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Hynes et al.

[11] **3,856,460**

[45] **Dec. 24, 1974**

[54] **DEVELOPING SYSTEM FOR FILM BY ADIABATIC HEAT FLOW**

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[73] Assignee: **Xerox Corporation**, Stamford, Conn.

[22] Filed: **Nov. 23, 1973**

[21] Appl. No.: **418,719**

[52] **U.S. Cl.** **432/59**, 219/216

[51] **Int. Cl.** **F27b 9/28**

[58] **Field of Search** ..... 95/89 R, 94 R; 219/216, 219/388; 226/113, 114, 195; 432/8, 59, 225; 242/75.3; 354/297, 299

[56] **References Cited**

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3,038,994	6/1962	Nelson et al.	219/388 UX
3,382,789	5/1968	Barker	95/89 R
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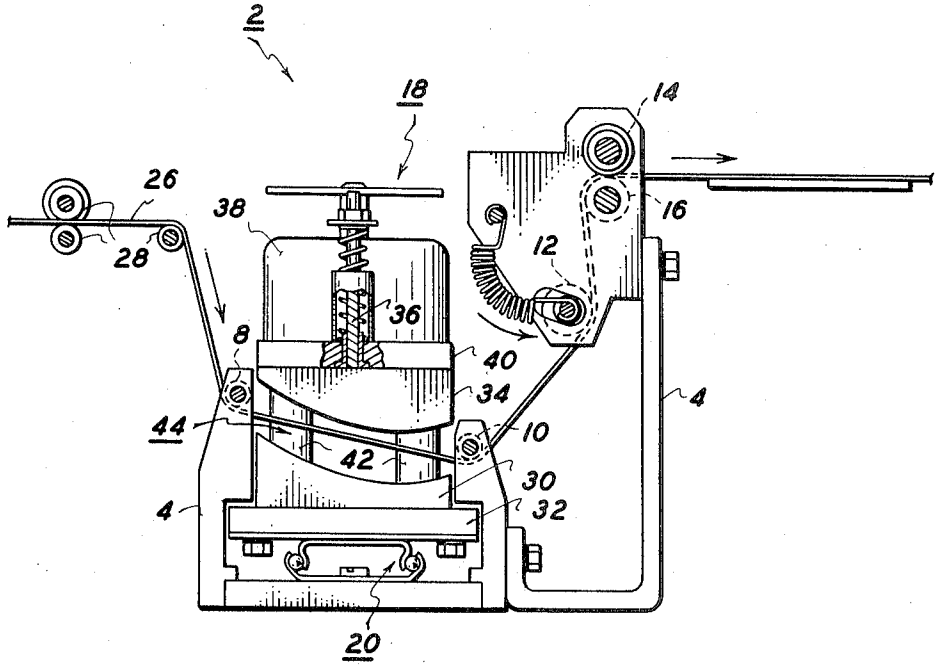
Primary Examiner—Fred L. Braun

Attorney, Agent, or Firm—Robert J. Bird

[57] **ABSTRACT**

A thermal cavity between heated platens is provided for processing heat-developable film. The platens are controllable to open the cavity and retract from the path of a mechanized film advance.

