July 31, 1956 R. B. APPLEGATE ET AL 2,756,782

LOOM PROTECTION APPARATUS

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Fig.1.

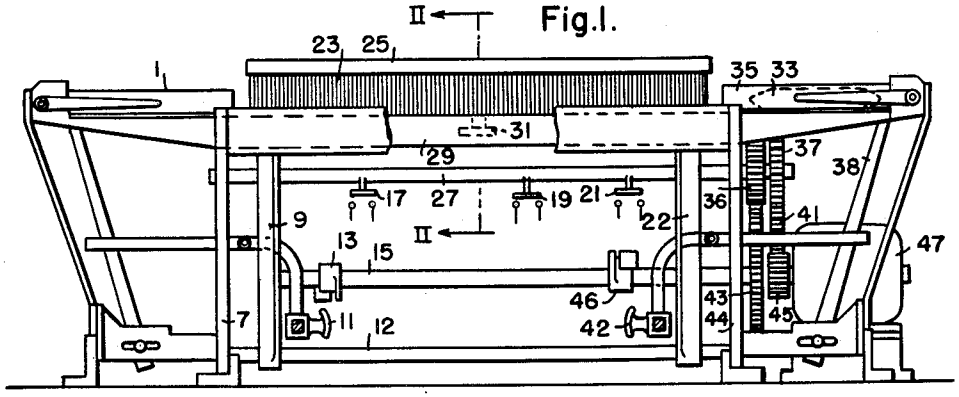


Fig.2.

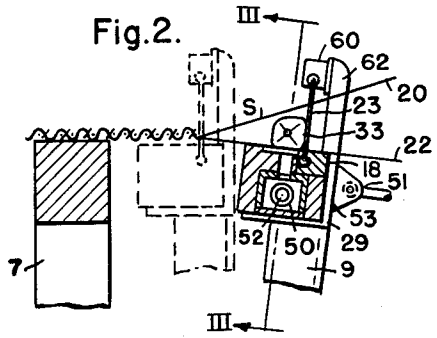


Fig.3.

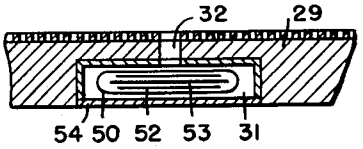


Fig.4.

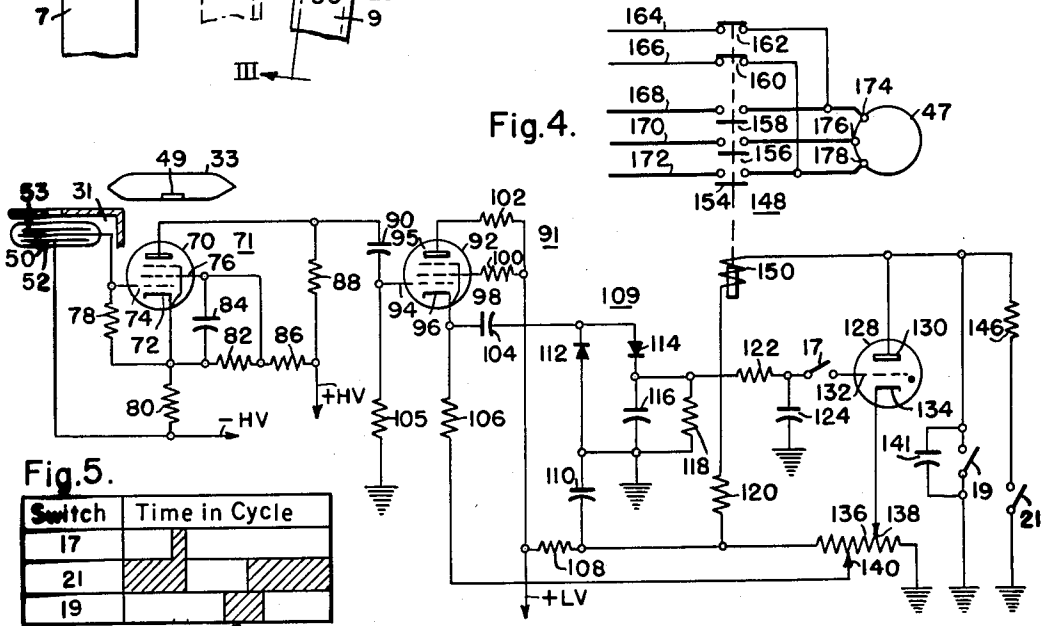


Fig.5.

