Jan. 10, 1961 W. M. FLOOK, JR 2,967,947

SHEET INSPECTION METHOD AND APPARATUS

Filed Oct. 4, 1956 3 Sheets-Sheet 1

Fig. 1

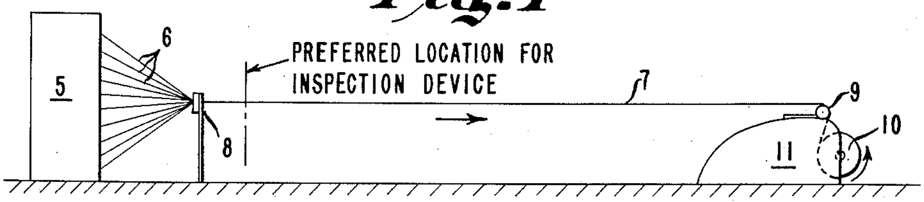


Fig. 2

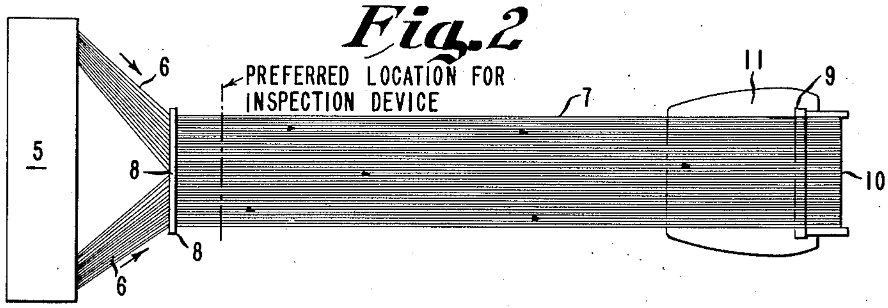


Fig. 3

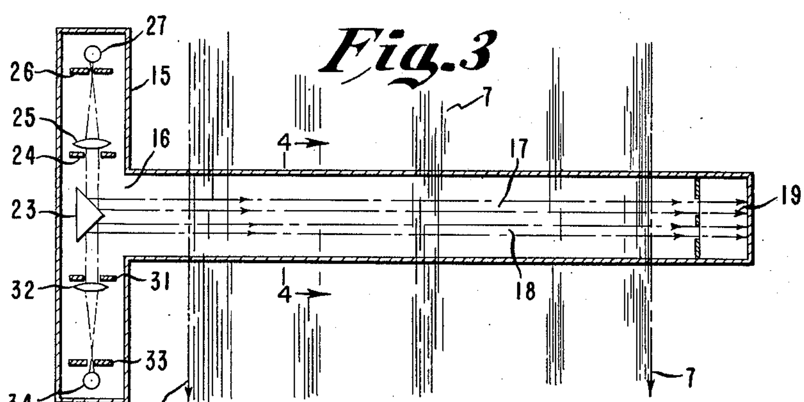
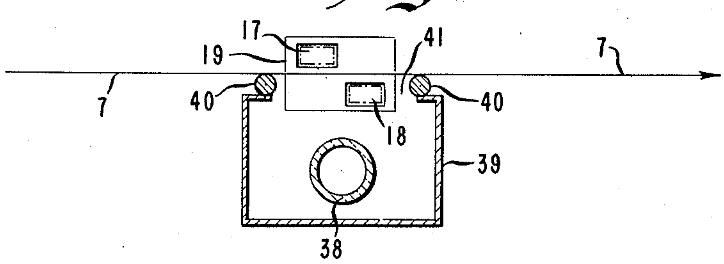


Fig. 4



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Jan. 10, 1961 W. M. FLOOK, JR 2,967,947