6 Claims, 6 Drawing Figures



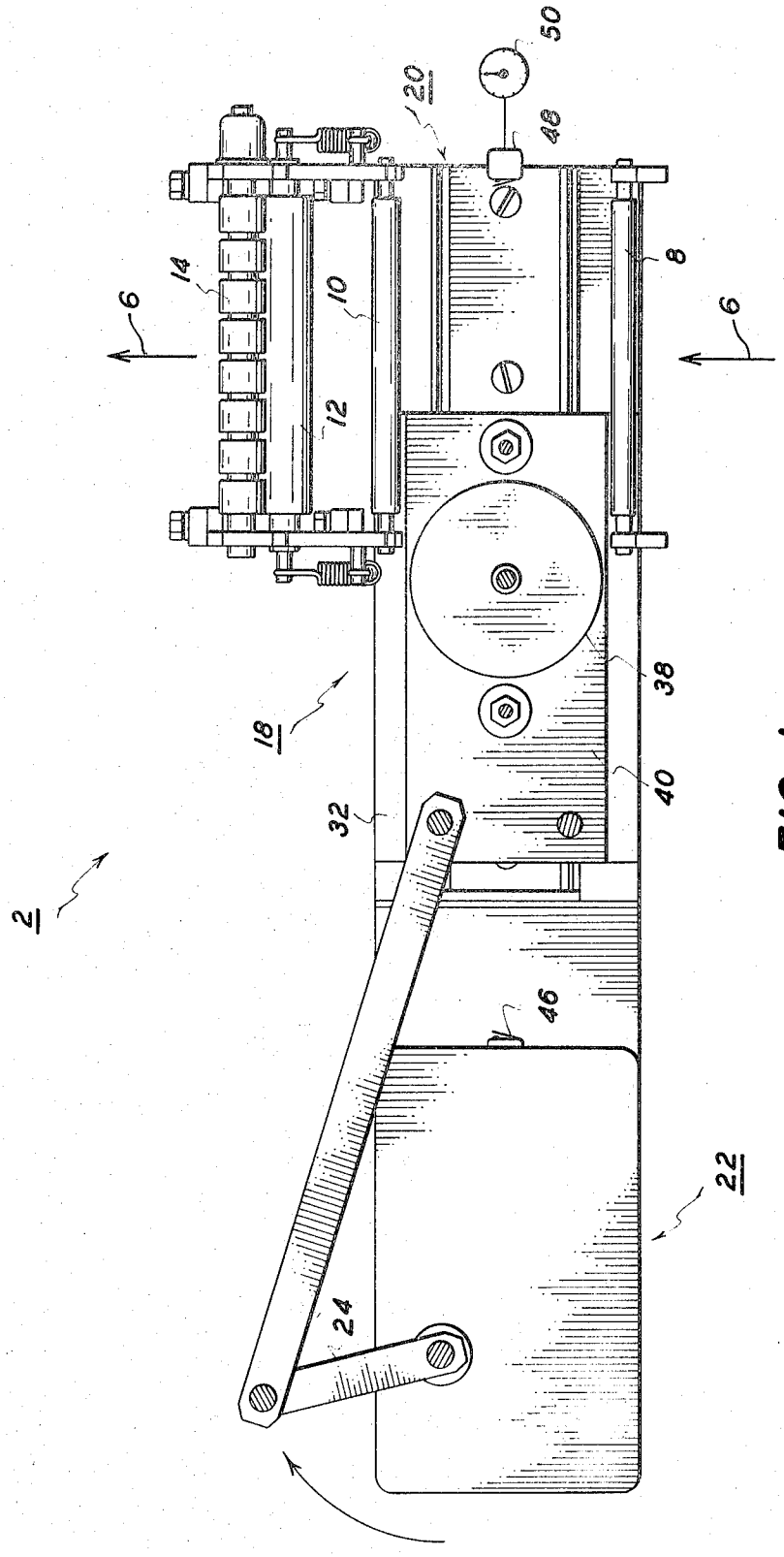


FIG. 1

