United States Patent

[11] 3,599,521

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[54] **AUTOMATIC FILM CUTTER**
7 Claims, 6 Drawing Figs.

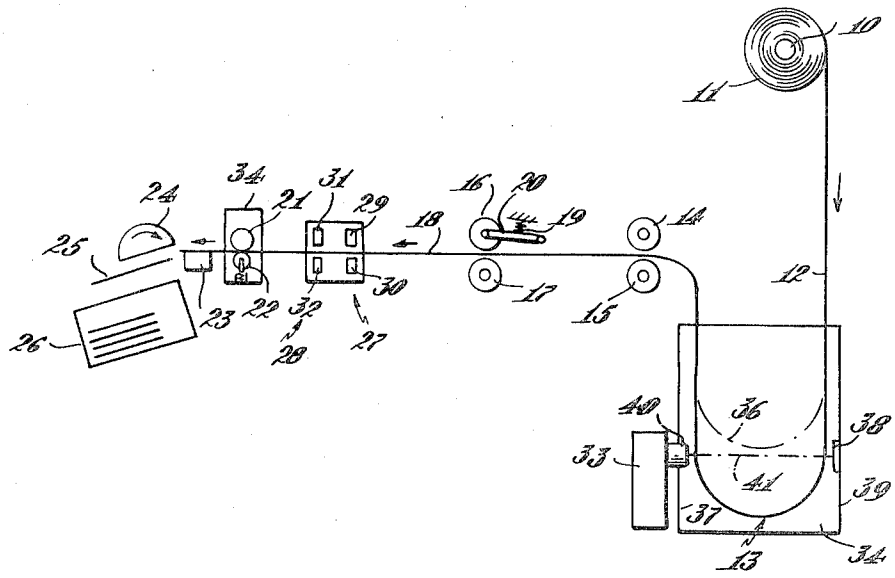
[52] **U.S. Cl.** **83/210,**
83/236, 83/251, 83/362, 83/364
[51] **Int. Cl.** **B26d 5/32,**
B26d 5/34
[50] **Field of Search** 83/210,
209, 236, 251, 283, 362, 364, 365, 367

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Primary Examiner—Frank T. Yost
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ABSTRACT: An apparatus for automatically and accurately cutting frames from a film strip, which apparatus uses a control system which advances the film strip to a cutter, at a high speed, changes the film strip advancement to a lower speed after the strip reaches a first predetermined position relative to the cutter, and brakes the film strip when it reaches a second predetermined position, at which latter position the cut is made. This operation is performed cyclically as the film advances so that a plurality of accurately cut frames results. Means are further provided for supplying the film strip material without longitudinal tension to avoid damage thereto.



