United States Patent

Hill

[15] **3,704,660**

[45] **Dec. 5, 1972**

[54] **FILM PROCESSING MACHINE**

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[22] Filed: **Aug. 3, 1971**

[21] Appl. No.: **168,636**

[52] **U.S. Cl.** ..... **95/89 D**
[51] **Int. Cl.** **G03d 3/00**
[58] **Field of Search** ..... 95/89 D

[56] **References Cited**

UNITED STATES PATENTS

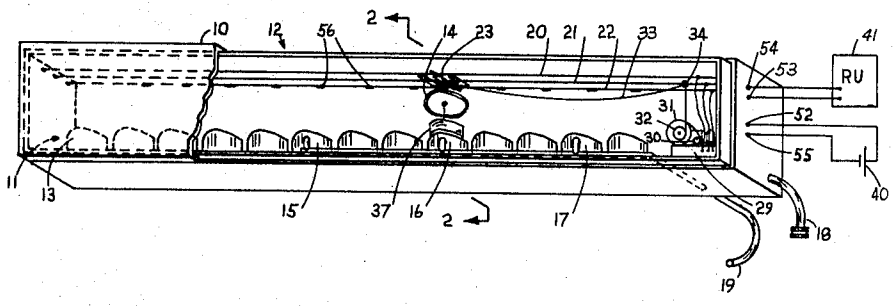
3,343,472	9/1967	Rosenberg	95/94 R
3,177,767	4/1965	Templeman	353/15
2,933,032	4/1960	Pardee	95/89 D
3,079,852	3/1963	Little et al.	95/89 D
2,453,900	11/1948	Gardiner et al.	95/89 D
3,187,626	6/1965	Mindell et al.	353/15

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Assistant Examiner—Richard M. Sheer
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[57] **ABSTRACT**

A film processing apparatus having a row of film developing tanks and a plurality of wires positioned above the tanks. The wires slidingly support a carriage over the row of developing tanks and also function as conductors to switches associated with the carriage. These switches control a motor for stopping the carriage over a successive tank and for reversing the motor to lower the film to be developed into the tank. The starting of the motor is controlled by a tape recorder that plays back tape on which audio-frequency signals of predetermined durations at predetermined intervals have been recorded.