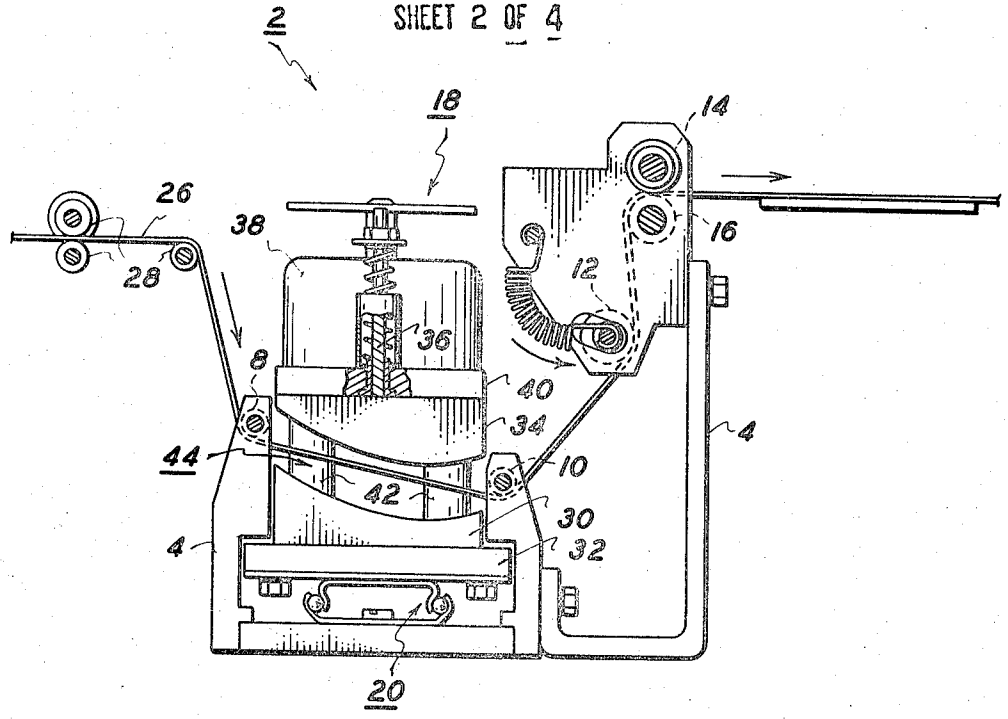
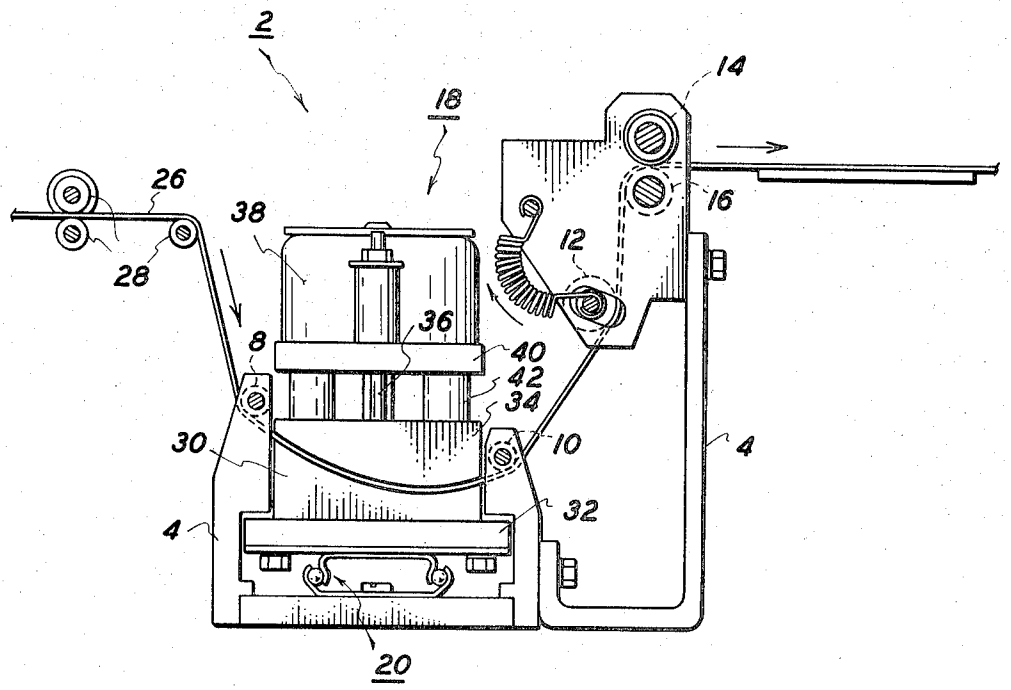

