

[54] **FILM CUTTING DEVICE**

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[30] **Foreign Application Priority Data**

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[52] U.S. Cl..... **83/210, 83/364, 83/371**

[51] Int. Cl..... **B26d 5/32, B26d 5/34**

[58] Field of Search..... 83/209, 210, 364, 365, 83/371

[56]

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[57]

ABSTRACT

An automatic film cutting device is used to cut rolled or strip film off into sheet film having a predetermined length. This film cutting device comprises detecting means for detecting film cutting marks on film to be cut off, film advancing means for advancing the film, and measuring means for measuring the advancement of the film. The measuring means is actuated in response to the output signal from the detecting means, and the film cutting means is actuated in response to the output signal generated by the measuring means when the film to be cut off is fed by a predetermined length, thereby cutting off the film into a predetermined length.

18 Claims, 22 Drawing Figures

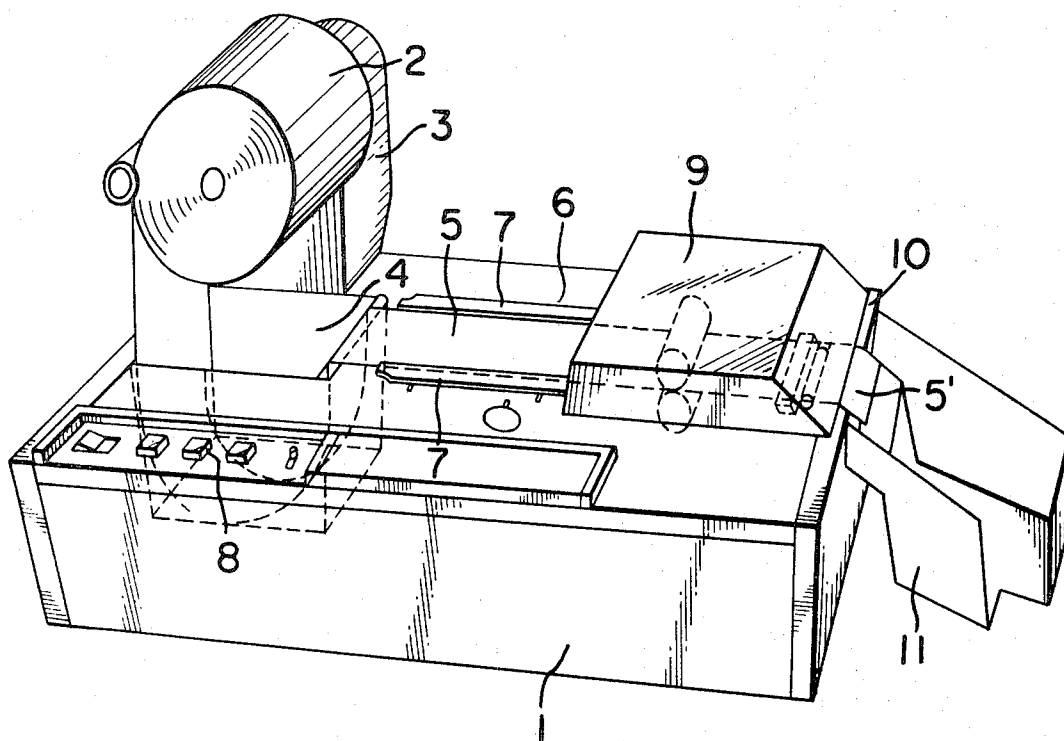


FIG. 1

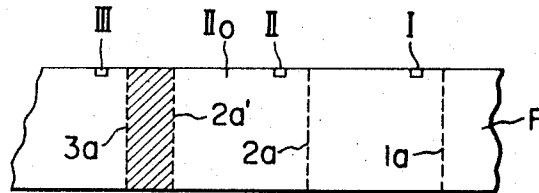


FIG. 2

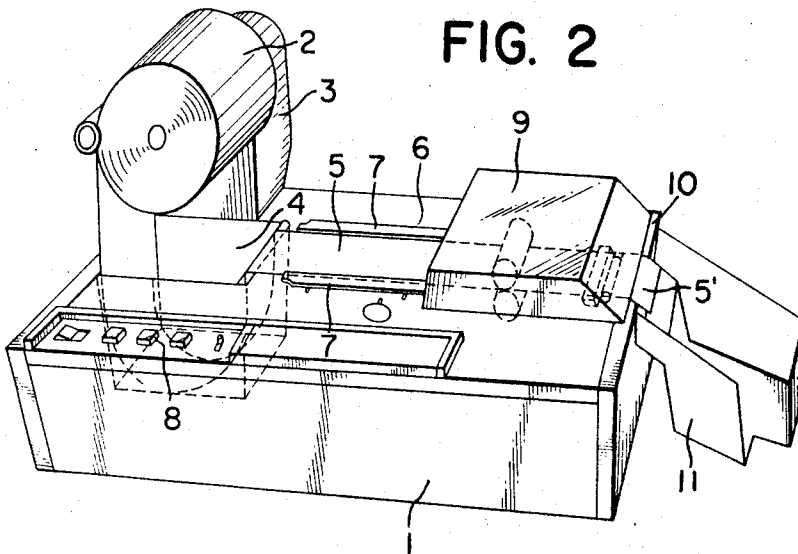


FIG. 3

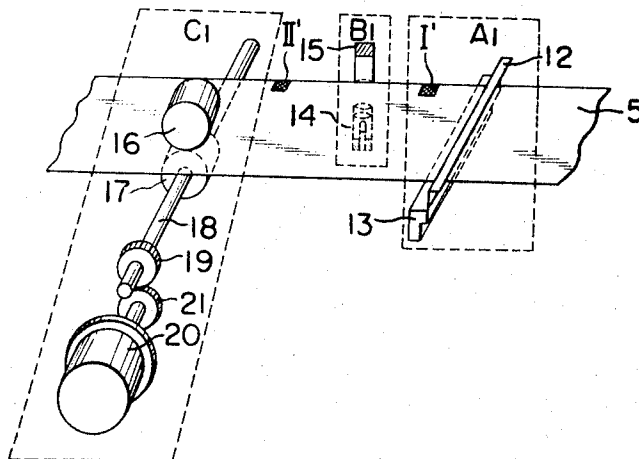


FIG. 4

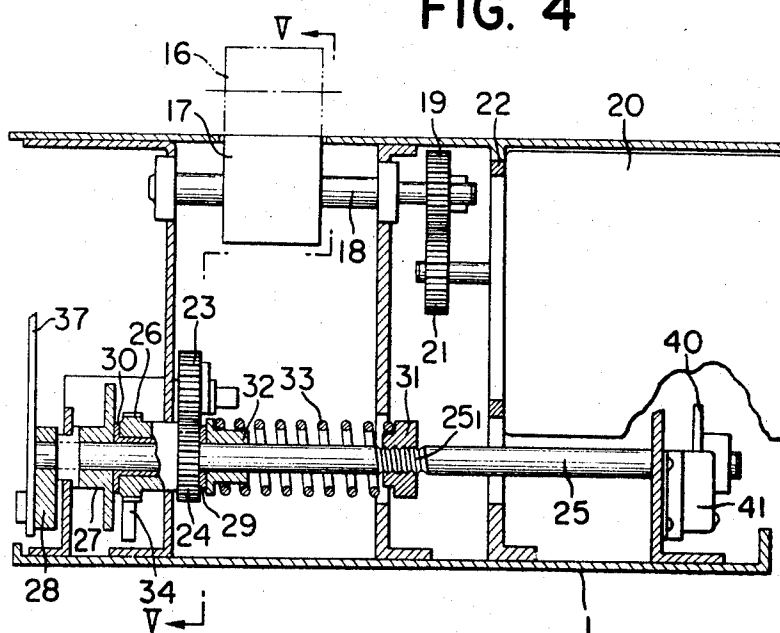


FIG. 5

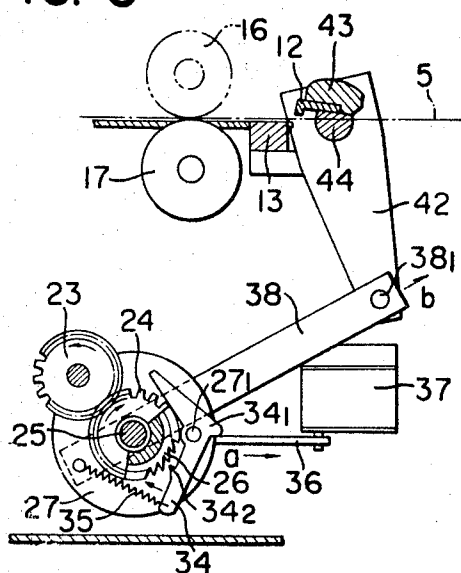


FIG. 6

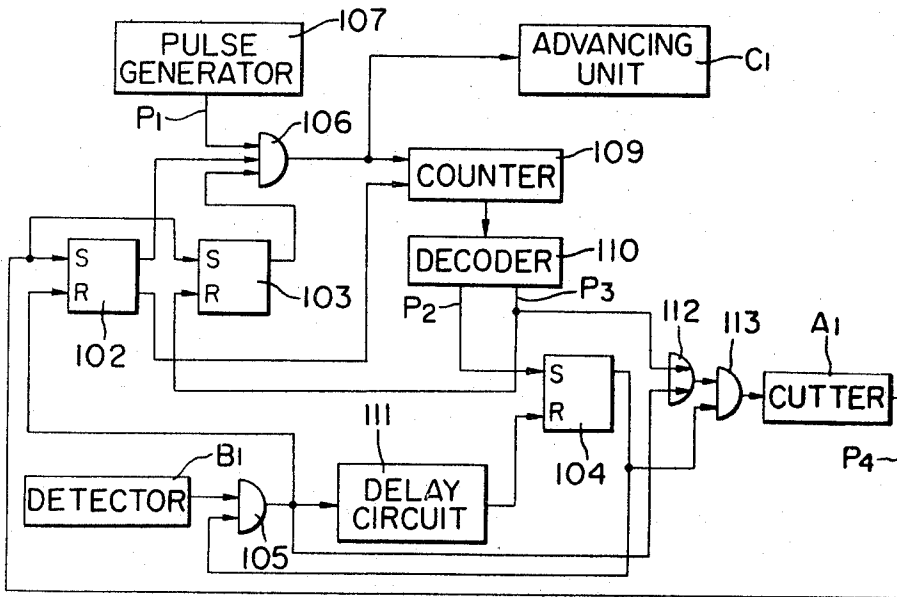


FIG. 8

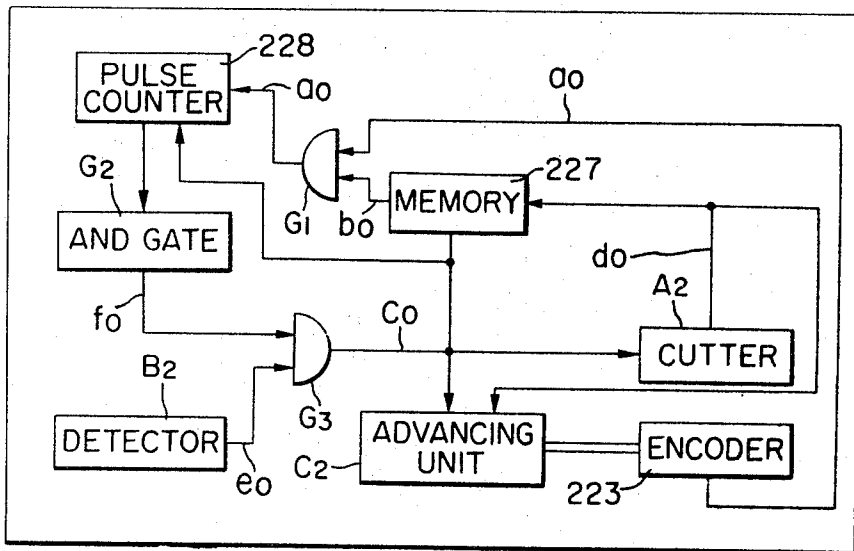


FIG. 7

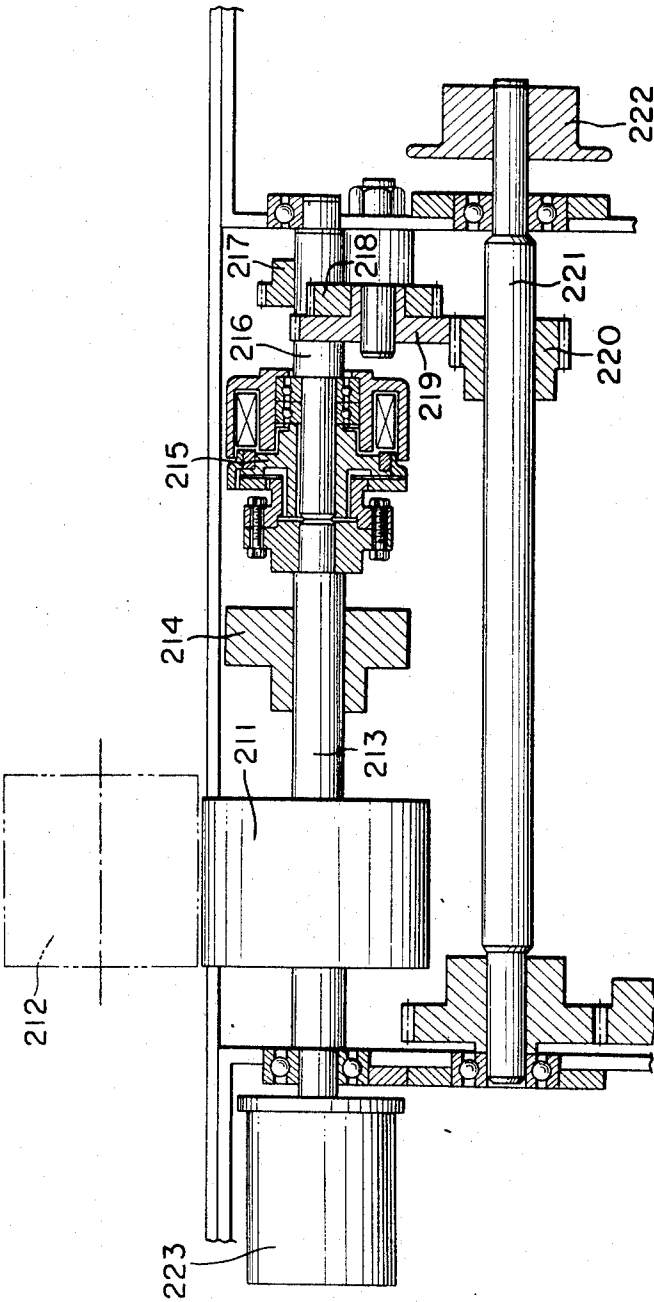


FIG. 9

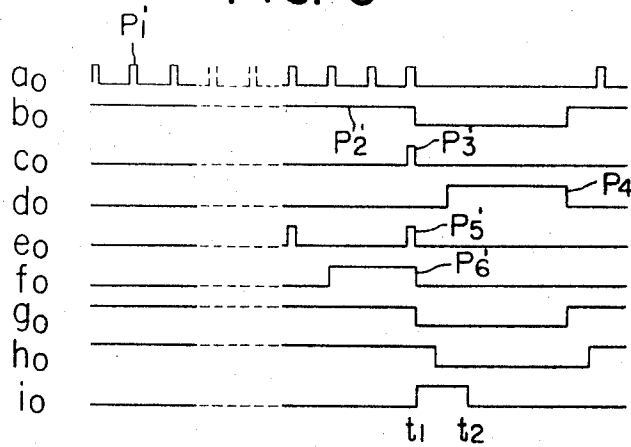
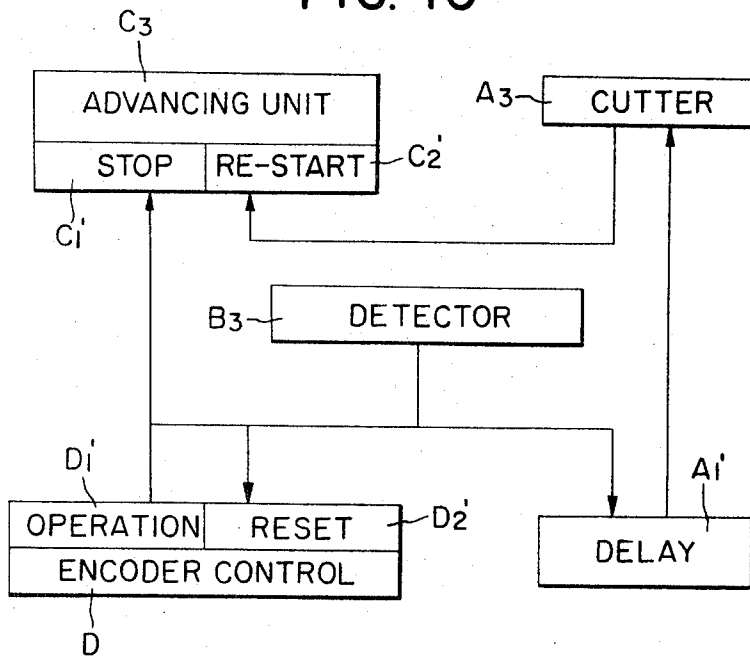