5 Claims, 4 Drawing Figures



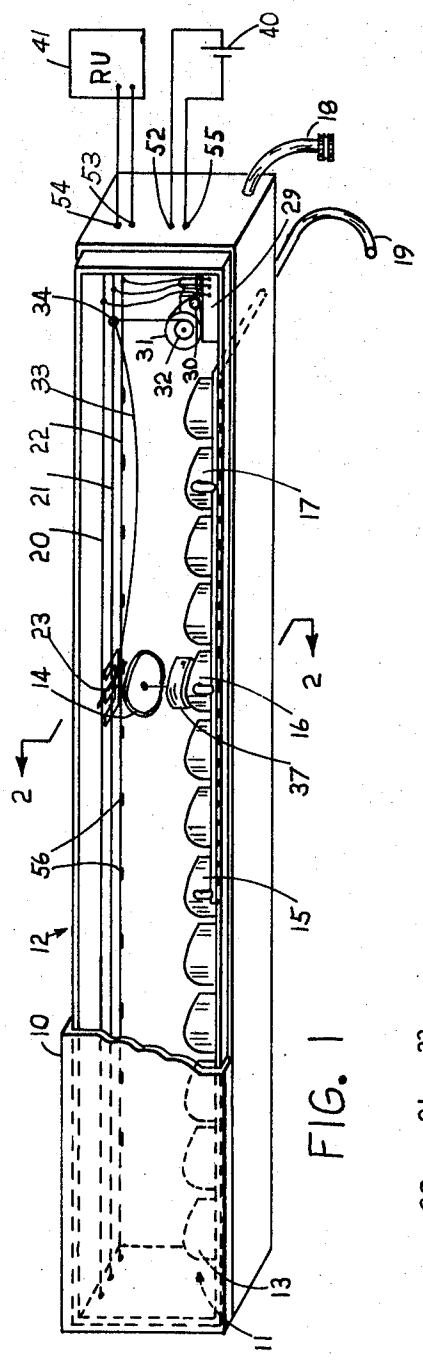


FIG. 1

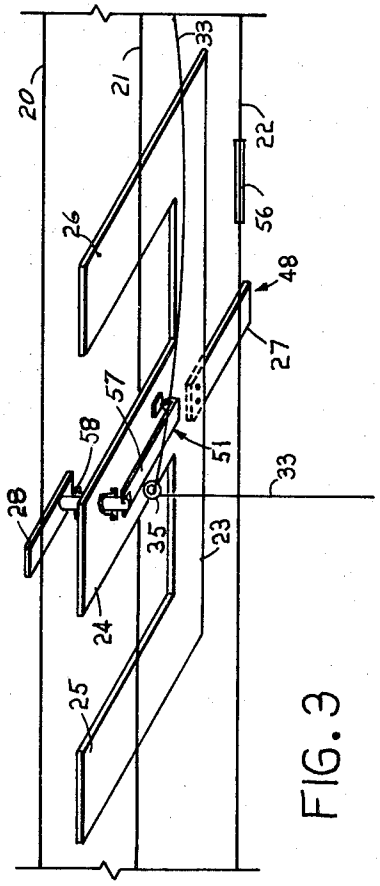


FIG. 3

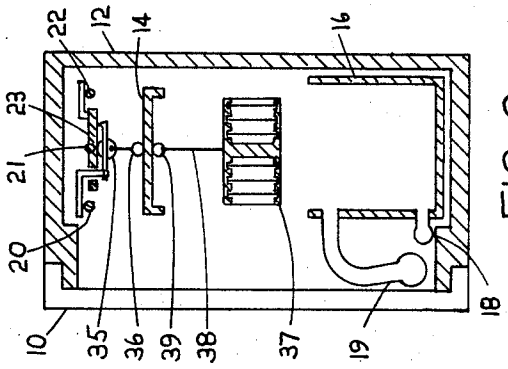


FIG. 2

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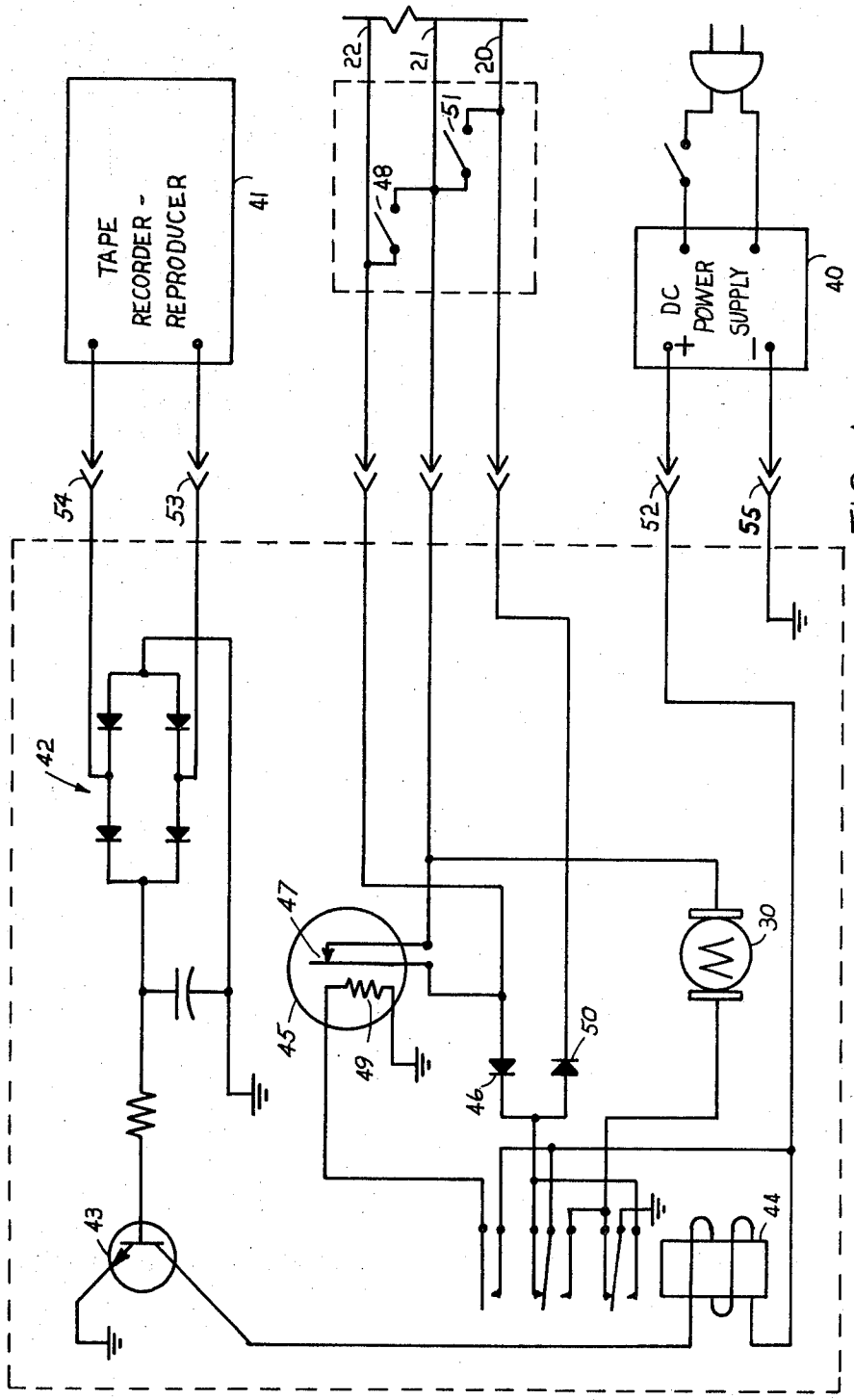


FIG. 4

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FILM PROCESSING MACHINE

BACKGROUND OF THE INVENTION

This invention pertains to film processing machines of the type that have an arrangement of tanks containing film processing solutions and means for automatically lowering film into the tanks and successively transporting the film between the tanks.

Commercial machines for processing film have containers or tanks of processing solutions arranged in a row, or in a circle, and have a carriage drivingly coupled to an electric motor for transporting the film between the tanks and for successively immersing the film in the solution in the tanks for predetermined intervals. Various driving arrangements for transporting the film between the tanks include chain and sprocket wheel arrangements and lead-screw arrangements connected between the motor and a carriage. The carriage may be supported at the end of an arm, and the arm may be operated by a cam to lower the film into the solutions. Other arrangements use a reel and a chain or a cord, and the chain or cord is unreeled to lower the film into the solutions.

U.S. Pat. No. 2,453,900 issued to W.R. Gardner on Nov. 16, 1948 shows a pair of parallel rails and a carriage slidingly mounted on the rails. A reel and an electric motor drivingly coupled to the reel are mounted at one end of the rails, and a cord extends from the reel through a pulley on the carriage to a film holder. After the carriage is positioned at that end of the rails opposite the motor, the motor is operated at intervals to pull the carriage between tanks while the holder is held upwardly close to the carriage, and after the motor stops operating, the weight of the film holder unwinds the reel to lower the film into the tank over which the carriage has been positioned. A trip rod is provided for stopping the motor when the carriage is over a tank. The carriage slides along the rod until a cog on the carriage engages a notch in the rod, and then the rod is moved in the direction of the movement of the carriage to operate a circuit breaker for stopping the motor.

In different commercial film processing machines, a timer is provided to control the operation of the motor for determining movement of the carriage. The timer usually comprises an electric motor and a cam-operated switching arrangement.

