

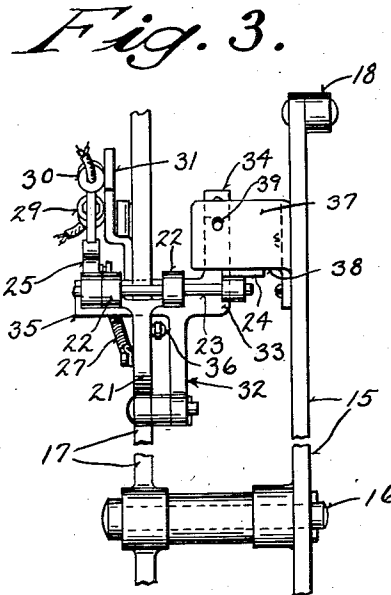
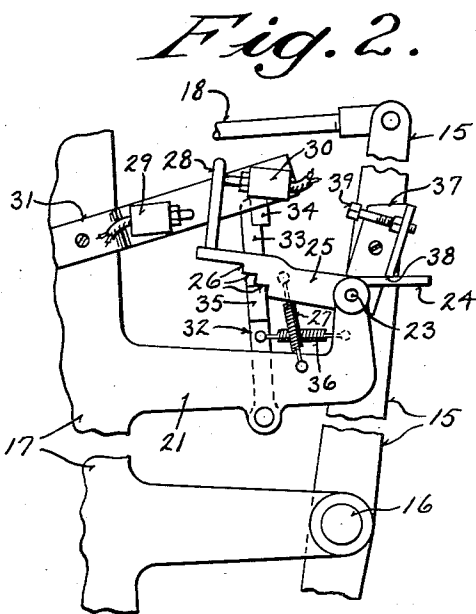
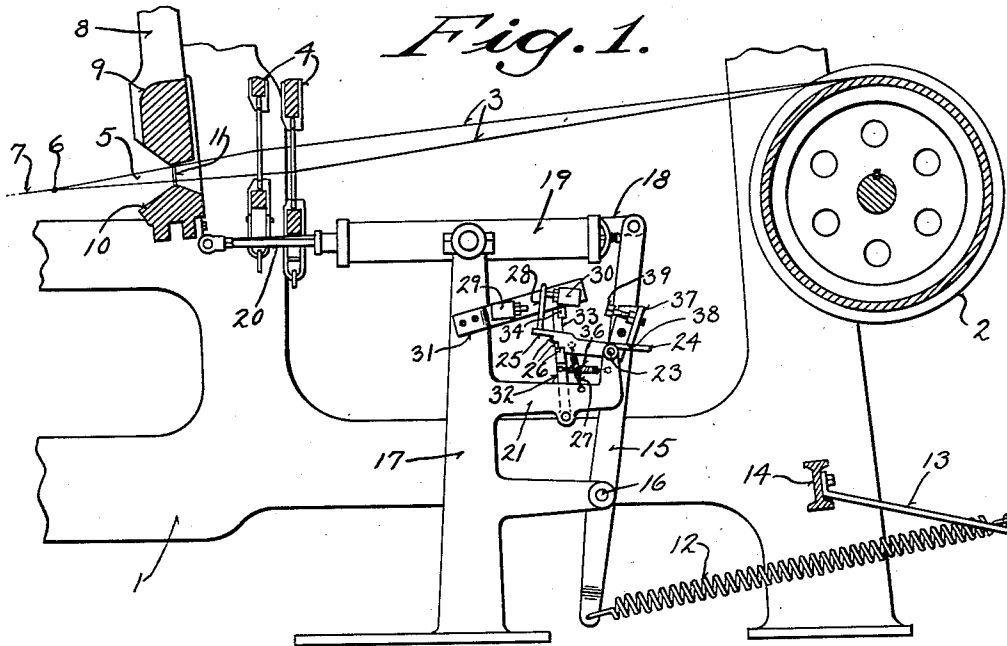
June 17, 1958

B. B. PURDY ET AL
SUPERVISORY CONTROL CIRCUIT

2,839,092

Filed Feb. 11, 1955

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

Fig. 4.

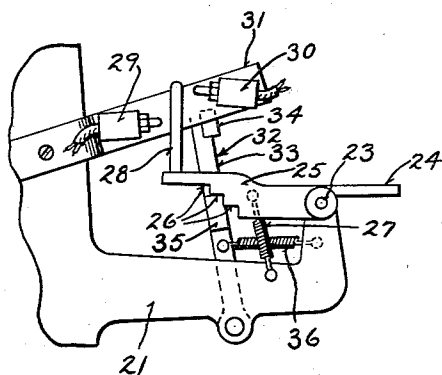


Fig. 5.

