

June 26, 1962

P. ANDERSEN

3,040,944

EDGE GUIDE FEED-BACK SYSTEM

Filed Jan. 8, 1960

3 Sheets-Sheet 1

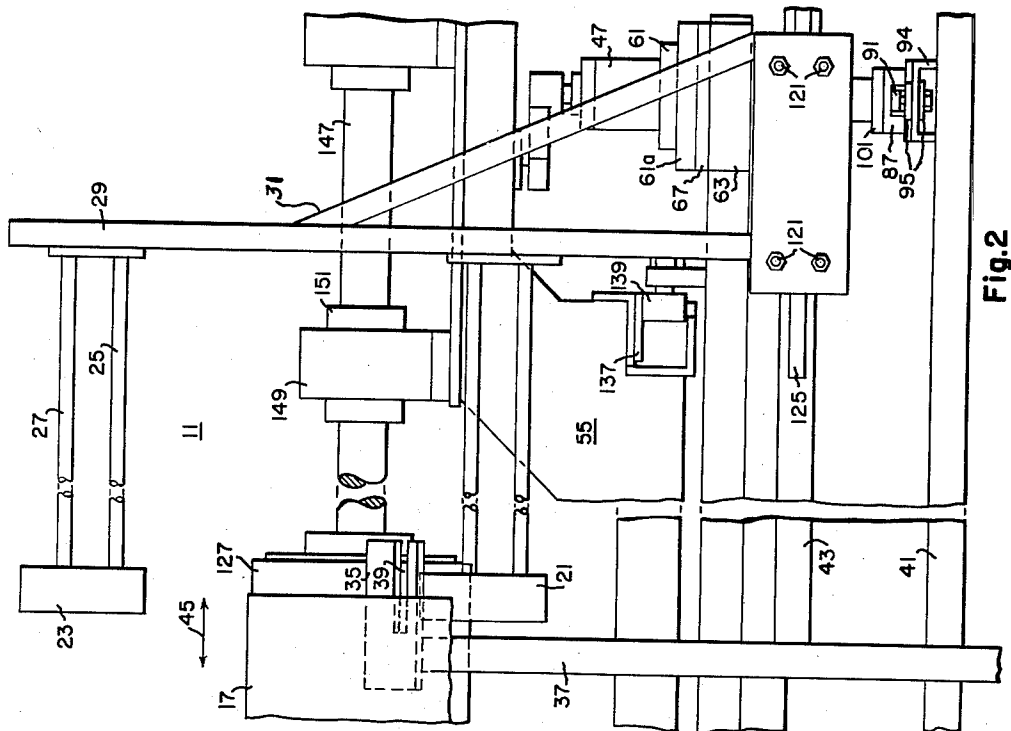


Fig. 2

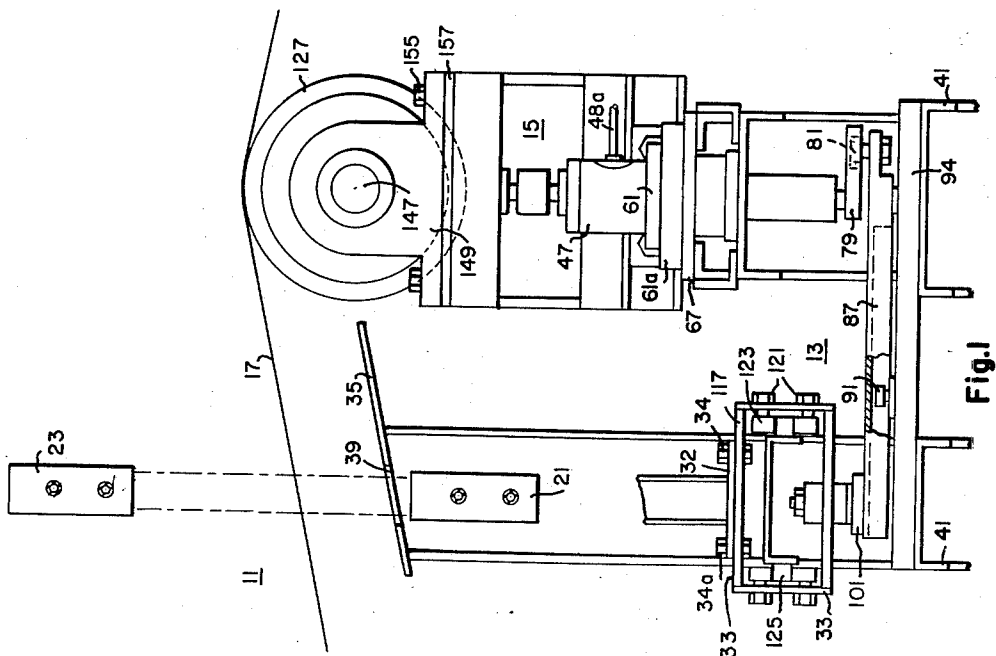


Fig. 1

June 26, 1962

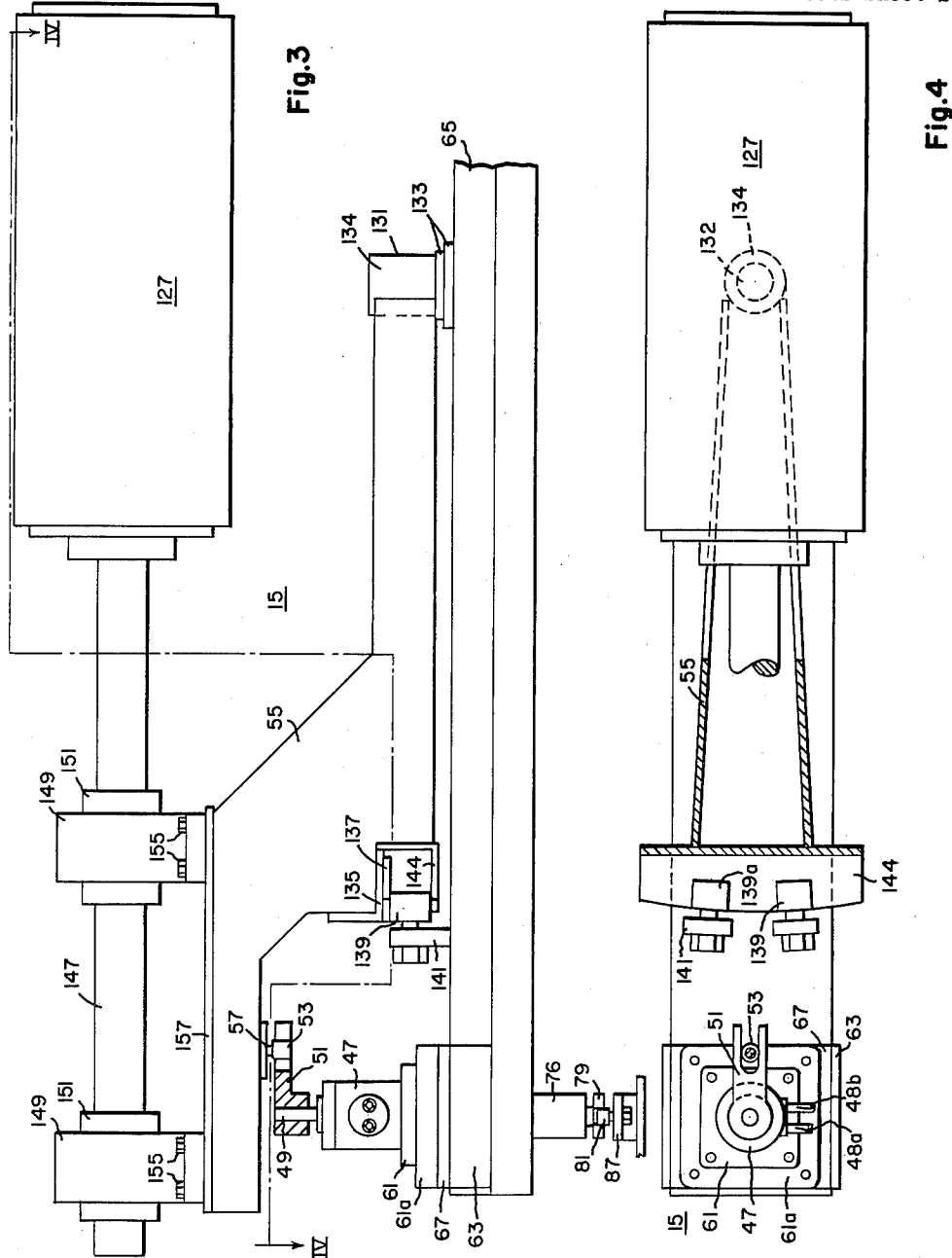
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Filed Jan. 8, 1960

