

Dec. 1, 1942.

J. F. FERM

2,303,533

STRIP FEEDING APPARATUS

Filed July 25, 1940

8 Sheets-Sheet 1

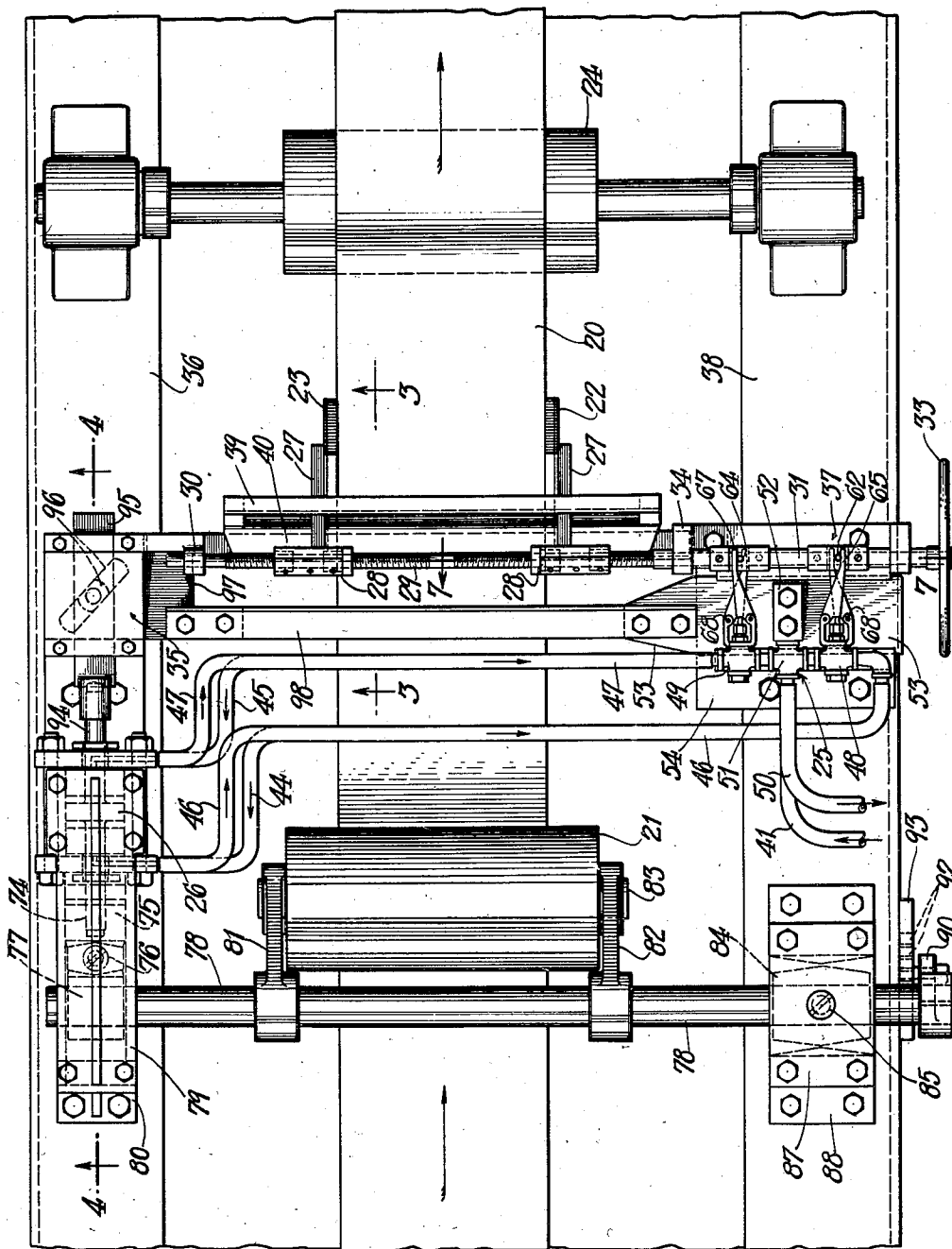


Fig. 1.

INVENTOR.

JOHN F. FERM.

BY

Ward Crosby & Neal

ATTORNEYS

Dec. 1, 1942.

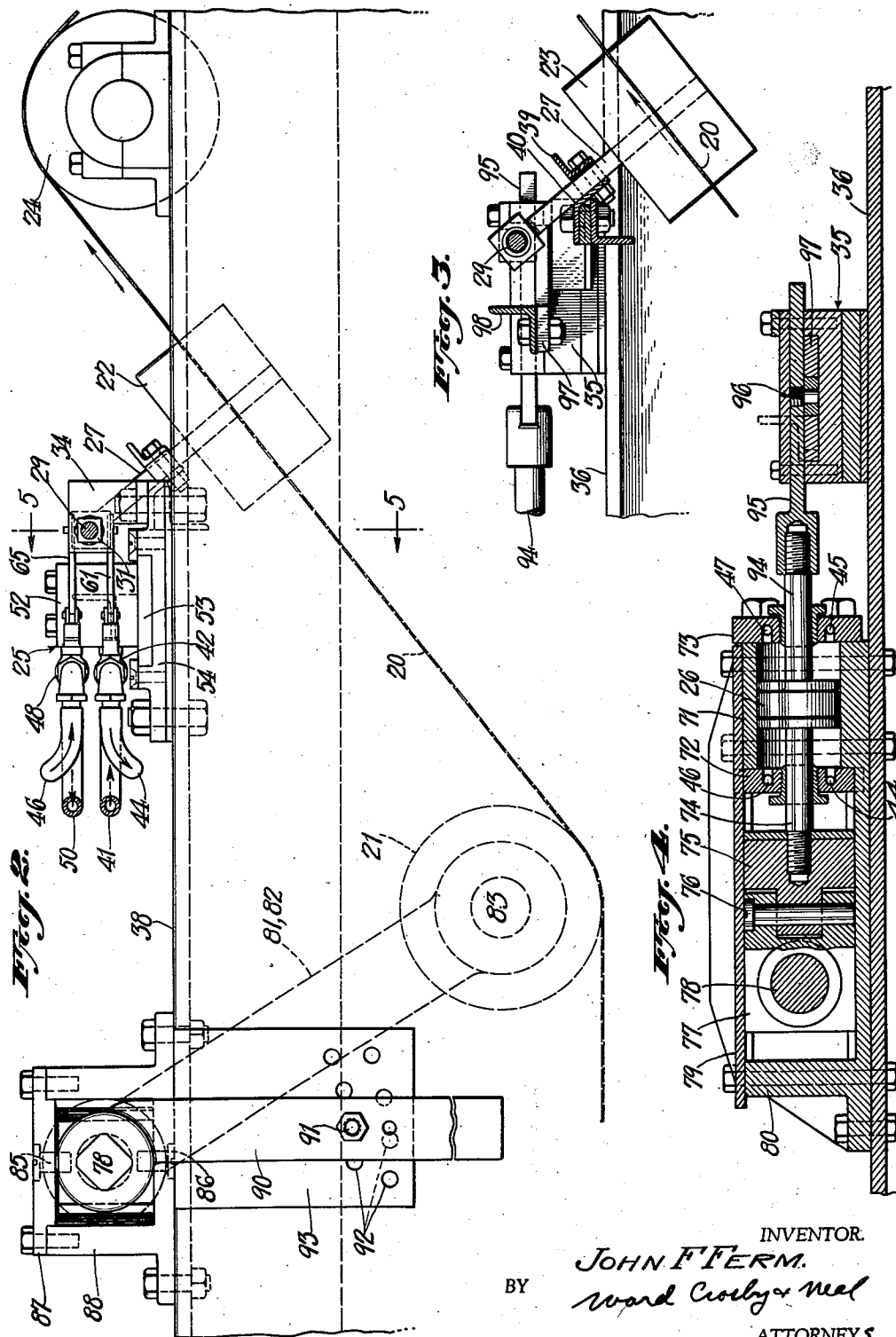
J. F. FERM

2,303,533

STRIP FEEDING APPARATUS

Filed July 25, 1940

8 Sheets-Sheet 2



INVENTOR.
JOHN F. FERM.
BY
Ward Crosby & Neal
ATTORNEYS

Dec. 1, 1942.