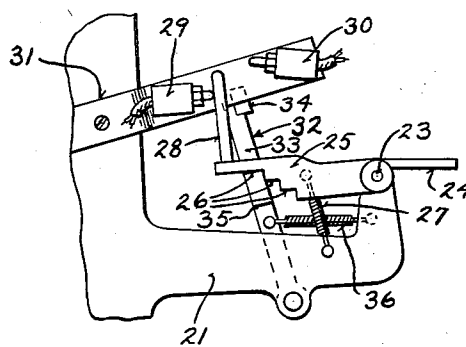
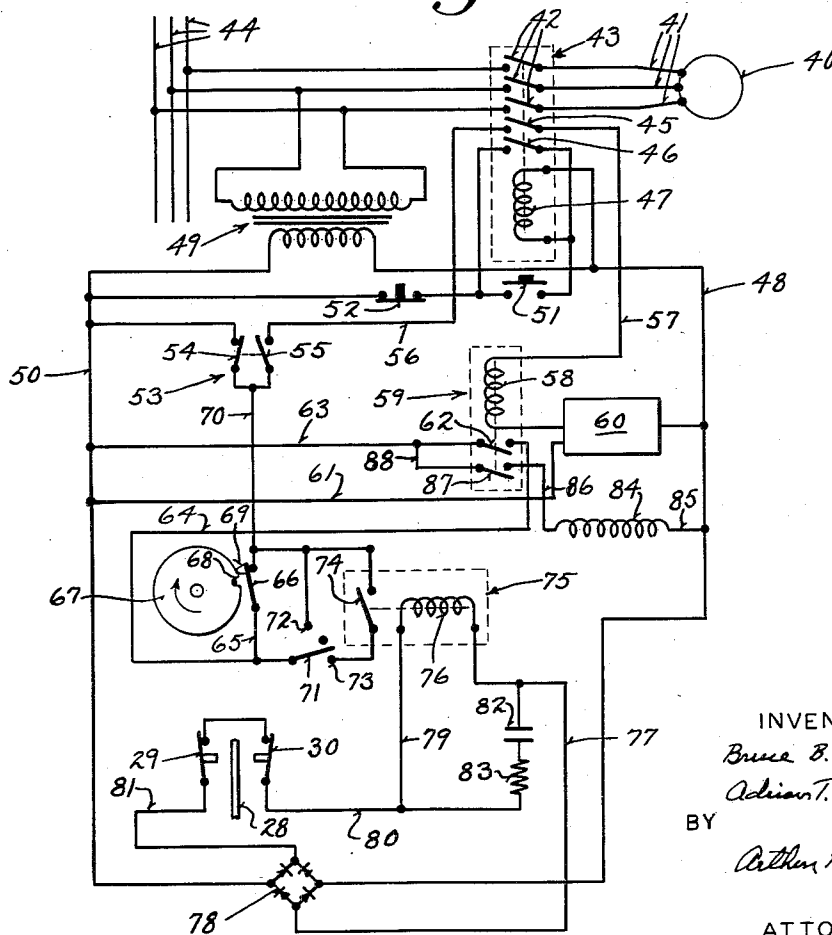


Fig. 6.



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2,839,092

SUPERVISORY CONTROL CIRCUIT

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Application February 11, 1955, Serial No. 487,522

13 Claims. (Cl. 139—336)

This invention relates principally to the governing of a loom operation, and as such resides more specifically in a control having a switch actuator movable to a position corresponding to the position of the beat line formed by the woven cloth, switch means which are in turn actuated by the switch actuator, and an electrical responsive element operable by the switch means to indicate whether the beat line is within a desired range of positions for continuation of the weaving operation.

In the weaving of Fourdrinier wires the spacing between weft threads must be regular and uniform throughout the cloth. In the usual weaving operation of this sort the lay advances toward the beat line with a very substantial kinetic energy, which energy is absorbed by the woven cloth as a weft is beat into position. Since the energy of the lay will vary as it moves through its stroke, the force of the blow delivered by the lay will be determined, to a degree, by the position of the beat line. The energy absorbed in arresting the lay affects the degree of penetration of the weft being beat between the warps, and also affects the formation of the knuckles in both the weft and the warp threads. As a consequence, the observance and consequent regulation of the beat line position is essential in the production of Fourdrinier wires.

It is an object of this invention to provide a control for a loom whereby the uniformity of spacing between adjacent wefts may be enhanced through continual automatic observance of beat line position for improving the quality of the cloth produced.

It is another object of this invention to provide a control for a loom that senses the beat line position and indicates to the operator a shift of the beat line position requiring an adjustment of the beat line to within a proper range of positions.

It is another object of this invention to provide a control for a loom that relieves the operator from making a visual inspection of the beat line as weaving progresses.

It is another object of this invention to provide a control for a loom that tests the beat line position to determine whether it is within a selected range of positions that is satisfactory for forming uniform cloth, and which causes the loom to be shut down at a particular predetermined point in the weaving operation in the event that the beat line has shifted outside said range.

It is another object of this invention to provide a control circuit network for a loom that is responsive to an indication of the beat line position occurring during one interval in the stroke of the lay, and which performs a signaling function in a subsequent interval of the lay stroke, at which time it is more advantageous to interrupt the weaving operation.

These and other objects and advantages of this invention will appear from the description to follow. In the description reference is made to the accompanying drawings which form a part hereof, and in which there is shown by way of illustration and not of limitation a specific form in which the invention may be embodied.

In the drawings:

Fig. 1 is a fragmentary side view in elevation and in section of a loom in which this invention is embodied,

Fig. 2 is a fragmentary side view in elevation of a portion of the loom showing switches and switch actuating apparatus employed in the practice of the invention,

Fig. 3 is a fragmentary rear view in elevation of the portion of the loom shown in Fig. 2,

Fig. 4 is another fragmentary side view in elevation of the portion of the loom shown in Fig. 2, with parts thereof in an alternative position,

Fig. 5 is another fragmentary side view in elevation of the portion of the loom shown in Fig. 2, with parts thereof in still another alternative position, and

Fig. 6 is a schematic wiring diagram of a control circuit for the loom that may be employed in the practice of the invention.

