

Oct. 19, 1943.

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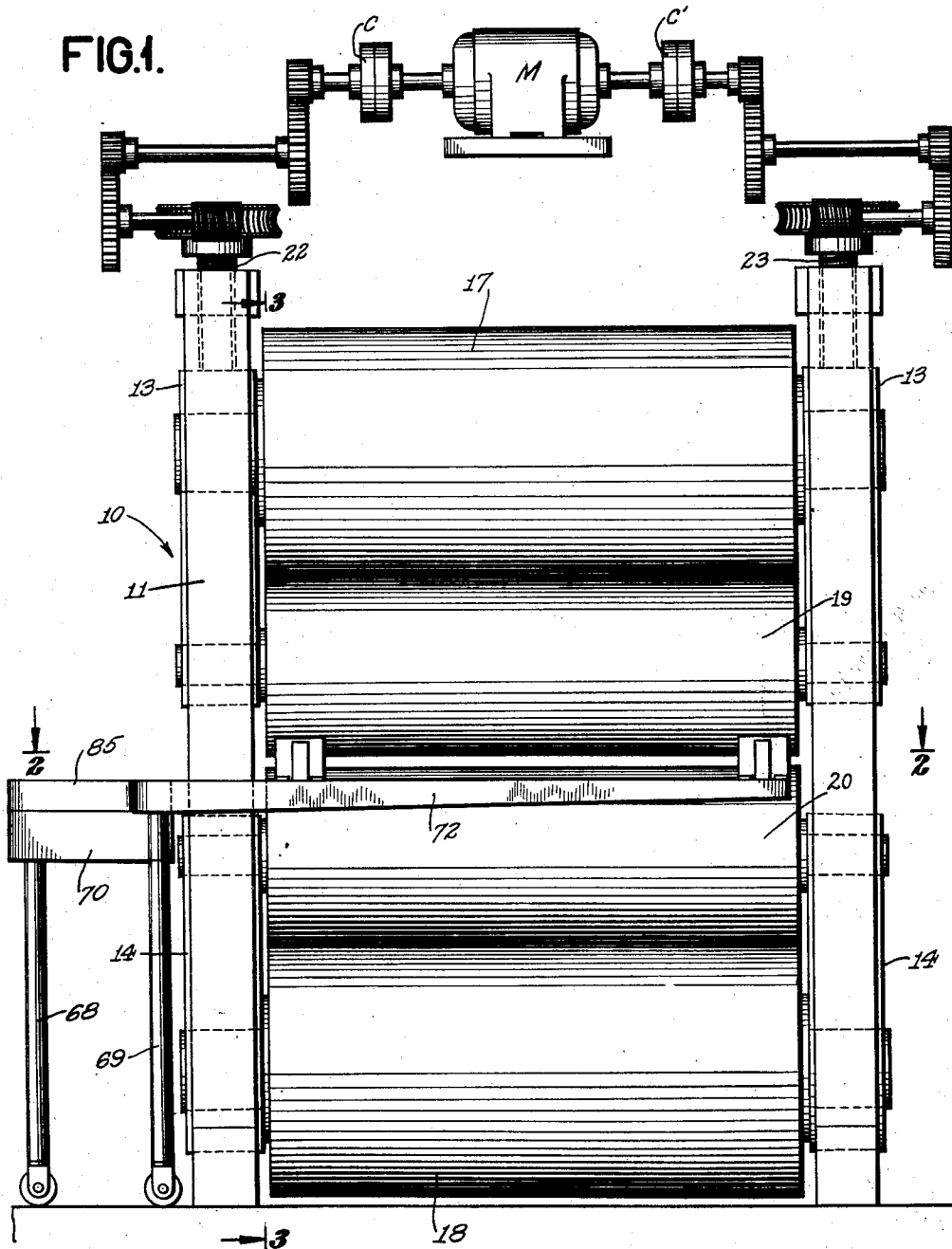
2,332,289

METHOD AND MEANS FOR LEVELING ROLLING MILLS

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3 Sheets-Sheet 1

FIG. 1.



