

[54] **FILM INSPECTION APPARATUS**

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[22] Filed: **Mar. 20, 1972**

[21] Appl. No.: **236,368**

[52] U.S. Cl. **340/260, 73/157, 200/61.13**

[51] Int. Cl. **G08b 21/00**

[58] Field of Search **340/260, 259; 73/157**

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Primary Examiner—David L. Trafton

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[57] **ABSTRACT**

A film inspection apparatus is provided for detecting partial transverse breaks extending inwardly from an edge of the film, wherein the film is moved at extremely high speed over the periphery of a roller with an edge thereof overhanging the side of the roller to form a stiff arcuate portion which will withstand considerable outwardly directed radial force without substantial bending. A feeler element is biased into engagement with the concave side of said arcuate portion and moves radially outward when a generally transverse break in said edge is encountered. This radially outward movement of the feeler element de-

flects a cantilever beam piezoelectric element to produce a corresponding electrical signal.

Film splices are also detected and counted while eliminating low amplitude or short duration pulses which may be due to dirt or other contaminants on the film. Splices longer than a predetermined amount are also detected and the film stopped, while facilities are provided for preventing the machine from being stopped in response to a series of closely spaced good splices which individually have a length less than said predetermined amount. Compensation is also provided for changes in film speed as the film is brought up to full speed so that relatively short good splices are not falsely interpreted as longer bad splices and the machine stopped.

Elongated sprocket holes are detected by engagement of a feeler element with a straight line portion of the film so that vibration of the feeler element due to chord effect is eliminated and vibration is not transmitted to the edge break feeler elements. The response characteristic of the elongated sprocket hole feeler element is compensated by mechanical damping and by variation in the gain characteristic of the associated amplifier channel so that splices are not falsely interpreted as elongated sprocket holes.

The splice detection channels, the elongated sprocket hole detection channel, and both edge break detector channels employ piezoelectric transducer elements, the signals from which are amplified without appreciable differentiation and transformed to low impedance levels prior to processing so that the desired movements of the respective feeler elements may be detected while the film is traveling at an extremely high rate of speed in the order of 1,600 feet per minute.

19 Claims, 15 Drawing Figures

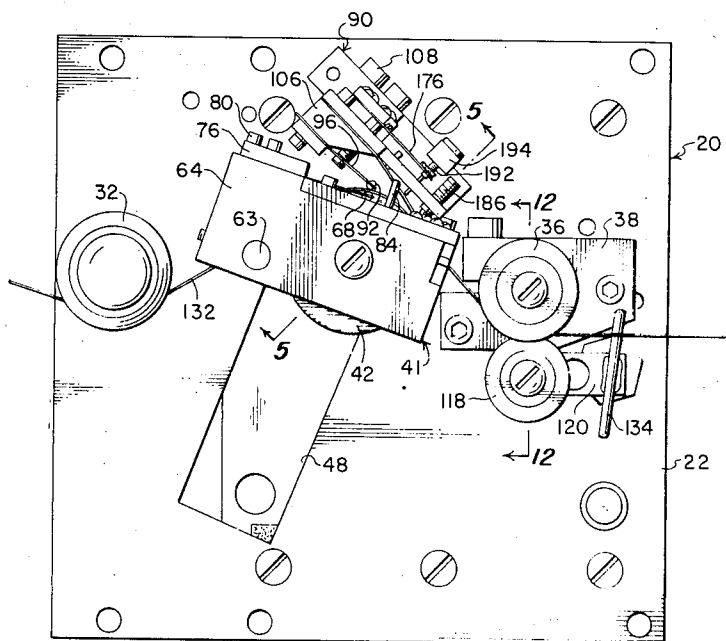


FIG. 1

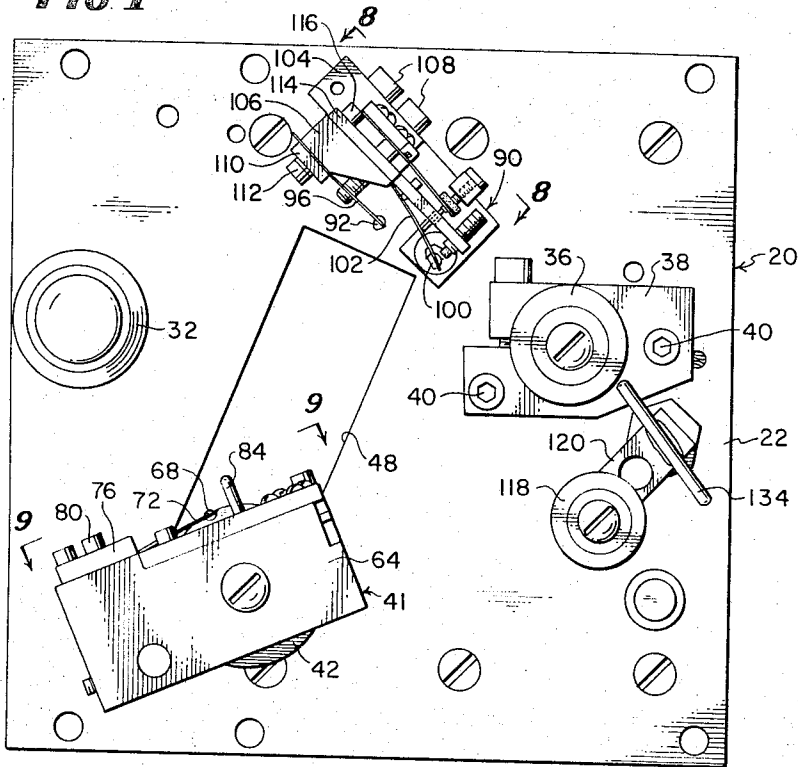
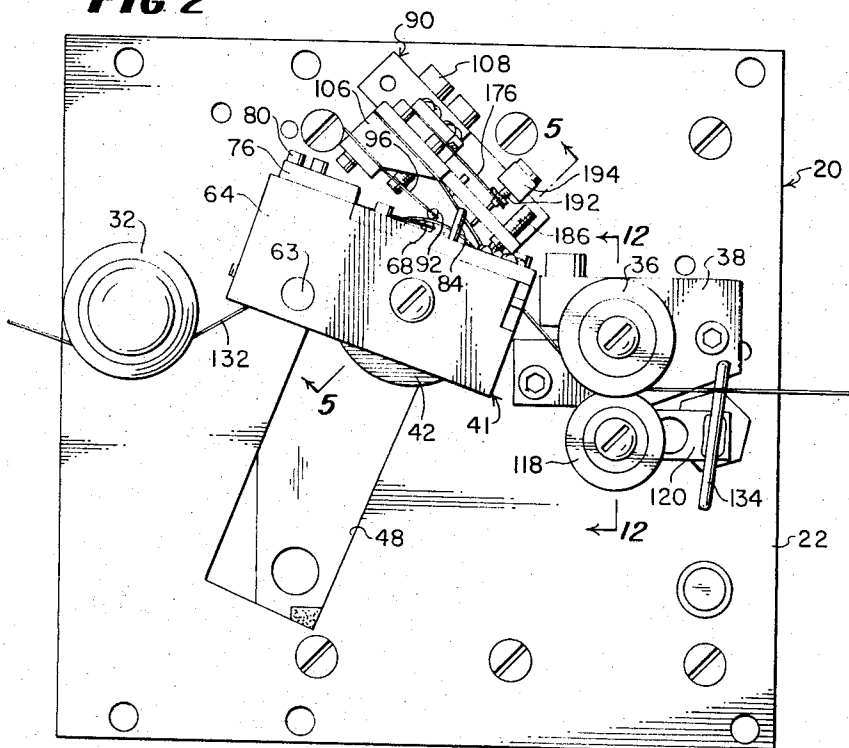
**FIG 2**

