United States Patent

[11] 3,625,243

[72] Inventors **Harry P. Hansen**
Martinsville;
Warren A. Barber, N. Planfield, both of N.J.

[21] Appl. No. **11,241**
[22] Filed **Feb. 13, 1970**
[45] Patented **Dec. 7, 1971**

[73] Assignee **The Singer Company**
New York, N.Y.

[54] **TIME CYCLE WARP-STOP MOTION CONTROL FOR WEAVING LOOMS**
7 Claims, 1 Drawing Fig.

[52] **U.S. Cl.** **139/336,** 139/1
[51] **Int. Cl.** **D03d 51/00**
[50] **Field of Search** 139/336, 353, 1, 349; 66/163; 28/51

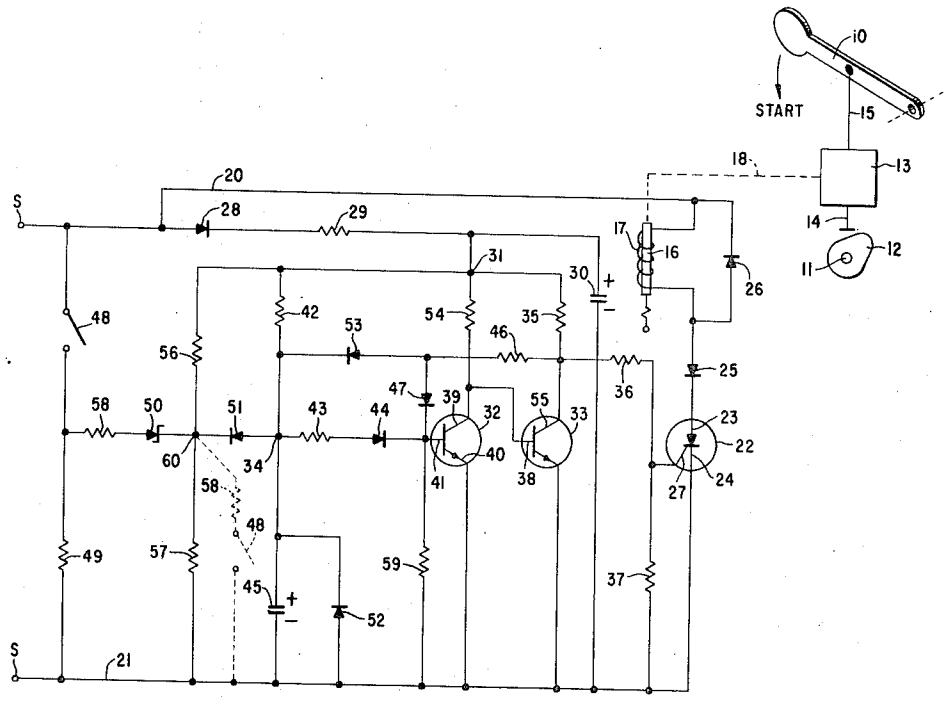
[56] **References Cited**

UNITED STATES PATENTS

3,530,690	9/1970	Nickell et al.	66/163
3,498,339	3/1970	Davis et al.	139/336
3,343,158	9/1967	Tellerman	66/163 UX
2,531,944	11/1950	Metcalf	139/353
3,373,773	3/1968	Balentine, Jr. et al.	139/336 X
3,529,444	9/1970	Romoli	66/163 X

