

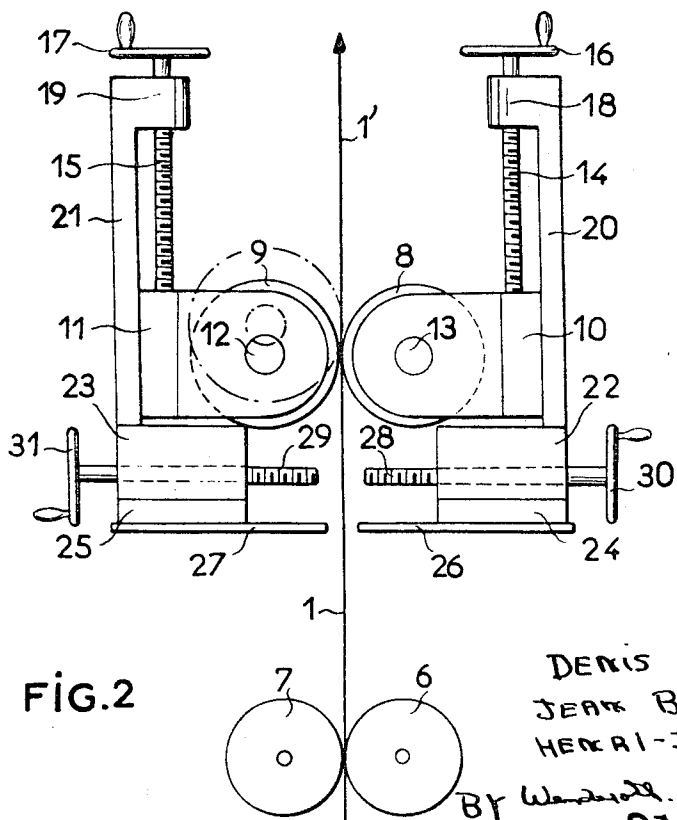
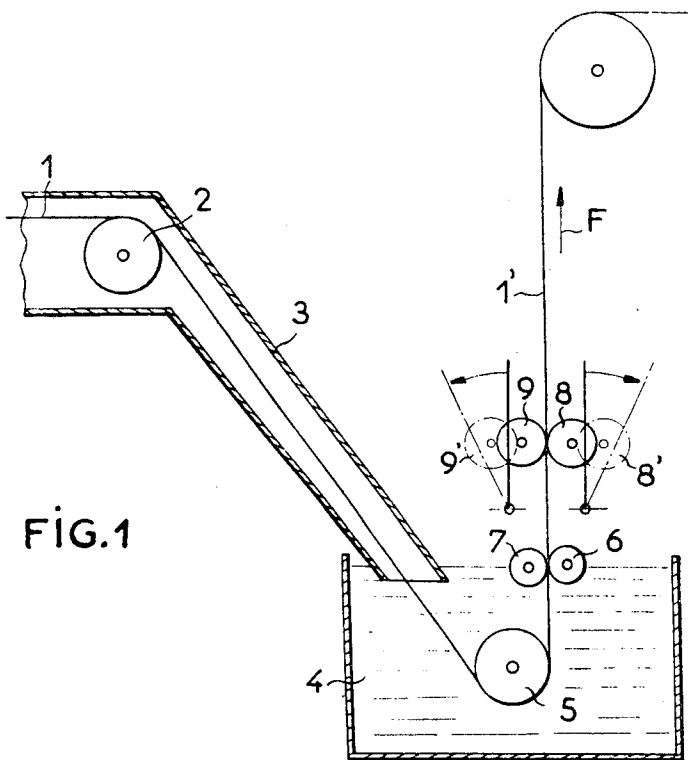
Aug. 4, 1970

