April 28, 1953 D. E. FEICK ET AL 2,636,603

APPARATUS FOR CONTINUOUSLY GAUGING AND CLASSIFYING SHEET MATERIAL FOR FLATNESS

Filed Jan. 11, 1950

3 Sheets-Sheet 1

FIG. 1.

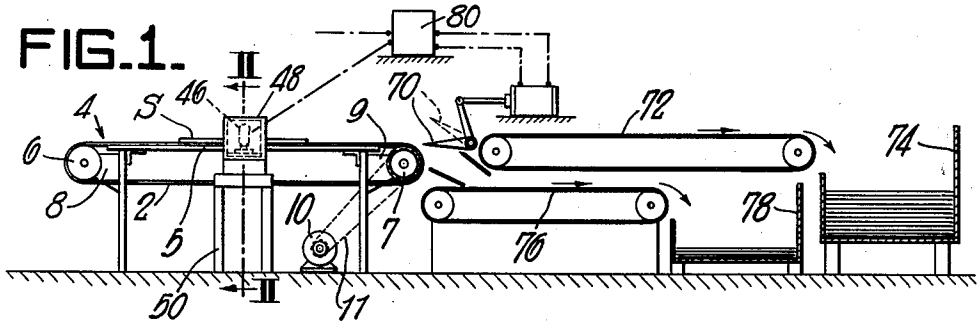



FIG. 2.

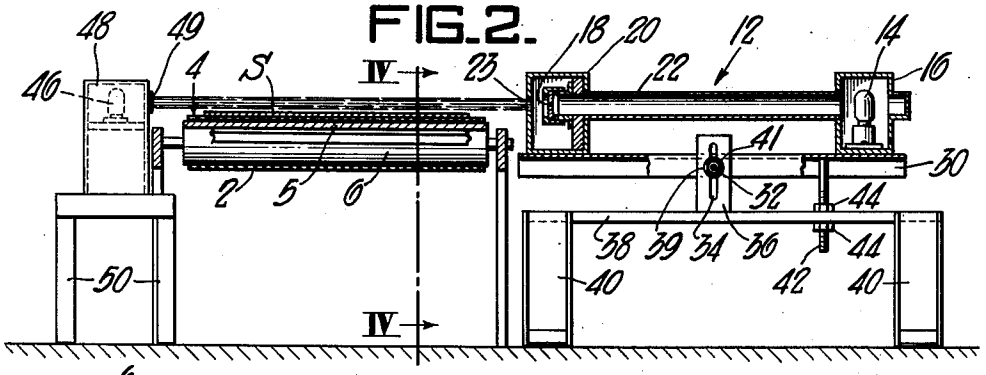
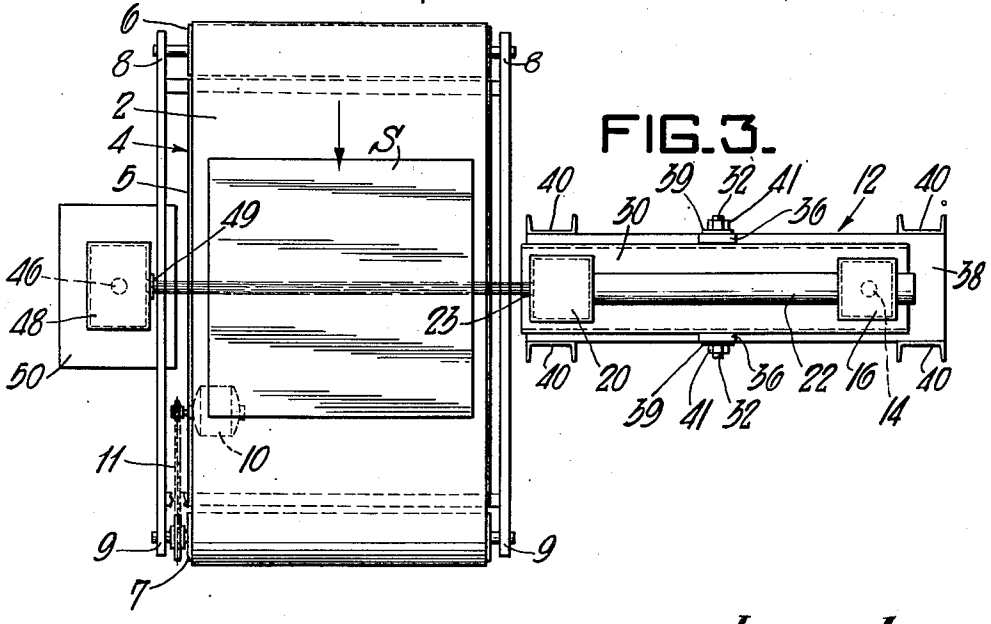



