United States Patent

Perl

[15] **3,675,014**

[45] **July 4, 1972**

[54] LIGHT-PROOFED AUTOMATIC RADIOGRAPHIC CASSETTE UNLOADER-RELOADER

[72] Inventor: **Theodore Perl,** Fayetteville, N.Y.

[22] Filed: **April 9, 1971**

[21] Appl. No.: **132,743**

[52] **U.S. Cl.** **250/66,** 95/14, 250/67
[51] **Int. Cl.** **H05g 1/60**
[58] **Field of Search** 250/65, 66, 67; 95/14

[56] **References Cited**

UNITED STATES PATENTS

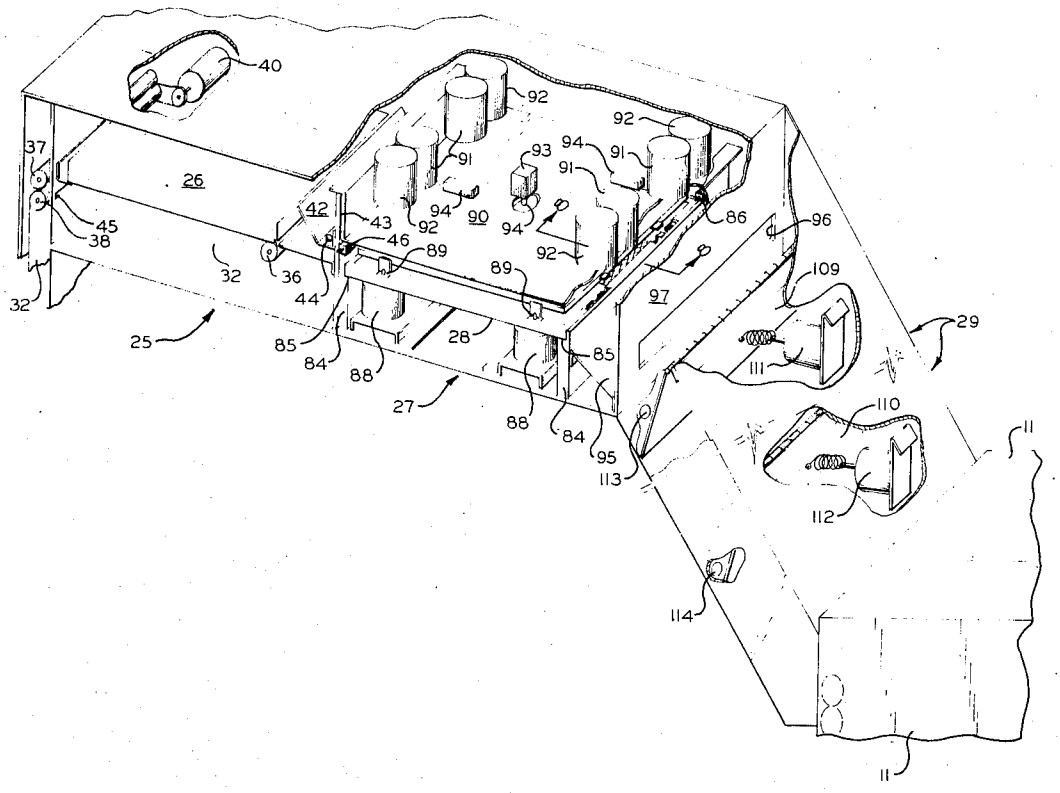
3,253,145	5/1966	Erikson	250/65
2,595,430	5/1952	Tuttle et al.	250/65
3,547,020	12/1970	Goldfarb	95/14

Primary Examiner—James W. Lawrence
Assistant Examiner—Harold A. Dixon
Attorney—Bruns & Jenney

[57] **ABSTRACT**

A light-proof cabinet housing has separate layers or modules for different sizes of cassettes. Each module has electrically operated means for opening the cassette, raising the cover, marking the film therein, extracting the film and feeding the film to a conventional processor. In each module means are provided for storage of a fresh supply of film and also electrically operated means for extracting one sheet at a time and feeding it to the opened cassette, then closing the cassette. Electrical sequencing means are provided for automatic operation, or for initially loading an empty cassette, and for stopping the machine upon any malfunction. A modified form of cassette is provided adapted to cooperate with cassette opening means in each module.