BRIEF DESCRIPTION OF THE INVENTION

An object of this invention is to provide an automatic film developer that is simple enough and low enough in cost to encourage its use by hobbyists at home.

A row of tanks for processing solutions and rinse are placed on the bottom of a long, narrow box that has a side cover to exclude light. A space is provided ahead of the processing tanks for location of a film container having a tight lid. A darkroom is not required because a photographic changing bag and the container can be used to exclude light before the side cover is placed on the box.

Three wires are suspended over the row of tanks to function as a track for a carriage and also as conductors for a switching system that controls movement of the carriage. A film holder is connected to one end of a cord; the cord is passed through an eye attached to the underside of the carriage; and then it is extended to a reel that is rotatably mounted in that end of the box

that extends past the last tank into which the film is to be lowered. The reel is connected to an electric motor that rotates in one direction to raise the film holder and then continues to rotate for moving the film holder to a position over a successive tank, and that rotates in the other direction to lower the film holder into either processing solution or rinse within the tank. To agitate fluid within a tank, the motor is operated a short interval in the direction for raising the film holder, and then it is operated in the reverse direction to lower the film holder.

The timing of the intervals between successive operations of the motor is provided by a tape recorder. The control circuit for the motor includes two switches associated with the carriage, also a thermal switch, and a starting relay controlled by timing signals supplied by the tape recorder. The two switches mounted on the carriage use the supporting wires for conductors. One of these switches comprises a contact for engaging one of the wires to complete an operating circuit for the motor, and the contact engages an insulated point on the surface of the wire located over each tank to break contact with the wire for stopping the motor. The other switch that is located on the carrier is in a reversing circuit, and it is engaged by the drive cord to hold it closed when the drive cord is held taut by the weight of the film holder containing the film that is being developed. The thermal switch is connected in parallel with that switch on the carriage that is used to operate and stop the motor, and it is effective to start the motor and operate it until it moves the carriage from over a tank and again closes the switch that is subsequently opened for stopping purposes.

The machine of this invention is simple to use by a hobbyist for developing color film automatically in a lighted room. The use of wires for supporting the carriage and also for switching purposes, a simple carriage, and a tape recorder for timing contribute to the low cost of the automatic film processor.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a front oblique view of the film processor of this invention;

FIG. 2 is a cross section of the film processor taken on the lines 2—1 of FIG. 1;

FIG. 3 is a bottom oblique view of the carriage that is shown in FIG. 1 for transporting a film holder; and

FIG. 4 is a schematic diagram of the control circuits of the motor of the film processor.

DESCRIPTION OF THE PREFERRED EMBODIMENT

With reference to FIG. 1, a required number of containers or tanks **11** for processing color film is mounted in a row on the bottom of a long, narrow box **12**. The container **13** at the left end of the row is removable and is adapted to receive a tight lid **14** so that the film to be developed can be placed in the container **13** and the lid placed on the container within a photographic changing bag to exclude light. A darkroom is not required because during the developing process a lid **10** is in place to cover the front side of the box **12**.

The tanks in the row **11** contain the usual processing fluids and rinses, and each of the tanks is preferably a suitable size for holding one pint of fluid, the amount

that is customarily provided in kits sold by suppliers of photographic goods for use by hobbyists. Each of the tanks **15**, **16**, and **17** used for rinsing by water have a lower inlet connected by a hose **18** to a water faucet, and an upper outlet connected by a hose **19** to a drain. Wires **20–22** for supporting a carriage **23** and for completing electrical switching circuits are stretched tightly in a parallel arrangement between the ends of the box **12** near the top of the box over the row of tanks **11**.

The carriage **23**, as best shown in FIG. **3**, is an E-shaped piece of conductive metal with spaced parallel members **24–26**. The carriage **23** is placed on the center supporting wire **21** such that the end members **25** and **26** are positioned above the wire and the middle member **24** is positioned below the wire. The longitudinal portion of the carriage may be bent as required to provide a desired amount of friction between the wire **21** and the carriage **23**, and thereby to provide desired control of the carriage as it is moved longitudinally along the wire **21**. The carriage is held horizontally by switch contact springs **27** and **28** that bear downwardly upon the wires **22** and **20** respectively.