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SHEET 1 OF 3

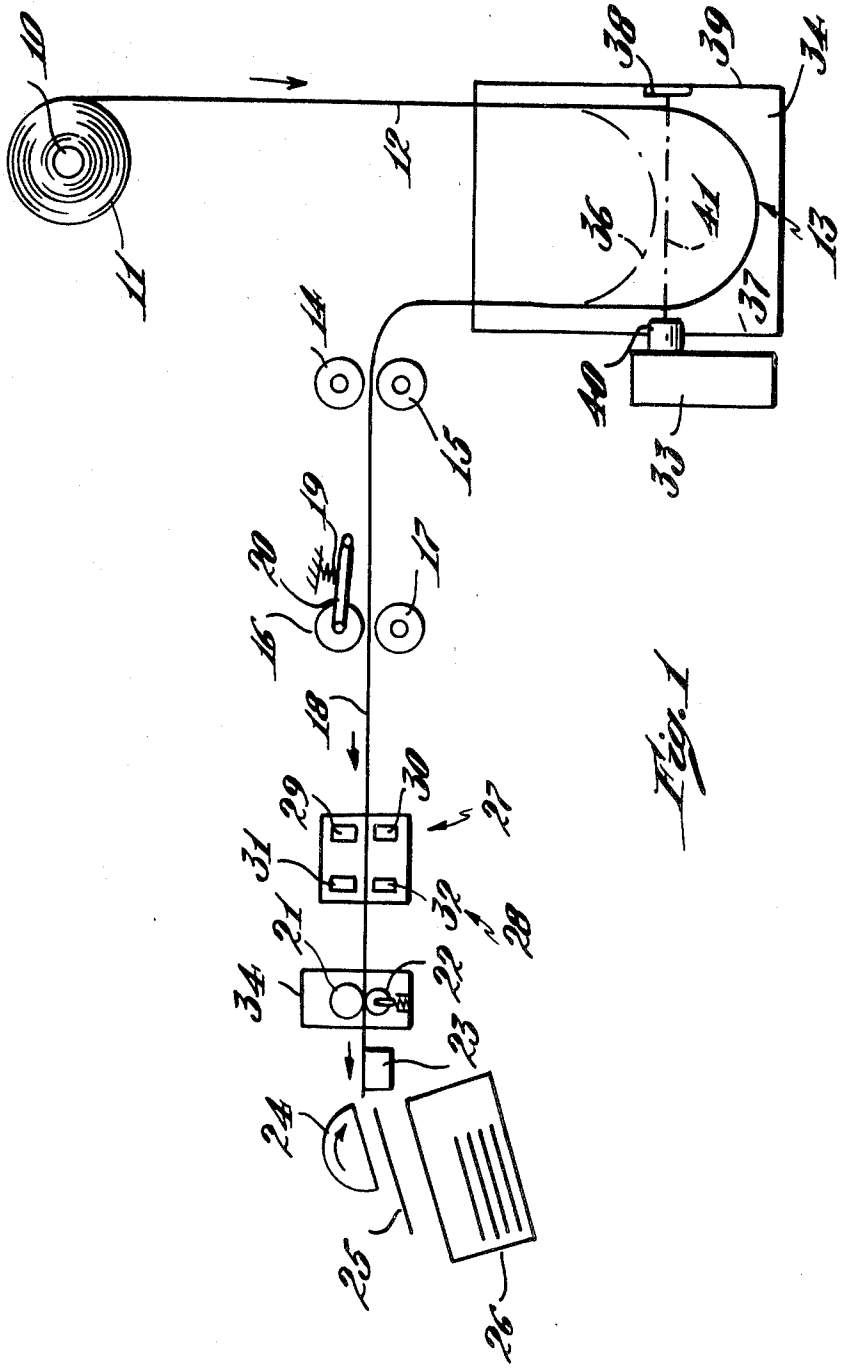


Fig. 1

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Attys

Fig. 2

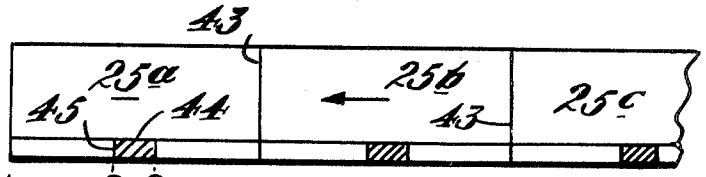


Fig. 2a

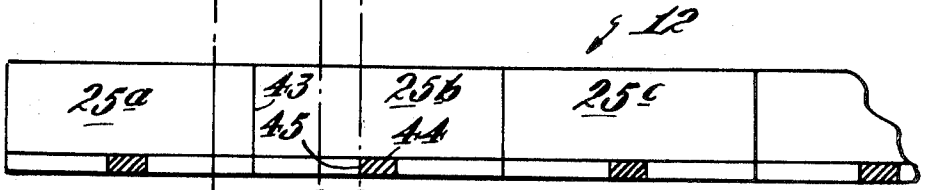


Fig. 2b

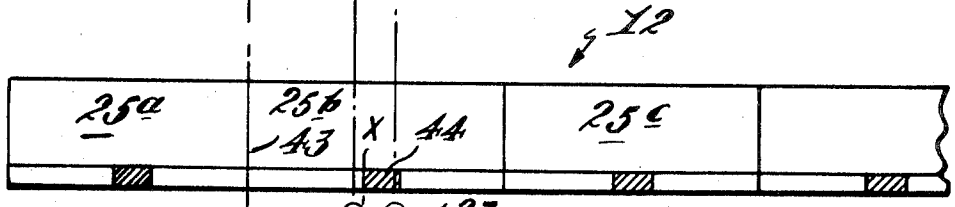
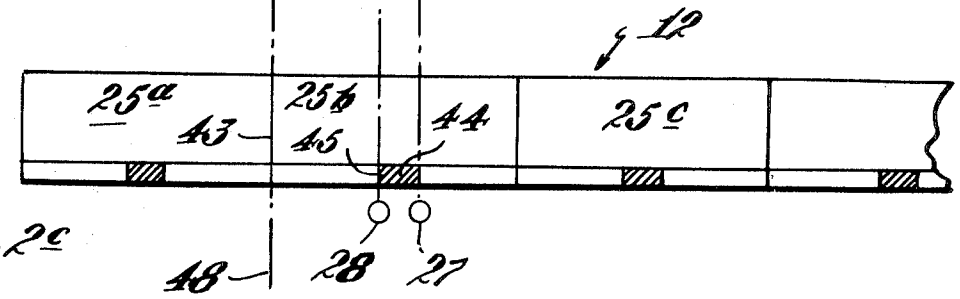