D. HUBERT ET AL.
METHOD OF PREVENTING SPANGLE FORMATION ON
HOT-DIP GALVANIZED STEEL STRIP

3,523,036

Filed March 3, 1967

6 Sheets-Sheet 1



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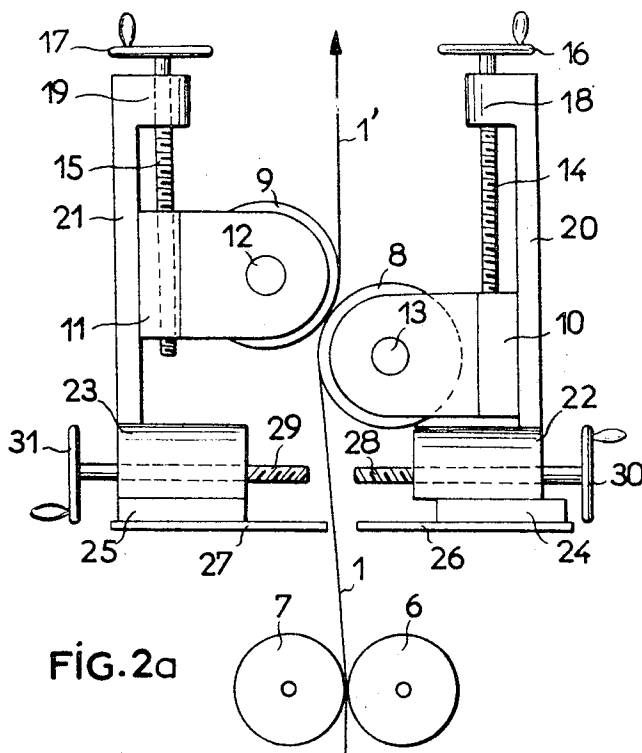


FIG. 2a

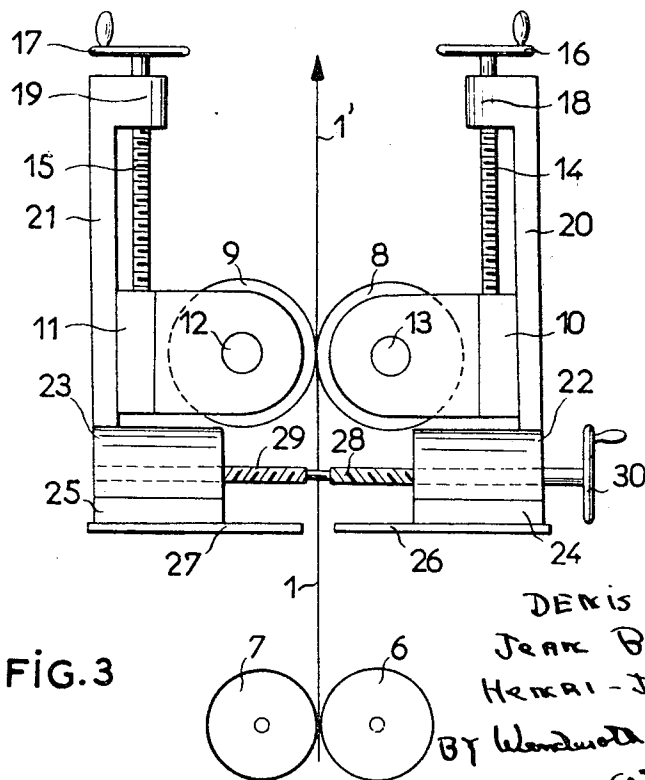


FIG. 3

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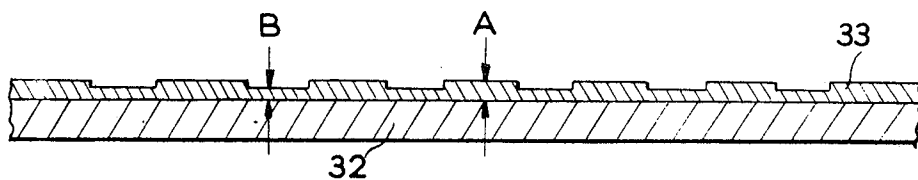


