, when the loom is thus automatically stopped, the tripping of the starting lever 159 into stopping position interrupts the circuit of switch winding 107 at the contactor 160, switch 106 thereupon opening to stop the warp drive motor 93. Contactor 160 remains in open position but, upon shifting of the shift lever 42 and actuation of the push button 120, to effect reverse drive of the pattern chain and of the warp beam, switch winding 107 is again energized by the relay switch 122 closing an energizing circuit for winding 107 so as to move the switch 106 into closed position. Reverse drive of the warp motor 93 thus starts substantially simultaneously with the reverse drive of the pattern chain and cloth roll by motor 70, and the circuit arrangements are such that both of these drives are halted substantially simultaneously.

The circuit closed by relay switch 122 at contact 154 extends from low voltage winding 126 of the transformer 126—127, conductor 128ª, contactor 124, contact 154, conductor 155, switch contact 112, conductor 156, switch winding 107, and then by way of conductor 157 back to the transformer winding 126.

This circuit, however, is interrupted, and the reverse drive is stopped, when winding 121 of relay switch 122 is de-energized by the time-delay relay 141, for winding 107 is de-energized by the now-open switch 124—154 and switch 106 opens to stop the warp drive motor; at the same time, winding 79 of the main switch 80 is open-circuited at 123—132 and switch 80 restored to open position. Thus the reverse drive by both motors 93 and 70 is halted substantially simultaneously.

The time interval determined, illustratively by the electronic time relay 141, may be, illustratively, of such duration that the reverse drive is sufficient to effect replacement of one pick or filling thread. If additional reverse drive is necessary, as for the replacement of a second broken filling thread, the operator simply pushes the push button 120 again, shift lever 42 being still in shifted counterclockwise position and switch 100 being still in its right-hand position for reverse drive of the warp beam motor 93, whence relay switch 122 is again actuated, thus to energize switch control winding 79 and cause actuation of clutch 81 and of motor 70 and also again to energize switch winding 107 to close warp drive motor switch 106; the resultant reverse drive, by both motors, again continues until the time control, as by the electronic relay 141, is again actuated to halt both drives. The push button switch 120 may thus be actuated as many times as is necessary according to the number of picks to be replaced. The extent or amount of reverse drive may be adjusted or predetermined by appropriately setting or adjusting the time delay relay 141.

Both motors, however, may be stopped in their reverse drive at any time, while under the control of the time-relay 141, by opening the multiple switch 100 which interrupts the circuit of the warp drive motor 93 and which, at switch blade 103, interrupts the circuit through which the relay switch winding 121 is held energized by the time-delay relay 141.

Opening of main switch 80 also, at contact 145 and blade 78, opens the auxiliary circuit 150—136 of the time delay relay 141, restoring the latter to normal condition and allowing its contactor 142 to restore to normal closed position.

After the time delay relay 141 has operated to

de-energize relay switch winding 121 and thus halt both motors, and the operator has replaced the pick, the loom is now ready to commence normal operation and hence the operator first actuates the shift lever 42, diagrammatically in clockwise direction in Figure 2, thus to restore the normal forward drive of the head-motion and related parts from the shaft 10, through the clutch 37 and thus also actuating the multiple switch 100 to move it from the right to the left, thus conditioning the circuit of the armature 94 of the warp drive motor 93, at switch blades 96—99, for operation in forward direction, and also, at switch blade 102 and contact 109, connecting the generator field winding H into an energizing circuit which includes the automatically actuated or whip-roll controlled rheostat 110 as above-described; switch 100 also puts a break, at switch blade 101 and contact 108, in the circuit of relay switch winding 121 so that it cannot be energized by push button switch 120, and the interruption at switch blade 103 and contact 112 prevents energization of relay winding 121 when starting the loom under manual control of starting lever 159. The operator next actuates the loom starting lever 159, placing its contactor 160 in closed position.

Contactor or switch 160 thus effects closure of the switch 106 of the warp drive motor 93 so that it drives in forward direction at a speed determined by the automatically actuated rheostat 110. The circuit closed by the contactor 160 extends from the transformer winding 126, conductor 128a, relay switch contactor 124, contact 153, conductor 161, contactor 160 (closed), conductor 162, switch winding 107, and then by way of conductor 157 back to the other side of transformer winding 126. Movement of loom starting lever 159 into stopping position opens the just-described circuit and halts the warp drive motor 93.