9 Claims, 15 Drawing Figures



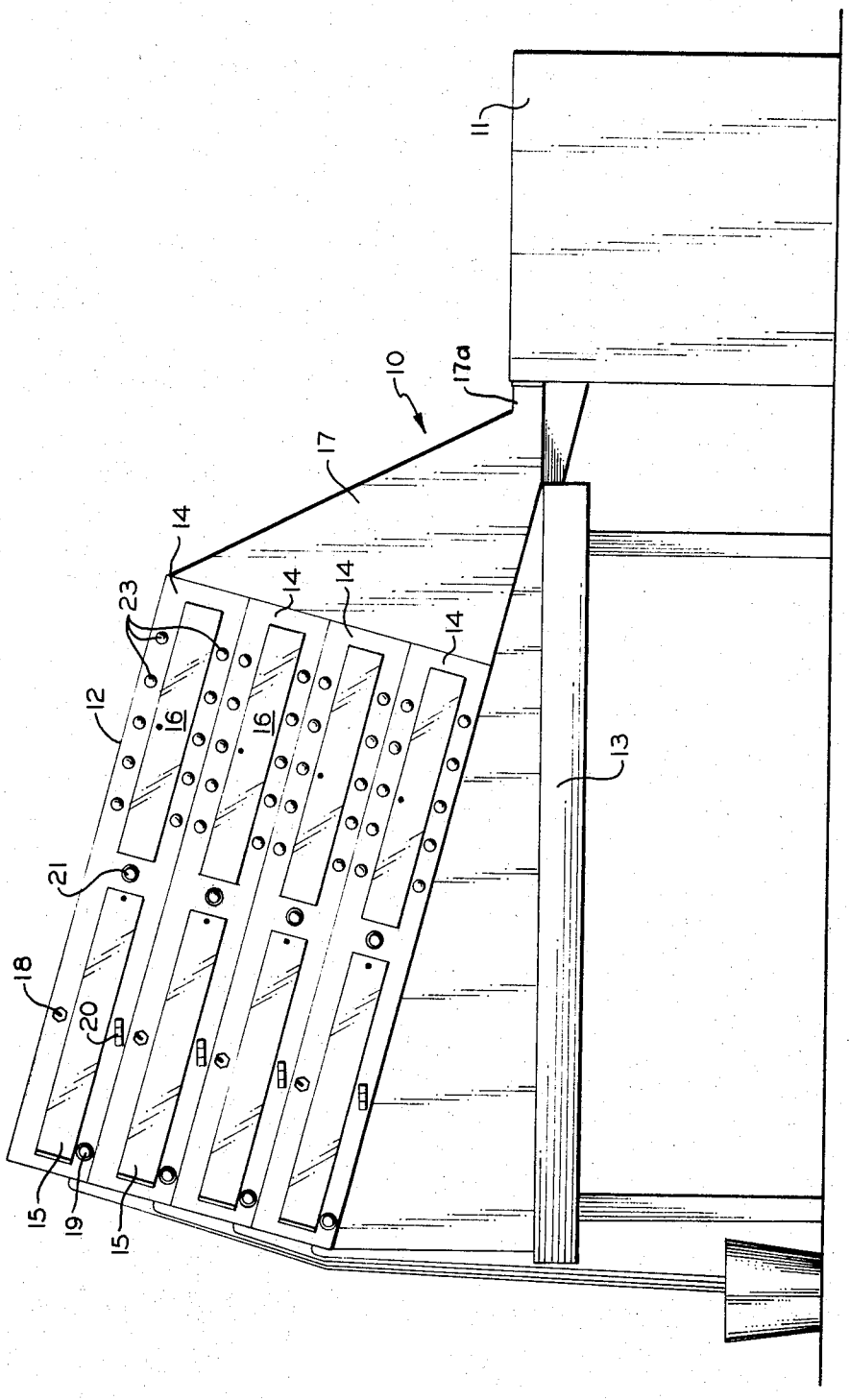


FIG. 1

INVENTOR.
THEODORE PERL
BY
Bruns & Jenney
ATTORNEYS

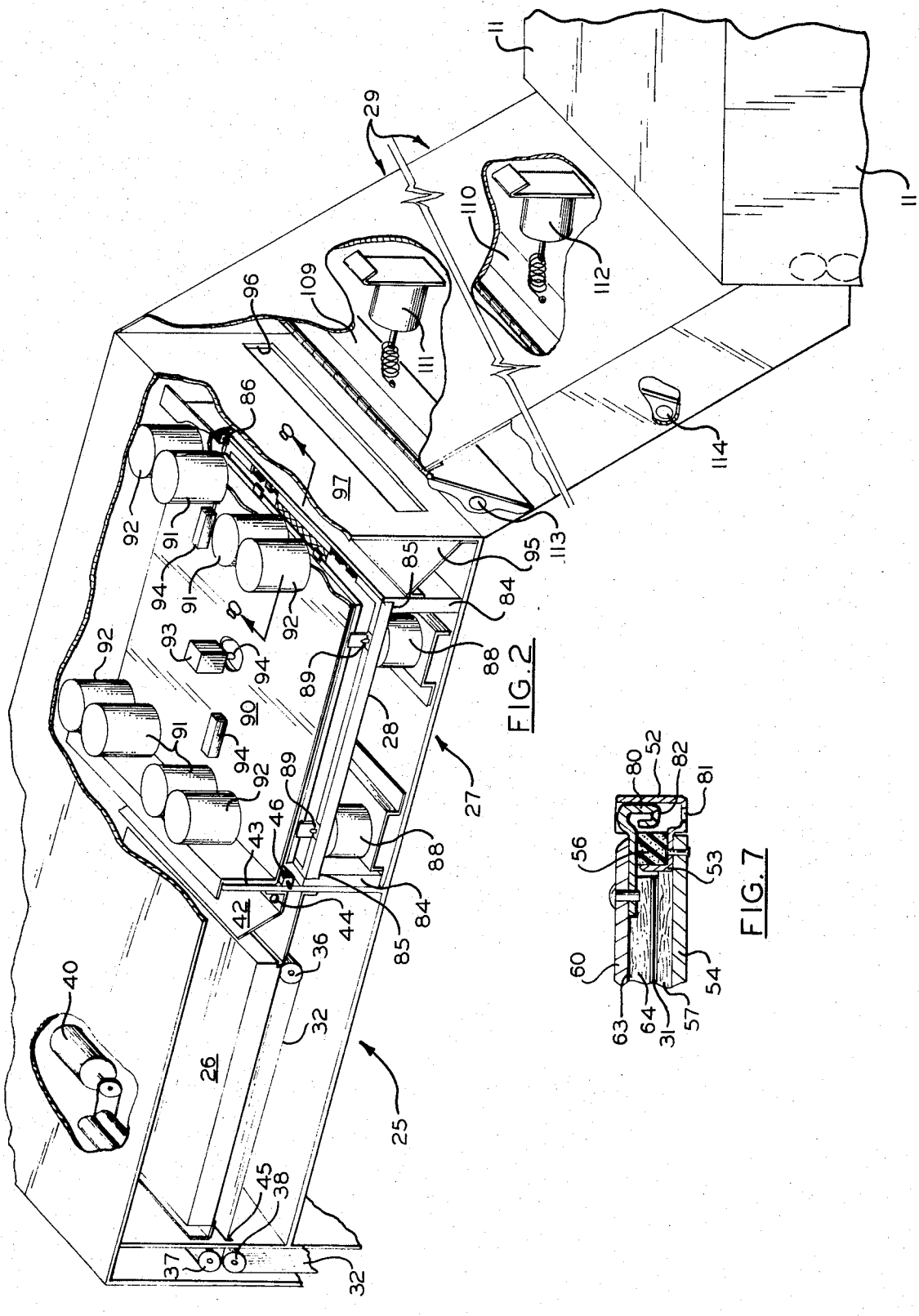

11
29
110
112
96
109
111
86
97
114
92
91
94
93
85
84
95
113
88
89
90
28
27
46
43
42
44
36
32
40
26
25
45
38
37