A chassis **29** (FIG. **1**) for a motor **30** and its electrical control circuits are mounted at the extreme end of the box **12** beyond the last tank in the row **11** that is used in processing a film. A motor **30** is a permanent magnet DC motor, and it is coupled to a pulley **31** that is mounted on a spindle that functions as a reel **32**. A drive cord **33** is wound on the reel and is threaded through an eye **34** that projects downwardly from the top of the box **12** and also through an eye **35** (FIG. **2**) at the bottom of the carriage **23**, and is hooked to a ring **36** secured to the center of the top of the lid **14**. A film holder **37** is connected through a short cord **38** to a ring **39** fastened to the center of the bottom of the lid **14**.

With reference to FIG. **4**, the application of power from a source of direct current **40** to the motor **30** is controlled by a tape recorder-reproducer **41**. The output of the recorder **41** is connected to a rectifier-and-filter circuit including the diode bridge **42**, and the DC output circuit of the rectifier is connected to the base control circuit of a transistor **43**. The emitter-collector circuit of the transistor **43** is connected in series with the winding of a relay **44** through the course of DC current **40**. Normally, the relay **44** is released and it is operated in response to the presence of signal on the output circuit of the tape recorder-reproducer **41** to cause the transistor **43** to become conductive.

The application of power to the motor **30** is controlled by the contacts of the relay **44**. The relay has a normally open pair of contacts connected between the heater **49** of a delay-relay **45** and the source of current **40**, and two other pairs of normally open contacts connected in a circuit including the motor **30**, the contacts **47** of the delay-relay **45**, the carriage-supporting wires **21–22**, the switching contacts **48** operated by movement of the carriage **23**, and a diode **46**. A circuit for reversing the direction of rotation of the motor **30** includes a pair of normally closed contacts connected in the circuit including the motor **30**, the carriage-supporting wires **20** and **21**, the switch **51** that is mounted on the carriage **23** and operated by pressure applied from the cord **33**, and the diode **50**. The switches **48** and **51** are described in detail in the following description of operation.

To prepare the film processor for operation, the tanks **15**, **16**, and **17** shown in FIG. **1** are supplied with clean rinse water by connecting the hose **18** to a water faucet and placing the drain hose **19** near a convenient drain. The remaining tanks in the row of tanks **11** are filled with film processing solutions. When the tanks are made no larger than necessary, the amounts of solutions usually supplied in photographic kits are sufficient. A source of direct-current voltage **40** is connected to the terminals **55** and **52**, and the tape recording unit **41** is connected to the terminals **53** and **54**.

The container **13**, its lid **14**, and its attached film holder **37** are removed from the box **12** to be placed in a photographic film changing bag along with the film that is to be developed. After the film is arranged in a loose spiral in the holder and the lid **14** is placed tightly on the container **13**, the container **13** is again placed in position in the row **11** at the end of the box. The carriage **23** is then moved to the left along its supporting wire **21** until it is positioned over the container **13**, and the driving cord **33** is pulled until it is slightly loose and can be attached to the ring **36** at the top of the lid **14**. The lid **10** must now be placed on the front of the box **12**, and it is to remain in place at least until the film has already been treated in the fixing solution.

Recording tape to provide timing has been prepared for use in the recording unit **41**. The durations of audio-frequency tones that are impressed upon the tape are dependent upon the time required for the motor **30** to move the carriage **23** between the adjacent tanks in the row **11** and the time required for the film holder **37** to be raised and lowered in the same tank to provide agitation of the solution within the tank. The interval between the commencements of the tones is dependent upon the length of time that the film is to be in the various solutions. In one embodiment, the duration of the tones for moving the holder **37** from one tank to the succeeding tank is 10 seconds, and the duration of the tones to cause the film holder **37** to be raised and lowered for agitation purposes is 2 seconds.

