

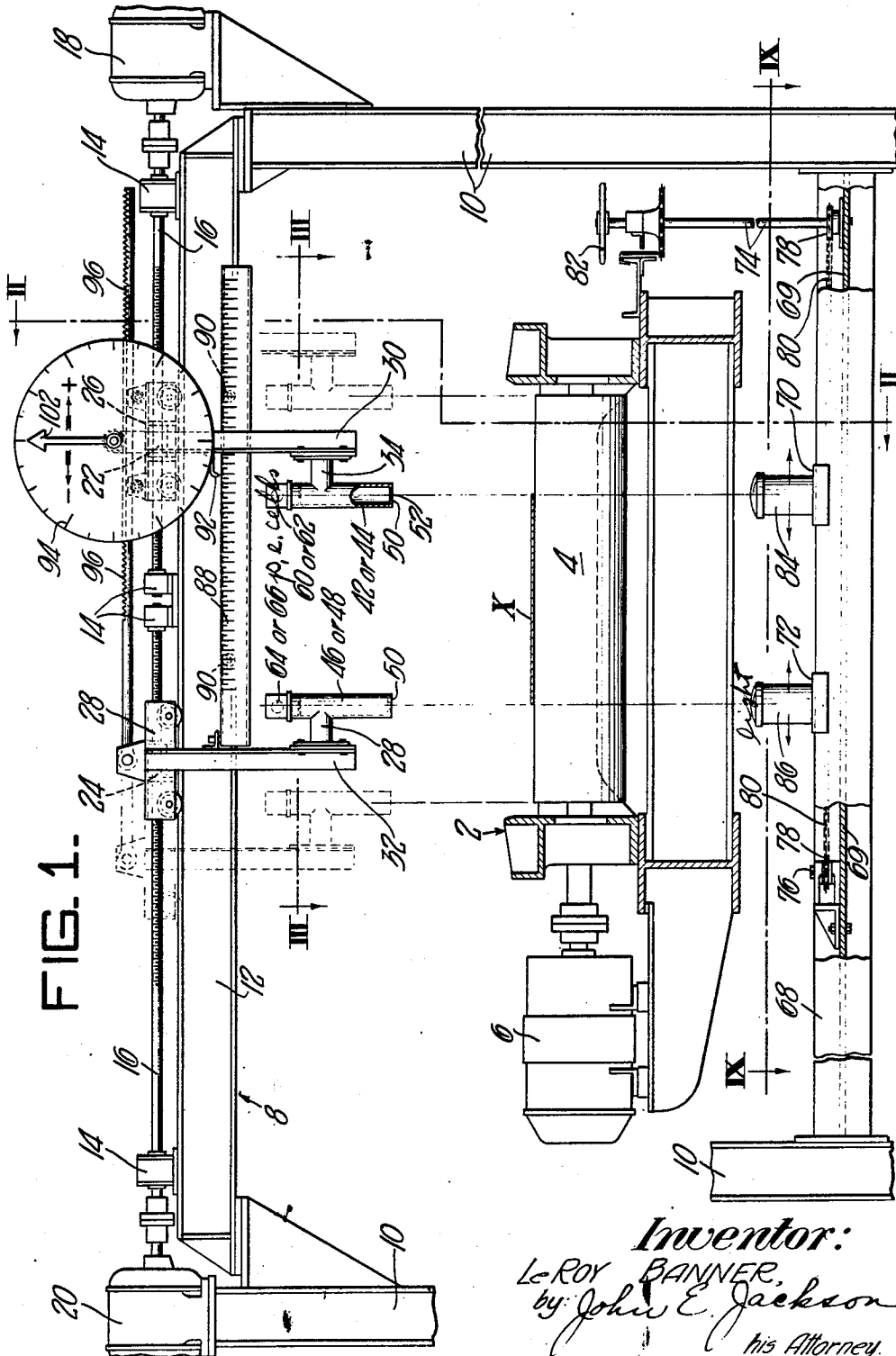
July 11, 1950

LE ROY BANNER
MEASURING APPARATUS

2,514,985

Filed Dec. 31, 1943

5 Sheets-Sheet 1



