Aug. 29, 1950

G. E. MIRFIELD ET AL
APPARATUS FOR CONVEYING AND SORTING
TIN PLATES OR THE LIKE

2,520,324

Filed July 3, 1946

5 Sheets-Sheet 1

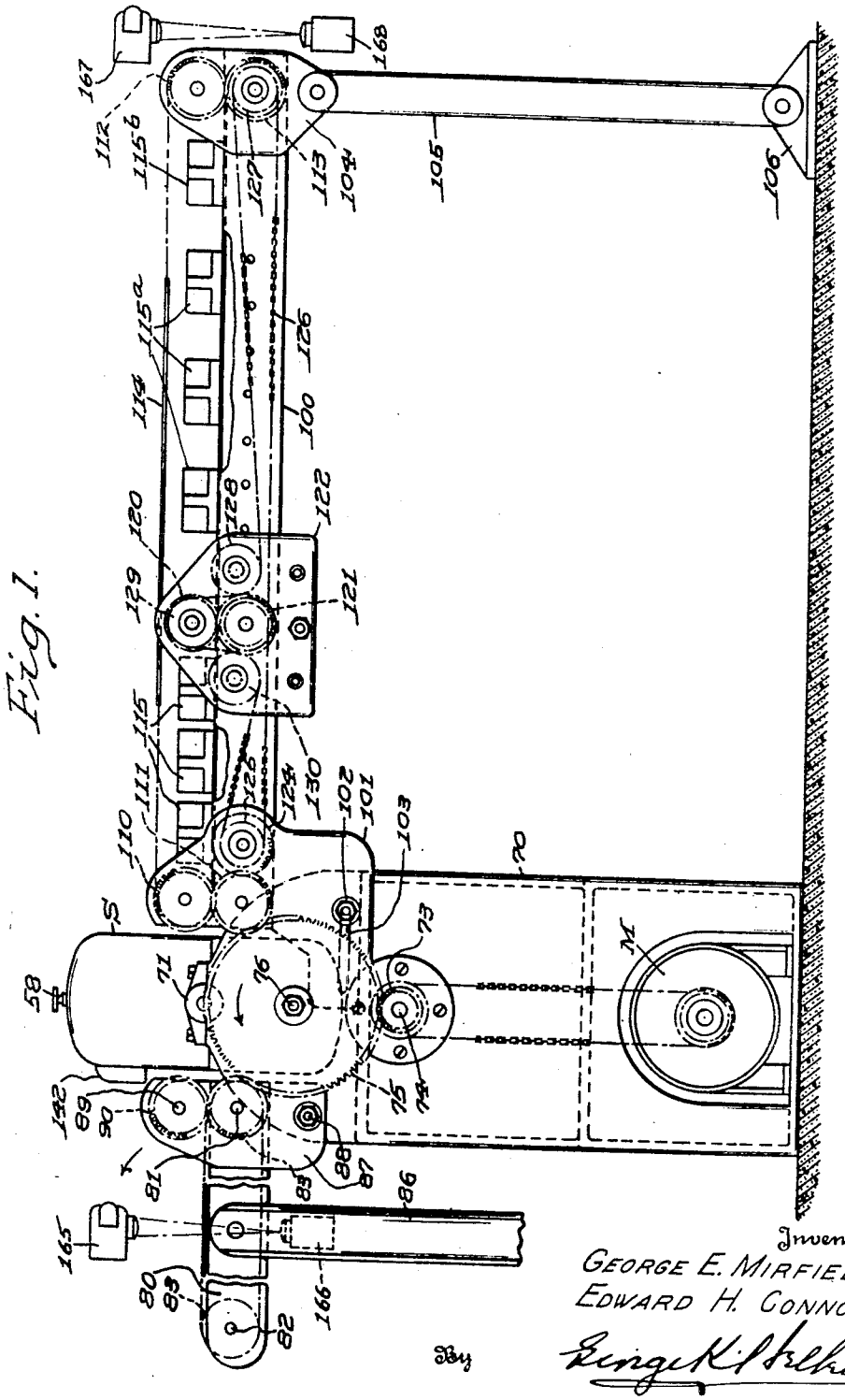


Fig. 1.