FIG. 3.




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3 Sheets-Sheet 2

FIG. 4.

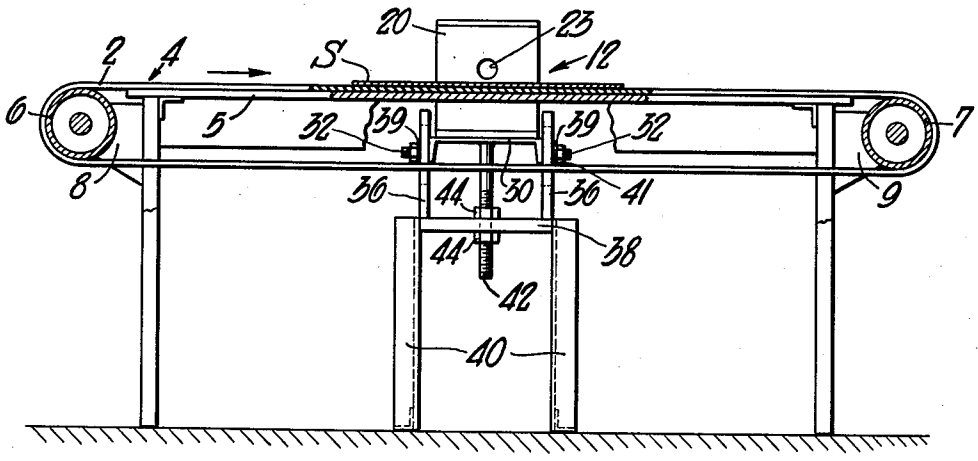
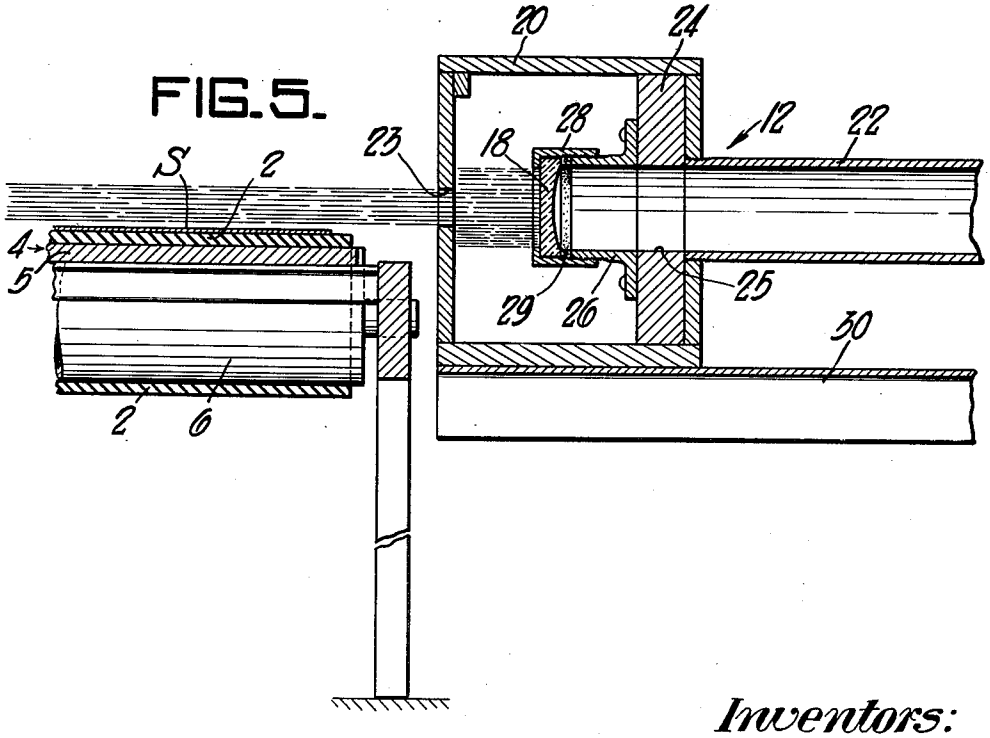