FIG. 10



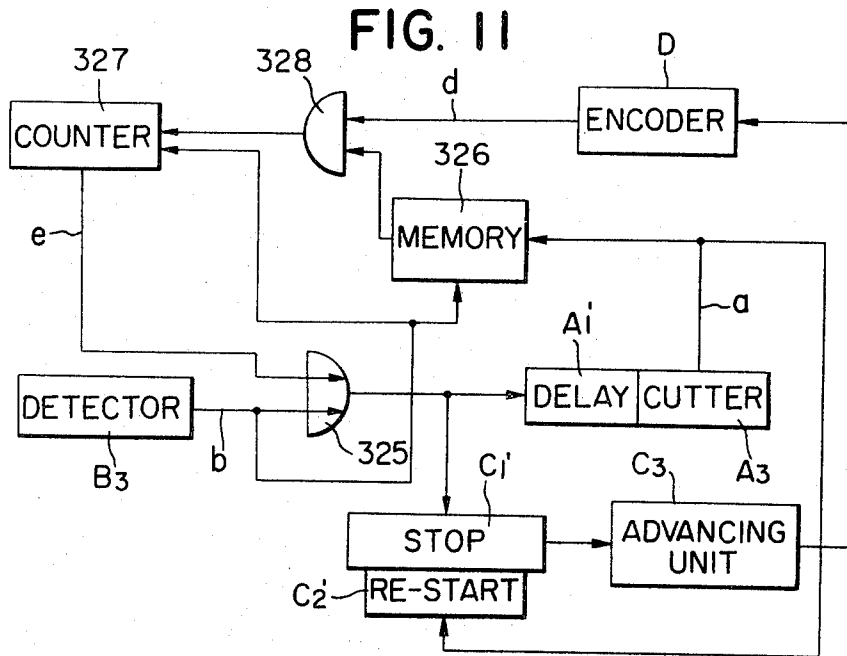
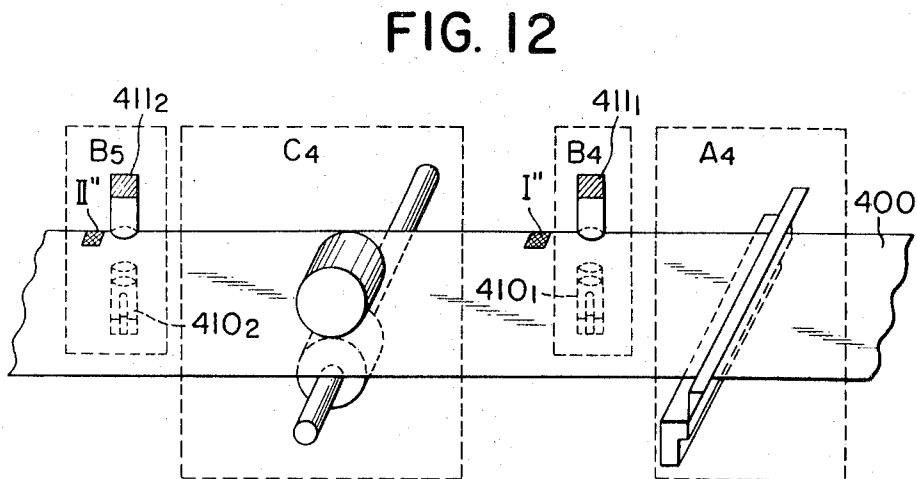


FIG. 13(a)

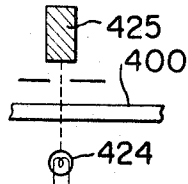


FIG. 13(b)

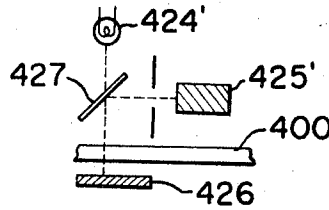


FIG. 14

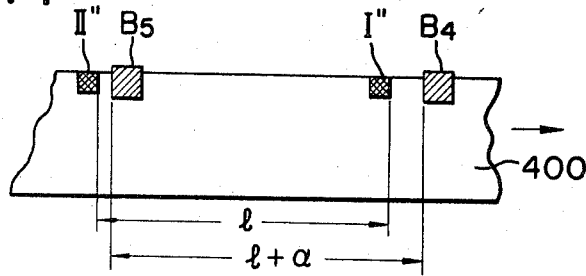


FIG. 15

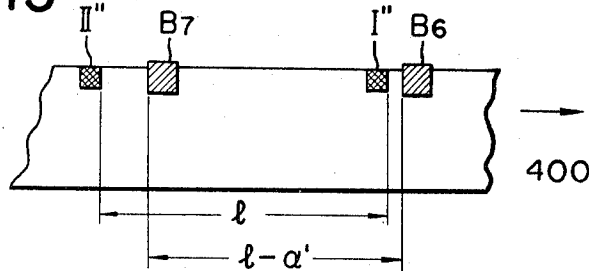


FIG. 16

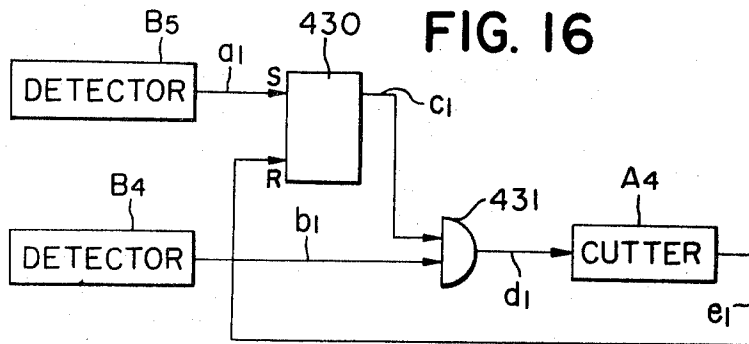


FIG. 17

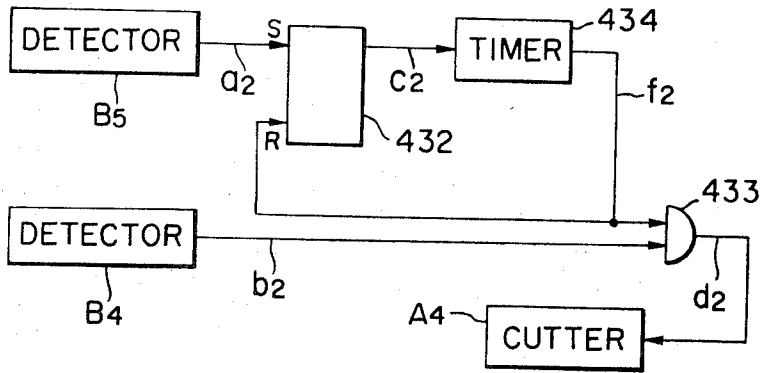


FIG. 18

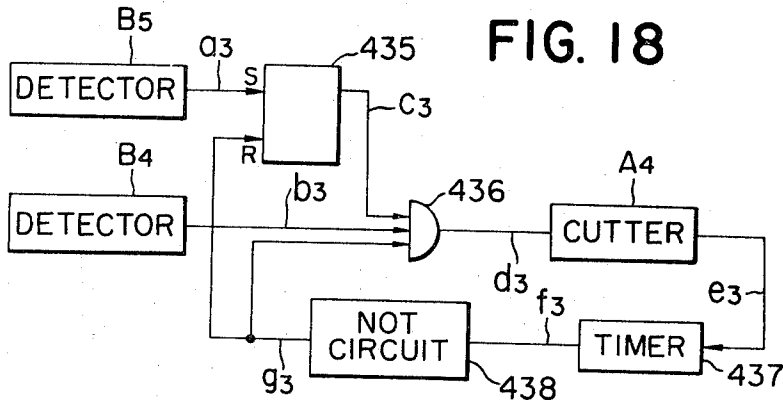


FIG. 19

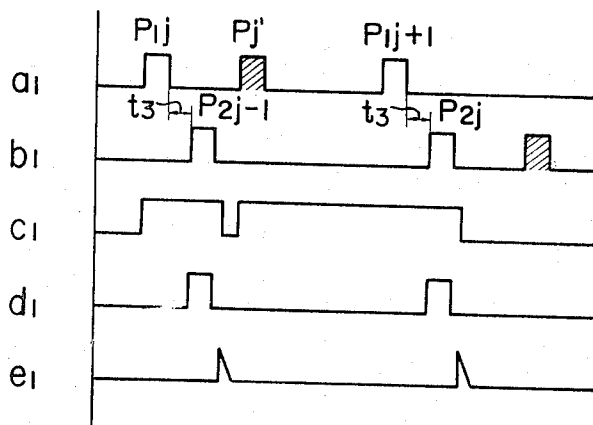


FIG. 20

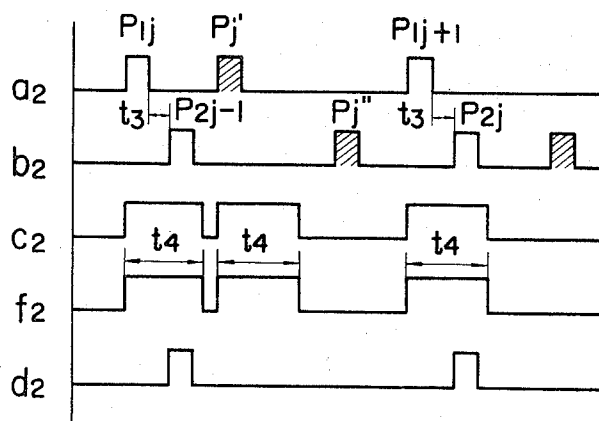
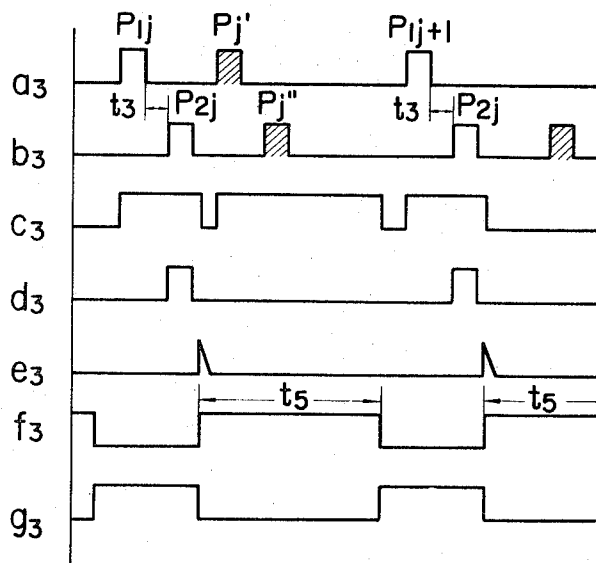