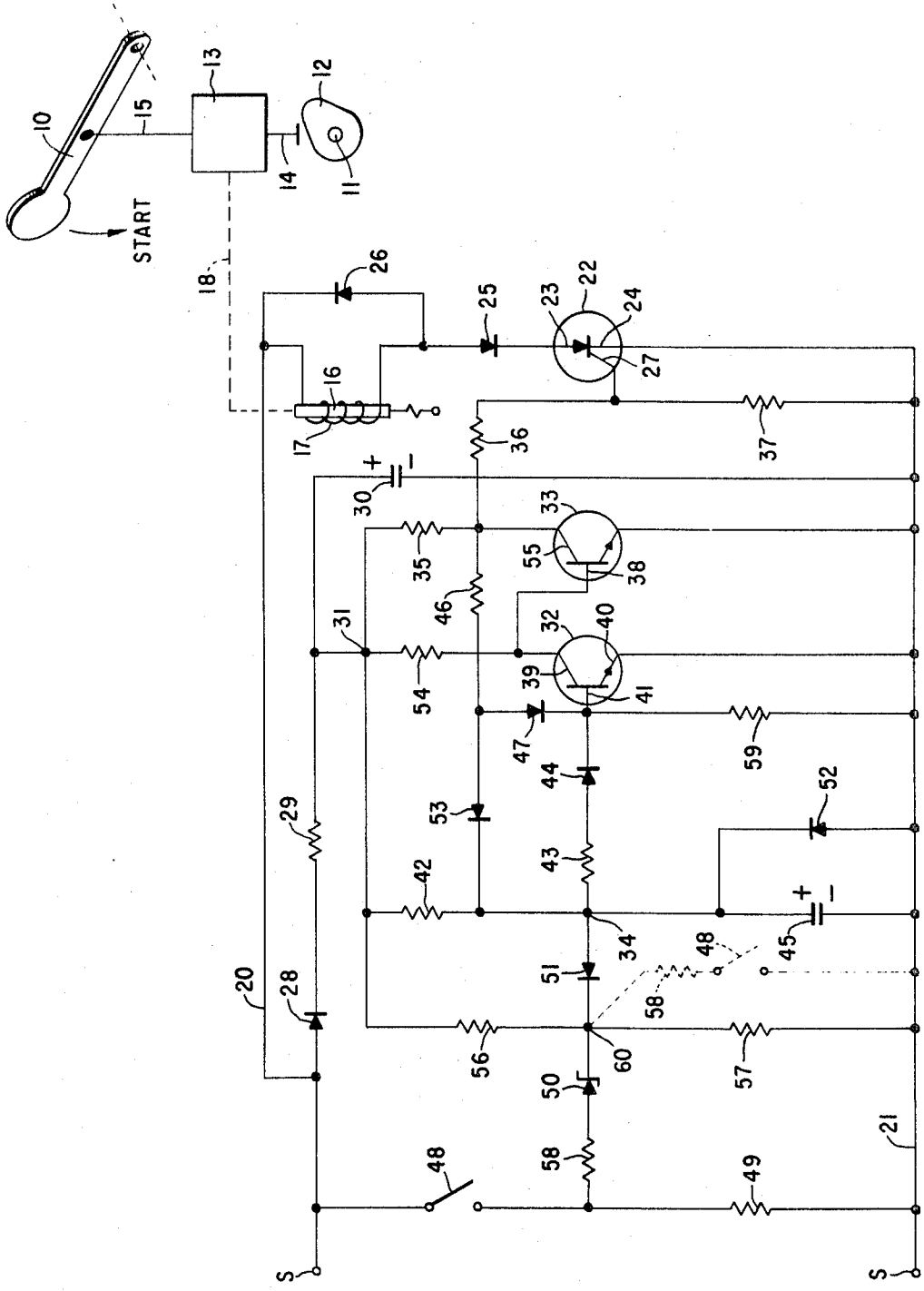
Primary Examiner—James Kee Chi
Attorneys—Marshall J. Breen and Chester A. Williams, Jr.

ABSTRACT: A circuit is disclosed for controlling the energization of the solenoid for actuating the conventional power-stop motion of a weaving loom in the event either of power failure or of breakage of warp threads. A silicon-controlled rectifier (SCR) is connected in series with the solenoid and an AC voltage supply. Gating of the SCR is controlled by a unique transistor flip-flop circuit, the state of which is responsive to two different threshold voltages established at a control point. The voltage at the control point is determined by an RC charging and discharging circuit conditionally responsive to the drop wire contacts. The RC circuit is adjusted so that a definite charging time must elapse after the opening of the drop wire contacts until the flip-flop changes state to gate the SCR into conduction. This time is made longer than the time of a pick-cycle of the loom.