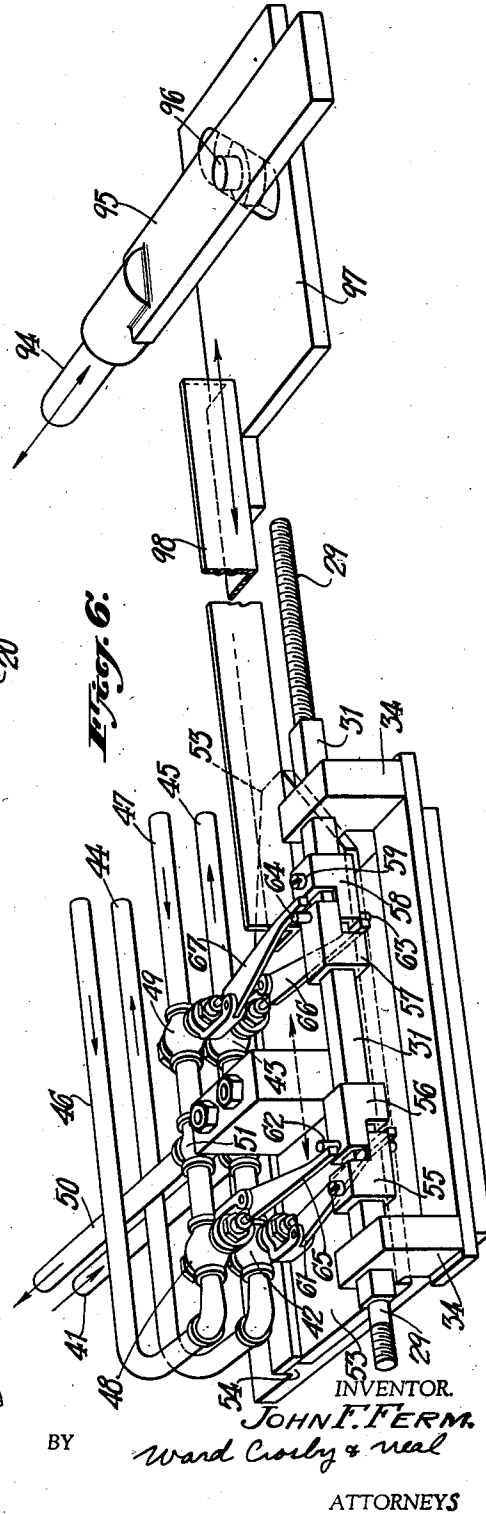
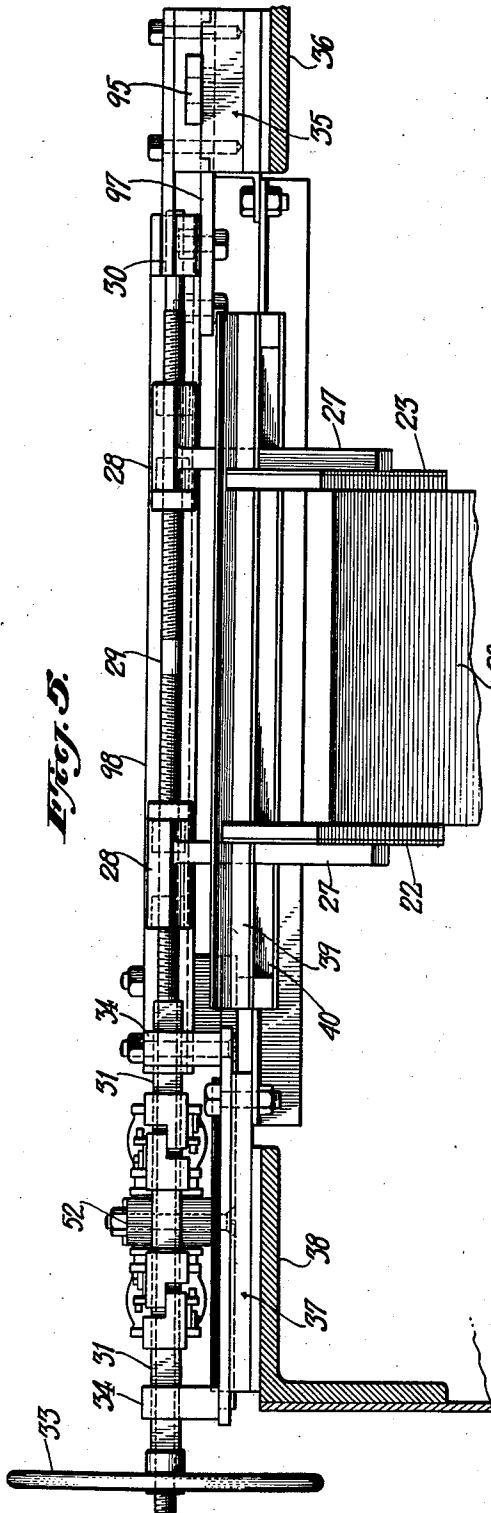
J. F. FERM

2,303,533

STRIP FEEDING APPARATUS

Filed July 25, 1940

8 Sheets-Sheet 3



Dec. 1, 1942.

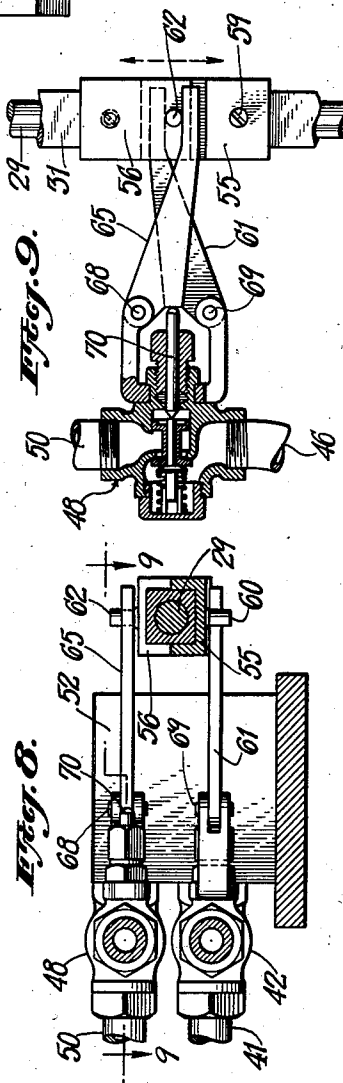
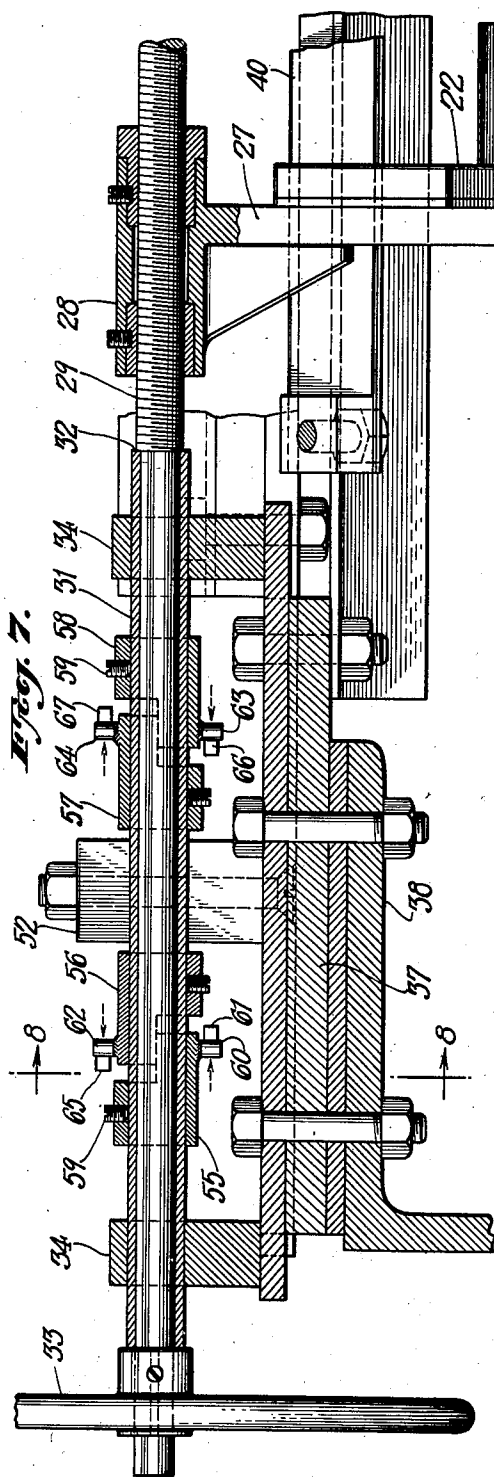
J. F. FERM

2,303,533

STRIP FEEDING APPARATUS

Filed July 25, 1940

8 Sheets-Sheet 4



INVENTOR.
JOHN F. FERM.
BY *Ward Crosby & Neal*
ATTORNEYS

Dec. 1, 1942.

