April 15, 1947. A. C. GRUNKE ET AL 2,419,070

STRIP COATING APPARATUS

Filed Aug. 28, 1944 3 Sheets-Sheet 1

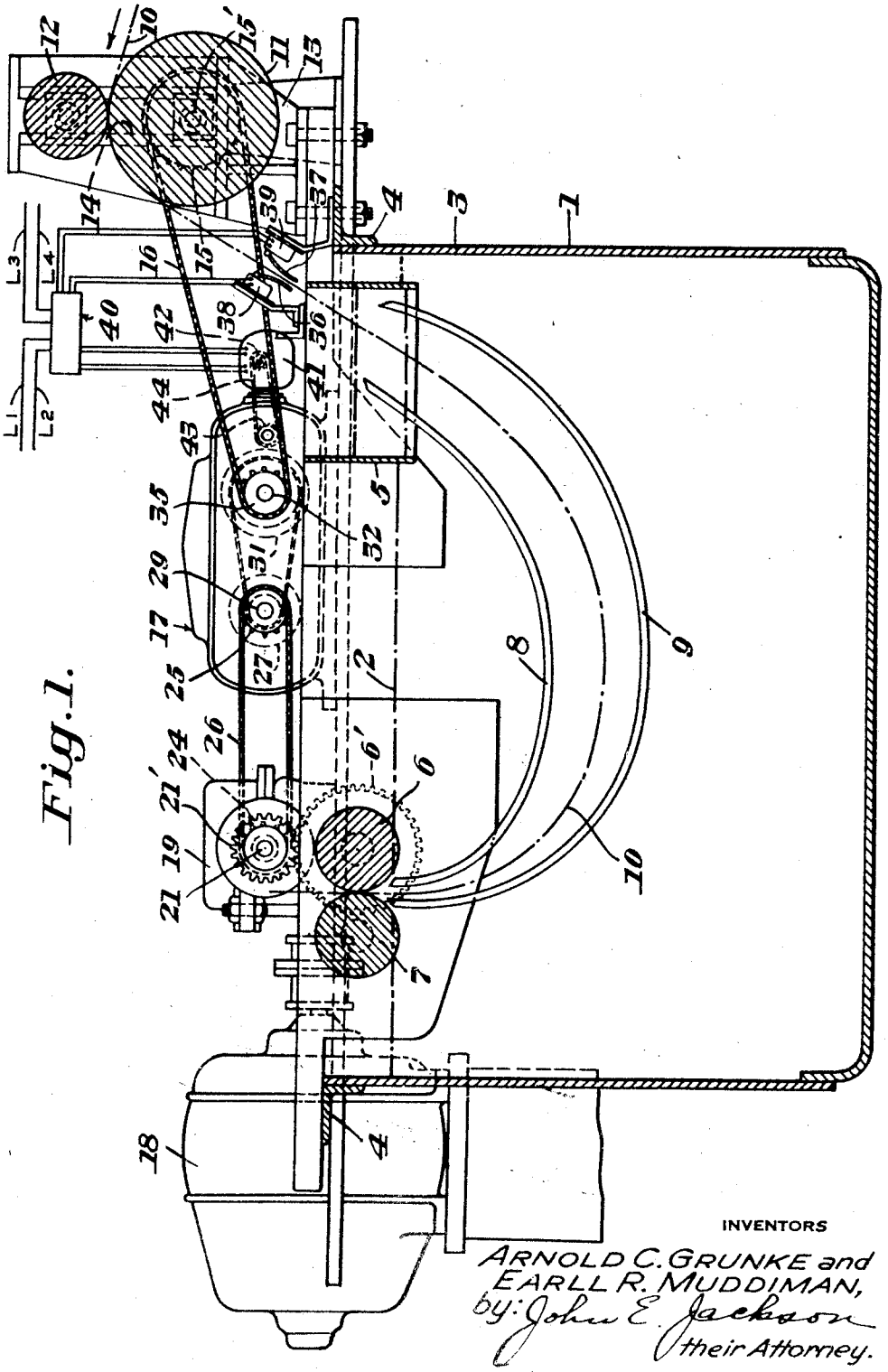


Fig. 1.