FIG. 4

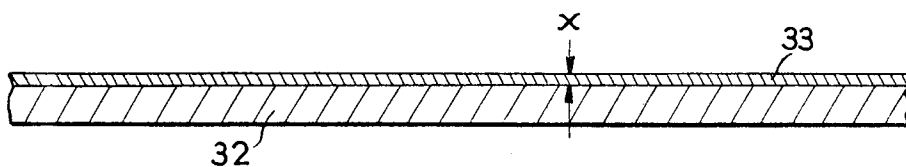


FIG. 5

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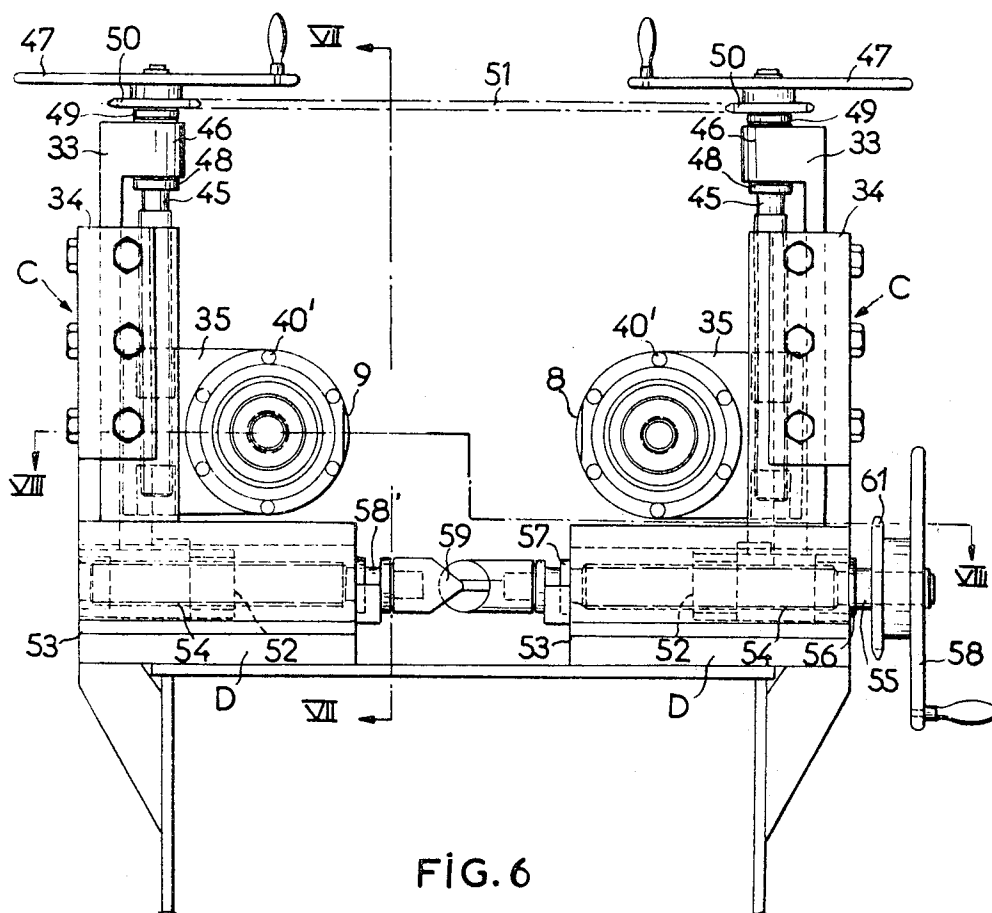
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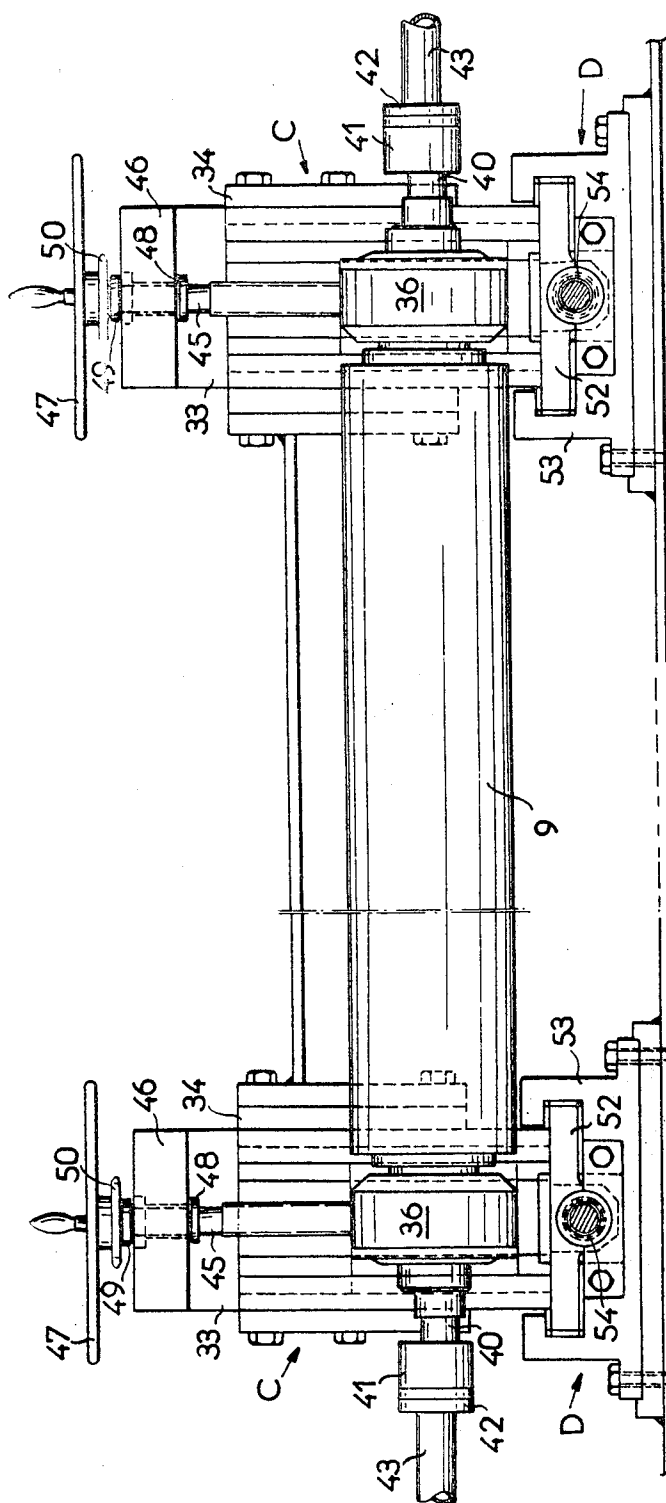