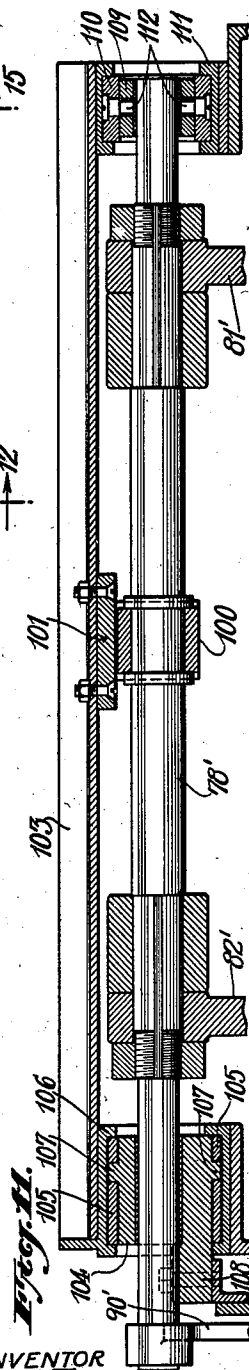
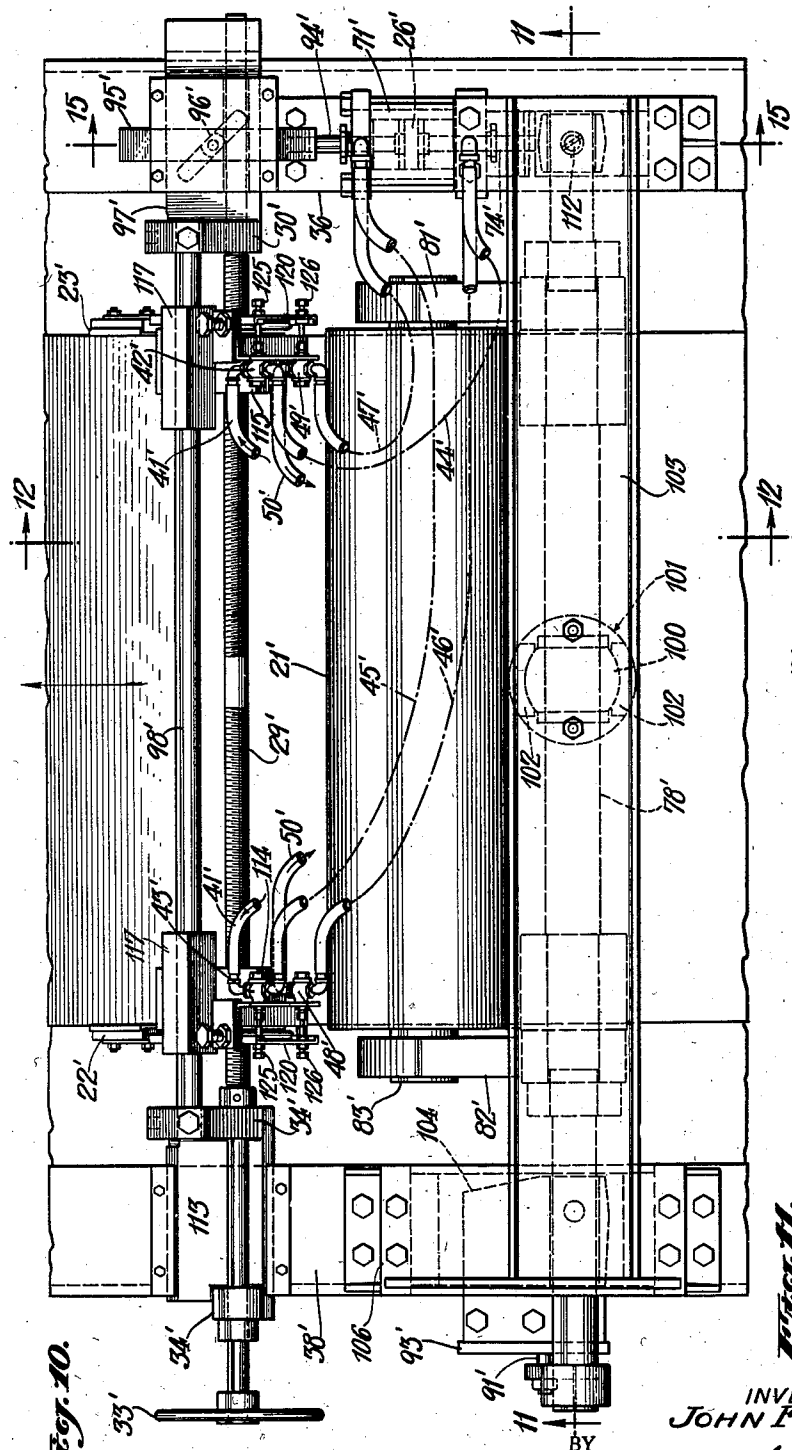
J. F. FERM

2,303,533

STRIP FEEDING APPARATUS

Filed July 25, 1940

8 Sheets-Sheet 5



INVENTOR
JOHN F. FERM.

ward Crosby & Neal
ATTORNEYS

Dec. 1, 1942.

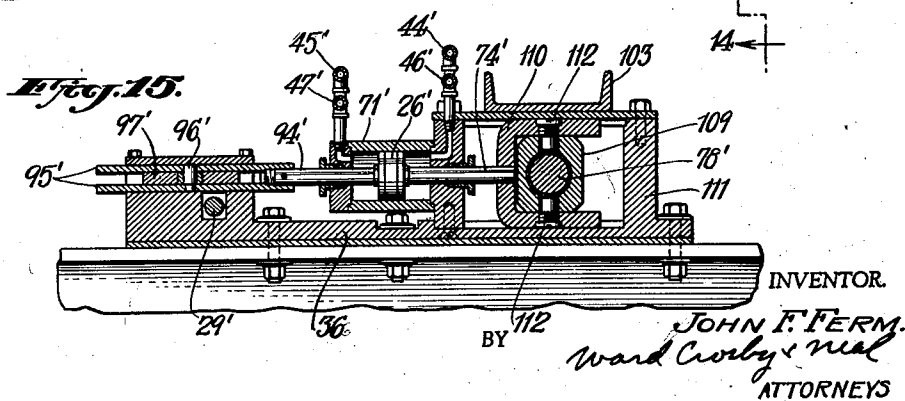
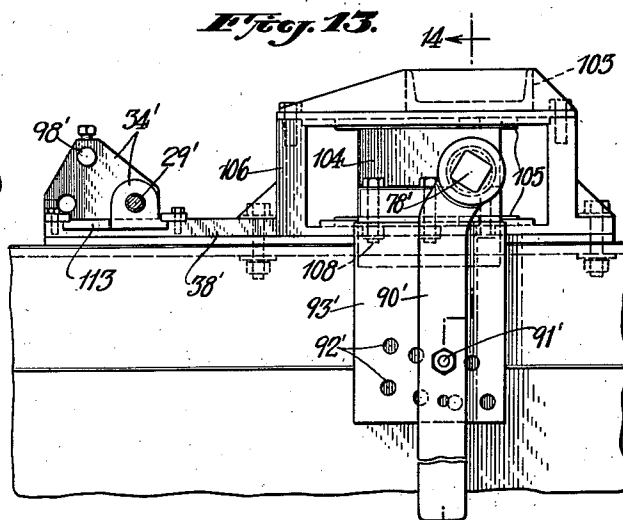
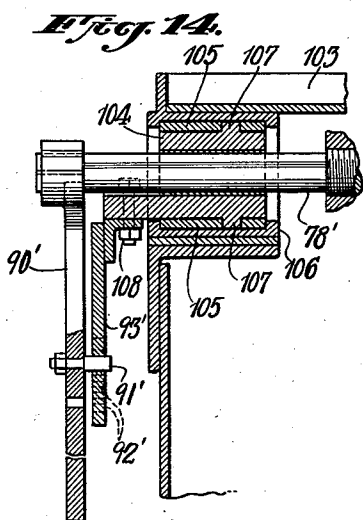
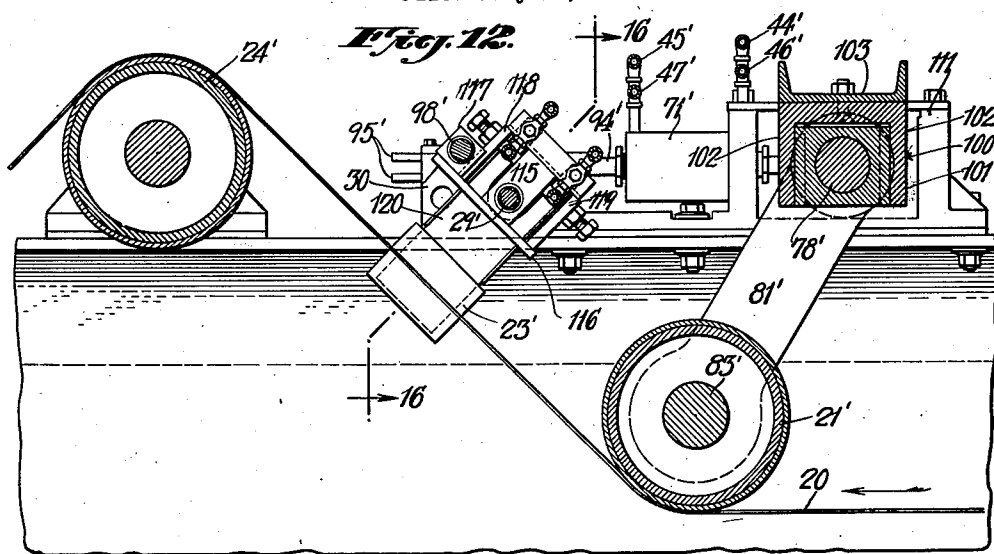
J. F. FERM

2,303,533

STRIP FEEDING APPARATUS

Filed July 25, 1940

8 Sheets-Sheet 6



INVENTOR.

JOHN F. FERM

Ward Crosby & Neal
ATTORNEYS

ATTORNEYS

Dec. 1, 1942.