FIG. 2

80
52
82
81
56
53
60
54
63
64
31
57

FIG. 7

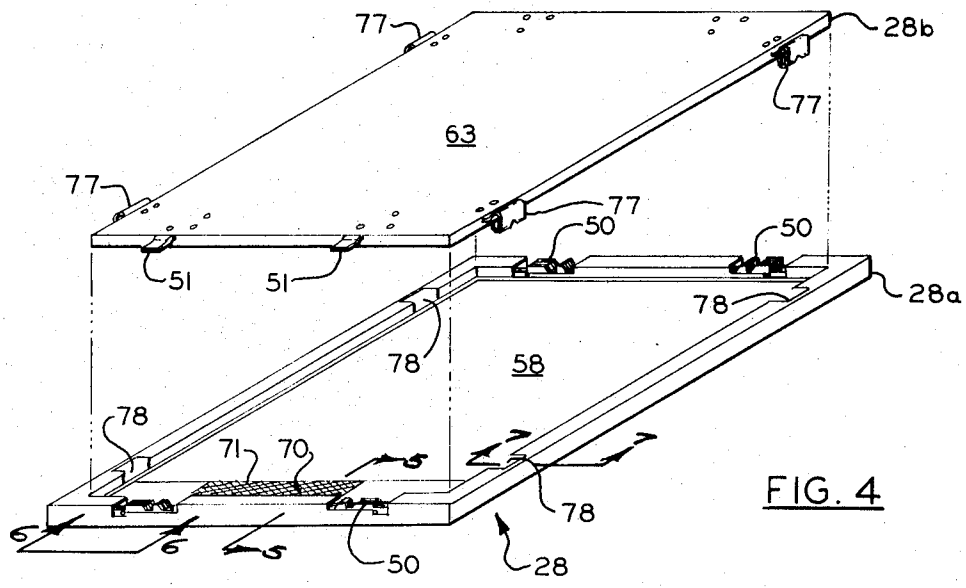

77
28b
77
63
77
77
50
50
51
51
28a
78
78
58
78
71
70
78
50
28

FIG. 4

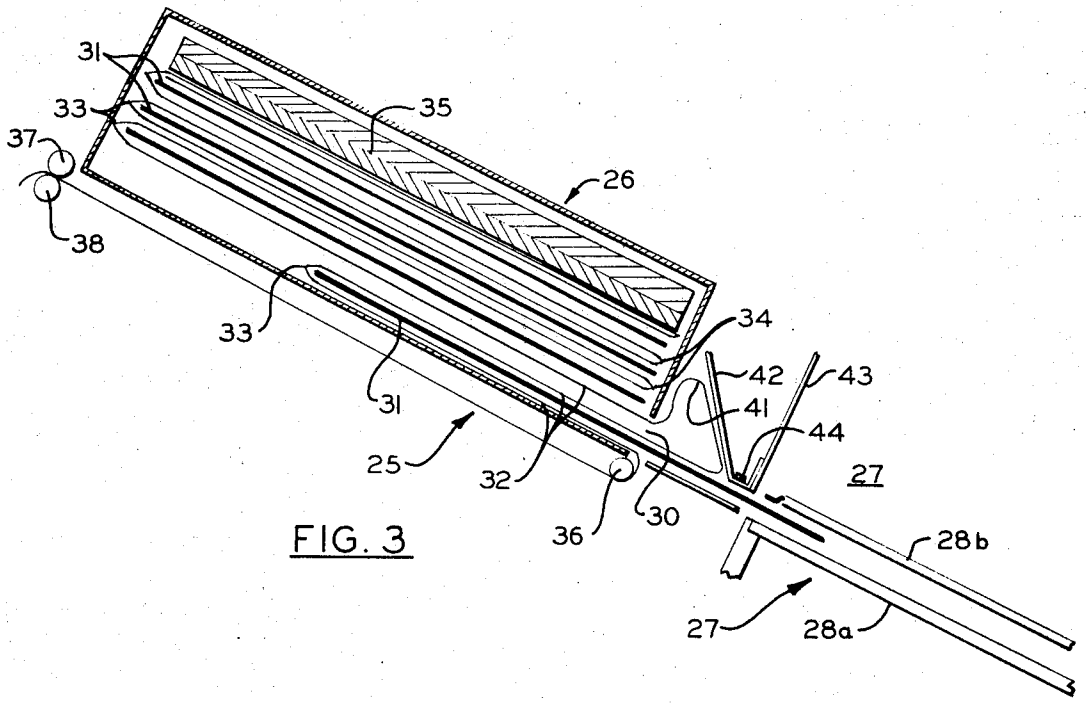

31
33
37
35
26
38
33
34
42
43
41
44
31
25
32
27
36
30
28b
27
28a

FIG. 3

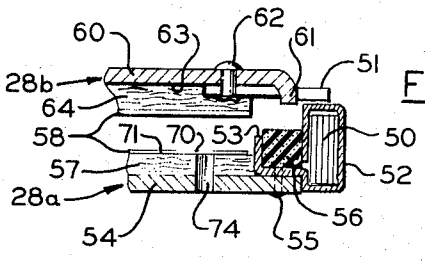


FIG. 5

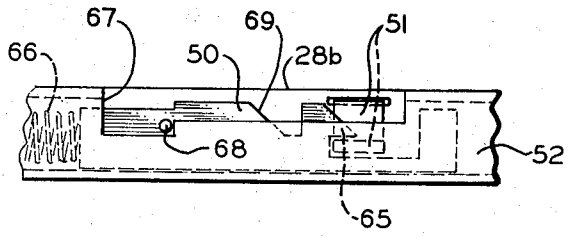


FIG. 6

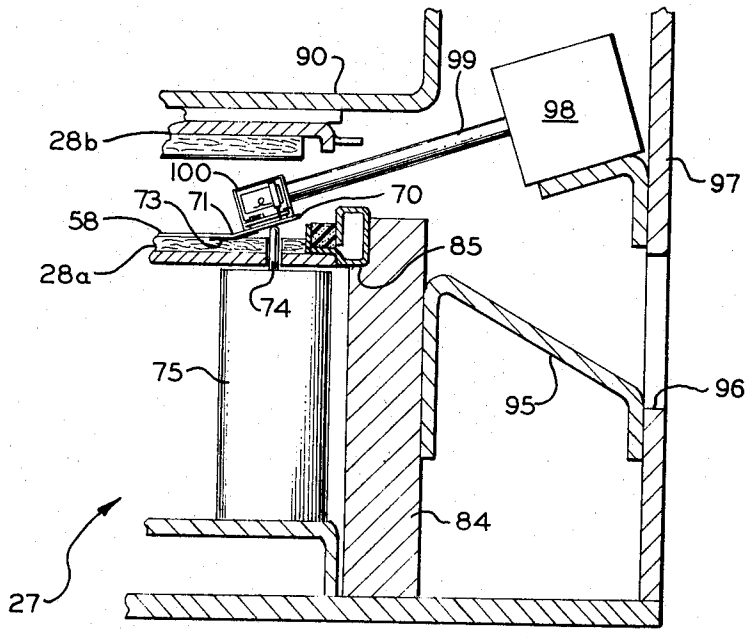


FIG. 8

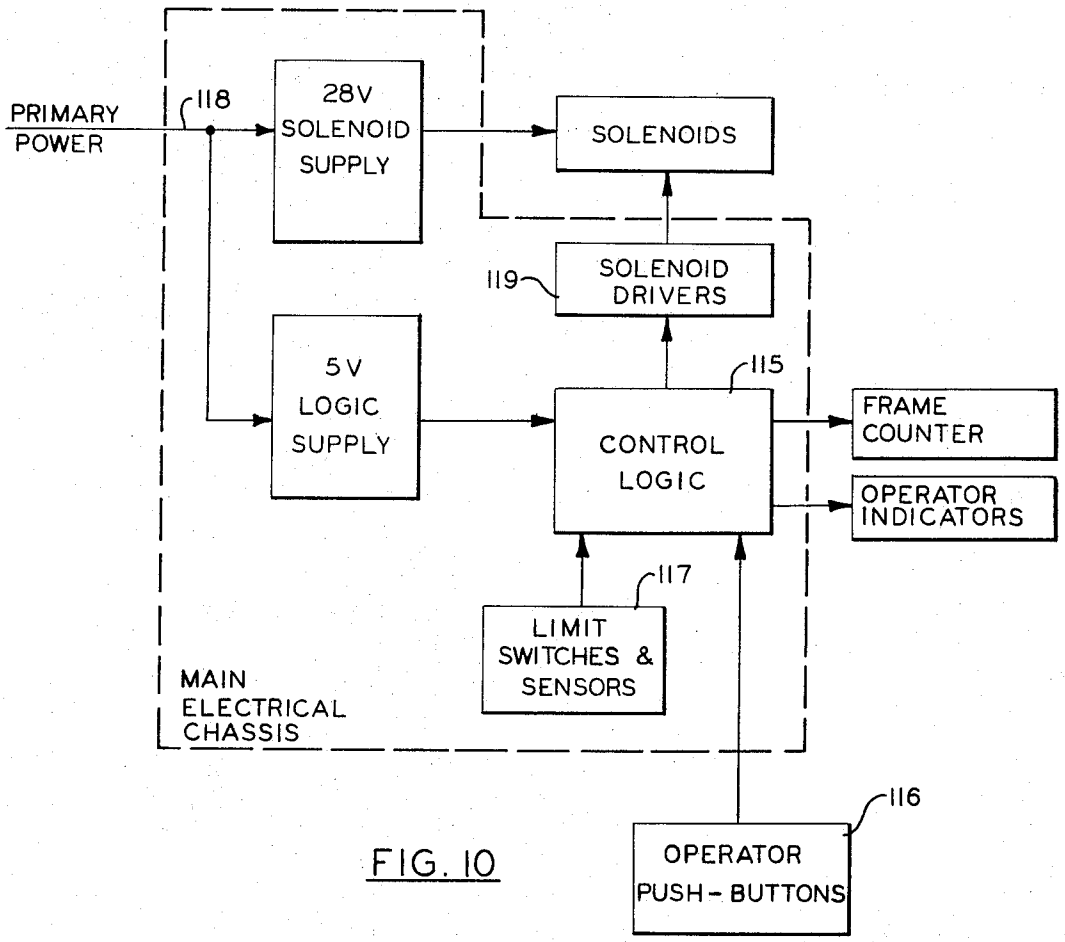

PRIMARY POWER
118
28V SOLENOID SUPPLY
SOLENOIDS
119
SOLENOID DRIVERS
5V LOGIC SUPPLY
115
CONTROL LOGIC
FRAME COUNTER
OPERATOR INDICATORS
117
LIMIT SWITCHES & SENSORS
MAIN ELECTRICAL CHASSIS
116
OPERATOR PUSH-BUTTONS