FIG. 5.




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3 Sheets-Sheet 3

FIG. 6.

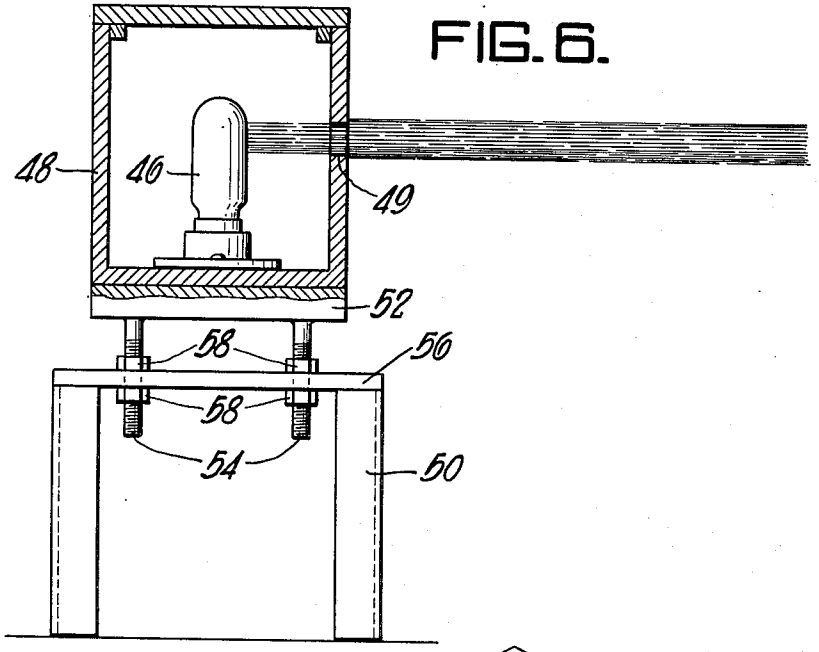
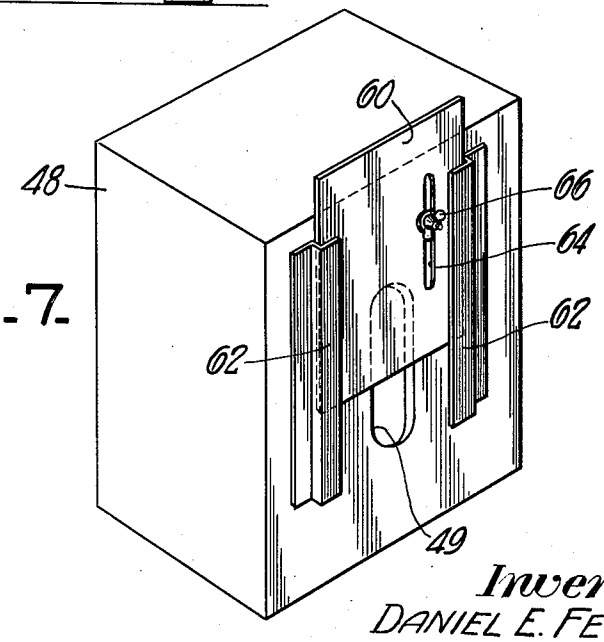



FIG. 7.




