United States Patent

Pierson

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[54] **APPARATUS FOR IMPROVING COATING CONNECTRICITY ON METALLIC COATED STRANDS**

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Related U.S. Application Data

[62] Division of Ser. No. 806,221, March 11, 1969, Pat. No. 3,632,392.

[52] **U.S. Cl.**.....**118/63**, 15/306 R, 34/160

[51] **Int. Cl.**.....**B05c 11/06**

[58] **Field of Search**.....118/62, 63, 401, DIG. 78, DIG. 19, 118/DIG. 22; 34/155, 156, 160; 15/306 A, 316 R

[56] **References Cited**

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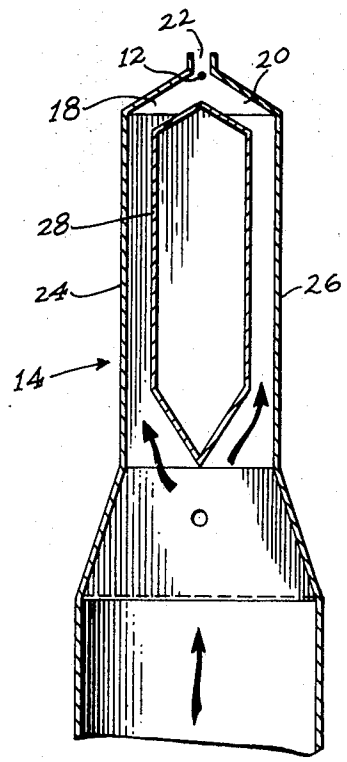
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[57] **ABSTRACT**

Fluid nozzle of inverted Y-shape in cross section wherein coated strand is passed through the intersection of the arms and the vertical stem of the Y in a horizontal path of travel, and fluid under pressure is applied to the arms of the Y, the stem being vented to atmosphere.