INVENTORS

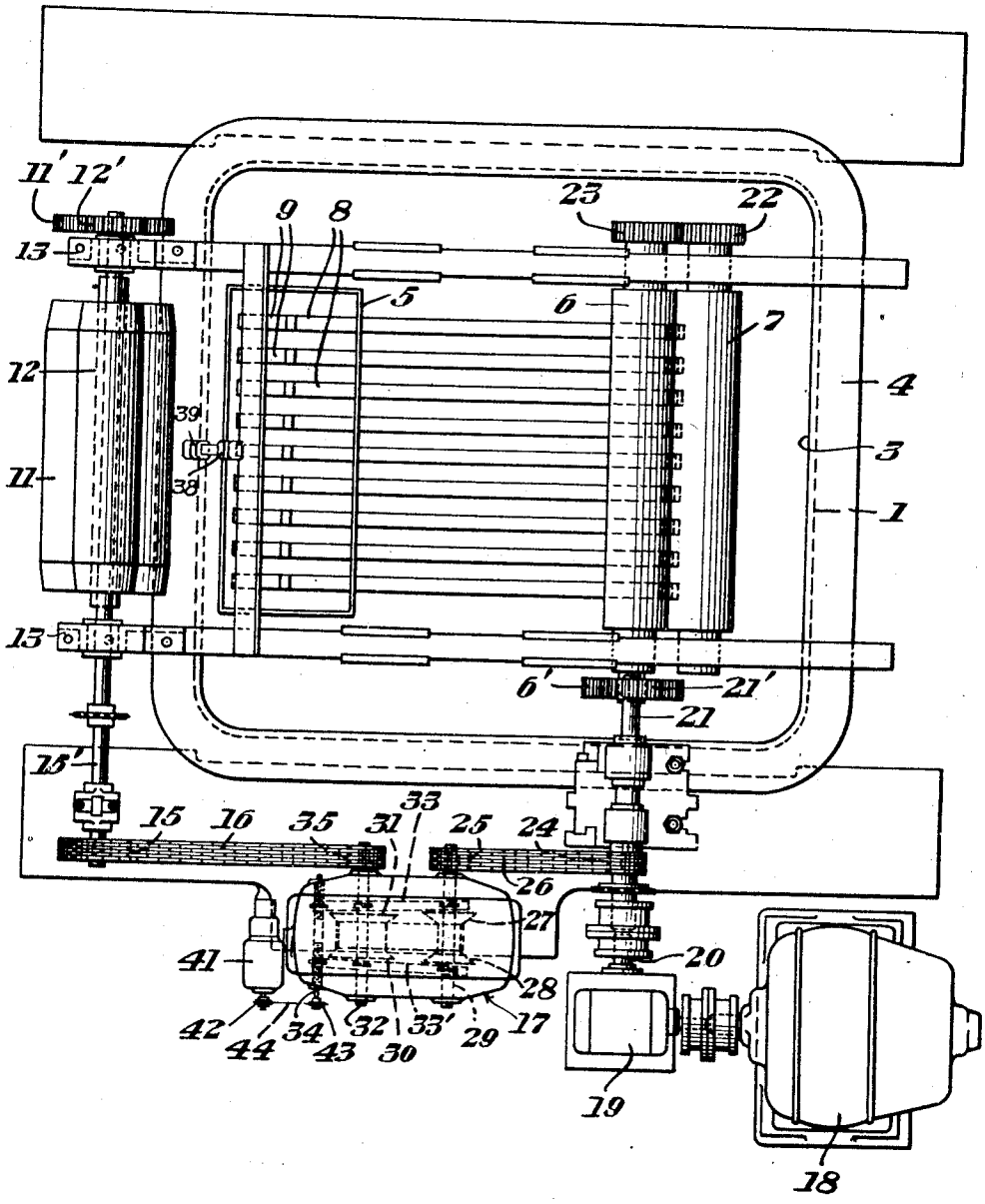
ARNOLD C. GRUNKE and
EARLL R. MUDDIMAN,
by: John E. Jackson
their Attorney.

April 15, 1947. A. C. GRUNKE ET AL 2,419,070

STRIP COATING APPARATUS

Filed Aug. 28, 1944 3 Sheets-Sheet 2

Fig. 2.



