United States Patent

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[45] Patented Mar. 9, 1971
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[54] **LOOM STOPPING SYSTEM**
1 Claim, 11 Drawing Figs.

[52] U.S. Cl. 139/336, 139/1
[51] Int. Cl. D03d 51/00
[50] Field of Search 139/336, 1, 1.4, 341, 55, 57; 139/336, 1, 1.4, 341, 55, 57

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ABSTRACT: A disabling system responsive to a loom malfunction is provided for disengaging the drive clutch prior to stopping the lay whereby the loom is brought to a halt in a smoother and more controlled manner than is possible with conventional looms.

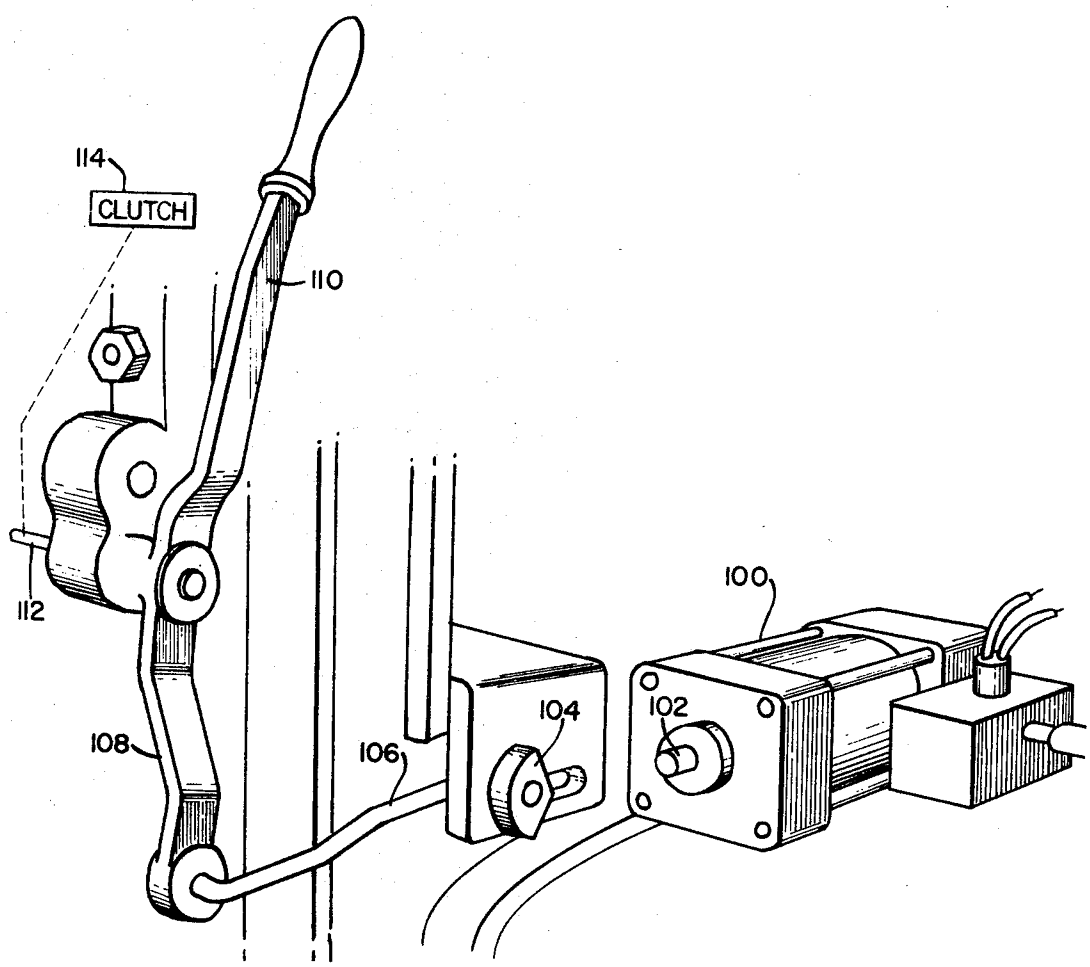


FIG. 1

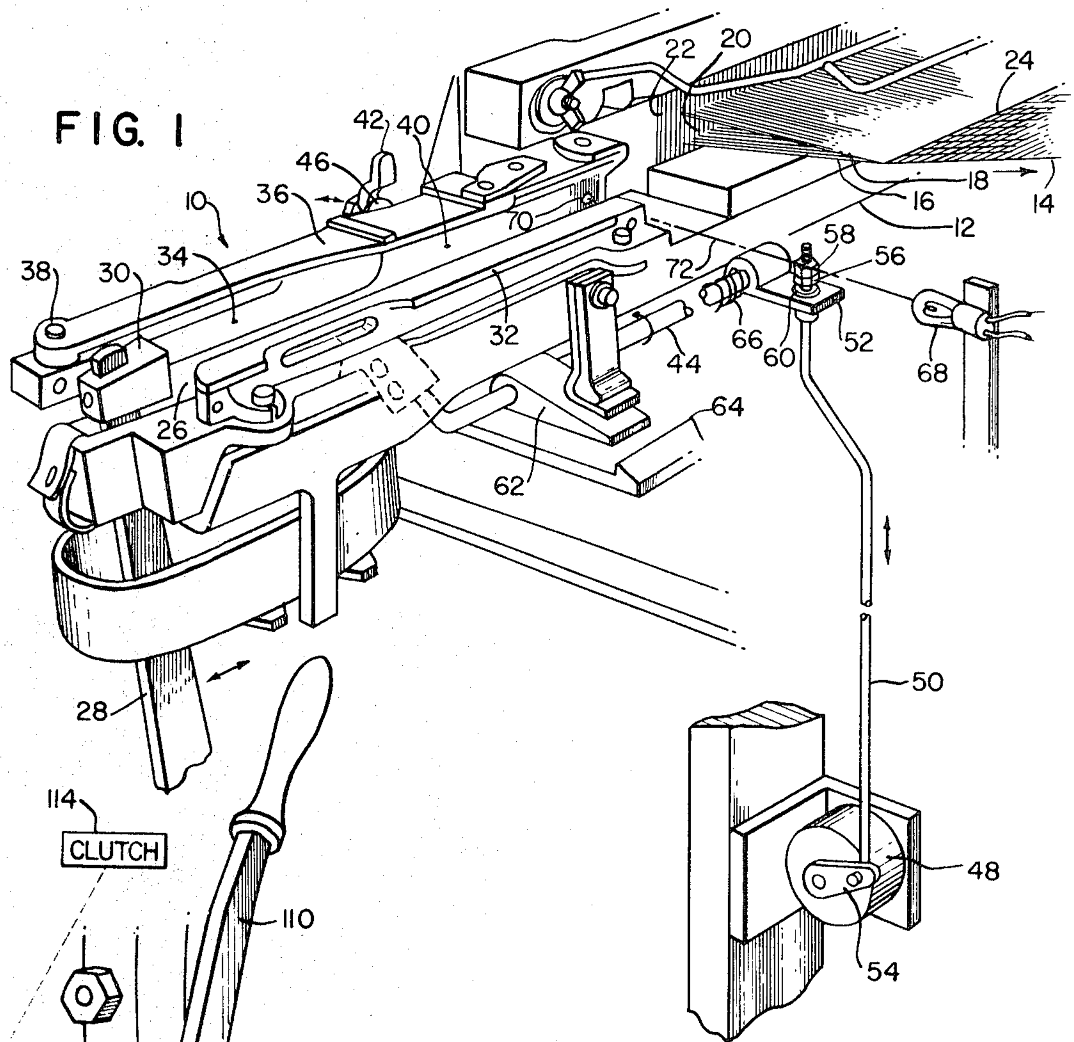
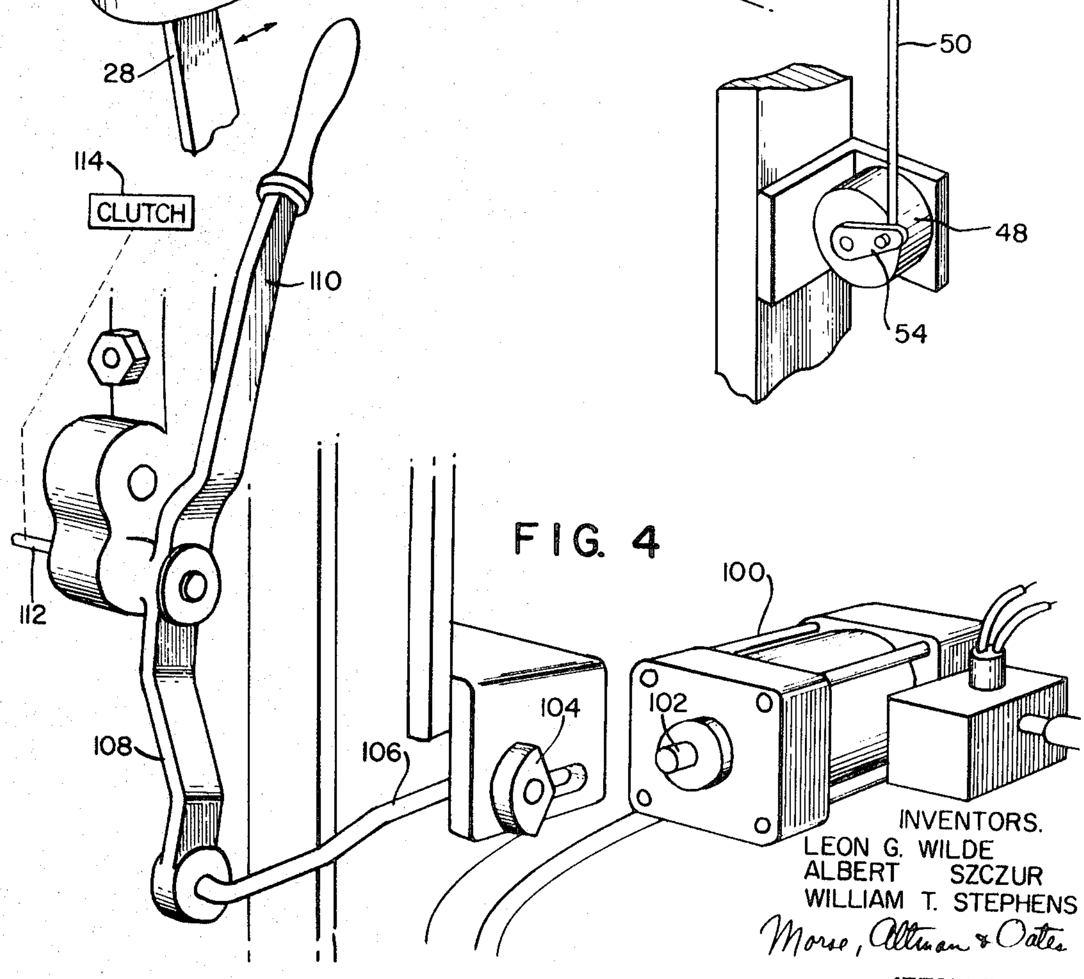


FIG. 4



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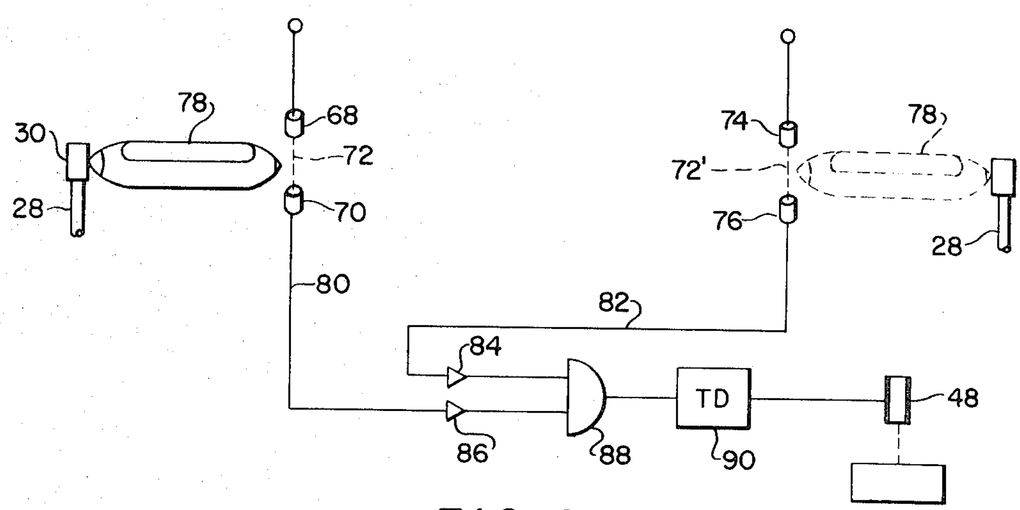