8 Claims, 3 Drawing Figures



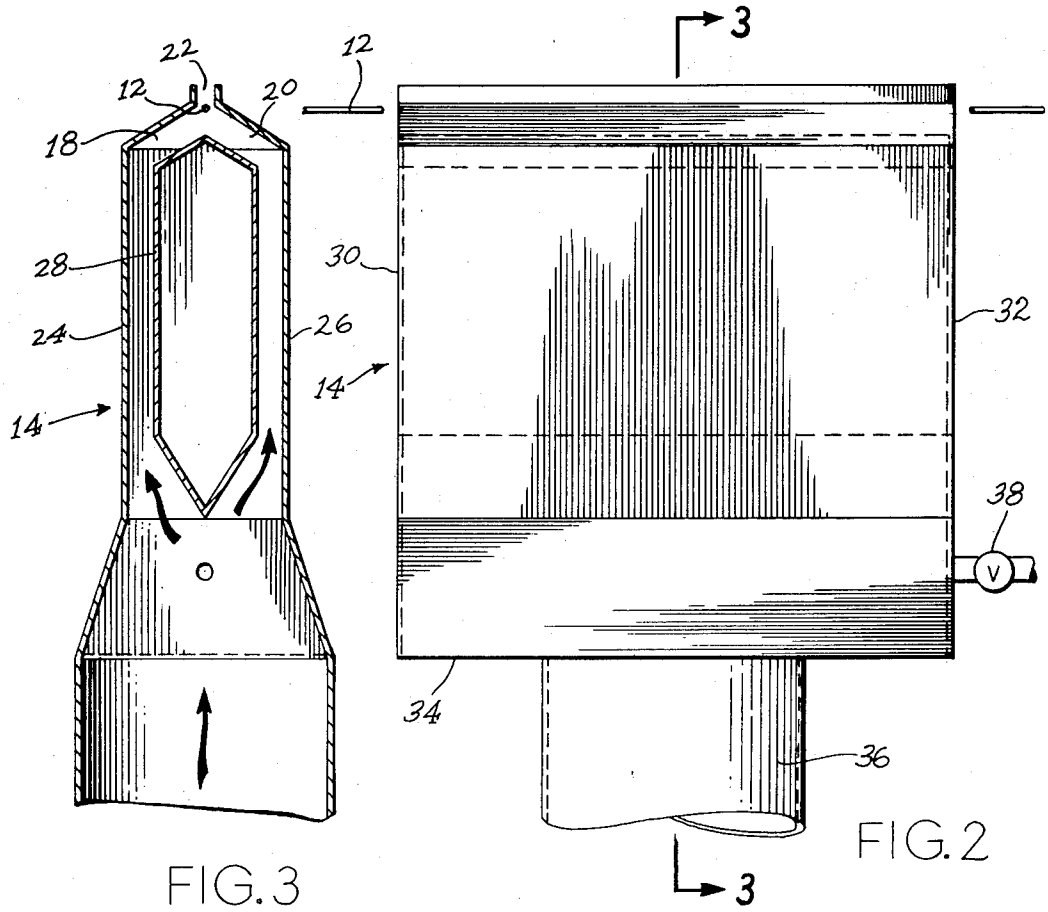


FIG. 3

FIG. 2

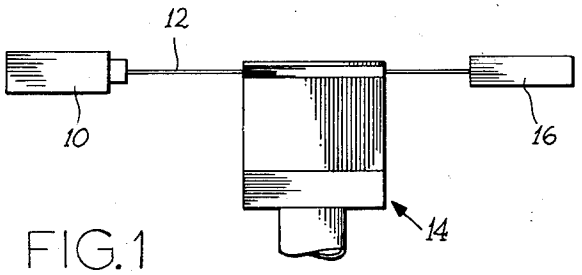


FIG. 1

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APPARATUS FOR IMPROVING COATING CONNECTRICITY ON METALLIC COATED STRANDS

CROSS-REFERENCE TO RELATED APPLICATION

This is a division of application Ser. No. 806,221 filed on Mar. 11, 1969 in the name of Marvin B. Pierson, now U. S. Pat. No. 3,632,392

BACKGROUND OF THE INVENTION

This invention relates specifically to the metallic coating of a ferrous metal base strand, such as wire, tubing, or the like, wherein the strand passes through the molten coating bath in a horizontal path of travel.

To meet varying metallic coating problems, the prior art has developed processes wherein the strand emerges from the metallic coating bath in either a horizontal path of travel or in a vertically upward path of travel. It is known, for example, that in the coating of steel tubing or the like which cannot readily be bent, a horizontal path of travel is necessary, and the instant invention is directed exclusively to this type of operation.

It is further recognized in the art that metallic coating operations of this type are faced with a severe problem in achieving concentricity of the coating with respect to the base metal strand. The so-called "concentricity ratio," which may be defined as the ratio between maximum coating thickness and minimum coating thickness normally experienced in horizontal coating according to the prior art, is on the order of 10 in the case of a 0.50 ounces per square foot aluminum coating. It will be recognized that this concentricity ratio varies with the coating weight and the diameter of the base metal strand.

The prior art has experimented for many years with various devices for eliminating or reducing the concentricity problem in horizontal coating operations. For example, it is known to use small, relatively high velocity jets blowing upward under the wire upon emerging from the coating bath. The art has also endeavored to utilize water currents for the same purpose, with little or no effect. It was discovered that the high velocity jets and vertical blower nozzle would produce a light bottom coating and heavy "sides." In other words, the molten coating was redistributed, but the uniformity was not substantially improved.

It has also been known to use two or more such jets directed at the underside of the strand in various angle combinations. These efforts have also proved unsuccessful.

SUMMARY OF THE INVENTION

The apparatus of this invention is a fluid nozzle in the form of an inverted Y in cross section, with the path line of the strand being at substantially the intersection of the arms and the vertical stem of the Y. Fluid under relatively low pressure (specified hereinafter) is applied to the arms of the Y, with the stem being vented to atmosphere.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic illustration of a portion of a horizontal metallic coating operation, including the apparatus of this invention.

FIG. 2 is a side elevational view of the apparatus of this invention.

FIG. 3 is a cross sectional view taken along the line 3—3 of FIG. 2.

DESCRIPTION OF THE PREFERRED EMBODIMENT

As indicated at the outset, this invention is concerned with an apparatus for improving the coating concentricity in a horizontal hot dip metallic coating process.