FIG. 10

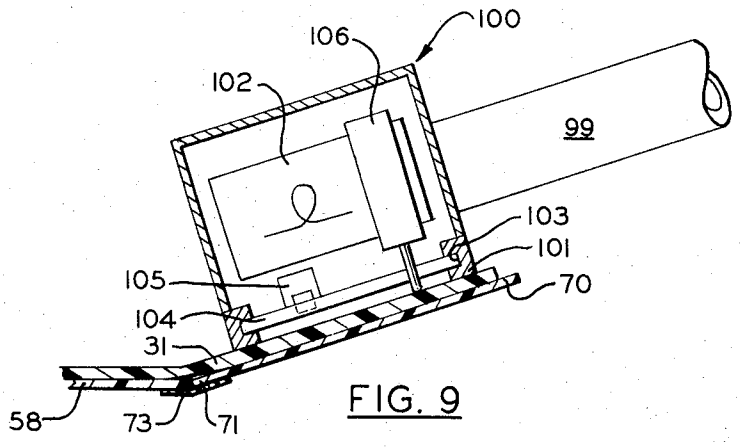

100
106
102
99
103
101
105
70
104
31
58
73
71

FIG. 9

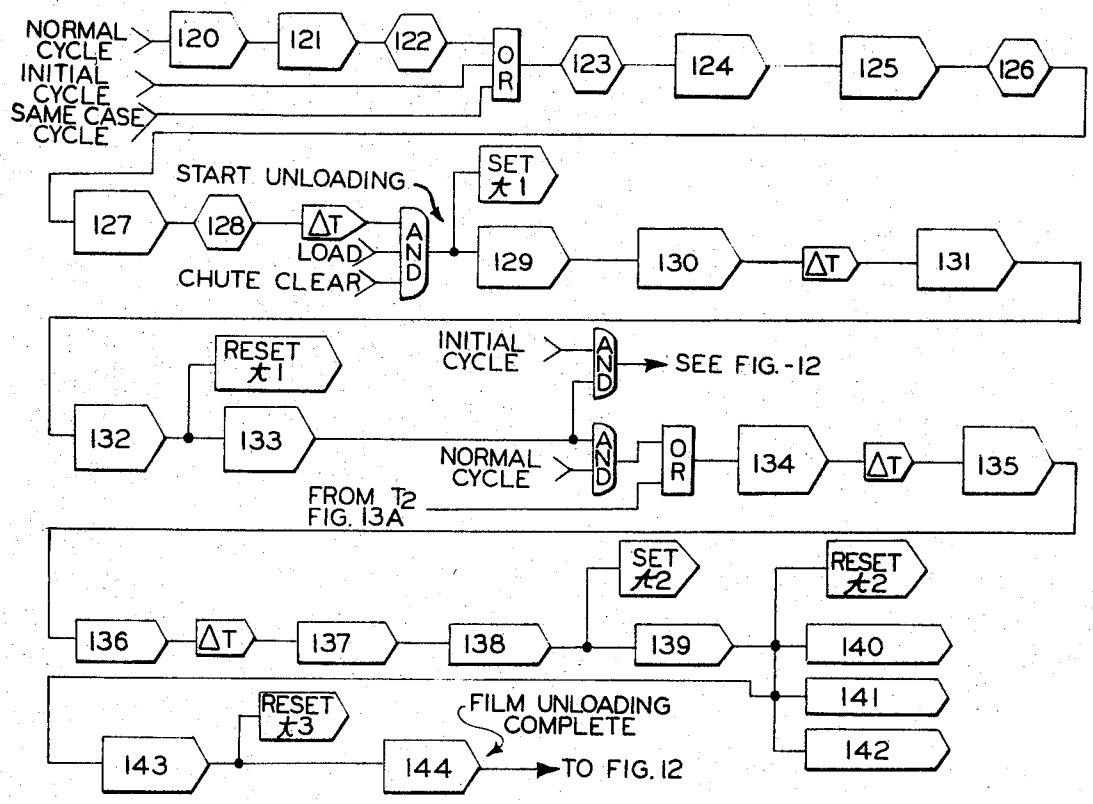


FIG. 11

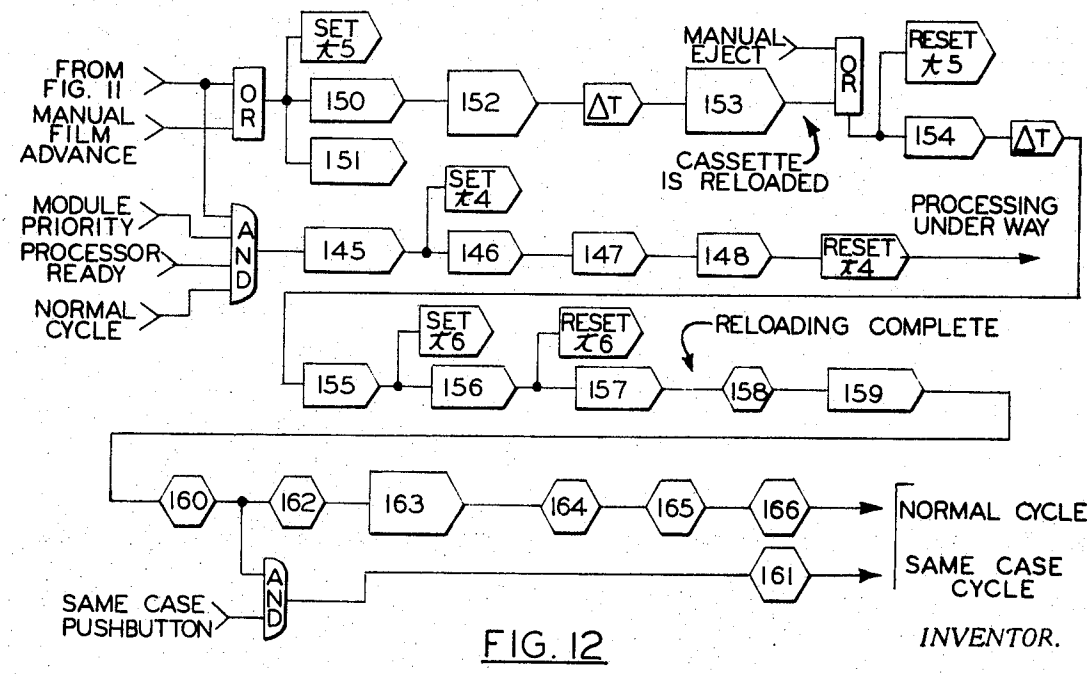


FIG. 12

INVENTOR.

BY

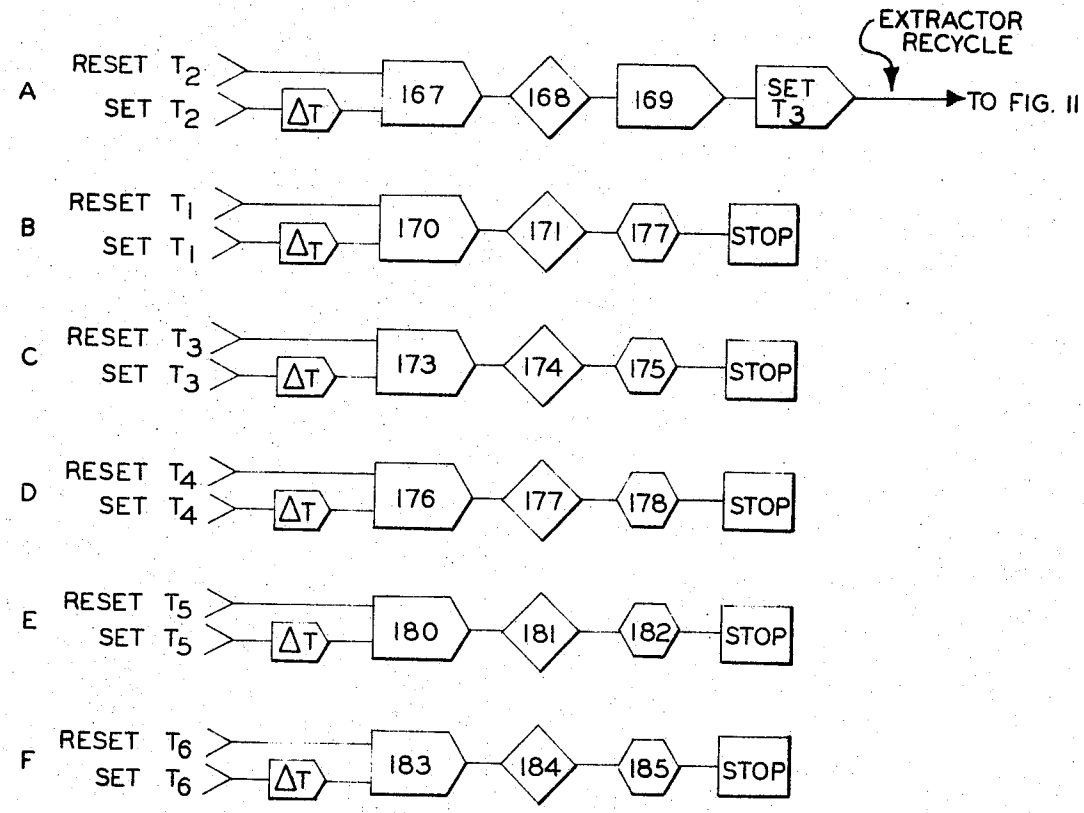


FIG. 13

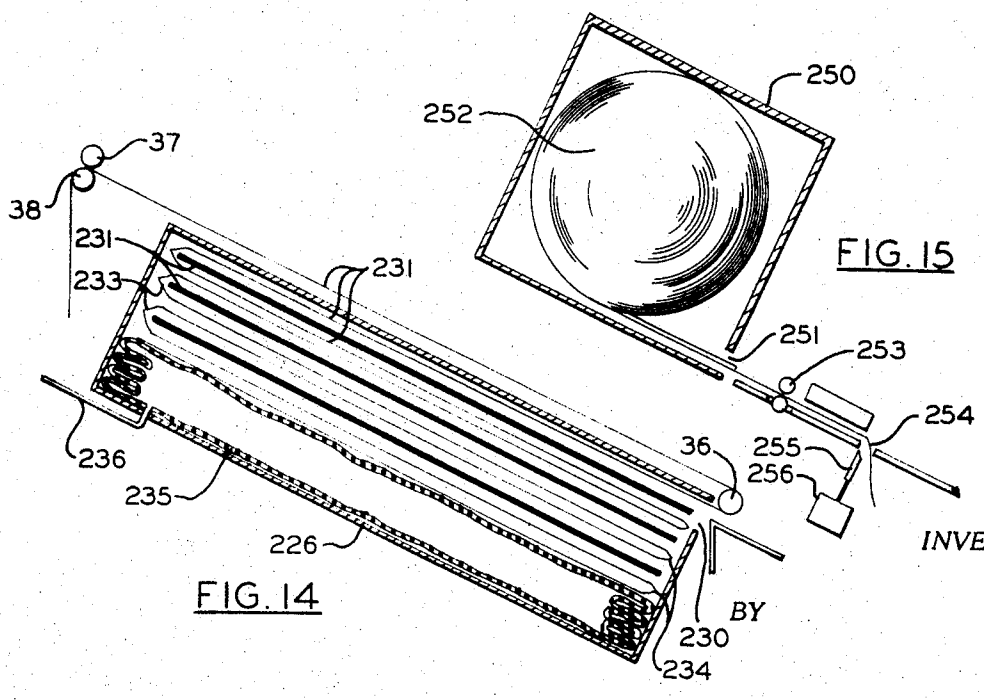


FIG. 14

FIG. 15

INVENTOR.