Referring now to the drawings, there is shown in Fig. 1 a side view in section of portions of a loom with which the present invention is associated. A left hand side frame 1 supports one end of a warp roll 2 from which a plurality of warp threads 3 are led forwardly. The warp threads 3 pass through a pair of heddles 4 which are vertically shifted in position with each beat, in the usual manner, to form the warp threads 3 into a shed 5. It is through the shed 5 that the weft threads, not shown, are laid by the usual shuttle operation, and at the apex of the shed 5 is the beat line 6. The beat line 6 is the rear edge of the woven cloth 7, which in turn is led forwardly.

The bottom portion of a lay 8 is shown with the lay cap 9 and the lay bottom 10 in section. Between the lay cap 9 and lay bottom 10 is a reed 11 through which the warps 3 pass as they advance to the beat line 6. The lay 8 is reciprocally mounted, so as to swing in a pendulum-like fashion, such that the reed 11 is moved from the retracted position shown in Fig. 1 forwardly, or to the left, toward the beat line 6. The forward movement of the lay 8 is in response to both gravity and the action of a lay spring 12 at the bottom and to the rear of the loom. One end of the lay spring 12 is secured to a stationary bracket 13 bolted to a beam 14 extending between the left side frame 1 and a similar side frame at the right hand side of the loom, which is not shown. The forward end of the lay spring 12 is secured to the bottom of a lever 15 that is pivoted by a pin 16 to a stand 17. The upper end of the lever 15 is pivotally connected to a link 18 which extends forwardly to a connection with the lay bottom 10. Thus, upon permitting the lay 8 to fall, by reason of gravity, so as to advance forwardly in a beat motion toward the beat line 6 the lay spring 12 augments the energy of the lay 8 by urging the lever 15 in a counterclockwise movement, as shown in Fig. 1, to urge the link 18 forwardly against the lay bottom 10. The forward movement of the lay 8 carries a weft thread, laid in the shed 5, forwardly toward the beat line 6, so as to perform a beating action in which the weft becomes a portion of the woven cloth 7, that defines the beat line 6.

The full impact of the lay 8 is borne by the woven cloth 7 along the beat line 6 and the penetration of the weft being beat between the warps 3, forming the shed 5, will be dependent upon energy of the lay 8, the spring 12 and connecting parts as it strikes the beat line 6. Thus, the spacing between adjacent weft threads, that have been beaten into the woven cloth 7, will be dependent, in a degree, upon beat line position.

To retract the lay 8 from its forwardmost position at the beat line 6 there is provided a lay retraction cylinder 19 pivotally supported at the top of the stand 17. Extending forwardly from the lay retraction cylinder 19 is a piston shaft 20 joined to the bottom of the lay 8.

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The piston shaft is operated by action of a piston in the cylinder 19, which is drawn rearwardly within the cylinder 19 after completion of the beating motion of the lay 8 in well-known fashion.

A support arm 21 is formed as an integral rearward extension of the stand 17, and the rear of the support arm 21 turns upwardly and is bifurcated to present a pair of spaced bearings 22, as is more clearly shown in Fig. 3. Rotatably supported by the bearings 22 is a shaft 23, to one end of which there is affixed a rearwardly extending lever 24, that may be depressed to cause a clockwise rotation of the shaft 23, as viewed in Figs. 1, 2, 4 and 5. At the opposite end of the shaft 23 is a forwardly extending step table 25 that is formed on the underside with a set of steps 26. A bias spring 27 is attached at one end to the step table 25 and at its opposite end to the support arm 21 to urge the steps 26 downwardly.

Similarly as the lever 24, the step table 25 is fixed to the shaft 23 for movement in unison therewith, and a downward movement of the step table 25 is accompanied by a rise of the lever 24. Extending upwardly from the forward end of the step table 25 is a switch actuator blade 28 that extends between a pair of switches 29 and 30 mounted upon a bracket 31 that is attached to the stand 17.

A knock-off arm 32 is pivotally supported at its lower end by the arm 21 and branches into an upwardly extending finger 33 presenting an abutment pad 34, and a horizontally extending latch 35 that engages the steps 26 of the step table 25. The configuration of the knock-off arm 32 is clearly shown in Figs. 2 and 3. A spring 36 is joined at one end to the knock-off arm 32 and extends rearwardly therefrom to the upright portion of the support arm 21 to urge the knock-off arm 32 to pivot rearwardly, or in a clockwise direction as shown in Figs. 1, 2, 4 and 5.

A bracket 37 is secured to one side of the lay actuating lever 15 and presents a cam edge 38 that extends above the lever 24 fixed on the shaft 23. The bracket 37 also mounts a threaded tappet 39 extending forwardly in a position to strike the abutment 34 of the knock-off arm 32 upon the lay actuating lever 15 moving counterclockwise, as shown in Figs. 1 and 2. A movement of the lay actuating lever 15 in the reverse direction will carry the cam edge 38 against the lever 24 and depress the same to raise the steps 26. Thus, movements are imparted to both the step table 25 and the knock-off arm 32 in response to movements of the lever 15, and hence of the lay 8.

With the lay 8 in retracted position the link 18 is shifted rearwardly and the upper portion of the lever 15 is moved rearwardly. The bracket 37 is likewise in its rearward position and the cam edge 38 retains the lever 24 depressed. With the lever 24 depressed, the shaft 23 is rotated to raise the step table 25 against the bias of the spring 27, whereby the spring 36 moves the knock-off arm 32 rearwardly to bring the latch 35 against the riser of the rearwardmost step 26. This described position of the step table 25 and knock-off arm 32 is shown in Figs. 1 and 2, and corresponds to a retracted lay position, from which the lay 8 will commence its stroke, of a forward beat motion to the beat line 6 and a retraction to the original position. With the step table 25 raised, the switch actuator blade 28 depresses the plunger of the switch 30, to place the contacts thereof in an open position.

