

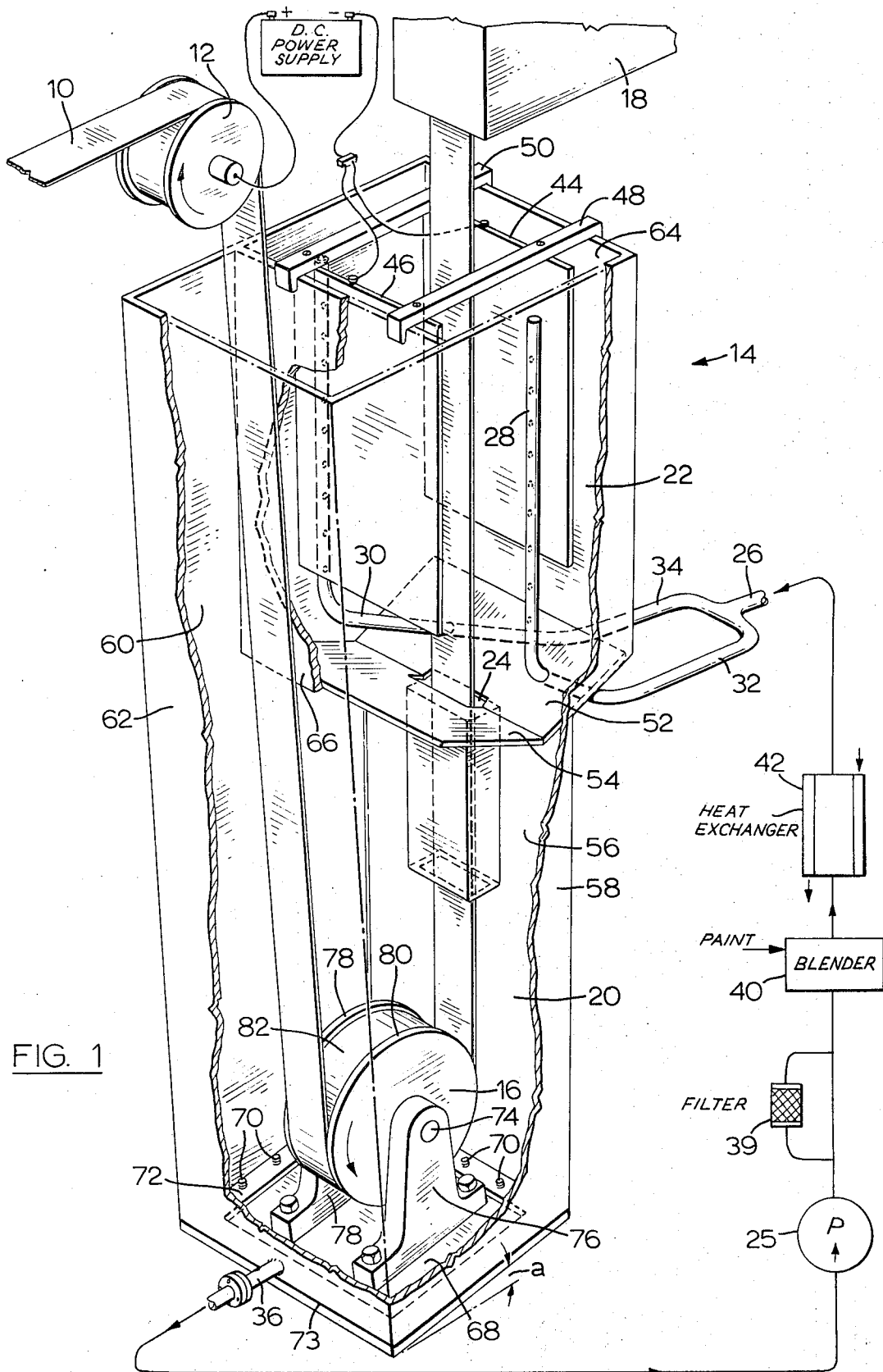
May 28, 1974

F. R. CROWNE ET AL

3,813,327

TANK FOR ELECTRO-COATING CONTINUOUS STRIP

Filed June 29, 1972



1

2

3,813,327

**TANK FOR ELECTRO-COATING
CONTINUOUS STRIP**

Francis R. Crowne, Rexdale, Ontario, Chiong-Heng Tan,
Mississauga, Ontario, and Martin A. Vandebroek,
Hamilton, Ontario, Canada, assignors to Abrex
Specialty Coatings Ltd., Oakville, Ontario, Canada

Filed June 29, 1972, Ser. No. 267,397

Int. Cl. B01k 5/02; C23b 13/00

U.S. Cl. 204—300

3 Claims

ABSTRACT OF THE DISCLOSURE

A tank for use in electro-coating strip as the strip moves through the tank continuously. The tank includes inner and outer chambers arranged so that the strip moves upwardly from the outer chamber through a passage and then through the inner chamber where the electro-coating takes place. The passage provides an electrical seal to prevent throw effects reaching the outer tank so that the coating applied to the strip can be controlled substantially within the inner chamber.