PATENTED DEC 7 1971

3,625,243



INVENTORS
Harry P. Hansen
Warren A. Barber

BY

Marshall J. Breen
ATTORNEY

WITNESS:
Marvin Rothberg

TIME CYCLE WARP-STOP MOTION CONTROL FOR WEAVING LOOMS

BACKGROUND OF THE INVENTION

Prior art circuits are known for controlling the energization of a solenoid in a conventional knockoff stop control for looms. So far as we are aware, these circuits have always relied on a shipper handle switch to reset the circuits by the same motion of the shipper handle used to restart the loom on Fail-Safe, Power-Failure-Protected Systems. This requires very critical adjustment of the switch to allow time for the solenoid to energize and "clear" the knockoff mechanism before the first pick. Any misadjustment of the switch results either in unnecessary shutdown of the loom or in a severe shock to the operator in holding the loom drive in engagement against the knockoff action. A prior circuit of this type is disclosed in the U.S. Pat. application Ser. No. 756,451, filed Aug. 30, 1968 now U.S. Pat. No. 3,498,337 and assigned to the same assignee as the present application

SUMMARY OF THE INVENTION

It is therefore a general object of the present invention to provide a solenoid control circuit for a knockoff stop system of a loom which overcomes the disadvantages of the prior art control circuits as described above.

It is a further object of this invention to provide a solenoid control circuit of this type in which reset of the circuit is independent of the control handle position and is automatically provided at the end of a time delay following the opening of the drop wire contacts.

It is a still further object of this invention to provide a solenoid control circuit of the above type in which the time delay is made longer than the pick-cycle time of the loom.

In attaining the objects of this invention, the circuit is powered *directly* from a low-voltage AC supply bypassing any shipper handle switch. Solenoid deenergization is controlled by the closing of drop wire contacts and is maintained for a time beyond the opening of said contacts by a timed-cycle circuit. Once a drop wire contact has caused deenergization of the solenoid, the latch-out will remain in effect for the duration of the drop wire contact plus a definite time delay longer than the loom pick cycle. Thus the solenoid will remain deenergized long enough to provide a controlled stop whether or not the drop wire remains in solid contact. Thus, after a controlled stop and after the broken warp threads have been repaired, the solenoid is already energized and the knockoff linkage is cleared before shipper handle engagement is attempted and without requiring any critical mechanical adjustment of a switch with respect to shipper handle movement.

DESCRIPTION OF THE INVENTION

The single FIGURE of the drawing is a wiring diagram of the circuit of this invention applied to a conventional loom-stop motion indicated schematically.

Referring now to the FIGURE, a conventional loom shipper handle **10** which is shown in "off" position, may be moved in the direction of the arrow shown to start the loom for normal running. A loom shaft **11**, provided with a cam **12** in conventional manner operates a knockoff mechanism, indicated schematically as **13**, when the high point of cam **12** engages a push rod **14** to actuate rod **15** which knocks the shipper handle **10** to "off" position and shuts down the loom. The function of the knockoff mechanism **13**, which is conventional, is to provide engagement or disengagement of the rods **14** and **15** responsively to the actuation of the armature **16** of solenoid **17** through a mechanical linkage **18**. Thus, when the solenoid **17** is deenergized, the rods **14** and **15** are connected mechanically by actuation of linkage **18** so that motion imparted to rod **14** by cam **12** in a predetermined angular position of shaft **11** will move rod **15** to actuate the shipper handle **10** to "off" position and shut down the loom. When, however, the solenoid **17** is energized, the linkage **18** moves to disconnect rod **14** from rod **15** and no motion is transmitted therebetween and the loom remains in operation. This type of solenoid-actuated knockoff mechanism is generally well known in the art and may, for example, be the same as that shown and described in the Sepavich et al. U.S. Pat. No. 2,436,022 and forms no part of this invention which is concerned with a circuit for controlling the energization of the solenoid **17**. This circuit will now be described.

A source S—S of low AC voltage supplies voltage to lines **20–21**. A silicon-controlled rectifier (SCR) **22** functions as a controlled switch has its anode **23** and cathode **24** connected in series with the solenoid **17** and a diode **25** across lines **20–21**. The diode **25** is used in conventional manner to protect the SCR **22** from reverse anode voltages. A conventional freewheeling diode **26** shunts the solenoid **17** and provides a path for forward solenoid current during the time period between conducting positive half-cycles. When proper voltage is applied to the gate **27** of SCR **22** it conducts half-wave rectified AC through the solenoid **17**. When this gate voltage is removed, the SCR **22** turns off by virtue of the zero voltage level at its anode **23** at the beginning of the next negative cycle in a well-known manner.