As the lay 8 swings forwardly in its stroke, the upper portion of the lever 15 will move forwardly and the cam edge 38 of the bracket 37 will likewise be carried forwardly to free the lever 24. The shaft 23 and the step table 25, together with the lever 24, may now rotate in response to the bias spring 27, but as the cam edge 38 departs from the lever 24 the step table 25 will remain in its raised position, since the latch 35 is en-

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gaged in the lowermost step 26. The forward motion of the lay 8 will be arrested by the impact of the reed 11 against the woven cloth 7 at the beat line 6. As the lay 8 progresses toward this forwardmost position of impact the tappet 39 on the bracket 37 strikes the abutment 34 and carries the knock-off arm 32 forwardly. The extent of this travel is determined by the forwardmost advance of the lay 8, and hence is a measure of beat line position. The latch 35 of the knock-off arm 32 may be moved out of engagement with the lowermost step 26, thus permitting the step table 25 to fall in response to gravity and the bias of the spring 27. Depending upon the amount of forward displacement of the knock-off arm 32, the middle step 26 may engage the latch 35 as shown in Fig. 4, or the uppermost step 26 may engage the latch 35, as shown in Fig. 5. Also, it may be that the latch 35 will not advance out from under the lowermost step 26, and the position of the step table 25 will remain as shown in Figs. 1 and 2. The step table position is, therefore, a measure of beat line position and the switch actuator blade 28 engages the switches 29, 30 to give an indication for an electrical control circuit, to be described. For the position of Fig. 4 both switches 29, 30 are closed, and for the position of Fig. 5 the switch 29 is opened.

When the retraction of the lay 8 is initiated by the lay retraction cylinder 19 the tappet 39 will back away from the abutment 34. The cam edge 38 will then advance rearwardly and after a substantial retraction of the lay 8 will strike the lever 24 to rotate the shaft 23 and raise the step table 25 against the bias of the spring 27. The knock-off arm 32 will then be retracted in response to the spring 36, and the elements will again assume the positions shown in Figs. 1 and 2 upon completion of the lay stroke.

In the diaphragm of Fig. 6 there is shown a drive motor 40 for the loom that is connected through a set of leads 41 to one side of the power contacts 42 of an electromagnetic line switch 43. The opposite sides of the contacts 42 connect to power lines 44, and the line switch 43 also includes auxiliary contacts 45 and 46 and an operating coil 47. The coil 47 is connected at one end to a power lead 48 extending from the secondary of a control voltage transformer 49, the primary of which is attached to a pair of the power lines 44. The end of the secondary of the transformer 49, opposite that connected to the lead 48, is joined to a second power lead 50 to provide a reduced voltage between the leads 48, 50 for the control circuit now described. The end of the line switch coil 47, opposite that connected to the lead 48, is connected to the lead 50 through a normally open start button 51 and a normally closed stop button 52, and in parallel with the start button 51 are the auxiliary contacts 46 that provide a self-holding circuit for the switch 43 that shunts the normally open start button 51.

A main manual control switch 53 for initiating and stopping the weaving action of the loom includes a set of normally closed contacts 54 and a set of normally open contacts 55. One side of the normally closed contacts 54 is joined to the lead 50 and the opposite side is connected to one side of the normally open contacts 55. The side of the contacts 55 opposite that side connected to the contacts 54 is joined through a lead 56, the auxiliary contacts 45 of the line switch 43 and a lead 57 to one side of a coil 58 of a control relay 59. The opposite side of the coil 58 is connected through a control circuit network 60, represented in block diagram form, to the lead 48. The control circuit network 60 includes circuits that govern motions of the loom as weaving progresses. For example, it may contain circuit networks that control shuttle movements and test whether the shuttle is in proper position at certain periods in the loom operation. In the event a malfunction is detected the energizing circuit of the relay 59 is interrupted, which interruption terminates weaving in the manner to be de-

scribed. The circuit network 60 may also include means for governing heddle action and lay movement, and for testing the presence of warp and weft threads, as well as other functions of the loom. To provide operating voltage for networks in the circuit 60 connection is made through a lead 61 to the lead 50, in addition to the connection with the lead 43. The circuit network 60 does not play a part of the present invention, but is illustrative of that with which the invention may be employed.

One set of normally open contacts 62, for the control relay 59, are joined at one side through a lead 63 to the lead 50, and at the other side through a lead 64 and a lead 65 to one side of a cam switch 66. The cam switch 66 is operated by a cam 67, rotated through an appropriate drive connected with the motor 40, that has a detent 68 in which a cam follower 69 of the cam switch 66 will fall to momentarily open the cam switch 66 for a short interval once in each rotation. The side of the cam switch 66 opposite the lead 65 is joined through a lead 70 to the common connection between the contacts 54 and 55 of the main control switch 53.

The cam switch 66 is also connected through the leads 65 and 64 to a three position manual switch 71. The switch 71 has an open position, a first closed position in which the switch arm closes a contact 72 to place a short about the switch 66, and a second closed position in which a contact 73 is closed to place the normally open contacts 74 of a test relay 75 in shunt with the cam switch 66. The test relay 75 includes a coil 76 having one end connected through a lead 77 to the output of a rectifier 78, which rectifier 78 has the input terminals thereof connected between the leads 48 and 50. The opposite end of the coil 76 is connected through a lead 79 and a lead 80 to one side of the switch 30. The opposite side of the switch 30 is connected to one side of the switch 29, and the opposite side of the switch 29 in turn is connected through a lead 81 to an output terminal of the rectifier 78. Disposed across the coil 76 of the test relay 75 is a capacitor 82 and a resistance 83, which are shown as being connected in series between the leads 77, on the one side, and the leads 79 and 80, on the other side.