SHEET INSPECTION METHOD AND APPARATUS

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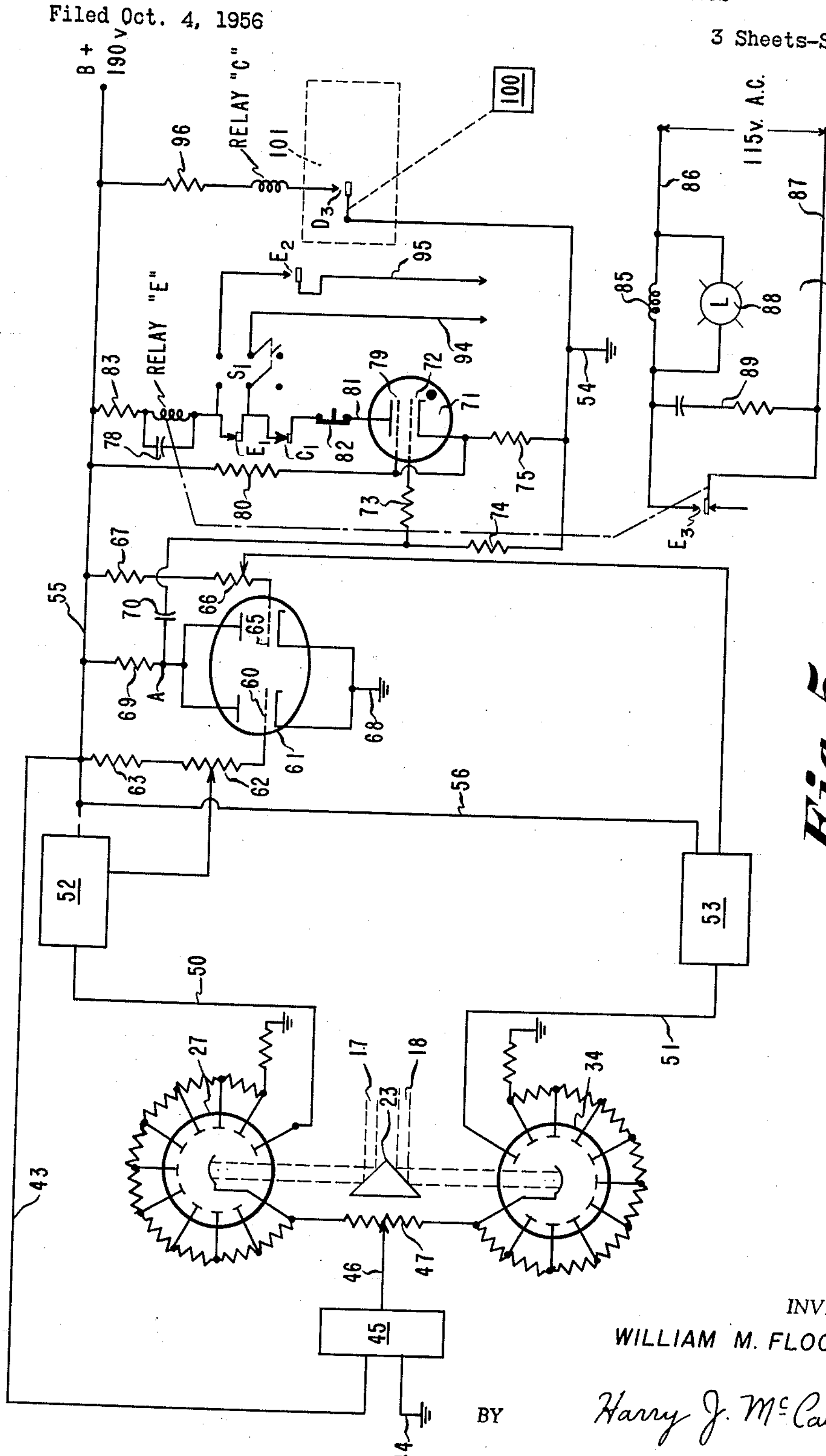

Fig. 5

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Fig. 6

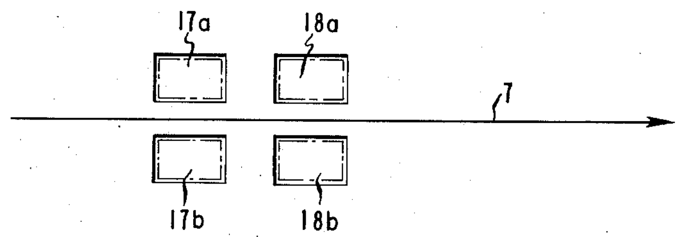
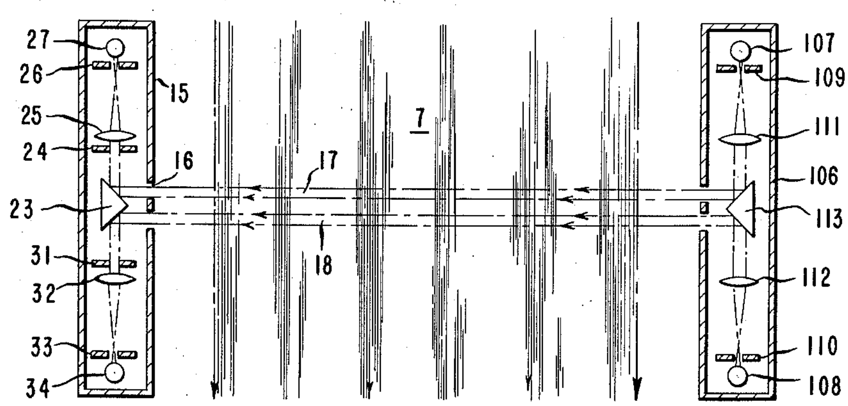


Fig. 7



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SHEET INSPECTION METHOD AND APPARATUS

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Filed Oct. 4, 1956, Ser. No. 613,926

9 Claims. (Cl. 250—219)

This invention relates to a method and apparatus for the inspection of a running sheet such as a textile yarn warp sheet, woven textile fabric, paper or the like, and particularly to a method and apparatus for the continuous inspection of a warp sheet of heavy denier yarn made up of textile tire cord yarn or similar strands.