FIG 3

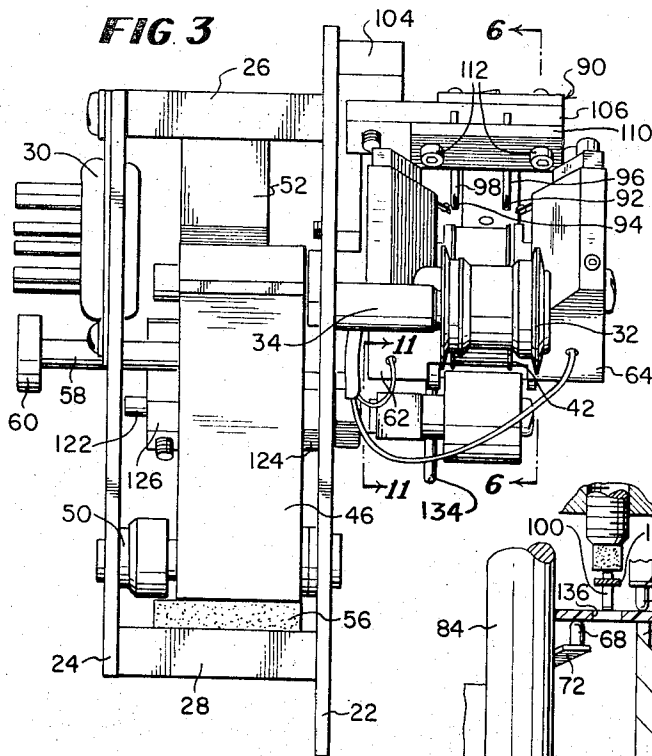


FIG 5

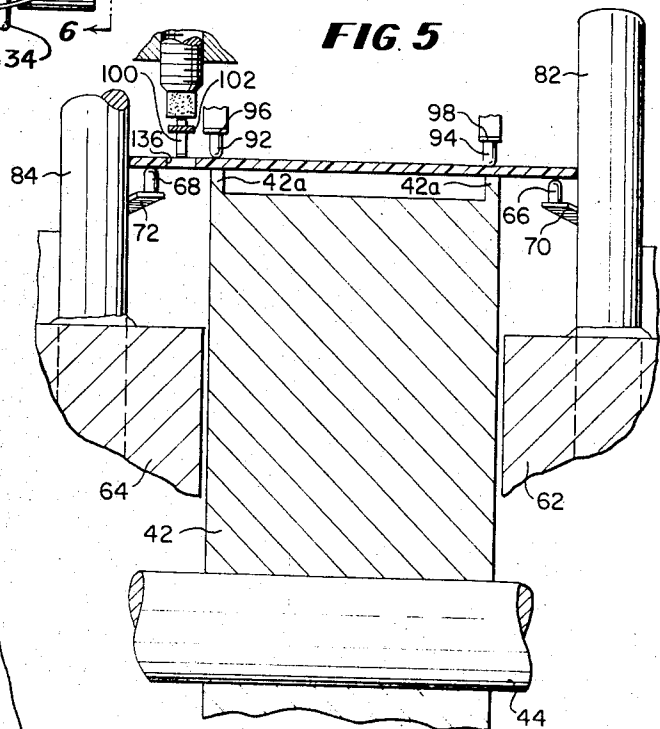


FIG 4

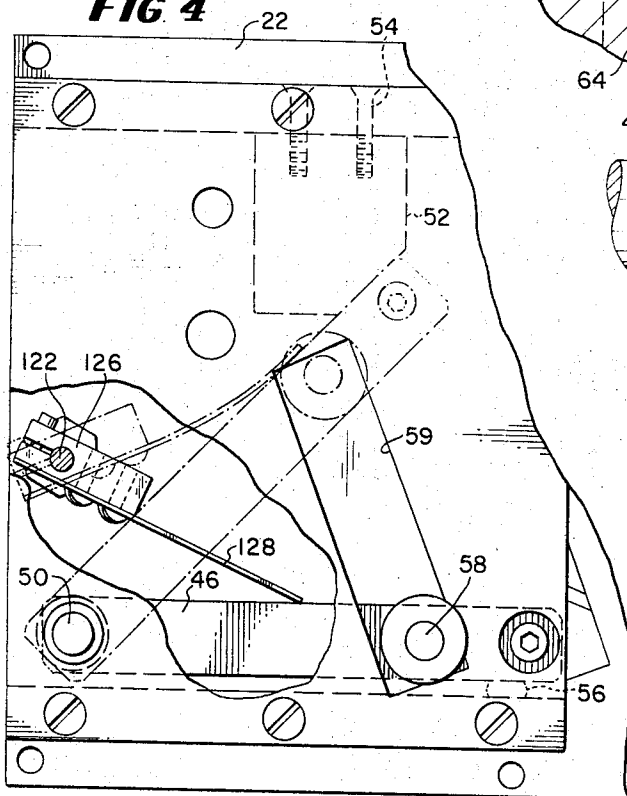


FIG 6

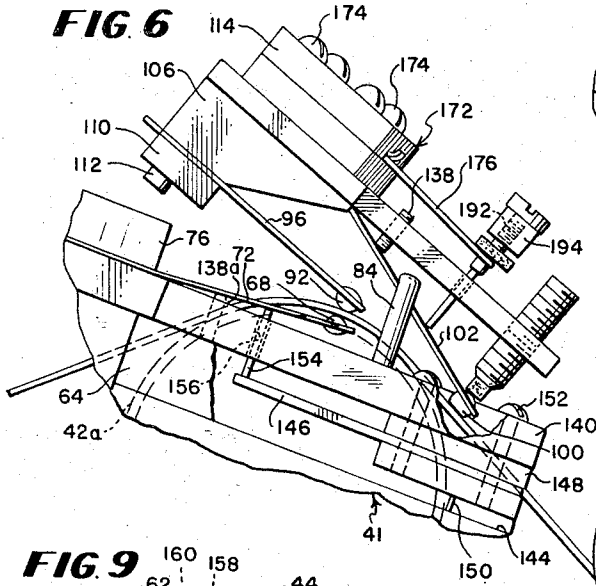


FIG 7

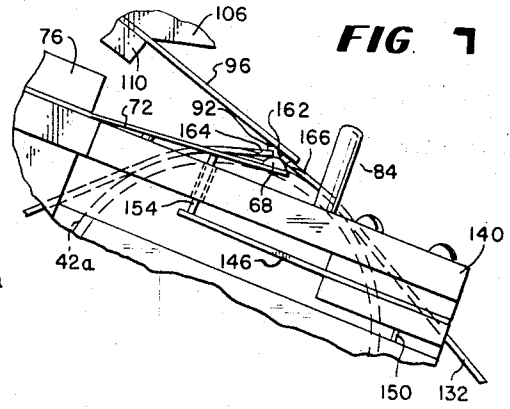


FIG 9

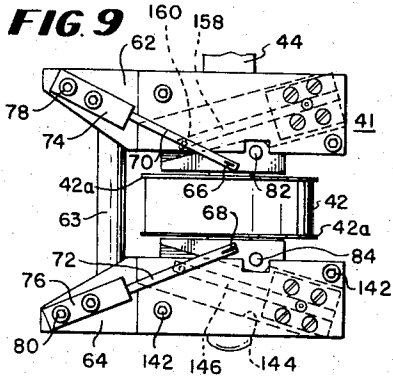


FIG 12

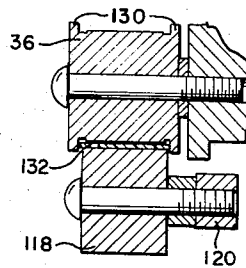


FIG 8

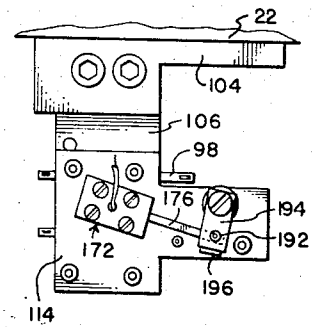


FIG 10

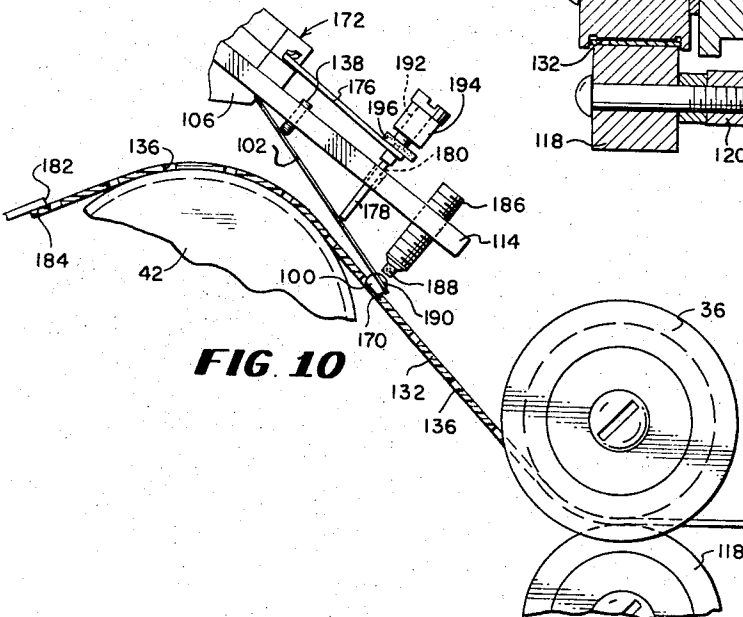
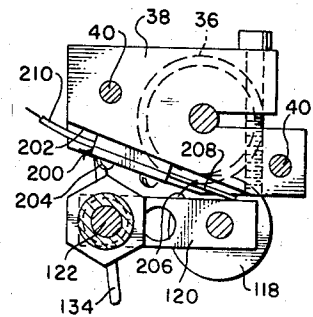