Fig. 2c



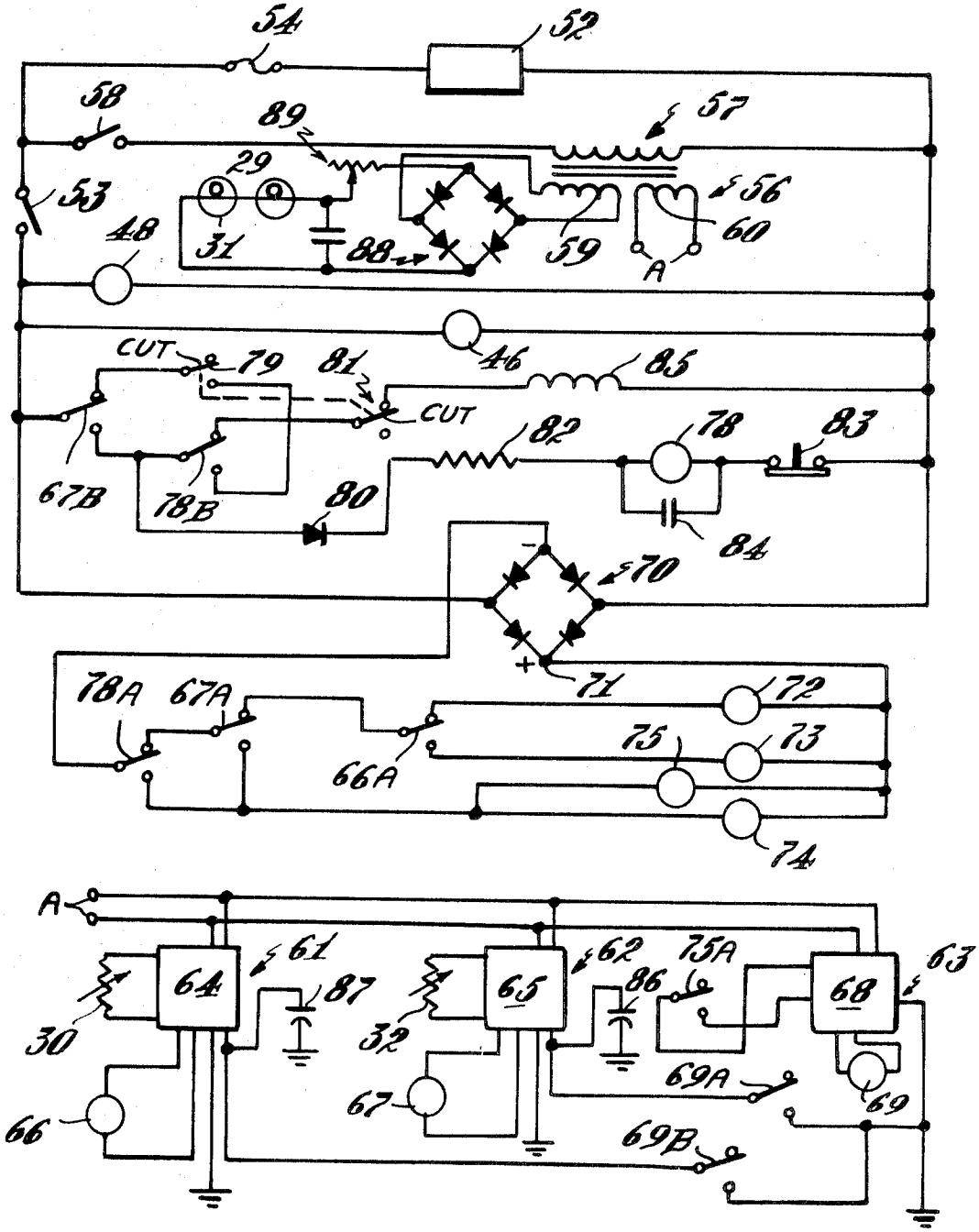

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Fig. 3

AUTOMATIC FILM CUTTER

This invention relates generally to machinery for cutting strips of material, such as film strips, and, more particularly, to automatic machinery of this type for providing extreme accuracy in the cutting process and for preventing erroneous cuts from being made as well as for providing protection against damage to the surface of the material during the operation of the machine.

In cutting strips of material, such as cutting individual frames from a roll of film strip, it is necessary that machines used for this purpose be capable of exceptional accuracy in locating the line along which a cut is to be made. Moreover, it is desirable that such location and cutting operation be performed automatically at a relatively high speed so that the greatest efficiency of operation can be achieved.