After the tape recorder **41** is turned on, a signal having a duration of 10 seconds is supplied by the recorder to cause the transistor **43** to become conductive for operating the relay **44**. A circuit for operating the motor **30** can be traced from the terminal **52** of the power supply **40** through normally open contacts of the relay **44** to a terminal of the motor **30**. The circuit is continued from the other terminal of the motor **30** through the carriage-supporting wire **21**, the switch **48**, the wire **22**, the diode **46**, normally open contacts of the relay **44** to the common or ground circuit that is also connected to the terminal **55** of the power supply **40**. Contacts **47** of the delay-relay **45** are in parallel with the contacts **48**, but before the carriage **38** is positioned over a succeeding tank, the contacts are opened by heat supplied from the heating element **49**. The heating element **49** was connected to the power supply through a pair of normally open contacts when the relay **44** was operated.

With reference to FIG. **3**, the switch **48** comprises the spring contact **27** that is in an engagement with the wire **22**. A short portion of the wire **22** directly over each of the tanks in the row **13** is insulated to prevent electrical contact between the spring contact **27** and the wire **22**. Insulating tape or insulating material **56** that adheres to the wire provides satisfactory insulated

points. The 10-second signal supplied by the tape recorder **41** maintains the relay **44** operated longer than the time necessary for the carriage **23** to be moved from over the container **13** to the first tank in the row **11** that contains processing solution. Also, the contact **47** of the delay-relay **45** has been opened before the carriage **23** is positioned over the tank. Therefore, when the contact **27** of the switch **48** is moved onto the insulated portion **56** of the wire **22**, the operating circuit to the motor **30** is opened to stop rotation of the reel **32** and movement of the carriage **23**. At the end of the ten-second interval when the signal being supplied by the tape recorder **41** ceases, the relay **44** releases and completes a circuit for reversing the direction of rotation of the motor **30**. The circuit can be traced from terminal **52** of the power supply **40** through normally closed contacts of the relay **44**, the diode **50**, the carriage-supporting wire **20**, the switch **51**, the carriage-supporting wire **21**, to a terminal of the motor **30**. The circuit is completed from the other terminal of the motor **30** through normally closed contacts of the relay **44** to the common circuit that is connected to terminal **55** of the power supply **40**. The motor **30** continues to operate in a reverse direction to lower the film holder **37** until the contacts **51** are opened.

As shown in FIG. 3, the switch **51** comprises spring contacts **28** and **57** mounted to the carriage **23** but insulated from it by an insulator **58**. The spring contact **28** is constantly in contact with the wire **20**, and is also connected to that end of the spring **57** that is connected to the carriage **23**. Normally, a gap exists between the other end of the spring **57** and the conductive surface of the carriage **23** and the spring **57** is moved upwardly to close the switch **51** by pressure of the operating cord **33** when it is drawn taut. The cord **33** passes below the central portion of the spring **57**, and since the spring **57** is below a straight line that can be drawn between the eye **35** at the top of the box **12**, the spring **57** is moved upwardly with sufficient force by the weight of the loaded film carriage **37** to close the switch **51**.

When the cord **33** slackens as the carriage **37** contacts the bottom of the tank into which it is being lowered, the switch **57** opens to stop operation of the motor **30** until a signal is again supplied by the tape recorder **41**. Since the switch **48** associated with the supporting wire **22** is now opened, the circuit for starting the operation of the motor **30** to move the carriage **23** to a position over a succeeding tank includes the contacts **47** of the delay-relay **45**. When the relay **44** was released in response to the cessation of signal from the tape recorder **41**, the circuit of the heating element **49** of the relay **45** was opened, and shortly thereafter the contacts **47** closed. Therefore, when the relay **44** is again operated to start the motor **30** for an interval between the circuit, the motor and the diode **46** can be traced through the contacts **47** of the delay-relay **45**. By the time the contacts **47** are again opened in response to current being supplied to the heating element **49** through contacts of the relay **44**, the carriage has moved the spring **27** of the switch **48** off the insulator **56** onto the conducting surface of the wire **22**. The motor then continues to operate until the next insulator **56** around the wire **22** is encountered as described above.