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3 Sheets-Sheet 2

FIG.2.

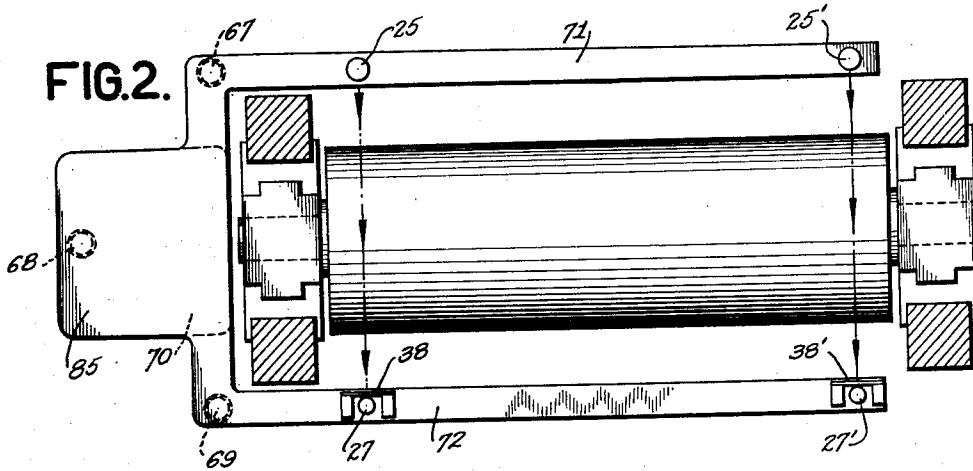


FIG.3.

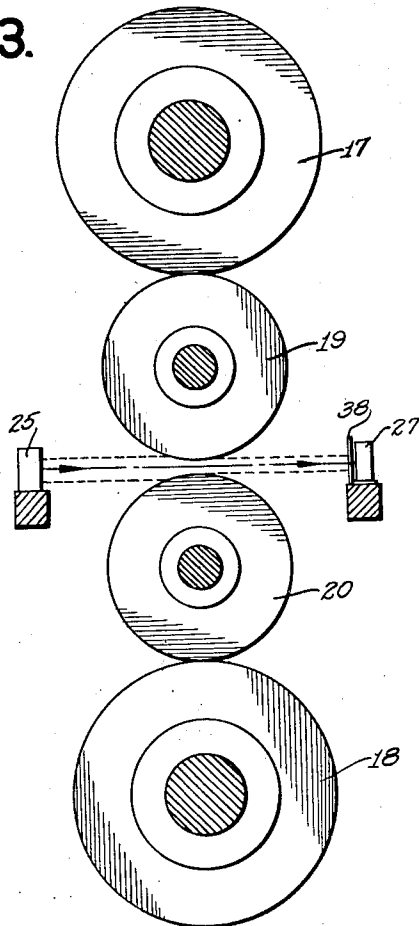
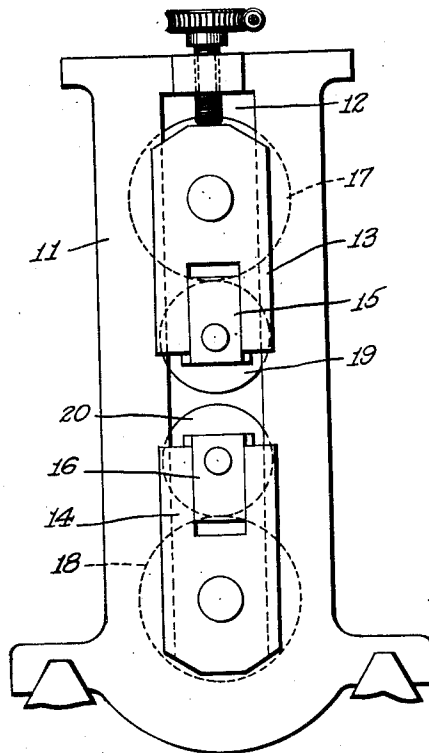


FIG.4.