A particular machine for performing such operation has been described in my previously filed application, Ser. No. 597,920 filed on Nov. 30, 1968 now U.S. Pat. No. 3,469,482, , in which sensing means, responsive to appropriate indicia on a film strip, control an electrical circuit which operates a feeding means and a cutting means so that each cut can be made at the correct position between individual prints, or frames, on the strip. On such prior art machine, described in more detail in my previously filed application, an electrically operable combination clutch and brake assembly is arranged to drive the feed rolls and to bring the film strip to a stop at an appropriately desired location in response to the operation of a sensing device which is, in turn, responsive to a predetermined mark or indicia on the edge of the film strip. When the film strip has been appropriately braked to a stop, actuation of a 1-revolution clutch occurs, such actuation thereby causing a rotary cutter to cut the film while the film is held at a stopped state. The placement of the sensing means, which may be suitable photocell and lamp combination, is adjustable so that the cutting action takes place at any desired location.

It has been found, however, that operation of such a device as previously described has certain disadvantages. For example, it is difficult to control the operation of the high-speed motor which is driving the film strip through the machine so as to cause it always to come to an abrupt stop at the correct position for cutting. The mechanical and electrical inertias involved in the mechanical elements of the apparatus as well as in its electrical circuitry are not so easily controlled so as to bring a fast-moving film strip to a complete stop at the proper point each time. Hence, the accuracy of the cut cannot be assured and, thus, the cut may not be exactly on the desired line midway between the frames. This invention provides an improvement in such a device which improvement produces greater accuracy in cutting, while at the same time prevents undue damage or scratching of the film surface.

In overcoming the deficiencies of the previous machine, this invention provides for the use of at least two sensing means, a first one of which is actuated by appropriate indicia on or near the edge of the film strip so as to decouple the drive shaft from the main high-speed drive motor and subsequently to couple such shaft to an auxiliary slow-speed drive motor. The film strip then advances at a relatively slower speed until the indicia moves into a position to be sensed by a second sensing means. Activation of the second sensing means causes the drive shaft to be decoupled from the slow speed drive motor and simultaneously applies an electric brake to stop the shaft and, hence, to stop the film strip. When the strip is stopped, the cutter means, which may be, for example, of the type mentioned above and described in my previous application, is actuated. Upon completion of the cut, the brake is removed and the high speed motor is again coupled to the drive shaft to resume the high-speed film advance. The use of an intermediate "slowdown" stage of operation allows the film strip to be stopped in a much more accurate manner so that appropriate cuts exactly midway between frames can be made in a repeatable fashion as desired.

Another disadvantage found in previous machines of this type is that the surfaces of the film are sometimes found to be scratched or otherwise damaged during operation thereof. Such damage is primarily due to the fact that the drive means causes the film strip to be unwound from its storage spindle under tension. Since such tension cannot be maintained at a constant value over the time period of operation of the machine, a certain amount of intermittent increase and decrease of such tension occurs. Such operation causes the film to move in a substantially oscillatory manner on its spindle so that surfaces of the film, which is wound in a coil on such spindle, tend to rub against each other and cause slight imperfections to arise.

In this invention, such disadvantages are substantially eliminated by providing a means for driving the spindle so that the film is unwound to form a relatively loose loop before being driven forward by the main drive means. The loose film loop extends generally downwardly into a well and, as described in more detail below, a third sensing element is utilized to maintain the depth of such loop at an appropriate level so that no tension is exerted upon the film supply as it is withdrawn from the supply spindle.

A particular embodiment of the strip is described in more detail with the help of the accompanying drawing in which:

FIG. 1 shows a diagrammatic view of the elements of the machine;

FIG. 2, 2A, 2B, and 2C show a film strip in various stages of its advancement during the operation of the device; and

FIG. 3 shows a diagram of the control circuit utilized in the operation of the device.

The structure of the invention has a general basic similarity to that shown and described in my above-referred and previously filed application in that it uses a cutting means, guiding means, and general spindle and drive shaft means as described therein. Consequently, many of the details discussed and described in such previous application will not be repeated here and reference is made thereto for such purpose.

The diagrammatic view of FIG. 1 shows a spindle **10** on which is wound a coil **11** of material, such as a roll of film, for example, which spindle thereby is adapted to supply such material in the form of a strip **12** for processing. A suitable drive motor (not shown) is utilized to drive spindle **10** so as to cause such strip to be withdrawn from the spindle in a generally downward direction as shown. The film strip is thereby caused to form a loop **13** which extends downwardly from the supply spindle and thence upwardly to a position between an upper flanged guide roller **14** and a lower idler roller **15**.