FIG. 21



FILM CUTTING DEVICE

This is a division of application Ser. No. 315,822, filed Dec. 18, 1972, now U.S. Pat. No. 3,822,624.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an automatic film cutting device for cutting a rolled or strip microfiche film into a plurality of microfiche sheets each having a predetermined length or cutting off rolled or strip film into the unitized form.

Microfilming technique has long found widespread applications in various fields because a large number of data may be recorded on a reduced scale in a very limited small area with an exceedingly high density. Of microfilm microfiche film has been widely used because a large number of data concerning to one subject may be recorded in rows in a single frame and further because the automatic continuous printing, development, and fixing are feasible in a simple manner.

2. Description of the Prior Art

However microfiche in the form of strip of roll is generally not convenient for indexing, retrieval and reading so that it is generally cut off into microfiche sheets of a predetermined size or sheets in the unitized form. In general the conventional film cutting devices used for this purpose are such that a cutter is actuated so as to cut off roll or strip film in response to the output signal from a photoelectric-cell type detector which detects a film cutting mark upon roll or strip film being transported. However the spacing between the adjacent cutting marks on rolled or strip film is generally not uniform because of some variations in length of film transported in one time in a camera when the cutting marks are photographed on the film together with the data to be recorded. Therefore the cut-off microfiche sheets are not uniform in length so that great inconvenience arises when they are used in conjunction with a reading or indexing machine or when they are stored in a container.

Furthermore the conventional film cutting devices have a serious defect that rolled or strip film is cut off erroneously not along a predetermined cutting line because the detector gives an erroneous signal when it detects the noise or stain, scratch or the like on the film in line with the cutting marks. As a result rolled or strip film is cut off into microfiche sheets not uniform in length and in the worst case the data recorded on a microfiche film are so damaged that some data cannot be reproduced.

SUMMARY OF THE INVENTION

One of the objects of the present invention is therefore to provide an automatic film cutting device which may overcome the above and other problems encountered in the conventional film cutting devices.

Another object of the present invention is to provide an automatic film cutting device comprising detecting means for detecting film cutting marks on film to be cut off, film feeding means for feeding the film, and measuring means for measuring the feed of the film, said measuring means being actuated in response to the output signal from said detecting means and said film cutting means being actuated in response to the output signal generated by said measuring means when the film to be cut off is fed by a predetermined length, thereby cutting off the film into a predetermined length.

Another object of the present invention is to provide an automatic film cutting device of the type described above wherein the film cutting means may be kept de-energized until the measuring means measures a predetermined length of the film to be cut off so that the erratic film cutting operation may be completely prevented.

Another object of the present invention is to provide an automatic film cutting device of the type described in which at least two detecting means for detecting the cutting marks on the film to be cut off are used so that when and only when both of said at least two detecting means give the output signals simultaneously the cutting means is actuated so as to cut off the film thereby preventing the film from being cut off along an erroneous cutting line.

The above and other objects, features and advantages of the present invention will become more apparent from the following description of some preferred embodiments thereof taken in conjunction with the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a fragmentary top view of a film strip to be cut off used for the explanation of film cutting marks marked thereupon;

FIG. 2 is a perspective view of a first embodiment of an automatic film cutting device in accordance with the present invention;

FIG. 3 is a fragmentary diagrammatic view thereof illustrating the arrangement of a film feeding mechanism, a detector and a film cutting mechanism;

FIG. 4 is a fragmentary sectional view of the film cutting device shown in FIG. 1;

FIG. 5 is a view looking in the direction indicated in the line V—V' of FIG. 4;

FIG. 6 is a block diagram of a control unit of the automatic cutting device shown in FIG. 1;

FIG. 7 is a side view, partly in cross section and on enlarged scale, illustrating only the essential component parts of a second embodiment of an automatic film cutting device in accordance with the present invention;

FIG. 8 is a block diagram of a control unit thereof;

FIG. 9 shows the waveforms of various signals generated in the control unit shown in FIG. 8 used for the explanation of the mode of operation thereof;

FIGS. 10 and 11 are block diagrams of two variations of the control unit shown in FIG. 8;

FIG. 12 is a fragmentary perspective view of a third embodiment in accordance with the present invention illustrating only the major component parts thereof;

FIGS. 13(a) and 13(b) are views used for the explanation of a detecting device used in the automatic film cutting device shown in FIG. 12;

FIGS. 14 and 15 are views used for the explanation of the relation between the spacing between two detecting means and a spacing between the adjacent film cutting marks on the film to be cut off;

FIGS. 16, 17 and 18 are block diagrams of three control units adapted for use in the automatic film cutting device shown in FIG. 12; and

FIGS. 19, 20, and 21 shows the waveforms of the signals used for the explanation of the mode of operation of the three control units shown in FIGS. 16-18, respectively.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

First referring to FIG. 1 illustrating a part of unrolled or strip film to be cut off, film cutting marks are generally marked upon a film along one side edge thereof. The transparency of the cutting marks is so selected as to be different from that of the film. As described hereinbefore, when the spacing between the adjacent cutting marks is not uniform, for example when the spacing between the cutting marks I and II is shorter than that between the cutting marks II and III, the length of one microfiche between the cutting lines 1a and 2a becomes shorter than that of another microfiche sheet between the cutting lines 2a and 3a. The second microfiche sheet must be cut off along the cutting line 2a' so that it has an unwanted extra portion 3a which may be a part of the third microfiche sheet bearing the data.

When there exists a noise, that is a stain or scratch II₀' on the film in line with the cutting marks II and III, the detector detects it and gives an erroneous signal so that the cutter cuts off film along an erroneous cutting line. Therefore microfiche sheets are not uniform in length and in some cases the data recorded on the film are seriously damaged as described hereinbefore.

The present invention was made in order to overcome the above and other related problems encountered in the conventional film cutting devices.

An automatic film cutting device in accordance with the present invention is shown in FIG. 2 as comprising a housing 1, a rolled microfilm 2 mounted on a supporting member 3 extending from the top of the housing 1, a film loop chamber 4 defined in the housing 1 for forming a loop of film unrolled from the rolled microfilm 2, a top panel 6 upon which is advanced an unrolled film 5 guided by a pair of guide members 7 located along the side edges of the passage for the film 5, a plurality of operating buttons 8 located at the front side of the top panel 6; a removable cover 9 placed over the top panel 6; a discharge outlet 10 through which a cutoff sheet film 5' is discharged, and a sheet film receiving box 11.

Next referring to FIG. 3, within the cover 9 are disposed a cutter assembly A₁ comprising a movable cutter 12 and a fixed cutter 13, a detecting device 3, comprising a light source 14 and a photoelectric cell 15 disposed upwardly and downwardly of the unrolled film 5, respectively and in opposed relation, and a film feeding device C₁ comprising a pair of feed rollers 16 and 17.

Next referring to FIGS. 3 and 4, a rotary shaft 18 of the feed roller 17 which is rotatably supported by a pair of suitable supporting members (not shown) disposed within the housing 1, has a gear 19 carried at one end thereof and engaged with a gear 21 carried by a rotary shaft of a pulse motor 20. Thus the rotation of the pulse motor 20 is transmitted to the feed roller 17 through the gears 21, 19 and the rotary shaft 18. An eccentric ring 22 is disposed in order to prevent the rotations in the reverse directions of the gears 19 and 21. Alternatively the pulse motor 20 may be directly coupled to the rotary shaft 18 of the feed roller 17.

Referring to particularly FIG. 4, an intermediate gear carried by a driving shaft of a motor (not shown) is in mesh with another intermediate gear 24 which is rotatably and slidably carried by a control shaft 25 which in turn is rotatably supported by a pair of supporting members. A ratchet wheel 26 which is rotatable in uni-

son with the gear 24, a holding or engaging disk 27 and a crank 28 are also carried in the order named at the right end of the control shaft 25. A friction disk 29 is interposed between the gear 24 and a sliding member 32 carried by the control shaft 25 for slidable movement, and a friction disk 30 is interposed between the holding disk 27 and the ratchet wheel 26. An internally threaded member or adjusting screw 31 is in mesh with externally threaded screws 25₁ of the control shaft 25. A coiled spring 33 is loaded between the internally threaded member 31 and the sliding member 32 so that the force of the coiled spring 33 may be adjusted by rotating the internally threaded member or adjusting screw 31. The holding disk 27 and the sliding member 32 slip relative to the friction disks 29 and 30, respectively even when the gear 24 and the ratchet wheel 26 are rotated by the intermediate gear 23 so that the control shaft 25 is normally rotated.

