This invention relates to apparatus for automatically maintaining the alignment of a strip during movement thereof and more particularly to apparatus for correcting for lateral movement of steel strip and the like from its path of travel during processing.

While various devices have hitherto been proposed for the same general purpose, a number of such devices rely upon electronic sensing means, such as photoelectric cells, to detect lateral movement of the strip and initiate corrective movement of the movable correcting means which compensate for the lateral wandering of the strip. While such devices are effective under ideal operating conditions, they are adversely affected by unfavorable operating conditions, such as the presence of steam, heat, dust or acid fumes in the vicinity of the sensing mechanism. In addition, each time the width of the strip being handled is varied, the sensing mechanism must be adjusted to accommodate the new strip width. This latter difficulty is also inherent in most mechanical sensing devices of the type wherein an arm is arranged to follow an edge of the strip and mechanically actuate the correcting mechanism upon the wandering of the strip edge from its intended path of travel. Furthermore, in both types of devices there is a tendency to overcorrect in that once the adjusting movement of the correcting mechanism has been initiated, such movement will continue until the strip has been returned to essentially its on-center position. For example, if the correcting means comprises a correcting roll which is pivotally mounted at one end and movably mounted at its opposite end so that the roll may be skewed relative to the strip, once the skewing movement of the roll has been initiated, it will continue until the strip returns to the on-center position and consequently the skew angle progressively increases so that the roll is at its greatest pitch at a time when the strip is approaching the on-center position. Consequently the lateral movement of the strip will continue and the strip will be caused to move off-center in the opposite direction, and it will continue in such direction until the sensing means acts to reverse the adjustment of the correcting roll and move the strip back toward the on-center position. The net result is an essentially constant hunting or shifting of the strip back and forth from one side of the center line to the other.

Accordingly, a principal object of the instant invention is the provision of strip guide mechanism which is simple, rugged and efficient, and which eliminates the foregoing enumerated difficulties, the mechanism acting to mechanically sense the location of the strip and, upon deviation of the strip from its intended path of travel, actuate control mechanism effective to shift the strip laterally so as to return it to the on-center position.

Another object of the instant invention is the provision of control mechanism operative to effect step-wise or increment adjustment of the strip shifting means so that such means will not tend to over-correct.

Still further objects of the instant invention is the provision of strip guiding mechanism which is capable of being used with strip material of varying widths without having to adjust the sensing and control mechanism when changing from one strip width to another.

The foregoing, together with other objects of the instant invention which will appear hereinafter or which will be apparent to the skilled worker in the art upon reading these specifications, are accomplished by those constructions and arrangements of parts of which certain exemplary embodiments shall now be described.

Reference is now made to the accompanying drawings wherein:

FIGURE 1 is a schematic plan view illustrating a double edge strip guiding mechanism in accordance with the instant invention.

FIGURE 2 is a vertical sectional view taken along line 2—2 of FIGURE 1.

FIGURE 3 is an alternative embodiment of the invention utilizing a single control arm.

FIGURE 4 is a vertical sectional view taken along the lines 4—4 of FIGURE 3 illustrating the four way control valve.

FIGURE 5 is a schematic plan view of another embodiment of the invention utilizing a pair of control arms and also a co-ordinated pair of correcting rolls.

Referring first to FIGURE 1 of the drawings, the reference numeral 1 indicates a strip of material, such as steel, which is being advanced in the direction indicated by the arrow A. As the strip is advanced, it passes over a correcting roll 2 of the type which is pivoted at one end, as at 3, and which at its opposite end may be moved back and forth so as to skew the roll in opposite directions depending upon the direction in which the strip has wandered. If, as illustrated, the strip is traveling in a westerly direction and begins to wander to the north, it may be caused to return to its on-center position by moving the adjustable end of the correcting roll 2 forward or in a westerly direction so that it assumes the position illustrated in dotted lines at 2a. On the other hand, should the strip wander in a southerly direction, the adjustable end of the correcting roll would be moved rearwardly or in an easterly direction, thereby causing it to assume the position illustrated in dotted lines at 2b.