The film strip then passes through a second roller combination in the form of an upper flanged guide roller **16** and a low idler roller **17**, upper roller **16** being appropriately spring loaded to bear against the upper surface **18** of film strip **12** by the combination of spring **19** and rocker arm **20**. Film strip **12** is subsequently passed between an upper drive roller **21** and lower idler roller **22**, lower roller **22** being appropriately spring loaded to provide a pressure nip between rollers **21** and **22** so as to drive film strip **12** in the forward direction as shown by the arrows. Film strip **12** thereby travels to a location at the cutter which, for example, comprises a combination of a fixed cutter blade **23** and a rotary butting blade **24** in much the same manner as shown with reference to my previously filed application. Rotation of rotary cutting blade **24** provides an extremely good transverse cut of the film so that a frame **25** that has been cut away from the main film strip portion can then drop into an appropriate receiving hopper **26** as shown.

Appropriate high speed and low speed motors, brake, and clutch mechanisms (not shown in detail in FIG. 1 and shown diagrammatically in FIG. 3) are appropriately mounted adjacent the drive rollers in a suitable housing **34**. The structure and mounting of such mechanisms are deemed to be well within the skill of those in the art and, consequently, they are not shown in further detail.

Mounted between guide rollers **16** and **17**, and drive rollers **21** and **22**, are a pair of sensing elements **27** and **28**. Each of said sensing elements includes an upper lamp for directing light downwardly toward a lower photocell device. For example, sensing element **27** includes a lamp **29** and a photocell **30** while sensing element **28** includes a lamp **31** and a photocell **32**. Such photocell devices are of conventional type which produce a change in electrical resistance with a change in light impinging on a light-sensitive element thereof. Sensing element **27** is hereafter sometimes referred to as the "low speed scanner" sensing element while sensing element **28** is sometimes hereinafter referred to as the "stop scanner" sensing element.

A third optical sensing element **33** is shown mounted on one side of a recess or well **34** located below film supply spindle **10**. For example, an appropriate combination of a lamp and a photocell is mounted at an inner wall **37** of well **34** and an appropriate reflector in the form, for example, of a beaded reflecting tape **38** is mounted at the opposite inner wall **39** of well **34** in line with the lamp and photocell combination aperture **40**. Thus, light from the lamp is reflected from reflector **38** and the reflected energy therefrom is picked up by the photocell via aperture **40**. When the film loop **13** is below a line **41** between the photocell aperture and the reflector, the photocell has a particular resistance value. If film loop **13** is raised to a point where all of the film is located completely above line **41**, as shown by dot-dash loop line **36**, the resistance of the photocell changes to a new value and causes the film supply drive motor to be actuated so as to increase the size of the loop, as described in more detail below.

The general operation of the device can be described more easily with the help of FIGS. **1**, **2**, **2A**, **2B** and **2C**. The film strip **12** is shown as comprising a plurality of frames **25***a*, **25***b*, **25***c*, etc. which are to be cut from the main film strip along cut lines **43** as shown. Substantially midway between the cut lines at the beginning and end of each frame is an appropriate indicia, or cut mark, which is shown in FIG. 2 as a substantially rectangular darkened region **44** having a sharp leading edge **45**. As the film advances at high speed to a position as shown in FIG. **2A** due to the actuation of drive rollers **21** and **22** by a high speed motor, a cut mark **44** nears the sensing elements **27** and **28**, the slowdown scanning element **27** being first encountered by a particular cut mark, as shown in FIG. **2A**. As leading edge **45** of cut mark **44** starts to pass by sensing element **27**, the photocell **30** thereof senses the change in the light being transmitted thereto from its associated lamp **29** and, consequently, senses the position of the leading edge **45** of cut mark **44**. As described in more detail later with reference to FIG. **3**, sensing element **27**, thereby causes the high-speed drive motor to be decoupled from the drive shaft of drive roller **21** and the film strip tends to coast, through the distance **46**, as shown in FIG. **2B**, without a positive drive means coupled to the drive shaft, until such drive shaft is appropriately coupled to a slow-speed motor when the film strip reaches the position shown in FIG. **2B**. Coupling occurs, for example, when the film has advanced so that the cut mark is at some point X between sensing element **27** and sensing element **28**. When the slow-speed motor is appropriately coupled to the drive shaft of drive roller **21**, the film is caused to travel forward through a distance **47** at a much slower rate than it had been traveling under the operation of the high-speed motor. As the cut mark **44** reaches stop scanner sensing element **28**, at the position shown in FIG. **2C**, the photocell **32** of such element senses the change in light transmission from its associated lamp **31** and thereby appropriately senses the leading edge **45** of cut mark **44** in a manner similar to that discussed with reference to sensing element **27**.