INVENTORS

ARNOLD C. GRUNKE and EARLL R. MUDDIMAN,

by: John E. Jackson

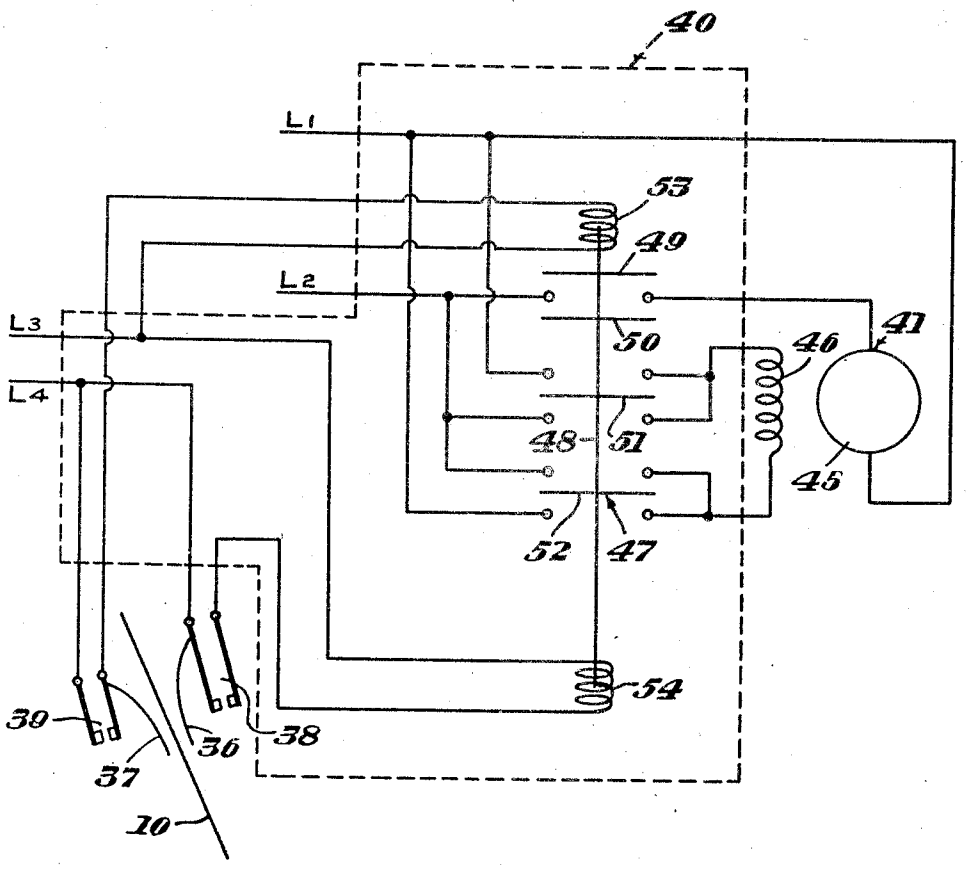
their Attorney.

April 15, 1947. A. C. GRUNKE ET AL 2,419,070

STRIP COATING APPARATUS

Filed Aug. 28, 1944 3 Sheets-Sheet 3

Fig. 3.



INVENTORS
ARNOLD C. GRUNKE and
EARLL R. MUDDIMAN,
by: John E. Jackson
their Attorney.

Patented Apr. 15, 1947

2,419,070

UNITED STATES PATENT OFFICE

2,419,070

STRIP COATING APPARATUS

Arnold C. Grunke, Apollo, and Earll R. Muddiman, Wilkinsburg, Pa., assignors to Carnegie-Illinois Steel Corporation, a corporation of New Jersey

Application August 28, 1944, Serial No. 551,494

7 Claims. (Cl. 91—12.7)

1

This invention relates to a device for the coating of strip material and more particularly to a device for effecting such coating by immersing strip metal in molten coating metal.

The invention has as one object thereof, the prevention of defects in the coating which are frequently caused by rubbing the coated metal against guides with the coating in heated and, therefore, soft condition.

Another object of the invention is the provision of means automatically synchronizing the entry and exit speeds of the strip metal into the coating device, whereby coating is possible at high speeds and the coating produced is uniform in thickness and quality.