Referring to FIG. 5, a pawl 34 is pivoted to the holding disk 27 with a pivot pin 27₁, and a spring 35 is loaded between the holding disk 27 and the pawl 34 so that the pawl 34 is biased to normally rotate in the clockwise direction. The leading end of a rod 36 coupled to an actuating member of a rotary solenoid 37 is in engagement with a stepped portion 34₁ of the pawl 34 so that when the rotary solenoid 37 is energized the rod 36 is shifted in the direction indicated by the arrow a and then returned to its initial position after a predetermined time. When the rod 36 is shifted in the direction a, it is released from the pawl 34 so as to permit the latter to rotate in the clockwise direction. The tooth 34₂ of the pawl 34 engages with the ratchet wheel 26 so that the holding disk 27 may rotate in unison with the ratchet wheel 26. As a result the control shaft 25 is rotated.

A lever 38 is eccentrically pivoted to the crank 28 so as to convert the rotation of the crank 28 into the reciprocal motion. A cam 40 (See FIG. 4) is fixed to the left end of the control shaft 25 so as to actuate a micro-switch 41.

A connecting lever 42 has its one end pivoted with a pin 38₁ to the lever 38 and its the other end pivoted to a shaft 44. A cutter supporting member 43 is fixed to the connecting lever 42. When the lever 38 is shifted in the direction indicated by the arrow b, the connecting lever 42 swings about the shaft 44 in the counter-clockwise direction so that the movable cutter 12 carried by the supporting member 43 is caused to move downwardly thereby cutting off the unrolled film 5 co-operating with the stationary cutter 13.

A control unit is shown in block diagram in FIG. 6 as comprising the detecting device B₁ for detecting the cutting marks, flip-flops 102, 103 and 104, an AND gate 105 to which are applied the output of the detecting device B₁ and the set output of the flip-flop 104; an AND gate 106 to which are applied the clock pulses of a clock pulse generator 107 and the set outputs of the flip-flops 102 and 103, the film feeding device or advancing unit C₁ including the pulse motor 20 which is driven by the clock pulses, and a counter 109 which is reset in response to the reset output of the flip-flop 102 and counts the clock pulses P₁ passing through the AND gate 106.

The control unit further comprises a decoder 110 coupled to the output terminal of the counter 109 so as to give to signals P₂ and P₃ when the counter 109 has counted a predetermined number of clock pulses P₁.

The signal P_2 is generated prior to the signal P_3 , and the feed of the unrolled film 5 may be adjusted by adjusting a setting value of the counter 109. A delay line 111 coupled to the output terminal of the AND gate 105 gives the output signal to the reset input terminal R of a flip-flop 104 to the set input terminals of which is applied the output signal P_2 of the decoder 110. The output signal P_3 of the decoder 110 is applied to the reset input terminal R of the flip-flop 103, and to one of the input terminals of an OR gate 112 to the other input terminal of which is applied the output signal of the AND gate 105. The output signal of the OR gate 112 is applied to one of the two input terminals of an AND gate 113 to the other input terminal of which is applied the output signal of the AND gate 105. The output signal of the AND gate 113 is applied to the film cutting device A_1 which gives the pulse P_4 when the unrolled film 5 is cut into a predetermined length. The pulse P_4 is applied to the set input terminals S of the flip-flops 102 and 103 thereby setting them.

Next the mode of operation of the control unit with the above construction will be described in detail hereinafter.

1. When a cutting mark is detected

In response to the detection of a cutting mark by the detecting device B_1 it gives the signal to the AND gate 105. Since the set output signal of the flip-flop 104 is also applied to the AND gate 105, the latter gives the output signal which resets the flip-flop 102. As a result the clock pulses from the clock pulse generator 107 cannot pass through the AND gate 106 so that the pulse motor 20 in the advancing or feeding device C_1 is stopped. Therefore the advancement of the unrolled film 5 is interrupted. When the flip-flop 102 is reset, the counter 109 is also reset. The output signal of the AND gate 105 is also applied to the AND gate 113 through the OR gate 112. Since the set output signal of the flip-flop 104 is also applied to the AND gate 113, the latter gives the output signal to the cutting device A_1 so that the unrolled film is cut off into a predetermined length. That is, in response to the output signal of the AND gate 113 the rotary solenoid 37 (See FIGS. 4 and 5) is energized so as to shift the rod 36 in the direction a to release the pawl 34. The pawl 34 is rotated in the clockwise direction under the force of the spring 35 so that its tooth 34₂ engages with the ratchet wheel 26 which is rotating in unison with the gear 24. Therefore the pawl 34 is rotated in unison with the ratchet wheel 26 so that the holding disk 27 and hence the control shaft 25 are rotated. Therefore the lever 38 which is coupled to the crank 28 is shifted in the direction b so that the movable cutter 12 carried by the supporting member which in turn is carried by the connecting lever 42 is caused to move downwardly so as to cut the unrolled film 5 in cooperation with the fixed cutter 13.

When the control shaft 25 makes one rotation and the rod 36 is returned to its initial position the rod 36 engages with the stepped portion 34₁ of the pawl 34 again so that the holding disk 27 is released from the ratchet wheel 26.

After the unrolled film 5 is cut off, the movable cutter 12 is returned to its initial position. Thus, in response to the detection of the cutting mark, the unrolled film is stopped and is cut off by the film cutting device A_1 .

The cam 40 rotates in unison with the control shaft 25 so as to actuate the microswitch 41 after the unrolled film 5 has been cut off, thereby giving the pulse P_4 representing the completion of the film cutting operation. In response to the pulse P_4 , the flip-flops 102 and 103 are set again and the set outputs of them are applied to the AND gate 106 so that the clock pulses P_1 are permitted to pass through the AND gate 106 and applied to the pulse motor 20 in the advancing or feeding device C_1 . Therefore the pulse motor 20 starts to rotate again so as to feed the unrolled film 5.

The clock pulses P_1 passing through the AND gate 106 are also applied to the counter 109. As described hereinbefore, when the counter 109 counts a predetermined number of clock pulses P_1 , it gives the output signal P_2 which is applied to the set input terminal of the flip-flop 104, and then gives the signal P_3 which is applied to the flip-flop 103 so as to reset it. When the flip-flop 103 is reset, the clock pulses P_1 cannot pass through the AND gate 106 so that the pulse motor 20 in the feeding device C_1 is stopped, whereby the film feed is interrupted. The output signal P_3 is also applied to the AND gate 113 through the OR gate 112 to which is also applied the set output of the flip-flop 104. Therefore the AND gate 113 gives the output signal so as to actuate the film cutting device A_1 in the manner described hereinbefore. The above operations may be summarized as follows: When the unrolled film is fed by a predetermined distance the feed of the film is interrupted regardless of the fact whether a film cutting mark is detected or not; and then the film cutting device is actuated to cut off the unrolled film. Upon completion of the film cutting operation, the pulse P_4 is generated from the film cutting device A_1 so as to set the flip-flops 102 and 103. The clock pulses P_1 are permitted again to pass through the AND gate 106 and applied to the pulse motor 20 in the film feeding or advancing device C_1 , whereby the film feeding is resumed. When a film cutting mark is detected, the film is cut off in response to the signal from the detecting device B_1 in the manner described hereinbefore.

2. When the surface flaws such as stains, scratches or the like on the film are detected erroneously

When the detecting device B_1 detects a correct cutting mark, its output, passing through the AND gate 105 and the delay line 111, is applied to the flip-flop 104 so as to reset the latter. Therefore, even when the detecting device B_1 gives the erroneous signal in response to the detection of a surface flaw such as a stain, a scratch or the like, the flip-flop 104 has been already reset so that no output signal is derived from the AND gate 113. As a result the film cutting device A_1 is not actuated so that the unrolled film 5 is not cut off at all. More particularly when the detecting device B_1 gives an erroneous signal when the counter 109 is counting the clock pulses, the film cutting device remains deactivated until the unrolled film is advanced by a predetermined distance. Thus the erratic film cutting operation may be completely prevented.

In the instant embodiment the flip-flop 104 is reset in response to the signal which is delayed in time by the delay line 111, but it will be understood that this delay line 111 may be eliminated. That is, the decoder 110 is so arranged as to give the signal when the counter 109 which has been reset starts to count the first clock pulse. In response to the signal from the decoder 110

the flip-flop 104 is reset so that the signal from the detecting device B₁ may be interrupted until the counter 109 counts a predetermined number of clock pulses, thereby preventing the erratic film cutting operation.