To complete the circuit of Fig. 6 a clutch coil 84 is connected at one end through a lead 85 to the power lead 48 and at the opposite end through a lead 86, a second set of normally open contacts 87 of the control relay 59, a lead 88 and the lead 63 to the power lead 50. The clutch coil 84 forms a part of a clutch, not shown, interposed between the motor 40 and the elements of the loom that are motor driven. Energization of the coil 84 engages the clutch and alternatively deenergization opens the clutch to discontinue weaving.

Upon depressing the start button 51 the coil 47 of the line switch 43 is energized and the contact 42 will close to start the motor 40. The accompanying closure of the auxiliary contacts 46 of the line switch 43 sets up a self holding circuit for the coil 47 that bypasses the start button 51, so that the button 51 may be permitted to reopen without interruption of the motor 40. If it is desired to stop the motor 40 depression of the stop button 52 will interrupt the circuit of the coil 47 to reopen the contacts 42.

The operation of the main control switch 53 is such that the contacts 55 are closed prior to an opening of the contacts 54. Initial closure of the contacts 55 completes a preliminary energizing circuit for the coil 58 of the control relay 59, which circuit extends from the power lead 50 through the contacts 54, the contacts 55, the lead 56, the auxiliary contacts 45 of the line switch 43 which are enclosed upon starting the motor 40, and the lead 57 to one end of the coil 58, and hence through the circuit network 60 to the lead 48. It will be presumed that the network 60 completes the circuit for the coil 58 and does not cause an interruption, as it plays no part of the present invention. As operation of the

control switch 53 is continued, the contacts 54 of the main control switch 53 will open, and for continued energization of the relay coil 58 the circuit therefor must extend through the lead 63, the contacts 62 of the relay 59 which are now closed, the lead 64, one of the alternative paths provided by either the three position switch 73, the cam switch 66, or the test relay contacts 74, and hence through the lead 70 to the common connection between the contacts 54, 55.

The clutch coil 84 is energized, upon operation of the main control switch 53, through a circuit including the lead 63 attached at one end to the power lead 50, the lead 88, the contacts 87 of the control relay 59, the lead 86 to one end of the clutch coil 84, and hence through the lead 85 to the power lead 48.

The energizing circuit for the coil 58 of the control relay 59 may be interrupted by an opening of the contacts 45 of the line switch 43, or an operation of the main control switch 53, or a switching operation within the network 60 that disconnects the coil 58 from the lead 48, or by interruption of each of the alternative paths afforded by the cam switch 66 and three position switch 71. In the event of one of these occurrences the control relay contacts 87 will open and the clutch coil 84 will become deenergized to cause a cessation in the drive of the loom.

If loom operation is to be halted, it is of advantage to cease movements with the lay retracted, the heddles spreading the warp threads to form a shed, and the shuttle readied for a flight through the shed. To this end the detent 68 in the cam 67 is disposed for opening the cam switch 66 as the above conditions are met, and each revolution of the cam 67 corresponds to one complete stroke of the lay 8. If alternative paths through the three position switch 71 are open, upon an opening of the cam switch 66 there will be an interruption of the circuit for the control relay coil 58. The ensuing stoppage of the loom will be accompanied by an overtravel that rotates the cam 67 into the position of Fig. 6, with the cam follower 69 past the detent 68 and the switch 66 reclosed for further operation. The loom may then be started by returning the main control switch 53 to its original position and then again operating it to reclose contacts 55.

If the three position switch 71 be disposed to close the contacts 72 the cam switch is removed from an active circuit relation with respect to the energization of the control relay coil 58, and if the switch 71 be disposed to close the contact 73 the test relay 75 is employed in conjunction with the cam switch 66, whereby upon each opening of the switch 66 the condition of the test relay contacts 74 will dictate loom operation. If the relay contacts 74 be open in the interval of the opening of the cam switch 66 the loom will be shut down, and if the relay contacts be closed in this interval the loom will continue. The test relay 75 is responsive to the switches 29 and 30, and hence the operation of the switches 29 and 30 in response to the advance of the lay 8 toward the beat line 6, will perform the function of governing weaving, whereby the loom is shut down in the event the beat line 6 is not within a desired range of positions.

Both of the switches 29 and 30 must be closed to energize the test relay coil 76. The coil 76 will then be energized through the lead 77 extending from one side of the rectifier 78 to one end of the coil 76, the lead 79 at the opposite end of the coil 76, the lead 80, the closed switches 29 and 30, and the lead 81 extending to the rectifier 78. The capacitor 82 and resistance 83 which shunt the coil 76 are interposed in the circuit network to provide a time delay in the build up and decay of the exciting currents for the coil 76. Thus, if the actuating blade 28 be moved to the position of Fig. 6 to close one of the switches 29, and 30, whereby each is permitted to remain closed, an excitation current for the coil 76 sufficient to cause closure of the contacts 74 will occur

only after a charge has been accumulated in the capacitor 82. The period of accumulating this charge delays relay operation, and the period of delay may be selected by proper proportioning of the capacitor 82 and resistor 83. Also, if one of the switches 29 or 30 be moved to an open position, at a time after the test relay coil 76 has been excited sufficiently to close the contacts 74, the decay of the excitation current of the coil 76 will be delayed. The energy within the field of the coil 76 and the capacitor 82 must be dissipated by transient current flow between the capacitor 82 and the coil 76. The resulting period of delay in the opening of the relay contacts 74 is again dependent upon the value of the resistor 83 and the size of the capacitor 82.