It will be evident that by shifting the correcting roll in accordance with wandering movement of the strip, the strip may be caused to return to its on-center position irrespective of the direction in which it wanders. This method of aligning strip material by skewing one or more carrying rolls is as such, well known in the art.

In accordance with the embodiment of the invention illustrated in FIGURE 1, lateral movement of the strip 1 is detected by means of a control arm 4 which is pivotally attached at 5 to a laterally movable carriage 6 having rollers 7 adapted to move along tracks 8 mounted on a fixed support 9 which overlies the path of travel of the strip. At one end the arm 4 mounts a depending strip edge roller 10 which is free to rotate on a vertical axis. At its opposite end the arm is bent, as at 11, and pivotally mounts an extension 12 which carries depending strip edge roller 13. The extension 12 is biased toward the side edge of the strip by means of spring 14 and seats against stop 12a, the arrangement being such that the extension will swing out when the strip is advancing through or irregular. If the strip width is changed, arm 4 automatically pivots about pivot point 5, thus enabling the apparatus to accommodate a great variation in strip width. In order to assure positive contact between the strip edge rollers 10 and 13 and the opposite sides of the strip, the control arm 4 is biased to strip engaging position by means of the cables 15 secured to the arm on opposite sides of its pivot 5, the cables passing around pulleys 16 with their free end connected to counterweights 17. Alternatively, the outer ends of the cables 15 may be connected to tension rods.

A rod or other rigid link 18 is pivotally connected at one end to the carriage 6 and, at its opposite end, is connected to the actuating arm 19 of a control switch 20 which, in the embodiment illustrated, comprises a four-way hydraulic control valve of known character having a rotatable core 20a to which the arm 19 is se-
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The control valve is in turn connected, through suitable conduits 21 and 22, to a hydraulic cylinder 23 having a piston 24 and a piston rod 25, the free end of which is pivotally connected to the sliding plate 26 which mounts the movable end of correcting roll 2.

With the arrangement just described, should the strip 18 be loosened or closed then against the strip edge roller 10 and, acting through the control arm 4, will cause the carriage 6 to move in a southerly direction. The carriage moves rod 18 with it and hence the actuating arm 19 is moved to the position illustrated in dotted lines, thereby rotating the valve core and opening the control valve 20 so that fluid under pressure will flow through conduit 21 and cause the piston 24 to move in an easterly direction, thereby shifting the correcting roll toward the position 20.

In order to provide for increment or step-wise adjustment of the correcting roll, the body of the control switch or valve 29 is mounted for pivotal movement about pivot point 27, thereby permitting the body of the valve to be moved relative to the actuating arm 19 and the valve core 20a. A connecting rod 28 is pivotally connected at one end to the valve 20 and at its opposite end to an extension 29 secured to sliding plate 26. Thus, when adjusting movement of the correcting roll is isolated upon movement of the piston in cylinder 23, the connecting rod 28 will also move and in so doing will initiate pivoting movement of the control valve 20 relative to the actuating arm 19 and the valve core 20a, thereby effectively closing the valve when the body thereof reaches the position illustrated in dotted lines. It will be understood that the conduits 21 and 22 are flexible and will move with the valve body. The correcting movement of the roll 2 is thus solely dependent upon the movement of control arm 4, but rather the adjusting movement of the correcting roll will cease after a step-wise movement determined by the relative positions of the actuating arm 19 and the valve body 20. Of course, if greater adjusting movement of the correcting roll is required, i.e. should the strip continue to travel in a southerly direction after movement of the correcting roll has been initiated, the control arm 31 will continue to move the carriage in a southerly direction and the actuating arm 19 will continue to move in a clockwise direction, thereby causing the valve to remain open until the pivoting body overtake it. If, on the other hand, the return movement of the strip toward its on-center position is initiated before the pivoting valve body overtook the actuating arm, the now northerly moving strip will cause the carriage 6 to move in the opposite or northerly direction, in which event the actuating arm 19 will be moved in the opposite or counterclockwise direction so as to close the valve to the flow of fluid and hence arrest adjusting movement of the correcting roll. Of course, should the northerly movement of the strip continue, the actuating arm will be moved so as to open the valve to the flow of fluid through conduit 22 and into the opposite end of cylinder 23, thereby moving sliding plate 26 in a westerly direction and hence moving the correcting roll in the opposite direction.