These and other objects of the invention will appear as the description proceeds.

The invention overcomes difficulties encountered in the use of conventional galvanizing pots wherein the moving strip enters the pot through a set of driven pinch rolls, passes down into the bath of molten coating metal between top and bottom guides located in the bath, through guide rolls located in the bath near the bottom of the pot, and then upward and into the exit pinch rolls. With such a device, it is necessary frequently to adjust the peripheral speeds of the entry and exit pinch rolls since the strip is engaged in both sets of driven rolls simultaneously. If the exit rolls are driven at too great a peripheral speed with respect to the speed of the entry rolls, the strip being coated is dragged against the upper guide and portions of the coating are injured or are completely scuffed off the upper face. If the peripheral speed of the exit rolls is too slow, on the other hand, the coated strip drags on the bottom guide with similar consequent injury to the coating on the bottom face. The adjustment of speeds of the entry and exit pinch rolls is rendered difficult since coating metal tends to build up on the peripheries of the exit pinch rolls, thereby progressively increasing their diameter. Thus, from time to time the exit rolls must be ground down to their original size, and the peripheral speeds of entry and exit rolls again adjusted. Other obvious consequences of failing to maintain proper relationship of the entry and exit rolls in the prior art coating devices are the production of uneven coatings on the strip due to the different lengths of time different parts of the strip are in the coating bath, and the occurrence of cobbles, which may so jam the strip between the guides as to cause a complete shut down of the coating device.

The present invention overcomes such difficulties by providing means for feeding strip metal through a metal coating device of the class described which maintains automatic synchronism between the peripheral speed of the entry pinch rolls and the exit pinch rolls. The speed of the entry rolls in the coating device of the present invention is varied automatically, as required, to be maintained in synchronism with the speed of the exit rolls, whereby the strip travels through the metal coating bath in a substantially fixed path without contacting any guide devices.

2

The invention will be more readily understood by reference to the accompanying drawings, in which:

Figure 1 is a vertical cross-section through the coating device of the present invention;

Figure 2 is a plan view of the device; and

Figure 3 is a schematic wiring diagram showing the manner in which the speed control motor is hooked up to the control switches.

The coating device shown in Figures 1 and 2 consists of a pot 1 containing a bath 2 of molten metal such as zinc, such metal being maintained at the proper temperature by heating means (not shown). The upper edge of sides 3 of pot 1 is provided with a flange-like member 4, to which are attached supports for the strip conveying means; that is, the feeding, or entry, and the withdrawing, or exit, rolls, and the speed change drive mechanism for the entry rolls. Pot 1 is provided on the entry side with a flux box 5 containing a suitable molten flux through which the strip passes before entering the molten metal bath. Extending from the flux box to a position closely adjacent exit pinch rolls 6 and 7 are upper and lower guides 8 and 9, respectively, between which the strip passes in its travel through the pot. Guides 8 and 9 are made of such configuration that the strip travels between them substantially equidistant between the two when the speeds of entry and exit rolls are properly synchronized.

The strip of metal to be coated, which is designated by the numeral 10, travels into the coating device in the direction of the arrow shown in Figure 1, between driven entry rolls 11 and 12, from which it enters the pot through the flux box 5, travels in a path which is substantially in the form of a catenary curve between the guides 8 and 9, and leaves the pot by means of driven exit rolls 6 and 7. Entry rolls 11 and 12 are supported by a frame 13 mounted at the top edge of the pot 1, frame 13 having vertical bearing guide slots 14 in the sides thereof within which the bearings for rolls 11 and 12 are retained and in which they may slide vertically. Top roll 12, which

is maintained in contact with the bottom roll by means of its own weight, is connected for rotation with roll 11 by gears 11' and 12'. Roll 11 is driven by sprocket 15 affixed to shaft 15', upon which roll 11 is supported, by means of chain 16, which is driven by change speed mechanism 17, presently to be described.

Exit rolls 6 and 7 are driven by means of electric motor 18, supported on a suitable pedestal, as shown, through the intermediary of reducing gear box 19, to the output shaft 20 to which is connected shaft 21 having a pinion 21' meshing with a gear 6' on roll 6. Roll 7 is driven from roll 6 by means of gear 22 affixed to its supporting shaft on the far end thereof, said gear meshing with gear 23 affixed to the shaft of roll 6.