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Patented Apr. 28, 1953

2,636,603

# UNITED STATES PATENT OFFICE

2,636,603

## APPARATUS FOR CONTINUOUSLY GAUGING AND CLASSIFYING SHEET MATERIAL FOR FLATNESS

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Application January 11, 1950, Serial No. 138,008

4 Claims. (Cl. 209—111)

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This invention relates to apparatus for sorting and classifying flat rolled sheet metal product, and in particular to apparatus for automatically gauging sheet material for flatness. In the manufacture of flat rolled sheet products such as tin plate, black plate and the like, a small quantity of "out-of-flat" material is produced. Heretofore the high operating speeds used in the processing of such material have made visual detection of flatness defects difficult and unreliable, making it necessary to employ costly hand assorting of the finished product.

It is an object of the present invention to provide apparatus capable of detecting out-of-flatness defects in sheet products and causing the sheets to be automatically classified on the basis of the presence or absence of such out-of-flatness defects.

It is a further object to provide automatic flatness inspection apparatus which is adapted to in-line operation with existing processing equipment.

These and further objects are made apparent from the following specification when read in conjunction with the attached drawings wherein:

Figure 1 is a schematic view of the sheet classifier and flatness gauge of the present invention;

Figure 2 is a cross sectional view taken along the line II—II of Figure 1;

Figure 3 is a top view of the inspection table showing the relative location of the component parts of the flatness gauge;

Figure 4 is a longitudinal cross section taken along the line IV—IV of Figure 2;

Figure 5 is a partial section showing the details of the construction of the lens housing of the light source used in the present invention;

Figure 6 shows an alternate arrangement of the photocell housing; and

Figure 7 shows a second alternate arrangement of the photocell housing.

With particular reference to the drawings, the numeral 2 indicates a flat endless conveyor belt for moving sheet material S over an inspection table 4 having a flat, smooth top provided by a metal plate 5 which is wider than the belt 2 and considerably longer than the longest sheet to be handled. The belt 2 is carried by conveyor rolls 6 and 7 mounted in suitable bearings 8 and 9 respectively at the ends of the table 4. Rolls 6 and 7 are positioned so that their top surfaces are flush with or slightly below the top surface of the plate 5, whereby the portion of the belt 2 engaged in conveying the sheets rides upon the plate 5, the weight of this portion of the belt and

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of the sheet material being supported by the latter. This arrangement provides a flat reference surface from which the flatness of the sheet material can be gauged. Movement of the belt 2 is accomplished by driving roll 7 from a suitable motor 10 through a chain and sprocket arrangement or its equivalent, indicated in general by the reference numeral 11.

Means 12 are provided at one side of the inspection table 4 for directing a beam of light across and above the table at approximately 90° to the direction of travel of the sheet material. The means 12 is comprised of a light source 14, which may be a conventional incandescent light bulb mounted in a housing 16, a plano-concave type lens 18 mounted in a housing 20, the oppositely disposed sides of the housings 16 and 20 being joined by a conduit 22 which provides an enclosed passage for light from the lamp. The front side of the lens housing 20 is provided with a circular opening 23 concentric with but of smaller diameter than the conduit 22. The lens 18 is mounted on a plate 24 secured to the interior rear wall of the housing 20, and has a focal length equal to the distance from the light source 14 to the center of the lens, whereby the light rays transmitted by the lens will be parallel. Plate 24 is provided with a hole 25 and a short threaded collar 26 is attached to its outer face concentric with the hole. The lens is fitted to the end of the collar 26 and is retained thereon by a packing nut 28. A felt gasket 29 can be provided between the lens and the collar to protect the lens against breakage.