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3 Sheets-Sheet 3

FIG. 5.

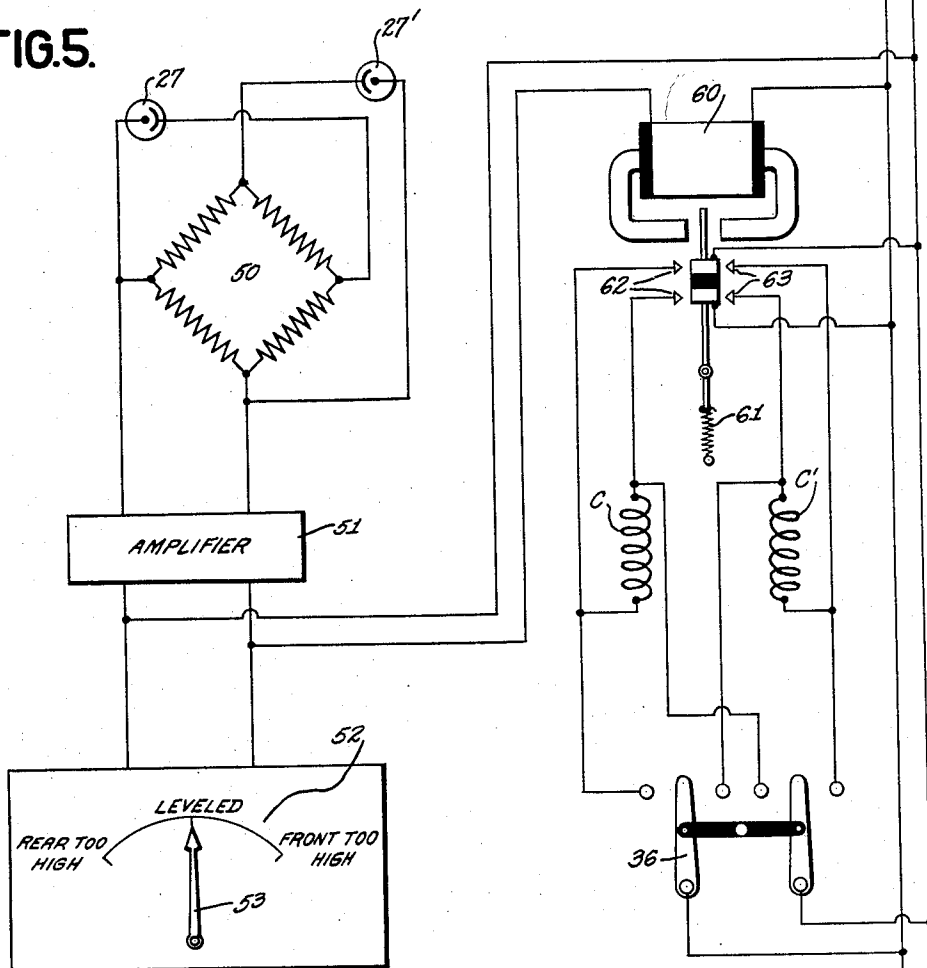


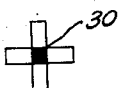
FIG. 6A.



FIG. 6B.



FIG. 6C.