BY

LIGHT-PROOFED AUTOMATIC RADIOGRAPHIC CASSETTE UNLOADER-RELOADER

BACKGROUND OF THE INVENTION

This invention relates to a single light-proof cabinet device, adapted to be joined to a conventional automatic film processor, housing film supply cartridges, cassette unloading chambers, and transport means to the processor for a plurality of radiographic cassette sizes, using specially modified cassettes and film supply cartridges for the automatic daylight unloading and reloading of cassettes and automatically passing the exposed films to the processor without using a darkroom.

After a radiographic film has been exposed, the doctor or his nurse normally must take the exposed film in its cassette to the darkroom and there manually unload the cassette and manually pass the exposed film to the processor. Then the operator must extract an unexposed film from a film pack or cartridge, place the film in the opened cassette, and manually close the cassette again, ready for use for the next radiographic picture.

Light-proofed devices have been developed for loading a cassette in daylight without resorting to a darkroom and other light-proofed devices have been developed for unloading an exposed film from its cassette and automatically loading it into the processor. No single dark cabinet device has heretofore been known for both automatically unloading the cassette and passing its exposed film to the processor and then, without removing the cassette from the device, reloading the cassette with fresh film so as to be ready for reuse. Furthermore, such light-proofed cassette loaders as are known take only one size of cassette. The unloader and reloader of the present invention takes a plurality of cassette sizes.

SUMMARY OF THE INVENTION

The present invention contemplates a single light-proofed cabinet which may be used in the diagnostic room together with a known automatic film processor to which it is operatively coupled. The cabinet has a plurality of layers or modules, each arranged for use with a particular size of cassette and ending in a chute for conducting the exposed film to the processor entrance.

Each module is disposed at an angle to the horizontal so that the film is conducted downward, insofar as possible, by gravity during unloading as well as during loading. Each module is provided with a compartment in which a cartridge containing a supply of unexposed film is stored, another chamber into which the cassette may be placed, and means for automatically performing the operations of unloading and reloading. Each module is provided with an entrance door through which the film cartridge may be manually introduced and another door through which the cassette may be manually introduced and removed. Each door has feeler switches associated therewith for ensuring that they are light tight before any of the loading or reloading can take place.

Signal lights and manual switches are provided externally for signalling when the automatic operations must be initiated by operation of the switches and sensing devices are provided interiorly for operating the signal lights and for stopping the automatic operation should there be any malfunction.

In each cassette chamber, means are provided for marking each exposed film with pertinent information, such as the patient's name, and this information is provided by means of a typewritten card inserted when the cassette is inserted in the chamber. Means are also provided in the chamber for opening the cassette and raising the rearward portion thereof, for starting the exposed film down the chute after the cassette has been opened, and for closing and locking the cassette after it has been reloaded. A specially modified cassette is used to cooperate with the cassette opening and closing means.

Means are provided in the chutes for controlling the passage of the exposed film down the chutes, to allow them to exit from the chutes according to a prearranged scheme of priority, and to allow them to enter the processor only when the processor is ready to accept them.

In each cartridge compartment, automatically controlled means are provided for extracting a sheet of unexposed film from the cartridge, upon call, and to release it to fall by gravity into the opened cassette. A specially modified cartridge is provided for cooperating with the film extracting means in the compartment. An externally visible counter is preferably provided for each compartment for showing at all times the number of sheets remaining in the cartridge.

Switch means are also provided for each module for operation of the module as a cassette loader to initially load the cassette. Electrical logic means are also provided in each module for automatically operating the mechanical elements in the module in response to the manual switches and manual closing of the doors and to sense malfunction of any of the parts.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a diagrammatic side elevational view of a cassette unloader-reloader according to the invention in association with a film processor;

FIG. 2 is a fragmentary perspective view of a single module of the machine of FIG. 1, certain parts being broken away for clarity;

FIG. 3 is a fragmentary diagrammatic sectional view of the film cartridge in its compartment, shown in FIG. 2, showing the operation of the film extracting means;

FIG. 4 is an exploded perspective view of the cassette shown in FIG. 2;

FIG. 5 is a sectional view on the line 5—5 of FIG. 4;

FIG. 6 is a fragmentary side elevational view of a portion of the cassette as viewed in the direction of the arrows 6—6 of FIG. 4;

FIG. 7, on sheet 2 of the drawings, is a sectional view on the line 7—7 of FIG. 4;

FIG. 8 is an enlarged sectional view on the line 8—8 of FIG. 2;

FIG. 9 is a further enlarged sectional view of the marker-extracter and associated parts shown in FIG. 8;

FIG. 10 is a block diagram of the electrical system of the machine of FIG. 1;

FIG. 11 is a logic diagram of a portion of the operation of the control logic associated with the module shown in FIG. 2;

FIG. 12 is a logic diagram of a further portion of the operation of the control logic;

FIGS. 13A–F are logic diagrams of still further portions of the control logic;

FIG. 14 is a view similar to FIG. 3 showing a modified form of film cartridge; and

FIG. 15 is a view similar to FIG. 3 showing another modified form of film cartridge.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1, the cassette unloader-loader 10 is attached to a conventional automatic film processor 11 and comprises a light-proofed housing 12 supported at an angle sloping downward toward the processor and supported on a table or shelf portion 13. Housing 12 is divided into a plurality of modules or layers 14, here shown as four, for different sized cassettes as, for example, 8 × 10 inches, 10 × 12 inches, 11 × 14 inches and 14 × 17 inches, respectively. Each module is provided at one side or the other with a light-proofed door 15 for access to the film cartridge compartment, a light-proofed door 16 for access to the cassette-containing chamber and, at the end, with a chute portion housed in the portion 17 leading to processor 11, all hereinafter described.

Each module has, adjacent to its door 15, a double throw toggle switch 18 for alternate switching to "normal cycle" or "initial cycle," a push button switch 19 which may be operated to manually advance the film in the loader, and a counter 20 which indicates the number of frames or sheets of film remaining in the film cartridge. Between doors 15 and 16 each module is provided with a push button switch 21 for initiating the "same case" cycle.

Above and below door **16**, 10 indicator lights **23** are labeled, respectively, "load marker," "load cassette," "in operation", "unload cassette," "unload marker," "cover jammed," "film jammed," "fault," "chute jammed," "reloading problem."

Referring now to FIG. **2**, each module **14** comprises a compartment portion **25** for a novel film cartridge or package **26**, a cassette chamber **27** in which a novel cassette **28** may be positioned, and a chute **29** in the chute portion **17**, each chute **29** ending a common chute **17***a* at the entrance to the processor **11**, all hereinafter described. Since each module is the same except for the changes in size of the cassette and film, only one module **14** is described, it being understood that each module is the same except for the size of the cassette and the consequent spacing of the various operating mechanisms therein.

Referring now to FIG. **3** a box-like film pack or cartridge **26** is shown as having a door slot **30** along a lower edge openable upon insertion of the cartridge in the compartment **25**. Each film sheet **31** has a layer **32** of paper above and below it, the paper being a continuous strip extending below the lowermost film sheet, then folded at the back edge of the film sheet at **33** to extend forward again along the top surface of the film to a fold **34** at the forward side of the box where it doubles back to extend along the under surface of the next film sheet to another fold **33**, the strip being thus continuously interleaved between the sheets **31** to the top of the pile of sheets. At the top of the pile a weight **35** in the form of a plate is placed on the top layer of paper **32** to ensure that the film sheets **31** are continuously fed downward as the lowermost sheets **31** are withdrawn sequentially.