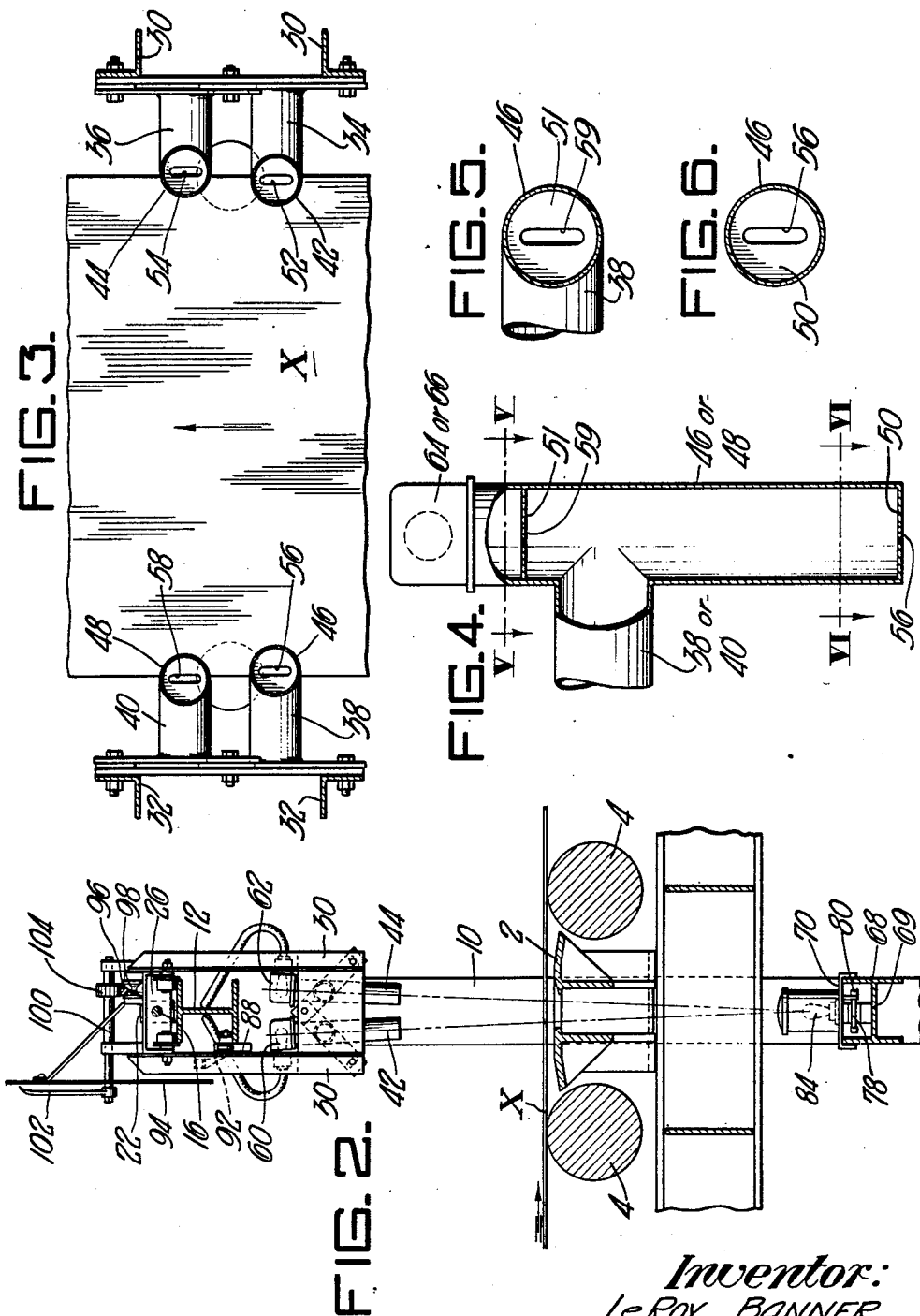
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5 Sheets-Sheet 2



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FIG. 6.