FIG 11



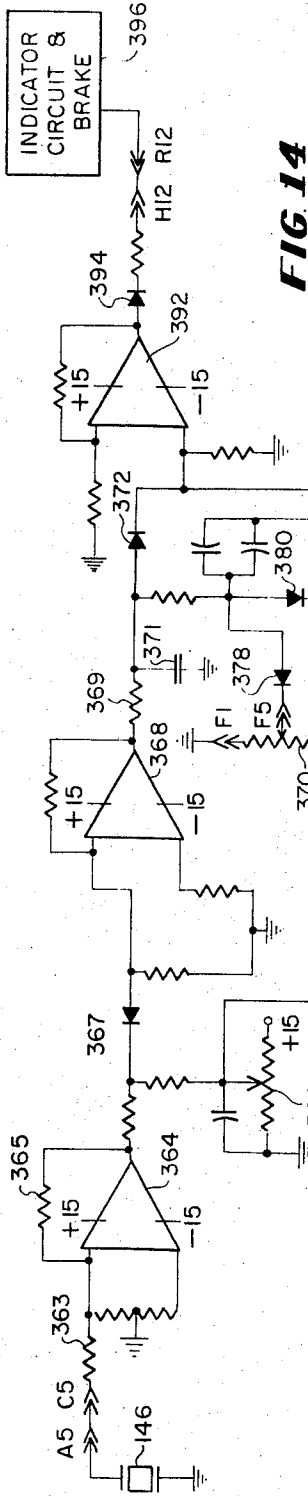


FIG. 13

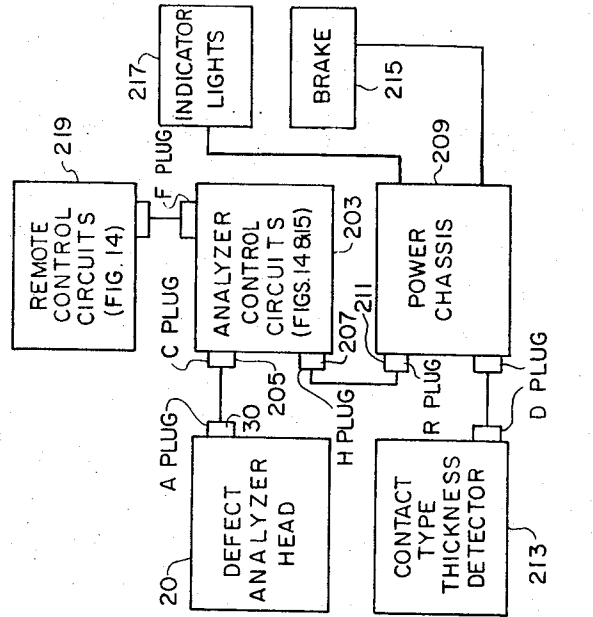
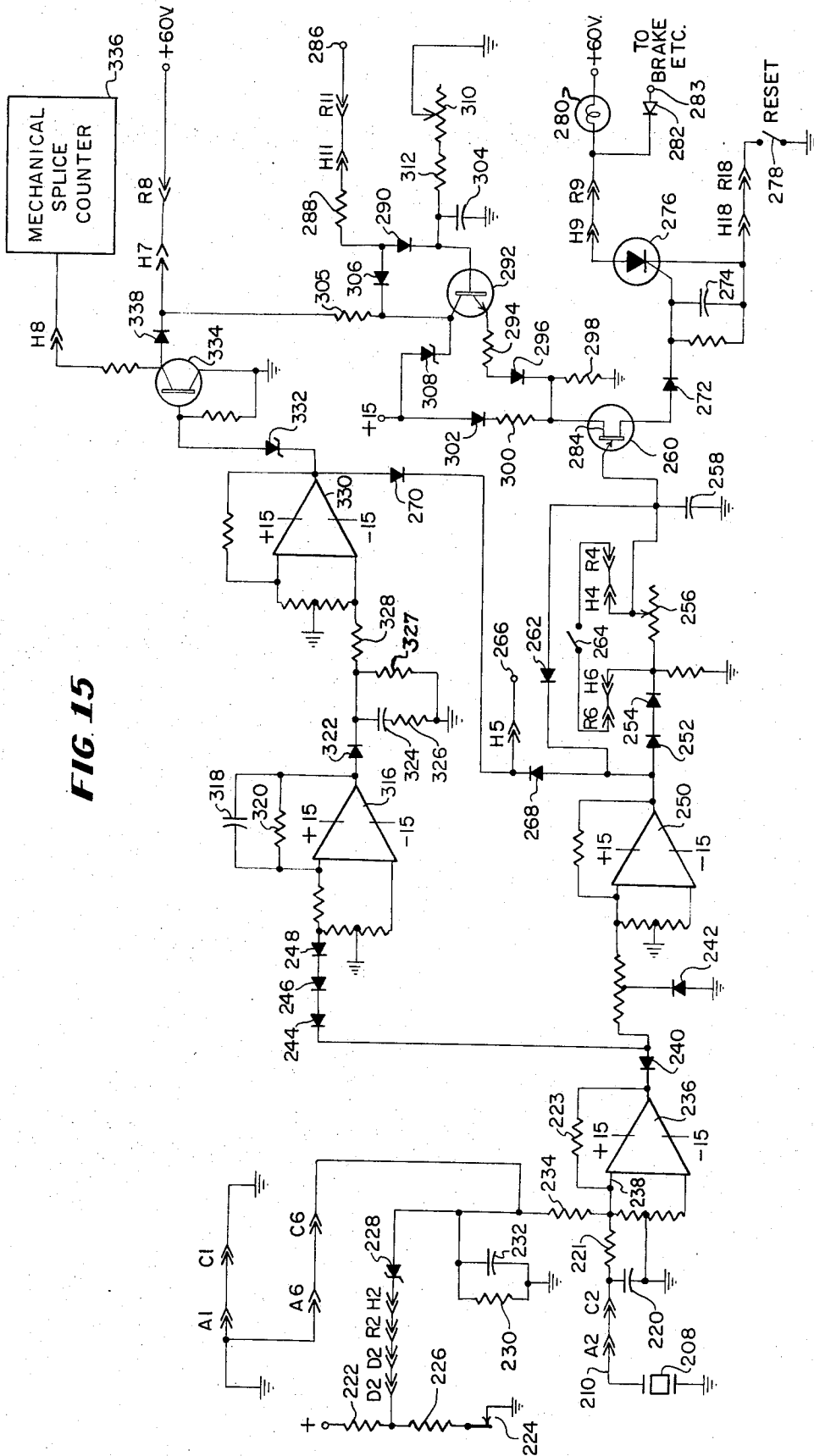


FIG. 15



FILM INSPECTION APPARATUS

The present invention relates to film inspection apparatus, and more particularly, to film inspection apparatus which is capable of analyzing motion picture film for various defects in the film while the film is traveling at a very high rate of speed so that a large number of reels of film may be rapidly inspected in a minimum amount of time.

Motion picture film usually consists of an elongated strip of material of a thickness of approximately 5 mils and having a picture track consisting of a series of successive pictures or frames occupying a substantial portion of the width of the film. A sound track is positioned adjacent the picture track on one edge of the film and a series of sprocket holes is provided in the opposite edge of the film to receive the sprocket wheels of a projector for proper indexing of the pictures as the film is shown. Outboard of the sprocket holes, the film has a continuous web or track which defines a continuous edge of the film.

After a film has been projected, especially after many projections, or after use on a faulty projector, it tends to acquire defects which will impair future projections. Among these defects are: elongated sprocket holes, sprocket runoff or punch, where the projector sprocket is run out of registry with the sprocket holes and has indented or embossed the film; sprocket holes torn laterally out to the edge of the film and identified as "edge breaks;" film splices which are poorly made and occupy an abnormal length along the film, usually in excess of one-eighth inch; splices made with pins, paper clips or staples; and breaks in the film.

In order to find and repair these defects and to establish any liability of the preceding film user for damage to the film, it is customary in the film industry to inspect each film after its use by one exhibitor and before it is sent to the next exhibitor. Various arrangements have been heretofore proposed for inspecting films for these types of defects. Such arrangements are shown, for example, in Grunwald, et al. U.S. Pat. Nos. 2,699,676; Grunwald, et al. 2,934,949; Grunwald, et al. 3,613,444; Phillimore 2,469,608; and Menary 3,180,143; and 3,501,760.

While these prior art arrangements have been generally satisfactory in detecting various types of defects in the film, they have been unsuitable for making such inspection when the film is moved past the inspection device at an extremely high rate of speed, in the order of 1,600 feet per minute. Thus, in the detection of edge breaks the sensitivity of the detector means used in prior art arrangements has not been sufficiently sensitive to permit film inspection speeds in the order of 1,600 feet per minute. In general, this lack of sensitivity is due to the fact that these prior art arrangements have failed to position the film so that an edge crack feeler element can be biased against the film with substantial force without bending the film under adverse temperature and humidity conditions. Also, full advantage has not been taken in prior art arrangements of the tangential movement of the film flaps adjacent an edge break when the film is moving in an arcuate test path. Furthermore, these arrangements have not provided any substantial degree of selectivity as to what types of edge break defects will cause a response in the detection apparatus. For example, very fine hair cracks may, in some instances, not be considered as defects by one op-

erator, but may for another. The same is true of dimples or embossing on the film which a particular operator may wish to consider as edge cracks.

With regard to the detection of film thickness discontinuities, such as splices, it has been customary to detect discontinuities of abnormal length, i.e., more than one-eighth inch in length, and to stop the inspection machine when such discontinuities occur. However, during periods when the driving motor is bringing the film up to speed good splices having only one-eighth inch in length are falsely interpreted as bad splices of considerably greater length since the duration of the pulse developed by the good splice when the film is traveling slowly is equal to or greater than that of an abnormally long splice when the film is traveling at speeds in the order of 1,600 feet per minute. This effect is, of course, particularly evident, and annoying when the film is run at an extremely high rate of speed and takes a considerable amount of time to come up to full speed. Furthermore, these prior art bad splice indicating arrangements have been responsive to a series of closely spaced good splices which have been falsely interpreted as a bad splice of considerably greater length. Also, pieces of dirt closely following a good splice have been interpreted as a somewhat longer splice and the machine stopped improperly. In these instances the operator may spend a considerable length of time looking at the film in an effort to determine the presence of a bad splice without realizing that a false indication has been made.

With regard to the detection of elongated sprocket holes, the prior art arrangements have provided a detector arrangement which falsely responds to the presence of film splices by giving an erroneous elongated sprocket hole indication. This is particularly true when the film is run at high speeds since the feeler element normally employed to detect elongated sprocket holes is given an abrupt shock in the outward direction at the start of a splice and moves inwardly at the end of the splice, i.e., in the same direction as movement produced in response to an elongated sprocket hole. Accordingly, the presence of a splice in the film may cause an erroneous indication in the elongated sprocket hole detection channel of prior art arrangements.

It is, therefore, a principal object of the present invention to provide a film inspection apparatus which eliminates one more of the above-discussed difficulties of prior art arrangements.

It is another object of the present invention to provide a new and improved film inspection apparatus which is capable of detecting edge cracks when the film is run at speeds in the order of 1,600 feet per minute.

It is still another object of the present invention to provide a new and improved film inspection apparatus wherein the film is moved over the periphery of a roller with the edge of the film overhanging the roller and forming a stiff arcuate portion and an edge break feeler element is positioned to engage the concave side of the film and is moved radially outward in response to an edge crack when the flap portions adjacent the crack tend to move to tangential positions with respect to the periphery of the roller.

It is a further object of the present invention to provide a new and improved film inspection apparatus which is capable of detecting edge breaks at speeds in the order of 1,600 feet per minute and wherein move-

ment of the feeler element is detected by means of a piezoelectric crystal element.

It is a still further object of the present invention to provide a new and improved film inspection apparatus wherein a high degree of selectivity is provided as to what type of edge crack defects will cause a response in the apparatus.