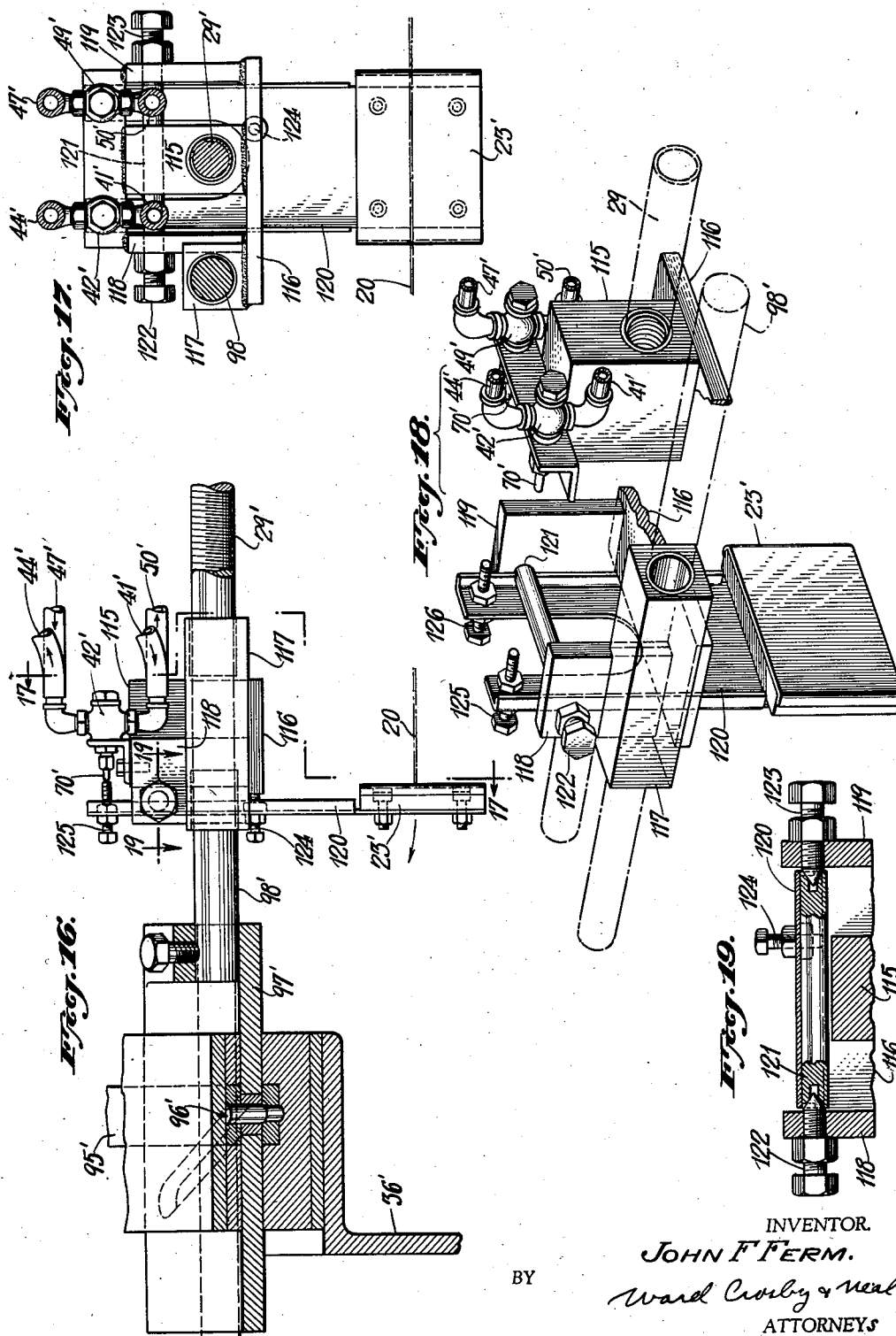
J. F. FERM

2,303,533

STRIP FEEDING APPARATUS

Filed July 25, 1940

8 Sheets-Sheet 7



Dec. 1, 1942.

J. F. FERM

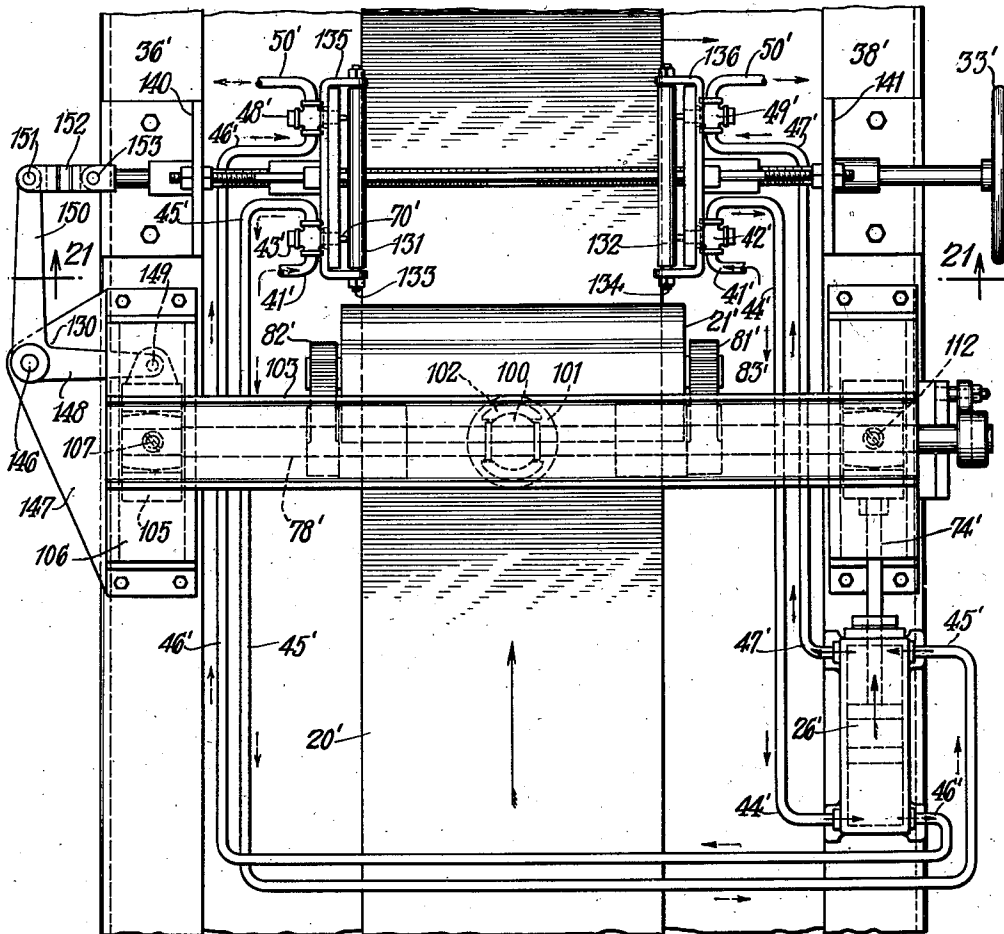
2,303,533

STRIP FEEDING APPARATUS

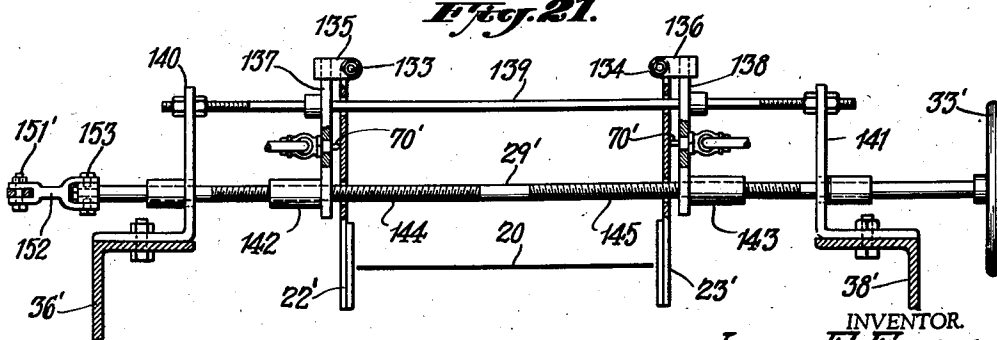
Filed July 25, 1940

8 Sheets-Sheet 8

Ft. 20.



Exej. 21.



INVENTOR.

INVENTOR
JOHN F. FERM.

BY

Wood, Casey & Neal.

ATTORNEYS

UNITED STATES PATENT OFFICE

2,303,533

STRIP FEEDING APPARATUS

John F. Ferm, Midland, Pa., assignor, by mesne assignments, to Crucible Steel Company of America, a corporation of New Jersey

Application July 25, 1940, Serial No. 347,427

17 Claims. (Cl. 271—2.6)

This invention pertains to apparatus for automatically guiding and maintaining in alignment, continuous and rapidly moving strip material, especially relatively thin, cold metal strip, such as steel strip employed in tin plating and the like.

In the tin plating and brightening of steel strip in a continuous process, the strip must be fed over rollers at a relatively high rate of speed through an extensive assemblage of cleaning baths, scrubbers, plating baths, brightening apparatus, etc., varying in aggregate length, depending upon the installation, from a few hundred to as much as a thousand feet or more, the strip being fed therethrough at rates up to 200 feet or more per minute. In the absence of special guiding means, it would be impractical to feed the strip continuously over such lengths and at such speeds, owing to the fact that the strip would swing laterally past the ends of one or more of the feed or idler rolls and jam against the supports thereof, thereby causing the strip to crumple, jam and tear, and thus to accumulate at this juncture into a confused mass of shapeless metal which would stop the entire operation.

Although various types of mechanical guides are known in which the impact of the strip against a contact or guide paddle furnishes the exclusive source of power or energy for adjusting the guiding mechanism, such types of guides are wholly impractical for use under the conditions and at the strip speeds above referred to, since the impact force required to thus mechanically adjust the guide is sufficient to bend and tear the strip with the deleterious results above stated.