In a manner described in more detail below with reference to FIG. **3**, the actuation of sensing element **28** thereby causes the slow-speed motor to be decoupled from the drive shaft of drive roller **21** and simultaneously causes a brake to be applied to such drive shaft. The film advance is thereby immediately stopped at a position such that cut line **43** is located directly along the cut line **48** of cutting blades **23** and **24**. Such cutting blades are then appropriately actuated to cut the film strip transversely along cut line **43** and thereby to remove frame **25***a* from the main film strip. The use of an intermediate slowdown stage where the advancement of the film strip passes from a high-speed to a relatively low speed drive allows the film strip to be stopped more accurately at the cut line and the cutting operation becomes repeatably accurate to a much greater degree than was possible in previously used devices.

As can be seen from the diagrammatic view of FIG. **1**, the film strip can be withdrawn from its supply spindle without tension because of the loop formed at the initial portion of the film strip travel. As soon as the loop becomes smaller, that is, the bottom of the loop is raised to a position above line **41**, actuation of sensing element **33** causes a spindle drive motor to drive a shaft attached to film supply spindle **10** so as to provide a positive drive for the film roll in the direction of its associated arrow so as to increase the size of the loop and bring it below line **41**.

In some applications it may be desirable to sue an indicia other than the darkened cut mark region shown in FIGS. **2**—**2C**. For example, where it is desired to cut individual sheets from a roll of unexposed, unprocessed film it is necessary to avoid using visible light sources and to utilize energy sources in a different portion of the frequency spectrum, such as infrared energy sources. In such circumstances, the cut mark regions described above can be replaced with a hole, or notch, appropriately punched along the edge of the film. The circuitry is then arranged so that, when infrared energy senses the presence of the notch and is thereupon passed through the notch to the infrared photocell scanning element, the film is appropriately changed from its high speed to its low speed of travel at the first sensing element and, thence, is brought to a stop at the second sensing element in a manner substantially similar to that discussed above. Although the notched film may be prepared ahead of time, an appropriate device for punching a notch in the film strip may be incorporated directly into the apparatus of the invention so that successive notches may be punched while the film is being conveyed through the apparatus. Thus, if the punching device is located, for example, a single frame length away from the stop scanner sensing element, the apparatus can be arranged to energize the notch punching device simultaneously with the energization of the cutting blades, In addition an infrared energy source and photocell arrangement can also be used in sensing element **33** which controls the supply of film from supply spindle **10**.

Operation of the electrical circuitry in combination with the sensing control elements of the device can be described most easily with reference to FIG. **3** which shows an overall circuit diagram for use therewith.

In FIG. **3** a conventional 110-volt, 60-cycle AC power supply **52** is utilized as the main power source for the operation of the device. A first high-speed motor **46** and a low speed motor **48** are connected to the power supply via switch **53**, the overall input power being supplied to the device through an appropriate fuse **54**. A pair of low voltage AC sources **55** and **56** are obtained via the operation of transformer **57**, the primary of which is connected to the input power source through switch **58**. A first secondary winding **59** of transformer **57** supplies a low AC voltage of approximately 6 volts, for example, the input terminals of a conventional bridge rectifier circuit **88** which provides a DC output voltage via resistor-capacitor circuit **89** to operate the excitation lamps **29** and **31** of sensing elements **27** and **28**, respectively. The resistor may be a variable one, as shown, so that the lamp excitation current can be appropriately adjusted as desired. A second winding **60** of transformer **57** supplies approximately 15 volts, for example, to operate photocell and amplifier circuitry **61**, **62** and **63**, respectively, as shown by corresponding terminals A–A.

Circuitry **61** includes photocell (shown as a variable resistance **30**) and an amplifier **64**, the amplifying characteristics of which are controlled by the resistance value of

photocell 30, the output of such amplifier thereby being caused to excite a first relay coil 66. Circuitry 62, comprising photocell 32 and amplifier 65, similarly is caused to excite a relay coil 67. Circuitry 63, including amplifier 68 and relay contacts 75A, is utilized to excite a third relay coil 69 and, hence, to actuate the latter 's associated relay contacts 69A and 69B, as described in more detail below.

A full wave rectifier 70, connected to input power source 52 through switch 53, has its positive output terminal 71 connected to one side of a pair of clutches 72 and 73, an electric brake 74 and a relay coil 75, as shown in FIG. 3, while its negative output terminal 76 is connected to the center contact of relay switching contacts 78A associated with a relay coil 78. The normally closed relay contact thereof is connected to the center contact of relay contacts 67A associated with relay coil 67 of circuitry 62 and the normally open contact is connected to the other side of brake 74, to the normally open contact 67A, and to relay coil 75, as shown. The normally closed contact of relay contacts 67A is connected to the center contact of relay contacts 66A associated with relay coil 66 of circuitry 61, while the normally closed and normally open contacts of 66A are connected to clutches 72 and 73, respectively.