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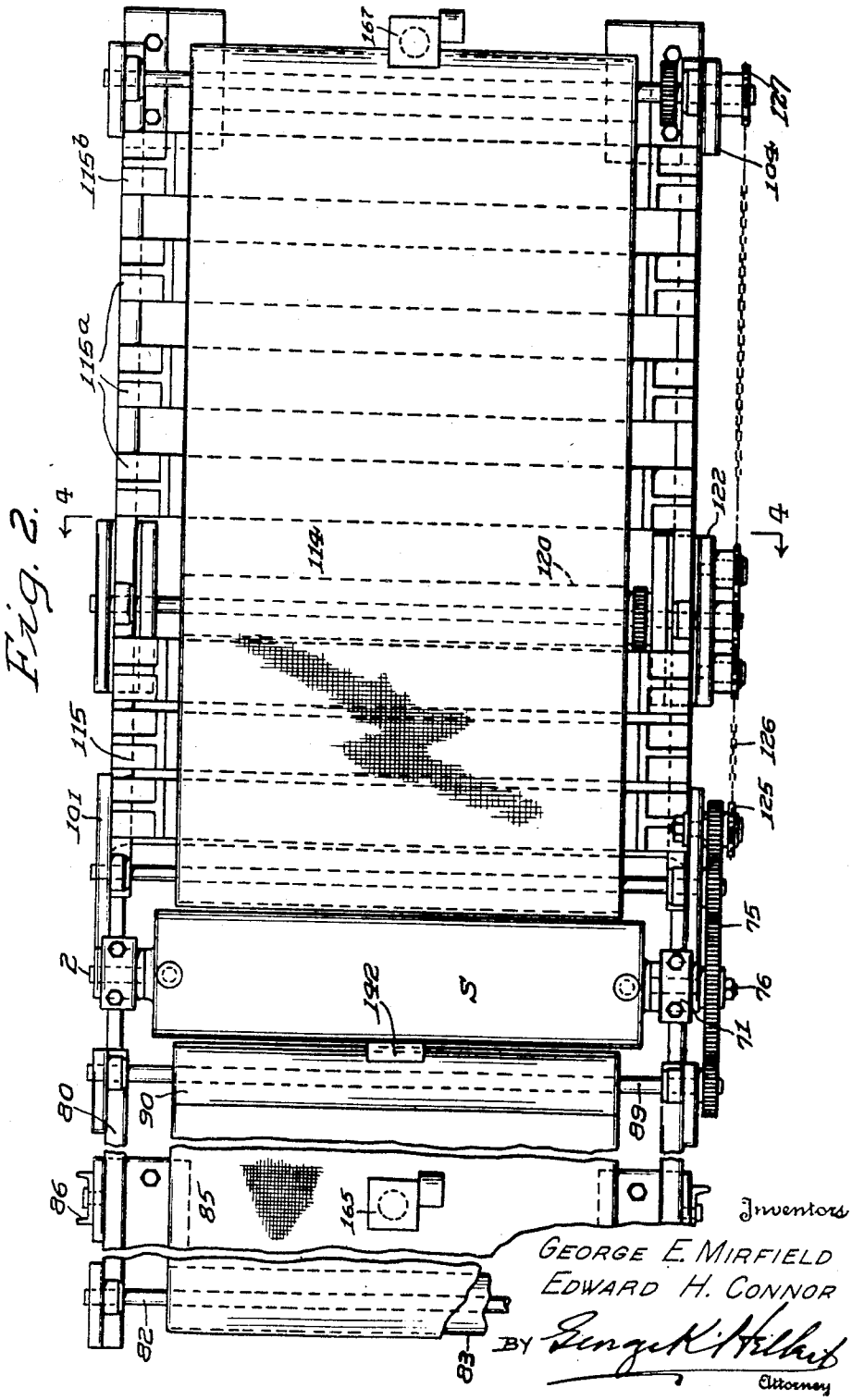
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5 Sheets-Sheet 2

Fig. 2.



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Fig. 3.

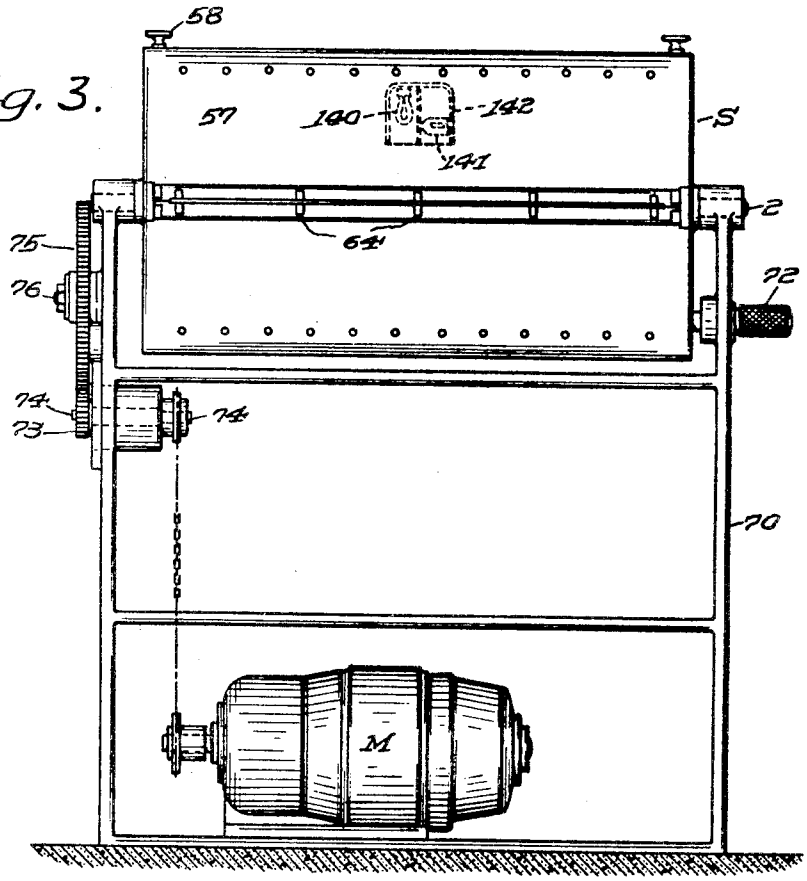
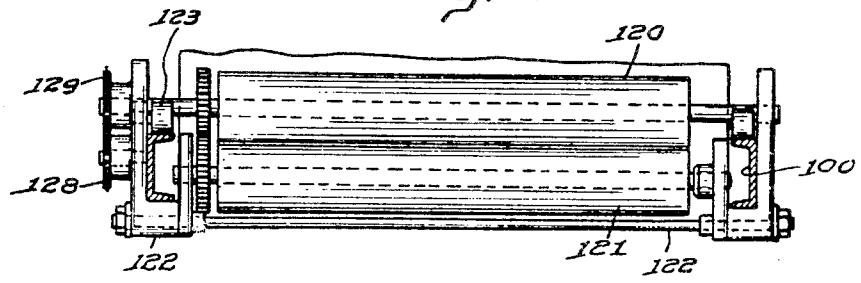


Fig. 4.