3 Sheets-Sheet 2



Filed Jan. 8, 1960

EDGE GUIDE FEED-BACK SYSTEM

3 Sheets-Sheet 3

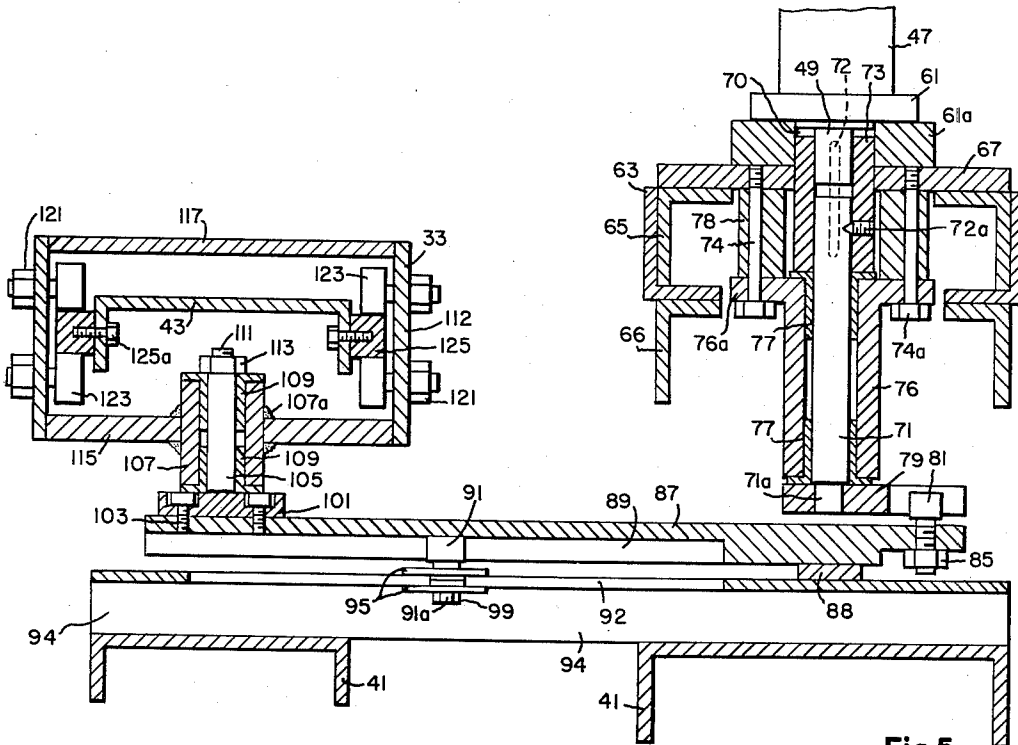


Fig.5

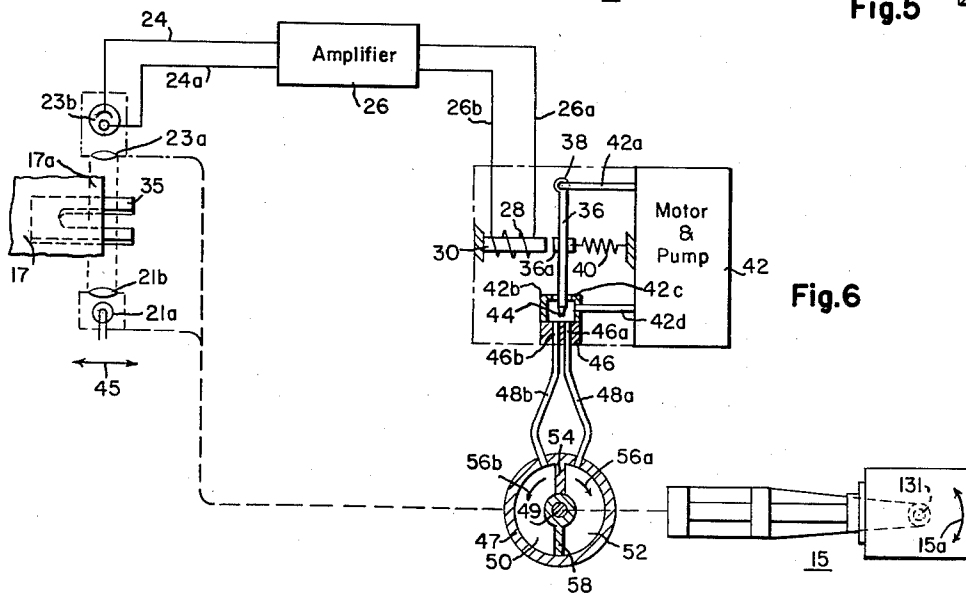


Fig.6

1

3,040,944

EDGE GUIDE FEED-BACK SYSTEM

Poul Andersen, Wallingford, Conn., assignor to The Wallingford Steel Company, Wallingford, Conn., a company of Connecticut

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3 Claims. (Cl. 226—21)

This invention relates to improvements in edge guide systems and relates in particular to an edge guide feed-back system.

In the manufacture of any continuous strip material, such as stainless steel strip or textile web, the material is fabricated into elongated bands that are subjected to processing steps involving treatment in a variety of mills that involve continuous passing of such strip over and through numerous rolls. Examples of such mills are hot rolling mills, cold rolling mills and annealing and pickling lines. When passing over such rolls and through such processing apparatus, it is necessary that the strip or web travel in a substantially uniform manner so as to minimize variations in properties due to variations in the exact position of the strip as it passes through heat zones and opposing rolls. The desired predetermined path for the strip to follow is generally referred to as the "pass line," and various methods have been devised to maintain such strip as accurately as possible on the pass line.

An edge guide as used in industry today is an automatic device that controls the position of a roll (or system of rolls) to maintain a fixed pass line in a continuous processing line for different types of strip or webs. The edge guide will normally consist of a sensing head, power unit and roll position unit. The sensing head can be either air or photoelectric operated, feeding the signal to the power unit where it is amplified. The amplified signal, in most cases, in the form of hydraulic pressure is transmitted to a hydraulic cylinder operating the steering roll or rolls.

Presently employed edge guides employ a stationary sensing head which is the main cause of "hunting" or constant over-correction of the steering roll. Such "hunting" results in the strip constantly wavering in and out of the pass line which is an undesirable condition leading to a non-uniform product. Hunting is mainly observed on low speed processing lines where the correction speed is too low for the response of the controlling unit. It is, of course, possible to decrease the sensitivity of the controlling unit and arrive at the right relationship between correction speed and sensitivity even at a very low strip speed. As described in the previous paragraph, there is only one processing speed that is correct for a certain sensitivity; if the sensitivity of the system is too high for the processing speed, "hunting" will occur; if too low, the steering roll will not respond quickly enough and the processed material will wander beyond allowed limits. An ideal system is one that possesses a high degree of sensitivity (responds quickly to a deviation in the pass line), but which will not create "hunting" due to such sensitivity. Such a system would be highly effective regardless of the speed of processing.