FIG. 2

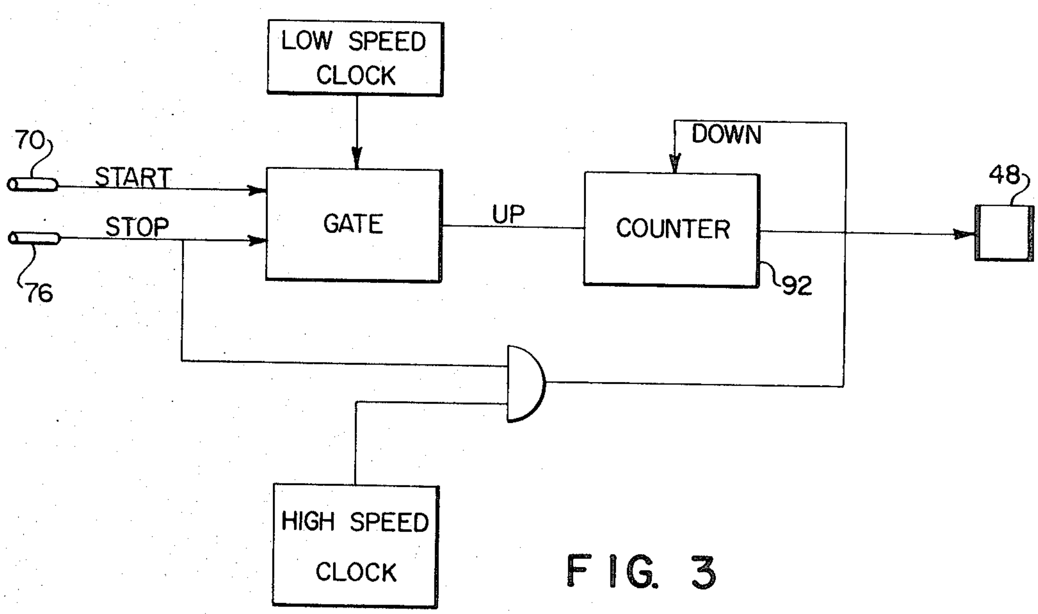

FIG. 3

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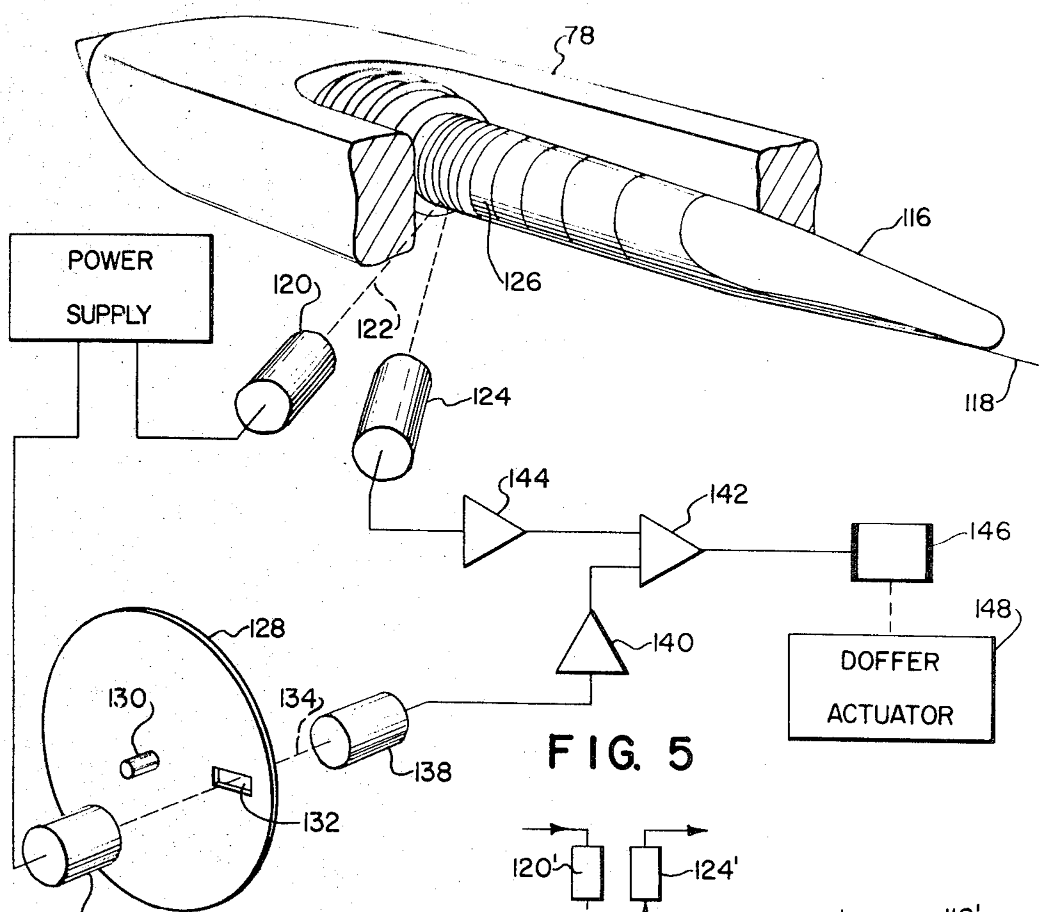

FIG. 5

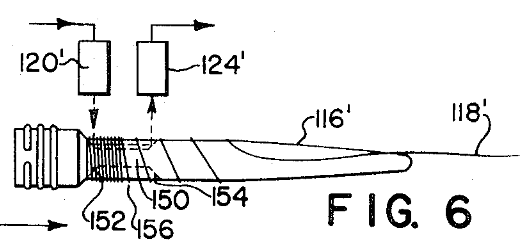

FIG. 6

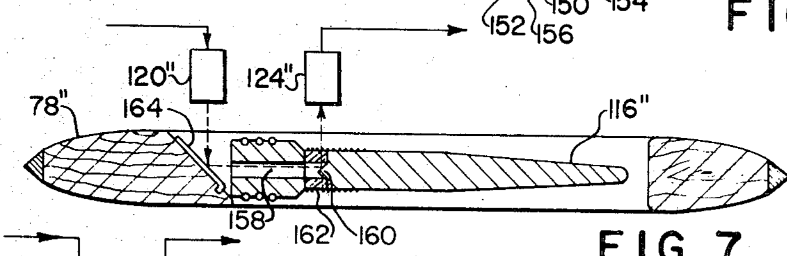

FIG. 7

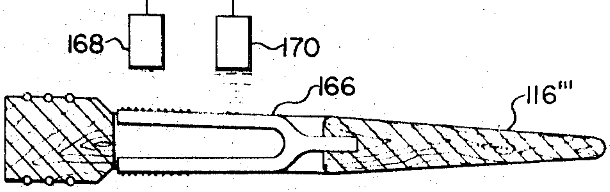

FIG. 8

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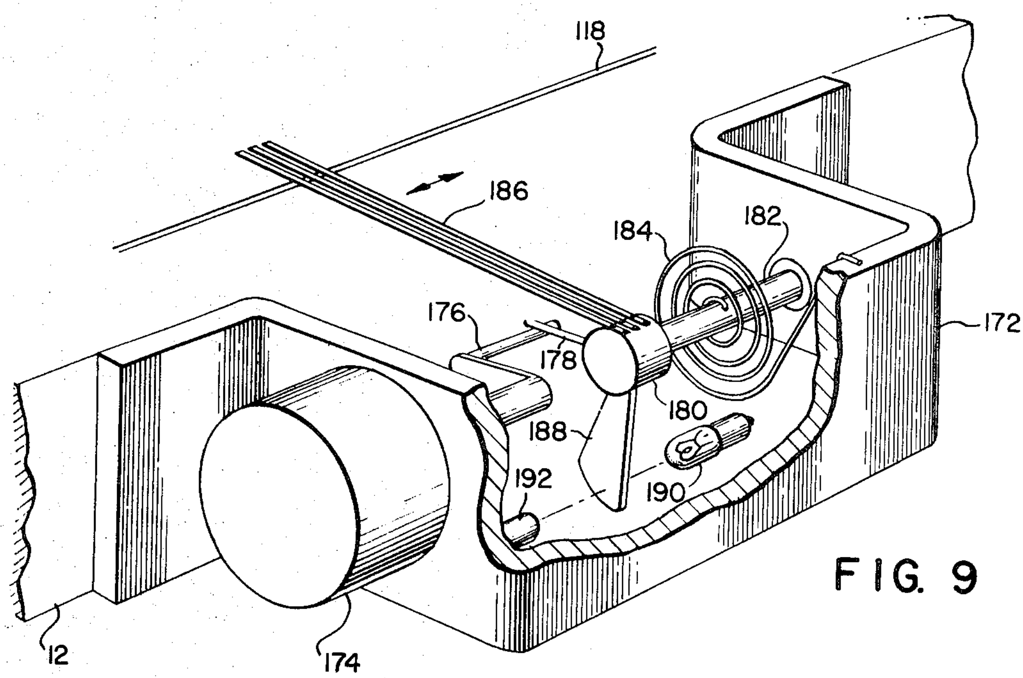