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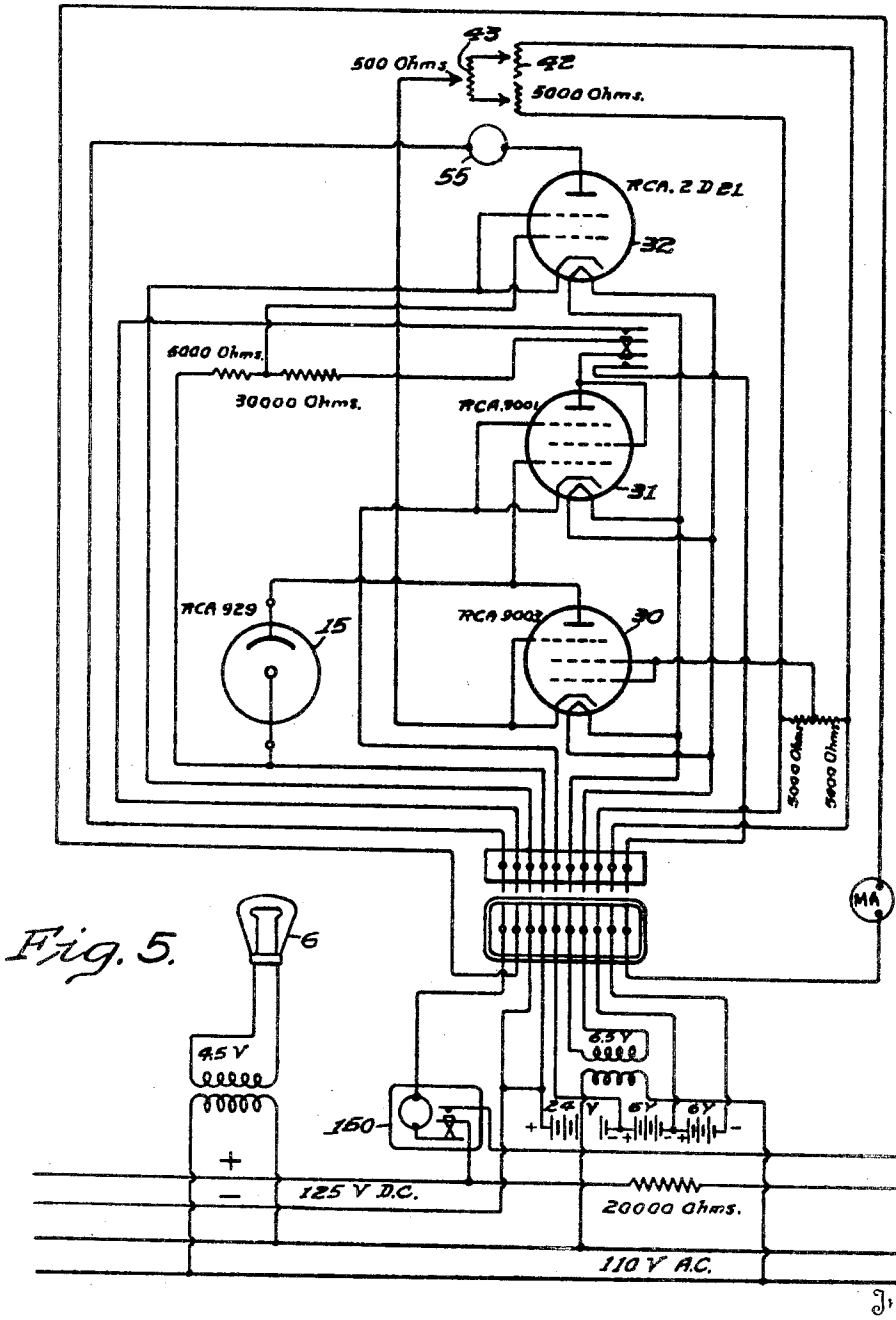


Fig. 5.