Switch	Time in Cycle
17	
21	
19	

t1 t2 t3 t4

WITNESSES

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LOOM PROTECTION APPARATUS

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9 Claims. (Cl. 139—341)

Our invention relates to improvement in motor control systems and more particularly to improvements in loom protection devices wherein operation of a loom is stopped if the shuttle (or yarn carrier) thereof is not correctly positioned at a given instant in the operating cycle of the loom.

In order to prevent the shuttle, or yarn carrier, of a loom from breaking threads in the warp shed thereof, it is essential that the shuttle complete its flight between the shuttle boxes before the warp threads are moved into the path of the yarn carrier. Should the shuttle be stopped in the warp shed or be appreciably delayed in its operating cycle for any reason, warp threads will almost inevitably be broken and the shuttle and other loom components may be damaged unless the loom is instantly stopped. Manifestly, it is desirable that such delay be detected before the shuttle reaches the shuttle box towards which it is traveling if sufficient time is to be provided for the loom to be stopped before damage occurs.

Typical of systems for loom protection that have been used in the past is that described in U. S. Patent 2,664,116 to A. C. Krukonis. Therein there is described an arrangement wherein a photoelectric cell is utilized to detect the passage of the loom shuttle at a point approximately midway between shuttle boxes. A light source is pulsed during the portion of the operating cycle of the loom at which the shuttle should be passing between the light source and the photoelectric cell. If the shuttle is delayed in its flight, the resulting increase in photoelectric cell current produced by light rays from the light source impinging thereon will be effective to energize braking apparatus associated with the drive motor of the loom. A prime disadvantage of this system is that the necessity of mounting the photoelectric tube and the light source on the loom renders these components susceptible to damage due to shock, vibration, etc. Inasmuch as failure of either the light source or the photoelectric tube would mean that the loom would not be stopped should faulty operation occur, it can be seen that totally reliable protection would not be provided for the loom. Additionally, dirt, lint and like particles prevalent in locales wherein looms are generally utilized tend to collect on the photocell and impair operation thereof by at least partially blocking the light rays passing from source to cell. As a result, the photoelectric cell must be periodically cleaned by the loom attendant. An additional shortcoming of the system referenced above is that the life of the light source will be considerably shortened as a result of pulsing thereof, which will require a rigid preventive maintenance program in view of the incomplete loom protection noted above. Still further, some warp sheds are so dense that very little light can penetrate therethrough to the photocell; this is particularly true of looms for heavy material.

One object of our invention is to provide a motor control system for a cyclically-operating work mechanism that is rugged, reliable, and employs a minimum number of mechanical moving parts.

Another object of our invention is to provide a loom protection system that will effectively prevent damage to a loom and to the material being fabricated thereby when the yarn carrier is delayed or unduly accelerated in its flight between shuttle boxes.

A further object is to provide loom protection apparatus that will stop operation of the loom in the event of failure of any of the component parts of the detection apparatus.

A still further object is to provide loom protection apparatus for stopping operation of a loom when the shuttle is delayed or unduly accelerated in its flight between shuttle boxes wherein the apparatus detecting the faulty movement of the shuttle will not be affected by dirt, lint and like particles that may collect thereon.

Yet another object is to provide loom protection apparatus for protecting a loom and the material fabricated thereby against damage caused by delayed or unduly accelerated action of the loom shuttle wherein the equipment for detecting such faulty operation has inherent long life and requires a minimum of maintenance and periodic inspection.