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METHOD AND MEANS FOR LEVELING
ROLLING MILLSAlexander Zeitlin, New York, N. Y., assignor to
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Application June 4, 1942, Serial No. 445,743

11 Claims. (Cl. 80—56)

This invention relates to continuous rolling mills. In these mills a short thick slab of metal which is discharged from the furnace at high temperature is passed successively through a series of rolling mill stands, usually ten in number, each of which applies pressure to cause repeated thinning out of the material until finally it issues from the No. 10 mill stand as a thin sheet of material several hundred feet in length. Each mill stand of the four-high variety comprises a pair of work rolls which are backed up by larger pressure rolls. The rolls are seven and a half feet in length, and it will readily be seen that unless the rolls are spaced apart equal distances at both ends, the sheet of material being rolled will not be of the same thickness at both sides. This is not only undesirable in the finished product, but also results in buckling of the material while passing between mill stands, due to the fact that the thinner side of the material is longer than the thicker side.

It is very desirable therefore that the rolls of each mill stand be leveled, that is to say, that the work rolls should provide a space between them which is uniform at both ends of the rolls. Various means for leveling the rolls of the mill stand have been proposed, but all of these have presented serious problems which have been difficult to solve. The most recent method employed has been in connection with strain gauges which measure the strain on the front and rear end frames of the mill stand, on the theory that if the pressures existing between the rolls at each end are equal when material of predetermined thickness is compressed between the rolls, the rolls will necessarily be of equal separation at both ends. This, however, has proven not to be the case, because even when the strain gauges give the same indication of pressure for the front and rear frames of the mill stand, the spacing between the front and rear ends of the rolls may not necessarily be the same. This is due to the fact that there are other factors of a mechanical and electrical nature which may influence the indications and result in differences between the indications of the front and rear housing indicators. Some of these secondary causes of a mechanical nature are the following:

1. Skewing of the rolls.
2. Side thrusts.
3. Unequal distribution of load due to two rows of conical roller bearings.
4. Friction between the rolls in an axial direction.
5. Eccentricity of the rolls and especially unequal eccentricity on both ends.
6. Not fully symmetrical crown of the rolls.

Examples of secondary causes of an electrical nature which may affect the indications of the

front and rear housing indicators are the following:

1. Small differences in the impedances of the electric systems which cause a different reaction of the systems during fluctuations of voltage or current.
2. Different degree of influence by outside electric and magnetic fields.
3. Possibility of hunting, etc.

It is impossible to eliminate all of the above sources of error, and therefore the task of leveling a mill by means of strain gauges or pressure indicators is extremely difficult. It is for this reason that applicant's invention for leveling the mill is independent of the strain gauge and the many factors which influence said gauge, and is based upon the feature whereby relative positions of the rolls are measured directly. Thus, an absolute measure of the relative positions of the work rolls, that is, of the distances separating the ends thereof, is obtained, and since these measurements are unaffected by any of the factors named above, leveling of the mill may be accomplished directly without recourse to first eliminating a plurality of factors which may be present in the rolls and in the mill stand frame.

It is a further object of this invention to provide a method and means for leveling a rolling mill stand of the type described, wherein the space between the rolls at both ends may be automatically adjusted in response to any differences in spacing at the respective ends. Thus, automatically the ends of the work rolls are brought to, and held in, such predetermined relation that the spaces between the work rolls at both ends thereof are always equal, and therefore insures leveling of the mill.

Other objects and advantages of this invention will become apparent in the following detailed description thereof.

In the accompanying drawings,

Fig. 1 is a front elevation of a rolling mill stand showing my invention applied thereto.

Fig. 2 is a plan view of the Fig. 1 device with parts broken away.

Fig. 3 is a section taken substantially on the line 3—3 of Fig. 1.

Fig. 4 is an end view of the Figures 1 and 2 device.

Fig. 5 is a wiring diagram.

Figs. 6A, 6B, 6C are diagrammatic views, illustrating the theory of obtaining a light sensitive area.