To carry out weaving with supervisory control of the beat line position, in accordance with the practice of this invention, the line switch 43 is energized to start the motor 40 and to ready the energizing circuit for the control relay 59. The main control switch 53 is then operated to close contacts 55 to energize the control relay 59, which in turn closes its contacts 62 to complete the self-holding circuit and its contacts 87 to energize the clutch 84. The loom will now commence the weaving operation, and to secure supervision of the beat line position the switch 71 is moved to close the contacts 73.

Commencing now with the lay 8 in the retracted position, as shown in Fig. 1, the switch actuator blade 28 holds open the switch 30, as shown in Fig. 2, and the coil 76 of the test relay 75 is consequently deenergized. As has been noted, for this position of the lay 8, the detent 68 in the cam 67 is slightly beyond the cam follower 69, so that the cam switch 66 will remain closed until near the end of one complete lay stroke. The lay 8 begins its stroke by moving forwardly toward the beat line 6 and the resulting forward motion of the upper end of the lay operating lever 15 will carry the tappet 39 into engagement with the abutment 34. As has been described, the knock-off arm 32 will be moved forwardly.

If the forward movement of the knock-off arm 32 is insufficient to move the latch 35 from beneath the lowermost step 26 the condition shown in Fig. 2 will be maintained throughout the stroke of the lay 8, and the switch 30 will be retained in contact open position. In this event the energizing circuit for the test relay coil 76 is not closed and the test relay contact 74 will be retained open. The rotation of the cam 67 will continue throughout the lay stroke, and the detent 68 will pass beneath the cam follower 69 as the lay 8 reaches its fully retracted position. The cam switch 66 is thus opened near the completion of the lay stroke to remove the short circuit path about the switch 71 and test relay contacts 74 provided thereby when closed, so as to place the contacts 74 in an active circuit relation to the other circuit network components. Since the relay contacts 74 will fail to provide a closed shunt about the cam switch 66 for a continued energization of the control relay coil 58, the coil 58 is deenergized and the relay contacts 62 and 87 are caused to open. The clutch 84 is therefore deenergized and the drive for the loom is disconnected to cease operation. The lay 8 will now remain in retracted position and the detent 68 will override the follower 69, as the loom is brought to a halt, to reclose the cam shaft 66 for a subsequent operation.

The step table 25 has the steps 26 so proportioned that if the latch 35 is not moved forwardly from beneath the lowermost step 26 it is an indication that the beat line 6 has shifted rearwardly to a position outside a zone of permitted positions. Adjustment of the beat line 6 should then be made before continuing the weaving operation. Thus, the indication of beat line position by the switch actuating blade 28 influenced the control circuit to halt the loom for correction of beat line position.

If the beat line be within a zone of permitted positions weaving will continue without interruption, in the following manner. As the lay 8 moves forwardly in its stroke

the travel will be increased and the tappet 39 will move the latch 35 from under the lowermost step 26 to beneath the middle step 26. The step table 25 will fall to place the switch actuating blade 28 in the position of Fig. 4, wherein each switch 29, 30 is closed. This positioning of the blade 28 occurs at the completion of the forward stroke of the lay 8, when the detent 68 is approximately diametrically opposite the cam follower 69. Closure of the switch 30 completes the energizing circuit for the test relay coil 76, and the contacts 74 will close with the time delay hereinbefore described. The closure of contacts 74 will occur well in advance of the passage of the detent 68 beneath the cam follower 69. As the lay 8 continues its stroke and swings rearwardly the cam edge 38 of the bracket 37 will engage the lever 24 and raise the step table 25. The switch actuator blade 28 is therefore moved to reopen the switch 30, which event also precedes in time the rearward most retraction of the lay 8 and the passing of the detent 68 beneath the cam follower 69. Thus, if the test relay 75 were immediately responsive to the opening of switch 30 the contacts 74 would be open as the cam switch 66 is opened. The loom would then be shut down, as in the previous instance when the beat line was outside the range of permissible positions. This is not desired, and the time delay occasioned by the capacitor 82 and resistance 83 will cause the relay coil 76 to carry sufficient exciting current for retaining the contacts 74 closed until after the detent passes beneath the cam follower 69. In this fashion the energizing circuit for the control relay 59 remains completed, since the cam switch 66 when open at the end of the lay stroke is shunted by the closed test relay contacts 74 to provide continued weaving without interruption. Thus, the test of the beat line position, made by placing the switch actuating blade 28 in a corresponding position to affect the test relay 75, is accomplished during one interval of the lay stroke, and that test is then applied at another interval near the end of a lay stroke, when the cam switch 66 is opened, and it is more advantageous to shut down the loom if the necessity has arisen.

In the event that the beat line 6 is advanced forwardly beyond the zone of permissible positions, then the control circuit should so indicate as the detent 68 passes beneath the cam follower 69 to cause a cessation of the loom, as in the instance where the beat line was shifted rearwardly, of the zone of permissible positions. For this condition of the beat line 6, the forward advance of the lay 8, and hence of the tappet 39, will be greater. The latch 35 of the knock-off arm 32 will be carried forwardly from beneath the middle step 26, so that the position of the step table 25 shown in Fig. 5 is assumed. The switch actuator blade 28 will open the switch 29. This open condition will be retained until the lay 8, in its retraction, causes the cam edge 38 to depress the lever 24. The period of time in which the switch 29 is open ensures that the test relay 75 is deenergized, whether or not there might have been a momentary energization as the switch actuator blade moved from the position of Figs. 1 and 2 to that of Fig. 5. It is necessary that the test relay 75 be retained deenergized, after the switch actuator blade 28 is moved rearwardly by a depression of the lever 24, until after the detent 68 is rotated under the cam follower 69. This is accomplished in the following manner.