Hot dip metallic coating processes include a preliminary preparation of the surface of the base metal strand to render it receptive to the molten coating metal. These preparatory steps do not per se form a part of this invention, but it will be understood that such procedures must be carried out to insure success with the apparatus of this invention. Exemplary preparatory procedures now in widespread commercial use are described in detail in various United States Patents in the name of Sendzimir, including, for example, U. S. Pat. No. 2,110,893. This particular patent, and others by the same inventor, contemplate preparation of the surface of the base strand by successive heating in an oxidizing atmosphere and then in a reducing atmosphere. It is recognized in the art that over and above the preparatory steps taught in the foregoing patents, adequate surface preparation of a wire will often require a pre-pickling step in order to remove drawing compounds and the like which have been embedded in the strand surface.

After the reducing heat treatment, the strand is led directly and without reexposure to atmosphere to a bath of molten coating metal. As already indicated, the surface preparation is such that a thorough and immediate wetting of the strand by the coating metal takes place.

In the case of the metallic coating of wire, tubing, or the like with a horizontal path of travel through the coating bath, it will be understood that the base strand emerges horizontally from an opening or aperture in the wall of the coating metal bath. It draws with it a quantity of still molten coating metal. It is well recognized in the art that the normal forces of gravity tend to cause the still molten coating to sag prior to the solidification process, resulting in very poor concentricity between the base metal strand and the coating metal.

For purposes of this application, coating concentricity is measured in terms of the concentricity ratio, which is equal to the maximum coating thickness divided by the minimum coating thickness. Prior art horizontal coating operations normally experience a concentricity ratio on the order of 10 for a 0.50 ounces per square foot of wire surface pure aluminum coating.

Referring now to FIG. 1, a metallic coating bath is indicated schematically at **10**, and the strand being coated is indicated at **12**. It will be observed that the strand is emerging from the coating bath in a horizontal path of travel.

The fluid nozzle of this invention is indicated generally at **14** in FIG. 1, and is shown in more detail in FIGS. **2** and **3**. It will be noted that the nozzle **14** is spaced a short distance away from the exit end of the coating bath **10**, both for convenience and to permit the formation of a small amount of surface oxide on the molten coating.

After emerging from the fluid nozzle 14, the coated strand is passed into a water quench bath indicated at 16. Obviously, this water quench serves to quickly solidify the molten coating.

Turning now particularly to FIG. 3, it will be observed that the upper portion of the fluid nozzle is, in cross section, in the shape of an inverted Y, the arms of the Y being designated at 18 and 20 and the vertical stem of the Y being indicated at 22. The arms of the Y 18 and 20 will be connected to a suitable supply of fluid under pressure as explained hereinafter, and the vertical stem of the Y 22 will be vented to atmosphere.

As will be apparent by examining FIGS. 2 and 3 of this application together, the fluid nozzle 14 includes the outer walls 24 and 26 shaped in cross section as shown in FIG. 3, and the internal divider 28. These components are each secured to the end walls 30 and 32 in the proper position to provide the relationship seen in FIG. 3. Of course, the fluid nozzle also includes the bottom member 34 which is provided with an aperture for connection to the fluid supply passage 36. If desired, a pressure tap for sensing or measuring the pressure can be added to the nozzle 14 as indicated at 38. The pressure can be regulated by a valve at the fluid inlet (not shown).

It was indicated earlier in this specification that the prior art has unsuccessfully attempted to utilize two or more fluid jets directed at the underside of the strand in various angle combinations. While not wishing to be bound by theory, applicant believes that the success of this invention is due in large part to the presence of the vertical stem 22 of the Y and to the angled relationship between the two jet streams acting on the metallic coating. When the angle is correctly adjusted with respect to the position of the strand, some of the coating will be displaced from the bottom of the strands to the sides and the top of the strand. Unless there is a fluid vector component against the sides of the strand, the displaced coating will remain on the sides.

It will also be understood that the angle between the arms of the Y is significant. That is, the angle between the arms 18 and 20 will determine the force of air against the bottom of the strand relative to the force of air against the sides of the strand. The angle between the arms 18 and 20 may be varied between 90° and 150°. The preferred angle will be more limited; namely, between 110° and 130°.