2
18
14
26
38
16
28
12
36
8
40
34
44
4
10
42
30
32
4
20

FIG. 2


2
18
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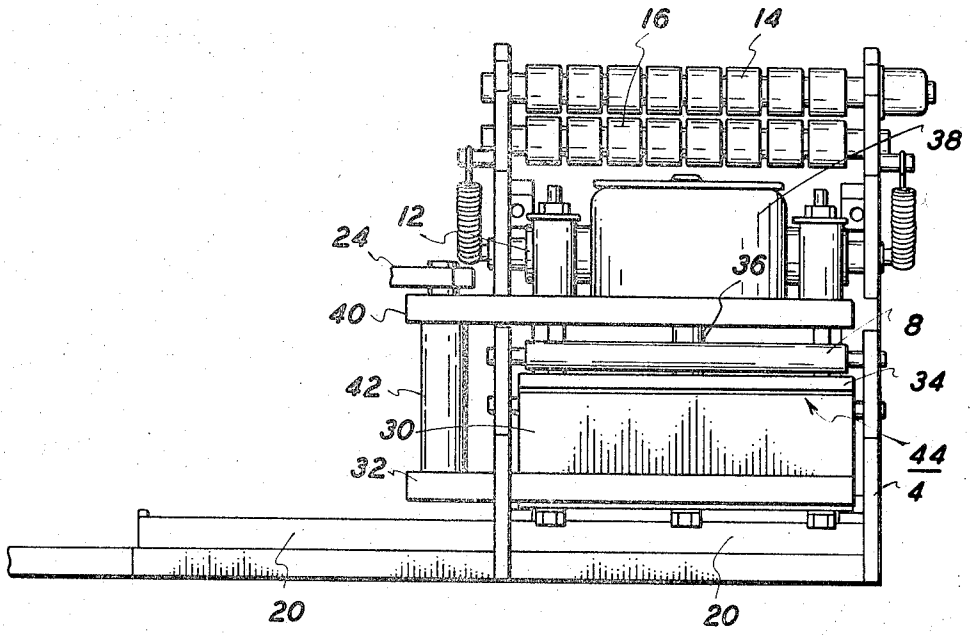
32
20

FIG. 3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36
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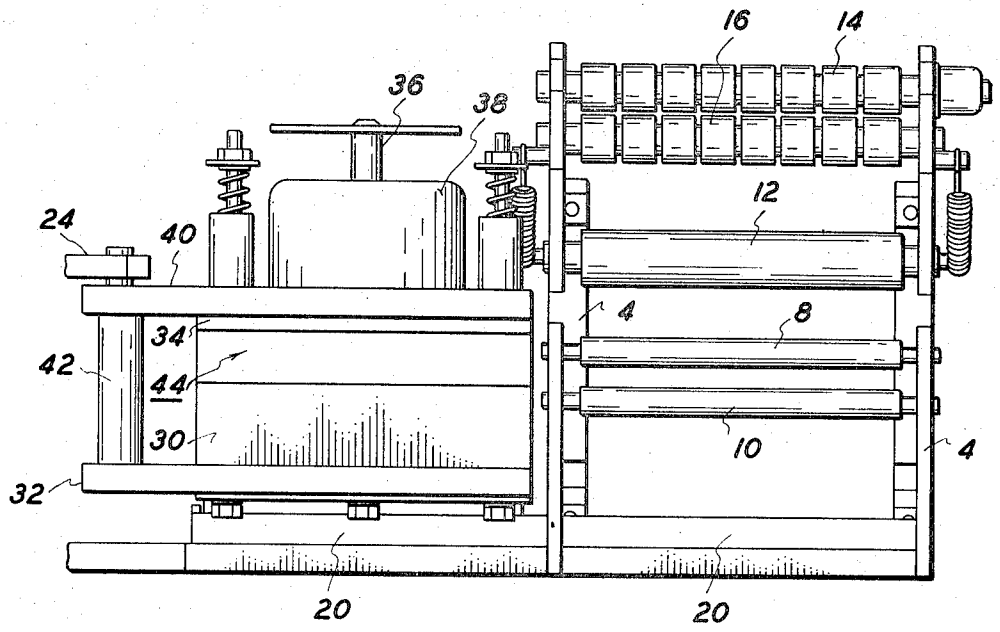
FIG. 5


16
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34
42
44
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32
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20