It is another object of the present invention to provide a new and improved film inspection apparatus wherein undesired film thickness discontinuities are detected and compensation is provided for changes in film speed.

It is a further object of the present invention to provide a new and improved film inspection apparatus wherein good film splices are detected and false signals due to dirt and contamination on the film are avoided by rejecting detector signals which have less than a predetermined minimum height.

It is still a further object of the present invention to provide a new and improved film inspection apparatus wherein a series of closely spaced good splices is not falsely interpreted as a bad splice of considerably greater length than the good splices.

It is another object of the present invention to provide a new and improved film inspection apparatus in which splices or other thick discontinuities in the film do not produce a false indication in the elongated sprocket hole detection channel.

Briefly, summarizing the present invention, the film is advanced at high speed over the periphery of a rotatable pulley and is held against this pulley while the edges thereof overhang the sides of the pulley and form stiff arcuate portions which will resist substantial upward bending even under adverse temperature and humidity conditions. Detection of edge cracks is made by providing a feeler element which is biased into engagement with the concave side of the film as it is moved over the curved test path defined by the periphery of the pulley. Due to the stiffness of the arcuate portions thus formed, the feeler element can exert a substantial upward force on the under side of the film without causing it to bend. When an edge crack is encountered, the flap portions on either side of this crack tend to become tangent to the periphery of the pulley and the feeler element moves radially outward into the V-shaped opening formed by the tangential flap portions of the film adjacent the break. With this arrangement a signal of substantial amplitude is provided even in response to very fine edge cracks and even though the film is moving at extremely high speeds in the order of 1,600 feet per minute. Movement of the feeler element is translated into an electrical signal by means of a cantilever type of piezoelectric transducer element which engages the spring arm supporting the feeler element at a point outside the edge of the film path.

To detect elongated sprocket holes a feeler element is positioned at a point beyond the curved test path so that it engages the opposite side of the film when it is moving in a straight line test path. Damping means are provided to inhibit upward movements of the feeler element in response to the leading edge of film splices. Furthermore, electronic facilities are provided for rendering the elongated sprocket hole detector means less sensitive for a period of time following the leading edge of each film thickness discontinuity so as to prevent the elongated sprocket hole detector means from falsely responding to thickness discontinuities of the film.

Good film splices are detected by a cantilever type piezoelectric transducer element and are counted while the film is moved at a high rate of speed. The counting of pulses due to dirt and the like on the film is prevented by measuring only those pulses which have more than a predetermined minimum height. When a thickness discontinuity of greater than a predetermined minimum length is encountered the machine is stopped and an indicator light is energized. Also, compensation for changes in film speed is provided so that good splices will not be falsely interpreted as bad splices and the machine stopped as the film is being brought to full speed. Furthermore, a bad splice indication in response to a series of closely spaced good splices is avoided by rapidly discharging the capacitor portion of a pulse duration measuring circuit so that responses due to several short good splices are not accumulated and falsely interpreted as a bad splice.

The invention, both as to its organization and method of operation, together with further objects and advantages thereof, will best be understood by reference to the following specification taken in connection with the accompanying drawings in which:

FIG. 1 is a front elevational view of the film defect detection apparatus of the present invention and shown with the movable film inspection assembly in open or film loading position;

FIG. 2 is a view similar to FIG. 1 and showing the inspection assembly in operative film inspecting position;

FIG. 3 is a left side view of the apparatus shown in FIG. 2;

FIG. 4 is a fragmentary rear view of the apparatus shown in FIG. 2;

FIG. 5 is a sectional view, taken along the line 5—5 of FIG. 2 and shown on a somewhat enlarged scale;

FIG. 6 is a fragmentary sectional view taken along the line 6—6 of FIG. 3 and shown on a somewhat enlarged scale;

FIG. 7 is a view similar to FIG. 6 and showing the operation of the detector element in detecting an edge crack in the film;

FIG. 8 is a sectional view taken along the lines 8—8 of FIG. 1;

FIG. 9 is a sectional view taken along the lines 9—9 of FIG. 1;

FIG. 10 is a sectional view similar to FIG. 6 and showing the detection of an elongated sprocket hole;

FIG. 11 is a sectional view taken along the lines 11—11 of FIG. 3;

FIG. 12 is a sectional view taken along the lines 12—12 of FIG. 2;

FIG. 13 is a block diagram of the film inspection apparatus of the present invention shown in relation to other portions of the film inspection equipment;

FIG. 14 is a schematic diagram of the two edge crack detector channels and the elongated sprocket hole detector channel of the present invention; and

FIG. 15 is a schematic diagram of the film thickness discontinuity detecting arrangement of the present invention.

Referring now to the drawings, the film defect analyzer portion of the apparatus of the present invention comprises a chassis indicated generally at 20 on which the operative components of the analyzer are mounted. The chassis 20 comprises a front panel 22, a rear panel 24, a top wall 26, and a bottom wall 28. The chassis 20 is arranged to be mounted in the main film inspection

machine and cooperates with various electronic control circuits therein, as will be described in more detail hereinafter. To this end, a multi-prong plug 30 is mounted in the rear wall 24 so that connection may be established through this plug to the various transducer elements described in detail hereinafter which are mounted on the analyzer head 20.

In order to guide the film properly with respect to the detector elements of the present invention, a first pulley 32 is rotatably mounted on a post 34 secured to the front panel 22 and a roller 36 is rotatably mounted on a block 38 which is secured to the front panel 22 by means of the screws 40, the block also supporting a piezoelectric thickness discontinuity detecting element, as will be described in more detail hereinafter. A third roller 42 which is part of a movable assembly 41, is rotatably mounted on a shaft 44 which is supported on a pivotally mounted member 46, the shaft 44 extending through a clearance slot 48 in the front panel 22. The member 46 is pivotally mounted on a shaft 50 which is supported between the front and rear panels 22 and 24 and the member 46 is arranged to be moved to the operative position shown in FIG. 3 in which position the member 46 engages a positioning block 52 which is secured to the upper wall 26 by means of the screws 54 (FIG. 4).

In order to move the member 46 and the assembly 41 from its inactive position shown in FIG. 1, in which position the member 46 rests on a cushioning member 56 (FIG. 4), to the output position of FIG. 2, a shaft 58 which is also secured to the member 46 and moves within a clearance slot 59, is provided with a roller 60 on the end thereof, the roller 60 being adapted to be engaged by a suitable operating lever in the main machine when the analyzer head 20 is installed therein so that the roller 42 may be moved from the inoperative or film loading position shown in FIG. 1 to the film inspection position shown in FIG. 2.

The movable detector assembly 41 also includes a pair of supporting blocks 62 and 64 which carry edge crack detector elements which are moved into engagement with the concave side of the stiff arcuate film portions which overhang the sides of the pulley 42 when the assembly 41 is moved to the position shown in FIG. 2. The blocks 62 and 64 are held together by an alignment pin 63 so that they act as an integral unit. More particularly, as can be seen in FIG. 5 a pair of edge crack feeler elements 66 and 68 are mounted on the ends of spring arms 70 and 72 which are clamped to the blocks 62 and 64, respectively, by means of the blocks 74 and 76 (FIG. 9) which are secured to the main supporting blocks 62 and 64 by means of the screws 78 and 80. The spring arms 70 and 72 extend inwardly at an angle with respect to the roller 42 so that the feeler elements 66 and 68 may be biased into engagement with the outer edges of the film which project beyond the sides of the roller 42, when the assembly 41 is moved to the position shown in FIG. 2. A pair of jewel guide rods 82 and 84 are mounted on the blocks 62 and 64, respectively, and extend upwardly beyond the upper edges of these blocks so as to guide the film during the film loading and running operation.

A fixed assembly indicated generally at 90 is mounted on the front panel 22 and includes a pair of hold down jewel elements 92 and 94 which are mounted on the spring arms 96 and 98, respectively, and an elongated jewel feeler element 100 which is

mounted on a spring arm 102. More particularly, the assembly 90 comprises a block 104 secured to the front panel 22 and a transversely extending mounting bar 106 is secured to the block 104 by means of the screws 108. The spring arms 96 and 98 are clamped to the bar 106 by means of the clamping plate 110 which is held in place by means of the screws 112. A mounting plate 114 is secured to the bar 106 by means of the screws 116 and the spring arm 102 is clamped between the plate 114 and the bar 106.

In order to detect film splices and other discontinuities in the thickness of the film, a roller 118 is rotatably mounted on a member 120 which is in turn connected to a shaft 122 mounted in a bearing element 124 (FIG. 3) secured to the front panel 22. A block 126, which is secured to the shaft 122 between the front and rear panels 22, 24, carries a spring arm 128 which rests upon the pivotally mounted member 46, as best illustrated in FIG. 4. Accordingly, when the member 46 is moved to the position shown in dotted lines in FIG. 4, i.e., in engagement with the block 52, and the assembly 41 is moved into operative engagement with the fixed assembly 90, the spring arm 128 functions to rotate the member 120 mounted on the shaft 122 and brings the roller 118 into operative position between the flanges 130 of the roller 36, as best illustrated in FIG. 12. Furthermore, the spring arm 128 provides spring bias so that the roller 118 is resiliently held in the position shown in FIG. 12 but can move away from the roller 36 when film discontinuities such as film splices or other abnormal thickness variations in the film are encountered.

Considering now the manner in which the movable assembly 41 cooperates with the fixed assembly 90 during a film loading operation, a length of film 132 is simply placed on the roller 42 between the guide posts 82 and 84 with the assembly 41 in the open position shown in FIG. 1 and with the film 132 extending between the rollers 118 and 36. The assembly 41 is then moved to the inspection position shown in FIG. 2 and as this occurs, the film 132 is moved upwardly between the flanges 130 of the pulley 36 as the roller 118 is moved to the position shown in FIG. 12. A jewel guide rod 134 is secured to the member 120 and moves with this member as it is pivoted to the loaded position shown in FIG. 2 so as to guide one edge of the film 132 into the nip of the rollers 36 and 118.