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APPARATUS FOR CONVEYING AND SORTING TIN PLATES OR THE LIKE

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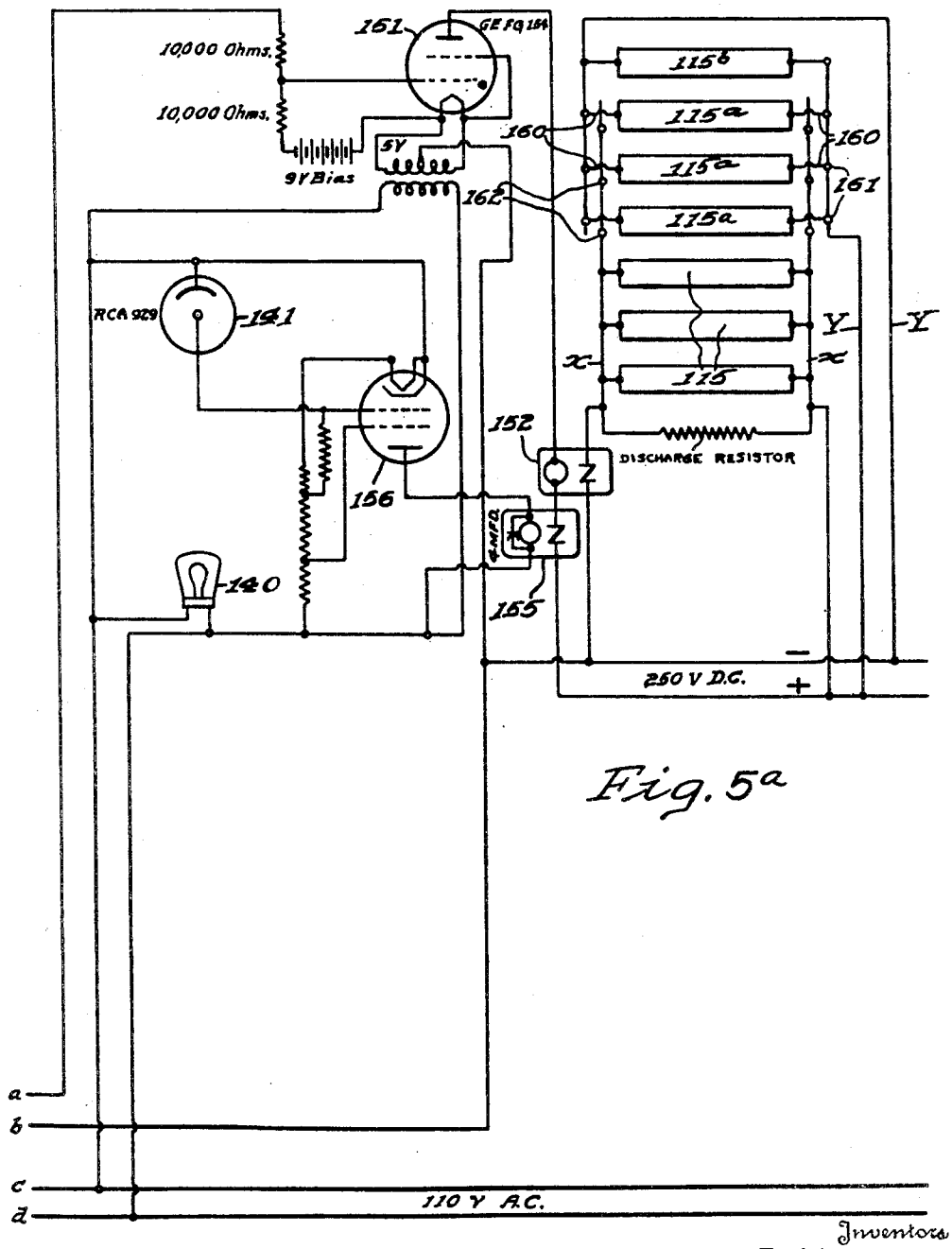


Fig. 5a

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Patented Aug. 29, 1950

2,520,324

UNITED STATES PATENT OFFICE

2,520,324

APPARATUS FOR CONVEYING AND SORTING TIN PLATE OR THE LIKE

George E. Mirfield and Edward H. Connor, Youngstown, Ohio; Thomas W. Craver executor of said George E. Mirfield, deceased

Application July 3, 1946, Serial No. 681,170

4 Claims. (Cl. 209—111)

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In our copending application for Letters Patent of the United States, Serial No. 597,118, filed June 1, 1945, now U. S. Letters Patent 2,430,526 granted November 11, 1947 of which this application is a division, we disclose an apparatus for inspecting tin plate or the like comprising essentially a scanning unit and means for passing the sheets of tin plate consecutively therethrough and then selectively delivering the perfect sheets at one point and the imperfect ones at another as determined by the operation of the scanner as influenced by the presence or absence of imperfections in each sheet as it passes therethrough.

While the said apparatus is therefore designed among other things to receive, inspect and sort sheets consecutively fed to it and, as a whole, we believe marks a distinct advance in the art, the construction and operation of the sorting means is not essentially dependent upon the specific construction and operation of the scanning unit as long as the latter is of a type capable of imparting to the sorting means a suitable indication of the presence of a defect in a sheet when passing through the scanner and thereby condition the sorting means for its reception, so that by the operation thereof it may be diverted from the normal path of the perfect sheets and thus separated from the latter.

Consequently the claims in our said patent are directed more particularly to the scanning unit of our invention and those herein to the sheet feeding and sorting means comprised in the apparatus as a whole.

Therefore the principal object of the invention herein claimed is the provision of conveying means of novel design for feeding tin sheets or the like to and through a scanner adapted to react to the presence of imperfections therein and thence selectively delivering the perfect sheets to one point and the defective ones to another.

A further object is the provision of such means adjustable in accordance with the length of the sheets whereby the maximum number of sheets, irrespective of their length, can be inspected and sorted per unit of time.

A further object is the provision of sheet conveying means of the character aforesaid comprising an endless belt and a plurality of magnets proximate the lower run thereof which, when energized, are effective to hold a sheet moving from the scanner against the belt so it will be carried thereby to a point of ultimate delivery but when deenergized, due to reaction of the scanner to the presence of a defect in a sheet,

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will allow the latter to drop from the belt and thus out of the path followed by the perfect sheets.

Another object is the provision of electrically actuated control means for returning the apparatus to normal operating condition following inspection and ejection of a defective sheet and thereby recondition it for inspection of the ensuing sheet.