FIG. 4

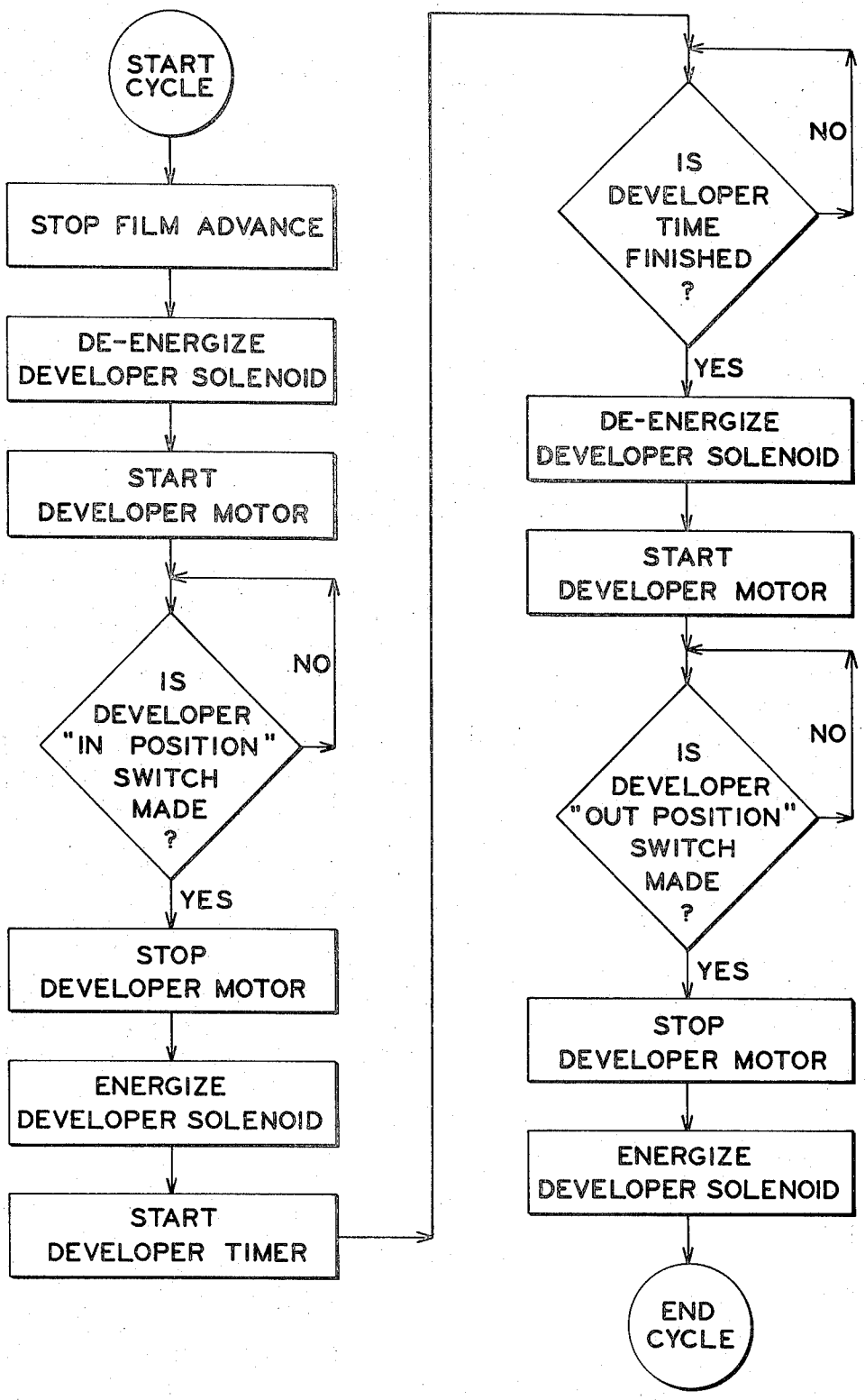
START CYCLE
STOP FILM ADVANCE
DE-ENERGIZE DEVELOPER SOLENOID
START DEVELOPER MOTOR
IS DEVELOPER "IN POSITION" SWITCH MADE ?
NO
YES
STOP DEVELOPER MOTOR
ENERGIZE DEVELOPER SOLENOID
START DEVELOPER TIMER
IS DEVELOPER TIME FINISHED ?
NO
YES
DE-ENERGIZE DEVELOPER SOLENOID
START DEVELOPER MOTOR
IS DEVELOPER "OUT POSITION" SWITCH MADE ?
NO
YES
STOP DEVELOPER MOTOR
ENERGIZE DEVELOPER SOLENOID
END CYCLE

FIG. 6

DEVELOPING SYSTEM FOR FILM BY ADIABATIC HEAT FLOW

BACKGROUND OF THE INVENTION

This invention relates to apparatus for developing dry processable film.