The speed change mechanism from which the entry rolls are driven derives its power from sprocket 24 attached to shaft 21, said sprocket being coupled to driving sprocket 25 of the speed change means 17 by chain 26. Speed change means 17, which may be of any standard type, is, in the embodiment shown, one which accomplishes speed change by the inverse variation in effective diameter of two V-grooved pulleys upon which runs a belt or chain of constant length. In the mechanism shown, the driving V-grooved pulley is made up of the two flange members 27 and 28 keyed upon driving shaft 29 for sliding movement toward and away from each other. The driven V-grooved pulley consists of two flange members 30 and 31 similarly mounted upon driven shaft 32. The flange members 27 and 31 and 28 and 30 are rotatably connected to pivoted levers 33 and 33', respectively, as shown, so that when the left hand ends of such members are caused to approach each other, members 27 and 28, constituting the driving pulley, move away from each other thus giving the driving pulley a smaller effective diameter, and flange members 30 and 31, constituting the driven pulley, are caused to approach each other, thus giving the driven pulley a greater effective diameter and decreasing the speed of driven shaft 32 as compared with the speed of driving shaft 29. The moving of the left hand ends of the levers away from each other will readily be seen to effect the opposite result, that is, to decrease the ratio of speed reduction of shaft 32 as compared with shaft 29. Movement of the levers toward and away from each other is accomplished by means of right and left hand threaded shaft 34 suitably journaled in the housing of the speed reducing means and having nuts of the corresponding hand threaded thereon, said nuts being pivotally mounted on the left hand ends of levers 33 and 33'. Sprocket 35, which is affixed to the projecting end of driven shaft 32, drives entry roll 11 by means of chain 16 and sprocket 15, heretofore mentioned.

In accordance with the present invention, the speed change mechanism 17 is automatically controlled by the strip entering the coating device, so that the speed of the entry rolls is synchronized with the speed of the exit rolls, that is, the peripheral speeds of the entry and exit rolls are made equal, and the strip in the coating pot progresses therethrough without contact with upper and lower guides 8 and 9. This object is attained by the provision of contact arms 36 and 37 placed in proximity to the upper and lower faces of the strip as it is about to enter the pot. Such arms are so positioned that when the entry rolls bear the proper speed relationship to the exit rolls and the strip thus follows the desired path through the pot, the strip does not touch them. If, however, the entry rolls are driven too fast relative to the exit rolls, the strip 10 will sag and contact arm 37 thereby depressing it and completing a circuit through switch 39, which may be in the nature of a micro-limit switch operated by pressure upon arm 37. Switch 38, which is similar to switch 39, will be operated when the entry rolls are driven too slowly and the strip accordingly is pulled into a position above the desired normal path of travel and into contact with arm 36. Switches 38 and 39 act through motor control means, indicated generally at 40 in Figure 1, to operate the speed control motor 41. Motor 41 is connected to shaft 34 of the speed reducing device by means of sprocket 42 on the motor, sprocket 43 on shaft 34, and chain 44 in such manner as to maintain the speeds of sprockets 25 and 35 of the speed reducing mechanism, and consequently the peripheral speeds of the entry and exit rolls, at synchronization.

The manner in which this is accomplished will be apparent upon consideration of Figure 3, wherein the control circuit is shown. The mechanism within the motor control device 40 is that which is shown within the dotted outline in Figure 3. Motor 41 in this instance is a shunt wound D. C. motor and consists of a rotor 45 and a field 46. Power for the motor is supplied by power lines L_1 and L_2. Rotor 45 is connected across the power supply but is disconnected therefrom whenever switch 47 is in a neutral open position, as shown in Figure 3. Switch 47 consists of a plunger member 48 to which is attached, by suitable insulation, rotor connecting and disconnecting switch members 49 and 50 and field connecting and disconnecting switch members 51 and 52. Switch plunger 48, which is normally maintained in the open position shown by means of springs or weights (not shown) is shifted upwardly by energization of upper solenoid coil 53 and is shifted downwardly upon the disconnecting of coil 53 and the energization of solenoid coil 54. In its upper position the switch closes the connection between the power lines L_1 and L_2 and rotor 45 by switch member 50, and connects field 46 to the power supply by means of switching members 51 and 52, the upper end of the field being connected to line L_1 and the lower end of the field being connected to line L_2. When the plunger 48 of the switch is in the downward position, the rotor is connected to the source of power by means of switching member 49 and the field is likewise connected to such source by members 51 and 52, but the top end of the field is then connected to line L_2 and the bottom of the field is connected to line L_1. Thus switch 47 allows the connecting and disconnecting of the motor 40 to the source of power, and provides for reversing direction of the rotation of the rotor, depending upon whether the switch plunger 48 is in upper or lower position.