Textile tire cord is typically made up from twisted filaments of yarn of about 840 denier. It is convenient to beam the yarn on a large common spool which often contains a multiplicity, typically 160, of ends wound adjacent one another, so that each end can be again unwound without interference from other ends by the purchaser who utilizes the yarn in the fabrication of tire cord. A number of small packages of yarn are commonly wound on the beam for each yarn end, the yarn from one package being spliced to that of a succeeding package with weaver's knots, which is an acceptable procedure not affecting the quality of the product. An average of 300 passable knots may occur in the processing of 160 individual yarn ends in the course of an hour of normal production, therefore, any inspection procedure must discriminate successfully in favor of passage of the knots as non-objectionable phenomena over true defects. Another anomaly which exists, but which is not presently classified in the trade as a cause for rejection, is the existence of loops, which may result from one or more monofilaments being longer than the rest and projecting from the yarn.

A more serious defect is the so-called "fluff ball," which usually consists of a small twisted mass in the yarn resulting from a break in one or more monofilaments at one point, or the collection of substantial lengths of such broken monofilaments at one point in the yarn. This defect is objectionable because it usually is accompanied by a loss of strength, if caused by the breakage of one or more filaments, and by difficulties in subsequent handling due to interference occasioned by the existence of the fluff ball in the product. Accordingly, it is the present practice to subject the running yarn to visual inspection, stopping the yarn in its travel whenever an objectionable number of fluff balls is determined to exist, cutting out the objectionable area, retying the severed ends and passing the product on to the beam. Visual inspection is tedious, vulnerable to human failure, and reduces production output, since the yarn could normally be wound at relatively high speeds if it were not for the necessity for slow speeds imposed by the inspection procedure. The following description is particularly directed to the inspection of yarn warp sheets; however, it will be understood that inspection of other sheet-like materials is equally feasible by the use of this invention and the term "sheet" as utilized herein is intended to comprehend opaque and transparent webs, such as paper, plastic, woven textile fabric and the like, as well as a multiplicity of running yarn ends disposed in generally parallel relationship in the manner of a textile warp.

An object of this invention is to provide an automatic

inspection procedure for running sheets traveling at very high speeds. Other objects of this invention are the provision of an electro-optical inspection method and apparatus for a warp sheet of running yarns which is capable of discriminating between passable and non-passable anomalies in the yarn to effect evaluation on the proper basis, and which can operate rapidly enough to detect defects at substantially greater operating speeds than are now possible. Further objects of this invention are the provision of a very stable sheet inspection apparatus which is capable of counting defects and giving a warning signal whenever a rejectable defect is encountered, together with automatic stopping of windup, if desired, which are achieved as brought out in the detailed description and the drawings, in which:

Fig. 1 is a partially schematic side elevation of a multiple end yarn beaming installation,

Fig. 2 is a top plan view of the installation of Fig. 1,

Fig. 3 is a schematic representation in sectional plan of a preferred embodiment of the optical arrangement of the inspection apparatus of this invention,

Fig. 4 is a section taken transverse the sighting paths on line 4—4 of Fig. 3,

Fig. 5 is a schematic representation of an electrical circuit adapted for use in conjunction with the optical arrangement of Figs. 3 and 4,

Fig. 6 is a schematic representation transverse the sighting paths of a split path embodiment of this invention, and

Fig. 7 is a schematic representation in sectional plan of an optical arrangement of inspection apparatus according to this invention wherein light beams are employed to scan the running yarn warp sheet.

Generally, this invention consists of a method and apparatus for sensing a defect in a running sheet in a pair of discrete regions spaced lengthwise of the sheet a sufficient distance apart so that rejectable defects solely are sensed coincidentally for both of the regions, and obtaining an indication of any defects responsive to coincidental sensing in the two regions.

A great variety of transducers are adapted to sense the existence of individual defects in a selected region of a running sheet, typical examples being a deflectible wire stretched across the sheet closely adjacent thereto and connected in circuit with a pulsing microphone, conventional capacitometers of various types, and other devices; however, it is preferred to utilize electro-optical means for conducting inspection according to this invention. In the following detailed description relating to electro-optical inspection systems particularly, the term "sighting path" is employed as a species comprehended within the generic term "discrete regions of defect sensing."