In addition, it will be observed that the fluid nozzle 14 is elongate along the path of travel of said strand. Thus, the jet fluid streams directed angularly upward at the base of the strand, though acting at low pressure, are effective over a relatively long length. Once the coating has been redistributed with the nozzle 14, resagging of the coating does not occur prior to the quench because of the chilling effect caused by the fluid jet stream, and the increasing thickness of the oxide film covering the molten coating.

This invention has been utilized commercially in the production of a pure aluminum coated 0.089-inch ACSR wire. The entire nozzle 4 was 8 inches long (along the path of travel of the strand) and the wire traveled at 150 feet per minute. With reference to FIG. 3, the arms 18 and 20 of the Y were each three-eighths inches across, and the vertical stem 22 was one-fourth inch across. Plenum pressure was equal to 1.0 inches of water column, and the following coating thicknesses and concentricity ratios were obtained on six wires:

Max. inches	Min. inches	Concentricity ratio
0.00250	0.00125	2.0
0.00225	0.00125	1.8
0.00225	0.00075	3.0
0.00200	0.00100	2.0
0.00250	0.00100	2.5
0.00250	0.00100	2.5

This commercial utilization of the nozzle disclosed above has proven that certain factors are critical to achieve successful operation. First of all, the positioning of the wire within the Y is very important. It must be centered, and the top surface of the strand must not be lower than the lower end of the vertical stem 22 of the Y. It is quite satisfactory for the strand to project slightly (approximately one-half the strand diameter) into the stem of the Y.

A second very critical factor is the fluid pressure in the nozzle. The plenum chamber pressure should be maintained between approximately 0.4 and 1.2 inches of water column. Pressures both above and below the range set forth above result in a redistribution of the molten coating without an improvement in concentricity.

Finally, the exposure time of the coated strand to the jet streams of the nozzle of this invention is important. The exposure time must not be less than one-fourth second. Exposure times beyond 1 second exert no further beneficial effect on either concentricity or quality of the coating, but do not seem to have any detrimental effect.

It is believed that the foregoing constitutes a full and complete disclosure of this invention. Numerous variations and modifications may be made without departing from the scope and spirit of this invention, and no limitations are intended except as specifically set forth in the claims which follow.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. Apparatus for improving the concentricity of a metallic coating on a strand comprising:
   a. a fluid nozzle having, in cross section, an inverted Y-shape, said strand passing through said nozzle in a horizontal path of travel substantially normal to the plane of said cross section and at substantially the intersection of the arms and the vertical stem of said Y;
   b. means for supplying fluid under pressure to the arms of said Y; and
   c. a vent in said stem open to the atmosphere.

2. The apparatus according to claim 1 wherein the fluid under pressure is supplied to said arms of said Y at a pressure on the order of 0.4 to 1.2 inches of water column.

3. The apparatus claimed in claim 1 wherein said nozzle is elongate along said path of travel of said strand.

4. The apparatus claimed in claim 1 wherein the cross sectional area of said vertical stem is less than the cross sectional area of any one of said arms.

5. In a hot dip metallic coating operation wherein a base metal strand carries said metallic coating in a molten state in a horizontal path of travel, apparatus for improving the concentricity of said strand with respect to said base metal strand comprising:

a. nozzle means for directly two elongate fluid jet streams angularly upward at said strand, said jets being elongate along said path of travel of said strand and said jets converging at an angle of at least 90° and not more than 150°; and

b. said nozzle including single exhaust means extending vertically upward above said strand, and centered vertically with respect to said strand.

6. The apparatus of claim 5 wherein the cross sectional area of said exhaust means is less than the cross sectional area of any one of said elongate fluid jet streams.

7. The apparatus of claim 5 wherein said jets converge at an angle of between 110° and 130°.

8. In a hot dip metallic coating operation wherein a base metal strand carries said metallic coating in a molten state in a horizontal path of travel, apparatus for improving the concentricity of said strand with respect to said base metal strand comprising:

a. nozzle means for directing two elongate fluid jet streams angularly upward at said strand, said jets being elongate along said path of travel of said strand and said jets converging at an angle of at least 90° and not more than 150°; and

b. said nozzle including vertical vent means for said converged jet streams, the lower end of said vertical vent means being disposed at or below the top surface of said strand, the upper end of said vertical vent means extending above said strand.

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