The edge guide system of the present invention prevents "hunting" on low speed processing lines while maintaining a high sensitivity on low as well as high speed lines.

In addition, it is inherent in the prior known edge guide systems that when the mill is, for any reason, brought to a complete stop, the steering rolls invariably assume a complete correction angle. Such a phenomenon is obviously undesirable since, unless adjustments to the rolls are effected prior to starting the mill, the strip will be caused to substantially deviate from the pass line. The

2

edge guide feed-back system of the present invention eliminates this difficulty, in that when this system is employed the mill may be stopped and started without adversely affecting the correction angle of the steering rolls.

It is the object of the present invention to provide an edge guide feed-back system on a strip processing line that will prevent or reduce hunting and still maintain a high degree of sensitivity.

It is a further object of the present invention to provide a strip guide feed-back system wherein the sensitivity of the system need not be adjusted in accordance with the speed of the of the processing mill.

Another object of the present invention is to provide a strip edge guide feed-back system wherein the strip processing mill may be brought to a complete stop without effecting an adverse correction angle to the steering rolls.

Further objects and advantageous features will be obvious from the following description when taken in conjunction with the accompanying drawings in which:

FIGURE 1 is a schematic view in elevation and partly in section of a strip guide apparatus embodying the teachings of this invention;

FIG. 2 is a view in elevation of the strip guide apparatus of FIG. 1, the illustration of FIG. 2 being rotated 90° from the position shown in FIG. 1;

FIG. 3 is a view in elevation and partly in section of the strip guide roll assembly 15 of FIG. 1, the illustration of FIG. 3 being rotated 90° from the position shown in FIG. 1;

FIG. 4 is a top plan view of the strip guide roll assembly of FIG. 3 being partly in section taken along the lines IV—IV of FIG. 3;

FIG. 5 is an enlarged view in elevation and partially in cross section of the strip guide and sensing head propelling mechanism 13 of FIG. 1; and

FIG. 6 is a schematic illustration of a sensing device and torque actuator (in section) that may be employed to control the apparatus of FIGS. 1 through 5.