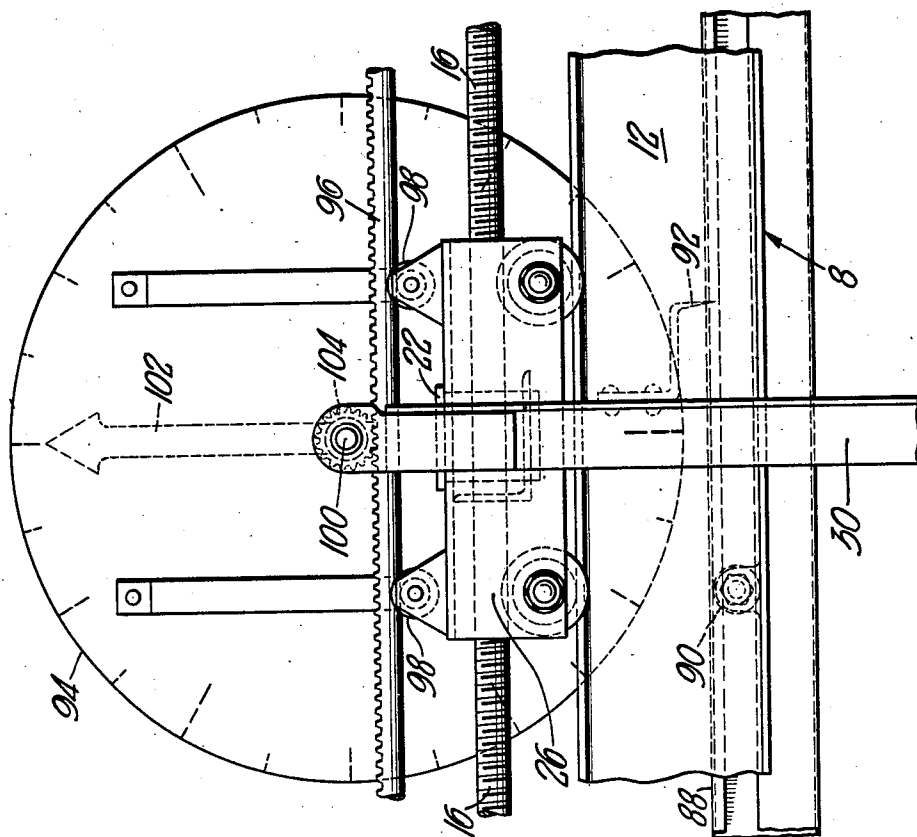
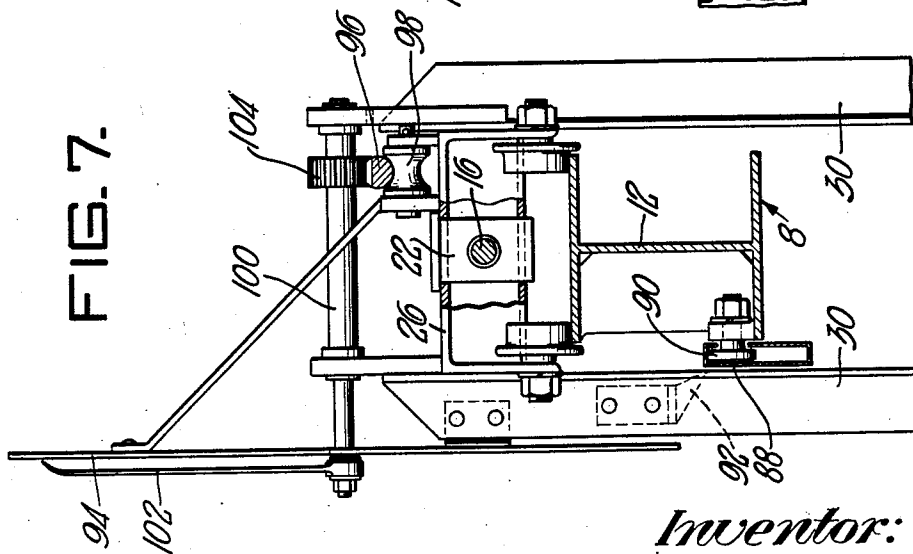


FIG. 7.



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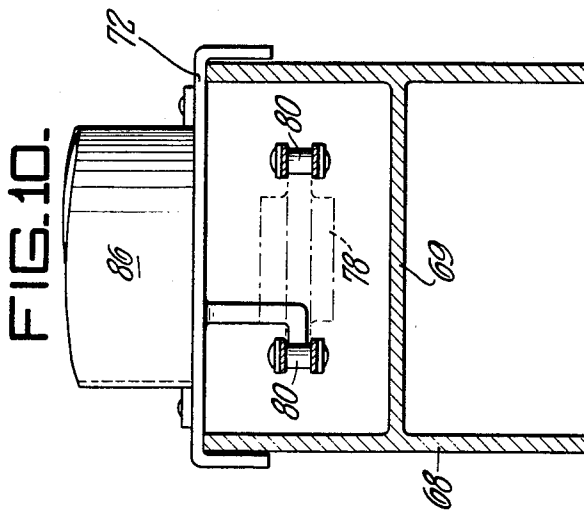
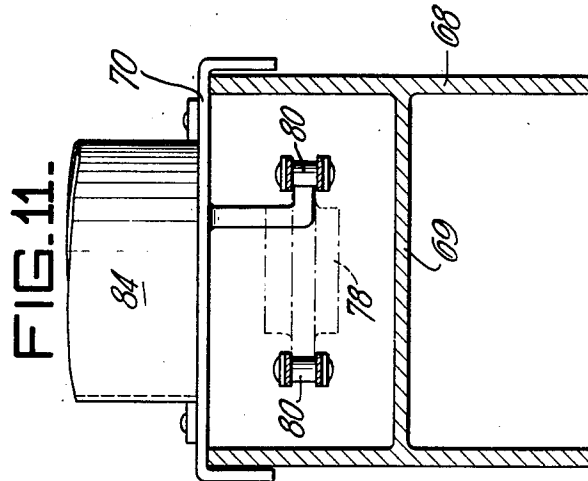
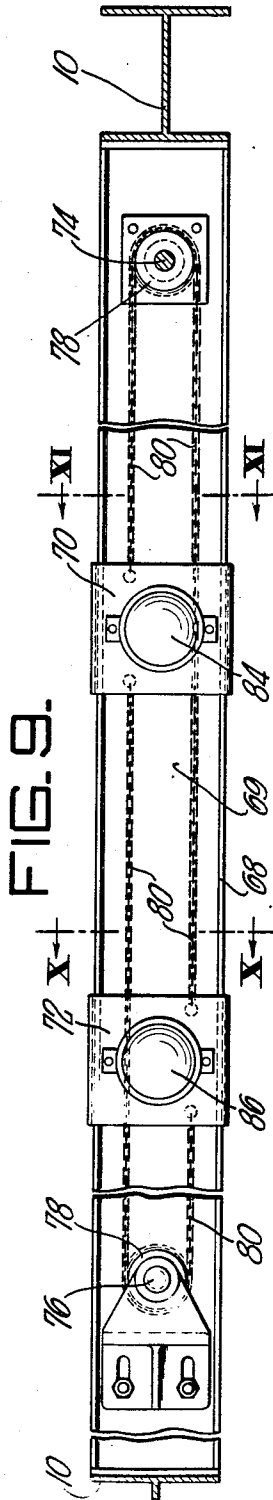
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5 Sheets-Sheet 4