Still other objects, advantages and novel features of design, construction and arrangement comprehended by the invention are hereafter mentioned or will be apparent from the following description, taken in conjunction with the accompanying drawings, of apparatus constructed in accordance therewith and adapted for use with sheets of tin plate or the like up to 30" in width and 4' in length to separate the perfect from the imperfect sheets as determined by the operation of the scanner.

Essentially the inspection apparatus as a whole comprises the scanner, the sheet conveying means including a feeding and an exit conveyor between which the scanner is disposed, and the electrical circuits and instrumentalities employed in conjunction with the scanner and the exit conveyor and for reconditioning the apparatus for inspection of the succeeding sheet after the preceding imperfect one has been rejected all as fully disclosed in our said patent; however for present purposes it will suffice to refer to the scanner in a general way and to describe only so much of the preferred electrical circuits and instrumentalities as are required to actuate the sheet sorting means and resetting devices following response of the scanner to the presence of an imperfection in a sheet.

Referring now more particularly to the said drawings, Fig. 1 is a fragmentary somewhat diagrammatic side elevation of the inspection apparatus as a whole;

Fig. 2 is a top plan view thereof;

Fig. 3 is a rear end view of the scanner and supporting frame;

Fig. 4 is a fragmentary section on line 4—4 in Fig. 2 looking in the direction of the arrows; and

Figs. 5 and 5*a*, intended to be read together, are schematic diagrams of electrical circuits and associated instrumentalities preferably employed in the inspection apparatus as a whole.

Like characters of reference are used throughout the drawings to designate the same parts.

The scanner S is preferably but not necessarily of the type more fully described in our said pat-

ent and thus inter alia comprises series of inspection units respectively extending transversely above and below the path of the sheets to be inspected, each unit including a light source 6, a light sensitive cell 15 and amplifying devices 30, 31, whereby as each sheet passes through the scanner each point on its upper and lower surfaces is subjected to the "scrutiny" of one or more of the cells, and if its light reflectivity differs from normal because of the presence of a defect, a change in the normal output of such cell or cells is brought about which is amplified and utilized to actuate the sheet selecting means as hereinafter described.

Each inspection unit in the scanner also includes a neon pilot light 55 so positioned that the light emitted from it will pass through a small window in one or the other of the removable casings 57 which respectively enclose the mechanism within the scanner and are held in position by thumb screws 58, the casings being suitably slotted at their juxtaposed edges to permit passage of the sheets which during such passage move between small rollers 64.

Thus when the various light sources and amplifying devices are suitably energized and the sheet passed through the scanner from left to right in Fig. 1, the beam from the light source 6 associated with each cell is reflected from the sheet and if the zone of the sheet which continuously moves past the point of incidence thereon of the reflected beam is of normal reflectivity from the leading to the rear edge of the sheet, the current induced in the cell will remain constant and the same conditions will obtain with respect to all the other cells. However, if there be a defect in the coating its normal reflectivity is changed and when such defect passes into the field of view of any of the cells the light reflected thereto is consequently reduced which causes a corresponding change in the output of the cell, and, as hereinafter more fully explained in connection with the description of the control circuit, is effective to deenergize the magnets associated with the exit conveyor belt so that the defective sheet is ultimately dropped from the latter instead of being carried by it to the place of delivery of the perfect sheets whereby the imperfect sheets are positively and effectively separated from the perfect ones.

The scanner is supported at the upper end of a frame 70 on trunnions 2 which rest in bearings in the frame beneath caps 71, the arrangement being such that the scanner can be turned on the trunnions from its operative position by withdrawing a spring pressed locking pin 72. In the base of this frame is disposed a motor M which, through a chain and sprocket connection drives a pinion 73 on a stub shaft 74 in turn driving a large gear 75 on a short shaft 76 carried by the frame.

The feed conveyor, located to the left of the scanner in Fig. 1, is of the belt type and thus comprises side members 80 adjacent the ends of which are journaled shafts 81, 82 carrying rolls 83 about which is disposed a belt 85 of canvas or other material which will not mar the sheets. approximately midway between their ends the side members are pivoted on fixed standards 86 and at their forward ends adjacent the scanner are secured side plates 87 removably connected with frame 70 by bolts 88. Thus when the bolts are removed, the side members and attached parts can be swung about the standards in the direction of the arrow in Fig. 1 to a substantially

vertical position. Roll shaft 81 is geared to a superjacent shaft 89 which carries a pinch roll 90 which cooperates with the belt to urge the sheets toward and into the scanner as they are consecutively delivered on the belt either manually or by suitable mechanical delivery means.

The exit conveyor is located on the opposite or right side of the scanner (Fig. 1) to receive the sheets therefrom and similarly comprises a pair of side members 100 to which adjacent the scanner are secured plates 101 which in their lower parts overlie frame 70 and are secured thereto by bolts 102 each extending through a slot 103 in the plate. Side plates 104 attached to members 100 at their opposite ends are pivoted to a link 105 in turn pivoted to a base 106 so that by loosening bolts 102 the conveyor may be slid away from the scanner in a generally horizontal direction. Thus when the feed conveyor is swung to substantially vertical position and the exit conveyor moved away from the scanner as just explained, the latter can be rotated in either direction on its trunnions after pin 72 is disengaged and either before or after the scanner casing is removed thereby greatly facilitating inspection, repair or replacement of any of the scanner parts by providing extremely convenient access thereto.