Referring to Figs. 1 and 2, yarn to be beamed is supplied from a multiplicity of packages mounted in a creel indicated generally at **5**, which deliver a plurality of yarn ends **6** for windup on a beam **10** driven by a conventional beaming machine **11**. The yarn warp sheet **7**, consisting of approximately 160 separate strands, is formed as a flat sheet of individual yarn strands disposed closely adjacent one another by convergence guide **8**, which receives ends **6** from the creel. In a typical case, warp **7** may be 54" wide and convergence guide **8** is spaced away from idler roll **9** on beaming machine **11** a distance far enough to permit stopping the yarn windup process, if desired, upon detection of a defect within a short enough time interval to remedy matters before the yarn is wound up on beam **10**.

A preferred arrangement of apparatus for effecting inspection according to this invention utilizing a pair of unitary discrete regions of defect sensing is shown in

Figs. 3 and 4. All of the optical components are preferably mounted within a common light-tight housing **15** which is provided with an opening **16** oriented transverse warp **7**. Opening **16** is sufficiently wide to accommodate two sighting paths **17** and **18** normal to warp **7**, path **17** (refer Fig. 4) preferably being disposed on the opposite side of the yarn from path **18**, although this is not essential. Paths **17** and **18** terminate in light trap **19**, which is simply a box closed at all points except for apertures in line with the sighting paths and painted on the inside with light absorptive black paint to provide a constant reference for operation of the apparatus and, at the same time, reduce the ambient light normally incident on photomultiplier detectors **27** and **34** hereinafter described.

Sighting path **17** is spaced from sighting path **18** a sufficient distance along the direction of yarn travel so that only rejectable defects will lie across both channels simultaneously and, thereby, give a coincidence signal, as hereinafter described, representative of anomalies which constitute a basis for rejection. That is, the spacing between sighting paths **17** and **18** in the direction of yarn travel is equal to the minimum length of defect it is desired to base rejection upon. Normally, a spacing of ¼" is satisfactory to achieve the necessary discrimination. The ends of the sighting paths within housing **15** terminate at silvered reflective 90° prism **23**, one face of which is disposed transverse sighting path **17** and the other face of which is disposed transverse sighting path **18**. Reflected light from path **17** is passed through collimating lens **25**, which is mounted behind light mask **24**, the light from lens **25** being thereby focused through the aperture of mask **26**, disposed at the focal point of lens **25**, on the light-sensitive cathode of photomultiplier cell **27**. The aperture of mask **26** in a typical case was 0.010" wide, the lens **25** used therewith having a focal length of 8". A completely symmetrical optical counterpatr consisting of light mask **31**, collimating lens **32**, mask **33**, and photomultiplier cell **34** is provided for the sighting path **18**.

Referring to Fig. 4, the light for the system is provided by a fluorescent tube bulb **38**, which may be a General Electric type 90/T17 operated on direct current with periodic reversal of polarity as hereinafter described, mounted in housing **39** open at **41** along the side adjacent yarn warp **7**. Although light source **38** is mounted beneath the yarn warp, it serves to also illuminate the region above the warp as well as the region below the warp, because light passes freely through the spaces between the running yarn strands. Smooth, wear-resistant steady rests **40** are preferably provided in abutment with the yarn warp at the opening of housing **39** to prevent cyclic vibrations or fluttering of the warp sheet, such as might occur from windage or the like. Where the distance between the inspection apparatus and guide **8** is relatively great, steady rests **40** are preferably supplemented by passing yarn warp **7** in an S-wrap about a pair of freely rotating rollers before the yarn passes to rests **40**.

One conventional circuit which has performed satisfactorily in conjunction with the inspection apparatus of this invention is detailed schematically in Fig. 5. As shown, light reflected from prism **23** is impressed on the cathode elements of photomultiplier tubes **27** and **34** individually, the output of photomultiplier **27** being representative of conditions existing along sighting path **17**, whereas the output signal of photomultiplier **34** is representative of conditions existing along sighting path **18**.

The power supply for photomultiplier tubes **27** and **34**, indicated generally at **45**, may deliver a thousand v. D.-C. filtered output, as does a Powell high voltage unit, which is utilized in association with a suitable auxiliary, such as a Model 28 Lambda power supply. The power input to supply **45** is derived from power supply line **55** through lead **43**, **44** being an electrical ground, and the output is delivered through lead **46** and the tap of resistor **47**, to the cathodes of tubes **27** and **34** in conventional manner. The amplified electrical output signals representative of the light amounts impressed on the respective cathodes are passed through leads **50** and **51** connected to the anode elements of the photomultiplier tubes to A.-C. adjustable gain voltage amplifiers **52** and **53** (operative in the 20–1000 c. range approximately), respectively. A.-C. amplifiers are utilized because the signals processed by the apparatus are electrical pulses and, accordingly, steady state D.-C. conditions have no effect on operations. Operating power is supplied to amplifier **52** by direct connection with B+ 190 v. power supply line **55**, while amplifier **53** is powered from the same source by connection through lead **56**. The circuit past the amplifiers is also powered from line **55**, the electrical circuit being completed through common ground **54**.