Other objects and features of our invention will become apparent upon consideration of the following description when taken in connection with the accompanying drawing wherein:

Figure 1 is a front elevation of a loom, parts being broken away, having the invention applied thereto;

Fig. 2 is an enlarged vertical section on line II—II of Fig. 1, showing the lay in full lines in the position which it occupies while the shuttle is in flight through the warp shed and in broken lines when the lay is in front center;

Fig. 3 is an enlarged view of a portion of the lay as shown in Fig. 1;

Fig. 4 is a schematic diagram of a form of electric circuit for carrying our invention into effect; and

Fig. 5 is a line diagram showing the portions of a cycle of operation of the loom over which indicated switches in the schematic diagram of Fig. 4 are closed.

In one aspect of our invention, a radioactive material is implanted in the shuttle or yarn carrier, and a radioactivity detector such as a Gieger-Mueller tube is stationed adjacent the point in the path of the carrier whereat the carried should be passing at a given instant in the cycle of operation thereof. If the carrier is on time during a given cycle of operation, output pulses from the radioactivity detector actuate control apparatus that permits the loom to continue to operate through another cycle of operation. If, however, the carrier is either late or early in its cycle of operation, no pulses will appear at the output of the detector over the time interval assigned for the passage of the carrier by the point at which the detector is stationed, and the control apparatus will be actuated to break the motor by plugging thereof or other convenient means.

With reference now to Fig. 1, there is shown a loom having left and right loom sides **1** and **35**, respectively, which support a rocker shaft **12** for left and right side lay-swords **9** and **22**, respectively, which support the lay designated by the reference numeral **29**.

The lay is swung backwards and forwards in the loom by power imparted to it from a top shaft **27** through connectors, one of which is designated **51** in Fig. 2. The top shaft is driven by means of motor **47** through a gear train including gears **45**, **41** and **37**. The bottom shaft **15** is driven from top shaft **27** through a gear train including gears **36** and **43**. Picking arms **13** and **46** are secured to shaft **15** for cooperation with picking

cams 11 and 42, respectively, operatively connected to picker sticks 5 and 38, respectively. The picker sticks operate one at a time and usually during the backward stroke of the lay when it is at or near its top center position approximate midway between its extreme front and back positions. The shuttle aligned with a picker stick will be propelled by it from one end of the loom to the other end, causing it to pass through a warp shed designated as S (Fig. 2) comprising upper or lower planes or groups of warp threads 20 and 22. The threads pass through reed 23, the lower end of which is positioned by the lay beam member 18 and the upper end of which is positioned by a hand rail member 60. As shown in Fig. 2, hand rail member 60 is supported by arm 62 which extends upward from the lay structure 29.

Implanted in the bottom of shuttle 33 is a slug or a pellet 49 of a radioactive material, preferably a beta-ray source such as Thallium 204. Approximately midway along the path of travel of the shuttle near the top edge of the lay beam 29 there is provided a cavity 31 which opens onto the top edge of the lay beam through channel 32. Within the cavity 31 there is provided a radiation detector 50, such as an ionization chamber, a Gieger-Mueller tube, or a proportional counter, which detector comprises an anode 53, a cathode 52 and an envelope or protective enclosure. To prevent the detector from being actuated while the shuttle is at a distance from the detector, except in the vicinity of channel 32, the cavity may be lined with a sheath of lead or other material through which radioactive emanations can penetrate only with extreme difficulty. This lining may or may not be necessary depending on the type of radioactive material embedded in the shuttle. Ionizing particles from the radioactive material should be able to penetrate to the radiation detector only when the shuttle is passing directly over channel 32.

The operation of motor 47 is controlled by the circuitry shown in Fig. 4. Power for the motor is provided from 3-phase alternating current lines 168, 170 and 172 which are respectively connected to terminals 174, 176 and 178 of motor 47 by normally open contactors 158, 156 and 154 of relay 148. Braking or plugging current for the motor is provided from D. C. lines 164 and 166 which are connected to motor terminals 174 and 178 through normally closed contactors 162 and 160.