At its front end adjacent the scanner the exit conveyor is provided with two inter-geared rolls 110, 111, the latter being driven from main gear 75 and operating as a pinch roll, while about the upper roll 110 and a corresponding roll 112 at the far end of the conveyor passes an endless belt 114, roll 112 being geared to a subjacent pinch roll 113. Extending transversely of the conveyor and between the runs of the belt are disposed a plurality of longitudinally spaced magnets 115 which are preferably arranged substantially as shown, that is, in two groups comprising three magnets, each of those in the first group being spaced relatively closely together proximate roll 111 and those 115*a* in the second being spaced more remotely from said roll and at greater distances apart while a single magnet 115*b* is disposed adjacent roll 112, the function of the magnets being to cause each sheet as it passes from the scanner to hug the lower run of the belt whenever the magnets are energized. As hereafter explained, as long as only perfect sheets are passing through the scanner, the magnets are maintained in energized condition with the result that such sheets are carried by the belt to and ultimately pass over roll 113 to another conveyor, piler or the like but when any sheet contains an imperfection to which the scanner responds, the magnets are immediately deenergized and the sheet being no longer supported by the belt falls beneath the exit conveyor as soon as its trailing end clears roll 110, thereby separating it from the perfect sheets.

The maximum length of sheet which can be inspected by the machine as a whole is necessarily determined by the distance between the pinch rolls at the opposite ends of the exit conveyor as if the sheets are longer than this distance imperfect sheets cannot drop between them when the magnets are deenergized. Now if this maximum length is, for example, four feet, it is obvious that if sheets 12" in length are to be inspected they would have to be fed through the scanner at intervals of something over four feet in the absence of the auxiliary pinch rolls hereinafter described, since if they were fed at shorter intervals the response of the scanner to an im-

perfect sheet might deenergize the magnets before the preceding sheet had reached pinch roll 113 at the remote end of the scanner and therefore cause it to drop into the pile of imperfect sheets beneath the conveyor. This result is obviated, however, by provision of auxiliary pinch rolls which can be positioned at a point at which they will grip the leading edge of each perfect sheet before a succeeding imperfect one can deenergize the magnets whereby the former is ultimately carried past roll 113 and the latter falls before it reaches that roll. Consequently before inspecting a batch of sheets of less length than the permissible maximum of four feet the auxiliary rolls are so positioned that imperfect sheets will have just room enough to drop before reaching them with the result that the maximum capacity of the apparatus for sheets of that length is insured.

More particularly said auxiliary inter-geared pinch rolls 120, 121 are carried by shafts journaled in a U-shaped frame 122 supported on small rollers 123 on the side members of the conveyor (Fig. 4) so it can be moved to any desired position therealong and secured therein by any suitable locking means, and with said rolls are associated means for driving them in any position in which they may be located. These driving means may comprise a gear 124 meshing with a gear on the shaft of pinch roll 111 and a sprocket 125 coaxial with and driven from gear 124. This sprocket carries a chain 126 the lower run of which extends over an idler sprocket 127 coaxial with pinch roll 113 at the far end of the conveyor and from which the upper run of the chain is carried beneath an idler 128 on frame 122, thence up and over a driving sprocket 129, thence under a second idler sprocket 130 to return to sprocket 125. The driving sprocket 129 is secured on the shaft of the upper auxiliary pinch roll 120 whose shaft is geared to the shaft of the lower of said rolls 121 so that irrespective of the adjusted position of the frame on the conveyor both of said rolls are positively driven in a direction to grip and urge the sheets toward the far end of the conveyor whenever gear 75 is rotated.

It may be noted at this point that a small electric lamp or other light source 140 and a photocell 141 are shown in Fig. 3 as disposed in a housing 142 attached to the upper section of the scanner casing, the housing being open at its bottom so that light from source 140 is reflected from a subjacent sheet to cell 141. The function of this light source and photocell is to reenergize the magnets after they have been deenergized by an imperfect sheet when passing through the scanner as will hereafter more fully appear.

We will now refer to so much of the preferred electrical circuits and other instrumentalities schematically illustrated in Figs. 5 and 5a as are directly concerned with the functioning of the sheet selecting portion of the apparatus as a whole and which are designed by suitable amplification of the change of current induced in one or more of the light sensitive cells 15 by the passage of an imperfect sheet into its field of view to deenergize the magnets 115 so as to permit that sheet to drop from the exit conveyor, and to thereafter return the apparatus to normal operative condition for inspection and classification of succeeding sheets.

Because of the character of the defects in tin plate which the apparatus as a whole is designed to detect, it is of utmost importance that an amplifying circuit of high sensitivity be employed including electronic tubes having certain special characteristics, and in the drawings we therefore as a matter of convenience have designated the various tubes we prefer to use by the initials of the maker, Radio Corporation of America or General Electric Company, as the case may be, and their trade numbers, although it will be understood that tubes of other makes having similar characteristics may be utilized instead.

Fig. 5 schematically shows inter alia the preferred arrangement of the circuits primarily concerned with the control and operation of light source 6, light sensitive cell 15 and amplifying tubes 30 and 31 comprised in each inspection unit of the scanner as more fully explained in our said patent; for present purposes it will therefore suffice to say that as long as the light level on cell 15 is maintained at the optimum, sufficient plate current flows in the plate circuit of tube 31 to furnish a voltage across the 30,000-ohm resistor appropriate for the biasing of the control grid of the thyratron tube 32 and prevents that tube from firing, which is the normal condition obtaining during the inspection of a perfect sheet.