The present invention provides automatic guides in which power from an auxiliary source is employed automatically to adjust the guiding mechanism in response to an extremely slight impact of the strip against contact paddles disposed in opposite sides thereof, the required impact being so slight that the strip can not be bent or injured or produce jamming in consequence of the impact. In accordance with the invention, the strip passes under a roller or equivalent guiding member extending transversely of, and normally at right angles to the desired direction of travel of the strip, and as the strip tends to drift to one side or the other, the axis of the roller in respect to the path of the strip is automatically varied by the auxiliary power source, from a normal right angle position to such an extent and in such direction that the

roller guides the strip back to substantially its normal and desired path. Such power means may be arranged to move the roller axis in either direction as required, under the control of means operated by and in approximate accordance with the drifting movements of the strip. The power means may comprise, for example, an hydraulic piston operated by water or other fluid pressure under the control of valves which in turn may be opened and closed by contact paddles responsive to the drifting movements. Preferably the arrangement is such that as the piston moves through a short distance in the process of correcting the drift of the strip, a follow-up device connected to the piston will act to shut off the hydraulic actuating pressure applied to the piston, thereby to prevent any abnormal corrective movements of the guide roller and lateral "hunting" movements of the strip. Also in this way the corrective movements of the guiding roller may be applied step-by-step in small steps, which may be automatically repeated only so long as the extent of the drift of the strip requires adjustment. In other words upon a small corrective movement of the control apparatus, the apparatus in effect automatically tests the results of such movement, and the movement is repeated in the same direction, only if the drift of the strip is great enough to demand such repetition. Moreover, according to the invention, as the strip is being restored to its normal path, the power means as controlled by the position of the strip, also acts to restore the guide roller to its normal position ready for another corrective movement in either direction.

Means other than a valve actuated hydraulic piston may be employed as the auxiliary source of power for adjusting the strip guide roll. For example, a reversible electrical motor may be used which is energized in one or the other directions of rotation as required, upon closure of mechanically actuated contacts due to impact of the strip against the contact paddles; or the motor may be similarly energized by a pair of photoelectric cells so arranged on opposite sides of the strip respectively that the strip intercepts light beams directed onto the cells as the strip drifts to one side or the other of its normal path of travel. However, such arrangements do not operate so satisfactorily, particularly at high strip speeds, as the hydraulic piston arrangements in accordance with the preferred modifications of the invention described more in detail hereinafter.

Various further and more specific objects, fea-

tures and advantages of the invention will appear from the detailed description given below, taken in connection with the accompanying drawings forming a part of this specification and illustrating merely by way of example certain embodiments of the invention. The invention consists in such novel features, methods, arrangements and combinations of parts as are shown and described herein.

In the drawings,

Fig. 1 is a plan view of one form of the apparatus of the invention, Fig. 2 is a side view thereof; Figs. 3 and 4 are sectional views taken substantially along the lines 3—3 and 4—4 respectively of Fig. 1;

Fig. 5 is a sectional view taken substantially along the line 5—5 of Fig. 2;

Fig. 6 is a perspective view of a control valve arrangement and accompanying follow-up mechanism as embodied in the apparatus of Fig. 1;

Fig. 7 is a sectional view substantially along the line 7—7 of Fig. 1; Figs. 8 and 9 are sectional views substantially along the line 8—8 of Fig. 7 and 9—9 of Fig. 8 respectively;

Fig. 10 is a plan view of an alternative embodiment of the invention, and Fig. 11 a sectional view taken substantially along the line 11—11 of Fig. 10;

Fig. 12 is a sectional view of the apparatus of Fig. 10 taken substantially along the line 12—12, and Fig. 13 is a view looking toward the left-hand end of the apparatus of Fig. 10;

Fig. 14 is a sectional view taken substantially along the line 14—14 of Fig. 13;

Fig. 15 is a sectional view taken substantially along the line 15—15 of Fig. 10; Fig. 16 is a sectional view taken substantially along the line 16—16 of Fig. 12; and Fig. 17 a sectional view taken along line 17—17 of Fig. 16;

Fig. 18 is a perspective view showing parts of the mechanism of Fig. 16 in spaced relation; Fig. 19 is a sectional view taken substantially along the line 19—19 of Fig. 16.

Fig. 20 is a plan view of another alternative embodiment of the apparatus; and Fig. 21 a section at 21—21 thereof.

Referring to Figs. 1 and 2, the rapidly moving strip to be guided is indicated at 20 and may be supplied from any desired source and passed under an idle roller 21, and thence between a pair of contact guide paddles 22, 23, and thence over a roller 24, the latter comprising one of the numerous rolls required for feeding or supporting the strip in its passage through the processing apparatus, such as a tin plating bath, etc. The roller 21 is normally so positioned that its axis will be substantially perpendicular to the normal path of travel of the strip 20, as shown in Fig. 1, whereby the strip will generally be guided along such path without deflection to either side. However, when for any reason the strip drifts to one side of the rolls, such as 24, it will contact with either paddle 22 or 23, which in turn actuate a valve mechanism, indicated generally at 25, for controlling the movement of a piston 26, which again in turn, by mechanism hereinafter described, controls the transverse position of the axis of the roller 21.

As shown, the strip 20 is maintained in surface contact with a substantial arc of roller 21. Accordingly, if the axis of the roller 21 is shifted from its right angle position, in respect to the normal path of travel of the strip, it will tend to guide the strip in a direction perpendicular to its new axial position. Thus if the strip drifts

toward and contacts paddle 22, the operation of the mechanism is such as to shift the axis of the roller 21 toward the left as viewed in Fig. 1, and about a pivot point 25 as described hereinafter. This in turn will cause the roller to tend to guide the strip back toward the paddle 23. Conversely, if the strip contacts paddle 23, the operation of the mechanism is such as to shift the axis of roller 21 toward the right as viewed in Fig. 1, with a consequent tendency of the roller to guide the strip back toward the paddle 22.

Referring now to the apparatus of Fig. 1 in further detail, the paddles 22, 23 are each supported upon arms, as at 27, formed with portions, as at 28, having oppositely threaded engagements respectively with a screw rod at 29. The rod 29 is rotatably and slidably journaled at one end in a bracket 30, while the other end of rod 29 is rotatable within a square sleeve 31. The sleeve 31 is fixed against sliding in respect to the rod 29 by a shoulder 32 (Fig. 7) on the latter for engaging one end of the sleeve 31, while at its other end the sleeve 31 abuts the hub of a hand wheel 33 fixed to the rod 29. The sleeve 31 is slidably mounted in a pair of bearing members as at 34, whereby the paddles 22, 23 and the members 29, 31 are slidable as a unit in either direction in response to drifting movements of the strip 20 against either of the paddles. However, by turning the hand wheel 33, the rod 29 may be turned independently of the sleeve 31, and thereby, due to the oppositely directed screw threads, provided on the rod 29, as shown, the spacing of the paddles 22, 23 may be adjusted to accommodate different strip widths and also the tolerance spacing between the strip and paddles.

The bearing 30 is carried by a bracket bolted, as shown in Fig. 5, to suitable supporting plate members, as at 35, fixed to a side frame member 36 forming part of the processing apparatus, such as a plating bath framework, upon which the equipment is mounted. The bearing members 34 may also be affixed to suitable plate members 37 bolted to another side frame 38 of the processing apparatus (Figs. 5, 7).

The paddle arms 27 may be guided and supported during their slidable movement as by a pair of angle irons 39, 40 (Figs. 3, 5) also fixed in respect to the side frames.

The fluid for operating the piston 26 may comprise water supplied from a suitable source under pressure through a flexible pipe or hose line 41 running to valves 42 and 43 (see particularly Fig. 6) and thence through flexible conduits 44 and 45 respectively, such as rubber hoses, to the chambers at opposite faces of the piston 26. Liquid from said chambers may be discharged respectively through similar flexible conduits 46, 47, valves 48, 49, to a flexible discharge pipe or hose line 50 connected to waste or to pumping equipment for reusing the water and supplying it under pressure to the pipe 41.

Thus the valves 42, 43 and 48, 49 control respectively the supply and discharge of water under pressure for controlling the position of piston 26. These valves may be supported by metal pipe connections as at 51 upon a supporting block 52, which in turn is fixed to a plate 53 slidably mounted in a guide member 54, the latter being fixed to the frame member 38. Except for the immediate supporting connections to the valves, the liquid conduits are made of rubber hose line or other flexible conduit so that

the four valves are free to slide with the support 52 and plate 53 as an assembled unit. That is, this assembly is slidable in directions parallel to the slidable rods 29 and 31.

Four block members as at 55, 56, 57, 58 (Figs. 6 and 7) are mounted upon the square rod 31 and affixed thereto at adjustable positions by set screws 59. Block member 55 is provided with a downwardly extending pin 60 (Fig. 8) for engaging operating lever 61 for valve 42. Similarly, the other block members are provided with pins 62, 63 and 64 for engaging respectively operating levers 65, 66, 67 for valves 48, 43 and 49.

Each of the above mentioned valves may be of a spring closed type as shown in Fig. 9, and such that it is normally closed. Each of the valve levers 61, 65, 66 or 67 may be pivotally mounted as at 68 or 69 (Fig. 9), whereby when the lever is operated by its accompanying pin, it will press against a valve rod as at 70 for opening the valve to an extent depending upon the movement of the operating lever, and so long as the lever is held out of its normal position.