In the apparatus of the present invention, the correcting motion of the steering rolls is, by a mechanical linkage, transmitted to the sensing head, perpendicular to the strip. This will allow the sensing head, after detecting a shift in the pass line, to follow the edge and satisfy itself with the steering roll in a correcting position. When the strip is returning to the original pass line, a new signal from the sensing head will actuate the control unit and the steering roll or rolls start returning to the neutral position; the sensing head will likewise, through the feed-back system, return to the original position.

The sensitivity of the guiding system is not related directly to the correction speed (a function of strip speed and steering angle) and can theoretically be as high as desired, limited only by the mechanical response of the roll unit.

The low limit of sensitivity is determined by the maximum correction speed versus speed of sensing head in accordance with the formula:

$$\frac{V_2}{V_1 \cos Y} \geq 1$$

where

V_2 —Speed of sensing head

V_1 —Maximum line speed

Y —Maximum correction angle

The amount of feed-back is determined either by maximum anticipated variation in pass line, or the sensitivity required for the complete guide system. The smaller the feed-back, the greater the sensitivity of the system, approaching zero feed-back, where the sensitivity is only

3

dependent on the response of sensing head and control unit. Accordingly, in the system of the present invention, the sensing head is caused to follow the deviating strip during correction so that the correction is cancelled in anticipation of the return of the strip to the pass line.

The device of the present invention requires the co-operation and functioning of three basic components or units to accomplish the desired strip guidance. These units are illustrated generally in FIG. 1 as the sensing head 11 (see also FIG. 2), the strip guide and sensing head propelling mechanism 13 (see FIG. 5) and the strip guide correction roll assembly 15 (see FIGS. 3 and 4).

The three units 11, 13 and 15 cooperate and function as a single unit. The following description is a broad and general explanation of the functions performed by each unit in cooperation with one another, with a more detailed description of the construction and operation of each unit following such broad and general description.

In general, a sensing head 11 is positioned to follow one edge of the metal strip (shown as 17 in FIG. 1) and when there is a deviation of the path of the strip 17, the sensing head 11 detects such deviation and transmits this information to the propelling mechanism 13, which immediately initiates and applies a corrective force to the strip 17 by adjusting the position of the roll unit 15. In the meantime, simultaneously and in accordance with the present invention, the propelling mechanism 13 effects a corresponding adjustment in the position of the sensing head 11 so as to propel the sensing head 11 in the same direction as the deviation movement of the strip. By so doing, the sensing head 11 satisfies itself with the edge of the strip 17 soon after the correction force applied through roll unit 15 takes effect and commences to return the strip 17 to its correct position. Upon satisfying itself with the strip edge, the sensing head 11 again transmits an impulse to the propelling mechanism 13 which cancels the correction force applied to the strip by roll unit 15 and effects a return of the roll unit 15 towards its original position and simultaneously effects a propelling of the sensing head 11 towards its original position. Should the strip fail to return to its accurate, original position but once again commences to deviate, the sensing head 11 will detect the variation in position of the edge of the strip and a correction force will be reapplied, as above, soon after such second deviation occurs, since the sensing head 11 will continue to follow the edge of the strip both during the deviation and during the correction.

The sensing head 11, particularly as shown in FIG. 2, is composed of a light source 21 and photoelectric detector 23 carried by a suitable supporting and adjustable positioning structure. The sensing head mechanism itself is well known in the art and is employed in many industries wherein strips of material pass over a series of rolls. The sensing head 11 can be of any suitable type such as the air or photoelectric cell operated types capable of feeding a signal to the power unit.

In the present embodiment, there is employed a sensing device and torque actuator such as is provided by the Askania Regulator Company of Chicago, Illinois (Askania Regulator No. 25AL) and the Ex-Cell-O Corporation of Detroit, Michigan (Rotac Model RN-32-2V). A schematic illustration showing generally the manner in which such a system functions is shown by FIG. 6. A light bulb 21a emits a light which is directed, by means of a lens 21b, to a second lens 23a which directs the light to a photocell 23b. Photocell 23b is of conventional manufacture, in the present embodiment being a Photocell RCA7163 (Radio Corporation of America). Such a cell performs its usual function of providing an electric current, the intensity of which varies in accordance with the amount of light directed toward it by light bulb 21a and lenses 21b and 23a. Such current flows through a wire 24 and is amplified by a conventional type amplifier illustrated generally in FIG. 6 by