Since the contactor 142 of time relay 141 is in closed position upon completion of the joint reverse drives by motors 70 and 93 and when starting lever 159 is moved to start the loom for normal operation and thus also to close switch 160, provision is made to guard against energization of winding 121 of the relay switch 122 when switch 160 is closed by the starting lever 159; for this purpose I make use of the auxiliary contact 112 and the switch blade 103 of the switch 100 which, upon setting of the shift lever 42, is put in its left-hand position, and hence energization of relay winding 121 does not take place because the possible circuit to do so, namely, transformer winding 126, winding 121, conductors 130—143, contactor 142 (closed), conductor 144, switch blade 103, contact 112, conductors 156—162, switch 160 (closed), conductor 161, contact 153, contactor 124 (closed), conductor 128, transformer winding 126, is open at switch blade 103 (to the left).

Normal operation of the loom is thus restored, the tension on the warp threads W being automatically maintained substantially constant by the speed control of the warp drive motor 93 in response to shifts in the position of the whip-roll 59 caused by changes in tension, the whip-roll 59 also effecting resetting of its position by effecting actuation of the switch mechanism S, to reverse the warp beam drive, when conditions arise in the loom such as bring the whip-roll 59 rearwardly or to the left in Figure 1a to or beyond a selectable position which may be adjusted or selected by appropriately adjusting the length of switch actuator 65k on the crank 65. Breakage of a filling thread automatically stops the loom and trips the starting lever 159 into stopping position, opening the circuit of switch winding 107 at contactor 160 and thus also halting the drive of the warp beam motor 93. To effect drive, the operator shifts the shift lever 42 to disengage or unclutch the normal forward drive of the loom as at clutch 37, the same operation of shifting lever 42 actuating switch 100 to the right to condition the various control circuits for push button and other automatic control and also to condition the circuit of the warp motor 93 for reverse drive; the operator then pushes button switch 120, whereupon motor 70 and clutch 81 effect drive to reverse the weaving action and warp motor 93 drives the beam B in take-up direction, all for and during a controllable time interval or extent of reverse drive, determined illustratively by the time relay 141. The operator replaces the pick, and if no more replacements are necessary, he shifts shifting lever 42 to condition the head-motion drive, at clutch 37, for forward drive from the main drive of the loom, the actuation of the shift lever 42 shifting the switch 100 to its left-hand position, thus conditioning the circuit of the warp drive motor 93 for normal forward drive under variable speed control by the whip-roll, at the same time conditioning the head-motion motor controls against accidental or unintentional actuation, and conditioning the warp drive motor switch 106 for control by the starting lever 159. Upon resetting the starting lever 159 and pattern chain pin 28 into starting position, the weaving action and related drives start up in forward direction and warp motor switch 106 closes at the same time to start drive of the warp beam under the control of the whip-roll.

It will thus be seen that there has been provided by this invention a method and apparatus in which the various objects hereinabove set forth together with many thoroughly practical advantages are successfully achieved. As various possible embodiments might be made of the mechanical features of the above invention and as the art herein described might be varied in various parts, all without departing from the scope of the invention, it is to be understood that all matter hereinbefore set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

What I claim is:

1. In combination with the head motion of a loom a main source of power for forward drive of the loom, a first clutch means for connecting and disconnecting said head motion and said source of power for forward drive, and a movable member adapted in one position to engage said first clutch means and in another position to disengage said first clutch means, a second source of power, a second clutch means for connecting and disconnecting said head motion and said second source of power, an electrical circuit including said second source of power, and control means for said second clutch means, a control switch, and a second switch connected to said movable member and adapted to be closed by the movement of said movable member to disengage said first clutch means, the closing of said second switch serving to condition said circuit so that said control means for said second clutch means is actuated to engage said second clutch upon the closing of said control switch, and timing means adapted to actuate said second

clutch control means after a predetermined interval to disconnect the said head motion from its said second source of power.