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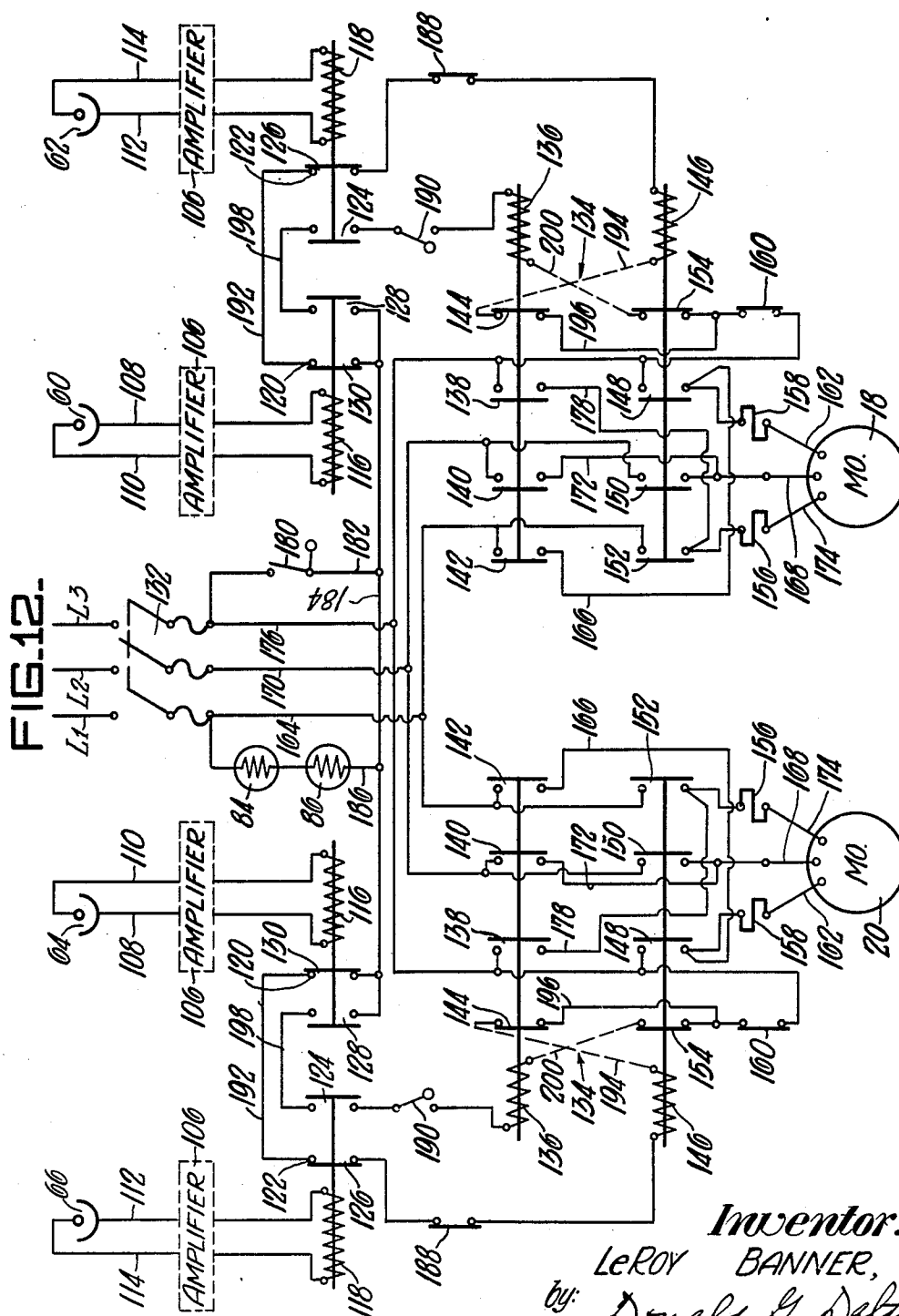
July 11, 1950

**LE ROY BANNER
MEASURING APPARATUS**

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5 Sheets-Sheet 5



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UNITED STATES PATENT OFFICE

2,514,985

MEASURING APPARATUS

Le Roy Banner, McDonald, Ohio

Application December 31, 1943, Serial No. 516,465

7 Claims. (Cl. 33-125)

1

This invention relates to measuring apparatus, and more particularly to one which is adapted for measuring certain dimensions of moving objects such as the width of traveling plates, strip, etc.