The actuating coil 150 of relay 148 is energized by the circuitry described below. The output pulses from radiation detector 50 are amplified by means of pulse amplification circuit 71. The anode 53 is connected to the control grid 74 of pulse amplifier tube 70 and the cathode 52 is connected to the negative terminal of a high voltage power supply (not shown) which supplies proper voltage for operating the radiation detector. Grid-leak resistor 78 is connected between control grid 74 and cathode 72 of amplifier tube 70 which may be of the 6SH7 type. A voltage divider circuit, including serially-connected resistors 86, 82 and 80 in the order named, is connected between the positive and negative terminals of the high voltage power supply. Screen grid 76 of amplifier tube 70 is connected to the juncture of resistances 82 and 86 and cathode 72 is connected to the juncture of resistances 80 and 82. Screen bypass condenser 84 is connected between screen grid 76 and cathode 72. Plate potential for amplifier tube 70 is provided from the positive terminal of the high voltage power supply through load resistance 88.

The output pulses from amplifier 71 are converted to square wave form by saturating amplifier 91. This amplifier includes vacuum tube 92 which may be a 6SH7 type tube having a cathode 96, control grid 94, screen grid 98, plate 93 and a suppressor grid 95 which is connected directly to the cathode. Grid leak resistor 105 is connected between control grid 94 and ground and pulses appearing across load resistor 88 of amplifier 71 are coupled to control grid 94 by means of coupling capacitor 90. A low voltage power supply (not shown) is connected to plate 93 through dropping resistor 102 and to screen grid 98 through dropping resistor 100. Cathode resistor 106 is connected between cathode 96 and tap 140 of low-voltage voltage-dividing resistance 136. In effect, amplifier 91 can be seen to be a cathode follower.

The square wave output pulses appearing across resistance 106 are coupled to a clipping and summing circuit 109 by means of coupling capacitor 104. The output pulses are clipped by means of rectifier 112 which is connected between coupling capacitor 104 and ground. The clipped output pulses are coupled by means of half-wave rectifier 114 to a summing capacitor 116 which is shunted by resistor 118. The other terminal of capacitor 116 is connected directly to ground. The value of capacitors 116 and 104 and resistor 118 are chosen so as to permit an accumulation of D. C. voltage across capacitor 116 only when a rapid succession of pulses appear at the output of radiation detector 50 such as will occur when the radioactive slug in the shuttle is directly above the detector. This minimizes the amount of shielding required around the radiation detector.

The output voltage across resistance 118 is coupled to the grid 132 of thyratron 128 through resistor 122 and switch 17. The cathode 134 of the thyratron is connected to tap 138 of voltage divider 136, thus allowing adjustment of the thyratron plate voltage. Voltage dividing resistor 136 is connected to the positive terminal of the low voltage source by means of resistor 108 and to ground, the negative terminal of low voltage supply likewise being connected to ground. The actuating coil 150 of relay 148 is connected between plate 130 of thyratron 128 and the juncture of resistances 108 and 136 through voltage dropping resistor 120. Plate 130 is connected to ground through switch 19 and through serially-connected resistor 146 and switch 21. Condenser 141 is connected between plate 130 and ground to minimize the effect of plate voltage surges.