This invention relates to a tank for electro-coating electrically conductive strip as the strip moves continuously through the tank.

Electrodeposition or electro-coating has found wide uses for applying a paint coating to electrically conductive objects. Typically the object to be coated is first phosphate treated and then it is immersed in a tank containing a coating paint and water with suitable solubilizing agents. Next the object is connected to the positive side of a direct current supply and cathodes are immersed in the tank and connected to the negative side of the supply. When electrical current passes, negatively charged particles of paint deposit on the object producing a paint covering on the object.

Electro-coating produces a thin uniform film having inherently even coverage. This is mainly because as the paint is deposited it insulates areas of the object causing the paint to deposit more readily on uncovered areas until an even, relatively non-conductive coat covers the entire object. As the paint is deposited on the object, water is squeezed out of the deposited film by a process known as electro-endosmosis. Consequently, when the object is lifted out of the tank, it will be covered with approximately 95 percent paint and 5 percent water. The paint is then baked to remove the water and harden the paint.

Electro-coating has been used for painting strips of metal continuously. The strip is fed through a tank containing a suitable liquid and rollers are used to connect the strip electrically into a circuit such that the strip becomes the positive or anode and separate immersed cathodes form the negative inside the tank. Consequently, the strip is coated as it passes through the tank.

The strip passes over an input roller above a tank and then downwardly to a bottom roller immersed in the tank. Next, the strip passes about the bottom roller and upwardly passed cathodes and out of the tank around an output roller. Anodic connections to the strip cause electro-coating to take place in the tank. It has been found that there is a tendency in this arrangement for imperfections to be formed in the coating caused by a characteristic of the electro-coating known as "throw." The term "throw" is used to define the peripheral effects caused by the passage of electrical current. A prime effect is that the current tends to flow between the anode and the cathode in varying densities over a range with the greatest density occurring nearer to the cathode. Because of throw effects, although the cathodes are located be-

tween the bottom roller and the output roller, there is nevertheless a tendency for electro-coating to take place on the strip before the strip reaches the bottom roller. Consequently the bottom roller tends to collect particles of coating which are then transferred unevenly onto the strip.

In an attempt to eliminate these problems the lower roller was made with a V-shaped annular depression so that the strip in passing about the roller was supported at its edges only. Although this improved the results when using a relatively narrow steel strip, it proved unsatisfactory for wide strips and for relatively weak strips of aluminum.

A further tank has been used in an attempt to coat wider strips and weaker strips. In this type of tank the strip enters a chamber containing the cathodes through a seal at the bottom of the chamber and leaves the chamber through an open top. The seal is provided to limit possible current flow and hence throw effects outside the chamber and for this reason the seal can be referred to as an electrical seal although in this application the seal is also a mechanical seal. Although various seals have been used, there is nevertheless a tendency for the resulting film to have a variable thickness and to include surface blemishes. This is caused in part by sliding contact between the seal and the strip.

It is an object of the present invention to provide a tank for electro-coating strip as the strip moves continuously through the tank such that the outcoming strip is coated with a film having a relatively constant thickness and a minimum of blemishes.

It is a further object of the invention to provide an electrical seal for an electro-coating tank so that strip can be coated continuously as the strip moves through the tank, there being substantially no sliding movement between the strip and parts of the tank.

Accordingly, the invention provides apparatus for use in electro-coating electrically conductive strip as the strip passes through the apparatus, the apparatus comprising: means defining a chamber for containing electro-coating liquid; means defining an upwardly-extending passage providing access upwardly into the chamber; guide rollers positioned to guide moving strip upwardly through the passage and then through the chamber without contacting said passage defining means; means adapted to circulate the electro-coating liquid in the chamber; and electrical circuit supplying direct current and coupled electrically to the strip whereby the strip is anodic and including at least one cathode positioned in the chamber so that the strip is coated as it passes through the chamber; said passage having proportions such that throw effects are contained within the passage to effectively seal the chamber electrically; and means limiting flow of electro-coating liquid downwardly through said passage whereby a substantially constant level of electro-coating liquid is maintained in the chamber.

The invention will be better understood with reference to the drawing, in which:

FIG. 1 is a perspective view of a tank according to the invention and including diagrammatic detail of hydraulic and electrical circuits associated with the tank when electro-coating strip.