Referring to Fig. 1, there is shown a rolling mill stand 10 which is one of a series arranged in line, the series usually comprising ten such stands. Each stand includes side frame members 11, in the central cutout portion 12 of which there operate blocks 13 and 14 within which are slid-

ably-mounted bearing blocks 15 and 16. The blocks 13 and 14 form the bearing members for large backup rolls 17, 18, and the bearing blocks 15 and 16 are the bearing members for the work rolls 19 and 20. Pressure is applied to the work rolls through the backup rolls by means of a screw-down motor M which, through suitable gearing and electro-magnetic clutches C, C', operates screws 22 and 23 which apply pressure to the bearing blocks 13 and 14 in the front and rear mill stand frames, respectively.

Heretofore the process of leveling the mill, that is to say, of bringing the work rolls 19 and 20 into such relationship that the spaces between said rolls at the front and rear ends thereof were equal, consisted in separating the rolls and then inserting between the extreme ends of said rolls, bars of metal, such as copper, of predetermined thickness. The clutches C and C' were then closed to permit the motor M to operate the screws 22 and 23 until the rolls just touched these copper bars. This, however, did not guarantee equal spacing of the front and rear ends of the work rolls, because the degree of touching, that is, the pressure between the work rolls and the bar at one end, could be different from the pressure between the rolls and the bar at the other end. Hence, when strain gauges were provided for measuring the pressure existing in the mill stand frames at each end of the rolls, the same degree of pressure as indicated by the strain gauges was applied at each end. It was then assumed that because the strain gauges on the front and rear frames indicated the same pressure, the spacing between the work rolls was the same at each end. However, as pointed out in the introduction hereto, many secondary factors of a mechanical and electrical nature enter into the indication of the strain gauge, so that the same reading on the gauges for the front and rear frames did not necessarily indicate the same degree of spacing between the ends of the work rolls.

Therefore the present invention operates on a principle entirely different from any heretofore employed, in that it measures directly the relative positioning of the ends of the pressure rolls. For this purpose I may provide means 25, 25' for producing an elongated band of light 26, as shown diagrammatically in Fig. 6A, designed to be projected through the space between the pressure rolls at one end thereof (see Fig. 3), and a similar band of light designed to be projected through the space between the pressure rolls at the other end thereof. On the opposite side of the work rolls from that where the light is being projected there may be positioned a photo-cell 27, 27' having an elongated sensitive area 28 as shown in Fig. 6B. The area 28 is positioned at an angle, preferably at right angles, to the band of light so that the band of light will cross the sensitive area of the photo-cell, thus producing an active area 30 where light from the source strikes the sensitive photo-cell surface as indicated in diagram 6C. By having the band of light cross the photo-cell sensitive area at an angle, it will be seen that slightly different positioning of the light source 25, 25' with respect to the photo-cell 27, 27' will have no effect upon the constancy of the active areas of the photo-cell surfaces which are struck by the light rays. Preferably the source of light is monochromatic. Thus, the light source may be ultra-violet, and is of an intensity which is relatively high compared to the intensity of the same type of light in the surrounding

medium, so that it will thus be possible to operate even in daylight. A filter 38, 38' is provided in front of the respective light cells 27, 27' to filter out all rays except those of the type transmitted from the light source so that the cells will respond only to rays of the selected type.

In operation of this device, the operator closes the double-throw switch 35 of motor M in one direction or the other to operate the screws 22 and 23 until the ends of the pressure rolls are brought to within the limits of the bands of light 26. From then on, any operation of the screws 22 and 23 will vary the intensity of the light striking the areas 30 to vary the voltages generated by the respective light cells 27, 27'. If the areas 30 of the cells at both sides are received light rays of equal intensity, the rolls are separated the same distance at the respective ends; but if not, then the output of the light cell 27 at one end is different from that of light cell 27' at the other end. The outputs from such cells may be indicated separately so that an operator may then operate one or the other of clutches C, C' by operating switch 36 to the proper position, to bring the ends of the roll at one end to the same relative separation as the rolls at the other end, as indicated by the outputs from said photo-cells. For this purpose the outputs from said cells may enter a mixing network 50, the output of which can be amplified by any suitable amplifier 51, and then operate any suitable indicator 52, which may be of the galvanometer type, to give an indication of the relative outputs. An operator then actuates the clutch C or C' until the pointer 53 is brought to the central position.