Just below the slot **30** an idler roller **36** extends across the compartment **25**. The cartridge **26** is originally provided with a sufficient number of paper layers **32** below the lowermost film sheet **31** so that the strip may initially be withdrawn through slot **30**, led over roller **36** and then passed between a pair of rollers **37** and **38** where it is free to fall to a suitable receptacle below. Roller **37** is an idler biased downward into contact with roller **38** which is shown in FIG. **2** as being driven, through a pulley and belt, by a motor **40**.

As shown in FIG. **3**, when motor **40** is started, the layer of paper **32** below the lowermost sheet **31** is withdrawn over roller **36** and the fold at **33** engages the rear edge of the film sheet **31** and slides the film sheet out of the door notch **30**. The layer of paper above the withdrawn sheet **31** is also pulled forward and the fold at **34** is unfolded as the withdrawn layer balloons up at **41** rearward of a paper guard **42**.

Just forward of the guard **42** and rearward of the partition **43** between compartment **25** and chamber **27** a senser **44** is located to signal when the trailing edge of the film sheet **31** passes below it. Senser **44** may be mechanical, in the nature of a limit switch, but preferably is a photoelectric cell sensitive to a color or form of light from a source, not shown, to which the film **31** is not sensitive.

When the trailing edge of sheet **31** passes senser **44** to slide by gravity into the cassette in chamber **27**, the motor **40** is turned off and the ballooned portion **41** of the paper strip remains until motor **40** is started again.

Referring to FIG. **2** again, the slot **45** through which the paper strip **32** passes before passing between rollers **37** and **38** is, of course, light-proofed by means not shown. In the chamber **27**, secured to the partition **43** a switch **46** is shown, the closing of the switch indicating that door **16** is closed. Preferably, another switch **46**, not shown, is located at the other end of the door and similar switches are provided for the door **15**.

Referring now to FIG. **4** a conventional cassette is shown modified for use in the loader **10**. The cassette **28** comprises a forward portion **28***a* used nearest the X-ray machine and behind the patient, hereinafter called the base, and a rearward portion **28***b*, hereinafter called the cover.

The conventional cassette has a hinged cover and a pair of sliding locks. Cassette **28** is not hinged but has four locks **50**, two at each end of the base, the cover being provided with mating tongues **51**. Referring to FIG. **5**, the base has a frame, a portion being square in cross-section, formed of a rectangular tubular portion **52**, in which the locks **50** slide, and, extending inward from portion **52**, an integral L-shaped tongue portion **53**. The tongue forms a recess at the bottom into which the metal panel **54** fits and is fastened to the tongue by rivets **55**. The bent-up end of tongue **53** forms a channel with portion **52** in which a strip **56** of spongy material lies to form a light seal with a lip on the cover.

A layer **57** of felt or other compressible material is glued to the panel **54** within the rectangle formed by the tongues **53** of the sides and ends of the base, and a screen **58**, comprising a thin sheet of plastic impregnated with calcium tungstate which glows when subjected to X-rays, is secured on top of the felt.

The cover **28***b* comprises a rectangular metal sheet **60** with a turned down lip **61** along all four sides which engages the spongy strip **56** of the base when the cassette is closed. At the locks the tongues **51** are secured to the under surface of sheet **60** by rivets **62**, the tongues **51** projecting outward through gaps in the lip **61**. The under surface of sheet **60** is coated with a lead layer **63**, to minimize X-rays going beyond the cassette, and a felt layer **64** is secured, as by adhesive, to the under side of sheet **60**. Another screen **58** is secured, as by adhesive, to the lower surface of the felt **64**, the film sheet **31** being adapted to lie compressed between the screens **58** when the cassette is closed.

Referring to FIG. **6**, the sliding lock **50** is conventional in that it is a laminated bar of metal, generally rectangular in cross-section at each end for sliding motion within the rectangular tube **52** of the base **28***a*. A hooked portion **65** is provided for sliding over the tongue **51** of the cover and a spring **66** biases the lock toward locked position.

The portion **52** of the base is recessed at **67** for providing access to the lock and a projecting pin **68** operating in a portion of the recess limits motion of the lock **50** in either direction. A modification adapting the cassette for use in loader **10** is the provision of a camming surface **69**, facing upward, formed in the upper portion of lock **60**, as shown.

Referring again to FIG. **4**, a portion or flap **70** of the screen **58** at one end of the base, cross-hatched for visibility in FIG. **4**, is divided along the line **71** from the rest of the screen and hinged thereto by a flexible strip **73** at the underside of the screen as indicated in FIG. **9**. A hole **74** is provided through the panel **54** and felt layer **57** for the plunger of a solenoid **75** for lifting up the screen portion **70** as shown in FIG. **8**. When a cassette without screens is used, the cassette is provided with upper and lower untreated plastic sheets to take the place of the screens.

Another modification of the conventional cassette is the provision of lifting arms **77** at the sides of the cover **28***b* as shown in FIG. **4**. These arms fit down into four sockets **78** provided in the base **28***a* when the cassette is closed. Referring to FIG. **7**, sockets **78** are fashioned by cutting away the top and a portion of the inside wall of the rectangular tube portion **52** of the base frame and the arms **77** are rivetted to the under side of the cover panel **60** like the tongues **51**. The outer ends **80** of the arms **77** are bent downward and then back on themselves providing a comparatively broad downwardly projecting arm which fill the tubular passage of portion **52**. At the bottom of portion **52** a hole **81** provides access to the downward projecting portion **80** and this latter portion has a conical recess **82** therein at its bottom.

Referring again to FIG. **2**, cassette chamber **27** is provided with two support members **84** having shelf-like shoulders **85** along their tops into which the ends of cassette **28** fit so that the cassette may be slid in along the shoulders like a tray in a rack. At the end of each member **84**, at the shoulder **85**, a switch **86** is positioned so as to be operated only when the cassette is precisely positioned, only one switch **86** being shown.

Below the cassette when it is in position four solenoids **88** are secured, only two being shown, and so positioned that when operated their plungers **89** are adapted to be raised to

pass through holes **81** in portions **52** of the base. These plungers are conically pointed so as to engage the recesses **82** at the bottom of arms **77**.

Above cassette **28** a shelf member **90** supports four unlocking solenoids **91** which are so positioned that their plungers, when operated downwards, contact the camming surfaces **69** of the cassette locks and slide the locks from locked to unlocked position. Also supported on shelf member **90** are four locking solenoids **92** so positioned that their plungers, when operated downward, contact the four corners of the cassette cover panel **60** and force it downward compressing the felt layers **57** and **64** until locks **50** slide into locking position biased by the springs **66**.

A limit switch **93** is also secured on shelf **90** with its operating arm **94** extending through a hole in the shelf for indicating when the cover **28***b* has been raised to its elevated position by solenoids **88**. Two cover-lowered limit switches **94** are also secured, as shown, on shelf **90** having their operating arms, not shown, extending biased downward for following the cover **28***b* downward and indicating when it has reached locked position.

Referring to FIG. **8** a chute floor portion **95** extends from the cassette support **84** to a door slot **96** in a partition **97** between the cassette chamber **27** and chute **29**. A marker-extracter operating solenoid **98** is secured on partition **97** and has a plunger **99** adapted to extend into the opened cassette, as shown. A marker-extracter head **100** is carried at the end of plunger **99** and the plunger, when extended, carries the head to a position over the screen flap **70** so that, when the flap is raised by solenoid **75**, the portion of the film **31** lying on the flap is pressed flat against the extracter or bottom surface **101** of head **100** as best seen in FIG. **9**.

The film-contacting surface **101** of the head is made from or coated with a slightly tacky substance as, for example, certain types of rubber so that, when the head **100** is withdrawn beyond the cassette **28** the leading edge of film **31** is withdrawn with it. Since the cassette chamber **27** is at an angle the film continues by gravity down the chute portion **95**.

Head **100** is substantially coextensive in width with the flap **70** and carries an elongated lamp **102** therein as shown in FIG. **9**. The bottom portion **101** is internally slotted at **103** so that a card **104** previously inscribed with pertinent information, such as the patient's name, may be inserted from one end, as shown, while head **100** is still withdrawn from the cassette. A limit switch **105**, at the far end of the head as viewed in FIG. **9**, signals for the introduction of head **100** into the opened cassette when a card in inserted. Another limit switch **106**, at the near end of the head as viewed in FIG. **9**, has its operating plunger directed downward so that when plunger **89** raises the flap **70** the film surface operates switch **106** flashing lamp **102** for photographically impressing the information typed on the card on the film.

