

- [54] APPARATUS AND METHOD FOR
OBTAINING UNIFORM COATING
THICKNESS
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3,773,013.
- [52] U.S. Cl. 117/102 M, 117/19, 117/114 A
- [51] Int. Cl. B05c 11/10
- [58] Field of Search 117/102 M, 19, 114 A;
118/63 X, 1

- [56] **References Cited**
UNITED STATES PATENTS
- 3,459,587 8/1969 Hunter et al. 117/102
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Attorney, Agent, or Firm—Joseph J. O’Keefe; John I.
Iverson; Robert M. Jones

- [57] **ABSTRACT**
- The weight and distribution of a metal coating on a vertically moving strip are controlled by streams of steam directed downwardly and across the face of the strip as it leaves a bath of molten coating metal.
- 5 Claims, 5 Drawing Figures**

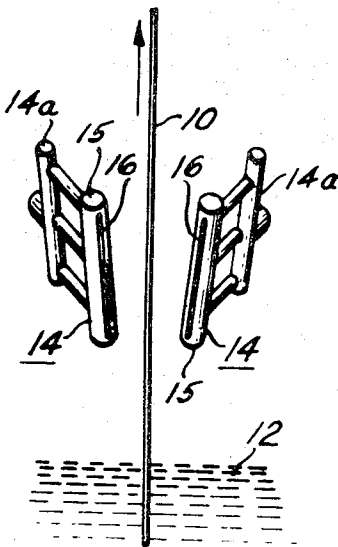


FIG. 1

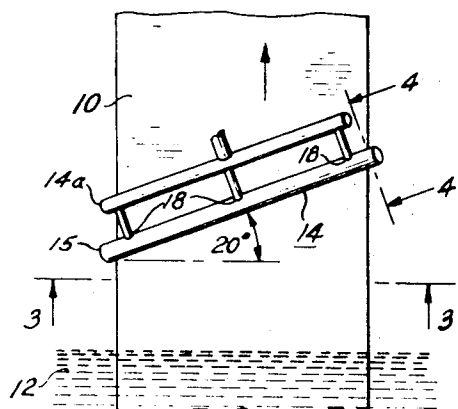


FIG. 2

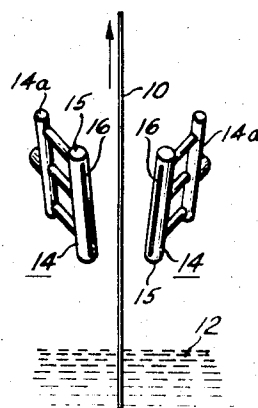


FIG. 3

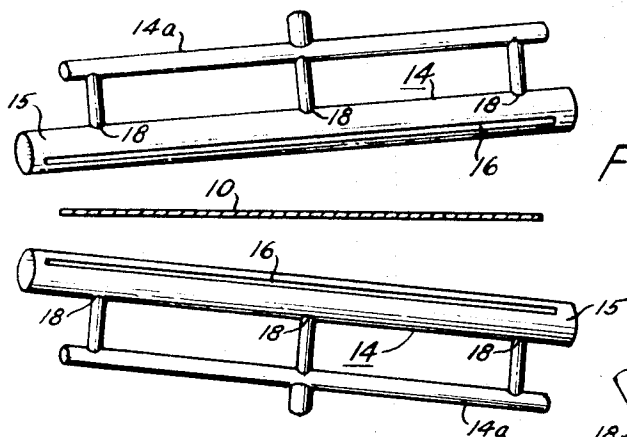


FIG. 5

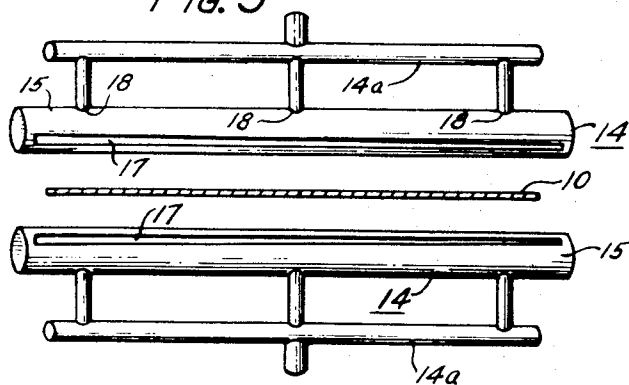
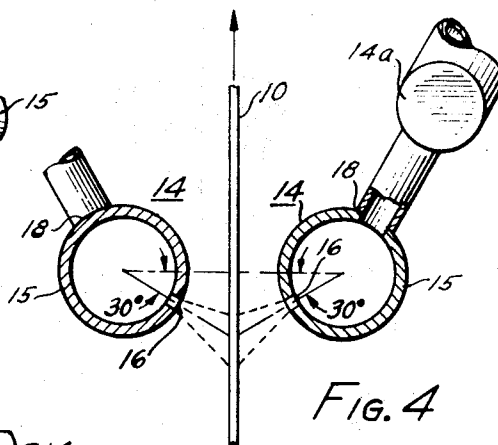