FIG. 7

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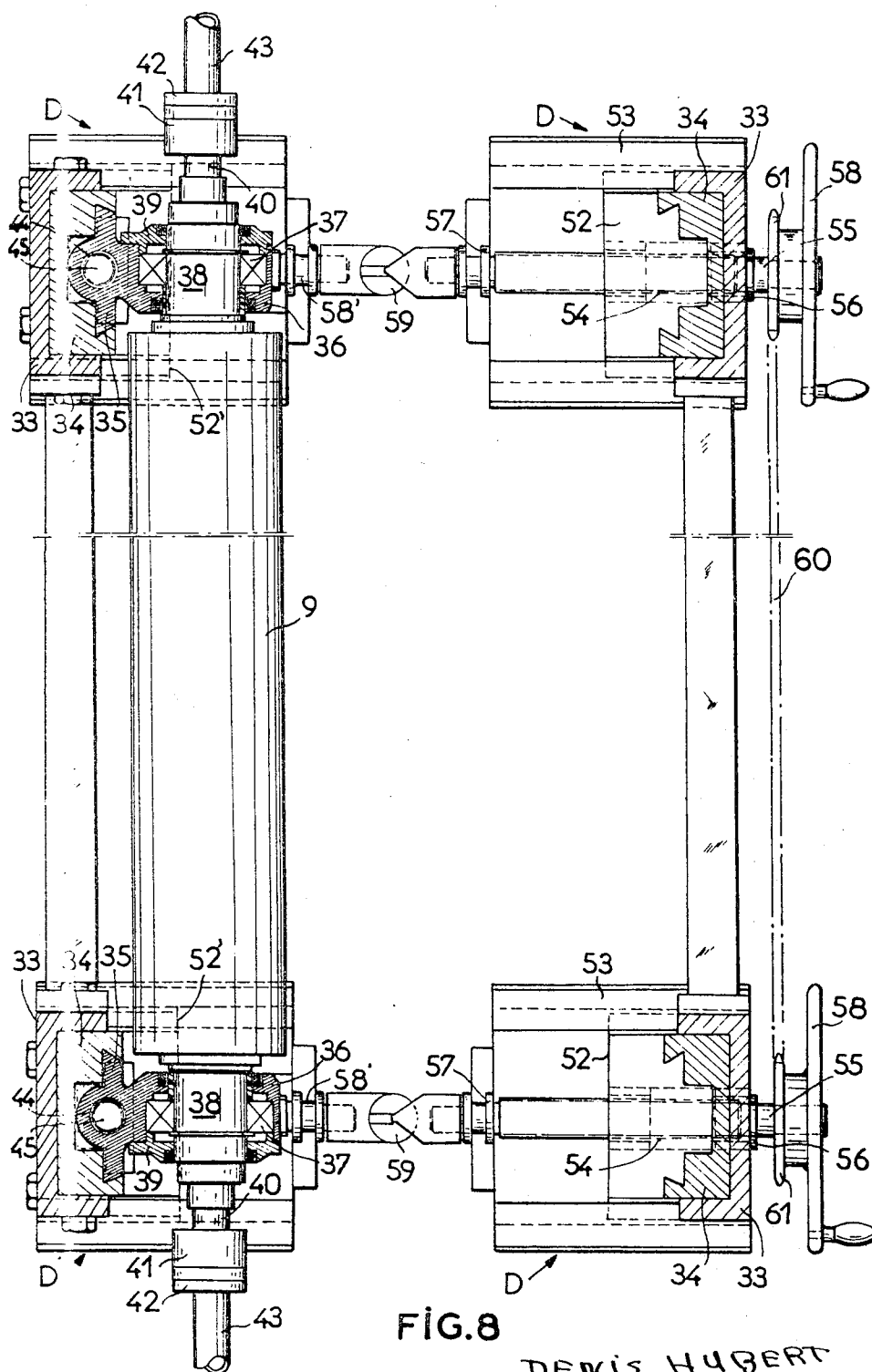