2. In a loom in combination with the cylinder gears for the harness frame and shuttle boxes, a drive member connected to the said gears, a main source of power, and means to connect and disconnect said main source of power and said member, a second source of power, and means operable simultaneously with the disconnecting from said member of said first source of power to condition means for connecting said second source of power to said member, means for completing the connection between said second source of power and said member and means serving to limit the duration of the said connection between said member and said second source of power.

3. In combination with the head motion of a loom, and drive means therefor, a main source of loom power, clutch means for interconnecting said head motion drive means and said main source of power for forward drive of the loom, a second source of power, and a second clutch means for interconnecting said head motion with said second source of power for reverse drive of the loom, control means for engaging and disengaging said second clutch means, and means operative when said first clutch means is disengaged to condition the said control means to engage said second clutch means upon the actuation of a manual control, manual control means for completing the actuation of said control means, and timing means adapted to actuate said second clutch control means to disengage said second clutch means after a predetermined interval of time, a warp beam, reversible means for driving the warp beam, and means operative substantially simultaneously with the engaging of said second clutch means to reverse the warp beam drive.

4. In combination with a loom having a head motion including pattern control means and cloth take-up roll driven during forward drive of the loom by a main source of power, and means for disconnecting said head motion and said take-up roll from said main source of power, a second source of power, clutch means for interconnecting said second power source and said head motion for driving said head motion during reverse drive of the loom, means operative upon disconnecting said head motion from said main source of power to connect said head motion to the cloth take-up roll for let-off of said roll during drive of the head motion by said second source of power, means to reverse the pattern control means during reverse drive of the loom, an electric circuit including a first switch, a second switch so related to said means for disconnecting the head motion from the main source of power that it is closed when said disconnecting means is actuated, means actuated upon the closing of said first switch to engage said clutch means provided said second switch is also closed, and timing means adapted to open said first switch after a given interval and thus to disengage said clutch and terminate the reverse drive of the loom.

5. In a loom in combination with the head motion the cloth roll and the warp beam, and means for driving the warp beam forwardly or in reverse, a main loom source of power for forward drive including drive of the head motion, means for disconnecting the head motion drive from the main loom source of power and simultaneously connecting it to the cloth take-up roll for actuation of the cloth roll in let-off direction, means independent of the main loom drive for driving said head motion for reverse of the weaving action and for let off of the cloth roll, said means comprising an electric circuit adapted when closed to actuate said warp beam drive means for reverse drive, and timing means adapted to open said circuit after a predetermined interval.

6. In a loom in combination with means for reversing the pattern control means and the cloth roll drive, and the warp beam, means for driving said warp beam forwardly and in reverse, control means for the forward drive of said warp beam, control means for the reverse drive of said warp beam, and means operable simultaneously with said pattern and cloth roll reversing means to cut out said control means for the forward drive of said warp beam, and to actuate said control means for the reverse drive of the warp beam, and timing means adapted to disconnect said reversing means and to condition said warp beam drive for forward drive after the warp in said loom has moved backward a desired distance.

7. In a loom in combination with the cloth roll, the warp beam, and the head motion, means independent of the main loom drive for driving said head motion, means operative when said independent means is operative to reverse the rotation of the cloth roll to cause it to let off the cloth, means independent of the main loom drive for driving said warp beam, control means, means operable upon actuation of said control means for interconnecting said head motion and its said independent driving means, and for conditioning said warp beam for reverse drive, and other means actuated by said control means for cutting out said warp beam conditioning means and for disconnecting the head motion and its said independent drive means after a timed interval.

8. In a loom in combination with a head motion, means for disengaging said head motion from a main source of power, a warp beam and reversible means for driving said warp beam, a second source of power for driving said head motion, means operative upon disengagement of said head motion from said main source of power to condition means to engage said head motion with said second source of power upon the operation of manual control means, and manual control means therefor, said means being so related to said warp beam drive means that the latter is reversed upon actuation of said means.