When the movable assembly 41 has thus been moved to the film inspecting position in which the member 46 is in engagement with the stop member 52, the feeler and hold down elements described heretofore engage the film 132 in the manner shown in detail in FIG. 5. Thus, referring to this figure, the hold down jewels 92 and 94 engage the film 132 immediately above the rim portions 42a of the pulley 42 so that the film is held against the rim portions 42a by means of the spring arms 96 and 98. The hold down force of the spring arms 96 and 98 and to a certain extent the tension on the film 132 as it is moved past the film inspection station by conventional drive apparatus, cooperate to hold the film against the outer periphery of the pulley 42 so that the overhanging edges of the film 132 form stiff arcuate portions which can resist the upward force exerted on the concave side of these edge portions by the spring biased feeler elements 66, 70 and 68, 72 without substantial bending of these edge portions even under

adverse conditions of temperature and humidity which tend to make the film soft and pliable.

The elongated jewel 100 engages the film outboard of the rim portion 42a of the pulley 42 and in line with the sprocket holes 136 of the film 132, the jewel 100 being urged against this portion of the film by the force exerted by the spring arm 102. In order to adjust the biasing force of the jewel element 100 the arm 102 may be adjusted by means of the adjustment screw 138 which extends through the plate 114 and engages the arm 102 near the point at which this arm is clamped between the bar 106 and the plate 114, as best illustrated in FIG. 6.

The edge crack feeler elements 66 and 68 engage the film at points well beyond the rim portions 42a of the pulley 42, it being noted that the jewel elements 68, 92, 66 and 94 engage the film 132 along a line which is transverse to the length of the film, the jewels 66 and 68 engaging the under side of the film near the extreme outer edge thereof and the jewels 92 and 94 engaging the upper side of the film 132 over the rim 42a. The force exerted by the spring arm 72 which carries the jewel 68 may be adjusted by means of the adjustment screw 138a which is mounted in a plate 140 (FIG. 6) secured to the block 64 by means of the screws 142 (FIG. 9). A similar adjustment is provided for the spring arm 70.

The plate 140 covers a channel 144 formed in the block 64 within which is mounted a cantilever type piezoelectric transducer element 146 which is employed to translate movement of the spring arm 72 into corresponding electrical signals. More particularly, the cantilever beam transducer element 146 is of the so-called series bimorph type which comprises two piezoelectric plates cemented together so that flexure of the beam 146 produces an electrical potential between the conductive base member 148 of the unit and the output conductor 150 which is connected to one of the terminals of the plug 30, the base of the bimorph unit 148 being secured to the plate 140 by means of the screws 152. A small pin 154 is secured to the free end of the beam 146 and extends through a clearance opening 156 in the plate 140, the upper end of the pin 154 resting against the spring arm 72 so that the cantilever beam 146 is stressed slightly when the assembly 41 is moved to the film inspection position shown in FIGS. 2 and 6 in the presence of intact film.

A similar transducer element in the form of a cantilever beam 158 is provided in the block 62 and a pin 160 secured to the end of the cantilever beam 158 is adapted to engage the spring arm 70, as best illustrated in FIG. 9.

Considering now the manner in which the detection of an edge crack is made in accordance with the present invention, and considering the cooperative action of the jewel element 68 which engages the under side of the film near the outer unsupported edge thereof and the laterally displaced hold down elements 92 and 94, in the absence of an edge crack in the film 132, the hold down jewels 92 and 94 force the film to conform to an arcuate path corresponding to the periphery of the rim portions 42a of the roller 42 so that the overhanging edge portions of the film are stiffened and the upward or radially outwardly directed force exerted by the jewel 68 on this stiffened edge of the film does not distort or bend the film out of its arcuate path, as shown in FIG. 6 of the drawing. This stiffness effect of the ar-

cuate portions of the film in the vicinity of the feeler elements 66 and 68 is particularly important under adverse temperature and humidity conditions when the film tends to become soft and pliant because radially outward deflection of these arcuate portions by the elements 66 and 68 can only occur by an actual stretching of the film in these areas and such stretching does not occur because the film is highly resistant to longitudinal stretching even under these adverse conditions. However, when an edge crack 162 in the film 132 is encountered, the adjacent portions 164 and 166 of the film adjacent the crack 162 tend to become tangent to the rim portion 42a and the feeler element 68 is urged in the radially outward direction against the tangentially extending film portions 164 and 166. In so doing the film portions 164 and 166 become more extended radially so that a substantial gap is left between the two film portions 164 and 166 and substantial radially outward movement of the feeler element 68 is thus provided, even though the hold down element 92 continues to hold a laterally displaced point on the film against the rim portion 42a. This substantially radial outward movement of the feeler element 68 and spring arm 72 causes the beam 146 to bend and a corresponding electrical signal is developed on the output conductor 150 of the piezoelectric detector element 146. A similar action takes place with respect to the hold down jewel 94 and the jewel element 66 which engages the other edge of the film 132 and cracks in this edge of the film are detected in an entirely similar manner by bending of the cantilever piezoelectric beam 158.

Considering now the manner in which elongated sprocket holes in the film 132 are detected in accordance with the present invention, it is first pointed out that the elongated jewel element 100 which rides on the upper surface of the film 132 in line with the sprocket holes 136 has a length which is longer than the conventional sprocket holes 136 but can move into a damaged or elongated sprocket hole, such as the sprocket hole 170 shown in FIG. 10 under the biasing force of the spring arm 102. A piezoelectric transducer unit indicated generally at 176 is mounted on the plate 114 by means of the screws 174 and is a cantilever beam element to the outer free end of which is secured a transversely extending pin 178 which engages the spring arm 102 through a clearance opening 180 in the plate 114. The elongated jewel element 100 straddles sprocket holes 136 of normal length in the film 132 of normal length and rides on the upper surface of the film, as shown in FIG. 6 of the drawings. However, when an elongated sprocket hole 170 (FIG. 10) is encountered the elongated jewel element 100 enters this sprocket hole and the consequent inward movement of the spring arm 102 is transmitted to the cantilever element 176 and results in the development of a corresponding electrical signal by the series bimorph unit. This electrical signal is then processed in the circuit arrangement shown in FIG. 14, as will be described in more detail hereinafter.

It will be noted that the jewel element 100 does not engage the film 132 where it is moving over the arcuate path defined by the rim portions 42a of the pulley 42, although this element is shown in FIG. 5 as engaging an arcuate point on the film for simplicity of illustration. By positioning the jewel element 100 to engage a straight line portion of the film path the slight vibratory motion of the spring arm 102 which would be encoun-

tered if the jewel element 100 engages the film while it is moving in an arcuate path, is eliminated. This slight vibratory motion is due to the chord effect in which the jewel 100 partially enters a normal sprocket hole 136 since it rests only on the opposite edges of this hole, whereas during periods when the jewel element 100 rides on a continuous arcuate film surface, it is lifted up slightly. By positioning the jewel element 100 on the linear traverse portion between the pulleys 42 and 32, this vibratory motion due to chord effect is completely eliminated. Furthermore, by positioning the jewel element 100 away from the point at which the edge crack jewels 66 and 68 engage the film, the above described vibrations due to chord effect are not transmitted to the edge crack detectors, thereby enabling more sensitive detection of fine edge cracks in the film 132.

When the elongated jewel element 100 encounters the leading edge 182 of a film splice portion 184 it is moved abruptly outwardly, particularly when the film 132 is moving at high speed. Also, when the splice portion 184 has moved past the jewel 100, it is moved inwardly back to its former position and this inward movement of the jewel 100 may be falsely interpreted as an elongated sprocket hole. In order to prevent such false sprocket hole detection signals, an adjustment screw 186 is mounted in the plate 114 and a piece of dead rubber damping material 188 is secured to the end of the screw 186 in proximity to the hump 190 formed in the end of the spring arm 102 when the jewel 100 is mounted therein. The damping material 188 is positioned so that it does not interfere with inward movement of the jewel 100 when it enters elongated sprocket holes 170. However, when a splice portion 182 is encountered, the damping material 188 functions to reduce excessive outward movement of the jewel 100 while simultaneously absorbing energy and thus aids in preventing the false development of elongated sprocket hole signals during the following inward movement of the member 100 when the splice is terminated. In addition, a screw 192 which is mounted in a post 194 secured to the plate 114 is adjusted so that a piece of dead rubber damping material 196 is positioned between the end of the screw 192 and the free end of the cantilever transducer element 166. The screw 192 is adjusted so that there is bidirectional damping for the outer end of the cantilever element 176 so as to reduce the effect of resonances of the beam 176 itself and indirectly arm 102. Also, the damping material 196 provides increased damping for upward movement of the beam 176 itself and indirectly the arm 102 when a splice 182 is encountered by the jewel element 100. Accordingly, additional preferential damping is provided so as further to minimize the development of false elongated sprocket hole signals.

Considering now the manner in which film splices are detected in accordance with the present invention, a series bimorph unit indicated generally at 200 is mounted in an inclined groove 202 formed in the rear side of the block 38, by means of the screws 204 (FIG. 11). The block 120, which is secured to the shaft 122, is positioned so that the upper edge 206 thereof is moved into engagement with the cantilever beam transducer element 208 of the series bimorph unit 200 when the roller 118 is positioned to engage the film 132 within the nip of the rollers 36 and 118, as described in detail heretofore. When the roller 118 is biased into its operative position by means of the spring arm 128,

the edge portion 206 of the block 120 flexes the cantilever beam transducer element 208 so that a predetermined voltage is briefly developed on the output conductor 210 of the unit 200, the other terminal of the series bimorph unit 200 being connected to ground through the block 38 and chassis 20. Accordingly, when a thickness discontinuity, such as the splice portion 182, is encountered and the roller 118 is moved away from the roller 36 by virtue of the increased thickness of the film in the splice area, the block 120 moves away from the block 38 so that the transducer element 208 is flexed by a lesser amount and a corresponding electrical signal is developed on the output conductor 210.