As the actuator blade 28 is swung rearwardly the switch 29 is reclosed, and for the interval in which the actuator blade 28 moves from the switch 29 toward the switch 30 and opens this latter switch, the energizing circuit for the test relay coil 76 will be closed. The exciting current of the coil 76, however, will not build up within this interval to a value sufficient to close the test relay contacts 74, because of the delay occasioned by the capacitor 82 and resistance 83. The actuating blade will now open switch 30 slightly in advance of full retraction of the lay 8 and the passage of the detent 68 beneath the cam follower 69. Thus, the test relay contacts 74 will be open

as the cam switch 66 opens, to interrupt the circuit of the control relay coil 58. Control relay contacts 62 and 37 will open, causing a shut down of the loom, that indicates to the operator that adjustment of the beat line 6 must be made.

If it be desired to operate the loom without the use of the circuit for testing the beat line position the switch 71 may be moved into its center open position. Then, as the loom is operated it will be halted at the end of each complete stroke of the lay 8 as the cam follower 69 falls into the detent 68. This mode of operation is desirable in setting up the loom, or when testing the loom. For continued operation of the loom, without the use of the beat line detection circuit of this invention, the switch 71 may be moved to close the contact 72. In this position the cam switch 66 is shunted so as to be removed from the active circuit.

We claim:

1. In a control for a loom having a lay that reciprocates toward and away from a beat line the combination of a switch actuator movable in response to advance of the lay toward the beat line within a range of positions corresponding to possible beat line position which range includes a permissible zone of positions corresponding to permissible positions for the beat line and zones of positions to each side of the permissible positions corresponding to unwanted positions for the beat line; switch means operable by movement of said switch actuator and operated to a predetermined switch means position upon said actuator being disposed in a zone of unwanted positions; a timing switch opened and closed in a regular sequence related to the lay stroke; electrically operable means for the control of the loom; and circuit connections joining said switch means and said timing switch with said electrically operable means to cause an operation of the latter when said switch means is placed in said predetermined position in response to said actuator having been in the zone of unwanted positions while corresponding to beat line position.

2. In a control for a loom having a lay that reciprocates toward and away from a beat line the combination of a switch actuator movable within a range of positions including unwanted positions at each end of the range that is cooperatively related to said lay to be moved thereby as the lay advances toward the beat line; switch means having contacts operable by movement of said switch actuator disposed in an open contact position upon the actuator being in an unwanted position; a timing switch opened and closed in a regular sequence related to the lay stroke; electrically operable means for the control of the loom; and circuit connections for joining said switch means contacts and said timing switch in parallel relation and said means for the control of the loom through such parallel relation to a power source whereby said timing switch is closed to electrically bypass said switch means contacts during a portion of the lay stroke and opens during another portion of the lay stroke when said switch means is indicative of actuator position to cause an operation of said means for the control of the loom if both the timing switch and the switch means are open.

3. In a control for a loom having a lay that reciprocates toward and away from a beat line the combination of a switch actuator movable in response to advance of the lay toward the beat line within a range of positions corresponding to beat line positions, which range includes a permissible zone of positions corresponding to permissible positions for the beat line and unwanted zones of positions at each end of the permissible zone; switch means including a switch to each side of the actuator operable by movement of said switch actuator whereby a switch is placed in predetermined position by the actuator when disposed in an unwanted zone; electrically operable circuit responsive means including a coil; and circuit connections for joining said responsive means

through said switch means to a power source whereby the responsive means is operated upon the switch actuator being disposed in an unwanted zone.

4. In a control for a loom having a lay movable through a stroke to beat weft into a beat line position the combination of an actuator cooperatively engaged with said lay movable thereby through a range of positions corresponding to the extent of the stroke of the lay as it moves toward the beat line position; switch contacts operated between open and closed positions by said actuator upon displacement of the actuator into or from positions at the ends of said range of positions; relay means including a coil in circuit with said switch contacts and relay contacts responsive to the excitation of the coil; a capacitive circuit component connected across said relay means coil whereby energization and deenergization of the relay coil in response to opening and closing of said switch contacts is delayed; an electrically operable loom drive control to be operated for interrupting weaving; and a timing switch in circuit with said relay contacts and said drive control placing said relay means contacts in an active circuit relation with the drive control during a particular time interval in the lay stroke whereby said drive control is operated to interrupt weaving upon said actuator being positioned at an end of said range of positions when corresponding to the extent of the stroke of the lay.

5. In a control for a loom having a lay movable through a stroke to beat weft into a beat line position the combination of an actuator cooperatively engaged with said lay movable during the stroke of the lay into a position corresponding to the extent of the stroke of the lay as it moves toward the beat line position and retracted from such position during a subsequent portion of the lay stroke; switch contacts operable by said actuator; relay means including a coil and relay contacts responsive to the excitation of said coil; a capacitive circuit component connected across said relay means coil to delay the build up and delay of the coil current; a direct current source; circuit connections joining said relay means coil through said switch contacts to the direct current source; loom controlling circuit means; a timing switch opened and closed in a regular sequence; and a test circuit joining said loom controlling means with said timing switch and said relay means contacts for connection to a power source, the completion of the circuit for connection to such a source being dependent upon the positions of said relay means contacts and said timing switch.