Switches 17, 19 and 21 are actuated by cams on top shaft 27. The switches are closed for various predetermined portions of each operating cycle of the loom as shown generally by the shaded areas in Fig. 5. Switch 21 is closed from the beginning of a cycle to a time $t2$ corresponding approximately to the instant at which the trailing edge of the shuttle 33 passes over radiation detector 50 when running normally. At time $t1$, corresponding approximately to the instant at which the leading edge of shuttle 33 passes over detector 50 when running normally, switch 17 is closed and remains closed until time $t2$. At a time $t3$, subsequent to time $t2$, switch 19 is closed to extinguish the thyratron. The time interval between $t2$and $t3$ is sufficient to allow the motor 47 to brake to a stop in the event that the shuttle is early or late in its flight between shuttle boxes. At some time $t4$, subsequent to time $t3$, switch 21 is closed and remains closed for the remainder of the cycle. Switch 19 opens very soon after switch 21 closes, prior to the end of the cycle. Switch 19 also may close momentarily after the closure of switch 21 at time $t4$ if care is taken to prevent a voltage surge that would trigger the thyratron. In either case, switch 19 must open after the closure of switch 21.

At the time of shuttle picking, the lay will be moving rearwardly and, while the shuttle is in flight through the warp shed, will reach its back center position under correct operating conditions. The lay will then start to move forward as the shuttle continues through the warp shed. Should the shuttle be traveling slower than usual, or should it be stopped in the warp shed for any reason, the reed 23 will push the shuttle forwardly through the warp shed and break some of the warp threads of the top and bottom thread groups 20 and 22 unless the loom is immediately stopped.

Let it be assumed, however, that the shuttle is on time

and that it is passing over radiation detector **50** at the instant in the operating cycle *t1* at which time switch **17** is closed and before switch **21** opens. A train of pulses produced by radioactive emanations from source **49** will appear at the output of radiation detector **50** and will produce a rapidly rising voltage on the grid of thyratron **128** (switch **17** being closed). This voltage will almost instantly reach a level sufficient to fire the thyratron. While the opening of switch **21** would normally interrupt the flow of current through relay coil **150**, the firing of the thyratron and the resulting current flow through coil **150** produced thereby is sufficient to hold the relay closed, and the motor will continue in operation. At time *t2*, switch **17** will open but the thyratron will remain fired; at time *t3* switch **19** will close, extinguishing the thyratron, and subsequently thereto at time *t4* switch **21** will close, reestablishing thyratron plate voltage as soon as switch **19** opens. Thus, from time *t3* of one cycle until time *t2* of the next cycle, relay **148** will remain closed.

Assume now that the shuttle is late in its cycle so that no pulses appear at the output of radiation detector **50** during the time interval from *t1* to *t2*. The thyratron cannot fire and inasmuch as switch **21** will be opened at time *t2*, the relay **148** will drop out. Plugging current from D. C. lines **164** and **166** will almost instantly stop the motor before switch **19** can close, thus protecting the loom and the material being fabricated thereby from damage.

It is readily apparent that the radiation detector need not be placed exactly midway between the shuttle boxes as indicated in Fig. 1, but may be placed at any position along the path traversed by the shuttle such as may be most advantageous to prevent damage. Likewise, more than one protective system may be incorporated so as to monitor the flight of the shuttle at various positions between the shuttle boxes. Additionally, a certain amount of latitude is permissible in setting the time intervals over which switches **17**, **21** and **19** are closed.

With regard to the choice of a source of radioactive material, it has been determined that a beta-ray source, such as Thallium 204, is the most suitable in this particular application. Of the three types of radiation, alpha rays are the least penetrating and have the smallest range in air. Beta rays are more penetrating, and gamma rays are the most penetrating of the three. In order to insure safety of operating personnel against contamination, it is necessary to encapsulate the source. If an alpha ray source were used, the capsule would have to be very thin to allow radiation to pass through, and would, therefore, be quite fragile and ill-adapted to withstand the shock and vibration associated with loom operation. A thick, dense warp shed could block alpha rays as effectively as light rays. Additionally, alpha radiation is by far the most dangerous of the three types noted above insofar as internal or ingested exposure is concerned, and this fact combined with the requisite thin capsule makes an alpha source highly undesirable. A source of gamma radiation, likewise, is not particularly desirable for two reasons. First, it is the least efficient ionizing agent of the three radiation types and would tend to render the detector insensitive to the passage of the shuttle. More important, however, is the fact that gamma radiation is so penetrating as to require excessive shielding in order to protect operating personnel. The range in air of gamma rays is such that it could easily reach over to adjacent machinery. If every loom in a work area had a radioactive source emitting gamma rays, there would result a marked rise in the normal radiation level of the area that could present a serious operating hazard, unless the radioactive source were adequately shielded.