9. In a loom, in combination with the head motion including the pattern control means, means for reversing the pattern control means, the cloth roll and the warp beam, means for driving said head motion during forward drive of the loom, driving means for said warp beam having reversing means for reversing the direction of drive of the warp beam and having means for varying the speed of drive of the warp beam, means responsive to changes in tension of the warp for controlling said speed varying means to vary the speed of drive of said warp beam in warp let-off direction, other means for driving the head motion to back up the cloth roll and the pattern control means, means to effect actuation of said warp drive reversing means to drive the warp beam in tape-up direction, and means operable to make said speed varying means ineffectual to respond to changes in tension of the warp threads during backward drive of said cloth roll and pattern chain and said warp beam.

10. In a loom, in combination with the head motion and the warp beam, means for driving said head motion for forward weaving action,

means for driving said head motion to reverse the weaving action, means for automatically timing the reverse drive and automatically stopping the reverse drive at a predetermined point in the weaving cycle, means for driving said warp beam in take-up direction, and means making said warp beam drive effective for the extent of the reverse weaving action.

11. In a loom, in combination with the pattern chain, the cloth roll and the warp beam, means for driving said pattern chain and cloth roll and operable to drive them in either forward or reverse direction, means for driving said warp beam and operable to drive it in either let-off or take-up direction, means responsive to changes in tension of the warp threads during forward drive of the pattern chain and cloth roll for changing the speed of drive of said warp beam by said drive means in let-off direction, and means making said tension-responsive means ineffective during concurrent drive by their respective drive means of said pattern chain and cloth roll in reverse direction and said warp beam in take-up direction.

12. In a loom, in combination with the pattern chain, the cloth roll and the warp beam, means for driving said pattern chain and cloth roll and operable to drive them in either forward or reverse direction, means for driving said warp beam and operable to drive it in either let-off or take-up direction, means operating during forward drive of said pattern chain and cloth roll, and during drive of the warp beam in let-off direction, to effect drive of the warp beam by its drive means in take-up direction in response to increase in the reach of the warp threads from the warp beam to the cloth roll and operable to halt said take-up drive in response to restoration of the desired reach, and means making said reach-responsive means ineffective during concurrent drive by their respective drive means of said pattern chain and cloth roll in reverse direction and of said warp beam in take-up direction.

13. In a loom, in combination with the pattern chain, the cloth roll and the warp beam, a source of power for driving said pattern chain and cloth roll in forward direction, a source of power for driving said pattern chain and cloth roll in reverse direction, means for driving said warp beam in warp take-up direction, interdependent control means for said sources of power whereby only one of them is effective at a time to drive said pattern chain and cloth roll, and means making said warp beam driving means effective for take-up concurrently with, and continuously for the extent of, the drive of said pattern chain and cloth roll in reverse direction by said second source of power.

14. In a loom in combination with a pattern chain, the cloth roll and the warp beam, means for driving said pattern chain and cloth roll and operable to drive them in either forward or reverse direction, means for driving said warp beam and operable to drive it in either let-off or take-up direction, means operating during reverse drive of said pattern chain and cloth roll and during drive of the warp beam in take-up direction to effect a change in the direction of drive of the warp beam by its drive means and cause it to the be driven in let-off direction in response to decrease in the reach of the warp threads from the warp beam to the cloth roll and operable to halt said let-off drive in response to increase in the reach of the warp threads beyond a given extent.

15. In a loom in combination with a pattern chain, the cloth roll, and the warp beam, means for driving said pattern chain and cloth roll and operable to drive them in either forward or reverse direction, means for driving said warp beam in either let-off or take-up direction including means responsive to changes in tension of the warp threads during forward drive of the pattern chain and cloth roll for changing the speed of drive of said warp beam in let-off direction, and means operable during reverse drive of said pattern chain and cloth roll to reverse the drive of said warp for the extent necessary to restore the tension within said permissible range of variation.

16. In a loom, in combination with the head motion, drive means for the head motion and including selectively operable control means for effecting forward or reverse drive of the head motion, a warp beam, drive means for said warp beam adapted to drive it either in take-up or let-off direction, control means for the warp beam drive means having means interlocking it with said selectively operable control means so that the warp beam drive is in take-up direction during reverse drive of the head motion and is in let-off direction during drive of the head motion in forward direction, means responsive to changes in tension of the warp during drive of the warp beam in let-off direction to control the speed of drive of the warp beam, and means for controlling the speed of drive of the warp beam in take-up direction during reverse drive of said head motion.