Thus, for example, when the metal strip 20 engages the paddle 22 and slides the rods 29, 31 toward the left as viewed in Figs. 6, 7, the pin 63 will operate valve lever 66 to open valve 43 and admit water to piston 26 in a direction for causing same to move toward the left as viewed in Fig. 1. At the same time, pin 62 will engage valve lever 65 to open valve 48, permitting water to be discharged from the opposite face of the piston 26. Similarly, when the strip 20 drifts in the opposite direction (toward the right as viewed in Figs. 5, 7), the valves 42 and 49 will be opened for admitting and releasing water respectively to operate the piston 26 toward the right as viewed in Fig. 1.

As shown more particularly in Fig. 4, the piston 26 is located in a cylinder 71 having cylinder heads 72, 73 within which inlet ports for hose lines 44, 45 and outlet ports for hose lines 46, 47 are located. A piston rod 74 extending from one side of the piston 26, is secured to a slidable block 75 having a pivotal connection in turn as at 76 with a slidable bearing block 77 for a shaft 78. The members 75, 77 are slidably mounted in members 79, 80, which in turn are bolted to the side frame 38 as shown in Figs. 1 and 4. The shaft 78 has fixed thereon a pair of supporting arms 81, 82 (Figs. 1, 2), for a shaft 83 upon which the guide roller 21 is rotatably mounted. The other end of the shaft 78 is pivotally mounted on a vertical axis in a housing 84 by means of bolts 85, 86 extending through members 87, 88 comprising said housing. In this way, movements of the piston serve to change the position of shaft 78 from its normal right angle relationship to the path of travel of the strip 20, and as the alignment of shaft 78 is thus varied, the axis of roller 21 is correspondingly varied to different transverse positions in respect to the strip 20 for guiding the strip back to its normal path.

In order to prevent the roller 21 from "riding up" or rotating about shaft 78 due to the upward force exerted on the roller by the strip 20, the shaft 78 is anchored against rotative movement by means of a lever arm 90 bolted as at 91 to the frame member 38, this lever arm being provided for this purpose with a polygonal or square slot which fits over a correspondingly shaped termination of shaft 78 projecting beyond the frame member 38, as shown more par-

ticularly in Figs. 1 and 2. For adjusting the arms 81, 82 carrying roller 21, to a desired angular inclination, as shown in Fig. 2, the frame plate 93 to which the anchoring arm 90 is bolted, is provided with a series of arcuately spaced bolt holes 92, into any of which the bolt 91 may be secured, in this way to fix the roller arms 81, 82 at the inclination desired.

Referring again to Figs. 1 and 4, the piston 26 is provided with another piston rod 84 threaded into a bar 95 slidably mounted in a housing 35 and having a pin and slot connection as at 96 (Fig. 6) with a plate 97 which is also slidably mounted in housing 35 and rigidly fixed as by an angle iron or rod 98 to the plate member 53 which carries the valve supporting block 52. It will be observed that plate 97 is slidable in housing 35 in a direction at right angles to that of plate 95, and that the pin and slot coupling 96 between these two members is such as to shift plate 97 downwardly in Fig. 1 when piston 26 moves to the left and vice versa. This assembly is referred to herein as the "follow-up" assembly or connection.

Accordingly, when the piston 26 moves, it will not only adjust the angular position of the guide roller 21 as aforesaid, but also through the follow-up connections above described, will shift the entire valve assembly in a direction to close the valves which were opened as above described by impact of the strip against one of the paddles 22 or 23. That is, assuming for example, the strip 20 in drifting, operates the lower paddle 22 to open valves 43 and 48, thereby moving piston 26 to the left as viewed in Fig. 1, then the pin and slot connection at 96 is such as to move the valve support 52 downwardly in Fig. 1, that is, in the same direction that the strip 20 drifted. This will carry the whole valve assembly including levers 66 and 65 also downwardly and away from pins 63, 62, thus closing or tending to close the valves 43 and 48 again. Hence as soon as the drifting of the strip operates the power means to adjust the position of the axis of roller 21, before such adjustment can become excessive, the follow-up connections will stop or tend to stop the movement of the piston 26, by closing or tending to close the control valves. But if the drift of the strip is great enough, the strip will again contact paddle 22 and will cause these valves to be opened again or opened further, for a further adjustment of the roller 21, but any such further adjustment will also be checked by the follow-up mechanism. In this way, the adjustment of the guide roller 21 takes place step-by-step in short steps to the extent necessary to cause the metal strip to start to drift back to normal position. Thereupon the strip will engage and operate the opposite paddle and the valve assembly, piston and roller 21 will be moved step-by-step back to approximately their normal positions. In this way, the guide roller 21 and its control mechanism following each small movement, will act in effect to test the position of the rapidly traveling metal strip and thereby either impart to the guide roller a more extreme adjustment, or restore it toward its normal right angle position in respect to the strip path, all to such an extent as may be required to effectively stabilize the longitudinal travel of the strip against any excessive sideways drifting. Even though the strip may drift to one side very abruptly, the guide roller is so adjusted and kept under control as to correct this drift while obviating any excessive correction which might react to cause abrupt drift-

ing in the opposite direction, or cause troublesome "hunting" of the strip to either side of its desired path.

Operation.—Although the operation of the system shown in Figs. 1 to 9, inc., has been touched upon in the detailed description of the various components given above, it will be briefly reviewed as follows: Assume that the strip 20, as it passes over rolls 21 and 24, drifts laterally against the contact paddle 22. Referring to Fig. 1, this will displace downward the entire assembly comprising paddles 22, 23, rod 29 and sleeve 31, causing valve pins 62, 63 to actuate valve levers 65, 66 to open valves 48, 43, thereby to apply hydraulic pressure to the right side of piston 26 over supply line 45, and to release the pressure on the left side of the piston through the discharge line 46. The piston 26 will accordingly shift to the left, as viewed in Fig. 1, thereby to swing the axis of roll 21 to the left about its pivotal support 85. This shift in the axis of feed roll 21 will feed the strip away from paddle 22 and to a higher position on roll 24, as viewed in Fig. 1, as it passes thereover. Concurrently with this operation, the shift in piston 26 to the left will also shift the valve support 52, 53 downward in Fig. 1 owing to the follow-up linkage 94 to 98 inc. above described, thereby again closing valves 43, 48. If now the strip 20 again drifts against paddle 22, the above cycle of operations will be repeated, and continue to be repeated so long as the strip continues to drift against paddle 22, thereby to provide step-by-step correcting adjustment due to the operation of the follow-up mechanism. This step-by-step adjustment of the guide roll prevents overcorrection and hence "hunting" of the apparatus, which is particularly important in the feeding of strip having slightly cambered edges formed when the strip is rolled or at welded junctions of strips from successive coils, resulting from the difficulty of perfectly aligning such strips upon effecting the junctions. Should, however, the strip drift against paddle 23, the corrective adjustment of the guide mechanism will be just the opposite to that above described. That is to say, the paddle and valve control assemblage 22, 23, 29, 31, will shift upwardly as viewed in Fig. 1, to actuate valve levers 61, 67 and open valves 42, 49, thereby to apply pressure to the left side of piston 26 over supply line 44 and to release the pressure on the right side thereof over discharge line 47, whereby the piston shifts to the right as viewed in Fig. 1, and likewise shifts the axis of the guide roll 21 to the right about its pivotal support 85. This adjustment of roll 21 will cause the strip to be guided to a lower position, referring to Fig. 1, as it passes over roll 24. Concurrently with this operation, the movement of piston 26 will shift the valve support 52, 53 upwardly as viewed in Fig. 1, by virtue of the linkage mechanism 94 to 98 inc., thereby again to close valves 42, 49, this entire cycle of operations being, of course, repeated intermittently so long as the strip 20 continues to drift against paddle 23, etc.

The modified form of the invention shown in Figs. 10 to 19, inclusive, except as hereinafter noted, operates in general according to the same principles as above described, and parts which correspond in general function to those of Figs. 1 to 9, inclusive, are identified in Figs. 10 to 19 by the same reference characters accompanied by prime marks.

As shown in Fig. 10, the guide roller 21' is mounted to rotate, preferably with anti-friction

bearings, on shaft 83' supported by arms 81', 82', which in turn, as shown in Fig. 11, are fixed to a shaft 78'. Whereas in Fig. 1, when the position of the shaft 78 is adjusted, the shaft pivots about a vertical axis 85 at one end of the shaft, the shaft 78' in Figs. 10 and 11 is arranged for pivotal movement about a vertical axis passing through its mid portion. That is, as shown in Fig. 10, the shaft 78' is journaled at its axial center through a bearing 100 having arcuate side portions as shown in Fig. 10, this bearing being rotatable within a bearing member 101 having two depending and corresponding arcuate portions 102. The member 101 is bolted as shown to a cross beam 103 mounted at its ends upon the side frames of the machine. With this arrangement, the adjustments of the transverse position of the roller 21' are effected about a vertical axis at the axial center of the roller rather than at the end as in Fig. 1, whereby the forces of the advancing strip upon the two ends of the roller are substantially equalized, even when the power operated piston alters the transverse position of the roller in either direction.