The center contact of a second set of relay contacts 67B associated with relay coil 67 is connected to one side of AC power supply source 52. The normally closed contact thereof is connected to the center contact of a single-pole, double-throw switch 79 and the normally open contact of 67B is connected to the center contact of a second set of relay contacts 78B of relay 78 and a solid state rectifier 80. The normally open contact of switch 79 is connected to the normally open contact of 78B, while the normally closed contact of the latter is connected to the center of another single-pole, double-throw switch 81 the operation of which is ganged to that of switch 79. Rectifier 80 is connected through a resistor 82 to relay coil 78, the other side of relay coil 78 in turn being connected to a manual, pushbutton switch 83 as shown. A capacitor 84 is connected directly across relay coil 78.

The normally open contact of ganged switch 81 is connected to a "cut" solenoid coil 85 which is used to actuate a 1 -revolution clutch-drive mechanism of the type described in my above-mentioned previously filed application, which mechanism in turn actuates the rotary cutting blade when such solenoid coil is energized.

Having, thus, described the configuration of circuit diagram of FIG. 3, the operation of the device now can be discussed in more detail. The operator of the device actuates control switch 58 which thereby energizes transformer 57 for supplying excitation voltage to lamps 29 and 31 and for supplying power to amplifier modules 61, 62 and 63 and thence to photocells 30 and 32. The operator then actuates motor switch 53 which turns on both high-speed drive motor 46 and low speed drive motor 48. At this point, clutch 72 is energized by the output from full wave rectifier 70 through sets of relay contacts 78A, 67A, and 66A, which are in their normally closed positions shown in the figure. Actuation of clutch 72 connects motor 46 to the shaft of drive roller 21 and, thus, high-speed advancement of the film strip occurs.

The operator then sets the ganged cut switches 79 and 81 to the "cut" position as indicated in FIG. 3. At this stage the film is advancing at a high rate of speed which in a preferred embodiment may be in the order of magnitude of 20 inches per second. When the cut mark 44 on the film strip edge reaches the low speed scanner element 27, the cut mark is interposed between the photocell 30 and lamp 29 so that the light intensity on and, consequently, the resistance of photocell 30 changes and an appropriate output signal from amplifier circuitry 61 (the output of which was formerly zero or, at least, below the threshold level required to energize relay coil 66) is produced so as to energize relay coil 66, Relay coil 66 is arranged to remain energized for a time period determined by the timed operation of amplifier module circuitry 61, as explained further below. Energization of relay coil 66 causes actuation of relay contacts 66A so as to remove energizing voltage from clutch 72 and apply such energizing voltage to clutch 73.

Deenergization of clutch 72 causes the film strip to coast for a short period of time without any drive means attached to drive roller 21. The energization of clutch 73 is arranged to occur a short time later (due to the mechanical inertial of the elements involved) and thereby provides such "coasting" period, after which the drive shaft of driving roll 21 is connected to low speed motor 48 so that the film strip continues to be advanced from that point on at a lower rate of speed which, in a preferred embodiment, may be in the order of magnitude of one-half inch per second. As described below, amplifier module circuitry 61 is timed so as to remain in operation long enough to allow the cut mark 44 to reach the stop sensing element 28 but not long enough to allow the film strip to be advanced by slow-speed motor 48 after a cut has been made. So long as circuitry 61 is in operation and relay 66 is actuated the "cut" solenoid 85 can be actuated.

When the cut mark 44 on the film strip edge reaches the stop scanner element 28, the cut mark is interposed between the photocell 32 and lamp 31 so that the light intensity on photocell 32, and hence, its resistance changes and an appropriate output signal from amplifier circuit 62 (the output of which was formerly zero or, at least, below the threshold level required to energize relay coil 67) is produced so as to energized relay coil 67. Relay coil 67 is arranged to remain energized for a time period determined by the timed operation of amplifier module circuitry 62, as explained further below.

Energization of relay coil 67 causes actuation of relay contacts 67A and 67B. Actuation of relay contacts 67A removes energizing voltage from clutch 73 and energizes brake 74, thus, stopping the travel of film strip 12 in a positive manner. Since the film strip at that point is traveling at a relatively slow speed, application of brake 74 brings the strip to an immediate stop when the leading edge of cut mark 44 intercepts the path between photocell 32 and lamp 31. Thus, cut line 43 is stopped accurately at its desired position relative to cutting blades 23 and 24.