6. In a circuit performing a delayed test of a switching function the combination of a switch actuator movable from an initial position through a stroke of variable length and back to the initial position; a first switch operable by said actuator when moved a predetermined distance from the initial position; a second switch operable by said actuator when moved from the initial position of rest to a position spaced beyond that at which operation of the first switch occurs; relay means including a coil and contacts actuated thereby; a capacitive component connected across said relay coil whereby build up and decay of coil exciting currents are retarded for delay of contact actuation; circuit connections joining said first and second switches in series with said relay coil for connection to a power source whereby operation of said relay contacts occurs with a time delay with respect to operations of said first and second switches; a timing switch having contacts opened and closed at intervals timed with respect to actuator movement; and circuit connections joining said timing switch contacts with said relay contacts whereby opening and closing of said timing switch contacts provides spaced time intervals occurring subsequent to a stroke of the actuator in which circuit completion may be had through said relay contacts to test the position of such contacts and hence the extent of the previous stroke of said actuator.

7. In a control for a loom having a lay movable in re-

peated strokes advancing toward and retreating away from a beat line the combination of a switch actuator cooperatively engageable by said lay for movement into a position corresponding to the extent of the advance of the lay to the beat line and for retraction from such position as the lay moves away from the beat line; switch contacts operable by said actuator upon movement into a position corresponding to advance of the lay; time delay relay means having a coil energized in response to switching of said switch contacts and relay contacts the operation of which is retarded with respect to said switch contacts; loom controlling circuit means; circuit connections for joining said loom controlling means through said relay contacts to a power source; and a timing switch having contacts in parallel with said relay contacts which are opened during a portion of the lay stroke subsequent to operation of said switch contacts by said actuator.

8. In a control for a loom the combination of a member reciprocated between a position at the beat line of cloth being woven on the loom and a position retracted from the beat line; a switch actuator moved by said member into a range of positions corresponding to possible beat line position and brought to a test position that corresponds to beat line position; switch means including a pair of switches at opposite sides of said actuator and a relay with contacts responsive to the pair of switches whereby the switch means relay contacts are placed in open position by the actuator upon being at either end of the range of positions; a timing switch opened and closed in repeated cycles to provide test intervals in timed relation to switch actuator movement; circuit means for control of the loom; and circuit connections for joining the circuit means to a power source through alternative paths of the timing switch and the switch means relay contacts whereby operation of the circuit means occurs if for a test interval of the timing switch said switch means relay contacts are in open position.

9. In a control for a loom the combination of a member reciprocated between a position at the beat line of cloth being woven on the loom and a position retracted from the beat line; a switch actuator moved by said member into a range of positions corresponding to possible beat line positions to be brought to a test position that corresponds to beat line position and then retracted from such range of positions; a pair of switches at opposite sides of said actuator one of which is operated by the actuator upon the test position assumed thereby being at either end of said range of positions; relay means having contacts and a coil joined to said switches to be responsive thereto and further having time delay means whereby operation of the relay lags operation of said switches to have the relay contacts correspond to switch actuator test position subsequent to the actuator assuming test position; a timing switch opened and closed to provide a test interval at a time in the loom operation when the relay contacts correspond to test position of the actuator; circuit means for controlling the loom; and circuit connections for joining the circuit means to a power source and with said timing switch and relay means contacts whereby for a test interval connection of said circuit means to a power source depends on position of said relay means contacts.

10. In a control for a loom the combination of a member reciprocated between a position at the beat line

of cloth being woven on the loom and a position retracted from the beat line; a switch actuator moved by said member into a range of positions corresponding to possible beat line positions to be brought to a test position that corresponds to beat line position and then retracted from such range of positions; a pair of normally closed switches at opposite sides of said actuator one of which is opened when the actuator is at an end of said range of positions; a direct current source; relay means having normally open contacts and a coil joined in series with said switches to said direct current source; a capacitor across the relay coil retarding relay contact action; a timing switch opened in timed relation to said retarded relay contact action; a current responsive loom control; and circuit connections joining the timing switch and relay contacts in parallel and the loom control to such parallel arrangement to be energized therethrough, whereby upon opening of the timing switch a simultaneous open condition for the relay contacts interrupts the circuit for the loom control.

11. In a control for a loom the combination comprising a member that advances to and retracts from a beat line; a switch actuator having an initial position and displaceable therefrom in response to advance of said member to the beat line, wherein the amount of displacement of the actuator is dependent upon the advancement of the member; a first switch to one side of the actuator and operable thereby upon a predetermined excessive displacement of the actuator, a second switch to the other side of the actuator and operable thereby upon a predetermined sufficient displacement of the actuator; a relay having a coil and contacts responsive to energization of the coil; and an energizing circuit for said coil joining the coil in circuit with said first and second switches.

12. A control for a loom in accordance with claim 11 which has a resistance-capacitance time delay network connected across said relay coil.

13. In a control for a loom the combination comprising a member that advances to and retracts from a beat line; a switch actuator having an initial position and displaceable therefrom to advance of said member to the beat line, wherein the amount of displacement of the actuator is dependent upon the advancement of the member; switch means having contacts responsive to predetermined excessive and insufficient displacement of said switch actuator; a timing switch opened and closed in timed relation with loom operation; and a test circuit having connections joining the timing switch contacts with the switch means contacts to test for the position of said switch means contacts at regular intervals.

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