In recent years, many types of film have been devised which, upon exposure to light, can be developed by heating the film to or above a predetermined threshold developing temperature. This film is commonly referred to as "dry film" and is exemplified by a silver halide based film disclosed in U.S. Pat. No. 3,455,075.

One particular method capable of rapidly and efficiently developing a dry film is set out in co-pending U.S. application Ser. No. 377,887, filed on July 9, 1973, by Joseph N. May. This particular method relies upon a heat conductive mechanism to rapidly heat the film above the threshold temperature and an adiabatic heat mechanism to hold the film at the predetermined developing temperature until development is completed. By conductively heating the film when in the transient state the film can be rapidly brought to the developing temperature. Adiabatically heating the film under steady state conditions provides for a relatively uniform development of extremely high density images.

In the May apparatus, the non-emulsion side of the film is tensioned against a heated platen surface. A second platen, which physically complements the first platen, is brought into close non-contacting proximity with the emulsion side of the film. In operation, the second or complementary platen is held at the same temperature as the contact platen whereby an adiabatic heating cavity is formed therebetween.

SUMMARY OF THE INVENTION

The primary object of this invention is to adapt the conductive-adiabatic dry film developing system for automatically processing a continuous web of dry film.

A further object of the present invention is to provide a dry film developing apparatus for automatically processing a continuous web of dry film whereby the film is rapidly brought to developing temperatures by means of a conductive heat mechanism and held at the development temperature under adiabatic conditions until development is completed.

These and other objects of the present invention are attained by means of a dry film developing apparatus having a pair of complementary surfaces heated to the same temperature so as to form a developing cavity therebetween, means to move the developing apparatus from a standby position adjacent to a web of dry film in process to an operable position wherein one of the heated surfaces is brought into contact with the film, and means to rapidly open and close the developing cavity as the developing apparatus moves between the standby position and the operative position whereby the cavity is maintained at a uniform developing temperature.

For a better understanding of the invention as well as other objects and further features thereof, reference is had to the following detailed description of the invention to be read in connection with the accompanying drawings.

DRAWING

FIG. 1 is a plan view illustrating a dry film processor according to the present invention;

FIG. 2 is a side elevation view of the processor shown from the right side of FIG. 1 illustrating the developing apparatus in a momentary open position;

FIG. 3 is similar to FIG. 2 and illustrates the developing apparatus in a closed operative position with one of the heated platen surfaces in contact with the web of film in process;

FIG. 4 is a partial elevation view of the processor shown from the front of FIG. 1 illustrating the developing apparatus in a momentary open position adjacent to the path of travel of the film;

FIG. 5 is a partial elevation view similar to that shown in FIG. 4 illustrating the developing apparatus in a closed operative position with the web of film being removed for illustrative purposes; and

FIG. 6 is a block diagram of the control system for the dry film processor of this invention.

DESCRIPTION

Referring now to FIG. 1, the film processor of the present invention is shown in plan view and generally indicated at **2.** Processor **2** includes a stationary frame **4** to define a film path and to guide the movement of a film web therethrough, in the direction indicated by the arrows **6.** A plurality of rollers **8, 10, 12, 14,** and **16** are mounted on frame **4** for the purpose of driving and tensioning the film web along the film path **6.**

A developing station is generally indicated at **18** and is reciprocable relative to the frame **4** on a suitable track **20.** Developing station **18** is reciprocated relative to the frame **4** by means of an actuator or motor **22** with associated drive mechanism **24** connected to station **18.**