The output of amplifier **52** is impressed on grid **60** of the first section of double triode section coincidence circuit tube **61** (which may be a 12AX7 type) through tapped resistor **62** (typically 5 megohms) connected in series with fixed resistor **63** (which may be 22 megohms) to power lead **55**. Similarly, the output of amplifier **53** is impressed on grid **65** of the other triode section of tube **61** through tapped resistor **66** in series with fixed resistor **67**, also connected to lead **55**. The cathode elements of both of the triode sections of tube **61** are grounded at **68**, while the plate elements of both of the triode sections are connected together to line **55** through fixed resistor **69**, which may have a magnitude of about 270K. The output signal of tube **61** is derived through coupling capacitor **70** (typically 0.01 mfd.) and impressed on the control grid **72** of thyratron tube **71** (which may be a type 2D21) through series resistor **73** (which may be a 100K resistor). Grid resistor **74** (of about 220K value) is connected to ground **54**. Thyratron cathode resistor **75** and resistor **80** together constitute a voltage divider to provide the appropriate cathode bias. The suppressor grid **79** is connected to the cathode element of tube **71** as is conventional practice.

The output signal from thyratron **71** is drawn from the plate element thereof through lead **81** connected to one contact of normally closed pushbutton switch **82**, the other contact of which is connected in series with normally closed relay contacts C_1 operated by relay C, hereinafter described. The circuit to power supply line **55** is completed through normally closed relay contacts E_1 of relay E, which are connected in series with the relay coil and fixed resistor **83**. Relay E may be a three contact type of 15 ma. size provided with a holding capacitor **78** of approximately 8 mfd. capacitance.

Two auxiliary circuits are provided to: (1) obtain a count of rejectable defects as these occur from time to time and (2) halt windup of the yarn by beaming machine **11**, at the operator's option, so as to permit cutting fluff balls or other defects from the ends and retying them prior to winding product on beam **10**.

The counter circuit, indicated generally at **84**, consists of a counter actuation coil **85** connected in series through normally open relay contacts E_3 of relay E with 115 v. A.-C. power lines **86** and **87**. An operative condition verifying flash lamp **88** is preferably connected in shunt with coil **85**, and an R-C arc suppressor network **89** is connected in shunt with relay contacts E_3.

A practical control circuit for beaming machine **11** utilizes a manually operated double pole, double throw switch S_1, the left-hand side of which is effective, when closed on the upper pair of switch contacts, to shunt the output signal from thyratron **71** around relay contacts E_1. The right-hand side in upper switch closure position is simultaneously effective to complete the circuit through control leads **94** and **95** in the power supply circuit (not further shown) of beaming machine **11**. An interlock is provided through normally open relay contacts E_2 of relay E, which are connected in series with leads **94** and

95. The lower pair of contacts of switch S_1 are open circuited.

The circuit includes relay C, which is connected in series with resistor **96** from power supply line **55** to ground **54** through normally open switch contacts D_3. Contacts D_3 are closed periodically at predetermined intervals of an hour, or somewhat longer, by a conventional timing cam, indicated generally at **100**, through the driving connection shown in broken line representation. Relay C is provided with additional contacts, not further detailed herein, which operate in the power supply **101** of fluorescent tube bulb **38** to thereby reverse the polarity thereon, as hereinbefore mentioned. This polarity reversal avoids localized accelerated deterioration of the phosphor lining of **38** with accompanying objectionable uneven illumination of the yarn.

In operation, it will be understood that a fluff ball or other rejectable defect in the running yarn will obtrude beyond the plane of yarn warp **7** either above or below the yarn, where it reflects light incident on it from fluorescent tube bulb **38** along the sighting paths. To constitute a registered defect, as hereinbefore brought out, light must be reflected simultaneously along both sighting paths **17** and **18**, so as to produce a signal of appropriate potential by actuation of coincidence circuit tube **61**. Tube **61** is operated so that each of its triode sections are normally conducting to saturation. Under these circumstances, the negative signal derived at the grid responsive to light impinging on a photo-multiplier tube, such as **27** as an example, immediately cuts off current flow through the associated triode section and raises the potential at point A in the plate circuit a finite amount. In the typical circuit described, the parameters are chosen so that cutoff of the left triode section results in a rise of potential at point A from an ambient level of about 40 v. to about 60 v., a rise of 20 v., whereas cutoff of both sections raises the potential of point A to the level of the B+ supply, or approximately 190 v.