A diode **28**, resistor **29** and capacitor **30** provide a DC voltage source at junction **31** for the gate **27** and the control circuitry. Transistors **32** and **33** and associated circuitry provide a high-hysteresis flip-flop which "snaps" from one state to the opposite state responsive to high- and low-limit threshold voltages developed at a control point **34** as will be described subsequently.

During periods when energization of solenoid **17** is required, transistor **32** is saturated and transistor **33** is cut off. Current for the gate **27** is then provided from junction **31** through resistors **35** and **36**. Resistor **37** is a gate-to-cathode shunt provided for SCR stability as is well known.

For as long as transistor **32** remains saturated, all drive to the base **38** of transistor **33** is removed by the low impedance of the path between the collector **39** and emitter **40** of transistor **32** whereby transistor **33** is kept fully cut off. In this state, transistor **32** is kept saturated by current supplied to the base **41** from junction **31** by two paths. The first path through resistors **42**, **43** and diode **44**, with time delay afforded by capacitor **45**, constitutes the timing control path. The second path, through resistors **35**, **46** and diode **47**, constitutes the latching path.

The switch **48** represents the drop wire contacts which are in common usage on looms to detect warp thread breakage. The function of switch **48** is to close responsively to warp breakage but obviously can be made to close responsively to any loom malfunction it is desired to detect. Thus, when switch **48** closes responsively to some loom malfunction, the AC voltage from S—S is applied to resistor **49**. When the next negative half-cycle of voltage from S—S reaches a value sufficient to overcome the breakdown voltage of Zener diode **50** and the forward voltage drop in diode **51**, discharge current rapidly flows out of capacitor **45** (which has previously been charged with the polarity shown) and discharges it. The diode **52** clamps the voltage at the control point **34** to eliminate large negative excursions thereof. An alternate to the discharge path through diode **51**, Zener **50**, resistance **58**, and switch **48** could be accomplished by a discharge network consisting of a timing resistor in series with the drop wire switch. This network would then be connected directly between line **21** and junctions **34** or **60**, as shown, for example, in dashed lines in the FIGURE.

When capacitor **45** has discharged to the extent that the voltage at the control point **34** falls below a lower threshold value of approximately 0.6 volts, both the timing path **42**, **43** and **44**, and the latching path **35**, **46** and **47** (by virtue of flow through diode **53**) are so severely shunted that all current is diverted from the base **41** and transistor **32** comes out of saturation. The voltage at collector **39** rises and applies base current drive to base **38** (limited only be resistor **54**) thus bringing transistor **33** out of cutoff. As transistor **33** begins to conduct, the voltage at its collector **55** decreases further removing

the latching current through resistor **46** and diode **47** to base **41**.

At this point the flip-flop snaps to the reverse state, that is, with transistor **32** fully cut off and transistor **33** fully saturated. Thus in this state, with collector **55** at approximately 0 volts, the current drive to the gate **27** is removed and the solenoid **17** is deenergized. The mechanism, now set for loom knockoff through linkage **18**, causes loom shutdown the next time the high point of cam **12** actuates the rod **14** as is well understood.

For as long as switch **48** remains closed, capacitor **45** cannot charge and transistor **32** cannot conduct. When switch **48** opens, however, capacitor **45** begins to charge from current supplied from junction **31** through resistor **42**. Thus the voltage at the control point **34** follows the capacitor voltage and, as soon as it reaches a sufficiently positive upper threshold level, transistor **32** begins to conduct causing transistor **33** to come out of saturation. Once the voltage at the collector **55** increases sufficiently, the latch-in current through resistor **46** and diode **47** to the base **41** is reapplied snapping the flip-flop into the state wherein transistor **32** is saturated and transistor **33** is cut off. The solenoid **17** will now be energized and is ready for the operator to start the loom.

Resistors **56** and **57** constitute a voltage divider for the voltage at **31** and provides a reference voltage at point **60** for comparison with the voltage at control point **34**. Thus, whenever the voltage at junction **31** drops, as would occur during a momentary power failure, the capacitor **45** is provided with a quick discharge path through resistor **57** and the circuit behaves in the same manner as described above with respect to closure of switch **48**. This guarantees a controlled stop even if power is suddenly reapplied. Resistor **58** limits the discharge current from capacitor **45** and resistor **59** controls the base bias of transistor **32**.