FIG. 9

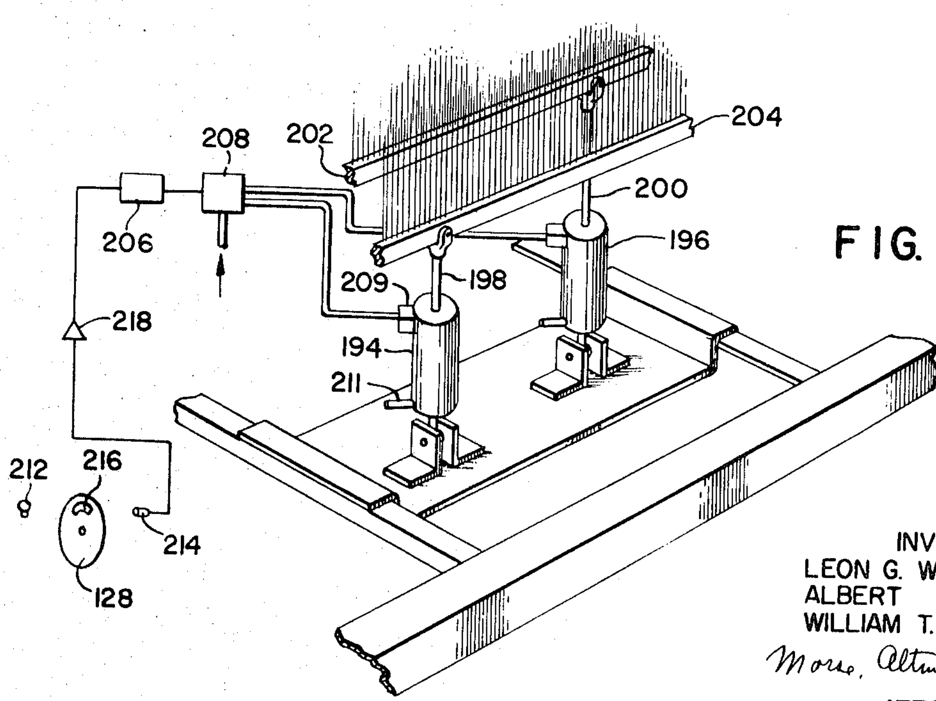

FIG. 10

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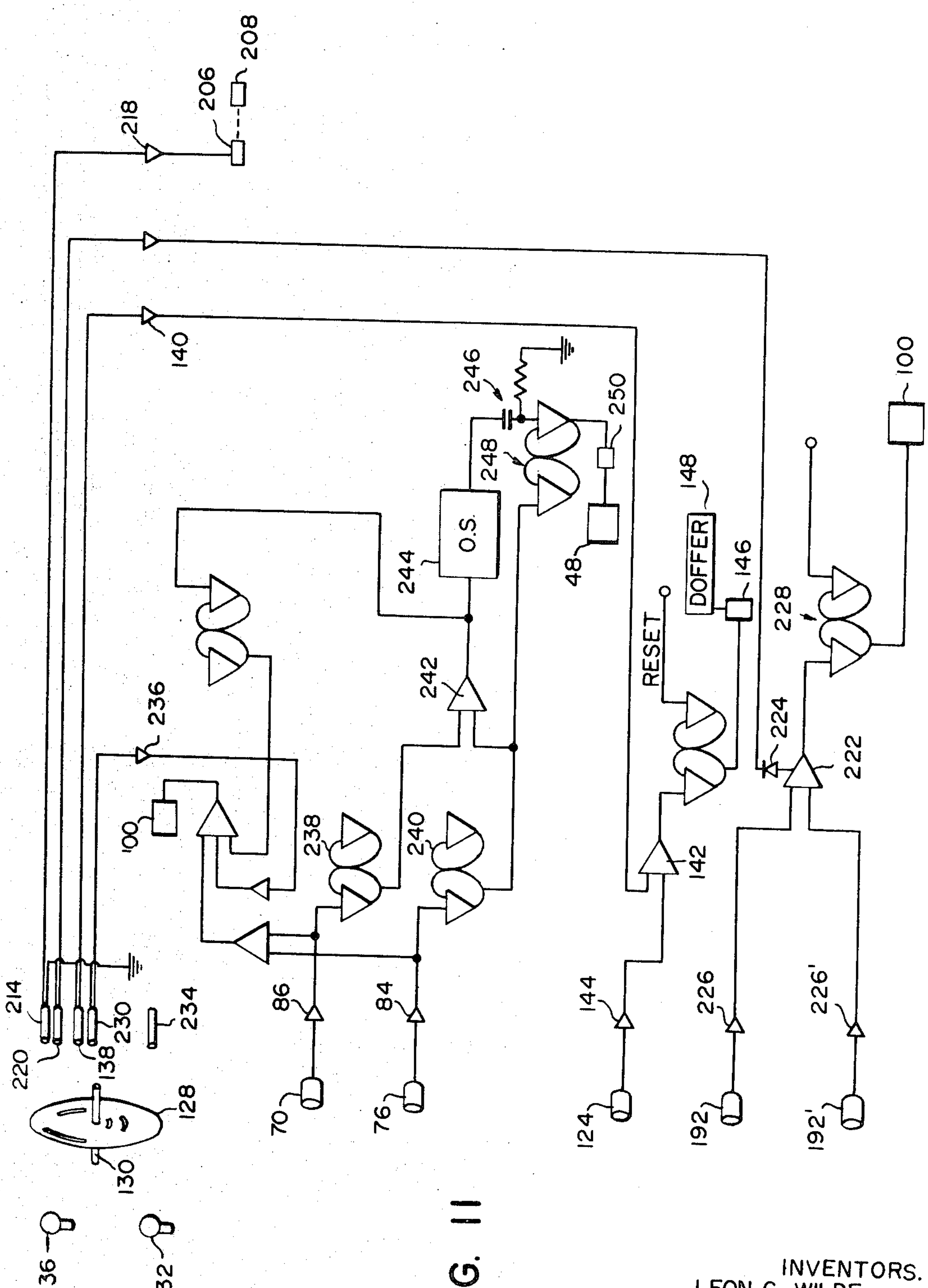

FIG. 11

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LOOM STOPPING SYSTEM

CROSS-REFERENCE TO RELATED APPLICATION

This is a division of U.S. application Ser. No. 634,978 filed May 1, 1967 now U.S. Pat. No. 3,451,438.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates generally to looms and more particularly is directed towards automatic high speed looms and associated components thereof.