As seen in the drawing, electrically conductive strip 10, suitably cleaned and which may be phosphate treated or chromate treated as required, is fed over an input roller 12 into a tank 14, under a guide roller 16, and then out upwardly into a curing oven 18. The tank 14 includes an outer chamber 20 and an inner chamber 22 which is in communication with the outer chamber 20 by way of an electrical seal in the form of an elongated passage 24 through which the strip passes upwardly on its way to

the oven 18. The tank 14 is coupled to a hydraulic circuit and contains a liquid (not shown for clarity of drawing) consisting essentially of paint dissolved in water. The liquid is circulated through the hydraulic circuit continuously by a pump 25 which forces the liquid into the chamber 20 by way of an input pipe 26 which feeds manifolds 28, 30 through branch pipes 32, 34. Liquid leaves the tank by an outlet pipe 36 and the pump 25 forces the liquid through a bypass filter 39, blender 40 and heat exchanger 42 before the liquid again reaches input pipe 26. Any suitable electro-coating liquid can be used.

An electrical circuit is also coupled to the tank and includes a pair of cathodes 44, 46 which are suspended by insulators 48, 50 from the top of the inner chamber 22 such that the cathodes are spaced vertically from passage 24. These insulators and the cathodes 44, 46 can have any suitable form and be of any suitable material. However, the cathodes are preferably of stainless steel. A direct current electrical supply is coupled to the cathodes 44, 46 and to the input roller 12 so that the electrically conductive metallic strip becomes an anode in the electrical circuit.

Tank 14 is of a fabricated construction and is coated throughout by a suitable two component epoxy resin system. The bottom of chamber 22 is defined by a pair of inclined plates 52, 54 which meet in a V formation and define the upper end of passage 24. The remainder of the passage 24 is defined by fabricated structure dependent from the inclined plates of the chamber 22 and preferably attached to an upright lower wall 56 of the outer chamber for support. The proportions of the passage are such that the strip does not contact the sides of the passage in moving upwardly towards the output roller 18, and the length of the passage is determined according to the liquid being used, and other factors as will be described.

The tank includes the wall 56 which is dependent downwardly from the underside of inclined plate 52; upright side walls 58, 60; inclined wall 62 which is generally parallel to the strip running from roller 12 to roller 16; upper side wall 64 above wall 58 and dependent from the outer extremity of plate 52; and an upright intermediate wall 66 which together with plates 52, 54 separates the inner chamber 22 from the outer chamber 20. As previously described the only communication between these chambers is through passage 24 so that the liquid in circulating from manifolds 28, 30 must pass downwardly through passage 24 before reaching outlet pipe 36. Of course other passages can be provided for proper flow as required provided throw effects are not permitted from the inner to the outer tank.

Outer chamber 20 also includes a bottom plate 68 attached by upwardly projecting bolts 70 to a peripheral flange 72 extending inwardly from the lower extremities of respective walls 56, 58, 60 and 62. The flange is formed so that the plate 68 is inclined to the horizontal (as indicated by angle α) for biasing the liquid towards outlet pipe 36. This reduces possible accumulation of deposits and foreign matter in the chamber 20. A gasket or seal 72 is positioned between plate 68 and flange 72 to prevent liquid losses.

Guide roller 16 is mounted on an axle 74 between a pair of pedestal supports 76, 78 fixedly mounted on the plate 68. The axle runs in suitable sealed bearings. The form of roller 16 is similar to that of roller 12 and includes raised end lips 78, 80 for locating the strip 10 axially. These lips border a cylindrical central portion 82 on which the strip is supported.

It will be appreciated that the passage 24 has sufficient length to prevent electro-coating in the outer chamber. The form of the tank is such that the level of liquid in the inner chamber 22 is maintained by using a similar level in the outer chamber 20. If preferred a similar result can be achieved by using a suitable mechanical seal at the bottom of the passage to trap the liquid in the inner cham-

ber. The liquid circulation would then take place directly to and from this chamber and seepage past the seal can be drained off or collected in a tray below the inner chamber. This arrangement has the disadvantage that the mechanical seal will require frequent maintenance.

Reference is again made to FIG. 1 to describe the use of the tank 10. Hydraulic circulation is first established by starting pump 25 and the temperature of the liquid is brought to about 70-80 degrees Fahrenheit by suitable use of the heat exchanger or other means. Paint is fed to the blender 40 until the liquid includes about 10 percent by weight of solids. Next, the strip is started simultaneously with the connection of the electrical supply and coating commences. The time during which coating is taking place can be calculated from the speed of the strip and the height of inner chamber 22. Further if the characteristics of the power supply are known (from suitable meters in the circuit) the thickness of coating for a given liquid can be established from test results. Alternatively, the tank can be calibrated directly for a given speed of strip feed and electrical power supply characteristics.