The lefthand end of the shaft 78' in Figs. 10 and 11 is journaled to a bearing member 104 mounted between upper and lower members 105 which are slidable in a housing 106 secured to the side frame of the machine. The bearing 104 is secured to members 105 by upper and lower studs 107, which also act as pivots for the bearing 104, permitting it to turn to the extent necessary when the shaft 78' is adjusted about its central vertical axis. In order to adjust as required, the angular inclination of arms 81', 82' and roller 21' in relation to strip 20 (see Fig. 12), shaft 78' is provided with a lever member 90' (Fig. 14) having a pin at 91' for engaging various holes 92' in a depending plate 93' in a manner similar to the corresponding parts in Fig. 2. However, in this case as shown, the plate 93' may be secured as at 108 to a protruding portion of the bearing member 104, so that on sliding movements of the bearing in the housing 106, the plate 93' will also move and the members 90', 91' will not interfere with such movements.

The righthand end of the shaft 78', as shown in Figs. 10, 11 and 15, is journaled in a bearing member 109 mounted within a yoke 110 slidable within a bearing housing 111 secured to the side frame 36 of the apparatus. The bearing 109 is pivotally connected by pins 112 to the yoke 110 so as to permit the axial alignment of shaft 78' to be adjusted as the yoke 110 slides. The yoke 110 is connected to a piston rod 74' in a manner similar to the corresponding connections of Fig. 4, and the other piston rod 94' is connected to slide bars 95' having a pin and slot connection 96' with a slidable plate 97' (Figs. 15, 10). The slidable plate 97' is rigidly connected as by a rod 98' to another plate 113 slidably mounted on the opposite side frame of the machine. A rotatable shaft 29' having oppositely threaded portions as shown, is mounted in bearings 34' upon plate 113 and rotatably adjusted as by hand wheel 33' to vary the spacing of the paddles 22', 23', with which the edges of the metal strip contact. The manner in which these paddles and the accompanying valve structure are supported and arranged on shafts 29', 98' will be described in further detail in connection with Figs. 16 to 19. The righthand end of the shaft 29' is mounted in a bearing 30' on plate 97' in a manner so that the shaft is free to turn as well as slide in re-

spect to said plate upon turning the hand wheel 33'.

Referring now to the valves and connections for controlling the admission and discharge of water to the piston 26', it will be noted that four valves 42', 43', 48', 49' are provided with accompanying inlet and drain line connections 41', 50' and with connections 44', 45', 46' and 47' to the cylinder 71', for operating the valves in a manner similar to the corresponding valves of Fig. 1. However, in Fig. 10, valves 42', 49' and 43', 48' are mounted in pairs on opposite sides of the strip, on supporting blocks 114, 115 having threaded engagement with the shaft 29', whereby upon turning the hand wheel 33', the spacing of the two pairs of valves may be adjusted to accommodate various metal strip widths.

The valve structure at the righthand side of Fig. 10 and the accompanying connections for operating the same by the paddle 23' will now be described in connection with Figs. 16 to 19, it being understood that the valve structure at the lefthand side of Fig. 10 is the same. The valve supporting block 115 is carried upon a plate member 116, which plate member is also fixed to a supporting block 117 slidably embracing the shaft 98'. A pair of supporting posts 118, 119 are mounted upon the plate 116 for carrying pivotal supporting means for an arm 120 which in turn carries the paddle 23'. Said pivotal supporting means, as best shown in Fig. 19, comprises a shaft 121 fixed transversely of the arm 120 and carried by a pair of pivot screws 122, 123, mounted in the supports 118, 119 respectively. Pivotal movement of the paddle 23' toward the right may be limited as by a set screw 124 for bearing against plate 116.

Upon pivotal movement of the paddle 23' toward the left, as occurs when the metal strip 20 drifts sideways toward such paddle, a pair of set screws as 125, 126 at the upper end of arm 120, will engage valve stems 70' for valves 42', 49', thus opening these valves and causing fluid to be admitted to the lower face of piston 26' (Fig. 10) and fluid to be discharged from the upper face of such piston. Thus the piston will travel in a direction to change the alignment of roller 21' for guiding the strip 20 back to its normal path. At the same time the piston 21' will through actuation of slidable members 95', 97' and 113, serve to slide the rod 29' toward the right as viewed in Fig. 10 (toward the left as viewed in Fig. 16). This movement of the rod 29' will carry with it the assembly of valves and supporting structure for the paddle 23' toward the left as viewed in Fig. 16. Accordingly the pressure of the moving strip 20 against the paddle 23' will be relieved and the valves 42', 49' will close again or tend to close.

Similarly, when the metal strip 20 engages the paddle 22', the valves 43', 48' will be properly actuated to change the alignment of the roller 21' in a direction to guide the strip back to its normal path. And as in the embodiment of the invention first above described, as the strip 20 is being guided back to its normal path, the roller 21' will also be restored to its normal position substantially at right angles to the normal path of the strip. As in the other example of the invention, the movements of the piston 26' and roller 21' take place step-by-step in small steps whereby the condition of the guiding apparatus is in effect automatically tested step-by-step and extreme or excessive movements of the roller 21' and "hunting" effects in the control equipment are avoided.

The modification of Figs. 20, 21 is generally similar in operation to that of Figs. 10 to 19 inc., but differs somewhat as to construction, principally as regards the follow-up mechanism which substitutes a bell-crank 130 arrangement for the pin-and-slot mechanisms 95, 96, 97, etc., of the previous modifications. In Figs. 20, 21, the guide roll 21' pivots about its axial center in identically the same manner as in Figs. 10, 11, its mounting being the same as shown by the similarly designated components and as previously described. In Fig. 20, shaft 78' pivotally supporting the guide roll 21', is, as previously, actuated at its righthand end by the hydraulic piston 26' through the piston rod 74' and pin connection 112 to shaft 78' as previously explained, whereby displacement of the piston rotates the shaft about its pivotal support. At its lefthand end, shaft 78' is, as previously, pin-connected as at 107 to member 105 slidable within housing 106 for displacing member 105 in conformity with rotary movements of shaft 78'.

As shown more clearly in Fig. 21, the strip 20' to be guided, passes between guide paddles 22', 23', which are hinged along their upper ends 131, 132 to bolts 133, 134 carried by shoes 135, 136, welded or otherwise, secured to supporting members 137, 138, the latter mounted on shafts 29', 139 supported by and between angle members 140, 141 bolted respectively to opposite frame members 36', 38' of the apparatus as shown. Supports 137, 138 slidably engage shaft 139 and are provided with sleeve members 142, 143 which are threaded respectively to the oppositely threaded portions 144, 145, of shaft 29', for adjusting the spacing of the guide paddles 22', 23' by means of the hand-wheel 33'.

Each of the supports 137, 138 carries a pair of valves 43', 48' and 42', 49', similar in construction to those previously described, valves 42', 43' being supplied with water or other fluid under pressure from flexible pressure hoses 41', which is conveyed thence to the lower and upper chambers of piston 26' over hoses 44', 45' respectively. Conversely, fluid discharged from the opposite chamber of the piston is discharged over flexible hoses 46', 47' and through valves 48', 49' respectively to drain lines 50'.

The valves are actuated by means of their associated valve rods 70' which project toward the outer faces of the hinged guide paddles in such relation as shown, that impact of the strip 20' against either paddle 22' or 23' will, by swinging the same about its hinged support 133 or 134, actuate valve pair 43', 48' or 42', 49', as the case may be. Actuation of such a valve pair will in turn open a passage from the supply line 41' to one chamber of the piston 26' and simultaneously open a passage from the opposite chamber thereof to the drain line 50', the connections being such as shown that when the strip engages paddle 22', the piston will move downwardly to swing the guide roll clockwise about its pivotal support 100, thereby to guide the strip away from paddle 22', and vice versa when the strip engages paddle 23'.

In order, however, to prevent this corrective action from proceeding to such an extent that the strip after engaging one guide paddle will be directed by the guide roll against the opposite guide, such as would cause "hunting," the bell-crank linkage 130 is brought into play to provide the above-mentioned follow-up operation. To this end, the bell-crank is pivotally secured at 146 to a stationary supporting member 147, one arm

148 of the bell-crank being pin-connected at 149 to the member 105 which undergoes slidable displacement in response to rotation of the guide roll about its pivotal support 100 as above described. The remaining arm 150 of the bell-crank is pin-connected at 151 to one end of a link member 152 having its opposite end pin-connected at 153 to shaft 29', whereby rotation of the bell-crank about its fixed pivot point 146 correspondingly shifts shaft 29' and with it the guide paddles 22', 23' rigidly supported thereon by members 137, 138 as explained.

Operation of the bell-crank linkage to provide follow-up actuation is as follows: Assuming that strip 20' drifts against paddle 22' to actuate valves 43', 48', by hinged displacement of the paddle against their associated valve stems 78', the guide roll will be rotated clockwise as above explained, tending thereby to guide the strip away from paddle 22'. The accompanying rotation of shaft 78' will displace member 105 upwardly and thereby rotate the bell-crank 130 counterclockwise about its fixed pivot point 146. Arm 150 will accordingly be displaced to the left and with it shaft 29' carrying the valve supports 137, 138. Valves 43', 48' will thus be backed away from paddle 22' which tends to hang vertically by virtue of its hinged support 133, whereby these valves close again to prevent further movement of the guide roll, etc. If the initial correction does not suffice, the strip will continue to drift against paddle 22', causing this sequence of operations to be repeated until the correction is adequate. The opposite sequence of operations will of course occur assuming the strip to drift against the opposite paddle 23'.