It is among the objects of the present invention to accurately and instantaneously obtain measurements of the type referred to.

Another object is the provision of a measuring apparatus of the class described which does not contact the work-object.

Still another object is the attainment of the foregoing by the use of instrumentalities which are comparatively easy and inexpensive to manufacture, install, and maintain.

In numerous industries it is desirable to accurately and rapidly measure certain dimensions of objects which are moving at substantial rates of speed. As a typical instance, reference is made to the manufacture of strip steel in substantial lengths wherein at frequent intervals it is desirable to determine whether or not the proper width is being maintained. Numerous apparatus of the prior art have been constructed and arranged for linear measurement of work-objects, and particularly of the width of traveling strip, but for the most part they require contact with the edges of the work-object. At certain stages of its manufacture it is impractical to contact the edges of traveling strip steel; and this is especially true of hot strip steel emerging from the roughing stand of a hot strip mill. At this point in its manufacture it is highly desirable to accurately and rapidly ascertain the width of the strip, for it is here that an immediate adjustment of the edgers can be made, with the result that proper width is maintained. If, on the other hand, the width of the strip is not accurately determined until later (as when after it has been coiled and permitted to cool to room temperature) it is too late to make proper adjustments to the edgers in order to accommodate discrepancies in width, with the result that several slabs will be rolled before the correction or adjustment is made.

The present invention seeks to provide an accurate measuring apparatus which may be efficiently employed to accurately and instantaneously obtain certain dimensions of moving objects, such as the width of traveling plates, strips, etc., and without the necessity of contacting the object.

In accordance with the teachings of the present invention, the measuring apparatus can be located at any desired point, for example, at the roughing stand of a hot strip mill, thereby enabling immediate manufacturing adjustments to accommodate discrepancies, such, for example, as improper adjustment of the edgers.

The invention, then, comprises the features hereinafter fully described and as particularly

2

pointed out in the claims, the following description and the annexed drawings setting forth in detail certain illustrative embodiments of the invention, these being indicative of several of the number of ways in which the principles of the invention may be employed.

In said drawings:

Figure 1 is a front elevation of the device;

Figure 2 is a sectional view on the line II—II

10 of Figure 1;

Figure 3 is a sectional view on the line III—III of Figure 1;

Figure 4 is a view partly in cross section of the tube for supporting the photoelectric cell;

15 Figure 5 is a sectional view on the line V—V of Figure 4;

Figure 6 is a sectional view on the line VI—VI of Figure 4;

Figure 7 is a side view of the gage;

20 Figure 8 is a view looking from the right of Figure 7;

Figure 9 is a view of the light moving mechanism taken on the line IX—IX of Figure 1;

25 Figure 10 is a cross sectional view taken on the line X—X of Figure 9;

Figure 11 is a cross sectional view taken on the line XI—XI of Figure 9; and

Figure 12 shows a schematic wiring diagram for operating the carriage motors.

30 Referring more particularly to the drawings, the reference numeral 2 designates a conveyor such as the delivery table which extends from the finishing mill stand of a hot strip mill. As shown the conveyor consists of a series of aligned parallel rollers 4, each of which is driven by an adjacently disposed electric motor 6.

35 Disposed over the delivery table 2 is an elevated platform 8 which is supported by means of the I-beams 10. More specifically, the elevated platform 8 comprises an I-beam 12, upon which there is disposed on either side of the vertical center line a pair of spaced aligned bearings 14, each pair of which supports a screw threaded shaft 16. Motor 18 is coupled to the right hand shaft 16 and motor 20 is connected to the left hand shaft 16 to impart rotation thereto. Carried on the right hand shaft 16 is a threaded traveling nut 22 while the left hand shaft 16 carries a similar nut 24. Secured to the traveling nuts 22 and 24 are carriages 26 and 28 respectively, the wheels of which contact and ride along the upper surface of the I-beam 12. Each of the carriages carries a pair of vertically depending legs indicated as 30 and 32 respectively. The vertically depending legs 30 carry a pair of inboard horizontal extensions 34 and 36, while the vertically depending legs 32 carry a pair of corresponding and opposed inboard horizontal extensions 38 and 40. The inboard horizontal extensions 34 and 36 are slightly longer than the inboard hori-

zontal extensions 36 and 40. From each of these horizontal inboard extensions 34, 36, 38 and 40, there depends a vertical tube as 42, 44, 46 and 48 respectively, each tube being provided with a closure 50 at its lower end and a second closure 51 above the lateral extension. Each of the vertical tubes has a slot in the closure 50 which extends at right angles to the elevated platform 8 and longitudinally along the strip X whose width is being measured. These slots are indicated at 52, 54, 56 and 58 respectively. A similar slot 59 is provided in each of the closures 51. As clearly shown in Figure 3, when the slots 54 and 58 are aligned with the edge of the strip X the corresponding slots 52 and 56 will be disposed slightly inwardly thereof. Associated with each of the vertical tubes 42, 44, 46 and 48, is a photoelectric cell or scanning tube designated as 60, 62, 64 and 66 respectively.