As described hereinbefore, the automatic film cutting device in accordance with the present invention is very simple in construction because in response to the detection of the film cutting mark, the counter is reset; the film cutting device is actuated in response to the output signal from the counter when the latter has counted a predetermined number of clock pulses so as to cut off the rolled film which has been advanced by a predetermined distance independently of a film cutting mark; and even when the spacing between the film cutting marks is long a rolled film may be cut off into film sheets of a predetermined length. The automatic film cutting device in accordance with the present invention is adapted for use in conjunction with the information retrieval. Furthermore the automatic film cutting device in accordance with the present invention may cut off both side edges of each sheet by a pair of movable and fixed cutters. Since the driving pulses applied to the film feeding device are counted by the counter, the unrolled film may be cut off into a predetermined length with a high degree of accuracy. Since the circuit for interrupting the signal from the detecting device is provided, the film cutting device will not be actuated until the counter has counted a predetermined number of clock pulses even when the detecting device gives an erroneous signal in response to the detection of a surface flaw such as a stain, a scratch or the like of the film so that erratic film cutting operation may be completely prevented.

Next referring to FIG. 7 the second embodiment of the present invention will be described hereinafter. The second embodiment is shown as comprising a pair of film feed rollers 211 and 212 carried by a rotary shaft 213 which also carries a ratchet wheel 214. When a pawl (not shown) engages with the ratchet wheel 214, the rotation of the rotary shaft 213 is stopped. An electromagnetic clutch 215 is carried by a shaft 216. Gears 218 and 219 which are formed integral are in mesh with a gear 217 and a gear 220 carried by a driving shaft 221, respectively. The driving gear 221 is drivingly coupled to a motor (not shown) through a sprocket wheel 222 fixed to the right end of the driving shaft 221. An encoder 223 fixed to the right end of the rotary shaft 213 is adapted to detect the angle of rotation of the rotary shaft so as to generate the signal. The encoder 223 of the type described above is well known in the art so that no detailed description will be made in this specification.

A control unit of the second embodiment is shown in FIG. 8. The control unit comprises a memory 227, a pulse counter 228 and AND gates G₁-G₃. The input signals are applied as indicated by the arrows, and a double line indicates a mechanical coupling. The waveforms of the output signals at various points in the control unit shown in FIG. 8 are shown in FIG. 9.

Next the mode of operation of the second embodiment will be described with reference to FIGS. 8 and 9. As the pair of feed rollers 211 and 212 in the advancing unit or feeding device C₂ rotates, the unrolled film is advanced and the pulses P₁' are generated from the encoder 223 as shown at A₀ in FIG. 9 and are fed into the counter 228 through the AND gate G₁ which is opened when the output signal I that is generated when

and only when the memory 227 is set is applied to the AND gate C₁. When the counter 228 has counted a predetermined number of pulses P₁', that is when the unrolled film has been advanced by a predetermined length, it gives the output signal which passes through the AND gate G₂ and is applied to the AND gate C₃ as a film cutting permission signal P'₆ as shown in FIG. 9 at f₀. Therefore the unrolled film is now ready to be cut off. When the pulse P'₅ (See e₀ in FIG. 9) is simultaneously applied to the AND gate G₃ from the film cutting mark detecting device B₂, the AND gate G₃ gives the output pulse P'₃ as shown at C₀ in FIG. 9 which is applied as a feed-interruption signal to the feeding device C₂ and also to the counter 228 and memory 227 so as to reset them. The output pulse P'₃ is further applied to the film cutting device A₂ so as to actuate the movable cutter for a time duration between t₁ and t₂ as shown at i₀ in FIG. 9. Now the unrolled film is stopped, held stationary and cut off. In this case the encoder 223 is de-energized so that the pulse P'₁ disappears. When the unrolled film is cut off, the cutting device A₂ gives a pulse P'₄ as shown at d₀ in FIG. 9 representing the completion of film cutting operation. The pulse P'₄ is applied to the memory 227 so as to set the same and also to the film feeding device C₂ so as to resume the film feeding operation. Then the encoder 223 is actuated so as to give the pulse P'₁.

When the pulse P'₆ (the film-cutting-permission signal) is not derived the gate G₃ remains closed so that even when the detecting device B₂ gives an erroneous pulse in response to the detection of a stain or scratch on the unrolled film, the erroneous pulse P'₅ as shown at e₀ in FIG. 9 cannot pass through the gate G₃. Therefore the cutting device A₂ is not actuated so that the unrolled film will not be cut off erroneously. Thus the erratic film cutting operation may be completely prevented by suitably selecting the time at which the cutting-permission pulse P'₆ is generated.

In FIG. 9, the high level shown at g₁ indicates a time duration when the current is fed to the driving motor in the feeding device C₂; the low level shown at h₀ indicates a time duration when the feeding device C₂ is actuated; and the high level at i₀ indicates a time duration when the movable cutter is actuated.

In the second embodiment, in response to the detection of a film cutting mark, means for measuring or detecting the unrolled film fed by a predetermined length is reset and gives the cutting-permission signal when the unrolled film has been advanced by a predetermined length so that the cutting device is actuated to cut off the unrolled film when and only when both the cutting-permission signal and the signal from the detecting device are present simultaneously. When the cutting-permission signal is not present, the cutting device will not be actuated even when the detecting device detects a stain or scratch on the unrolled film so that the erratic cutting operation may be completely prevented.

Next referring to FIGS. 10 and 11 the variations of the control unit of the present invention will be described. In a block diagram shown in FIG. 10, to an actuating circuit in the cutting device A₃ are applied the output signal of the detecting device B₃ and the signal from an actuating circuit D'₁ in an encoder control unit D both of which are delayed in time through a time delaying circuit A'₁. The output signals of the detecting device B₃ and the actuating circuit D'₁ are also applied

to a film feed interruption circuit C_1' of the feeding device D_3 , that is a control circuit for disengaging the electromagnetic clutch 215 (See FIG. 7) thereby stopping the rotation of the ratchet wheel 214. The output signal derived when the film cutting device A_3 has cut off the unrolled film is applied to a film-feed-restarting circuit C_2' in the feeding device C_3 , that is a control circuit for accomplishing the operation opposite to that carried by the film-feed-interruption circuit C_1' . The signal from the cutting mark detecting device B_3 is applied to a reset circuit D_2' in the encoder control unit D . The cutting device A_3 , the detecting device B_3 and the film feeding device C_3 are similar in construction to those in the second embodiment described hereinbefore.

In the variation of the control unit shown in block diagram in FIG. 11, in response to the detection of a film cutting mark the detecting device B_3 gives the pulse b which is applied through an OR gate 325 to the feed-interruption circuit C_1' in the film feeding device C_2 and to a delaying circuit A_1' in the cutting device A_2 which cuts off the unrolled film after it has been stopped and held stationary. The pulse b from the detecting device B_3 is also fed into a memory 326 and a counter 327 so as to reset them. After the cutting device A_3 has cut off the unrolled film, it gives the pulse a (representing the completion of the film cutting operation) which is fed to the feed-restarting circuit C_2' in the feeding device C_3 so as to resume the feed of unrolled film. The pulse a is also fed into the memory 326 so as to set it.

When the feed of unrolled film is stored again, the encoder D gives a pulse d which is fed through an AND gate 328 into the counter 327 so as to be counted. Therefore the feed of unrolled film may be stored.

When the film cutting marks on the unrolled film is spaced apart by a predetermined distance as indicated by the cutting marks II and III, the counter 327 gives a pulse e when the unrolled film is advanced by a predetermined distance. This pulse e is applied through the OR gate 325 to the feed-interruption circuit C_1' in the feeding device C and to the delaying circuit A_1' in the cutting device A_3 so that the unrolled film is stopped and is cut off along the broken line $2a'$ shown in FIG. 1.

When the detecting device B_3 detects the next cutting mark III, it gives the pulse b so that the unrolled film is cut off along the dotted line $3a$ in the manner described above.

In the variations of the control unit described above, the encoder is set in response to either of the signals generated by the cutting device, and when the counter counts a predetermined number of pulses, the unrolled film is cut off even when a cutting mark is not detected. Therefore even when the spacing between the cutting marks is long, the unrolled film may be cut off into a predetermined length. Thus all of the cut-off film sheets have a uniform length so that the film sheets may be conveniently stored in a tray in a microfiche retrieving machine or the like.

Furthermore in response to the signal given when the unrolled film is cut off the encoder is set so that the length of the unrolled film to be cut off may be measured with a higher degree of accuracy. In the automatic film cutting device in accordance with the present invention only a pair of movable and stationary cutters are used to cut off both side edges (in the lateral di-

rection) of the unrolled film so that the automatic film cutting machine may be made simple in construction and may be fabricated at a less cost.

Next referring to FIG. 12, the third embodiment of an automatic film cutting device in accordance with the present invention will be described. In the first and second embodiments described hereinbefore, only one film cutting mark detecting device is used, but in the third embodiment at least two film cutting mark detecting devices are used. The detecting devices detect the film cutting marks on the unrolled film so as to actuate the cutting device and to prevent the erratic film cutting operation.