In considering the circuit arrangements which are provided in accordance with the present invention to amplify the electrical signals developed by the various piezoelectric transducer elements described heretofore, reference is first made to FIG. 13 wherein the main components of the film inspection device are shown in block diagram form. Referring to this figure, the defect analyzer head 20 is connected by means of the plug 30, otherwise identified as the "A" plug, to the plug 205 ("C" plug) of the analyzer control circuits 203 which are shown in detail in FIGS. 14 and 15 of the drawings. A series of remote control circuits 219, which are shown in detail in FIG. 14 of the drawings, are connected by means of the "F" plugs, to the analyzer control circuits 203. A power chassis 209 provides regulated plus 15 and minus 15 volt supply voltages for the circuitry in the control circuits 203 by means of the "R" plug 211 and the "H" plug 207. In addition, the power chassis generates certain control signals as will be described in more detail hereinafter.

The analyzer control circuits 203 are arranged so that a make-and-break contact type of thickness detector 213, such as described in Grunwald, et al. U.S. Pat. No. 2,699,676 for example may be employed in the place of the assembly 20 and still utilize the corresponding amplifier channels in the analyzer control circuits 203. To this end the conventional contact type of thickness detector 213 is connected through the "D" plugs to the power chassis 209 and through the "R" and "H" plugs 207 and 211 to the analyzer control circuits 203.

The control circuits 203 are also arranged to supply signals to indicator lights 217, a green light being lit whenever a bad splice is detected and a red light being lit whenever an edge crack or elongated sprocket hole is detected. In addition, a brake 215 is controlled in accordance with signals developed by the control circuits 203 so that movement of the film 132 is stopped whenever any of the above-described defects is detected. Also, a mechanical splice counter is employed to count good splices under the control of signals developed by the circuits 203 as will be described in more detail hereinafter.

Before considering the detailed circuit arrangements shown in FIGS. 14 and 15, it is pointed out that the amplifying arrangements employed to amplify the signals developed by the piezoelectric transducers 146, 158, 176 and 208, must fulfill several requirements if the above described defects are to be detected in a reliable manner when the film is moving at a high speed in the order of 1,600 feet per minute.

Since each of the piezoelectric transducers is equivalent to a generator in series with a capacitor having a

capacity in the order of 1,000 picofarads, it is necessary to use an extremely large shunt resistor so that the signals produced by the transducer element are not objectionably differentiated. Such differentiation of the transducer signals will produce overshoot pulse portions which cross over the zero axis and will be falsely interpreted as movements of the jewels in the direction indicating a defect when no such defect actually occurs.

Furthermore, while the hold down elements 92 and 94 tend to hold the film in conformity with the periphery of the pulley 42 the film nevertheless tends to drift toward and away from the periphery of the pulley when the film is moved at extremely high speeds. Accordingly, the edge crack feeler elements 66 and 68 will experience radially outward movement due to this floating type of film movement away from the pulley 42 and if the edge crack transducer signals are materially differentiated, pulses of sufficient amplitude to trigger the indicator circuits 217 and brake 215 may be generated.

It is also desirable in the edge crack and elongated sprocket hole channels to provide level setting potentiometers whereby the level of pulses which will cause a response may be adjusted by the operator. However, this signal processing must be done at an impedance level which is quite low compared to the high impedance piezoelectric transducers themselves or else differentiation and signal wave form distortion will be produced.

In accordance with an important aspect of the invention, the signal from each of the piezoelectric transducer elements is applied through an extremely high series resistance to the input of a stabilized operational amplifier which is capable of accepting the extremely high resistance input circuit connected to the piezoelectric transducer element and transforming it to a relatively low output impedance level suitable for subsequent signal processing. Such an arrangement is employed in each of the detector channels so that the respective transducer signals are not differentiated and an output signal at low impedance levels and having good high frequency response and band width is provided for subsequent processing in each channel, as will be described in more detail hereinafter.

Considering now the circuit arrangement shown in FIG. 15 which is provided in accordance with the present invention for amplifying and processing the signal developed by the film splice piezoelectric detector element 208, this element is connected through the plug contacts (A2, C2) to a shunt capacitor 220 which discriminates against voltage spikes of short duration which may be regarded as noise. The signal appearing across the capacitor 220 is connected through a resistor 221 having a resistance value of 30 megohms to the input terminal 238 of an internally stabilized operational amplifier 236. By way of example, the operational amplifier 236 as well as the other operational amplifiers described hereinafter in connection with FIGS. 14 and 15 are of the Fairchild type 741 which are internally stabilized for phase shift or temperature drifts and the like. However, other types of operational amplifiers having external stabilization circuits may equally well be employed insofar as the present invention is concerned. Any suitable external offset compensating arrangement (not shown) may be employed.

In accordance with an aspect of the invention, and as discussed generally heretofore in connection with FIG.

13, a circuit arrangement is provided so that a conventional thickness detector 213 employing make-and-break contacts may be automatically connected to the amplifier circuit 236 in place of the piezoelectric element 208. More specifically, when a conventional detector unit 213 is used the assembly 20 is unplugged so that the contacts A1, A2 and A6 are disconnected and the make-and-break thickness detector contacts are connected through the plug contacts D2, R2 and H2 to the control circuits 203. More particularly, the unit 213 includes a series circuit, comprising a resistor 222, a low value resistor 226, and the make-break thickness detector contacts 224, which is connected between a positive potential source and ground.

The junction of the resistors 222 and 226 is connected through the D2, R2 and H2 plug contacts and through a 7.5 volt Zener diode 228 to an RC network comprising resistor 230 and capacitor 232.

The Zener diode 228 is provided to prevent signals less than 7.5 volts in amplitude from being transmitted to the input of the amplifier 296. However, the diode 228 has a certain leakage resistance through which the signals developed across the resistor 226 when the contacts 224 are closed, may be transmitted to the input of the amplifier 236. Since this amplifier is extremely sensitive to signals applied to the input thereof, it is necessary to provide the resistor 230, which may have a value of 1,000 ohms, and is equal to the value of the resistor 226, so that a large voltage divider action is provided between the leakage resistance of the Zener diode 228 and the resistor 230 insofar as the input to the amplifier 236 is concerned. Since the Zener diode 228 also has a considerable capacitance, it is necessary to provide the capacitor 232 which removes signals coupled through the Zener diode 228 during periods when the contacts 224 are closed.

In this connection it will be understood that the contacts 234 are opened when a thickness discontinuity is experienced, so that the full voltage of the positive potential source to which the resistor 222 is connected is applied to the Zener diode 228 and the amplitude of signal above this clipping diode is then applied through the input resistor 234 to the input of the amplifier 236. The feedback resistor 223 of the amplifier 236 has a value of 60 megohms and the resistor 234 may have a value of 15 megohms, so that signals may be applied either from the make-break contacts 224, or the piezoelectric element 208 without requiring any switching arrangement other than the connection of one particular type of detector assembly to the indicated plug elements.

It will be noted that with the indicated values for the resistors 221 and 223 a gain of only two is provided in the amplifier 236 for the transducer element 208. However, the signal wave form is precisely preserved so that no material differentiation of the pulses developed by the transducer element 208 is produced while at the same time a low impedance level is provided at the output of the amplifier 236 for the reasons discussed in detail heretofore.

When the defect analyzer assembly 20 is connected to the analyzer control circuits 203 the contacts C6, A6 are closed to ground so that the circuitry including the Zener diode 228 and the networks 230, 232 are automatically disabled. Also, the low impedance at the input terminal 238 of the operational amplifier 236 prevents further interaction between the two circuits

when the conventional contact type detector 213 is used. When the analyzer head plug 30 is disconnected the short is removed from the junction of the Zener diode 228 and capacitor 232 while at the same time the piezoelectric element 208 is removed by disconnection of the contacts A2, C2.

Considering now the manner in which the undifferentiated signal provided at the output of the amplifier 236 at low impedance level is formed, the diode 240 provides a 0.6 volt voltage drop and has the function of blocking drift voltages at the output of the amplifier 236. This technique is employed through the several stages of amplification in both portions of the thickness detector channel and in the channels shown in FIG. 14 and means that the output of amplifier 236 can move as positively as possible without affecting the following circuits and also can go 0.6 volt negative without affecting the next circuit. Accordingly, no probable drift at the output of any particular stage can cause an output of the channel.

Considered generally, the thickness detector facilities comprise a first channel, shown as the lower channel in FIG. 15, which is responsive to the pulses developed by the piezoelectric element 208 and is effective to detect thickness defects or discontinuities of any type which exceed more than a predetermined thickness and more than a predetermined length, and stop movement of the film. These defects may comprise splices made with pins, paper clips or staples, splices made with patches of adhesive or cellophane tape, or other splices of the film which are over a predetermined amount in length. A good splice is defined as a thickness discontinuity of approximately one-eighth inch in length, whereas a thickness discontinuity which should be detected and the equipment stopped may be as short as one-half inch of cellophane tape on the film.

The other channel of the thickness detector facilities, shown as the upper channel in FIG. 15, is arranged to ignore dirt and other short duration thickness defects but is arranged to detect the good splices and count these splices, these splices being approximately one-eighth inch in length.

Considering the lower thickness detector channel in which abnormal thickness discontinuities are detected and the equipment stopped, the output of the amplifier 236 is clipped by the shunt diode 242 and the resultant limited amplitude signal is applied to a second operational amplifier 250, wherein it is amplified and supplied through the series diodes 252 and 254 to a time constant circuit comprising a potentiometer 256 and capacitor 258. This time constant circuit is designed to reject good splice pulses resulting from splices approximately one-eighth inch in length, but if a thickness discontinuity is one-half inch in length or greater, the capacitor 258 will be charged by an amount sufficient to fire a unijunction transistor 260.