2. Background of the Invention

Present day looms are mechanically complex, automatic machines in which a bobbin-carrying shuttle is propelled back and forth through a shed of warp threads. The shuttle lays down a filler thread or pick on each pass and after each pick the reed beats the filler against the formed fabric and the warp threads alternate positions to form the shed for the next pick. The shuttle is propelled back and forth at a rather high rate of speed by means of picker sticks which, at the proper timed moment, are actuated to drive the shuttle across the lay through the shed. A shuttle box is located each side of the loom in position to catch the shuttle after it passes through the shed. The shuttle box is provided with a braking mechanism intended to grab the shuttle at the end of its flight. Numerous control components have been added and these include a trip mechanism in the event that the shuttle is not properly seated in the shuttle box, a thread depletion detector for initiating the doffing mechanism which replaces the empty bobbin with a full bobbin and mechanisms for detecting broken weft threads.

While looms that are properly adjusted operate more or less satisfactorily for a time, they have a great tendency to work themselves out of adjustment primarily due to the mechanical complexity of the various control mechanisms and the constant vibration of the loom when operating. Looms thus require frequent readjustment otherwise the loom will shut itself down when there is a malfunction and also when there is a false indication of a malfunction. To the weaver this is time consuming and bothersome since it necessitates correcting the malfunction and restarting the machine. For the mill the starting and stopping of the machine is undesirable since it represents loss in production time and with certain materials, an interruption in the weaving process produces an objectionable mark on the finished fabric.

Accordingly, it is a general object of the present invention to provide improvements in high speed looms. More specifically it is an object of the invention to provide an automatic loom capable of increased speed and reliability coupled with reduced waste and of generally more efficient operation.

SUMMARY OF THE INVENTION

This invention features an automatic loom control system and associated components including a shuttle positioning system adapted to stop and precisely position the shuttle in its appropriate box each time it has completed a pick of the warp shed. The shuttle positioning system includes a photoelectric device at the entrance of each shuttle box. Each device is operatively connected through a time delay to an actuating mechanism adapted to brake the shuttle in the shuttle box at a precisely determined and repeatable position. Logic circuitry responsive to the electric eyes is provided for stopping the loom in the event of a malfunction or in the event that the shuttle is not properly positioned. This invention also features an improved system for detecting the depletion of weft thread on the bobbin and for actuating the doffing mechanism with a minimum amount of thread waste.

This invention also includes an improved broken thread detector comprising a spring biased finger adapted to bear against the filler thread after it is deposited in the shed by the shuttle. The finger controls a shutter between a photocell and a light source whereby a signal is produced indicating the condition of the thread.

As a further feature of the invention, novel means are provided for disengaging the drive clutch to the loom prior to stopping the movement of the lay. This reduces the kinetic energy of the loom which is operating at a high speed.

Yet another feature of this invention includes the employment of power cylinders under the control of timing systems for operating the loom harnesses.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a view in perspective of a shuttle box control mechanism made according to the invention,

FIG. 2 is a schematic diagram, in a simplified form, of the shuttle box control system,

FIG. 3 is a block diagram of a variable time delay circuit for the shuttle box control,

FIG. 4 is a view in perspective of a trip mechanism for actuating the loom stop mechanism,

FIG. 5 is a somewhat schematic diagram of a thread depletion system made according to the invention.

FIGS. 6, 7, and 8 are similar views showing modifications of the FIG. 5 system,

FIG. 9 is a view in perspective of a broken filler thread detecting device made according to the invention,

FIG. 10 is a view in perspective of a power cylinder system for operating the loom harnesses, and

FIG. 11 is a schematic diagram of the logical circuitry for the various control units.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

By way of introduction a brief description of the construction and operation of a loom will be given. The principle on which the loom is based is that of manipulating two series of yarns namely, the warp and the weft, so that the two are woven as the warp threads are drawn slowly through the loom. The warp threads are separated frequently and the filler thread, which is contained in a shuttle, is propelled through the transverse opening called the shed formed by the separated warp threads. The warp threads are crossed after each pick of filling is inserted and pushed into place by a comblike structure called the reed so as to force the last pick into place against the previously woven material.

In making the cloth, some of the warp threads must be raised and others lowered to produce the triangular space through which the filler is passed. This space is called the shed and through it the shuttle containing the filler thread on a replaceable bobbin is thrown from side to side.

The throwing across of the filler thread is known as picking. The shuttle being thrown from one side of the loom to the other, leaves the filler thread some distance from the edge or fell of the cloth. It is therefore necessary to push it forward to the cloth, that is to the pick that has been previously pushed in to form the fabric.

The shuttle is a hollow boat-shaped receptacle, intended to carry the filler thread wound on a bobbin and leave a trail of yarn behind it as it is thrown through the shed of warp yarns. When the supply of yarn on the bobbin, carried by the shuttle, is almost depleted, a doffing mechanism is actuated which automatically replaces the nearly empty bobbin with one that is full and the weaving is continued without interruption.

The shuttle is thrown between two mechanisms known as shuttle boxes, one located at each end of a movable beam known as the lay. A picker stick extends into each shuttle box and serves as the means for driving the shuttle from one box to the other. The box guides the shuttle as it is thrown across the lay and also serves as a receptacle for the shuttle, gradually retarding its motion as it enters the box at the end of its pass. In practice, one of the sides of the shuttle box is pivoted to act as a brake which is slightly curved inward so that it projects into the shuttle box and presses against the side of the shuttle as it enters the box. Pressure is applied to the brake, which is known as a binder, by means of a finger and spring device mounted on a protector rod, the finger being kept pressed against the binder by means of the spring.

One of the main problems in automatic looms involves the control of the shuttle. Rather frequently the shuttle will not come to rest in the shuttle box at the same spot each cycle. If the shuttle does not stop at the same position, various malfunctions can occur. For example, if the shuttle does not go far enough into the shuttle box it will not be in the proper position to be driven by the picker stick for the return movement. Also the thread depletion mechanism will not contact the bobbin at the proper point and may indicate an empty bobbin when in fact the bobbin may still have a substantial supply of weft thread left on it. This will actuate the doffing mechanism and result in substantial waste of unused weft thread. If the shuttle goes too far into the shuttle box it may bounce against the driving end of the picker stick and rebound, again coming to rest out of position to be properly driven by the picker stick. In any event, present mechanisms for operating the shuttle box requires frequent adjustment for proper operation and also place a limit on the speed at which the loom can be operated.

Referring now to FIG. 1 there is shown a perspective view of a shuttle box control mechanism, the shuttle box being generally indicated by the reference character 10 and mounted on the end of a lay 12. For purposes of discussion and illustration only one shuttle box is shown and described and it will be understood that a similar shuttle box is located on the opposite end of the lay and functions in the same fashion.

In FIG. 1 there is shown a portion of woven cloth web 14 coming from the loom with warp threads 16 and 18 forming a triangular shed 20 through which the shuttle is propelled. The shed is formed by reciprocating harnesses to be described more fully in connection with FIG. 10. A reed 22 is mounted on the lay 12 and cyclically advances the filling thread or pick towards the woven edge or fell 24 of the cloth 14.