FIG. 8

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3,523,036

METHOD OF PREVENTING SPANGLE FORMATION ON HOT-DIP GALVANIZED STEEL STRIP

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Int. Cl. C23c 1/02

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2 Claims

ABSTRACT OF THE DISCLOSURE

In a process of galvanizing steel strips, the formation of a "frost flower" or "spangled" crystalline structure is prevented by subjecting the galvanized strip to a dry cold treatment by means of a set of water-cooled cylinders capable of being adjusted both in the vertical and horizontal directions.

BACKGROUND OF THE INVENTION

This invention relates to processes and apparatus for hot-galvanizing steel objects of various kinds by immersion in a bath of molten metal.

It has already been known for a long time to protect various steel objects against corrosion by coating them with a thin layer of zinc.

For example, when hot-galvanizing steel strip the coating is applied continuously by immersing the strip in a bath of molten zinc at approximately 450° C. After various preliminary thermal treatments the strip is immersed by a continuous process in the pot containing the molten zinc. The strip leaves the bath by passing through two coating rolls, the coated strip subsequently being finally rolled up into a coil.

It is known also that the coating produced in this way on the strip, by hot-galvanizing, shows a crystalline structure in relief known as "spangle."

This spangle in relief is no disadvantage as long as the strip is used in the ordinary way, but if the strip is subsequently given a coat of paint, or an outer protective layer of synthetic plastic, for decorative or finishing purposes, then it is found that the spangled relief surface of the galvanized sheet usually reappears through the paint or plastic film and spoils the decorative effect.

There are certain devices in use at the present time which reduce the areas of the crystalline structures, but they do not eliminate them entirely, and moreover they require the strip, which shows a residual spangling, to be passed through cumbersome and expensive mechanical devices which act to remove, by pressure between rollers, the residual spangle which has by this time solidified and hardened.

If should be observed that although cold-rolled steel is free from this fault, it does not enjoy the same degree of anti-corrosion protection.

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On the other hand, although sheet material electroplated with zinc does not show a spangling in relief, nevertheless its cost of production is considerably higher than that of hot-galvanized sheet.

The present invention concerns a process and an apparatus for hot-galvanizing steel objects of various kinds, particularly steel strip, by immersing them in a bath of molten metal, the process consisting of a single, simple and comparatively inexpensive continuous operation which prevents the formation of spangle on the hot-galvanized strip and at the same time allows a variety of surfaces to be obtained, according to choice, for example a smooth surface, a matt surface, a grained surface or a burnished surface, whose structure is durable.

The process according to the invention is characterized essentially in that the strip is subjected, after it leaves the zinc bath, and in the case of the continuous process mentioned above, after it leaves the coating rolls, to an abrupt cooling by a dry method.

In one version of the process according to the invention the abrupt cooling by a dry method is effected at a position about half-way between the surface of the metal bath and the region where the spangle begins to appear, but the abrupt cooling can if desired be effected at a position below this.

In both cases, the appearance of the surface of the product resembles that of cold-rolled steel, and that of steel electroplated with zinc, but the product produced by the process according to the invention has better anti-corrosive qualities than cold-rolled steel, and its production cost is considerably less than that of steel electroplated with zinc.

The process provides the following advantages, among others:

(1) The process in no way changes the chemical composition of the coating and does not impair its adhesion to the metal support.

(2) The process decreases the thickness of the zinc layer required to obtain a given anti-corrosive effective thickness.

In its wider aspect this improvement can be applied to any steel object coated with zinc by hot-galvanization.

The invention also includes a galvanizing apparatus for performing the process mentioned above.

The apparatus is of the kind which comprises a galvanizing pot to contain a bath of molten metal consisting essentially of zinc, and comprises furthermore two coating rolls partly immersed in the bath, the strip passing between these two rolls where it leaves the bath, and the apparatus is characterized by the fact that there are two cooling rolls or cooling cylinders between which the coated strip passes after leaving the pot and after passing between the coating rolls, there being means for keeping these cylinders at a temperature below that of the bath of molten metal.