Referring again to FIG. **2**, the chute **29** has a first light-proofed door **109** and a second door **110** spaced therefrom so that a film sheet passing through the slot **96** may be detained in the between-door space of the chute until the processor **11** is ready to accept it.

Doors **109** and **110** are operated by solenoids **111** and **112**, respectively, it being understood that the doors may be spring-closed and solenoid-opened or vice-versa or may be operated by solenoid and spring in tandem as shown.

A sensor **113** in front of door **109** opens the door when the leading edge of a film sheet passes it. The film falls into the chute and is stopped by door **110** which opens only when the processor is ready to receive it. When the trailing edge of the film passes senser **113**, the door **109** is closed to make the chute light-tight.

The cassette loader **10** may be operated to initially load a cassette **28**, in what is called "initial cycle," or it may be operated to unload a cassette and subsequently pass its film sheet **31** to the processor **11** and in the same operation reload the cassette, called "normal cycle." In the normal cycle, when several cassettes of the same size having films taken of the same patient are unloaded and reloaded consecutively, it is not necessary to remove the patient information card **104** and several steps involving removal of the card and insertion of another card may be omitted. This results in a shortened cycle called the "same case cycle."

Referring to FIG. **10**, the loader **10** is electrically operated by the control logic **115**, hereinafter described, supplemented by operator push button controls **116** and signals from the limit switches and sensors **117**. Electrical power from the supply **118** is supplied to the solenoids and logic, as shown, the control logic **115** operating the solenoids through solenoid switching devices **119**.

Referring to FIG. **11**, after the desired module **14** of the loader is turned on by operation of the appropriate switch **18**, normally the first step in operating the apparatus is the loading of the marker-extracter **100** signalled by the "load marker" signal lamp **23** indicated in box **120** of the logic diagram. Loading of the marker with card **104** depresses switch **105** as indicated at step **121** in the diagram. This extinguishes and resets the "load marker" lamp **23** at step **122**. This point in time can logically be reached by two other paths—the initial cycle path or the same case cycle path as indicated by the OR box in the diagram.

Following the loading of the marker the "load cassette" light **23** is lit or set as step **123**. The operator will then insert cassette **28** as step **124**. The cassette depresses limit switches **86** as step **125** and the "load cassette" light is reset as step **126** only if the cassette is correctly positioned.

The operator closes door **16** at step **127** and the operation of switches **46** at the door sets the "in operation" light **23** at step **128**.

At this point in time, after a short delay ΔT, a logical AND function is performed based on the fact that the cassette is in place, the door is closed, and any film in the chute has been removed from the apparatus.

At this point the unloading starts. Two events occur simultaneously: the timer T1 is set and the logic signal known as "load" at **129**. Clearing the "load" logic signal prevents a potential oscillation.

The unlocking solenoids **91** are energized at **130** and after a short delay ΔT the cover lifting solenoids **88** are energized as step **131**. When the cover is lifted sufficiently it operates switch **93** as step **132** which resets T1 and the unlocking solenoids **91** are deenergized at **133**.

At this point a logic decision is made based on whether this is a normal or initial cycle. If there is no exposed film in the cassette, the switch **18**, set at its "initial cycle" position, causes a jump in the sequence to the start of FIG. **12**. If switch **18** is set at "normal cycle" the removal of the exposed film continues as shown in FIG. **11**. This point in time can also be reached logically by the recycling of the marker extracter as shown in FIG. **13A**.

Normal operation continues with the insertion at **134** of the marker-extracter or head **100** between the raised cover and the base of cassette **28** and, after a delay ΔT, solenoid **75** is operated at **135** to elevate the flap **70** on which a portion of the film rests. As the exposed film strikes the head **100** switch **106** is operated as step **136** flashing the light **102** as step **137** after a brief delay to allow the film to settle.

At this point in time the film has been labeled and removal of the exposed film is begun by retraction of head **100** as solenoid **98** is operated to retract as step **138** and timer t2 is set. As the leading edge of the film passes with head **100** out of the cassette it is no longer supported by flap **70** and separates from head **100** and the film slides downward to operate sensor **113** as step **139**.

At this time, timer t2 is reset, solenoid **75** is deenergized as indicated by box **140**, the light trap door **109** is opened as indicated by box **141**, and the head **100** continues to withdraw to its fully retracted position as indicated by box **142**. As the film slides down chute **29** its leading edge operates sensor **114** as step **143** to reset timer T2, if it has been set, and to close door **109** as step **144** thus completing the cassette unloading cycle.

Referring now to FIG. 12, there are two paths of operation which may be concurrent or one may be initiated before the other. One is the start of removing fresh film from cartridge 26 and transferring it to the empty cassette. The other path is transferring the exposed film to processor 11 as shown by the second line of boxes or steps in FIG. 12.

To start the transfer of the removed film to the processor four conditions must be met:

1. The film must have been properly removed to chute 29;
2. the processor must be ready to accept new film;
3. the machine must be operating in normal cycle; and
4. the module priority scheme must be satisfied.

As shown in FIG. 12, step 145, the opening of light trap door 110, occurs when these four conditions are satisfied. The timer *t*4 is then set and when the trailing edge of the film operates sensor 114, as step 146, the door 110 is closed at 147 and this generates a chute clear signal at 148. Timer *t*4 is then reset and processing the film is started in processor 11.

The reloading of the cassette is started at 150, regardless of whether the chute is emptied, by the energizing of motor 40 withdrawing the interleaved paper from cartridge 26. At the same time, timer T5 is set and counter 20 is operated at 151 to show one less film sheet in the cartridge. It will be noted that these operations may also be initiated by pressing the manual film advance button. The next step 152 is the operation of sensor 44 actuated by the trailing edge of the extracted film sheet and, after a delay, motor 40 is deenergized as step 153 and the new film sheet slides into the open cassette. At this point, or in response to a manual eject, timer T5 is reset and the cover lifting solenoids 88 are deenergized at 154. After a delay, cover locking solenoids 92 are energized at 155, timer T6 is set and limit switches 94 indicate the cover is locked at 156. Timer T6 is reset at this point and then, at step 157, cover locking solenoids 92 retract. At this point reloading is complete and the "unload cassette" lamp 23 is set at 158.

When the cassette is removed at 159, the "unload cassette" lamp is reset at 160 and then the "unload marker lamp" is set at 162 or the subsequent steps may be by-passed by pressing the "same case" button which resets the "in operation" lamp 23 at 161.

In the normal cycle, the marker card 104 is removed as step 163, the "unload marker" lamp is reset at 164, the "in operation" lamp is set at 165, and the "load marker" lamp is set at 166. A new cycle proceeds again as shown in FIG. 11.

Referring now to FIG. 13, line A indicates the operation if the extractor head 100 fails to remove the exposed film at step 138, FIG. 11. Between the set and reset of timer *t*2 a time delay ΔT allows comparison logic at 167 to determine if normal time for the operation is exceeded and, if it is, a decision at 168 causes the reinsertion at 169 of the head 100 and a recycling of steps 134–139 as shown in FIG. 11 and a set of timer *t*3 as indicated.

A similar testing of the unlocking and opening of the cassette is shown at line B. Comparison logic at 170 compares the time between set and reset of timer *t*1, and, if too long, results in a decision at 171, causes the "cover jammed" lamp to light as step 172 and the machine to stop.

Another test of timer *t*3 is shown at line C and a comparison at 173, if too long, results in a decision at 174 to set the "film jammed" lamp at 175 and to stop the machine.

At line D, a test of timer t4 is made for testing the passage of the unloaded film from the chute 29 to processor 11. Comparison at 176 causes a decision at 177, if too long, to set the "film jammed" lamp as step 178 and the machine stops.

The testing of the cassette reloading is shown in line E where a comparison at 180 is made of any over normal delay in the resetting of timer *t*5. If the "too long" decision is made at 181, the "reloading problem" lamp is set at 182 and the machine stops.

Testing of timer t6 is shown at line F of FIG. 13 to show failure to relock the cassette. Comparison at 183 results in a decision at 184, if too long, to set the "cover jammed" lamp at 185 and to stop the machine.