An important advantage of the combined initiation and response control system is its ability to proportion the correcting roll adjustment and the amount the strip is off-center. For example, for light gage strip it is preferred to adjust the apparatus so that the correcting roll movement and the counter arm for a given strip. In the embodiment of the invention illustrated in FIGURE 3, the single control arm 31 is pivotally connected at 32 to a frame member 33 which also may conveniently mount the slide plate 34 to which the movable end of correcting roll 35 is secured. The free end of control arm 31 is a strip edge roller 36 at the adjacent edge of strip 37, the control arm being biased toward strip engaging position by means of cable 38, pulley 39 and counterweight 40. In this embodiment, movement of the correcting roll is controlled by means of a four-way hydraulic valve 41 which has an actuator arm 42 operatively connected to a rotatable valve core 43 received in valve body 44. A cable 45 extends between the free end of control arm 31 and the actuator arm 42, the cable extending beyond the actuator arm where it will bear against a pulley 46 and is secured to a counterweight 47. As can be best seen in FIGURE 4, the pulley 46 is mounted on a bracket 48 projecting upwardly from a base plate 49 to which the valve body 44 is pivotally connected, as by means of pivot pin 50. The valve body is thus mounted for pivotal movement relative to control arm 43, and with reference to FIGURE 3, it will be seen that an extension 51 projects outwardly from the valve body 44 and is operatively connected through connecting rod 52 to an extension 53 secured to sliding plate 34. As before the sliding plate and the correcting roll are moved by means of the cylinder 54 having a piston 55 and a piston rod 56 connected to the extension 53. The opposite ends of cylinder 54 are connected through conduits 57 and 58 to the corresponding connections 57a, 58a forming a part of the four-way control valve 41.

With the arrangement just described, it will be evident that when the strip 18 is arrested in a southerly direction, the cable 45 will move the actuator arm 42 in a clockwise direction against the resistance of counterweight 47. In this connection, the counterweight 47, which acts through cable 58 to bias the control arm 31 into strip edge contact, will be heavier than counterweight 47.

The movement of the actuator arm 42 will serve to open the connection 57a to the flow of fluid which, upon passage through conduit 57 and entry into the cylinder 54, causes the piston 55 to move in an easterly direction and hence skew the correcting roll 35 accordingly. At the same time the connecting rod 52 will be moved in an easterly direction so as to thereby rotate the valve body 44 also in a clockwise direction about its pivot pin 50; and in so doing the control valve 41 will be effectively closed, thereby arresting the adjusting movement of the correcting roll 35. It will be evident that should the strip wander in a northerly direction, the control arm 31 will be pivoted counterclockwise in the line of the force of counterweight 40, and the resultant slack in cable 45 will be taken up by counterweight 47 which will act to move actuator arm 42 in a counterclockwise direction, thereby rotating valve core 43 so as to initiate fluid flow through connection 58a and hence into the opposite end of the cylinder 54 so as to reverse the adjusting movement of the correcting roll.

FIGURE 5 of the drawings illustrates yet another modification of the invention wherein a pair of correcting rolls 61 and 62 are connected at their movable ends to a single slide bar 63 for joint movement therewith, the movement of the slide bar being controlled by a cylinder 64 operatively connected to a control valve system 65, which may comprise electrically actuated hydraulic control valves. In this embodiment the control valve system 65 is adapted to be energized by a micro switch 66 having a switch arm 67, with the body of the switch mounted for pivotal movement about the pivot point 68. Pivoting movement of the switch 66 is effected by means of a connecting rod 69 operatively connected through extensions 70 and 71 to the switch 66 and the slide bar 63, respectively. As in the embodiment of FIGURE 1, a common strip deviation is controlled by means of a transversely movable carriage 73 the movement of which is controlled by the control arms 74 and 75 arranged to contact opposite side edges of the strip 76. A pair of cables 77 and 78 connects the arms 74 and 75, respectively, to a tension unit 79 mounted on the carriage 73, the end 80 which contacts the carriage 73 being biased toward position of the strip 76 by springs in a supplementary fashion so that they will be pay-out and reeled-in in unison. The arms will thus automatically adapt themselves to accommodate varying strip widths.
but once the arms have engaged opposite sides of a
given strip, they will move in unison as the strip wander
s, moving the carriage and through it the switch arm 67. As before, the shifting of the slide plate 63 will
effect rotation of the micro switch 66 relative to the
switch arm and hence will arrest adjusting movement
of the correcting rolls in a step-wise fashion.