Solenoid coil 53 is energized whenever strip 10 contacts arm 37 sufficiently strongly to cause closing of switch 39. This in turn completes the circuit from control power supply L_3 and L_4 and energizes solenoid 53, thereby causing switch plunger 48 to assume its upward position. This in turn causes motor 41 to rotate in such direction as to cause the left hand ends of levers 33 and 33' to approach each other and sprocket 35 to rotate more slowly. Consequently the entry rolls are rotated at a slower speed so that the exit rolls take up the slack and cause strip 10 to

be removed from contact with arm 37. When this correction occurs, switch 39 opens, solenoid 53 is deenergized, switch 47 returns to its normal open position, and motor 41 stops, thus giving for the moment a fixed speed relationship between sprockets 25 and 35 of the speed change device 17, and consequently a fixed speed relationship between the entry and exit rolls.

If, on the contrary, the entry rolls should rotate too slowly and strip 10 should thereby be pulled up into contact with arm 36 by the exit rolls, switch 38 will be closed, solenoid 54 will be energized, and plunger 48 of switch 47 would be pulled to its downward position. Thereupon motor 41 will rotate in a reverse direction to separate the left hand ends of arms 33 and 33', thereby to increase the speed of sprocket 35 with respect to that of sprocket 25 and consequently to increase the speed of the entry rolls relative to the exit rolls. When the entry roll speed has been increased sufficiently to cause strip 10 to clear arm 36, switch 38 will be opened, solenoid 54 will be deenergized, switch 47 will return to its normal open position, and motor 41 will stop.

Guides 8 and 9 are employed to facilitate threading of the strip initially through the pot 1 and the exit rolls. During operation of the device, however, the strip does not contact them, since the space between them is sufficient to allow the strip to deviate from its normal path of travel sufficiently to actuate the means for restoring synchronism between the entry and exit rolls without contacting either guide. Thus the device of the invention produces coated strip metal wherein the coating is free of defects caused by contact of the heated coating metal with guide devices. Furthermore, because strip 10 passes through the coating bath at a substantially constant speed, with each unit length of the strip being in contact with the coating metal for substantially the same length of time, the coating produced is uniform in thickness and quality. Although the device has been described as working upon strip material, it is obvious that it may be employed, with suitable changes in the entry and exit rolls, for the coating of other continuous products such as wire.

Whereas we have shown and described a preferred embodiment of our invention, it is to be understood that the invention is not to be confined thereto, but that its scope is defined in the following claims.

We claim:

1. In a coating device of the class described comprising in combination a pot for holding a bath of coating material, and base material conveying means comprising means for feeding a continuous length of base material to be coated into the pot, and means for withdrawing the coated base material from the pot, the improvement which comprises means for driving the feeding means, means for driving the withdrawing means, speed change mechanism in the train of the driving means for one of the base material conveying means, and means operated by the base material passing through the coating bath when such material deviates from the normal path of travel to effect a change in the speed ratio of the speed change mechanism, whereby the speed of the conveying means driven by the speed change mechanism is altered to restore the base material to its normal path of travel.

2. In a coating device of the class described comprising in combination a pot for holding a bath of molten coating material, means for feeding a continuous length of base material to be coated into the pot, and means for withdrawing the coated base material from the pot, the improvement which comprises means for driving the feeding means, means for driving the withdrawing means, speed change mechanism in the train of the driving means for the feeding means, and means operated by the base material passing through the coating bath in a path which is substantially in the form of a catenary curve suspended from the feeding and withdrawing means when such material deviates from the normal path of travel to effect a change in the speed ratio of the speed change mechanism, whereby the speed of the conveying means driven by the change speed mechanism is altered to restore the base material to its normal path of travel.