In a first version of the invention, the cylinders are hollow and have at their ends connecting means which allow the cylinders to be included in a cooling circuit, the cooling medium being preferably water, so that the surfaces of the cylinders, and therefore the galvanized strip, can be kept at a temperature below that of the molten zinc.

The pressure contact between the internally cooled rolls

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and the galvanized strip prevents spangle from forming, and in a single operation entirely eliminates any tendency for spangle to form. If it is desired to give the galvanized strip a particular kind of surface, for example frosted, burnished, grained or the like, this is done by using cooling cylinders whose surfaces have the desired character. In this way in a single operation (in a single pass) spangling is prevented and at the same time the strip is given the desired appearance.

There is no limit to the type of surface obtained. This depends only on how the cylinders have been processed before use. A further advantage obtained is that the mechanical action of the rolls on the galvanized strip makes the layer of zinc more homogeneous and more uniform in thickness, with the result that for a given degree of anti-corrosive protection the thickness of the coating can be less. This is because it is generally recognized in the customary process of galvanizing, in which spangling is produced, that the anti-corrosive quality of the coating is determined exclusively by the least thickness of the layer occurring at certain locations.

The applicants have found that the good results obtained using given cylinders depend on a number of parameters, for example the following—the thickness of the strip, the thickness of the coating on each side, the velocity of advance of the strip, the chemical composition of the zinc bath and its temperature, and the ambient conditions. In order to allow adjustment of the apparatus as defined above to suit the parameters of the particular galvanizing operation it is proposed according to the invention that the apparatus shall be equipped with means for adjusting the position of each cylinder, both vertically and horizontally, so that the gap between the cylinders can be adjusted during operation to be either equal to or less than the thickness of the coated strip advancing between the cylinders.

The initial vertical adjustment in position, above the level of the zinc bath, of the mechanical supporting assembly for the rolls is determined by the height at which the spangling begins to appear on the strip. The height of the line of contact between the roll and the strip is in practice adjusted to be a predetermined distance below the region where spangling first appears, the precise distance depending on the result desired this distance being halfway between the surface of the bath and the region where spangling usually begins.

Further characteristics of the apparatus according to the invention will be derived from the description now given, as an example, on the basis of the accompanying drawings in which:

FIG. 1 is a diagrammatic representation of a first embodiment of the invention, in which the horizontal distance between the cylinders is adjustable.

FIG. 2 is a diagrammatic representation of a part of another version of the invention in which the cylinders can be adjusted in position both vertically and horizontally.

FIG. 2a shows an arrangement whereby the cylinders can be adjusted in position independently the arrangement being in other respects as shown in FIG. 2.

FIG. 3 shows a variant of the arrangement for horizontal adjustment of the cylinders.

FIG. 4 is a section through a galvanized steel strip, showing spangling in process of development.

FIG. 5 is a section through a galvanized strip which has been coated with a uniform layer of zinc, with no spangles, by the process according to the invention.

FIGS. 6, 7 and 8 are detailed representations of the apparatus shown diagrammatically in FIG. 3. FIG. 6 is an end elevation showing the mechanism controlling the cylinders, FIG. 7 is a section along the line VII—VII of FIG. 6 and FIG. 8 is a section along the line VIII—VIII of FIG. 6.

In FIG. 1 the steel strip 1 arriving from the treatment furnace passes over the guide roll 2 and then down

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through the chute 3 into the bath of molten zinc 4, in which the strip passes under the sinker roll 5 and then up (in the direction of the arrow F) between the two coating rolls 6 and 7, which determine the load of zinc on the strip kilograms per square metre). Reference 1' designates the coated strip. Above the coating rolls 6 and 7, there are, according to the invention, two cooling rolls 8 and 9 which are connected (not shown in the drawing) to a cooling circuit through which there flows a cooling liquid to keep the temperature of the rolls below that of the molten zinc.

The distance between the cooling cylinders 8 and 9 is adjustable. For example these cylinders can be moved outwards into the positions 8' and 9'.

The cooling rolls 8 and 9, when adjusted in position are supplied with cooling fluid and then brought into contact with the strip. The line of contact between the rolls and the galvanized strip is situated below the region where spangling usually appears, preferably approximately halfway between this region and the surface of the bath 4.