As should be evident from the foregoing description of
certain exemplary embodiments of the invention, vari-
ous modifications may be made without departing from
its spirit and purpose. Thus, while the strip guide me-
chanism is essentially a mechanical linkage, such linkage
may be utilized to actuate hydraulic or pneumatic valve
means, or electrical switch means, or combinations
thereof, to effect the step-wise correcting said cor-
trolling or rolls, as the case may be. However,
preferable is expressed for hydraulic valves in that,
dependent upon the degree to which such valves are
opened, the fluid medium may be regulated in accordance
with the severity of the lateral movement of the strip. For
example, if the last named end of said control arm is
centered, the valve will be opened only a fraction of its
full area and hence only a slight adjusting move-
ment of the correcting roll will result. If, on the other
hand, the lateral displacement of the strip is drastic, the
valve will be opened to full flow with a proportionate
large adjusting movement of the correcting roll.

It will be equally evident that the correcting rolls,
whether they be carrying rolls, pinch rolls, bridge rolls,
or vertically adjustable rolls, do not constitute a limita-
tion upon the invention and that other means of strip
correcting or positioning means may be utilized provided
such means are coupled with an arrangement to effect
relative movement between the body of the control switch
or valve and its actuating arm so as to de-energize the
correcting means upon a step-wise correcting movement.

Similar considerations apply with respect to the use of
hydraulic cylinders for effecting adjusting movement of
the correcting rolls, and it will be evident that other
forms of power means may be utilized.

Having, however, disclosed the invention in certain ex-
emplary embodiments, what it is desired to secure and
protect by Letters Patent is:

1. For use in a strip guide mechanism, a sensing de-
vice for detecting lateral movement, particularly of a strip from a pre-
determined path of travel, said sensing device comprising a
arm moveable laterally of the strip on tracks over-
lying the path of travel of the strip, a control arm piv-
ottally connected intermediate its ends to said carriage to
control lateral movement of said carriage, strip edge con-
tacting means mounted on the opposite ends of said con-
trol arm, and means for actuating said carriage
mechanism for shifting the position of the strip in
accordance with lateral movement of the carriage.

2. The device claimed in claim 1 including an exten-
sion pivotally mounted to said control arm at one end
thereof, said extension mounting the strip edge contact-
ing means at the last named end of said control arm
and spring means extending between said arm and said ex-
tension and arranged to bias said extension in the direc-
tion of the strip edge to be contacted thereby.

3. In a strip guide mechanism wherein a strip is ad-
vanced in contact with a strip positioning means movable
in opposite directions and operative upon movement thereof
to effect lateral movement of the strip, reversible
power means operatively connected to said strip posi-
tioning means to selectively effect movement thereof in
opposite directions, actuating means for energizing said
means, said means comprising a body pivotally
connected to a support and an actuating arm operatively
connected to said carriages and said actuating arm
operatively connecting said correcting roll to the pivotally
mounted body of said actuating means and operative
upon skewing movement of said correcting roll to effect
pivotal movement of said body in the same direction as
the movement of said actuating arm, whereby to effec-
tively return said actuating arm to its intermediate in-
operative position and thereby de-energize said power
means.