However, should the light reaching cell 15 be reduced by reason of an imperfection passing into its field of view with consequent reduction in the normal reflectivity of the sheet, a reduction of the bias voltage on the thyratron occurs, allowing it to fire and thus energize supervisory relay 150 through the neon pilot lamp 55 associated with the affected inspection unit. The supervisory relay, which may be of any suitable type, when so energized applies a positive voltage through its normally open contact to the grid of a thyratron tube 151 (Fig. 5a), usually located outside the scanner, sufficient in amount to reduce the bias on that tube to a point at which it also fires to thereby energize a suitable contactor 152 which deenergizes conveyor magnets 115 through its normally closed contact. It results that when the imperfect sheet reaches the magnets it is unsupported and falls beneath the exit conveyor.

When supervisory relay 150 is energized as just described, its normally closed contact interrupts the plate circuit of thyratron 32 and assuming that the optimum light level on cell 15 has by this time been restored, the defect having passed out of its field of view, tube 32 is instantly reset for the next operation. However, tube 151 continues to fire and so holds the magnets deenergized until its plate circuit is opened by the energizing of a photo-switch relay 155 through the introduction of the succeeding sheet which reflects from source 140 to cell 141 to thereby operate switch relay 155 through tube 156. The circuit through the magnets being thus reestablished, the latter are reenergized before the said sheet reaches them and are thus in condition to support it on the conveyor, assuming it is a perfect sheet.

It may be noted at this point that tube 30 is of the miniature pentode type with remote cut-off grid characteristic which is made use of to maintain high sensitivity over a comparatively wide range of current values, while tube 31 is likewise of the same type but with a sharp cut-off grid characteristic which is made use of to maintain precision of the firing point of tube 32. Rheostats 42, 43 are respectively main and vernier controls affecting the biasing voltage and therefore the sensitivity level of tube 30, while

the primary function of neon lamp 55, desirably a 1-watt 100-volt type, connected in series with the output of tube 30, is not only to give a visual signal to the operator of the rejection of a sheet but also to conduct sufficient current to energize supervisory relay 150 upon firing of the tube.

Because of the extra impedance of cell 15 as well as to provide initial biasing voltage to the grid of tube 31, the negative B-connection for tube 30, as will be apparent from the schematic drawing, is supplied with a somewhat higher voltage from the control voltage source than is the corresponding connection for tube 31, and the battery may be considered either as the source of the control voltage or as a ballast across a rectified A. C. source, the rectifier (not shown) being supplied for the primary purpose of keeping the battery charged to maintain a steady voltage at all times. The 125-volt. D. C. supply is furnished by a separate power pack while the 250-volt D. C. supply from which the magnets are energized may be drawn from any convenient source and regulated for the purpose by appropriate voltage regulating apparatus (not shown). To maintain constant primary voltage on all transformers, all light source and heater voltages are preferably alternating current regulated by a 1 kilowatt induction volt regulator.

Mention has been made of the preferred grouping of the sheet supporting magnets and the manner in which magnets 115 are deenergized through the operation of contactor 152 when a defective short sheet is passing through the apparatus, in which case, of course, the auxiliary pinch rolls are positioned so only magnets 115 lie between them and the scanner. When operating on longer sheets, however, the auxiliary rolls must be moved farther from the scanner as previously explained so that, depending on the position of the rolls, one or more of the magnets 115*a* will also lie between them and the scanner and consequently, similarly to magnets 115, must be deenergized when an imperfect sheet is encountered. On the other hand, irrespective of the position of the auxiliary rolls, all the magnets which lie in rear thereof must be constantly energized to properly support the perfect sheets passing through the rolls whatever be their length, and means now to be described are therefore provided whereby any of the magnets 115*a* which may lie in front of the auxiliary pinch rolls in any adjusted position of the latter may be included in the circuit controlled by contactor 152, while all those lying behind the rolls are maintained fully energized. More specifically and as will be apparent from Fig. 5*a*, magnets 115 are permanently connected in parallel across the leads X—X controlled by contactor 152 but magnets 115*a* are respectively provided with flexible cables 160 having plugs at their extremities which can be inserted in sockets 161 in a separate feed circuit Y—Y, as shown, or in sockets 162 in leads X—X, whereby any magnet in the group can at will be connected across either of the two feed circuits. Consequently as the auxiliary pinch rolls are moved away from the scanner to the desired position of adjustment for a particular length of sheet, whatever magnets in the 115*a* group are thus exposed between the rolls and the scanner can be connected for control by contactor 152 and thus deenergized upon the passage of a defective sheet. Normally the rolls are never moved nearer the scanner than the magnets in group 115 so the latter may be permanently connected across leads X—X, nor are they ever moved to a position to bring the last magnet 115*b* between them and the scanner so that it may be permanently connected across leads Y—Y.

To enable an accurate record to be kept of the number of perfect and imperfect sheets which pass through the apparatus, we preferably dispose an electronically operated counter 165 above and a light source 166 below the entrance conveyor belt 85 and a similar counter 167 and light source 168 beyond rolls 112, 113 respectively above and below the path of the sheets as they emerge therefrom, counter 165 being operative to count all the sheets as they consecutively enter the apparatus and counter 167 to count the perfect sheets as they leave it; thus the difference between the numbers registered by the two counters at any time represents the number of imperfect sheets which have fallen from the exit conveyor. The counters and their respective light sources may be of any construction suitable for their intended purpose and as belt 85 is formed of a relatively open fabric it interposes no material obstacle to the passage of the light beam from source 166 to counter 165, though of course each sheet as it interrupts the beam is operative to energize the counter in the ordinary way and, equally, each perfect sheet ejected from the apparatus to energize counter 167.