It will be apparent from the foregoing that other means for withdrawing separate sheets of film from a cartridge or film pack may be employed. In FIG. 14 a box-like cartridge 226 is shown having its door-slot 230 at the top. The film sheets 231 are interleaved with a paper strip 231 with folds 233 at the back and 234 at the front similarly to the cartridge 26.

Instead of the gravity feed, however, an inflatable sack or balloon member 235 is provided at the bottom of the cartridge and it has a tube 236 through which air may be pumped into the balloon as needed. A hand operated bulb may be provided for the operator to pump air as needed or an aneroid-barometer type of air valve may be provided to automatically regulate the required pressure in balloon 235 from a supply of compressed air.

In FIG. 15 another film pack or cartridge 250 is provided having a door slot 251. A roll of film 252 is contained in cartridge 250 which may be unrolled as needed by a driven pair of rolls at 253, a strip of paper 254 being provided at the end of the roll for manual threading between the rolls for initially starting the film between the rolls. A knife 255 operated by solenoid 256 cuts the film 252 into sheets of the desired length, the rolls 253 being operated to remove film from the cartridge at carefully timed intervals.

Other means than the extractor head surface 101 and flap 70 may be used to initially raise the exposed film from the cassette, after it has been opened, as, for example, jets of air directed from outside the cassette under the film in the cassette and head 100 may then be eliminated by installing the marker portion 102–105 at the end of the chutes 29 in the common portion of the chutes 17*a* (FIG. 1) just before the entrance to the processor 11.

As will be apparent to those familiar with the art, the invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof.

I claim:

1. A light-proofed automatic radiographic cassette unloader-reloader adapted for use with an automatic film processor and for use with a cassette having a cover removable from its base, comprising: a single light-proof cabinet; a compartment in the cabinet for storing a plurality of sheets of unexposed film; a cassette chamber in the cabinet for supporting the cassette therein in a fixed position; cassette-unlocking means in the chamber; cassette cover-removing and cover closing means in the chamber; means operable when the cover is removed to extract an exposed film sheet from the cassette and means to convey it to the processor; means associated with the compartment for extracting unexposed sheets of film one-at-a-time and means for conveying the extracted sheet to the opened cassette; and electrical programming means for successively operating the unlocking means, the cover removing means, the exposed film extracter and conveyer means, the unexposed film extractor and conveyer means, and the cover closing means.

2. A light-proofed automatic radiographic cassette unloader-reloader adapted for use with an automatic film processor and for use with a cassette having a cover removable from its base, comprising: a single light-proof cabinet; a compartment in the cabinet for storing a plurality of sheets of unexposed film; a cassette chamber in the cabinet having means supporting the cassette therein in fixed position; unlocking plungers associated with the chamber for unlocking the cassette cover from its base, the cassette having a plurality of sliding locks, each lock having a slanted camming surface for sliding the lock from locked to unlocked position when contacted by an unlocking plunger and being spring biased toward locked position for automatic locking when the cassette cover is forced against its base; cover lifting plungers associated with the chamber, the cassette cover having projecting lifting tabs adapted to be contacted by the lifting plungers to raise the cover above its base; cover closing plungers associated with the chamber for forcing the cover against its base; motor means for operating each plunger; means operable when the cover is raised to extract an exposed film sheet

from the cassette and means to convey it to the processor; means associated with the compartment for extracting unexposed sheets of film one-at-a-time and means for conveying the extracted sheet to the opened cassette; and electrical programming means for successively operating the unlocking plungers, the cover lifting plungers, the exposed film extractor and conveyer means, the unexposed film extractor and conveyer means, and the cover closing plungers.

3. The unloader-reloader defined in claim 2 having a plurality of layers in a single cabinet, each layer having the components recited in claim 1 and each layer being adapted for use with a different size of cassette, each layer terminating in a chute leading to a common chute at the entrance to the processor, and the programming means including means for successively releasing film sheets from the layer chutes in a planned scheme of priority.

4. A light-proofed automatic radiographic cassette unloader-reloader adapted for use with an automatic film processor and for use with cassettes having a cover removable from its base, comprising: a single light-proof cabinet having a plurality of vertically stacked layers, a compartment in each layer for storing a plurality of sheets of unexposed film, a chamber in each layer having means therein for supporting a cassette therein in fixed position, each chamber terminating in a chute leading to the processor, the compartment and chamber each having a floor inclined to the horizontal down from the compartment to the chamber and the chute being inclined down to the processor; unlocking plungers associated with each chamber for unlocking the cassette cover from its base, the cassette having a plurality of locks, each lock having a slanted camming surface for sliding the lock from locked to unlocked position when contacted by an unlocking plunger and being biased toward locked position for automatic locking when the cover is forced against its base; cover lifting plungers associated with each chamber, the cassette cover having projecting lifting tabs adapted to be contacted by the lifting plunger to raise the cover above its base; cover closing plungers associated with each chamber for forcing the cover against its base; motor means for operating each plunger; means operable when the cover is raised to extract an exposed film sheet from the cassette so that it will slide down the chute; means associated with each compartment for extracting unexposed sheets of film one-at-a-time so that the sheet will slide down the compartment floor to an opened cassette in the adjacent chamber; each layer having a compartment and chamber adapted to receive film sheets and cassettes of a different size; electrical programming means associated with each layer for successively operating the unlocking plungers, the cover lifting plungers, the exposed film extractor, the unexposed film extractor, and the cover closing plungers; and means in the chutes associated with the programming means for planned release of film sheets from the chutes to the processor.

5. The unloader-reloader defined in claim 4 wherein the unexposed film extracting means comprises a cartridge containing a plurality of stacked film sheets interleaved with a continuous strip of flexible sheet material in the compartment, the strip forming a double layer between each film sheet and having a fold at the leading edge side of the sheet stack, the lower layer of each double layer being folded over the trailing edge of the underlying sheet to the double layer underneath, the cartridge having an exit opening for one sheet at one end of the stack, the stack being biased toward said one stack end, a pair of parallel rollers mounted in the compartment, one roller being motor driven and the rollers being biased toward one another, and one end of the strip being adapted to pass through the exit opening and be threaded between the pair of rollers, whereby, as the strip is pulled through the exit by the rollers, a fold at the trailing edge of the stack engages the edge of the end sheet in the stack and withdraws the sheet through the exit opening.

6. The unloader-reloader defined in claim 4 wherein the unexposed film extracting means comprises a cartridge containing a continuous roll of film in the compartment, the cartridge having an exit slot at one side through which the film may be drawn, a pair of parallel rollers in the compartment adjacent the slot, one roller being biased toward contact with the other, and one roller being motor driven, whereby the film may be threaded between the rollers, shearing means in the compartment adjacent the rollers, and timing means in the programming means for controlling the motor drive of the rollers and operation of the shearing means, whereby sheets of film of desired length are cut from the roll.

7. The unloader-reloader defined in claim 4 wherein the exposed film extracting means comprises at least one flap raising plunger in the chamber, the cassette base having a hinged flap at one end and a light-proofed entrance means for the flap raising plunger, motor means operable by the programming means for raising the flap raising plunger into contact with the flap and for raising the end of the exposed film sheet in the open cassette above the cassette base, an extractor head in the chamber normally spaced from the cassette, motor driven means operable by the programming means for introducing the head into the opened cassette above the flap and for withdrawing it therefrom after the flap is raised to contact the head, the head having an area substantially coextensive with the flap at least partially coated with a tacky material whereby the exposed film in the cassette is drawn with the head from the cassette base when the head is withdrawn from the cassette.

8. Film marking means in combination with the unloader-reloader defined in claim 7 comprising: a card having information typed thereon, the head having means therein for positioning the card immediately above the film in the cassette, a light source in the head above the card and substantially coextensive with the card, the light source being adapted to be briefly illuminated by the programming means after the head has been introduced into the open cassette and the flap raised to contact the head, whereby the exposed film in the cassette is marked with the information on the card.

9. The unloader-reloader defined in claim 7 having light-proofed doors to the compartments and chambers; sensing means for signalling to the programming means the passage of a film sheet between each compartment and chamber, between each chamber and its chute, and at the end of each chute; sensing means at each door for signalling that the door is closed; sensing means in each chamber for signalling when a cassette is in place, when the cover is raised, and when the cover is closed; signal lights associated with each chamber and operated by the programming means for signalling malfunctions in the automatic operations and for signalling for manual insertion of film into the compartment and a cassette into the chamber; and switch means associated with each chamber for changing the operation of the programming means for initial loading of an empty cassette.

* * * * *