Thyratron **71** in this instance was adjusted to fire on a sudden voltage rise of about 30 v., so that the thyratron will fire only when there is coincidental cutoff of both of the triode sections of tube **61**. Since cutoff of both sections occurs only in the presence of a rejectable defect, it will be understood that discrimination is thereby achieved against all anomalies except those which are known to be of rejectable nature. If this criterion is met, grid **72** of thyratron tube **71** has impressed thereon a positive signal, which causes the thyratron to conduct with delivery of an output pulse to relay E.

Assuming that switch S_1 is in open position as shown in Fig. 5, the output pulse from thyratron **71** causes relay E to close contacts E_3 in the counter circuit, which permits current to flow temporaily through coil **85**, thus giving a single count. Relay E at the same time acts to open relay contacts E_1, and to hold them open for a finite interval by the time delay action of capacitor **78**. This time interval is proportioned to permit sufficient time for counter **84** to make a count while, at the same time, restoring the circuit to detection condition as rapidly as practicable to safeguard against registration of a plurality of defects as only a single defect. Opening of relay contacts E_1 terminates conduction through thyratron **71**, whereupon the tube is restored to inspecting condition.

With the foregoing operation, inspection is limited solely to the counting of rejectable defects. Where it is desired that beaming halt upon the occurrence of a defect, the operator closes switch S_1 on the upper set of contacts. Switch S_1 then shunts contacts E_1 while, at the same time completing the electrical circuit through control leads **94** and **95**, except for relay contacts E_2. If the apparatus now detects a defect, contacts E_2 close and an appropriate signal passes through leads **94** and **95**, halting windup by beaming machine **11** until the operator can remove the defect from warp **7**, or otherwise take corrective action. Opening of relay contacts E_1 does not, with this operation, halt conduction through thyratron **71** and the operator must open switch **82** manually to clear the circuit for further inspection service, thus insuring that attention has been given to matters before resumption of beaming. The counter circuit is, of course, actuated through one count corresponding to each individual defect regardless of the setting of switch S_1.

Periodic reversal of polarity of fluorescent tube bulb **38** under control of timing cam **100** will give a spurious rejection signal unless positive safeguards are provided, because some light is always passed to the photomultiplier tubes due to stray light effects, which light drops to zero level when bulb **38** goes off during polarity reversal. Relay C averts the possibility of spurious signals by opening relay contacts C_1 upon closure of switch contacts D_3 a slight interval in advance of polarity reversal. With contacts C_1 open relay E remains unenergized and there is no defect registration by the apparatus for the brief interval contacts D_3 remain closed. Since polarity reveral requires only a few milliseconds time, and occurs but once during an hour or more of operation, this is no serious disadvantage.

The gains of amplifiers **52** and **53** are adjustable, as hereinbefore described, which permits adjustment of the sensitivity of the inspection apparatus with respect to density of defects encountered.

In some instances improved defect discrimination is obtained by the use of a pair of split path regions of defect sensing, such as the sighting paths represented in Fig. 6. Here each sighting path is divided into two separate portions, the leading path consisting of **17*a***, above warp **7**, and **17*b***, below the warp. Similarly, path **18** is divided into an upper part **18*a*** and a lower part **18*b***, each disposed along the line of warp travel with a spacing of about ¼" from their counterparts in path **17**, as hereinbefore described for the embodiment of Figs. 3 and 4. The cross sectional areas of **17*a*** and **17*b*** may each be about equal to that of **17** previously described, **18*a*** and **18*b*** each then equalling **18**. The optical system for the arrangement of Fig. 6 is identical with Fig. 3, it being understood that radiation received along the two split portions of each sighting path now passes to a common detector for each path and that operation is otherwise identical with that hereinbefore described. The increased reliability of the scanning arrangement of Fig. 6 is probably due to the fact that each sighting path now views areas both above and below the warp. Unsymmetrical defects which may project, for example, more above the warp than below it are less likely to fail to yield coincidence signals.

While it is preferred to conduct the inspection with defect sensing based on light reflected from individual defects, it is also practicable to employ selective interruption of light transmission in the sensing, a preferred optical arrangement for which is detailed in Fig. 7. Here the detection side of the system is identical with that shown in Fig. 3; however, the opposite side corresponding to what was formerly light trap **19** is now housing **106** for the light source, which may be two independent 50 watt incandescent light bulbs **107** and **108**, each disposed back of individual masks **109** and **110**, respectively, in line with collimating lenses **111** and **112**, respectively. The two light beams are deflected along sighting paths **17** and **18** by silvered reflective 90° prism **113** and constitute the defect sensing means by virtue of selective interruption of light transmitted therealong responsive to the presence of rejectable defects. It will be understood that the same electrical circuit as shown in Fig. 5 can be employed in conjunction with the embodiment of Fig. 7, except that it is now necessary to adjust the gain control suitably to accommodate for the changed ambient light level. When the arrangement of Fig. 7 is utilized, fluorescent tube bulb **38** is dispensed with.