The shuttle box 10 is slotted at 26 to receive the upper end of a picker stick 28. A picker 30 is mounted on the upper end of the picket stick and is formed with a conical socket on the inner face thereof to receive the pointed end of the shuttle. The picker stick is pivoted clockwise under considerable force each time the shuttle is to be thrown to the opposite shuttle box.

The box is also provided with fixed front and rear walls 32 and 34, respectively located on either side of the box opening. The generally rectangular opening within the box is dimensioned to accommodate the shuttle although somewhat longer than the shuttle. Associated with the fixed wall 34 is a movable member 36 known as the binder and pivoted about a pin 38 at the end of the wall 34. The binder 36 is provided with a working leather covered face 40 which is adapted to move towards a cooperating leather covered face on wall 32. The binder serves to frictionally engage the sides of the shuttle and in cooperation with the fixed wall 32 to bring the shuttle to a halt.

Movement of the binder 36 is by means of an arm 42 fixed to a control rod 44 extending parallel to the lay. The arm 42 is provided with an adjustable stop 46 which bears against the outer surface of the binder 35. The control rod 44 is pivotally mounted to the lay by suitable bearings (not shown) and is angularly deflected about its longitudinal axis by means of a solenoid 48 drivingly connected by a rod 50 to a crank 52 fixed to the control rod 44. The solenoid 48 is of the rotary type having a crank arm 54 connected to the lower end of the rod 50. It will be understood that each time the solenoid 48 is actuated, the rod 50 will be pulled downwardly to bias the rod 44 and the arm 42 to the right as viewed in FIG. 1, forcing the binder into the shuttle box. The upper end of the connecting rod 50 is provided with an adjustment nut 56, a lock nut 58 and a compression element 60, allowing a certain amount of play between the connecting rod and the crank 52. Thus when the shuttle is in the box, the play allows the actuating mechanism to move through a certain distance before the inertia load of the crank and its attachments are met. The compression elements 60 may be a conventional helical spring or an annular resilient bushing to allow the actuating mechanism to continue traveling when actuated and apply a gradually increasing force to the binder.

Also carried by the control rod 44 is a latch 62 which in its lowered position is adapted to engage an abutment 64 which stops the motion of the lay and in its raised position will clear the abutment 64 thus maintaining continued operation of the loom. It will be understood that if the shuttle is in the box the movement of the binder 36 will be limited and the latch 62 will not be dropped low enough to engage the abutment 64 but rather will clear the abutment so that the operation of the loom will continue. In the event that the shuttle for some reason should not enter the box, the binder 36 would offer no resistance to the arm 42 with the result that rod 44 will be rotated more than normal and through an arc sufficient to drop the latch 62 down to engage the abutment 64, thus stopping the loom. In practice, the control rod 44 is spring-loaded as by a preloaded spring 66 so as to urge the rod normally counterclockwise as viewed in FIG. 1.

The solenoid 48 is under the control of a shuttle detecting and positioning system which includes a light source such as a bulb 68 producing a photo beam 72 across the shuttle box entrance against a photoelectric detecting device 70 on the opposite side of the box. Assuming the shuttle is moving in its proper fashion it will interrupt the beam 72 as it enters the shuttle box. This will produce a signal from the photoelectric device 70 which in turn will initiate a time delay of a very short duration, after which the solenoid 48 will be actuated. The time delay is sufficient to permit the shuttle to move into the box before the binder is actuated. The timing is such that the shuttle will be brought to a full stop at a predetermined, precise and repeatable position within the shuttle box without rebounding. It will be understood that a photoelectric sensor is located at the entrance of each shuttle box and the same solenoid 48 through the control rod 44 actuates each binder simultaneously.

Referring now to FIG. 2 there is shown a simplified schematic diagram of the control circuitry associated with the shuttle box control system. In FIG. 2 two photoelectric eye systems are shown with the bulb 68, and the sensor 70 on the left-hand side of the loom and a bulb 74 and sensor 76 on the right-hand side of the loom at each entrance of the shuttle boxes. A shuttle is indicated by the reference character 78 and it will be understood that the shuttle is propelled back and forth between the photoelectric sensor systems by means of the picker sticks 28 and 28′. The two photoelectric sensors 70 and 76 are connected by leads 80 and 82 through amplifiers 84 and 86 to a gate 88. The output of the gate is to a time delay unit 90 which in turn is connected to the solenoid 48. It will be understood that a signal will be generated each time the shuttle 78 crosses the beam 72 or 72′ and when a pair of signals are produced by the shuttle 78 leaving one shuttle box and entering another, these two signals will indicate that the shuttle has successfully traversed the shed. The two signals will thus appear at the gate 88 to provide an output to the time delay 90, which in turn will actuate the solenoid 48 causing the binder to grab the shuttle and bring it to a stop.

In FIG. 2 the time delay 90 is of a fixed duration. In FIG. 3 there is shown a schematic diagram for a variable time delay. The FIG. 4 system affords means for varying the time at which the braking solenoid is energized as a function of the speed of the shuttle in crossing the shed. The faster the shuttle is traveling the sooner the brake will be actuated. The reverse is also true in that if the shuttle were traveling slowly there would be a longer delay and less braking action. The circuit of the variable control means is generally organized about a reversible counter 92 which is started to count upwards as soon as the shuttle 78 interrupts the photocell at the exit of the box from which it is being propelled and continues to count upwards as the shuttle traverses the shed. The counter is stopped and reversed in direction when the shuttle interrupts the second photocell in the receiving shuttle box. After reversal takes place, the counter commences to count downward at a much faster rate and, when it reaches the same number at which it originally started, the braking solenoid 48 is energized. The faster the shuttle is moving the fewer counts are accumulated by the counter and therefore actuated sooner for fast shuttles than for slow shuttles. The relative delay may be changed by adjusting either of the counting rates.

Referring now to FIG. 3 there is shown a further feature of the invention. In FIG. 4 a piston or solenoid 100 is mounted to the loom frame and is provided with a driving piston 102 adapted, when extended, to engage a member 104. The member 104 is connected by means of a rod 106 to a crank 108 on the lower end of a manual control arm 110. The arm 110 is fixed to a control rod 112 which actuates a clutch and brake 114 in the loom drive mechanism. The function of the solenoid is to automatically disengage the clutch and engage the brake in the event of a malfunction. The solenoid 100 is timed to disengage the clutch before the lay 12 is brought to a halt by means of the latch 62 engaging the abutment 64 as shown in FIG. 1. By disengaging the clutch before the lay stopping mechanism is engaged the loom may be operated at a higher speed without the attendant higher kinetic energy being concentrated on one stopping mechanism. By disengaging the clutch first before stopping the lay a substantial portion of the kinetic energy is separated from the lay so that it may be brought to a stop much more easily and without damage. The clutch remains subject to manual control by means of the arm 110.