When the unijunction 260 fires, the diode 272 which is connected to one base element of the unijunction 260 conducts and supplies the charge on the capacitor 258 to a capacitor 274 which energizes the gate element of a silicon controlled rectifier 276 and fires this SCR. The cathode of the SCR is normally connected through the plug contacts H18 and R18 and a reset switch 278 to ground and the anode is connected through the plug contacts H9 and R9 and an indicator lamp 280 to a plus 60 volt source. When the SCR 276 fires a signal is supplied to a diode 282 in the power

chassis 209 so that a low potential is applied to the terminal 283 while at the same time the brake 215 is energized to stop movement of the film.

A diode 262 is provided across the time constant potentiometer 256 so as to enable the capacitor 258 to discharge quickly between good splices so that if a number of good splices occur relatively close together the unijunction 260 will not be fired. If desired, a stop-on-splices switch 264 may be closed which shorts out the effective portion of the potentiometer 256 so that the capacitor 258 is quickly charged and the unijunction 260 is fired and the machine stopped, as described hereinafter, at each splice or other thickness discontinuity of the film 132.

When the machine is started a relatively high voltage is applied to the terminal 266 and through plug contact H5 to the diodes 268 and 270 so that both channels of the thickness detector circuit are enabled. However, when the machine is stopped a low potential is applied to terminal 266 so that both the diode 268 and the diode 270 are rendered conductive and disable the respective channels of the thickness circuit.

The potential supplied to the second base 284 of the unijunction 260 is the reference voltage against which the potential on the capacitor 258 is compared. In accordance with an important aspect of the invention, this reference voltage is varied from a relatively high value of approximately 20 volts when the machine is at rest to a somewhat lower voltage when full speed of the film 132 is achieved. With this arrangement, compensation is made for variation in speed of the film as it is being brought up to full speed by the driving motor so that good splices of relatively short length are not improperly detected as abnormally long thickness discontinuities and the machine stopped. More particularly, a potential which is the complement of the potential applied to terminal 266 is applied to the terminal 286 in the power chassis 209. This potential is high when the film 132 is stopped and is applied through the plug contacts R11, H11, a resistor 288 and a diode 290 to the base of a transistor 292. A resistor 294, diode 296 and resistor 298 are connected from the emitter of the transistor 292 to ground. Also, the base 284 of the unijunction 260 is connected through a resistor 300 and a diode 302 to plus 15 volts and the base 284 is also connected to the junction of the resistor 298 and diode 296. Under rest conditions, a capacitor 304 connected from the base of the transistor 292 to ground is fully charged. A diode 306 is connected from the collector of the transistor 292 to the junction of the diode 290 and resistor 288 and protects the transistor 292 from the high potential on the terminal 286 when the machine is at rest.

The collector of the transistor 292 is connected through a load resistor 305 to the plus 60 volt supply. However, since this supply is unregulated the portion of the reference current controlled by the transistor would not be sufficiently accurate to provide precise speed compensation. This is avoided by connecting a 22 volt Zener diode 308 from the regulated plus 15 volt supply to the collector of the transistor 292 so that the reference voltage applied to the base 284 is regulated and is highly accurate so that the acceleration curve of the driving motor can be simulated under all operating conditions.

When the machine is started the potential on the terminal 286 drops to approximately ground so that the

capacitor 304 is permitted to discharge through the base resistance of the transistor 292, a resistor 312, and a potentiometer 310 which may be called a velocity compensation control. The time constant curve of the elements 304, 310, 312 and the base resistance of the transistor 292 is chosen to approximate the acceleration curve of the driving motor for the film 132 so that the current through the transistor 292, and hence the reference voltage applied to the base 284, exactly matches the motor acceleration characteristic. Variation of this reference potential thus compensates for misleading longer pulses produced by good splices as the film accelerates so that these pulses do not fire the unijunction 260.

Considering the upper channel of the thickness detector circuits, the rectifiers 244, 246, 248 discriminate against small pulses due to dirt so that only pulses which exceed a predetermined amplitude determined by the series voltage drops of these three rectifiers are applied to the input of an operational amplifier 316. This amplifier is provided with an integrating feedback circuit comprising the capacitor 318 and resistor 320 so that lower gain is provided for pulses which are of shorter duration than those produced by good splices having a length of one-eighth inch, which are to be counted. These shorter duration pulses may be due to dirt or other material on the film and are discriminated against first on a height basis by means of the diodes 244, 246 and 248, and then on a duration basis by the integration in amplifier 316.

A diode 322 is provided in the output of the amplifier 316 so that the following pulse stretching circuit including a capacitor 324 and current limiting resistor 326 does not discharge quickly through the output of the amplifier 316 which is of relatively low impedance. A pulse stretching or integrating arrangement is thus provided for pulses representing good splices and these pulses are divided in amplitude by the series resistor 328 by a factor of approximately 10 to 1 so as to prevent discharge of the capacitor 324 between pulses, except by means of the discharge resistor 327, the resistor 328 being connected to the input of an operational amplifier 330 which further amplifies the stretched pulses. The output of the amplifier 330 is disabled by the signal applied to the diode 270 from the terminal 266 when the machine is stopped, as explained above.

During periods of film movement the output of the amplifier 330 is supplied through a Zener diode 332 to the base of a transistor 334, this Zener diode being employed to make sure that a large amplitude pulse from the amplifier 330 is supplied to the base of transistor 334. A mechanical splice counter 336 is provided in the collector circuit of the transistor 334 and the rectifier 338 is provided for spike protection of the transistor 334 from the plus 60 volt terminal in the power chassis.

Considering now the amplifier arrangement shown in FIG. 14 which is provided to amplify the output of the elongated sprocket hole transducer element 176, a first operational amplifier 340 is provided for impedance conversion to a relatively low impedance output from the high impedance input of the piezoelectric transducer element 176 without differentiating the pulses produced by this transducer. More particularly, the element 176 is connected through a 15 megohm series resistor 339 to the input of the amplifier 340 and a 3.3 megohm feedback resistor 341 is employed so that the

gain from the transducer 176 to the output of the amplifier 340 is substantially less than one to achieve a high frequency response which is substantially flat to 16,000 kilocycles. This high frequency response is necessary to provide adequate detection of elongated sprocket holes of a length of 0.077 inch with an elongated jewel having a flat bottom edge of a length of 0.062 inch at film speeds in the order of 1,600 feet per minute. The resistor 339 cannot have a value much less than 15 megohms without introducing undesired differentiation of the transducer pulses and the feedback resistor 341 cannot be much larger than 3.3 megohms and still provide faithful reproduction of 16 kilocycle components by the amplifier 340.

A capacitor 342 and resistor 344, connected to the output of the amplifier 340, form a high frequency pre-emphasis circuit and the potentiometer 346 is provided to set the level at which a diode 352 will conduct and transmit pulses to a second operational amplifier 354.

When a splice is encountered by the elongated jewel element 100, this element is moved outwardly away from the straight line film path between the pulleys 42 and 32 and a large pulse is produced at the leading edge of the splice which is supplied through a diode 343 to a time constant circuit comprising a capacitor 348 and resistor 350 and charges the capacitor 348. Accordingly, when the other end of the splice is encountered and the jewel 100 moves inwardly, i.e., in the same direction that it would move if an elongated sprocket hole were encountered, the voltage across the capacitor 348 is available to offset the negative pulse transmitted through the diode 352 due to this inward movement of the jewel 100, so that a false indication of an elongated sprocket hole is not made and the machine stopped. The output from this voltage combination is supplied to the input of the amplifier 354 and the output of this amplifier is applied to a level setting vernier adjustment which includes an isolating diode 356 and a potentiometer 358. The potentiometer 358 is employed to set the level of pulses which are supplied through a diode 376 to a common amplifier 392 for both edge crack detector channels and the elongated sprocket hole detector channel. The output of the amplifier 392 is coupled through a diode 394 to an indicator circuit and brake indicated generally at 396.

A similar level setting potentiometer 359 is provided in the remote control circuits 219 and is connected by way of the F plug contacts and an isolating diode 357 to the blocking diode 376. The capacitors 360 and 362 filter out hash on the leads which are connected to the remote control circuits 219. Accordingly, the level of pulses necessary to trigger the indicator circuit and brake 396 may be adjusted by adjusting either one of the potentiometers 358 or 359 as desired by the operator.

Considering now the facilities provided for amplifying the signals developed by the two edge crack transducers 146 and 158, these signals are applied to the operational amplifiers 364 and 384, respectively, in such manner as to prevent differentiation of these pulses while providing an output signal at a low impedance level. More particularly, the transducer 146 is connected through a 30 megohm resistor 363 to the input of amplifier 364 and a 30 megohm feedback resistor 365 is employed. This gives a gain of approximately one from transducer 146 to the output of amplifier 364. A similar arrangement is used in amplifier 384. The

minimum level in the two edge crack detector channels is set by the common potentiometer 366 and this potentiometer is normally set by the operator to pass all pulses except those corresponding to very fine hair cracks in the film 132. The potentiometer 366 controls the amplitude of pulses passed through the diode 367 to the input of a second operational amplifier 368 and the output of this amplifier is supplied to an integrating circuit comprising a resistor 369 and a capacitor 371. This integration network establishes a signal which is a function of defect length and the diode 372 may be set to pass pulses anywhere on the integration curve output of the network 369, 371. More particularly, a level setting potentiometer 382 may be employed through the diode 380 to set the level at which the diode 372 will conduct. A similar remote potentiometer 370 and isolating diode 378 is provided for remote control. Thus, very fine hair cracks in the edge of the film may either be detected by adjustment of one of the potentiometers 382 or 370 or can be ignored if desired by the operator. This integration and level setting arrangement permits extremely fine variation in the types of cracks which are detected by the edge crack detector. A similar arrangement is employed for the edge crack detector element 158 wherein the amplifier 384 and 386 are provided and the level of the integrated output which is passed to the diode 374 may be set by either one of the potentiometers 388 or 390. In this connection, it will be noted that a defect output in any one of the three channels shown in FIG. 14 is effective to energize the indicator light in the circuit 396 and stop the machine.