Actuation of relay contacts 67B thereby applies AC power from power source 52 to cut solenoid 85 via contacts 78B and switch 81, thus, releasing a 1-revolution drive clutch (not shown) to power the rotary knife blade in a manner such as is described in adequate detail in my above-referenced, previously filed application. Actuation of the relay contacts 67B simultaneously provides a DC voltage from rectifier 80 to the circuit comprising resistor 82 and capacitor 84 which circuit controls the energization of relay coil 78. When capacitor 84 is sufficiently charged, relay coil 78 is energized so that its relay contacts 78B are actuated to remove power from the cut solenoid coil 85. The resistor and capacitor values are selected so as to control the length of time that the cut solenoid is energized in order to provide for one, and only one, activation of rotary cutting blade 24.

As described below, amplifier module circuitry 62 is timed to remain in operation only long enough to allow the cutting blades to make their cut and to have the rotary cutting blades return to its normal position so as not to interfere with film advance for the next cycle of operation.

The timing of the operation of amplifier circuit modules 61 and 62 is accomplished by the operation of amplifier modu 63. Relay contacts 69A are arranged, when actuated, to provide a ground disabling connection to amplifier 65 and relay contacts 69B are arranged, when actuated, to provide a ground disabling connection to amplifier 64. Consequently, when actuation of relay contacts 67A occurs (at the time cut mark 44 reaches the stop scanning element), relay coil 75 is energized and relay contacts 75A are actuated so as to activate amplifier module circuitry 63 so as to produce an output excitation voltage for relay coil 69. The operating time of circuit module 68 is set to maintain energization of relay coil 69 and, hence, actuation of relay contacts 69A and 69B for a preselected time interval so that amplifier modules 61 and 62 are appropriately "timed out" (i.e., they are made inactive) after a cut has been made.

When amplifier circuitry **62** is, thus, made inactive, relay coil **67** is deenergized, thereby releasing brake **74** and reenergizing clutch **72**, provided amplifier circuitry **61** is also inactive. The film then recommences to advance at high speed to begin the next feed-and-cut cycle. Release of relay **67** also releases relay **75** which thereby prevents operation of amplifier circuitry **63** which then deenergizes relay coil **69** and, hence, causes relay contacts **69A** and **69B** to return to their normally open positions so that amplifiers **61** and **62** can resume their normal operation for the next cycle. So long as relay coil **69** is energized it is impossible to obtain an output voltage at relays **66** and **67** from amplifier circuit modules **61** and **62**. This arrangement, thus, provides for an adjustably controlled "blanking" feature, the time in which amplifier module circuitry **63** is excited being adjusted to suit the intervals between cut marks **44**. Capacitors **86** and **87** are used to filter out any false blanking signals such as may be caused by line transients, for example.

Thus, the invention provides for automatically feeding the strip material and successively actuating the high-speed motor **46**, the low speed motor **48**, and the brake **74** in a cyclic fashion whereby the strip changes its speed of travel from high speed to low speed when it reaches a first predetermined position along the path of travel and, then, stops when it reaches a second predetermined position.

What I claim is:

1. A machine for cutting strip material comprising

cutting means;

means for supplying a continuous strip of said material for movement along a predetermined path of travel toward said cutting means;

first means for moving said strip material at a first speed along said path of travel;

second means for moving said strip material at a second speed along said path of travel, said second speed being slower than said first speed;

braking means for stopping the movement of said strip material;

control means for successively actuating said first moving means said second moving means, and said braking means in a cyclic fashion, whereby said strip material is successively and cyclically caused to move along said path at said first speed, to change its speed of travel to said second speed when selected portions of said strip material reach a first predetermined position along said path of travel; and

means for actuating said cutting means to cut said strip material each time said strip material is stopped.

2. A machine for cutting strip material in accordance with claim **1** wherein said supplying means includes means for supplying said strip material without longitudinal tension.

3. A machine for cutting strip material in accordance with claim **1** wherein said control means includes

first sensing means responsive to a change in the characteristics of said strip material for producing a first control signal;

means responsive to said first control signal for disabling said first moving means and for actuating said second moving means;

second sensing means responsive to said change in the characteristics of said strip material for producing a second control signal;

means responsive to said second control signal for disabling said second moving means and for actuating said braking means.

4. A machine for cutting strip material in accordance with claim **3** and further including

means for delaying the actuation of said second moving means for a preselected time period after the disabling of said first moving means.

5. A machine for cutting strip material in accordance with claim **3** and further comprising means responsive to said second control signal for actuating said cutting means when said strip material is stopped.

6. A machine for cutting strip material in accordance with claim **3** wherein said first and said second sensing means each includes

a light source for directing energy toward a portion of said strip material from one side thereof;

photoelectric means responsive to a change in the energy transmission characteristics of said portion of said strip material to produce an electrical signal; and

circuit means for producing a control signal in response to said electrical signal.

7. A machine for cutting strip material in accordance with claim **6**, wherein said energy is visible light energy.