Referring now more particularly to FIG. 5 there is shown a novel thread depletion detector. As mentioned previously, the shuttle 78 carries a replaceable bobbin 116 which is wound about with a supply of filler thread 118 which unravels from the bobbin on each pick, leaving a trail behind the shuttle. In order to provide a continuous weaving operation the bobbin 116, when its supply of filler thread is almost depleted, is replaced with a full bobbin by a doffing mechanism. The doffing mechanism knocks out the nearly empty bobbin from the shuttle and replaces it with a full bobbin. The doffing mechanism heretofore has been actuated by means of a mechanical device which probes against the bobbin each time it enters the shuttle box. As long as there is a supply of thread on the bobbin the probe merely pushes against it and retracts. When the yarn depletes past a certain point the probe strikes against the bobbin surface and is biased in such a manner as to mechanically actuate the doffing mechanism. This technique is unsatisfactory for a number of reasons including an objectionable marking of the weft thread by the contacting probe, which marking shows up on the finished fabric, and a substantial waste in that the actuating mechanism is usually initiated while there is still a fair supply of yarn on the bobbin.

These problems are overcome by the system in FIG. 5 which features a photodetector employed to monitor the supply of weft thread on the bobbin. As shown, a light source 120 directs a beam 122 against the bobbin 116 near the base thereof. A photodetector 124 is located to pick up the reflected beam 122. The light source 120 and the photodetector 124 are located on the side of the loom and are timed to scan the bobbin thread supply each time the shuttle is brought to a stop by the brake. As is usually the case, the filler thread 118 is white and the beam 122 will be reflected back to the detector 124 as long as there is a supply of filler thread on the bobbin. The bobbin is provided with a dark, preferably black, annular band 126 near the base of the bobbin and it will be understood as the thread unwinds the dark band will be exposed and the beam 122 which is aimed at the base of the bobbin will no longer reflect. This will cut off the signal from the photodetector 124 indicating that the yarn is almost depleted and will actuate the doffing mechanism to bring in another bobbin with a fresh supply of thread.

The thread depletion detecting system is operated in conjunction with a timing arrangement whereby the thread is inspected during a certain period in the time cycle of the loom. This protects against false indications at all other times. The detector is used in conjunction with controlling means for initiating the doffing action at the proper time after detection has been accomplished. The timing arrangement includes a timing disc 128 which is driven by the loom main drive shaft 130. The timing disc is formed with a number of predetermined apertures including an aperture 132 adapted to pass a beam 134 from a light source 136 to a photodetector 138. The output of detector 138 is through an amplifier 140 to an amplifier 142. Similarly the output of photodetector 124 is through an amplifier 144 to the same amplifier 142. Thus, depending upon the character of the signal from the detector 124, the solenoid 146 will be energized to actuate the doffing mechanism generally indicated by reference character 148.

In FIGS. 6, 7 and 8 there are shown modifications of the thread depletion detector. In the FIG. 6 embodiment a bobbin 116′ is formed with a reduced portion 150 at its base, the reduced portion forming conical faces 152 and 154.

Formed about the reduced portion 150 is a transparent filler 156 the outer cylindrical surface of which is flush with the remaining portion of the bobbin. The transparent filler provides an optical path between the opposing conical faces which are naturally reflective. The yarn 118′ is wound about the bobbin in the usual fashion and depletes from right to left as viewed in FIG. 6. Light source 120′ is directed at the base of the bobbin towards the conical face 152. The detector 124′ is located opposite the conical face 154. As the yarn unwinds, the conical face 152 will be uncovered to admit the light from source 120′ to reflect off face 152 and against face 154 to be directed against the detector 124′. This, of course, will initiate the doffing mechanism.

In the FIG. 7 embodiment a bobbin 116″ is formed with a central passage 158 in its base terminating at a conical face 160 within a transparent core 162. The core 162 is of the same diameter as the bobbin shank and is adapted to register with a photodetector 124″ located radially outwards from the core. A light source 120″ is located in position to direct a beam of light against an angularly mounted reflective plate 164 carried by the shuttle. The beam of light travels up through the passage 158 striking the conical face 160 to be directed radially outwards. As the thread unwinds the core 162 will be uncovered and the beam of light will impinge upon the photoelectric device 124″ to actuate the doffer.

In the FIG. 8 embodiment a bobbin 116‴ carries a tuning fork 166 the arms of which extend lengthwise of the bobbin towards the left as viewed in FIG. 8. The outer surface of the tuning fork arms normally extend slightly out from the face of the bobbin and when thread is wound about the bobbin it binds against the tuning fork arms. A high frequency sound generator 168 is located to direct, on signal, a sonic pulse against the tuning fork each time the shuttle with its bobbin stops in position at the shuttle box. If there is still an ample supply of thread on the bobbin the thread will immediately dampen the signal, whereas when the thread supply is depleted the tuning fork will resonate and this resonance will be picked by a transducer 170 to actuate the doffing mechanism.

Referring now to FIG. 9 of the drawings there is illustrated an improved device for detecting tension and/or breakage of the filler thread. The device is generally organized about a bracket 172 and the device may be mounted as a single unit at the center of the lay or the device may be employed in pairs, one at each end of the lay. In any event the bracket 172 of the illustrated device is mounted firmly to the lay below the shed and carries a rotary solenoid 174 having a crank arm 176 adapted to engage a finger 178. The finger 178 extends out from a hub 180 on the end of a spring-loaded shaft 182 mounted coaxially with the solenoid on an opposite wall of the bracket. The shaft 182 is normally urged counterclockwise as viewed in FIG. 9 by means of spring 184. The hub 180 has fixed thereto thread sensing fingers 186 mounted in spaced parallel relation to one another. Mounted also to the hub 180 is a shutter 188 adapted to move between a light source 190 and a photoelectric detector 192. The finger and shutter assembly have very low inertia being of very light construction as compared to other types of thread detecting mechanisms. The fingers 186 are urged normally downwards by means of the spring 184 and the preloading force on the fingers is relatively large as compared with the inertia to prevent bouncing of the fingers and shutter. The shutter is disposed as to expose light to the detector when an unbroken and properly tensioned filler thread is laid down on each pass of the shuttle.

The device operates as follows. When the shuttle is fired from one of the shuttle boxes a signal is sent to the solenoid 174 energizing it and flipping the crank 176 along with the fingers 186 upwardly through the warp threads to be clear of the shuttle as it flies past. When the shuttle has passed, the solenoid is deenergized and the spring 184 will bias the fingers 186 downwardly against the filler thread left by the shuttle. Assuming that the filler thread is unbroken it will have sufficient tension to keep the fingers 186 from passing through the lower layer of warp threads and will hold it substantially in the position shown in FIG. 9 with the shutter 188 clear of the beam between the light source and the detector 192. The signal generated by the detector will indicate an unbroken properly tensioned yarn. If the yarn is broken or not properly tensioned the filler will not have sufficient tension to prevent the fingers 186 from dropping down and this will cause the shutter 188 to move between the light source 190 and detector 192. A dark indication will thus be present when the yarn is broken or poorly tensioned. The configuration is fail safe in that if the light source should fail for any reason, it will give the same indication as a broken thread, stopping the loom for correction of the malfunction.