3. A coating device of the class described comprising in combination a pot for holding a bath of molten coating metal, conveying means comprising means for feeding a continuous length of metal to be coated into the pot, means for withdrawing the coated metal from the pot, said feeding and withdrawing means conveying the metal being coated in a path which is substantially in the form of a catenary curve through the pot, means for driving the feeding means, means for driving the withdrawing means, speed change mechanism in the train of one of the driven conveying means, means located at the side of the pot into which the continuous metal feeds for detecting substantial deviations of such metal from its desired normal path of travel, and means operated by the detecting means upon such deviation for effecting a change in the output speed of the speed change mechanism to such value that the continuous metal is restored to its normal path of travel.

4. A coating device of the class described comprising in combination a pot for holding a bath of molten coating metal, conveying means comprising means for feeding a continuous length of metal to be coated into the pot, means for withdrawing the coated metal from the pot, said feeding and withdrawing means conveying the metal being coated in a path which is substantially in the form of a catenary curve through the pot, means for driving the feeding means, means for driving the withdrawing means, speed change mechanism in the train of one of the driven conveying means, detecting means located above and below the normal path of travel of the continuous metal on the side of the pot into which the metal feeds, said metal contacting said detecting means when it rises substantially above or falls substantially below its normal path of travel through the pot, respectively, and means operated by the detecting means for adjusting the speed change device to increase the speed of the feeding mans relative to the speed of the withdrawing means when the continuous metal contacts the upper detecting means and to decrease the speed of the feeding means relative to the speed of th withdrawing means when the continuous metal contacts the lower detecting means.

5. A coating device of the class described comprising in combination a pot for holding a bath of molten coating metal, conveying means comprising means for feeding a continuous length of metal to be coated into the pot, means for withdrawing the coated metal from the pot, said feeding and withdrawing means supporting the metal being coated between them and conveying it in a path which is substantially in the form of a catenary curve through the pot, means for driv-

ing the feeding means, means for driving the withdrawing means, speed change mechanism in the train of one of the driven conveying means, detecting means in the form of electric switches having pressure operated means for closing the circuit therethrough located above and below the normal path of travel of the continuous metal on the feed side of the pot, said metal contacting said pressure operated means when it rises substantially above or falls substantially below its normal path of travel through the pot, respectively, and a reversible electric motor connected to the speed change mechanism and operated by the electric switches for adjusting the speed change mechanism to increase the speed of the feeding means relative to the speed of the withdrawing means when the continuous metal contacts the upper pressure operated means and to decrease the speed of the feeding means relative to the speed of the withdrawing means when the continuous metal contacts the lower pressure operated means.

6. A coating device of the class described comprising in combination a pot for holding a bath of molten coating metal, means for feeding a continuous metal strip into the pot comprising pinch rolls, means for withdrawing the coated strip from the pot comprising pinch rolls, said feeding and withdrawing pinch rolls supporting the metal directly between them and conveying it in a path which is substantially in the form of a catenary curve through the pot, means for driving the feeding pinch rolls, means for driving the withdrawing pinch rolls, speed change mechanism in the train of the feeding pinch rolls, means located at the feed side of the pot for detecting substantial deviations of the metal strip from its desired normal path of travel through the pot, and means operated by the detecting means upon such deviation for effecting a change in the output speed of the speed change mechanism to such value that the strip metal is restored to its normal path of travel.

7. In a coating device of the class described comprising, in combination a pot for holding a bath of coating material, and base material conveying means comprising means for feeding a continuous length of base material to be coated into the pot, and means for withdrawing the coated base material from the pot, the improvement which comprises means for driving the feeding means, means for driving the withdrawing means, the driving means for one of the base material conveying means being selectively variable in speed, and means operated by the base material passing through the coating bath when such material deviates from the normal path of travel to effect a change in the speed of the variable speed driving means, whereby the speed of the conveying means driven by the variable speed driving means is altered to restore the base material to its normal path of travel.

ARNOLD C. GRUNKE.
EARLL R. MUDDIMAN.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,375,434	Moise et al.	May 8, 1945
970,134	Syabo	Sept. 13, 1910