The split sighting path arrangement of Fig. 6 may, if desired, be employed with defect sensing by the apparatus of Fig. 7, conventional light dividers being then employed to define the separate light beams which are directed along paths **17***a*, **17***b*, **18***a*, and **18***b*.

It will be understood that the several embodiments hereinbefore described for the inspection of warp sheets are equally applicable to the inspection of sheet materials generally, such as paper, plastic, textile fabrics and the like, except that it is, of course, then necessary to use an individual light source on opposite sides of the sheets wherever the sheets are light-opaque.

From the foregoing it will be understood that my invention provides a method and apparatus capable of inspecting running sheet material which is adapted to distinguish between rejectable defects and non-rejectable anomalies rapidly and dependably, and that numerous alterations can be made therein without departure from the essential spirit, wherefor it is intended to be limited only by the following claims.

What is claimed is:

1. An apparatus for the inspection of a running sheet for defects protruding along a normal to said sheet comprising in combination a pair of sighting paths disposed transverse said sheet closely adjacent thereto in planes substantially coparallel to the plane including said running sheet and spaced apart in the direction of sheet travel a distance equal to the minimum length of defect it is desired to base rejection upon, a light source directed at said sheet in the vicinity of said sighting paths, and electro-optical means responsive to light reflected along said sighting paths from said defects consisting of a pair of individual photomultiplier tubes each responsive to light from one of said sighting paths solely, a voltage amplifier in electrical circuit with the output of each of said photomultiplier tubes individually, a coincidence circuit including a vacuum tube having two triode sections, the grid of one of which triode sections is in electrical circuit with the amplified voltage output of one said photomultiplier tube while the grid of the other of said triode sections is in electrical circuit with the amplified voltage output of the other of said photomultiplier tubes, a thyratron tube having its control grid in electrical circuit with the combined output of both of said triode sections of said vacuum tube in said coincidence circuit, and means responsive to the output of said thyratron tube indicating the existence of individual ones of said defects.

2. An apparatus for the inspection of a running sheet according to claim 1 wherein said light source consists of a fluorescent tube operated on direct current having means periodically reversing the polarity of said direct current across the terminals of said fluorescent tube and a switch momentarily rendering said electro-optical means indicating the existence of defects in said sheet inoperative during the time interval in which said polarity is in course of reversal.

3. An apparatus for the inspection of a running sheet for defects protruding along a normal to said sheet comprising in combination a pair of sighting paths disposed closely adjacent to and transverse said sheet in planes substantially coparallel to the plane including said running sheet, each of said sighting paths being split into a portion disposed above said sheet and another portion disposed below said sheet, the corresponding portions of each sighting path being spaced apart in the direction of sheet travel a distance equal to the minimum length of a defect it is desired to base rejection upon, a light source directed at said sheet in the vicinity of said sighting paths, and electro-optical means responsive to light reflected along said sighting paths from said defects indicating the existence of individual ones of said defects which obtrude coincidentally in said pair of sighting paths.

4. An apparatus for the inspection of a running sheet for defects protruding along a normal to said sheet comprising in combination a pair of sighting paths disposed transverse said sheet directed toward the region closely adjacent to said running sheet in planes substantially coparallel to the plane including said running sheet, and spaced apart in the direction of sheet travel a distance equal to the minimum length of defect it is desired to base rejection upon, a light source directed down each of said sighting paths, and electro-optical means responsive to changes in the amount of light transmitted down each of said sighting paths due to the presence of a defect in said paths indicating the existence of individual ones of said defects which obtrude coincidentally in said pair of sighting paths.

5. A method for the inspection of a running sheet for defects protruding along a normal to said sheet, comprising scanning the space closely adjacent to said running sheet in planes substantially coparallel to the plane including said running sheet, detecting the presence of a defect in each of a pair of discrete regions spaced apart lengthwise of said sheet a distance equal to the minimum length of a defect it is desired to base rejection upon, and obtaining an indication of any defects responsive to coincidental detecting in said pair of discrete regions.

6. A method for the inspection of a running sheet according to claim 5 wherein detecting of said defects in said discrete regions is conducted on opposite sides of said sheet.