If desired, the control may be effected automatically by causing the output from the amplifier to act upon a polarized relay 60 which, when the output from the amplifier is in one direction, will actuate magnetic clutch C by closing contacts 62, and when the output is in the other direction will actuate magnetic clutch C' by closing contacts 63 to operate the respective screw 22 or 23 to bring the respective ends of the work roll into the same relative spacing as the other ends of said work rolls so that the same light intensities strike the areas 30. When this occurs, there is no output from the amplifier, and the armature of the relay 60 is held in neutral position by means such as springs 61.

For convenience in operation, the light cells may be mounted upon a carriage 70 which may take the form of a tripod support 67, 68, 69 having two arms 71, 72 extending rearwardly of the mill stand frame and spaced a distance somewhat greater than the width of the mill stand frame so that the carriage may be positioned with the arms 71 and 72 on opposite sides of any of the ten mill stand frames. One arm carries the light sources 25, 25' designed to produce the bands (Fig. 6A), while the other arm may carry the filters 38, 38' and the photo-cells 27, 27' designed to provide the sensitive surfaces (Fig. 6B) so that the active surfaces 30 (Fig. 6C) will be formed. Thus, by means of this carriage a device is obtained which can be used on any mill stand frame by merely rolling it into proper position. The weight of the arms may be counterbalanced by a suitable counterweight portion 85.

In accordance with the provisions of the patent statutes, I have herein described the principle and operation of my invention, together with the apparatus which I now consider to represent the

best embodiment thereof, but I desire to have it understood that the apparatus shown is only illustrative and that the invention can be carried out by other equivalent means. Also, while it is designed to use the various features and elements in the combination and relations described, some of these may be altered and others omitted without interfering with the more general results outlined, and the invention extends to such use.

Having described my invention, what I claim and desire to secure by Letters Patent is:

1. In combination with a rolling mill stand having a pair of work rolls and means for relatively positioning the ends of said rolls, means for obtaining equal spacing between the rolls at both ends thereof, said last named means comprising a source of radiant energy at each end of said rolls, means for passing said energy through the space between the rolls at the respective ends, means at the respective ends responsive to said energy after passing through said spaces, indicating means, and means whereby said responsive means actuates said indicating means.

2. In combination with a rolling mill stand having a pair of work rolls and means for relatively positioning the ends of said rolls, means for obtaining equal spacing between the rolls at both ends thereof, said last named means comprising a source of radiant energy at each end of said rolls, means for passing said energy through the space between the rolls at the respective ends, means at the respective ends responsive to said energy after passing through said spaces, indicating means, and means whereby said responsive means at the respective ends actuates said indicating means differentially.

3. In combination with a rolling mill stand having a pair of work rolls and means for relatively positioning the ends of said rolls, means for obtaining equal spacing between the rolls at both ends thereof, said last named means comprising a source of radiant energy at each end of said rolls, means for passing said energy through the space between the rolls at the respective ends, means at the respective ends responsive to said energy after passing through said spaces, and means whereby unequal responses of said responsive means at their respective ends actuates said positioning means so as to render equal said responses at both ends of said rolls.

4. In combination with a rolling mill stand having a pair of work rolls and means for relatively positioning the ends of said rolls, means for obtaining equal spacing between the rolls at both ends thereof, said last named means comprising a source of radiant energy at each end of said rolls, means for passing said energy through the space between the rolls at the respective ends, means at the respective ends responsive to said energy after passing through said spaces, and means whereby unequal responses of said responsive means at the respective ends selectively actuate said positioning means so as to render equal said responses at both ends of said rolls.