It will now be apparent that the sheet conveying and sorting apparatus of our invention embodies many novel features and characteristics which in coordinated relation and operation render it extremely efficient and satisfactory for its intended purpose as well as facilitate its maintenance in optimum operative condition without waste of time in effecting adjustments, repair or replacement of parts. Moreover, it will be understood that while we have herein described a preferred embodiment of the invention we do not thereby desire or intend to limit or restrict ourselves specifically thereto as numerous changes and modifications in the design, construction and assembly of the various instrumentalities employed may be made if desired without departing from the spirit and scope of the invention as defined in the appended claims.

Having thus described our invention, we claim and desire to protect by Letters Patent of the United States:

1. In apparatus of the class described, a scanner adapted for the passage of the sheets to be inspected including a series of inspection units each responsive to a change in the normal reflectivity of a sheet, a conveyor operable to consecutively feed the sheets into the scanner, an exit conveyor operable to remove the sheets therefrom and comprising a pair of rolls proximate the scanner, a second pair of rolls remote therefrom, an endless belt extending between said pairs of rolls with its lower run substantially aligned with their passes, a pair of pinch rolls on opposite sides of said lower run intermediate said pairs of rolls and adjustable to different positions between them, means for driving said pinch rolls in any position of adjustment, and a series of magnets interposed between and extending transversely of the runs of the belt operative when energized to hold the sheet against the outer face of the lower run of the belt as it emerges from the first mentioned rolls preparatory to its passage between the adjustable pinch rolls.

2. In apparatus of the class described, a scanner adapted for the passage of the sheets to be

inspected including a series of inspection units each responsive to a change in the normal reflectivity of a sheet, a conveyor operative to consecutively feed the sheets into the scanner, an exit conveyor operable to remove the sheets therefrom and comprising a pair of rolls proximate the scanner, a second pair of rolls remote therefrom, an endless belt extending between said pairs of rolls with its lower run substantially aligned with their passes, a pair of pinch rolls on opposite sides of said lower run intermediate said pairs of rolls and adjustable to different positions between them, means for driving said pinch rolls in any position of adjustment, a series of magnets interposed between and extending transversely of the runs of the belt operative when energized to hold the sheet against the outer face of the lower run of the belt as it emerges from the first mentioned rolls preparatory to its passage between the adjustable pinch rolls, and another magnet between the pinch rolls and the rolls remote from the scanner operative to hold sheets passing beyond the pinch rolls against the lower run of the belt while they are passing to said last mentioned rolls.

3. In apparatus of the class described, a scanner adapted for the passage of the sheets to be inspected including a series of inspection units each responsive to a change in the normal reflectivity of a sheet, a conveyor operable to consecutively feed the sheets into the scanner, an exit conveyor operable to remove the sheets therefrom and comprising a pair of rolls proximate the scanner, a second pair of rolls remote therefrom, an endless belt extending between said pairs of rolls with its lower run substantially aligned with their passes, a pair of pinch rolls on opposite sides of said lower run intermediate said pairs of rolls and adjustable to different positions between them, means for driving said pinch rolls in any position of adjustment, a series of magnets interposed between and extending transversely of the runs of the belt operative when energized to hold the sheet against the outer face of the lower run of the belt as it emerges from the first mentioned rolls preparatory to its passage between the adjustable pinch rolls, another magnet between the pinch rolls and the rolls remote from the scanner operative to hold sheets passing beyond the pinch rolls against the lower run of the belt while they are passing to said last mentioned rolls, and electrical means operative on response of any of the inspection units to a change in the normal reflectivity of the sheet to

deenergize said series of magnets and thereby permit the sheet to fall from the belt before its leading end reaches the adjustable pinch rolls.

4. In apparatus of the class described, a scanner adapted for the passage of the sheets to be inspected including a series of inspection units each responsive to a change in the normal reflectivity of a sheet, a conveyor operable to consecutively feed the sheets into the scanner, an exit conveyor operable to remove the sheets therefrom and comprising a pair of rolls proximate the scanner, a second pair of rolls remote therefrom, an endless belt extending between said pairs of rolls with its lower run substantially aligned with their passes, a pair of pinch rolls on opposite sides of said lower run intermediate said pairs of rolls and adjustable to different positions between them, means for driving said pinch rolls in any position of adjustment, a series of magnets interposed between and extending transversely of the runs of the belt operative when energized to hold the sheet against the outer face of the lower run of the belt as it emerges from the first mentioned rolls preparatory to its passage between the adjustable pinch rolls, another magnet between the pinch rolls and the rolls remote from the scanner operative to hold sheets passing beyond the pinch rolls against the lower run of the belt while they are passing to said last mentioned rolls, electrical means operative on response of any of the inspection units to a change in the normal reflectivity of the sheet to deenergize said series of magnets and thereby permit the sheet to fall from the belt before its leading end reaches the adjustable pinch rolls, and means actuated by light reflected from the following sheet to return said electrical means to normal condition and thereby reenergize the magnets before said following sheet reaches the belt.

GEORGE E. MIRFIELD.
EDWARD H. CONNOR.

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