4

box 26. The amplified electric current flows through a line 26a and a coil 28 to induce a magnetic force into a core 30. The circuits are completed to amplifier 26 and photocell 23b, respectively, through wires 26b and 24a. Hence, it may be readily seen that the intensity of the electric current flowing in coil 28 depends on the amount of light emitted by bulb 21a and directed by lens 21b that reaches photocell 23b. It is obvious that the magnetic force induced into core 30 also depends on the intensity of such electric current. A steel jet nozzle such as is illustrated at 36 is pivotally mounted to a stationary member (not shown) at 38. A magnetic force of attraction imposed by core 30 tends to pivotally attract jet nozzle 36; however, this tendency is opposed by a spring 40 that is attached to the other side of jet nozzle 36 to a stationary member, in the present embodiment shown to be motor and pump 42. Member 36a is an integral part of jet nozzle 36 and serves as an attachment member for spring 40 and as a spacer member for magnetic attraction from core 30. Jet nozzle 36 is supplied with hydraulic fluid under pressure from the motor and pump, shown schematically at 42, through an inlet hose 42a. The jet outlet 44 is positioned contiguously with a distributor member 46. The conventional motor and pump 42 supplies fluid pressure to jet nozzle 36 through an inlet hose 42a. Jet outlet 44 is substantially enclosed in the vicinity of distributor 46 by enclosure 42b which confines the fluid force emitted by the jet nozzle 36. An opening 42c is provided in enclosure 42b into which jet nozzle 36 projects. Opening 42c is of sufficient size to permit pivotal movement of jet nozzle 36 inside the enclosure 42b. Fluid returns to the motor and pump 42 for re-circulation through outlet hose 42d. Distributor member 46 has two outlets 46a and 46b that converge on substantially the same point contiguous with the jet of hydraulic fluid emitted by nozzle 36 when it is in a vertical position. Outlets 46a and 46b lead to hydraulic hoses 48a and 48b which, in turn, lead to torque actuator 47. Torque actuator 47 (shown in cross section in FIG. 6) is composed of two chambers 50 and 52 that are separated by a stationary fin 54 and a rotatable fin 58 that is rigidly attached to shaft 49 as by welding, etc. In operation, the tension of spring 40 is so adjusted that when the edge 17a of strip 17 only blocks half the light emitted by bulb 21a directed by lenses 21b and 23a to photocell 23b, the amplified electric current flowing through the coil 28 is just sufficient to maintain pivotally mounted jet nozzle 36 in a vertical position. When jet nozzle 36 is in a vertical position, the jet stream emitted flows equally into passageways 46a and 46b of distributor member 46. Such hydraulic force flows through pressure hoses 48a and 48b and into compartments 50 and 52 of torque actuator 47. Since these forces (represented by arrows 56a and 56b) are equal, they cancel one another and the rotatable fin 58 and hence the shaft 49 remain stationary and no correction on the correction roll assembly is effected. On the other hand, if the strip 17 deviates from the pass line so as to block out or cover more than half the light emitted from bulb 21a and directed by lens 21b to photocell 23b, the electric current in lines 24 and 24a and, hence, the current in coil 28 is appropriately diminished; consequently, the magnetism induced into core 30 is diminished. As a result of the diminished magnetic attraction imposed by core 30 on jet nozzle 36, spring 40 overcomes the attraction to the degree the electric current was diminished and jet nozzle 36 is pivotally moved in the direction of spring 40 and a greater amount of the hydraulic fluid jet stream is directed toward passageway 46a than 46b so that greater hydraulic pressure flows in hose 48a than in 48b and the pressure in chamber 52 of torque actuator 47 becomes greater than that in chamber 50 and the fin 58 is caused to rotate in the direction shown by the arrow 56a which causes rotation of shaft 49 to effect a correction angle to correction roll unit 15 as will be hereinafter described in detail.

5

The hydraulic pressure directed by jet nozzle 36 that ultimately effects greater hydraulic pressure in chamber 52 continues until the correction has taken effect and the sensing head 11 has satisfied itself with the strip edge 17a in which event the amount of the light emitted by bulb 21a and that is received by photocell 23b provides an electric current to effect the necessary magnetic attraction in core 30 to oppose spring 40 and position jet nozzle 36 in a vertical position. With jet nozzle 36 in a vertical position, as shown above, the pressure in chamber 50 becomes equal to that in chamber 52 of torque actuator 47 and the opposing hydraulic forces 56a and 56b cancel one another. If strip 17 deviates from the pass line in such a manner as to cause a greater portion of the light emitted from bulb 21a and directed by lenses 21b and 23a to reach photocell 23b, a greater electric current will flow through coil 28, hence a magnetic force is induced into core 30 that will overcome the spring 40 to the extent of the deviation of strip 17. In this event, the jet stream emitted by jet nozzle 36 will be directed in the direction of passageway 46b of distributor 46 and a greater hydraulic force will result in chamber 50 than chamber 52 of torque actuator 47. In this event, fin 58 and hence shaft 49 of torque actuator 47 will be revolved in the direction indicated by the arrow 56b and a correction of roll unit 15 will be effected in a reverse direction to that previously described. When strip 17 responds to the correction force, the light emitted by bulb 21a and directed to photocell 23b by lens 21b will be diminished effecting a diminished electrical current in coil 28 and hence reducing the magnetic attraction of core 30 to permit jet nozzle 36 to return towards its vertical position or to once again effect a greater hydraulic force in chamber 52 of torque actuator 47.

Adjacent to torque actuator 47 as shown in the schematic illustration of FIG. 6, there is shown, for illustrative purpose, a schematic top view of a roll unit 15. As will be shown in detail, rotation of shaft 49 of torque actuator 47 effects a pivotal movement of roll unit 15 about pivot 131 as shown by the double arrow 15a.

The mechanism of the present embodiment is designed specifically for the processing of heated steel strip so that special precautions must be taken to protect the equipment from the heat emitted from the metal and the annealing furnace. For example, the photoelectric detector 23 and the light source 21 of sensing head 11 are water cooled. Cooling water is supplied to these members through members 25 and 27 (see FIG. 2) which are metal tubes that serve as water inlets and outlets, respectively, as well as supporting members for these components. Members 25 and 27 are mounted on a vertical supporting member 29 which is, in turn, rigidly mounted on a movable platform 33 that is part of the propelling mechanism 13 (described hereinafter in greater detail). Cooling water is supplied and drained from tubular members 25 and 27 through hose connections (not shown) leading from a convenient source of water and to suitable drains. Diagonal supporting member 31 lends additional support to vertical supporting member 29 and is attached to member 29 and to a plate 32 as by welding, etc. Plate 32 is bolted to plate 117 of platform 33, as shown in FIG. 1, by bolts 34 and nuts 34a. Supporting member 29 is also bolted (not shown) to platform 33 in a manner similar to that of diagonal supporting member 31.