The above described light projecting assembly is mounted on a channel member 30. Threaded studs 32 extend outwardly from the downwardly extending flanges of the channel 30 at approximately the longitudinal center line of this member, and project through vertically slotted holes 34 provided in upwardly extending brackets 36 which are welded to a sub-base plate 38 which in turn is supported and firmly fastened to the floor by legs 40. Said studs 32 are provided with lock washers 39 and nuts 41 whereby the channel member may be firmly clamped at any desired elevation within the limits imposed by the slotted openings 34. This arrangement provides a means of postitioning the beam of light projected by the means 12 at a desired distance above the top of the inspection table 4. Means for leveling the light projecting assembly are provided by a stud 42 extending from the under side of the channel member 30 through a hole in the sub-base plate 38, said stud having leveling nuts 44 one above

and one below the plate which permit the light beam to be made parallel to the top of the inspection table 4.

Located on the opposite side of the inspection table 4 from the light projecting assembly 12 is a photo-electric tube 46 mounted in a protective housing 48 on a suitable pedestal or supporting stand 50. The front wall of the housing 48 is provided with an opening 49 which permits entry of the light beam projected by the means 12. The photo cell 46 may be either the high sensitivity type requiring full energization, i. e., any reduction in the quantity of light to the cell below its rating, such as will result upon interruption of a part of the light beam, will deenergize the cell; or the low sensitivity type which is not deenergized until complete interruption of the light beam occurs. If the first type is used the bottom rays of the light beam reaching the photo cell define a plane of interception with respect to the top of the table 4 at which the photo cell will be deenergized. When the second type is used the top rays of the beam reaching the cell define this plane.

While means have been provided in the construction of the light projecting means 12 for adjusting the height of the light beam above the surface of the inspection table 4, that is to say, for setting the plane of interception at a predetermined height above the table, in some instances it will be desirable to provide vertical adjusting means in conjunction with the photo cell itself for this purpose since this will facilitate adjusting the apparatus during operation. This may be done as shown in Figure 6 by mounting the cell and its protective housing on a plate 52 having two downwardly extending threaded studs 54 which project through suitably located holes in the top plate 56 of the pedestal 50, each of the studs 54 being provided with a pair of leveling nuts 58, one above and one below the plate 56. An alternate arrangement is shown in Figure 7, wherein the opening 49 in the photo cell housing 48 is made variable by providing a shutter 60 slidably mounted in the Z-shaped members 62 attached to the front face of the housing 48. The shutter 60 is provided with a vertically slotted hole 64 through which a thumb screw 66 can be engaged in a threaded hole in the face of the housing 48. This permits the shutter 60 to be clamped at any desired position. The arrangement shown in Figure 6 is particularly adapted for use with the high sensitivity type whoto cell, while that shown in Figure 7 is adapted for use with a low sensitivity cell.

Located at the discharge end of the belt conveyor 2 is a pivotally mounted deflector gate 70 for directing sheet material from the conveyor belt 2 to either of two belt conveyors 72 and 76 arranged one above the other. The conveyor 72 will move the sheet to a piler mechanism 74 and the conveyor 76 to a similar piler arrangement 78. This arrangement of conveyor belts and deflector gate is commonly known as a sheet classifier and need not be described in detail. In the present description the piler 74 is termed the prime piler; the piler 78, the out-of-flat piler. The position of the deflector gate 70 depends upon the condition of the photo cell 46, i. e., when the photo cell is energized the deflector gate will be in its normal position as indicated by the solid lines in the drawing, and deenergization of the cell will cause the deflector gate to move to the dotted position. The means for accomplishing this dependency of action are well known and have therefor been merely indicated schematically by the control box 80; the dot and dash lines representing the required electrical and mechanical connections between the photo cell, control and deflector gate.