FIG. 4



APPARATUS AND METHOD FOR OBTAINING UNIFORM COATING THICKNESS

This is a division of application Ser. No. 223,535, filed Feb. 4, 1972, now U.S. Pat. No. 3,773,013.

BACKGROUND OF THE INVENTION

This invention relates to an apparatus and a method for producing a coated metal strip characterized by a coating of uniform thickness. More particularly, it relates to a coating die which directs a stream of gas downwardly and across the face of the strip as it leaves a bath of molten coating metal to control the weight and the uniformity of the thickness of the coating on the strip.

It is broadly old to use fluid streams such as gas, e.g. air or steam, for controlling the thickness, or weight, of a coating on one or both sides of a steel strip as the strip emerges from a bath of molten coating metal, e.g. zinc. The apparatus for directing the stream of gas toward the strip is generally referred to as a coating die, and may comprise conduit means, e.g. a pipe, having a source of gas connected thereto through a manifold. The pipe is provided with an exhaust slot along its length. Typically, such a prior art coating die was disposed horizontally and was provided with an exhaust slot of constant width, inclined downwardly whereby the stream of fluid emitted from said slot is directed. Coated steel strip wiped by such a die was generally characterized by a non-uniform coating thickness, the thickness being at times as much as 20% greater at the sides than at the middle of the strip.

It is an object of this invention to provide an improved apparatus and method for obtaining a more uniform coating thickness.

SUMMARY OF THE INVENTION

It has been found that the characteristically heavier coatings at the sides of strip wiped by prior art die arrangements are caused by turbulence resulting from gas collisions at the edges of the strip. I have discovered that such turbulence can be minimized by providing a pair of coating dies in registry on opposite sides of a vertically moving strip as it leaves the coating bath, each coating die comprising a manifold connected to conduit means extending transversely of, and overlapping the side edges of the strip, the conduit means being angularly disposed relative to the horizontal whereby one end of the die is at a greater distance from the bath than the other end. Each of the conduit means is provided with an exhaust slot along the length thereof whereby a narrow stream of fluid is directed out of the exhaust slot downwardly across the face of the strip. The force per unit area with which the stream impinges on the strip progressively decreases as the height of the point of impingement of the stream increases.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevational view of the coating dies relative to the strip being coated.

FIG. 2 is an end elevational view of the apparatus shown in FIG. 1.

FIG. 3 is an enlarged sectional view taken along the lines 3—3 of FIG. 1.

FIG. 4 is an enlarged sectional view taken along the lines 4—4 of FIG. 1.

FIG. 5 is an enlarged bottom plan view of an alternative embodiment of the coating dies of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

As shown in FIG. 1, a steel strip 10 is leaving a bath 12 of molten zinc. The strip is passing vertically upwardly through a pair of coating dies 14, only one of which can be seen in FIG. 1 since the dies 14 are disposed in registry on opposite sides of the strip. As can be seen, each die 14 makes an angle of about 20° with a line perpendicular to the edge of the strip.

As is shown in FIGS. 2 and 3, each die 14 comprises a manifold 14a and conduit means 15 provided with an exhaust slot 16 along the length thereof through which a stream of fluid is directed downwardly toward the face of the strip. Preferably, the fluid is steam if the coating metal is molten zinc. Means (not shown) is provided for supplying the steam to each manifold 14a, and preferably the manifold 14a is connected to several points 18 intermediate the ends of the conduit means 15. The exhaust slot 16 is of constant width, e.g. 0.015 in., and the steam is supplied to the manifold 14a at an inlet pressure of 40 psi., for example, for a coating weight of 2½ oz. per square ft., although the proper inlet pressure is dependent upon the desired coating weight and the distance of the conduit means 15 from the face of the strip. Typically, inlet pressures may vary from 40 to 95 psi.