Additional protection from a possibly broken strip is provided by a protector plate 35 mounted on a supporting member 37. Protector plate 35 is formed with a slot 39 through which the light from light source 21 may be projected to the photoelectric detector 23.

The over-all unit, as shown in FIGS. 1 and 2, including propelling mechanism 13 and roll unit 15, is supported by inverted U-shaped beams 41 and sensing head 11 is movably supported, as will hereinafter be described, on inverted U-shaped beam 43.

The sensing head 11 is so positioned that the steel strip

6

17, while correctly positioned in the processing line, runs so that its edge is in the center of the light beam emitted from light source 21 and passing to photoelectric detector 23 so that deviation in the path of travel or "pass line" of the strip 17 in the directions indicated by double arrow 45 in FIG. 2 will cause a variation in the light intensity received by photoelectric detector 23. Such variation, as previously described, effects a hydraulic pressure in torque actuator 47 that, in turn, effects a correction angle to correction roll unit 15.

The propelling mechanism 13 is composed of the positioning torque actuator 47 which provides the predetermined motivating force for positioning the roll unit 15 and additionally for the sensing head 11. The torque actuator 47, as described above, effects rotation of a drive shaft 49 when actuated by hydraulic pressure. Torque actuator 47 is provided with a flange 61 that is rigidly attached as by welding or bolting to attachment plate 61a. Flange 61 of torque actuator 47 and attachment plate 61a are, in turn, rigidly attached as by bolting or welding to supporting members 63, 65 and plate 67 which are welded or bolted together to form a rigid boxlike structure that provides adequate support for the torque actuator 47 and other components hereinafter described.

Rotation of drive shaft 49 effects a swinging motion of forked arm 51 (see FIG. 3) that is received on the upper end thereof. Riding in the slot of the forked arm 51 is a rotating cam follower 53 that is attached to the roll unit base 55 through a rigidly attached plate 57.

The roll unit base 55 itself is rotatably mounted to supporting member 65 through a pivot 131. Pivot 131 is composed of an upwardly projecting cylindrical member 132 that is rigidly attached to supporting member 65, as by welding, etc., and which projects into a cylindrical bearing receptacle 134 that is rigidly attached at one end of the unit base 55, as by welding, etc. Thrust washers 133 surrounding cylindrical member 132 prevent the roll unit base 55 and cylinder 134 from bearing directly on support member 65 when the roll unit base 55 rotates about pivot 131. The unit base 55 is additionally supported by two cam followers 139 and 139a that are rigidly mounted on supporting member 65 by means of supporting members 141. The cam followers 139 and 139a support and engage bearing plate 137 that is rigidly attached, as by welding, etc., to an angle beam 135 that is in turn rigidly attached, as by welding, etc., to the unit base 55. Angle beam 144, which is also rigidly attached to the unit base 55 and projects outwardly beneath the rotatable cams 139 and 139a, acts as a guide member for the unit base 55.

It may be seen that rotation of shaft 49 by actuator 47 effects a swinging motion to forked arm 51 which, in turn, bears on cam 53 to effect a swinging motion to the unit base 55 about pivot 131. Bearing plate 137 is supported and effects rotation of cams 139 and 139a during such motion. Since shaft 49 turns for only a predetermined degree, the correction angle effected on roll 127 by pivotal motion of unit base 55 about its pivot 131 is also predetermined.

The correction roll itself is, of course, a conventional drive roll 127 mounted on a plate 157 that is rigidly attached, as by welding, etc., to the unit base 55. This roll assembly is composed of an idler roll 127 mounted on a shaft 147 that is rotatably mounted in bearing members 151 assembled in clamp members 149. Clamp members 149 are bolted to plate 157 by bolts 155 that project through both the flanges of members 149 and the plate 157.

Referring to FIG. 5, it is noted that the drive shaft 49 of the torque actuator 47 and another shaft 71 project downwardly from the lower end of the torque actuator through an opening 70 formed in plate 61a and plate 67 of the general boxlike structure formed by members 63 and 65 and supporting member 66 that serve as support for the over-all structure. Shaft 71 is in alignment with

and is keyed to shaft 49 as shown by the dotted lines at 72 so that shaft 71 rotates with shaft 49. A seamless coupling 73 is disposed around the keyed junction 72 of shafts 71 and 49 and is rigidly affixed by set screw 72a to the shaft, and hence rotates when shaft 49 and shaft 71 rotate. The function of coupling 73 is, of course, to connect the two shafts 49 and 71 and to provide a thrust bearing support therefor when seated on the flange of bushings 77. A flanged seamless tube 76 surrounds the shaft 71 and acts as a housing for bushings 77 as well as a supporting member therefor. It is noted that tube 76 is flanged at its upper end as shown at 76a and is bolted through spacer 78 to torque actuator base plate 67 by bolts 74 and 74a. Bronze bushings 77 are disposed about the opposite ends of the flanged seamless tube 76 to provide bearing surfaces for shaft 71 and tube 73 (which rotates with shafts 49 and 71).

A forked arm 79 is affixed to the lower end of shaft 71 at 71a as by means of welding with the slotted portion of the arm 79 engaging a rotatable cam follower 81 disposed therein. The cam follower 81 is secured to a slotted arm 87 by a nut 85. The slotted arm 87 is positioned horizontally below the roll unit 15 and the positioning torque actuator 47 (see FIG. 1) and projects outwardly therefrom to beneath the movable platform 33 on which sensing head 11 is mounted. Arm 87 is provided with an undercut slot 89, as shown in FIG. 5, that runs horizontally from one end thereof for about $\frac{3}{4}$ of its length.