The length of the passage 24 must be determined for a given coating operation. In a typical tank for treating phosphate steel strip having a width of 0.75 inches and a thickness of 0.015 inches at a speed of 60 feet per minute, the passage has a rectangular cross-section of 1.0 inches by 0.25 inches and is 8.0 inches long. Typically there will be a film build of 0.50 mils (i.e. 0.0005 inches) using a 130 volt direct current supply.

In another application of the invention aluminum strip of 1.0 inch width and 0.020 inch thickness was coated to a thickness of 1.0 mils at a speed of 50 feet per minute using an epoxy ester with a supply of 200 volts direct current. The passage had rectangular dimensions of 0.25 inches by 1.25 inches and was 15.0 inches long.

It will be evident that although the passage has been described as having a rectangular cross-section it will be changed when the strip is of a different cross-section. For instance when coating 18 gauge copper wire with epoxy ester at 100 feet per minute a passage of 0.5 inches diameter is used and the passage is 10 inches long. A film build of 0.9 mils can be achieved with a 175 volt direct current supply.

It will be appreciated that several strips could be fed through the tank in side-by-side relationship with suitable guide roller arrangements and a wider passage 24 to seal the chamber 22 electrically.

The description thus far has been of apparatus for depositing paint on the anode. Compositions are however, available for cathodic coating and the apparatus is equally useful with such coatings. When used with cathodic coatings the strip is negatively charged to become the cathode and the polarity of cathodes 44 is changed so that they are effectively anodes immersed in the tank. In general therefore, the cathodes 44 can be termed immersed elements and the strip and elements are then coupled electrically to a direct current electrical supply. The polarity of the strip and elements will depend on whether or not anodic or cathodic coating is to take place.

What we claim as our invention is:

1. Apparatus for use in electro-coating electrically conductive strip as the strip passes through the apparatus, the apparatus comprising:

- means defining a chamber for containing electro-coating liquid;
- means defining an upwardly-extending passage providing access upwardly into the chamber;
- guide rollers positioned to guide moving strip upwardly through the passage and then through the chamber without contacting said passage defining means;
- means adapted to circulate the electro-coating liquid in the chamber;
- an electrical system supplying direct current and coupled electrically to the strip and including at least one element positioned in the chamber and spaced

5

vertically upwards from the passage, the element being coupled electrically to the system to have a polarity opposite to that of the strip so that the strip is coated as it passes through the chamber;

said passage having proportions such that throw effects are contained within the passage to effectively seal the chamber electrically; and

means limiting flow of electro-coating liquid downwardly through the passage whereby a substantially constant level of electro-coating liquid is maintained in the chamber.

2. In apparatus of the type used for electrocoating electrically conductive strip as the strip passes through the apparatus and including a chamber adapted to contain electro-coating liquid, means adapted to guide the strip through the chamber; a hydraulic system for circulating the liquid in the tank; and an electrical system supplying a direct current and coupled to the strip and to an element immersed in the chamber and coupled to the electrical system to have a polarity opposite to that of the strip, the improvement wherein the apparatus further comprises: means defining an upwardly-extending passage spaced vertically downwards from the immersed element and providing access upwardly into the chamber, the passage being proportioned so that the strip passes upwardly through the passage without touching the means defining the passage, and the passage being proportioned to prevent throw effects outside of the chamber; and means limiting flow of electro-coating liquid downwardly through the passage whereby a substantially constant level of the electro-coating liquid is maintained in the chamber.

3. Apparatus for use in electro-coating electrically conductive strip as the strip passes through the apparatus, the apparatus comprising:

a tank including an outer chamber;

6

an inner chamber disposed within the outer chamber; means defining an upwardly-extending passage providing access upwardly from the outer chamber into the inner chamber;

guide rollers positioned to guide moving strip downwardly into the outer chamber to a position below the passage and then upwardly through the passage without contacting said passage defining means;

means adapted to circulate the electro-coating liquid in the inner chamber;

an electrical system supplying direct current and coupled electrically to the strip and including at least one element positioned in the inner chamber and spaced vertically from the passage, the element being coupled electrically to the system to have a polarity opposite to that of the strip so that the strip is coated as it passes through the inner chambers; and

said passage having proportions such that throw effects are contained within the passage to effectively seal the inner chamber electrically from the outer chamber.

References Cited

UNITED STATES PATENTS

2,820,752	1/1958	Heller	204—300 EC
3,006,820	10/1961	Berman	204—206
2,800,448	7/1957	Fredenburgh	204—300 EC
3,074,857	1/1963	Altenpohl	204—206

TA-HSUNG TUNG, Primary Examiner
W. I. SOLOMON, Assistant Examiner

U.S. Cl. X.R.

204—28, 206, Dig. 7