As shown in FIG. 2, each cylinder 8 and 9 is supported by a mechanism which allows adjustment of the height of the cylinder above the surface of the zinc bath 4 and above the free surface of the bath 4, and furthermore allows adjustment of the distance apart of the cylinders in the vertical and in the horizontal plane.

For this purpose, each cylinder 8 and 9 is mounted to rotate in a bearing block 10 and 11 respectively, each of which provides at 12, 13 a passage for the cooling fluid. The bearing blocks 10 and 11 are adjustable in position vertically by means of screw-thread shafts 14 and 15 which are actuated by handwheels 16 and 17. The shafts 14 and 15 rotate in bearings in extensions 18 and 19 of two upright members 20 and 21, which at the same time are slide rails for guiding the bearing blocks 10 and 11 in their vertical movements. Uprights 20 and 21 are themselves mounted on lower blocks 22 and 23 capable of sliding horizontally on base blocks 24 and 25 which are themselves anchored to supports 26 and 27. Supports 26 and 27 are adjustable in height by means not shown in the drawing, for example by hydraulic jacks. The lower blocks 22 and 23 are traversed by screw-threaded shafts 28, 29 actuated by handwheels 30, 31.

Thus the cylinders 8 and 9 are adjusted in position horizontally by means of handwheels 30 and 31 and vertically by means of the handwheels 16 and 17.

The threaded shafts 14, 15, 28 and 29 can if desired be actuated independently. For example the cylinder 9 can be moved upwards to bring its axis above that of the cylinder 8, as shown in the broken lines in FIG. 2. Furthermore, the two cylinders 8 and 9 can if desired be staggered in position vertically and adjusted horizontally in such fashion that the horizontal projection of the distance between their axes is less than the sum of the two radii of the cylinders. In this case, as represented diagrammatically in FIG. 2a, in which the cylinder 8 is lower than the cylinder 9, the strip 1 curves around between the two cylinders and the surface of the strip which is in contact with the lower cylinder, that is to say the cylinder 8, is the reference surface, that is to say the surface of higher commercial quality.

FIG. 3 shows a variant of the arrangement of FIG. 2 and in these two figures the same parts have the same reference numbers. In FIG. 3 the two shafts 28 and 29 are of one piece and are actuated by a single hand wheel 30, the threads running in opposite directions, so that the cylinders 8, 9 approach each other or recede from each other, according to the direction of rotation of the hand wheel 30. However, the cylinders 8, 9 are still adjusted vertically independently of each other.

FIG. 4 is a diagrammatic cross-section of a steel strip 32 coated with a zinc layer 33 which is spangled as indicated by the thicker regions A alternating with thinner regions B, these thickness differences being characteristics of spangling. In a galvanized sheet of this kind, made by

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the customary processes, the lesser thickness B is used as the technical and commercial criterion for the anti-corrosive quality of the sheet, even though there are regions A where the zinc layer is thicker.

Using the apparatus described above the anti-corrosion coating is evened out by the passage of the strip between the cylinders 8 and 9, the thickness of the layer being uniformly x, a value between A and B. For a given anti-corrosive quality of the sheet, a galvanized sheet made according to the invention has a lesser load of zinc, compared to a sheet galvanized by the customary method and consequently the cost of production is lower in regard to the consumption of zinc.

FIGS. 6 to 8 show a practical version of the apparatus in detail based on the arrangement shown diagrammatically in FIG. 3.

FIG. 6, which is an end elevation of the apparatus shows the two cylinders 8 and 9, their axes being perpendicular to the plane of the paper. Each cylinder has at each end a mechanism for vertical adjustment in position, indicated as a whole by the letter C; and a mechanism for horizontal adjustment in position, indicated as a whole by the letter D.

The mechanism C, for vertical adjustment in position comprises an upright member 33 which supports a vertical guide rail 34 of dovetailed cross-section. In the vertical guide rail 34 there slides up and down block 35 which has an extension 36 in the form of a cup which contains a bearing 37 in which rotates journal 38 of the cylinder 9. The cup 36 (see FIG. 8) is closed by a cover 39 secured by bolts 40 which are shown in FIG. 6 but not in FIG. 8 in order not to overload the latter. The journal 38 is continued, towards the left in the drawing, by an extension 40 of a lesser diameter on the end of which is mounted a connection of known kind for admitting water, this connection comprising a part 41 fixed to the extension shaft 40 and a part 42 connected to waterpipe 43. This water connection is arranged so that the part 41 rotates with the cylinder 9, whereas the part 42 remains stationary. Water passes from the pipe 43 into the cylinder 9, there being sealing means between the parts 42 and 41.