The device illustrated in FIG. 9 is particularly suited for center mounting of the lay of the loom although it will be understood that such a device may be mounted on either end of the lay at the ends of the shed. Also, in place of the solenoid actuating mechanism a conventional actuating means may be employed where the unit is to be located adjacent the shuttle boxes. In such an installation opposing fingers are mounted on the opposite side of the weft and the pivoted finger will try to interlace with the fixed fingers each time the thread is laid down. A shutter and photocell system would be maintained and in the event of a broken thread or poor tension a signal will be generated to stop the loom.

Regardless of the type of mounting arrangement either singly or one on both sides, signals from the photocells are correlated with timing signals derived from the timing disc 128 coupled to the loom shaft to be described more fully below. The signal from the detector photocell 192 is examined only during a short interval corresponding to the time that the filling thread should be in engagement with the sensing fingers. Logic and control means consisting of electronic circuits are used in the preferred embodiment to energize solenoids which operate the stopping mechanism when required. The above device is of simple construction highly accurate in its detection and is substantially immune to wear since there are few moving parts which might wear or get out of adjustment.

Referring now to FIG. 10 there is disclosed a novel system for controlling the shedding motion of the loom in a manner adapted to reduce yarn breakage while increasing the speed capability of loom. In a conventional loom the warp threads are moved in the shedding action by means of harnesses which are vertically reciprocated by cams, the cams followers being linked to the harnesses to provide a variety of motions. The cam arrangement is not particularly smooth and results in rather high frequency of warp thread breakage due to the jerky motion. A further disadvantage is that there is no convenient means for adjusting the timing of the opening and closing of the shed or adjusting the duration of the time period during which the opening or closing is taking place.

With the present improved shedding system a smoother motion of the harnesses is obtained thus decreasing the breakage of the warp yarns and increasing efficiency. The system is also easily adjusted as to timing and duration of the opening and closing of the shed.

As shown in FIG. 10 the system includes pneumatic or hydraulic cylinders 194 and 196 mounted upright to the loom frame and having pistons 198 and 200 drivingly connected to harnesses 202 and 204. Only two cylinders are shown for the sake of simplicity and are used when weaving a plain weave fabric. For more fancy weaves additional harnesses and cylinders are employed. The upper ends of the harnesses are connected in the common fashion by straps wrapped about pulleys so the harnesses operate in unison. An air valve 206 actuated by a solenoid 208, controls admission of air to each cylinder. Each cylinder is provided with a two-way air valve 209 which admits air under pressure to the top of the cylinder or vents that end of the cylinder. The opposite end of the cylinder is provided with a vent 211 which regulates the flow of air from the bottom end of the cylinder when air under pressure is admitted to the top of the cylinder, moving its harness down or which vents regulate the admission of atmospheric air to the bottom of the cylinder when its piston is pulled upwards by the rising of its harness, the power for the rising of the harness being furnished by the opposite harness moving downward. Separate vents and corresponding restrictive orifices may be provided when it is required to maintain the proper speed of motion and tension in the linkage between harnesses in separate directions. Other arrangements for venting and switching the air supply may be used to advantage.

The air control solenoid 206 is actuated by the rotary timing disc 128, the operation of which will be described more fully below. The timing disc is formed with an arcuate slit 216 adapted to register with a light source and photodetectors 212 and 214 respectively. The slot is substantially 180° of the entire circle representing two picks of the loom. The photocell output is amplified to a level sufficient to energize the solenoid-operated valves controlling the air flow to the cylinders.

Referring now to FIG. 11 there is shown a somewhat schematic diagram of the logic circuit employed to operate the various portions of the loom described above. Generally the logic circuit is a timing arrangement adapted to provide proper sequential operation of the loom and its components. The timing arrangement is basically under the control of the timing disc 128 which is slotted with a plurality of arcuate slots adapted to pass a light from a source 136 to a bank of photodetectors in a predetermined sequence and for the predetermined periods. The bank of photodetectors includes detector 214 which controls the operation of the harnesses as described in FIG. 10. Detector 138 is employed in conjunction with the thread depletion unit described in connection with FIG. 5 and operating in cooperation with photodetector 124 for examining the supply of yarn on the bobbin and for actuating the doffing mechanism when required.

Detector 220 in the bank serves to control the timing action of the broken thread detector and operates in cooperation with photodetector 192 and where two broken thread detectors are employed a second photodetector 192′ is employed. In any event, the timing signals from detector 220 are fed into an amplifier 222 through an extender diode 224. Amplifier 222 also receives inputs from photodetectors 192 and 192′ through amplifiers 226 and 226′. The output of amplifier 222 is through a flip-flop 228 out to the solenoid 100 which stops the loom. It will be understood that a stop signal will be generated only when a positive signal is generated by the broken thread detector.

The shuttle box control system includes detector 230 in the bank which cooperates with photodetector 70 and 76 located at the entrances of each shuttle box. The timing disc 128 makes a single revolution for each complete cycle of the loom, that is the shuttle having been propelled from both right and left shuttle boxes with two picks of filler thread having been laid down across the warp threads. The detector 138 provides timing signals for the shuttle box braking system through the solenoid 48. This channel is provided with a pair of arcuate slots on the timing device one of which operates in conjunction with light source 136 and photocell 230 which controls the solenoid 48. The second of the arcuate slots operates in conjunction with a light source 232 and a photodetector 234 for use in stopping the loom by means of the piston or solenoid 100 when the shuttle is not in the proper position. Slots are formed in the disc along the appropriate channel and positioned so that photodetector 230 receives light for a short period of time the beginning of which occurs not earlier than the latest time the shuttle is normally fully positioned in the appropriate shuttle box, and the end of which occurs not later than the earliest time in which the shuttle commences to be propelled from the appropriate shuttle box.

The signals from photodetectors **70** and **76** and from detector **230** are fed respectively to electronic amplifying and limiting means consisting of limiting amplifiers **84**, **86** and **236** respectively, the latter being coupled to flip-flops **238** and **240**, gate **242**, time delay device **244**, differential means **246**, flip-flop **248**, power amplifier **250** and solenoid **48**. Other slots cut in the disc **128** are positioned so that photodetector **234** receives a light for a period of time the beginning of which occurs not earlier than the latest time the shuttle can be properly received and fully positioned in its appropriate shuttle box and not later than the earliest time in which the shuttle is propelled from the appropriate box. The signal from photodetectors **70** and **76** and **234** are fed respectively to amplifiers **84** and **86**.

We claim:

1. A loom stopping system for a loom having a rotary timing shaft, a clutch and mechanical stop means for stopping a loom

in the event of a malfunction, comprising:

a. a timing disc drivingly connected to said timing shaft and formed with apertures therein;

b. a light source located on one side of said disc and a photodetector located on the opposite side of said disc adapted to generate timing signals upon rotation of said disc;

c. means for detecting the integrity of weft thread in said loom and adapted to generate other signals;

d. logic means operatively connected to said photodetector and said sensing means and adapted to produce an output signal in the event of a malfunction determined by said sensing means;

e. a solenoid operatively connected to said logic means;

f. clutch control means responsive to manual and automatic operation thereof and operatively connected to said solenoid; and

g. said sensing means being adapted to energize said solenoid to decouple said clutch in advance of said stop means in the event of a malfunction.