Exhaust slot 16 is inclined downwardly so that the steam emitted therefrom is directed downwardly toward the face of the strip. Preferably, as is shown in FIG. 4, the plane passing through the centerline of the stream of steam emitted through the slot 16 makes an angle of about 30° with a plane through the axis of the conduit means 15 and normal to the face of the strip.

With an exhaust slot of constant width, it is essential that the lower end of the die 14 be positioned closer to the strip than is the upper end of the die. The molten zinc runs down the strip as it passes from the bath and, as the distance from the bath increases the coating, until it solidifies, becomes thinner. Hence, the steam is required to have less force per unit area as the distance from the bath increases if the coating is to be of uniform thickness across the strip face. For a strip 48 inches wide, for example, the conduit means 15 is preferably ½ inch from the strip at the lowermost point, and 1 inch from the strip at the uppermost point.

Alternatively, as is shown in FIG. 5, the dies can be positioned parallel to the plane of the strip if the exhaust slot 17 is tapered whereby the width of said slot 17 decreases as the height of said die increases. This arrangement also results in a larger force per unit area against the strip 10 where the steam from the lower end of the die impinges on the strip, the force per unit area progressively decreasing as the point of impingement increases in distance from the surface of the bath. Typically, the width of the slot 17 progressively decreases from 0.025 inch at the lower end of the die to 0.015 inch at the upper end thereof.

As a result of the above-described die construction and arrangement relative to the strip being coated, the uniformity in coating thickness is much improved over prior art coating dies. For example, I have produced galvanized strip having coatings which varied from 2.12

oz./ft.² at the center of the strip to a maximum of 2.40 oz./ft.² at the sides thereof with a pair of dies making an angle of 20° with a line perpendicular to an edge of the strip and having a constant width exhaust slot of 0.020 inch disposed whereby steam emitted there-
 through is directed downwardly at 30°. The variation in coating thickness, which is about 11.7 percent, was the average of 55 tests. I have also produced galvanized strip having coatings which varied from 2.08 oz./ft.² at the center of the strip to a maximum of 2.18 oz./ft.² at the sides thereof with a pair of dies making an angle of 20° with a line perpendicular to an edge of the strip and having a tapered exhaust slot of 0.015-0.025 inches disposed whereby steam emitted therethrough is directed downwardly at 30°. This variation in coating thickness, which is about 4.6 percent, was the average of 50 tests. On the other hand, a pair of prior art dies, horizontally disposed, having a constant width exhaust slot of 0.015 inch disposed whereby steam emitted therethrough is directed downwardly at 13°, resulted in coatings which varied from 2.03 oz./ft.² at the center of the strip to a maximum of 2.60 oz./ft.² at the sides thereof. This variation, which is about 20.4 percent, was the average of 35 tests. Thus, as a result of the invention, coating uniformity can be improved by as much as a factor of 4.

While the invention has been described in connection with conventional galvanizing, it also has utility in the one-side galvanizing process. In this case, only one die would be used, and would be positioned so as to direct steam toward the side of the strip having the zinc coating thereon.

I claim:

1. An improvement in the method of controlling the thickness of a metal coating on a vertically moving strip

as it leaves a bath of molten coating metal, comprising directing a narrow stream of fluid angularly downwardly across the face of said strip on each side thereof, the streams on opposite sides of said strip being in registry, the height of the point of impingement of said fluid increasing and the force per unit area of said fluid decreasing as said point of impingement progresses from one edge of the strip to the other.

2. An improvement as recited in claim 1, in which the point of impingement of said fluid increases at an angle of about 20° with a line perpendicular to an edge of the strip, as said point progresses from one edge of the strip to the other.

3. An improvement as recited in claim 1, in which the plane passing through the centerline of said stream of fluid makes an angle of about 30° with a plane normal to the face of said strip and passing through the centerline of the area impinged upon by said stream.

4. An improvement as recited in claim 2, in which the plane passing through the centerline of said stream of fluid makes an angle of about 30° with a plane normal to the face of said strip and passing through the centerline of the area impinged upon by said stream.

5. An improvement in the method of controlling the thickness of a metal coating on a vertically moving strip as it leaves a bath of molten coating metal, comprising directing a narrow stream of fluid angularly downwardly across the face of said strip, the height of the point of impingement of said fluid progressively increasing and the force per unit area of said fluid progressively increasing and the force per unit area of said fluid progressively decreasing as said point of impingement progresses from one edge of the strip to the other.

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