Disposed beneath the delivery table 2 is a bed 68 which extends in parallelism with the elevated platform 8. Resting upon the bed 68 is a pair of spaced carriages 70 and 72, each of which comprises an inverted channel shaped member the legs of which embrace the outer faces of the upper ends of the flanges of the I-beams comprising the bed 68. Carried by the bed 68 adjacent each of its outer ends are vertically extending pins 74 and 76 respectively, each of which having mounted thereon a horizontally disposed sprocket 78. In the embodiment shown the vertically extending pins 74 and 76 are mounted on and project from the upper face of the web 69 of the bed 68 and the sprockets 78 lie within the space defined by the ends of the flanges of the bed. A chain 80 having one end connected to the carriage 70 and the other end connected to the carriage 72 passes around one of the sprockets 78. A similar chain 80 is connected to the carriages 70 and 72 and passes around the other sprocket 78 as best shown in Figure 9. The chains 80 may be moved in any suitable manner and in the embodiment shown, receive movement through the right hand sprocket 78 by means of the hand wheel 82 connected to the shaft 74. Carriages 70 and 72 carry shielded light sources 84 and 86 respectively, which lie below the delivery table 2 and may be made to occupy varying spaced distances with respect to the adjacent edges of the strip X, the light therefrom projecting beyond the edges of the strip toward the slots 52, 54, 56 and 58 respectively. The moving strip traveling above the shielded light sources 84 and 86 blocks off the light within the span of its width but the remaining rays of light continue vertically outside thereof toward the slots 52, 54, 56 and 58.

As described hereinbefore there is an offset relationship of each pair of the vertical tubes 42, 44 and 46, 48, the axis of one tube of each pair being slightly to one side of the strip and the axis of its companion tube being slightly on the other side thereof. Therefore, each edge of the strip will just darken the aperture of one tube of each pair and permit light rays to enter the aperture of its companion tube. This is the neutral position so long as the strip is of the same width throughout. However, the invention seeks to move the carriages 26 and 28 in accordance with variations in the width of the strip and to actuate indicating media by such movement. For indicating purposes, the legs 32 of the carriage 28 have attached thereto a horizontal scale 88 which extends behind the front leg 30 of the carriage 26 and rides upon a pair of rollers

90 which are mounted on the platform 8. An index or pointer 92 is carried by one of the legs 30 of the carriage 26 for the purpose of indicating various positions along the scale 88.

In addition to the foregoing means of measurement and indication thereof, the apparatus of the invention provides for magnification of the increments or variations in the width of the strip when such occur. This means comprises a dial 94 having large graduations as shown and which is mounted on the carriage 26. Secured to and extending from the carriage 28 is a horizontally extending rack 96, the bottom of which is suitably contoured for contact with an aligned pair of rollers 98, which are mounted on the top of the carriage 26. Also, on the top of the carriage 26 is a suitably journaled rotatable shaft 100 occupying a position at right angles to the rack 96 and provided with an integral extension which extends through the center of the dial 94 and carries for cooperation therewith a pointer 102. Immediately above the rack 96, the rotatable shaft 100 has secured thereto a pinion 104 which meshes with the said rack whereby the reciprocatory movement of the latter imparts rotative movement to the pointer 102.

As stated hereinbefore, the operation of the apparatus of the present invention contemplates the movement of the pairs of the vertical tubes 42, 44, and 46, 48, toward and away from each other in accordance with the variations in width of the strip X whereby the scale 88 and its pointer 92 indicate the width of the strip while the dial 94 and its indexing instrumentality 102 indicate minus or plus departures from the neutral position. The movement of the carriages 26 and 28 toward and away from each other in order to obtain the desired indications is effected through the medium of the electric motors 18 and 20, the energization and de-energization of which are controlled by the photoelectric cells 60, 62, 64 and 66, one of which is carried by each of the vertical tubes 42, 44, 46 and 48, respectively.

The photoelectric circuit for controlling the energization of the motors 18 and 20 is schematically shown in Figure 12. The purpose of the control is to cause the carriages 26 and 28 to move in such a manner that they will follow the edge of the traveling strip X. Each of the light sensitive devices 60, 62, 64 and 66 is connected through a standard amplifying device 106 which has the function of amplifying the photoelectric current from the tube to a value sufficient to operate an electric relay. The circuit for operating the motor 18 is the same as that for operating the motor 20 and therefore the operation of the circuit will be described in reference to the motor 20, it being understood that the operation of the circuit controlling motor 18 is the same. The reference characters applied to the various parts of the circuit are the same in both instances.