5. In combination with a rolling mill stand having a pair of work rolls and means for relatively positioning the ends of said rolls, means for obtaining equal spacing between the rolls at both ends thereof, said last-named means comprising means cooperating with each end and responsive to the space between the rolls at the respective ends, said cooperating means comprising a beam of light at one side of the rolls at each end thereof adapted to be projected through the

spaces between the ends of the rolls, and a light-sensitive cell at the other side of the rolls at each end thereof adapted to receive the light from the respective beams passing between the rolls.

6. In combination with a rolling mill stand having a pair of work rolls and means for relatively positioning the ends of said rolls, means for obtaining equal spacing between the rolls at both ends thereof, said last-named means comprising means cooperating with each end and responsive to the space between the rolls at the respective ends, said cooperating means comprising a beam of light at one side of the rolls at each end thereof adapted to be projected through the spaces between the ends of the rolls, and a light-sensitive cell at the other side of the rolls at each end thereof adapted to receive the light from the respective beams passing between the rolls, and means for indicating the voltage generated by said cells.

7. In combination with a rolling mill stand having a pair of work rolls and means for relatively positioning the ends of said rolls, means for obtaining equal spacing between the rolls at both ends thereof, said last-named means comprising means cooperating with each end and responsive to the space between the rolls at the respective ends, said cooperating means comprising a beam of light at one side of the rolls at each end thereof adapted to be projected through the spaces between the ends of the rolls, a light-sensitive cell at the other side of the rolls at each end thereof adapted to receive the light from the respective beams passing between the rolls, and means whereby the differential voltages generated by said cells actuate said positioning means in a direction to render said voltages equal.

8. In combination with a rolling mill stand having a pair of work rolls and means for relatively positioning the ends of said rolls, means for obtaining equal spacing between the rolls at both ends thereof, said last-named means comprising means cooperating with each end and responsive to the space between the rolls at the respective ends, said cooperating means comprising a beam of light at one side of the rolls at each end thereof adapted to be projected through the spaces between the ends of the rolls, and a light-sensitive cell at the other side of the rolls at each end thereof adapted to receive the light from the respective beams passing between the rolls, each of said beams of light forming an elongated area at its source, and each of said cells having an elongated sensitive area positioned at an angle to said first area.

9. In combination with a rolling mill stand having a pair of work rolls and means for relatively positioning the ends of said rolls, means for obtaining equal spacing between the rolls at both ends thereof, said last-named means comprising means cooperating with each end and responsive to the space between the rolls at the respective ends, said cooperating means comprising a beam of light at one side of the rolls at each end thereof adapted to be projected through the spaces between the ends of the rolls, and a light-sensitive cell at the other side of the rolls at each end thereof adapted to receive the light from the respective beams passing between the rolls, each of said beams of light forming an elongated area at its source, and each of said cells having an elongated sensitive area positioned at right angles to said first area.

10. In combination with a rolling mill stand having a pair of work rolls and means for rela-

tively positioning the ends of said rolls, means for obtaining equal spacing between the rolls at both ends thereof, said last-named means comprising means cooperating with each end and responsive to the space between the rolls at the respective ends, said cooperating means comprising a beam of monochromatic light at one side of the rolls at each end thereof adapted to be projected through the spaces between the ends of the rolls, a light-sensitive cell at the other side of the rolls at each end thereof adapted to receive the light from the respective beams passing between the rolls, and a filter cooperating with each cell to filter out all rays other than those of the type transmitted by said beams.

11. In combination with a rolling mill stand having a pair of work rolls and means for relatively positioning the ends of said rolls, means for indicating the spacing between the rolls at both ends thereof, said last-named means comprising a carriage, said carriage having a pair of arms adapted to cooperate with opposite sides of the mill stand adjacent the work rolls, one of said arms supporting means for generating a beam of light adjacent each end of the work rolls, and the other of said arms supporting a plurality of light-sensitive cells adapted to receive the light from the respective beams passing between the rolls.

15

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