A source of beta radiation, on the other hand, has enough penetrating ability to allow strong encapsulation, and its range in air is sufficiently short so that adjacent looms would be virtually unaffected by the radiation from any one set of shuttles. A one-quarter inch thickness of wood effectively attentuates beta radiation, thus virtually eliminating the necessity for the shielding **54** noted above. In most instances, the requirement for shielding is entirely eliminated. Beta radiation emanating from channel **32** passes through the most dense warp shed virtually unaffected. The human skin stops all but the hardest of beta rays, thus minimizing possibilities of surface burns, even presuming careless handling of the radioactive source.

It is readily apparent that our invention has achieved the objects set forth above. Failure of the radiation detector or any of the tubes in the control apparatus will prevent the thyratron from firing at its appointed time in the operating cycle of the loom so that the loom will be instantly stopped. The detecting apparatus is inherently not affected by dirt or lint inasmuch as the detector is actuated by radioactive emanations rather than by light rays which may be masked by dirt, lint and the like. Both the radiation detector and the radioactive emitter are inherently rugged and have long operating lifetimes so as to require a minimum of maintenance and periodic inspection. The control apparatus actuated by the radiation detector may be stationed at a sufficient distance from the loom so as to be unaffected by the shocks and vibrations produced thereby, and should present no extraordinary maintenance problem as a result thereof.

Manifestly, our invention may take forms other than that specifically described above. For example, the detecting head may be used as a limit switch to control operation of a motor driven reciprocating planer, by implanting the radioactive source in the reciprocating planer table and stationing the radiation detector at a position whereat the source will pass when the table is to be reversed. Impulses from the detector, after suitable amplification, may be used to trigger the electrical control apparatus normally associated with the machine tool so as to initiate the sequence of operation of said control apparatus that reverses the direction of operation of the planer table. Therefore, the invention is not to be restricted to the specific structural details, arrangement of parts or circuit connections herein set forth, as various modifications thereof may be effected without departing from the spirit and scope of this invention.

We claim as our invention:

1. In protection means for a loom operating with a yarn carrier which when running on time passes a given point along the path thereof at a given time in the loom cycle, radioactive means implanted in said yarn carrier, radiation detecting means stationed at a position whereat radiation particles from said radioactive means will be detected when said shuttle passes said given point, pulse amplifying means responsive to the output indications from said radiation detecting means, saturating amplifier means adapted to produce rectangular-wave pulses responsive to the output of said pulse amplifying means, clipping and summing means responsive to the output indications from said saturating amplifier means adapted to provide a direct voltage, the amplitude of which is functionally related to the frequency of the pulses from said radiation detecting means, thyratron means adapted to actuate means for continuing loom operation for an additional cycle of operation, switch means actuated by said loom adapted to couple said output of said clipping and summing means to said thyratron during a predetermined portion of each cycle of loom operation and to extinguish said thyratron at the end of said each cycle should said thyratron be in a conducting state thereat.

2. In protection means for a loom operating with a yarn carrier which when running on time passes a given point along the path thereof at a given time in the loom cycle, radioactive means implanted in said yarn carrier, radiation detecting means stationed at a position whereat radiation particles from said radioactive means will be

detected when said shuttle passes said given point, pulse amplifying means responsive to the output indications from said radiation detecting means, saturating amplifier means adapted to produce rectangular-wave pulses responsive to the output of said pulse amplifying means, clipping and summing means responsive to the output indications from said saturating amplifier means adapted to provide a direct voltage, the amplitude of which is functionally related to the frequency of the pulses from said radiation detecting means, and means responsive to the attainment of a predetermined amplitude by the output voltage of said clipping and summing means during a given portion of a given operating cycle of said loom adapted to continue operation of said loom for an additional cycle of operation and to stop said loom in the event that said output voltage of said clipping and summing means fails to attain said given amplitude during said given portion of said given operating cycle.