The pair of photoelectric tubes 64 and 66, following the left edge of the strip, are connected by wires 108, 110 and 112, 114, respectively, through the amplifier 106 to the coils 116 and 118, respectively, of the relays 120 and 122. With the tube aperture illuminated, the amplified energy of the tube 66 is sufficient to energize the coil of relay 122, closing the normally open contact 124 and opening the normally closed contact 126. In a similar manner, light striking the aperture of tube 64 closes the normally open contact 128 and opens the normally closed contact 130 of relay 120. When there is no illumination of the tube apertures, the relay connected to that tube will

5

be in the de-energized position shown in Figure 12.

A standard three-pole single throw knife switch 132 is used for connecting the motor and control circuits to a two hundred and thirty volt, three phase A. C. power source. However, the functions of the device can be performed with the motor operating on either A. C. or D. C. and at any available voltage. The number of poles on the switch and on the motor starters will be governed by the type of electrical power used.

The reference numeral 134 indicates a standard reversing motor starter. Energization of the coil 136 of the in-contactor causes the power contacts 138, 140 and 142 to close and the auxiliary control contact 144 to open. In like manner, energization of the coil 146 of the out-contactor closes contacts 148, 150 and 152 and opens contact 154. The auxiliary control contacts or interlocks 144 and 154 prevent energization of either contactor if the other contactor is already energized. In other words, only one of the coils 136 and 146 of the contactor can be energized at one time. The power circuit to the motor passes through two heater elements 156 and 158 which causes the overload contact 160 to open when the motor is overloaded. When the in-contactor is closed, line L—1 is connected to motor terminal 162 through switch 132, line 164, closed contact 142, line 166 and heater element 158; line L—2 is connected to motor terminal 168 through line 170, closed contact 140, and line 172; and line L—3 is connected to motor terminal 174 through line 176, closed contact 138, line 178, and heater element 156. When the motor is connected in this manner, it runs in the direction which causes the carriage 28 to move toward the center of the strip.

When the out-contactor is closed, line L—1 is connected to motor terminal 174 through switch 132, line 164, closed contact 152 and heater element 156; and line L—3 is connected to motor terminal through switch 132, line 176, closed contact 148 and heater element 158. The connection between L—2 and motor terminal 168 remains the same. This reverses one phase of the three phase line feeding the motor 20 and causes it to operate in the opposite direction, thus moving the carriage away from the center of the strip.

A flag switch 180 operated by the strip X is located in the line leading from the line L—3 to the relays 120 and 122 and prevents operation of the gage except when the strip is passing there-through. Otherwise, the carriages 26 and 28 would continue to approach each other seeking the edges of a non-existent strip. The light sources 84 and 86 operate only when the flag switch 180 is closed, since their circuit is L—3, 182, 184, 186 to L—1.

A limit switch 188 is located at the outer limit of the carriage slide and a second limit switch 190 at the inner limit, both switches normally being closed. These switches are located in the control circuit and when the carriage reaches either of these extreme positions, it opens the limit switch at that position, thus interrupting the control circuit to the motor starter, opening the starter contacts and stopping the motor.

The operation of the device is as follows:

When a strip of steel passes below the gage, the flag switch 180 is closed and the light sources 84 and 86 energized. If the apertures 52, 54, 56 and 58 are positioned with respect to the strip X as shown in Figure 3, with the apertures 52 and 56 dark and the apertures 54 and 58 bright,

6

no movement of the carriages 26 and 28 takes place. If the gage carriage 28 is too far toward the center of the strip, the strip will interrupt the light to both tubes 64 and 66. The contactors of relays 120 and 122 remain as shown, this completing the circuit through the coil 146 of the out-contactor from L—3 through closed contacts of switch 180, lines 182, 184, closed contact 130, line 192, closed contact 126, switch 188, coil 146, line 194, closed contact 144, line 196 and line 176. This energizes coil 146 and causes the motor 20 to operate in an out-direction carrying the gage carriage 28 away from the center of the strip until the extreme outer travel is reached which causes switch 188 to open or until the tube 66 passes the edge of the strip and causes the contact 126 to open. Either of these occurrences interrupts the control circuit and stops the motor 20. The variations in the width of the strip are indicated by the relative movement of scale 88 and pointer 92 and also by the relative movement of the scale 94 and pointer 102.

If the carriage 28 is too far from the center of the strip, light strikes the apertures 56 and 58, thus causing current to flow through coils 116 and 118, respectively. This opens the normally closed contacts 126 and 130 and closes the normally open contacts 124 and 128 to complete a circuit from line L—3 through switch 180, lines 182, and 184, closed contact 128, line 198, closed contact 124, limit switch 190, coil 136, line 200, closed contact 154, overload contact 160, and line 176. The energization of the in-coil 136 causes the motor 20 to operate in an in-direction until it reaches the extreme in-position and opens limit switch 190, or until the light to tube 64 is blocked off by the strip, thus opening the contact 128. Either of these occurrences interrupts the circuit and stops the motor.

In a similar manner carriage 26 is moved in accordance with the supply of light to the tubes 60 and 62.

While one embodiment of the invention has been shown and described, it will be apparent that other modifications and adaptations may be made without departing from the scope of the following claims.