In FIG. **2,** a film web **26,** after having been exposed and ready for processing, is fed into the processor over guide rollers **28.** The film feed is by means of a step movement mechanism, not shown, which advances the film in discrete increments, corresponding to the size of individual film frames. The film feed is stopped at the end of an individual feed stroke by a limit switch, not shown. Developing station **18** includes a lower platen **30** fixed by means of suitable fasteners to a base plate **32** which is mounted for reciprocal movement along track **20.** Developing station **18** also includes an upper platen **34** which is operatively connected, by suitable guide rods and compression springs to the plunger **36** of a solenoid mechanism **38,** for vertical reciprocation therewith. Developer solenoid **38** is preferably an electrically controlled solenoid and its position in the deenergized state is the raised or retracted position shown in FIG. **2.** Solenoid **38,** with movable plunger **36** and upper platen **34,** is mounted on a horizontal frame member **40** which is secured by means of vertical supports **42** to the base plate **32.** Base plate **32,** frame member **40,** and vertical supports **42** are thus an integral frame movable along track **20** relative to the stationary frame **4.** This movable frame comprising elements **32, 40, 42** is operatively connected to the actuator or developer motor by means of the drive mechanism **24.** (Refer also to FIGS. **4** and **5.**)

FIG. **2** shows the development station **18** at a momentary open and inoperative position relative to the film **26.** In this retracted position, upper platen **34** is re-

tracted to open the cavity **44** between platens **30** and **34** to permit the advance of the film. This open position is momentary or transient; in its operative development position and in its standby position, the development cavity **44** between platens **30** and **34** is closed to conserve heat and to avoid thermal gradients across the cavity. Referring now to FIG. **3**, the same arrangement is shown except with the cavity **44** closed by the extension of the solenoid and the lowering of platen **34** toward platen **30**. As described in greater detail in Application Ser. No. 377,887, filed July 9, 1973, the upper and lower platen surfaces are both electrically heated under controlled conditions whereby the working surfaces on both platens are elevated to the same temperature. The working temperature of the system is at or preferably above the threshold developing temperature of the film and process. As a result, when the platens are brought together into thermal communication with the film web, the upper platen serves to rapidly heat the film to the desired developing temperature by a conductive heat transfer process and the lower platen maintains an adiabatic steady state condition because of the equal termperatures maintained at the platen working surfaces. Thus, the film is kept at a steady thermal condition throughout the development process.

Referring back to FIG. **1** and to FIG. **6**, the motor **22** and solenoid **38** of this apparatus are controlled by limit or position switches **46** and **48** and by the film feed limit switch (not shown) in an automatic sequence control. The automatic control is represented in the block diagram of FIG. **6** showing the control logic. In this arrangement, the film feed limit switch is made to start developer motor **22** to drive the developing station **18** forward into the film path **6** and also to de-energize solenoid **38** to open the cavity **44**. At this point, the platens **30** and **34** are advancing over the film **26** as shown in FIG. **2**. When platens **30** and **34** are, respectively, under and over the film developer in-position switch or control means **48** is made to stop developer motor **22** and to energize solenoid **38** to extend the plunger **36** and platen **34** down against the film **26** as shown in FIG. **3**. After a preset time period, which is on the order of **5** to **10** seconds, switch **48** is made by timer **50** to de-energize solenoid **38** and start motor **22** to return the developing station **18** out of the path of film **26**. Finally, position switch or control means **46** is made to stop motor **22** and energize solenoid **38** to close cavity **44** for the rest or standby position of the apparatus. Thus, one complete cycle is performed. In short, the development cavity of developing station **18** is opened and advanced over the film, closed around the film, re-opened and retracted, and closed, completing a film development cycle. Film web **26** is then advanced a discrete amount whereupon the developing or processing cycle is repeated to develop another frame on the film.

In an alternative emobidment, motor **22** and solenoid **38** could simply be actuated by separate, manually operated switches, with timing being completely in the control of the operator. Similarly, the apparatus could be provided for simple manual control without electrical drives. In other words, mechanism **24** could be driven by a hand crank instead of electrical means and plunger **36** with platen **34** could be motivated by mechanical or manual apparatus.

More detail with respect to some of the elements described is set out in other, related patent applications. Application Ser. No. 377,888, filed on July 9, 1973, by David M. Thompson discloses specific construction of the platen members **30** and **34**. Application Ser. No. 399,590, filed Sept. 21, 1973, by Frank R. Hynes discloses the spring structure connected to roller **12** by which tension on the film **26** is maintained constant. The disclosures in these applications as well as the earlier mentioned application Ser. No. 377,887, are hereby incorporated by reference in this specification.