The above described apparatus is made ready for operation by adjusting the position of the light projecting means 12 to provide a light beam parallel to and at a height above the surface of the inspection table 4 equivalent to the maximum deviation from the flat allowable in any portion of the sheet material. If a high sensitivity type photo cell is used, the required distance of the beam above the inspection table is set with reference to the bottom of the beam; if the low sensitivity type cell is used, from the top of the beam. If either of the auxiliary adjusting means described in connection with Figure 6 or Figure 7 have been provided, then the height of the beam is merely roughly adjusted by positioning the light projecting means and the final setting of the plane of interception is made by adjusting the position of the photo cell itself or the position of the movable shutter. Having set the tolerance limit of the gauge, a series of single sheets may be delivered to the conveyor 2 from a feeding mechanism or from the delivery conveyor of a piece of preceding equipment, neither of which have been shown in the drawings. The sheets will be moved by the conveyor under the light beam and, if they are within the set tolerance limit of flatness, will be delivered to the prime conveyor 72 since the deflector gate 70 remains in its normal position, the photo cell being energized. A distorted sheet, however, will cut the plane of interception in the light beam causing the photo cell to become deenergized, which condition will cause the control 80 to function to raise the deflector gate 70 and maintain it in the raised position for a sufficient time for the lead edge of the defective sheet to be directed downwardly toward the conveyor 76, hence to the "out-of-flat" piler 78. The control returns the gate to its normal position at the end of this time interval unless another defect has cut the light beam in the meantime.

While we have shown and described a specific embodiment of our invention, we do not wish to be limited exactly thereto except as defined by the scope of the appended claims.

We claim:

1. Apparatus for continuously gauging and classifying sheet material for flatness comprising in combination a supporting member providing a substantially flat reference surface for a sheet to be gauged, conveyor means for moving said sheet over said surface, means at one side of said member for directing a light beam across and above said sheet supporting surface and parallel thereto, a photo-electric cell located on the opposite side of said member and energized by said beam, a housing for said photo-electric means having an opening therein to permit entry of said light beam, a vertically adjustable shutter associated with said opening whereby the plane of interception of said light at which the photo cell becomes deenergized may be set at a predetermined distance above said reference surface, classifying means receiving the sheet material from the conveyor, and means responsive to the deenergization of the cell to actuate the classifying means.

2. Apparatus for continuously gauging and classifying sheet material for flatness comprising in combination a member having a plane upper surface providing a support and a flat

reference surface for a sheet to be gauged, conveyor means for moving said sheet over said surface, means at one side of said member for directing a light beam across and completely above said surface and parallel thereto, a photo-electric cell located on the opposite side of said member and energized by said light beam, said light directing means including a light source and a vertically adjustable pivotally mounted support for said light source whereby a plane of interception in said light beam at which said photo cell becomes deenergized may be set at a predetermined height above said reference surface and the light beam made parallel to the plane of the reference surface, classifying means for receiving the sheet from said conveyor, and means responsive to the deenergization of the photo cell to actuate said classifying means.

3. Apparatus for continuously gauging and classifying sheet material for flatness comprising in combination a member having a plane upper surface providing a support and a flat reference surface for a sheet to be gauged, conveyor means for moving said sheet over said surface, a light source and a plano-concave lens at one side of said member arranged to direct a light beam across and completely above said surface, a vertically adjustable pivotally mounted support for said light source and lens whereby the height of said light beam above said plane sheet supporting surface can be adjusted and the light beam made parallel thereto, a photo-electric cell located on the opposite side of said member, said photo-electric cell being normally energized by said light beam and deenergized by the interception of said beam, and means operable by said photo-electric means to classify a sheet as "out-of-flat" if it intercepts said light beam during its passage over said sheet supporting surface.



4. Apparatus for continuously gauging and classifying sheet material for flatness comprising in combination a sheet supporting member having a plane upper surface providing a flat reference surface for a sheet to be gauged, conveyor means for moving said sheet over said surface, a light source and a plano-concave lens at one side of said member arranged to direct a light beam across and completely above said surface, a vertically adjustable, pivotally mounted support for said light source and lens whereby the height of said light beam above said sheet supporting surface can be adjusted and the light beam made parallel thereto, a photo-electric cell located on the opposite side of said member, said photo-electric cell being normally energized by said light beam and deenergized by the interception of said beam, means operable by said photo-electric cell to classify a sheet as "out-of-flat" if it intercepts said light beam during its passage over said sheet supporting surface, and a vertically adjustable support for said photo-electric cell.

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