In order to control the degree of movement of the platform 33 in response to a movement of the power unit 47, the slotted arm 87 is mounted on an adjustable cam follower 91 which functions as a pivot for the arm 87. Thus rotation of shafts 49 and 71 imposed by torque actuator 47 effects a swinging motion to forked arm 79 and such motion will cause a pivotal motion of slotted arm 87 about the cam follower 91 which rides in the slot 89 of arm 87. Brass plate 88 is rigidly attached to support beam 94 and provides support to arm 87 which slides over this member. The cam follower 91 is adjustably mounted in a slotted channel 92 formed in a support beam 94 by means of spaced plates 95 disposed on opposite sides of slotted beam 94 and secured together as by means of the shaft 91a of cam follower 91 and a nut 99. Thus, the cam follower 91 may be adjusted horizontally along the arm 87 by loosening the nut 99, which in turn permits adjustable motion of the clamp by loosening the clamping force of plates 95 on the slotted channel 92 of beam 94. Horizontal adjustment of cam follower 91 relative to the arm 87 affects the amount of travel of platform 33 and hence, sensing unit 11 along the fixed rails 125. On the other end of the slotted arm 87, there is mounted an annular flange 101 that is rigidly attached to the arm 87 by means of bolts 103. A stud shaft 105 projects to the center of annular flange 101 and is welded thereto to provide a rigid mounting. A seamless tube 107 is disposed about the shaft 105 with bearing bushings 109 disposed therebetween, such assembly being secured in assembled position as by means of the nut 113 on the threaded head 111 of the shaft 105. Thus, relative rotative movement is obtained between the shaft 105 and the tube 107 as the arm 87 swings about cam follower 91. The tube 107 is rigidly attached by welding 107a to the movable platform 33 carrying sensing device 11. The movable platform 33 is composed of side members 112, a bottom plate 115 and a top plate 117, all of which are rigidly attached together, as by welding, etc. Bottom plate 115 is rigidly attached to seamless tube 107 by welding. Four spaced cam followers 123 are attached to opposed side members 112 by means of their shafts projecting through holes in plates 112 (not shown) and nuts 121. Cam followers 123 are disposed to bear on associated rails 125 that are rigidly attached as by welding to supporting beam 43. Rails 125 are rigidly attached to supporting beam 43 by means of bolts 125a. Supporting beam 43 is shown

in the present embodiment to be rigidly attached to upwardly projecting supporting member 37 (see FIG. 2) on one end and is attached to a similar member on the other end (not shown). Thus, it may be observed that rotation of shafts 49 and 71 by torque actuator 47 effects a swinging motion to forked arm 79 that bears on cam 81 to cause a pivotal swinging motion to arm 87 about cam follower 91 that effects corresponding propulsion to movable platform 33 through shaft 105, hence effecting a propelling of the sensing unit 11 along the rails 125 in the same direction as the deviation of the strip 17 in the direction shown by the double arrows 45 of FIG. 2. Such motion has been effected simultaneously with the swinging motion of forked arm 51 which, as shown above, imparts a correction angle movement to roll 127.

Thus, it is seen that variation of the beam of light emitted by light source 21 directed to photoelectric detector 23 of sensing head 11 by the strip 17 deviating from the "pass line" in either direction shown by the double arrow 45 of FIG. 2 effects a predetermined correction rotation of shaft 49 by torque actuator 47. Such rotation in turn effects a swinging motion of forked arm 51 on the upper end and forked arm 79 on the lower end through connecting shaft 71. While forked arm 51 swings and effects a correcting angle to the roll 127 by pivotal motion of the unit roll base 55 pivoting on pivot 131, forked arm 79 effects a pivotal motion of slotted arm 87 due to the effect of cam follower 81 in the slot of forked arm 79 and consequently through shaft 105, which is rigidly attached to the other end of arm 87, effects corresponding propulsion to movable platform 33, thus effecting a movement of the light source 21 and photoelectric detector 23, due to the movement of the platform 33, in the direction 45 of the deviating strip. It is also apparent that when the correcting angle of roll 127 commences to effect a return of the strip 17 to the correct position of the pass line, the light beam emitted by light source 21 and directed to photoelectric detector 23 will be re-established. Since the sensing device 11 followed the edge of the strip 17, it will re-engage the edge much sooner than if it had remained stationary. Upon re-establishment of the balanced beam, the torque actuator 47 is activated to return sensing unit 11 to its original position, and simultaneously returns the roll 127 to its initial position. The shaft 49 rotates to its original position and effects a return of forked arm 51 to its original position and hence, cam follower 53 causes pivotal motion of the unit base 55 about pivotal connection 131 to return the base to its original position. Simultaneously, shaft 49 effects rotation of shaft 71 to its original position, causing a reverse effect on forked arm 79 and cam follower 81, pivotally swinging arm 87 about cam follower 91 to its original position which, in turn, effects a return of the movable base 33 carrying the sensing unit 11, and causing the light beam emitted from source 21 to photoelectric detector 23 to follow the strip back.

If the edge guide feed-back system was not employed and the sensing head 11 was fixed in a stationary position, then the system would be illustrative of the prior known edge guide systems. It can be seen that if such were the case and the strip mill were stopped during any period wherein the edge 17a of strip 17 varied even very slightly from the pass line, which for practical purposes is always the case, the current in coil 28 (see FIG. 6) would be affected and jet nozzle 36 would not be in an absolutely vertical position. From the above, it is readily seen that this will cause a greater hydraulic force in one of the chambers 50 or 52. Since the correction angle consequently imposed cannot be reversed or stopped because the strip is stopped and there is no response to the correction angle imposed, the steering rolls will ultimately effect a full correction angle no matter how small the hydraulic pressure varies between the two chambers 50 and 52.