While there has been illustrated and described a single embodiment of the present invention, it will be apparent that various changes and modifications thereof will occur to those skilled in the art. It is intended in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the present invention.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. A film inspection mechanism for detecting defects in the edges of the film, comprising in combination, an arcuate support over which the film may pass, means for advancing the film over the periphery of said support with an edge thereof extending outwardly beyond the side of said support, means for holding the film into engagement with said support with the overhanging portion of the film forming a stiff arcuate portion which will withstand considerable radially outwardly directed force on the concave side thereof without substantial deflection, a feeler element, means for biasing said feeler against the concave side of said overhanging portion with a radially outwardly directed force so that said feeler element moves radially outward when a defect in said edge portion is encountered, and means for developing a control signal in response to said radially outward movement of said second feeler element.

2. The combination of claim 1, wherein said signal developing means includes a member which is mechanically stressed to produce an electrical signal by direct piezoelectric effect.

3. The combination of claim 2, wherein said biasing means comprises a spring tensioned arm in one end of which said feeler element is mounted, said member comprises a piezoelectric element in the form of a cantilever beam positioned so that the free end thereof is in proximity to said spring arm, and means intercon-

necting said spring arm and the free end of said cantilever beam so that said member is stressed in response to said radially outward movement of said first feeler element.

4. In a film inspection mechanism for detecting partial transverse breaks in the film extending inwardly from an edge thereof, the combination of, a base member, a detector assembly pivotally mounted on said base member and movable to a film test position, a pulley rotatably mounted on said assembly and adapted to guide the film in a curved test path when said assembly is in said film test position, the outer edge of the film overhanging the side of said pulley and forming a stiff arcuate portion which resists a radially outwardly directed force, a spring arm mounted on said assembly and carrying a feeler element, said feeler element being positioned to engage the under side of said stiff arcuate film portion when said assembly is in said film test position, and means responsive to radially outward movement of said feeler element when said assembly is in said test position and an edge break in the film is encountered by said feeler element for developing a control signal.

5. The combination of claim 4, which includes second spring arm fixedly mounted on said base member and carrying a second feeler element on the end thereof, said second feeler element engaging the upper side of the film at a point spaced laterally inwardly from said first named feeler element when said assembly is moved to said test position, thereby to hold the film against said pulley as it moves in said curved test path.

6. In a film inspection mechanism for detecting portions of the film such as splices which have a thickness which exceeds a predetermined value, the combination of, a pair of film-receiving rollers adapted to straddle a film, one of said rollers being fixedly mounted, means for moving the other roller toward and away from said one roller, means resiliently biasing said other roller toward said one roller, a piezoelectric element in the form of a cantilever beam, means responsive to movement of said other roller away from said first roller for stressing said element, and means for deriving a control signal in response to stressing of said piezoelectric element which indicates variations in the thickness of the film.

7. The combination of claim 6, wherein said other roller is rotatably mounted on a pivotally movable member, and resilient biasing means for urging said movable member in the direction to move said other roller toward said one roller.

8. The combination of claim 7 which includes stop means for limiting inward movement of said other roller by said biasing means to prevent overstressing of said piezoelectric element.

9. A film inspection arrangement comprising, in combination, a pair of film receiving rollers adapted to straddle the film, means fixedly supporting one roller, a pivotally mounted arm retractably supporting the other roller in relation to said one roller, means for developing an electrical signal in response to movement of said other roller away from said one roller when thickness discontinuities in the film pass between said rollers, means for moving the film between said rollers at a high rate of speed, detector means controlled by said electrical signal for developing an output signal when said thickness discontinuities exceed a predetermined length along the film, and means for automati-

cally compensating said detector means for and in response to changes in the speed of said film so that thickness discontinuities less than said predetermined length do not cause said detector means to produce a false output signal.

10. The combination of claim 9, wherein said detector means includes a storage capacitor, means for charging said capacitor in proportion to the duration of said electrical signal, means normally operative to develop said output signal when the charge on said capacitor reaches a predetermined amount, and means for varying the amount of charge necessary to develop said output signal in inverse relationship to the speed of said film.

11. The combination of claim 9, wherein said film moving means has a predetermined acceleration characteristic, said compensating means develops a second electrical signal simulating said acceleration characteristic, and said detector means is jointly responsive to said first and second electrical signals.

12. A film inspection arrangement comprising, in combination, a pair of film receiving rollers adapted to straddle the film, means fixedly supporting one roller, a pivotally mounted arm retractably supporting the other roller in relation to said one roller, means for developing an electrical signal in response to movement of said other roller away from said one roller when thickness discontinuities in the film pass between said rollers, means for moving the film between said rollers at a high rate of speed, detector means controlled by said electrical signal for developing an output signal when said thickness discontinuities exceed a predetermined length along the film, said detector means including a storage capacitor, means for charging said capacitor in proportion to the duration of said electrical signal, means operative to develop an output signal when the charge on said capacitor reaches a predetermined amount, and means for rapidly discharging said capacitor between electrical signals so that said output signal is not developed in response to a series of closely spaced electrical signals which individually do not charge said capacitor said predetermined amount.

13. In a film inspection mechanism for detecting elongated sprocket holes in the film, the combination of, a base member, a detector assembly pivotally mounted on said base member and movable to a film test position, a first pulley rotatably mounted on said assembly, a second pulley rotatably mounted on said base member and offset from said first pulley when said assembly is in said test position so that the film extends in a straight line from its points of tangency with said first and second pulleys, means for advancing the film over said pulleys and along said straight line portion, a feeler element having a length greater than a normal sprocket hole in the film, means including a spring arm for resiliently biasing said feeler element into engagement with said straight line portion of the film and in alignment with sprocket holes in the film when said assembly is in said film test position, means for developing a control signal in response to movement of said feeler element into the film path when elongated holes are encountered, said signal developing means including a member which is mechanically stressed to produce an electrical signal by direct piezoelectric effect, said member comprising a piezoelectric element in the form of a cantilever beam positioned so that the free end thereof is in proximity to said spring arm and

means interconnecting said spring arm and the free end of said cantilever beam so that said piezoelectric element is stressed in response to movement of said feeler element, and means defining a stop member fixedly positioned adjacent the free end of said piezoelectric element, and vibration damping means positioned between the free end of said piezoelectric element and said stop member.

14. The combination set forth in claim 13, wherein said stop member is adjustable.

15. In a film inspection mechanism for detecting elongated sprocket holes in the film, the combination of, a base member, a detector assembly pivotally mounted on said base member and movable to a film test position, a first pulley rotatably mounted on said assembly, a second pulley rotatably mounted on said base member and offset from said first pulley when said assembly is in said test position so that the film extends in a straight line from its points of tangency with said first and second pulleys, means for advancing the film over said pulleys and along said straight line portion, a feeler element having a length greater than a normal sprocket hole in the film, means including a spring arm for resiliently biasing said feeler element into engagement with said straight line portion of the film and in alignment with sprocket holes in the film when said assembly is in said film test position, means for developing a control signal in response to movement of said feeler element into the film path when elongated holes are encountered, said signal developing means including a member which is mechanically stressed to produce an electrical signal by direct piezoelectric effect, said member comprising a piezoelectric element in the form of a cantilever beam positioned so that the free end thereof is in proximity to said spring arm and means interconnecting said spring arm and the free end of said cantilever beam so that said piezoelectric element is stressed in response to movement of said feeler element, and including means defining a stop member fixedly positioned adjacent the free end of said spring arm, and vibration damping means positioned between the free end of said spring arm and said stop member.

16. The combination set forth in claim 15, wherein said stop member is adjustable.

17. A film inspection arrangement comprising, in combination, a pair of film receiving rollers adapted to straddle the film, means fixedly supporting one roller, a pivotally mounted arm retractably supporting the other roller in relation to said one roller, means for developing an electrical signal in response to movement of said other roller away from said one roller when thickness discontinuities in the film pass between said rollers, means for moving the film between said rollers at a high rate of speed, detector means controlled by said electrical signal for developing an output signal when said thickness discontinuities exceed a predetermined length along the film, and means for preventing said detector means from responding to electrical signals which do not exceed a predetermined minimum amplitude, said detector means including signal amplifying means, and signal integrating feedback means for said amplifying means, said feedback means causing electrical signals of less than a predetermined duration to be amplified by said amplifying means with substantially reduced gain.

18. A film inspection arrangement comprising, in combination, a feeler element positioned on the end of

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a flexible spring arm member, means including said spring arm for resiliently biasing said feeler element into engagement with a moving film, means including a piezoelectric transducer element which is mechanically stressed in proportion to movement of said feeler element for developing an electrical signal by direct piezoelectric effect, means for amplifying said electrical signal without substantial differentiation of the signal components thereof, an integrating network connected to the output of said amplifying means for developing a modified output signal the amplitude of which is a function of the duration of said developed electrical signal, an amplitude selection means connected to said integrating network for selecting only those modified output signals which exceed a predetermined value.

19. A film inspection arrangement comprising, in

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combination, a feeler element positioned on the end of a flexible spring arm member, means including said spring arm for resiliently biasing said feeler element into engagement with a moving film, means including a piezoelectric transducer element which is mechanically stressed in proportion to movement of said feeler element for developing an electrical signal by direct piezoelectric effect, and means for amplifying said electrical signal without substantial differentiation of the signal components thereof, said electrical signal developed in response to elongated sprocket holes in the film, and means for preventing said amplifying means for falsely responding to movements of said feeler element which are caused by splices in the film.

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