17. In a loom, the combination with the head motion and a main loom power drive therefor including clutch means for connecting or disconnecting the head motion and the drive, an electric motor for driving the head motion in reverse direction, a warp beam, means for driving said warp beam comprising an electric motor, a reverse switch operable to determine the direction of drive of said second motor in either warp let-off or warp take-up direction, an electric circuit including a switch for controlling said first motor and including timing means for actuating said switch to halt its drive of the head motion in reverse direction, means responsive to changes in the length of the reach of warp from the warp beam to the head motion for actuating said reversing switch to maintain the length of the reach within limits during forward drive of the head motion, means for actuating said clutch in a direction to disconnect the head motion drive from said loom drive and for shifting said reversing switch to a position to effect reversing drive of said second motor, and means responsive to actuation of said last-mentioned means to make ineffective said reach-responsive means and to condition the circuit and controls of said first motor for drive of the head motion in reverse under control of said timing means.

18. In a loom, the combination with the head motion of, drive means for the head motion including selectively operable control means for effecting forward or reverse drive of the head motion, said control means including electro-responsive actuating means, a warp beam, drive means for said warp beam adapted to drive it in either take-up or let-off direction and including control means therefor for determining the direction of drive and for halting the drive of the warp beam, an electric relay circuit having therein an electro-responsive relay switch with a starting switch therein and a stopping switch

therein, means responsive to actuation of said relay switch to make said electro-responsive actuating means effective to actuate said selectively operable control means for reverse drive of the head motion, timing means made effective in response to reverse drive of the head motion and adapted to actuate said stopping switch after the lapse of a time interval, means responsive to actuation of said stopping switch for operating upon said warp beam drive control means to halt the drive of the warp beam, and means dependent upon said warp beam drive means control for preventing actuation of said relay switch under the control of said starting switch except when said warp beam drive control means is set for reverse drive of the warp beam.

19. In a loom, the combination with the head motion of, drive means for the head motion including selectively operable control means for effecting forward or reverse drive of the head motion, said control means including electro-responsive actuating means, a warp beam, a reversible electric motor for driving said warp beam, a reversing switch for said motor, an electro-responsive switch for starting and stopping said motor, a relay switch and an energizing circuit therefor including a start switch and a stop switch, means responsive to actuation of said relay switch for making said electro-responsive actuating means effective upon said selectively operable control means to effect reverse drive of the head motion and to actuate said electro-responsive start and stop motor switch into starting position, and means responsive to the position of said reversing switch for preventing actuation of said relay switch under the control of said starting switch except when said reversing switch is in position for reverse drive of the warp beam by its motor.

20. In a loom, the combination with the head motion of, drive means for the head motion including selectively operable control means for effecting forward or reverse drive of the head motion, said control means including electro-responsive actuating means, a warp beam, a reversible electric motor for driving said warp beam, a reversing switch for said motor, an electro-responsive switch for starting and stopping said motor, a relay switch and an energizing circuit therefor including a start switch and a stop switch, means responsive to actuation of said relay switch for

making said electro-responsive actuating means effective upon said selectively operable control means to effect reverse drive of the head motion and to actuate said electro-responsive start and stop motor switch into starting position, means including a switch in the circuit of said electro-responsive motor start and stop switch for halting the drive of the head motion in forward direction and through said motor switch halt the forward drive of the warp beam by its motor, means controlled by said relay switch for effecting actuation of said electro-responsive motor switch into motor starting position, and means interlocking said reversing switch and said electrical relay circuit whereby actuation of said relay switch under the control of said starting switch to effect reverse drive of the head motion and to effect actuation of said electro-responsive motor switch into starting position is accomplished by reverse drive of the warp beam motor.

21. The method of operating a loom to replace a broken pick which comprises driving the pattern chain and the cloth roll in reverse, positively driving the warp roll in reverse continuously for the duration of the reverse weaving action, and interrelating both drives to control their duration and render them co-extensive, timing the reverse drive of said pattern chain and cloth roll and stopping said reverse drive automatically at a predetermined point in the cycle of the pick.

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