To agitate processing fluid in a tank, signal for a short interval, such as 2 seconds, is supplied by the tape recorder **41** after the film holder **37** has been lowered into the tank. In response to the operation of the relay **44**, the circuit through the contacts **47** of the delay-relay **45** as described above is completed to operate the motor **30** until the film holder **37** is raised only part of the way vertically toward the carriage **23**. In response to the relay **44** releasing when the short signal ceases, the circuit for reversing the operation of the motor as described above is completed through the switch **51** until the driving cord **33** slackens.

The operation of the motor **30** is repeated in response to signals being supplied from the tape recorder **41** until the film that is being processed has been removed from the last tank in the row. After the last control signal on the tape has been supplied, the tape recorder can be shut off either automatically or manually. The finished film can be removed from the holder **37** at any later time.

I CLAIM:

1. In a film processing unit having a row of film processing tanks, carriage means including a track supported horizontally over said row of tanks and a carriage mounted on said track, said carriage having means for holding film, and an electric motor drivingly coupled to said carriage and operable to move said carriage along said track to lower said film successively into said tanks, to raise said film therefrom, and to transport said film therebetween, electrical control means for controlling operation of said motor comprising:

a timer,

an operating circuit for said motor connected between said timer and said motor, said operating circuit including first and second switching means, each separately operable to be closed to complete said operating circuit for operating said motor,

said first switching means normally being closed for operating said motor, said first switching means including a switching element for each of said tanks distributed along said track, engageable by said carriage, and operable in response to engagement by said carriage to open said first switching means, each of said switching elements being positioned to be engaged by said carriage in response to said carriage being moved over a respective one of said tanks,

said timer supplying signals at different intervals dependent upon the amount of time film is to be immersed in each of said tanks,

said second switching means being closed for a predetermined interval in response to application of signals from said timer to start operation of said motor for moving said carriage, and a successive one of said switching elements being operable in response to its engagement by said carriage to stop operation of said motor for stopping movement of said carriage

said track being a plurality of parallel conductive wires including first and second wires, said carriage being conductive and being slidingly mounted to said first wire, said first switching means including a first switching contact means extending from said carriage to press on said

second wire, and said switching elements comprising insulating material applied to the surface of said second wire at each of the points where said first switching contact means presses on said second wire when said carriage is positioned over any of said successive ones of said tanks.

2. A film processing unit as claimed in claim 1 wherein said timer is a tape reproducer for reproducing recorded timing signals occurring at predetermined intervals and having different predetermined durations.

3. A film processing unit as claimed in claim 1 wherein said second switching means includes a thermal delay-relay.

4. A film processing unit as claimed in claim 1 including a reversing circuit for said motor and wherein said track includes a third wire, said reversing circuit comprising:

a second switching contact means mounted on said carriage, said second switching contact means having a portion contacting said third wire to complete a circuit between said third wire and said carriage, a reel and a cord, said reel being operatively coupled to said electric motor and said cord extending between said reel and said carriage, a film holder, said carriage having an eye through which said cord extending between said reel is loosely threaded and attached to said holder below said carriage, the weight of said holder maintaining s-aid cord taut, said second switching contact means normally being open and being engaged by said cord in response to said cord being pulled taut to close said second switching contact means, said second switching means including normally closed reverse circuits, said normally closed reverse circuits, said third wire and said second switching contact means being connected in series to said motor to operate it in a reverse direction of rotation in response to release of said second switching means while said second switching contact means is closed.

5. A film processing unit as claimed in claim 4 wherein the first tank of said row has a lid to exclude light, and said lid is suspended by said cord above said film holder.

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