It is readily seen that by employing the edge guide feed-back system of the present invention this phenomenon does not occur. When the mill or strip has stopped moving, the feed-back system will function as usual so that the sensing head 11 will satisfy itself as to the edge of strip 17 so that the light emitted by bulb 21a and directed by lens 21b that arrives at photocell 23b will be precisely the amount required to effect that electric current in coil 28 that will result in a magnetic attraction by core 30 to oppose spring 40 and maintain jet nozzle 36 in a vertical position. Thus, the hydraulic pressure in chambers 50 and 52 will be the same and no further correction angle will be imposed on the steering roll 127.

I claim:

1. In a strip guide apparatus wherein a sensing head is disposed to follow one edge of the strip and upon deviation of said strip from its pass line effect a signal to a torque actuator that is disposed to effect rotation of a vertically positioned shaft in response to said signal that in turn effects a correction angle to a steering roll over which said strip passes to effect a return of said strip to said pass line and said sensing head being further disposed to effect a signal to said torque actuator to effect a reverse rotation of said shaft to cancel the correction angle of said steering roll upon the return of said strip to said pass line, the improvement in combination therewith comprising, a horizontally positioned arm formed with a longitudinal slot and disposed to pivot about a fixed cam projecting into said slot, a forked arm attached to said shaft and disposed to swing in a horizontal plane upon rotation of said shaft, a cam rigidly attached to one end of said horizontally positioned arm disposed to project into the fork of said forked arm, a movable platform on which said sensing head is mounted, said platform being disposed to travel on a predetermined path and said platform being rotatably connected to the remaining free end of said horizontally positioned arm so that a swinging motion of said forked arm will effect pivotal motion of said horizontally positioned arm through said cam within the fork of said forked arm and about said fixed cam projecting into said longitudinal slot formed in said horizontally positioned arm, such pivotal motion being transmitted to said platform through said rotatable connection to effect travel of said sensing head corresponding to the correction angle effected in said steering roll by said shaft so that said sensing head will travel in the direction of said deviation during said deviation and in the direction of return during said return.

2. In a strip guide apparatus wherein a sensing head is disposed to follow one edge of the strip and upon deviation of said strip from its pass line effect a signal to a torque actuator that is disposed to effect rotation of a vertically positioned shaft in response to said signal that in turn effects a correction angle to a steering roll over which said strip passes to effect a return of said strip to said pass line and said sensing head being further disposed to effect a signal to said torque actuator to effect a reverse rotation of said shaft to cancel the correction angle of said steering roll upon the return of said strip to said pass line, the improvement in combination therewith comprising, a horizontally positioned arm formed with a longitudinal slot and disposed to pivot about a fixed cam projecting into said slot, means for adjusting the fixed position of said cam so that the pivotal motion of said horizontal positioned arm about said fixed cam can be varied, a forked arm attached to said shaft and disposed to swing in a horizontal plane upon rotation of said shaft, a cam rigidly attached to one end of said horizontally positioned arm disposed to project into the fork of said forked arm, a movable platform on which said sensing head is mounted, said platform being disposed to travel on a predetermined

path and said platform being rotatably connected to the remaining free end of said horizontally positioned arm so that a swinging motion of said forked arm will effect pivotal motion of said horizontally positioned arm through said cam within the fork of said forked arm and about said fixed cam projecting into said longitudinal slot formed in said horizontally positioned arm, such pivotal motion being transmitted to said platform through said rotatable connection to effect travel of said sensing head corresponding to the correction angle effected in said steering roll by said shaft and the amount and speed of said travel depending on the fixed position of said fixed cam so that said sensing head will travel in the direction of said deviation during said deviation and in the direction of return during said return.

3. In a strip guide apparatus wherein a sensing head is disposed to follow one edge of the strip and upon deviation of said strip from its pass line effect a signal to a torque actuator that is disposed to effect rotation of a vertically positioned shaft in response to said signal that in turn effects a correction angle to a steering roll over which said strip passes to effect a return of said strip to said pass line and said sensing head being further disposed to effect a signal to said torque actuator to effect a reverse rotation of said shaft to cancel the correction angle of said steering roll upon the return of said strip to said pass line, the improvement in combination therewith comprising, a horizontally positioned arm formed with a longitudinal slot and disposed to pivot about a fixed cam projecting into said slot, an elongated member horizontally positioned beneath said slotted arm said elongated support member being formed with a slotted channel, clamping means attached to said fixed cam and disposed to clamp to said elongated member within said slotted channel, a forked arm attached to said shaft and disposed to swing in a horizontal plane upon rotation of said shaft, a cam rigidly attached to one end of said horizontally positioned arm disposed to project into the fork of said forked arm, a movable platform on which said sensing head is mounted, said platform being disposed to travel on a predetermined path and said platform being rotatably connected to the remaining free end of said horizontally positioned arm so that a swinging motion of said forked arm will effect pivotal motion of said horizontally positioned arm through said cam within the fork of said forked arm and about said fixed cam projecting into said longitudinal slot formed in said horizontally positioned arm, such pivotal motion being transmitted to said platform through said rotatable connection to effect travel of said sensing head corresponding to the correction angle effected in said steering roll by said shaft and the amount and speed of said travel depending on the fixed position of said fixed cam so that said sensing head will travel in the direction of said deviation during said deviation and in the direction of return during said return.

References Cited in the file of this patent

UNITED STATES PATENTS

60	2,632,642	Cooper	Mar. 24, 1953
	2,709,588	Staeger	May 31, 1955
	2,716,026	Axworthy	Aug. 23, 1955
	2,735,630	Ziebolz	Feb. 21, 1956
	2,782,030	Webster et al.	Feb. 19, 1957
65	2,842,361	Miller	July 8, 1958
	2,928,409	Johnson et al.	Mar. 15, 1960

FOREIGN PATENTS

70	410,859	Great Britain	May 28, 1934
	762,837	Great Britain	Dec. 5, 1956
	1,151,045	France	Aug. 19, 1957