From the above description, it will be apparent that the flip-flop action of transistors **32** and **33** is responsive to two critical threshold values of the voltage at control point **34**. Above a certain value, say 2.2 volts, at point **34**, the solenoid will be energized and below a lower value, say 0.6 volts, at point **34**, the solenoid will be deenergized. Between these two values, the solenoid can be either energized or deenergized depending on its previous condition. The voltage at point **34** can vary from substantially 0 volts (when capacitor **45** is discharged) to that voltage determined substantially by the voltage of junction **31** and the ratio of resistors **56** and **57** modified somewhat by diode and transistor junctions. By choice of circuit constants, rate of discharge of capacitor **45**, initiated by closure of switch **48**, can be made such that the time for the voltage at **34** to drop 0.6 volts can be very small in which case the solenoid **17** is deenergized substantially simultaneously with closure of switch **48**. Similarly by choice of other circuit constants, the rate of charging of capacitor **45**, initiated by opening of switch **48** can be made such that a definite predetermined time must elapse for the voltage at point **34** to rise from 0 to 2.2 volts, in which case the energization of the solenoid **17** takes place at a definite time delay after the opening of switch **48**.

In a practical embodiment of this invention applied to a loom having a pick-cycle time of from 300 to 500 milliseconds, the time delay is set at 750 milliseconds which insures a controlled stop for any opening of the switch **48** and for even a momentary loss of power. Obviously, the time delay may be chosen, in any specific case, to be sufficiently longer than the pick-cycle time to attain the above-desired results in accordance with the teachings of this invention.

Having thus described the invention, it will be seen that changes and modifications may be made therein by those skilled in the art without departing from the spirit and scope of the invention and no limitation thereof is intended with respect to the details disclosed.

Having thus set forth the nature of this invention, what we claim herein is:

1. In a stop system for a loom having a knockoff device rendered effective responsively to deenergization of a solenoid to cause the shipper handle to stop the loom at a predetermined point in its operating cycle when actuated by a cyclically moving part of the loom, a circuit for controlling the energization of the solenoid from a voltage source comprising:
   a. a controlled switch,
   b. means connecting said controlled switch in series with said solenoid and with said voltage source,
   c. means applying a signal to said controlled switch sufficient to cause it normally to conduct and energize said solenoid,
   d. switch means actuated to a first position responsive to a loom malfunction for removing said gating signal and deenergizing said solenoid,
   e. means operative responsively to actuation of said switch means from its first to its second position upon removal of said malfunction to initiate the reapplication of said gating signal to said controlled switch, and
   f. means for delaying the reapplication of said gating signal to said controlled switch, for a definite time following the initiation thereof, said definite time being related to the time period of a loom operating cycle.

2. A circuit according to claim **1** wherein:
   a. a flip-flop having two stable states controls respectively the application and removal of said gating signal to and from said controlled switch, and
   b. a capacitor, charged and discharged at controlled rates by actuation of said switch means, determines the state of the flip-flop.

3. In a stop system for a loom having a knockoff device rendered effective responsively to deenergization of a solenoid to cause the shipper handle to stop the loom at a predetermined point in its operating cycle when actuated by a cyclically moving part of the loom, a circuit for controlling the energization of the solenoid from an AC voltage source comprising:
   a. a controlled rectifier,
   b. means connecting said rectifier in series with said solenoid and with said AC voltage source,
   c. a flip-flop having two stable states controlling respectively the application and removal of a DC conduction gating signal to and from the controlled rectifier,
   d. a capacitor,
   e. means for charging and discharging said capacitor,
   f. normally open switch means actuated to closed position responsive to loom malfunction,
   g. means responsive to the closing and opening of said switch means for initiating respectively the discharging and charging of said capacitor,
   h. means responsive to the voltage across said capacitor for causing the flip-flop to change state, and
   i. means for controlling the charging time of said capacitor so that the time required to change the state of the flip-flop in one direction is longer than the period of one operating cycle of the loom.

4. A circuit for controlling the energization of a solenoid according to claim **1** wherein said controlled switch is a solid-state semiconductor device.

5. A circuit for controlling the energization of a solenoid according to claim **4** wherein said solid-state semiconductor device is a controlled rectifier.

6. A circuit for controlling the energization of a solenoid according to claim **1** wherein said voltage source is a relatively low AC voltage source.

7. A circuit for controlling the energization of a solenoid according to claim **1** wherein said switch means in said first position is closed and in said second position is open.

* * * * *