7. An apparatus for the inspection of a running sheet for defects protruding along a normal to said sheet, comprising in combination means scanning the space closely adjacent to said running sheet in planes substantially coparallel to the plane including said running sheet, means detecting a defect in said sheet in a pair of discrete regions spaced apart lengthwise of said sheet a distance equal to the minimum length of a defect it is desired to base rejection upon, and means responsive to said means detecting said defect indicating the existence of any defects which are detected coincidentally in said pair of discrete regions.

8. An apparatus for the inspection of a running sheet according to claim 7 wherein said means detecting a defect in said sheet in said pair of discrete regions spaced lengthwise of said sheet are adapted to detect said defects on opposite sides of said sheet.

9. An apparatus for the inspection of a running sheet for defects protruding along a normal to said sheet, comprising in combination a pair of sighting paths disposed transverse said sheet closely adjacent thereto in planes substantially coparallel to the plane including said running sheet, and spaced apart in the direction of sheet travel a distance equal to the minimum length of defect it is desired to base rejection upon, a light source directed at said sheet in the vicinity of said sighting paths, and electro-optical means responsive to light reflected along said sighting paths from said defects indicating the existence of individual ones of said defects which obtrude coincidentally in said pair of sighting paths.

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UNITED STATES PATENT OFFICE
Certificate of Correction

Patent No. 2,967,947 January 10, 1961

William M. Flook, Jr.

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

In the drawings, Sheet 2, containing Fig. 5, should appear as shown below instead of as in the patent:

Jan. 10, 1961 W. M. FLOOK, JR **2,967,947**

SHEET INSPECTION METHOD AND APPARATUS

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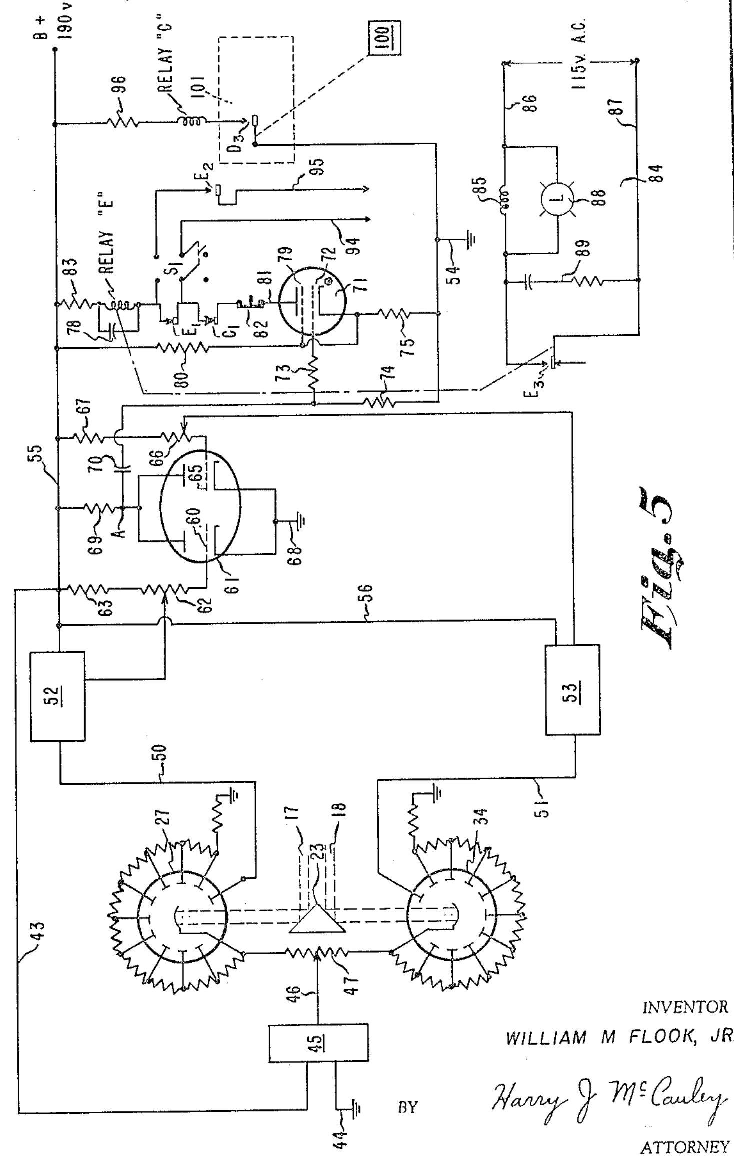

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column 3, line 38, for "patr" read —part—; column 5, line 53, for "temporaily" read —temporarily—.

2,967,947

Signed and sealed this 20th day of June 1961.

[SEAL]

Attest:

ERNEST W. SWIDER,
Attesting Officer.

DAVID L. LADD,
Commissioner of Patents.