The third embodiment generally comprises the cutting device A_4 , the cutting mark detecting devices B_4 and B_5 for detecting the film cutting marks I'' , II'' , and so on on the unrolled film 400, and the film feeding device C_4 . The cutting device A_4 and the film feeding device C_4 are substantially similar in construction to those of the first and second embodiments described hereinbefore. It should be noted that the first detecting device B_4 is interposed between the cutting device A_4 and the feeding device C_4 .

Each of the two detecting devices B_4 and B_5 comprises a light source 410₁ or 410₂ and a photoelectric cell 411₁ or 411₂ so as to detect the film cutting marks I'' , II'' and so on on the unrolled film 400 and to give the signals.

FIGS. 13(a) and 13(b) show the devices for detecting the film cutting marks on the unrolled film. In FIG. 13(a) a light source 424 is disposed upwardly of the unrolled film 400 whereas a photoelectric cell 424 is disposed downwardly of the film. That is, the detection device shown in FIG. 13(a) is of a transmission type. In FIG. 13(b) a reflecting mirror 426 is disposed downwardly of the film 400 and a light source 424', a half mirror 427 and a photoelectric cell 425' are disposed upwardly of the film in such a manner that the light emitted from the light source 424' may pass through the half mirror 427, reflected back by the reflector 426 and then by the half mirror 427 and intercepted by the photoelectric cell 425'. Therefore the arrangement shown in FIG. 13(b) is a reflection type detecting device.

FIGS. 14 and 15 show the relation between the positions of the detecting devices and the film cutting marks on the unrolled film. In FIG. 14, the detecting devices B_4 and B_5 are so located as to detect the film cutting marks I'' , II'' , and so on marked along one side of the unrolled film 400 and as to be spaced apart from each other by a distance equal to or slightly longer than the distance l or $l + \alpha$ between the projected images of the two cutting marks. Therefore the detecting devices B_4 and B_5 may simultaneously detect the cutting marks or the detecting device B_5 first detects the cutting mark II'' and then the detecting device B_4 detects the cutting mark I'' a short time later when the unrolled film 400 is transported in the direction indicated by the arrow.

In FIG. 15 the two detecting devices B_4 and B_5 are spaced apart from each other by a distance slightly shorter than the distance between the projected images of the adjacent cutting marks. That is, the distance between the two detecting devices B_4 and B_5 is $(l - \alpha')$.

FIG. 16 is a block diagram of a control unit when the detecting devices B_4 and B_5 are arranged as shown in FIG. 14. The control unit comprises the two detecting devices B_4 , B_5 , a flip-flop 430, an AND gate 431, and

the film cutting device A_4 . The signals are applied as indicated by the arrows.

The mode of operation of the control unit shown in FIG. 16 will be described with reference to FIG. 19 illustrating the waveforms of various signals. In response to the pulse P_{ij} (See FIG. 19, a_1) generated by the detecting device B_5 when the latter detects the cutting mark on the unrolled film 400 being transported, the flip-flop 430, which has been reset, is driven into the set state to give the signal as shown at C_1 in FIG. 19 to the AND gate 431. Next the detecting device B_4 detects the cutting mark t_3 after the detecting device B_5 detected the cutting mark and gives the pulse signal P_{2j-1} as shown at d_1 in FIG. 19 to the AND gate 431 so that the latter gives the output signal as shown at d_1 in FIG. 19 to the cutting device A_4 . Therefore the cutting device A_4 is actuated so as to cut off the unrolled film 400. After the unrolled film 400 has been cut off, the cutting device A_4 gives the signal as shown at e_1 in FIG. 19 to the reset input terminal R of the flip-flop 430 so that the latter is driven into the reset state. When the detecting device B_5 detects a stain or scratch on the film 400, it gives an erroneous pulse P_j' to the flip-flop 430. Therefore the flip-flop 430 is set and gives the output signal as shown at C_1 in FIG. 19 to the AND gate 431. However, the output signal of the detecting device B_4 is not applied to the AND gate 431, the AND gate 431 will not give the output signal to the cutting device A_4 so that the latter is not actuated mistakingly. Thus the erratic film cutting operation is completely prevented.

When the detecting device B_5 detects the next film cutting mark to give the pulse P_{1j-1} , the flip-flop 430 has been already in the set state. When the detecting device detects the cutting mark to give the pulse signal P_{2j} to the AND gate 431, the latter gives the output signal such as shown at d_1 in FIG. 19 because the flip-flop 430 has been already set. Therefore after the unrolled film is stopped and held stationary the film cutting device A_4 is actuated so as to cut off the film. The above operations are cycled to consecutively cut off the unrolled film. When the detecting device B_4 detects a stain or scratch on the film 400 and gives a pulse signal, the flip-flop 430 has been already reset so that the cutting device A_4 is not actuated. Thus, the erratic film cutting operation may be prevented. However, when the detecting device B_4 detects a stain or scratch on the film and gives the erroneous signal immediately after the first detecting device B_5 has detected the stain or scratch, the cutting device A_4 is actuated so as to cut off the film erroneously. This erratic film cutting operation may be prevented by the control units shown in FIGS. 17 and 18, in which similar reference numerals are used to designate similar circuit components.

The control unit shown in FIG. 17 generally comprises the two detecting circuits B_4 and B_5 , a flip-flop 432, an AND gate 433, a timer 434 and the cutting device A_4 . In response to the set output signal of the flip-flop 432, the timer 434 is activated and then deactivated a time t_4 later, and the flip-flop 432 is reset in response to the trailing edge of the output pulse of the timer 434.

The mode of operation will be described with reference to FIG. 20. In response to the detection of a film cutting mark on the film 400 being transported by the feeding device, the detecting device B_5 gives the pulse signal (a_2 in FIG. 20) which drives the flip-flop 432 into the set state. The flip-flop 432 gives the signal as shown

at C_2 in FIG. 20 in response to which the timer 434 is actuated to give the pulse signal as shown at f_2 in FIG. 20 to the AND gate 433. After the time t_3 later, the detecting device B_4 detects the cutting mark and gives the pulse P_{2j-1} as shown at b_2 in FIG. 20 to the AND gate 433. Therefore the AND gate 433 gives the output signal as shown at d_2 in FIG. 20 to the cutting device A_4 so that the latter is actuated so as to cut off the unrolled film 400 after it is stopped and held stationary. The flip-flop 432 is driven into the reset state the time t_4 after the timer 434 has been activated.

When the film is transported again and the detecting device B_5 detects the noise to give the pulse P_j' shown at a_2 in FIG. 20, the flip-flop 432 is set and the timer 434 is activated. Since the timer 434 resets the flip-flop 430 the time t_4 after it has been set, the AND gates 433 gives no output signal even when the detecting device B_4 detects the noise and gives the pulse signal P_j'' shown at b_2 in FIG. 20. Therefore the cutting device A_4 is not actuated so that the erratic film cutting operation may be prevented. The timer 434 is so set that as to give the pulse signal for a time duration slightly longer than the time duration between the time when the first detecting device B_5 detects the correct cutting mark and the time when the second detecting device B_4 detects the same cutting mark.

The control unit shown in FIG. 18 generally comprises the detecting devices B_4 and B_5 , a flip-flop 435, a three-input AND gate 436, a timer 437 a NOT circuit and the cutting device A_4 . The timer 437 is activated in response to the signal from the cutting device A_4 representing the completion of film cutting operation and is deactivated a time t_5 later.

Upon detection of a cutting mark, the detecting device B_5 gives the pulse signal P_{1j} as shown at a_3 in FIG. 21 to the flip-flop 435 so that the latter is set and gives the output signal as shown at C_3 in FIG. 21 to the AND gate 436. When the detecting device B_4 detects the cutting mark and gives the pulse signal P_{2j-1} as shown at b_2 in FIG. 21, the AND gate 436 gives the output signal as shown at d_3 in FIG. 21 to the cutting device A_4 because the timer 437 is deactivated (See FIG. 21, f_3). Therefore the cutting device A_4 is actuated so as to cut off the unrolled film when it is stopped and held stationary. After having cut off the film, the cutting device A_4 gives the signal as shown at e_3 in FIG. 21 to the timer 437 to activate it. The timer 437 gives the output signal as shown at f_3 in FIG. 21 to the NOT circuit 438 which in turn gives the output signal as shown at g_3 in FIG. 21 to the flip-flop 435 so that the latter is driven into the reset state. As long as the timer 437 is activated, the NOT circuit 438 gives a low-level signal (See FIG. 21, g_3) to the AND gate 436 so that the latter will not give the output signal. Therefore the cutting device A_4 is not actuated even when the detecting devices B_4 and B_5 detect the noise such as a stain or scratch on the film and give the pulse signals P_j' and P_j'' so that the erratic cutting operation may be completely prevented.

Furthermore the control units shown in FIGS. 17 and 18 may be combined to provide a variation of a control unit in which the flip-flop 435 is set in response to the output signal of the timer 434 shown in FIG. 17. When the distance between the cutting marks on the film is constant, the detecting devices B_4 and B_5 may be spaced apart from each other by a distance equal to the spacing between the adjacent film cutting marks.