3. In protection means for a loom operating with a yarn carrier which when running on time passes a given point along the path thereof at a given time in the loom cycle, an electric motor for driving said loom, radioactive means implanted in said yarn carrier, radiation detecting means stationed at a position whereat radiation particles from said radioactive means will be detected when said shuttle passes said given point, pulse amplifying means responsive to the output indications from said radiation detecting means, saturating amplifier means adapted to produce rectangular-wave pulses responsive to the output of said pulse amplifying means, clipping and summing means responsive to the output indications from said saturating amplifier means adapted to provide a direct voltage, the amplitude of which is functionally related to the frequency of the pulses from said radiation detecting means, and means responsive to the attainment of a predetermined amplitude by the output voltage of said clipping and summing means during a given portion of a given operating cycle of said loom adapted to continue operation of said loom for an additional cycle of operation and to brake said motor in the event that said output voltage of said clipping and summing means fails to attain said given amplitude during said given portion of said given operating cycle.

4. In a loom having a driving motor and a yarn carrier actuated thereby in a normal timed sequence, an energizing circuit and a brake circuit for said driving motor, switch means adapted to connect said energizing circuit to drive said motor in a first position and to connect said brake circuit to said motor in a second normal position, first means driven by said motor and synchronized with normal carrier travel to actuate said switch means into said first position over a first predetermined time interval in each cycle of said travel, second means driven by said motor and synchronized with normal carrier travel to actuate said switch means into said first position over a second predetermined time interval in each cycle of said motor overlapping said first time interval and extending over the major portion of said each cycle not covered by said first time interval and responsive to an electrical signal having a given characteristic, radioactive source means carried by said yarn carrier, radiation detection means disposed at a point in the path of said carrier corresponding to the beginning of said second time interval, and means coupling said radiation detection means to said second means adapted to generate said electrical signal of said given characteristic responsive to output indications from said radiation detection means.

5. In a loom having a driving motor and a yarn carrier actuated thereby in a normal timed sequence, an energizing circuit and a brake circuit for said driving motor, switch means adapted to connect said energizing circuit to drive said motor in a first position and to connect said brake circuit to said motor in a second normal position, first means driven by said motor and synchronized with normal carrier travel to actuate said switch means into said first position over a first predetermined time interval in each cycle of said travel, second means driven by said motor and synchronized with normal carrier travel to actuate said switch means into said first position over a second predetermined time interval in each cycle of said motor overlapping said first time interval and extending over the major portion of said each cycle not covered by said first time interval responsive to an electrical signal having a given characteristic, radioactive source means carried by said yarn carrier, radiation detection means disposed at a point in the path of said carrier corresponding to the beginning of said second time interval, said second means comprising a gas discharge tube having at least cathode, plate, and control electrodes, the plate circuit of said tube including the actuating coil of said switch means, means coupling said control grid of said tube to said radiation detection means over said second time interval adapted to fire said tube responsive to output signals from said radiation detection means produced by the detection of emanations from said radioactive sound, and means connected to the plate of said tube adapted to extinguish said tube at a predetermined time in said cycle of loom during said first predetermined time interval.