I claim:

1. Apparatus for automatically guiding rapidly advancing continuous strip material along a given longitudinal direction of travel, comprising: a pivotally supported roller over which the strip is fed, laterally displaceable contact members disposed on each side of the strip, and power actuated means responsive to impact of the strip against either of said contact members for pivoting said roller to guide said strip in a direction slightly away from that producing said contact, said means including an hydraulic piston for controlling the axial position of said roller, normally closed spring valve means selectively actuated by said contact members for selectively displacing said piston in opposite directions, and follow-up means responsive to displacement of said piston for releasing the so actuated valve means.

2. Apparatus for automatically guiding rapidly advancing continuous strip material along a given longitudinal direction of travel, comprising: a pivotally supported roller over which the strip is fed, laterally displaceable contact members disposed on each side of the strip, and power actuated means responsive to impact of the strip against either of said contact members for pivoting said roller to guide said strip in a direction slightly away from that producing said contact, said means including an hydraulic piston for controlling the axial position of said roller, valve means operated by one contact member for displacing said piston in one direction, other valve means operated by the other contact member for displacing said piston in the opposite direction, and means responsive to displacement of said piston when so actuated for releasing the valve means producing said actuation.

3. In apparatus for controlling a rapidly ad-

vancing metal strip against sideways drifting, a roller pressing against the strip and against the surface of which roller the strip forms a loop, supporting means for said roller, angularly adjustable about an axis generally parallel to but spaced substantially from the roller axis, whereby the position of the roller may be varied to vary the included angle of the loop, and means for automatically varying the angular position of the supporting axis in respect to the normal line of travel of the strip, whenever the strip drifts to one side or the other, whereby the position of the roller axis is likewise varied, in a direction to cause the roller to guide and restore the strip toward its normal line of travel.

4. In apparatus for controlling a rapidly advancing metal strip against sideways drifting, a pair of members for contacting respectively with the sides of the strip upon such drifting, a rotatable rod extending transversely of the strip and engaging said members respectively with oppositely directed screw threads whereby rotation of the rod adjusts the positions of said members to accommodate strips of various widths, means for slidably supporting said rod, means for variably guiding the strip in respect to its normal path, and control means for said guiding means, operable by the sliding movements of said rod.

5. In apparatus for controlling a rapidly advancing metal strip against sideways drifting, a pair of members for contacting respectively with the sides of the strip upon such drifting, means for supporting said members for slidable movement upon the occurrence of such drifting, means for variably guiding the strip in respect to its normal path, control means for such guiding means, operatively connected for actuation by the slidable movements of said supporting means, and means for movably supporting said control means, operatively connected to said guiding means, whereby operation of the guiding means moves said last named supporting means to modify said actuation of the control means.

6. In apparatus for controlling a rapidly advancing metal strip against sideways drifting, fluid pressure operated means for guiding the strip in either direction in respect to its normal path, a plurality of valves for controlling said means to operate same in either direction, a support for said valves operatively connected to said means for movement in either of two directions, depending upon the direction of operation of the guiding means, and means operated by sideways drifting of the strip for so actuating said valves as to operate the guiding means in a direction to counteract the drift, and whereby the consequent movement of the valve support by the guiding means also tends to restore the valves to normal condition.

7. Strip guiding apparatus comprising: a pivotally supported guide and a pair of displaceable vanes along and between which the strip is fed respectively, means including a pressure-actuated piston and valves selectively actuated by displacement of either of said vanes due to contact of the strip therewith, for compensatively adjusting said guide about its pivotal support, and a follow-up member displaceable by said piston for releasing the valves so actuated.

8. Strip guiding apparatus comprising: a centrally pivoted guide and a pair of displaceable vanes, along and between which the strip is fed respectively, means including a pressure-actuated piston and valves selectively actuated by displacement of either of said vanes due to con-

tact of the strip therewith, for compensatively adjusting said guide about its pivotal support, and a follow-up member displaceable by said piston for releasing the valves so actuated.

9. In combination with a fluid pressure reversibly operable piston for controlling drifting of a metal strip sideways in either direction during longitudinal movement of the strip, valve means for turning on or off a source of the fluid pressure for operating said piston in either direction, members for contacting the sides of the strip, means operatively connected to said members for actuating said valve means to turn on said pressure to actuate the piston in one direction or the other depending upon the direction of drift of the strip, movable supporting means for said valve means, and follow-up connections between the piston and said movable supporting means whereby such actuation of the piston tends to restore the valves to normal condition and stop the piston, and then to reactuate the valve means to cause reverse movement of the piston and of the valve supporting means during restoration of the strip to its normal path.

10. In combination with a fluid pressure reversibly operable piston for controlling drifting of a metal strip sideways in either direction during longitudinal movement of the strip, a pair of valves for controlling the admission and discharge of the fluid respectively to and from opposite sides of the piston for operating said piston in one direction, an independent pair of valves for similarly controlling the operation of the piston in the other direction, a pair of members for respectively contacting opposite sides of the strip upon the drifting of same, means movable by and in accordance with movements of said members for actuating one pair of said valves when the strip drifts to one side and for actuating the other pair of said valves when the strip drifts in the opposite direction, a support for said valves movable in directions toward and away from said actuating means, and a follow-up connection between the piston and said support whereby movement of the piston in either direction tends to cause the valves effecting the latter movement to be carried out of actuating relationship with said actuating means.

11. In combination with a fluid pressure reversibly operable piston for controlling drifting of a metal strip sideways in either direction during longitudinal movement of the strip, a pair of normally closed spring valves at one side of the strip for respectively controlling the admission and discharge of the fluid to and from opposite sides of the piston for operating said piston in one direction, and another pair of such valves at the other side of the strip for similarly controlling the operation of the piston in the other direction, a pair of swingable members for respectively contacting opposite sides of the strip upon the drifting of same and for them respectively actuating one of the pairs of valves, and a follow-up connection between said piston and said pair of members, whereby movement of the piston in either direction tends to cause the member which initiated such piston movement to be carried out of contact with the strip while tending to carry the other said member toward the strip.

12. In combination with a fluid pressure operable piston for controlling sideways drifting of a metal strip during its longitudinal movement, a support movable transversely of the strip, valve means on said support for controlling the piston,

a member swingably mounted on said support for contacting the strip edge upon drifting of the strip and for then actuating said valve means, and a follow-up connection between the piston and said support for moving said support in a direction away from the strip edge, upon movement of the piston under control of said valve means.

13. In apparatus for controlling a rapidly advancing metal strip against sideways drifting, a pair of members for contacting respectively with the sides of the strip upon such drifting, supporting means for each of said members, a rotatable rod extending transversely of the grip and connected to said supporting means respectively through oppositely directed screw threads whereby rotation of the rod adjusts the position of said members to accommodate strips of various widths, means for slidably supporting said rod, fluid pressure operated means for variably guiding the strip in respect to its normal path, and valve means for controlling such guiding means, operable by the movements of said supporting means resulting from contact of said members with the strip.

14. In apparatus for controlling a rapidly advancing metal strip against sideways drifting, a pair of members for contacting respectively with the sides of the strip upon such drifting, means for supporting said members for movement transversely of the strip upon the occurrence of such drifting, means including a piston operated by fluid pressure for variably guiding the strip in respect to its normal path, valve means for controlling movements of said piston, operatively associated with said supporting means for actuation by movements of said members upon contacting the drifting strip, and means connected to said piston for varying the relation of said valve means and supporting means to modify the operation of the valves in accordance with movements of the piston.

15. Strip guiding apparatus comprising: a pivotally supported guide and a pair of displaceable vanes along and between which the strip is fed respectively, means including an oppositely threaded shaft carrying a hand wheel for adjustably positioning said guides in equal increments, and means including a pressure-actuated piston and valves selectively actuated by displacement of either of said vanes due to contact of the strip therewith for compensatively adjusting said guide about its pivotal support, said valves respectively being mounted adjacent said vanes and also adjustably positioned by said shaft.

16. Strip guiding apparatus comprising: a pivotally supported guide and a pair of displaceable vanes along and between which the strip is fed respectively, and means including a pressure-actuated piston and quick-acting, spring-controlled valves selectively actuated by displacement of either of said vanes due to contact of the strip therewith for compensatively adjusting said guide about its pivotal support.

17. In combination with a fluid pressure reversibly operable mechanism for controlling sideways drifting of a metal strip during rapid longitudinal movement of the strip, valve means for turning on or off a source of the fluid pressure for operating said mechanism in either direction, a member for contacting with one side of the strip and operatively connected to said valve means to turn on said fluid pressure upon such drifting of the strip toward said side,

another member for contacting with the other side of the strip and operatively connected to the valve means to turn on fluid pressure to operate the mechanism in the reverse direction, upon drifting of the strip against the latter member, and a follow-up connection between said members and said mechanism, so constructed and arranged that the mechanism upon

being actuated in either direction, then moves said members and thus causes operation of said valve means in directions tending to stop said mechanism, and then to reverse said mechanism and the movement of said members during restoration of the strip to its normal path.

JOHN F. FERM.