I claim:

1. A gage for determining the distance between two opposite edges of an elongated substantially opaque article comprising a pair of light sources at one side of said article, each adjacent a respective edge, two carriages on the other side of said article, each adjacent a respective edge, means mounting said carriages for movement toward and from each other, a pair of light responsive devices on each carriage, one of each pair being normally aligned with a respective edge of said article and the other of each pair being disposed slightly inwardly of its respective edge, a scale connected to be moved by one carriage, a pointer moving over said scale and controlled by movement of the other carriage, and means responsive to changes in light from said sources incident on the respective devices as a result of variation of said distance for independently moving the respective carriages to restore said alignment whereby said scale and pointer continuously indicate said distance.

2. A gage for determining the distance between two opposite edges of an elongated substantially opaque article comprising light sources at one side of said article, each in substantial alignment with a respective edge, two carriages on the other side of said article, each adjacent a re-

spective edge, means mounting said carriages for movement toward and from each other, a light responsive device on each carriage normally aligned with its respective edge, a scale connected to be moved by one carriage, a pointer moving over said scale and controlled by movement of the other carriage, and means responsive to changes in light from said sources incident on each device as a result of variation of said distance for independently moving the respective carriages to restore said alignment whereby said scale and pointer continuously indicate said distance.

3. A gage for determining the distance between two opposite edges of an elongated substantially opaque article comprising light sources at one side of said article, each in substantial alignment with a respective edge, two carriages on the other side of said article, each adjacent a respective edge, means mounting said carriages for movement toward and from each other, a pair of light responsive devices on each carriage, one of each pair being normally aligned with a respective edge of said article and the other of each pair being disposed slightly inwardly of its respective edge, a scale connected to be moved by one carriage, a pointer moving over said scale and controlled by movement of the other carriage, and means responsive to changes in light from said sources incident on the respective devices as a result of variation of said distance for independently moving the respective carriages to restore said alignment whereby said scale and pointer continuously indicate said distance.

4. A gage for determining the distance between two substantially parallel edges of an elongated substantially opaque article comprising light sources at one side of said article, each in substantial alignment with a respective edge, means mounting each source for movement toward and from each other, two carriages on the other side of said article, each adjacent a respective edge, means mounting said carriages for movement toward and from each other, a pair of light responsive devices on each carriage, one of each pair being normally aligned with a respective edge of said article and the other of each pair being disposed slightly inwardly of its respective edge, a scale connected to be moved by one carriage, a pointer moving over said scale and controlled by movement of the other carriage, two motors each connected to move a respective carriage, and means responsive to changes in light from said sources incident on the respective devices due to changes in said distance, for controlling said motors to so move said carriages as to restore said normal alignment whereby said scale and pointer continuously indicate said distance.

5. A gage for determining the distance between two substantially parallel edges of an elongated substantially opaque article comprising light sources at one side of said article, each in substantial alignment with a respective edge, means mounting each source for movement toward and from each other, two carriages on the other side of said article, each adjacent a respective edge, means mounting said carriages for movement toward and from each other, a pair of light responsive devices on each carriage, one of each pair being normally aligned with a respective

edge of said article and the other of each pair being disposed slightly inwardly of its respective edge, a first means connected to be moved by one of said carriages, a second means connected to be moved by movement of the other of said carriages, and means responsive to changes in light from said sources incident on the respective devices due to changes in said distance for controlling said motors to so move said carriages as to restore said normal alignment whereby said first and second means continuously indicate said distance.

6. A gage for determining the distance between two opposite edges of a moving elongated substantially opaque article comprising a pair of light sources at one side of said article, each adjacent a respective edge, two carriages on the other side of said article, each adjacent a respective edge, a pair of closed tubes on each carriage, said tubes being spaced apart in the direction of travel of said article, each tube having a slot therein on the end adjacent the article and a light responsive device at the opposite end, each of said slots being elongated in the direction of movement of said article with one edge of one slot in each pair of tubes being in substantial alignment with one edge of the other slot, the slot in one of each pair of tubes being disposed slightly inwardly of the slot in the other of each pair, means responsive to changes in light from said sources incident on the respective devices as a result of variation of said distance for independently moving the respective carriages to restore said alignment, and means controlled conjointly by relative transverse movement of said devices for indicating said distance.

7. A gage for determining the distance between two opposite edges of a moving hot steel strip comprising two carriages on one side of said strip, each adjacent a respective edge, a pair of closed tubes on each carriage, said tubes being spaced apart in the direction of travel of said strip, each tube having a slot therein on the end adjacent the strip and a light responsive device at the opposite end, each of said slots being elongated in the direction of movement of said strip with one edge of one slot in each pair of tubes being in substantial alignment with one edge of the other slot, the slot in one of each pair of tubes being disposed slightly inwardly of the slot in the other of each pair, means responsive to changes in light incident on the respective devices as a result of variation of said distance for independently moving the respective carriages to restore said alignment, and means controlled conjointly by relative transverse movement of said devices for indicating said distance.

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