4. In a strip guide mechanism wherein a strip is ad-
vanced over a correcting roll pivotally mounted at one end
and moveably mounted at its opposite end so that
said roll may be skewed relative to the strip so as to
cause the strip to move laterally in either direction from
a central position, a reversible power means operatively
connected to the moveable end of said correcting roll
to effect skewing movement thereof in opposite direc-
tions, an actuating means for energizing said power
means, said means comprising a body pivotally
connected to a support and an actuating arm operatively
connected to said carriages and said actuating arm
operatively connecting said correcting roll to the pivotally
mounted body of said actuating means and operative
upon skewing movement of said correcting roll to effect
pivotal movement of said body in the same direction as
the movement of said actuating arm, whereby to effec-
tively return said actuating arm to its intermediate in-
operative position and thereby de-energize said power
means.
said roll may be skewed relative to the strip so as to cause the strip to move laterally in either direction from a central position, a reversible power means operatively connected to the movable end of said connecting roll to effect skewing movement thereof in opposite direction, an actuating means for energizing said power means, said actuating means comprising a body pivotally connected to a support and mounting an actuating arm operative upon movement thereof relative to said body to energize said power means, said actuating arm being movable in opposite directions from an intermediate inoperative position to opposite operative positions effective to actuate said power means in opposite directions, a pivotally mounted control arm positioned to engage and follow an edge of the strip being advanced, said control arm being pivotally connected at one end to a support lying to one side of the path of travel and mounting a strip edge follower on its opposite end, a biasing means connected to said control arm to bias it into contact with the strip edge, a cable connecting said control arm to said actuating arm, means for keeping said cable taut, said last named means applying insufficient tension to pull said strip edge follower from constant contact with the edge of said strip, whereby movement of said control arm will cause said actuating arm to move to one of its operating positions, depending upon the direction of movement of said control arm, and a connecting rod operatively connecting said correcting roll to the pivotally mounted body of said actuating means and operative upon skewing movement of said correcting roll to effect pivotal movement of said body in the same direction as the movement of said actuating arm, whereby to effectively return said actuating arm to its intermediate inoperative position and thereby de-energize said power means.

9. The strip guide mechanism claimed in claim 8 wherein said control arm biasing means comprises a counterweight, and wherein said cable tensioning means also comprises a counterweight of lesser magnitude than said first named counterweight.

10. In a strip guide mechanism wherein a strip is advanced over a correcting roll pivotally mounted at one end and movably mounted at its opposite ends so that said roll may be skewed relative to the strip so as to cause the strip to move laterally in either direction from a central position, a reversible power means operatively connected to the movable end of said connecting roll to effect skewing movement thereof in opposite directions, an actuating means for energizing said power means, said actuating means comprising a body pivotally connected to a support and mounting an actuating arm operative upon movement thereof relative to said body to energize said power means, said actuating arm being movable in opposite directions from an intermediate inoperative position to opposite operative positions effective to actuate said power means in opposite directions, a pair of movable control arms pivotally mounted on supports lying on opposite sides of the path of travel of the strip, a carriage overlying the path of travel of the strip and movably laterally thereof on tracks, a tension reel mounted on said carriage, cables extending between said tension reel and said control arms and acting to bias said control arms into strip edge contact, a rod connecting said carriage to said actuating arm so that movement of said carriage in response to movement of said control arms will cause said actuating arm to move to one of its operating positions, depending upon the direction of movement of said carriage, and a connecting rod operatively connecting said correcting roll to the pivotally mounted body of said actuating means and operative upon skewing movement of said correcting roll to effect pivotal movement of said body in the same direction as the movement of said actuating arm, whereby to effectively return said actuating arm to its intermediate inoperative position and thereby disengage said power means.

11. The strip guide mechanism claimed in claim 10 wherein said power means comprises a hydraulic cylinder, and wherein said actuating means includes valve means operative to open and close conduits supplying fluid under pressure to said cylinder.

12. For use in strip guide mechanism, a sensing device for detecting lateral movement of a strip from a predetermined path of travel, said sensing device comprising a carriage movable laterally of the strip on tracks overlying the path of travel of the strip, a pivotally mounted control arm operatively connected to said carriage and positioned to engage and follow an edge of the strip to control lateral movement of said carriage, and means for operatively connecting said carriage to mechanism for shifting the position of the strip in accordance with lateral movement of the carriage.

13. The sensing device claimed in claim 12 wherein a pair of control arms are pivotally mounted one on each side of the strip, and wherein said pair of control arms are operatively connected to said carriage by means of cables extending between said control arms and a tension unit mounted on said carriage and arranged to maintain said control arms in contact with the opposite edges of the strip.

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