The mode of operation of the control unit in which the detecting devices B_6 and B_7 are spaced apart from each other by a distance $(l - \alpha')$ slightly shorter than the spacing l between the projected images of the adjacent cutting marks will not be described in this specification because it is apparent to those skilled in the art when the detecting devices B_4 and B_5 are replaced by the detecting devices B_6 and B_7 , respectively in the above explanation.

The difference α or α' between the spacing $(l \pm \alpha)$ between the detecting devices and the spacing l between the projected images of the adjacent cutting marks may be suitably selected, but it is preferable to select a small difference α or α' in order to attain the high degree of accuracy in detection.

So far the unrolled film has been described as a medium to be cut off by the automatic cutting device in accordance with the present invention, but it will be understood that any rolled transparent or opaque medium such as paper or the like may be cut off by the cutting device of the present invention. In case of a transparent medium such as film the cutting marks are preferably opaque and in case of an opaque medium such as paper it is preferable to mark the cutting marks by a pencil or ink or to perforate the medium. Furthermore more than two detecting devices may be used in a control unit.

As described hereinbefore in the third embodiment two detecting devices are used in such a manner that only when both of them give the signals simultaneously, the film cutting device is actuated. Therefore when the detecting devices detect the noise and generate the erroneous signals, the cutting device is not actuated so that the erratic film cutting operation may be prevented.

So far only the essential features of the present invention have been described in this specification, but it will be understood that various modifications and variations can be effected within the scope of the present invention.

We claim:

1. A film cutting device comprising:
at least two detecting means for detecting film cutting marks disposed on a film spaced apart by a predetermined distance, said two detecting means being arranged to be disposed such that when a mark or the projection thereof comes to be located near to one detecting means, the mark or the projection thereof adjacent to said mark or projection comes to be located near to the other detecting means spaced apart by the predetermined distance in the direction of feeding of the film;
a film cutting means for cutting film;
a control means for operating said cutting means when each of the detecting means generates their respective detecting signals;
a feeding means for feeding said film into said detecting means and said film cutting means.
2. A film cutting device in accordance with claim 1, wherein said detecting means are spaced apart by an equal distance to that of the spacing between the adjacent cutting marks or projections.
3. A film cutting device in accordance with claim 1, wherein said detecting means are spaced apart by a distance slightly longer than the spacing between the adjacent film cutting marks or projections thereof.

4. A film cutting device in accordance with claim 1, wherein said detecting means are spaced apart by a distance slightly shorter than the spacing between the adjacent cutting marks or projections thereof.

5. A film cutting device as set forth in claim 3 wherein said control means includes

a timer which is activated for a predetermined time in response to the output signal of one of said at least two detecting means, and said film control means is actuated so as to cut off said film in response to the output signal from the other detecting means while said timer is being activated.

6. A film cutting device as set forth in claim 3 wherein said film control means includes

a timer circuit which is activated for a predetermined time in response to the film cutting operation of said cutting means, and

a gate circuit for suppressing the output signals of said at least two detecting means when said timer circuit is being activated, whereby said film cutting means may be kept de-energized when said timer circuit is activated.

7. A film cutting device as set forth in claim 4 wherein said film control means includes

a timer which is activated for a predetermined time in response to the output signal of one of said at least two detecting means, and

said film control means is actuated so as to cut off said film in response to the output signal from the other detecting means while said timer is being activated.

8. A film cutting device as set forth in claim 4 wherein said film control means includes

a timer circuit which is activated for a predetermined time in response to the film cutting operation of said film cutting means, and

a gate circuit for suppressing the output signals of said at least two detecting means when said timer circuit is being activated, whereby said film cutting means may be kept de-energized when said timer circuit is activated.

9. Film cutting device in accordance with claim 3, wherein said control means further comprises:

a flip-flop connected to one of said detecting means; an AND gate for operating said cutting means when the other detecting means generates a detecting signal after said flip-flop receives a detecting signal.

10. A film cutting device in accordance with claim 4, wherein said control means further comprises:

a flip-flop connected to one of said detecting means; an AND gate for operating said cutting means when the other detecting means generates a detecting signal after said flip-flop receives a detecting signal.

11. A film cutting device in accordance with claim 3, wherein said control means further comprises:

a flip-flop connected to one of said detecting means; a circuit for generating predetermined timing signals when said flip-flop receives a detecting signal; an AND gate for operating a cutting means when the other detecting means generates a detecting signal during the period when a signal is being generated from said circuit.

12. A film cutting device in accordance with claim 4, wherein said control means further comprises:

a flip-flop connected to one of said detecting means; a circuit for generating a predetermined timing signal when said flip-flop receives a detecting signal;

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an AND gate for operating a cutting means when the other detecting means generates a detecting signal during the period when a signal is being generated from said circuit.

13. A film cutting device in accordance with claim 3, 5
wherein said control means further comprises:

a flip-flop connected to one of said detecting means,
a circuit for generating a predetermined timing signal
in response to the operation of said cutting means;
a gate circuit for intercepting the detecting signal 10
from each of the detecting means during the period
when the signal is being generated from said circuit.

14. A film cutting device in accordance with claim 4,
wherein said control means further comprises: 15

a flip-flop connected to one of said detecting means;
a circuit for generating a predetermined timing signal
in response to the operation of said cutting means;
a gate circuit for intercepting a detecting signal from
each of the detecting means during the period 20
when the signal is being generated from said circuit.

15. A sheet material cutting device comprising:

a cutting means for cutting sheet material;
at least two detecting means for detecting marks disposed
on a sheet material marked at predetermined spacing,
said detecting means being arranged spaced apart by a
slightly shorter distance than that of the spacing between
adjacent marks or the projections thereof in the direction
of feeding of said sheet material; 30

a signal receiving means to receive a detecting signal
of each detecting means for operating said cutting
means, said receiving means comprising a signal
output circuit for generating a predetermined timing
signal when one of the detecting means generates a
detecting signal, and said receiving means operating
said cutting means when the other detecting means
generates a detecting signal while the signal is being
generated from said circuit; and 40
a feeding means for feeding said sheet material to
said detecting means and cutting means.

16. A sheet material cutting device comprising:

a cutting means for cutting sheet material;
at least two detecting means for detecting marks on
the sheet material disposed at predetermined spacing,
said detecting means being arranged spaced apart by a
slightly longer distance than that of the spacing
between adjacent marks or the projections thereof in
the direction of feeding of said sheet material; 50

a signal receiving means to receive a detecting signal

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of each detecting means for operating said cutting
means, said receiving means comprising a signal
output circuit for generating a predetermined timing
signal when one of the detecting means is generating
a detecting signal, and said receiving means operating
said cutting means when the other detecting means
generates a detecting signal while the signal is being
generated from said circuit; and
a feeding means for feeding said sheet material to
said detecting means and cutting means.

17. A sheet material cutting device comprising:

a cutting means for cutting sheet material,
at least two detecting means for detecting marks on
the sheet material disposed at predetermined spacing,
said detecting means being arranged spaced apart by a
slightly shorter distance than that of the spacing
between adjacent marks or the projections thereof in
the direction of feeding said sheet material;

a signal receiving means to receive a detecting signal
of each detecting means for operating said cutting
means, said receiving means comprising a signal
output circuit for generating a predetermined timing
signal in response to the operation of said cutting
means, and a gate circuit for intercepting detecting
signals from each detecting means while the output
signal is being generated from said circuit; and

a feeding means for feeding said sheet material to
said detecting means and cutting means.

18. A sheet material cutting device comprising:

a cutting means for cutting sheet material;
at least two detecting means for detecting marks on
the sheet material marked at predetermined spacing,
said detecting means being arranged spaced apart by a
slightly longer distance than that of the spacing
between adjacent marks or the projections thereof in
the direction of feeding said sheet material;

a signal receiving means to receive a detecting signal
of each detecting means for operating said cutting
means, said receiving means further comprising a
signal output circuit for generating a predetermined
timing signal in response to the operation of
said cutting means, and a gate circuit for intercepting
the detecting signals from each detecting means
while the output signal is being generated from said
circuit; and

a feeding means for feeding said sheet material to
said detecting and cutting means.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,868,877 Dated March 4, 1975

Inventor(s) AKIRA SHOJI, ET AL.

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

- Column 3, line 45, "3₁" should read --B₁--;
- Column 4, line 51, "clock" should read --block--;
- Column 4, line 52, "drvice" should read --device--;
- Column 5, line 11, "of which" should read --to which--;
- Column 6, line 56, "erraneous" should read --erroneous--;
- Column 7, line 30, "erraneous" should read --erroneous--;
- Column 7, line 44, "driving gear 221" should read --driving shaft 221--;
- Column 9, line 37, "is" should read --are--;
- Column 9, line 67, "latral" should read --lateral--;
- Column 11, line 29, "actuated mistakingly" should read --mistakingly actuated--;
- Column 12, line 16, "gates" should read --gate--;
- Column 12, line 22, "is so set that" should read --is so set as--;

Signed and sealed this 15th day of July 1975.

(SEAL)

Attest:

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Attesting Officer

C. MARSHALL DANN
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