6. In a loom having a driving motor and a yarn carrier actuated thereby in a normal timed sequence, an energizing circuit and a brake circuit for said driving motor, switch means adapted to connect said energizing circuit to drive said motor in a first position and to connect said brake circuit to said motor in a second normal position, first means driven by said motor and synchronized with normal carrier travel to actuate said switch means into said first position over a first predetermined time interval in each cycle of said travel, second means driven by said motor and synchronized with normal carrier travel to actuate said switch means into said first position over a second predetermined time interval in each cycle of said motor overlapping said first time interval and extending over the major portion of said each cycle not covered by said first time interval responsive to an electrical signal having a given characteristic, radioactive source means carried by said yarn carrier, radiation detection means disposed at a point in the path of said carrier corresponding to the beginning of said second time interval, said second means comprising a gas discharge tube having at least cathode, plate, and control electrodes, the plate circuit of said tube including the actuating coil of said switch means, means coupling said control grid of said tube to said radiation detection means over said second time interval adapted to fire said tube responsive to output signals from said radiation detection means produced by the detection of emanations from said radioactive source, and switch means coupled to said motor adapted to couple an extinguishing voltage between said cathode and plate electrodes at a predetermined time during said first predetermined time interval.

7. In a loom having a driving motor and a yarn carrier actuated thereby in a normal timed sequence, an energizing circuit and a brake circuit for said driving motor, switch means adapted to connect said energizing circuit to drive said motor in a first position and to connect said brake circuit to said motor in a second normal position, first means driven by said motor and synchronized with normal carrier travel to actuate said switch means into said first position over a first predetermined time interval in each cycle of said travel, second means driven by said motor and synchronized with normal carrier travel to actuate said switch means into said first position over a second predetermined time interval in each cycle of said motor overlapping said first time interval and extending over the major portion of said each cycle not covered by said first time interval responsive to an electrical signal having a given characteristic, radioactive source means carried by said yarn carrier, radiation detection means disposed at a point in the path of

said carrier corresponding to the beginning of said second time interval, said second means comprising a gas discharge tube having at least cathode, plate, and control electrodes, the plate circuit of said tube including the actuating coil of said switch means, saturating amplifier means coupled to said radiation detection means adapted to convert output pulses from said detection means to rectangular wave pulses of uniform amplitude, clipping and summing means responsive to the output of said saturating amplifier means adapted to produce a direct voltage, the amplitude of which is functionally related to the frequency of pulses fed thereto, and switch means coupling said direct voltage to said control grid of said gas discharge tube to permit firing of said gas discharge tube when said direct voltage reaches a predetermined amplitude.

8. In a loom having a driving motor and a yarn carrier actuated thereby in a normal timed sequence, an energizing circuit and a brake circuit for said driving motor, switch means adapted to connect said energizing circuit to drive said motor in a first position and to connect said brake circuit to said motor in a second normal position, first means driven by said motor and synchronized with normal carrier travel to actuate said switch means into said first position over a first predetermined time interval in each cycle of said travel, second means driven by said motor and synchronized with normal carrier travel to actuate said switch means into said first position over a second predetermined time interval in each cycle of said motor overlapping said first time interval and extending over the major portion of said each cycle not covered by said first time interval responsive to an electrical signal having a given characteristic, a source of beta radiation carried by said yarn carrier, radiation detection means disposed at a point in the path of said carrier corresponding to the beginning of said second time interval, said second means comprising a gas discharge tube having at least cathode, plate, and control electrodes, the plate

circuit of said tube including the actuating coil of said switch means, saturating amplifier means coupled to said radiation detection means adapted to convert output pulses from said detection means to rectangular wave pulses of uniform amplitude, clipping and summing means responsive to the output of said saturating amplifier means adapted to produce a direct voltage, the amplitude of which is functionally related to the frequency of pulses fed thereto, and switch means coupling said direct voltage to said control grid of said gas discharge tube to permit firing of said gas discharge tube when said direct voltage reaches a predetermined amplitude.

9. In a motor control system, in combination: a cyclically-operating work mechanism, an electric motor driving said work mechanism through its cycle, first means adapted to control operation of said electric motor in accordance with electrical indications received thereby during predetermined portions of said cycle, second means for initiating said indications including a radioactive source means, radiation detecting means responsive to emanations from said radioactive source, one of said radioactive source means and said radiation detection means being carried by said work mechanism and the other being stationed relative thereto so that said detection means receives said emanations only during said predetermined portions of said cycle, said first means being coupled to said second means and responsive to indications therefrom.

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