The foregoing description of an embodiment of this invention is given by way of illustration and not of limitation. The concept and scope of the invention are limited only by the following claims and equivalents thereof which may occur to others skilled in the art.

What is claimed is:

1. Developing apparatus for processing a web of dry film having a heat developable emulsion on one side of a support material, including:

a frame to support and guide a web of film in tension along a film path,

a developing station movably mounted on said frame and operatively connected to a drive means for reciprocating movement along a first axis between a standby position and an operative position relative to said film path,

said developing station including a pair of heatable platens having substantially mating facing surfaces defining a cavity therebetween and actuator means to effect reciprocating movement of one of said platens relative to the other of said platens along a second axis to respectively close and open said cavity,

said platens being disposed one on each side of said film when said developing station is in its operative position relative to said film path, said platens being out of contact with said film when said cavity is open, and one of said platens being in contact with the side of said film opposite said emulsion when said cavity is closed, and

control means interconnecting said drive means and said actuator means to interdependently control:

1. said drive means to move said developing station to and from its operative position relative to said film path, and
2. said actuator means to open and close said cavity.

2. Developing apparatus as defined in claim **1** in which said first and second axes are substantially perpendicular to each other and to said film path.

3. Developing apparatus as defined in claim **1** in which said drive means and said actuator means are electrical actuators.

4. Developing apparatus for processing a web of dry film having a heat developable emulsion on one side of a support material, including:

a. a frame including a plurality of rollers to support and guide a web of film in tension along a film path,

b. a developing station movably mounted on a track on said frame and operatively connected to a drive motor for reciprocating movement along a first axis between a standby position and an operative position relative to said film path, said developing station including:

i. a pair of heatable platens having substantially mating facing surfaces defining a cavity therebetween, and

ii. actuator means to reciprocate at least one of said platens along a second axis between an open cavity position and a closed cavity position relative to the other of said platens,

said platens being disposed one on each side of said film when said developing station is in said operative position, said platens being out of contact with said film when said cavity is open to permit advancement of said film along said film path or movement of said developing station along said track, and one of said platens being in contact with the side of said film opposite said emulsion for holding said film in close non-contacting proximity to the other of said platens when said cavity is closed, and

c. control means interconnecting said drive motor and said actuator means to interdependently control:

i. said drive motor to move said developing station to and from its operative position relative to said film path, and

ii. said actuator means to open and close said cavity.

5. Developing apparatus as defined in claim **4** in which said drive motor and said actuator means are electrical actuators and in which said control means includes:

start control means to start said drive motor and open said cavity at said standby position,

first control means responsive to the presence of said developing station at its operative position to stop said drive motor and close said cavity,

timer means responsive to the passage of a predetermined time span after the closure of said cavity at said operative position to open said cavity and start said drive motor and,

second control means responsive to the presence of said developing station at its standby position, to stop said drive motor and close said cavity.

6. Developing apparatus for processing a web of dry film having a heat developable emulsion on one side of a support material, including:

a frame to support and guide a web of film in tension along a film path,

a cylindrical compliance roll rotatably mounted in slotted apertures for rotation and lateral translation relative to said frame, said compliance roll positioned for rolling contact with said film and being biased against said film to maintain said film in constant tension with changes in the geometry of said film path,

said bias being by means of a compression spring of substantially constant compression force throughout its displacement operatively connected between said frame and said compliance roll,

a developing station movably mounted on said frame and operatively connected to a drive means for reciprocating movement along a first axis between a standby position and an operative position relative to said film path,

said developing station including a pair of heatable platens having substantially mating facing surfaces defining a cavity therebetween and actuator means to effect reciprocating movement of one of said platens relative to the other of said platens along a second axis to respectively close and open said cavity,

said platens being disposed one on each side of said film when said developing station is in operative position relative to said film path, said platens being out of contact with said film when said cavity is open, and one of said platens being in contact with the side of said film opposite said emulsion when said cavity is closed.

* * * * *