The sliding block 35 has an internally screw-threaded drilling 44 in which rotates externally screw-threaded shaft 45, which rotates in a bearing in head 46 of the upright 33 and supports hand wheel 47. Threaded shaft 45 has two locating collars 48 and 49 on either side of bearing head 46, so that the shaft 45 can rotate but cannot move axially. Above collar 49 there is mounted on the shaft 45 a chain sprocket wheel 50 over which passes an endless chain 51.

The cylinder 9 is supported by two mechanisms C and D, partly shown in FIG. 8, and the cylinder 8 is also supported by two mechanisms C and D. The mechanism C on the right in FIG. 6 has the same index numbers as that on the left. Chain 51 can if desired pass around four sprocket wheels (not all shown in the drawing), or alternatively there can be a second chain 51 passing over the sprocket wheel 50 and over the corresponding sprocket wheel of the mechanism supporting the other journal of the cylinder 9.

In the first case, rotation of the hand wheel 50 and the shaft 45 causes all the other corresponding shafts to rotate at the same time, with the result that all the sliding blocks 35 are adjusted in height simultaneously, and the cylinders 8 and 9 are adjusted in height, simultaneously.

In the second case the two cylinders 8 and 9 are adjusted in height independently.

Adjustment mechanism D for each journal of the cylinders 8 and 9 is arranged as follows:

The upright member 34 is mounted on a lower member 52 capable of sliding horizontally in a stationary guide member 53. Member 52 has an internally threaded drilling 54 in which there rotates an externally threaded

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shaft 55, which is itself prevented from moving axially by two locating collars 56 and 57. On one end of shaft 55 there is mounted a hand wheel 58, and on the other end a ball joint 59 which is also connected to corresponding shaft 58' of the mechanism D for the cylinder 9. The two shafts 58 and 58' are screw-threaded in opposite directions.

When the mechanism is in operation rotation of the hand wheel 58 moves the parts 52 towards each other or away from each other, as the case may be, and consequently moves the upright members 34 and the journals 38 of the cylinders 8 and 9 correspondingly.

A chain 60 can connect the hand wheel 58 mounted on the shaft 55 with sprocket wheel 61 of the mechanism D shown at the right and near the bottom in FIG. 8, so that the cylinders 8 and 9 can be made to approach each other or recede from each other by actuating only one of the handwheels 58 or 58'.

However, in view of the fact that each shaft has its own hand wheel the vertical and horizontal adjustments can be effected independently.

Using an apparatus as shown in FIG. 6 to 8, applicants have provided a galvanizing apparatus having the following parameters and this apparatus has produced galvanized sheet without any spangling.

Thickness of strip after coating—0.6 mm.

Width of strip—1000 mm.

Throughput of galvanized sheet—4 metric tons per hour

Linear velocity of strip—14.20 metres/minute

Temperature of zinc bath—452° C.

Load of zinc on first surface—150 grammes/m.², on second surface—170 grammes/m.²

Additions to zinc bath:

Al—0.120%

Pb—0.230%

Fe—0.026%

Cd—0.014%

Cu—0.0008%

In—0.009%

the remainder being Zn.

Ambient temperature—35° C.

Height of normal spangling region above the surface of the zinc bath—3.00 m.

The process was performed using the following operating conditions:

Diameter of cooling rolls—150 mm.

Surface of roll on granulating table—150 to 160 micro-inches

Temperature of cooling liquid (water)—15° C.

Temperature of roll surface in operation—40° C.

Distance between the generator of the lowest roll and the zinc bath—1450 mm.

Vertical height between the axis of the lowest roll and that of the upper roll—12 mm.

Horizontal distance between the axes of the two rolls—150.3 mm.

In this operation the apparatus directly produced a galvanized strip entirely without spangle and having a uniform and finally burnished surface appearance, allowing the strip to be used without any further finishing process (skin-pass, brushing or the like) directly for decorative purposes. Alternatively it could be given a coat of paint or a synthetic plastic or other coating.

We claim:

1. A process for hot galvanizing a strip of steel consisting in immersing the strip of steel in a molten bath having zinc as its base constituent and in subjecting the coated strip before the coating begins to crystallize, to a cooling down, by a dry method, to a temperature below that at which the coating would normally crystallize whereby such coating is free of any spangle.

2. A process according to claim 1 wherein the sudden cooling of the coated strip by a dry method is effected

at a height substantially half-way between the free surface of the metal bath and the region where spangling due to crystallization would normally appear.

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