May 1, 1945. A. L. BUNTING ET AL 2,375,173

APPARATUS FOR DRYING METALLIC ARTICLES

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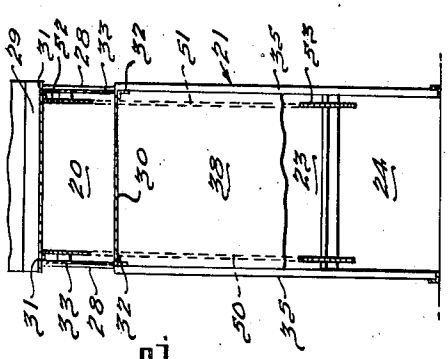


Fig. 2.

Fig. 1.

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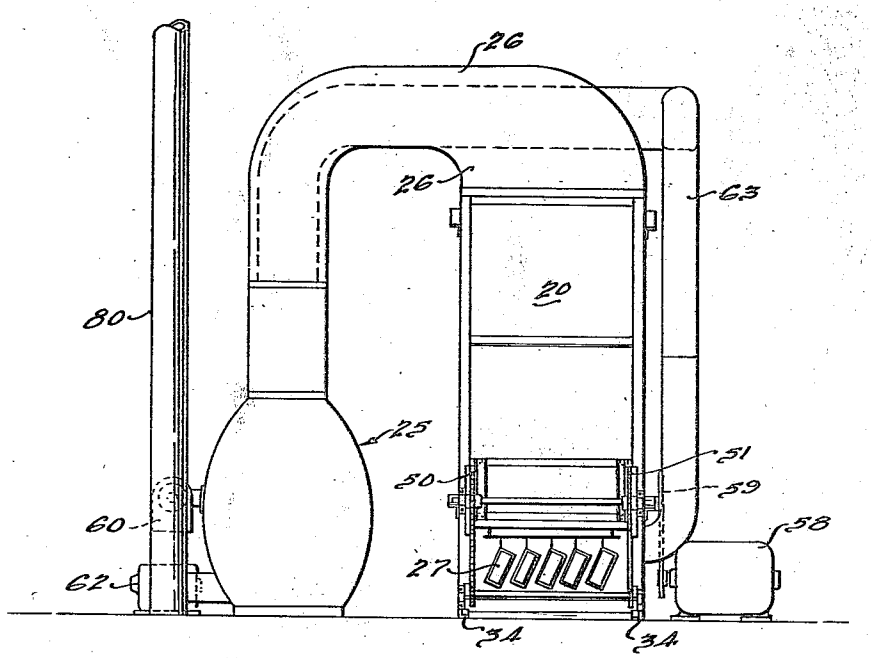


FIG. 3.

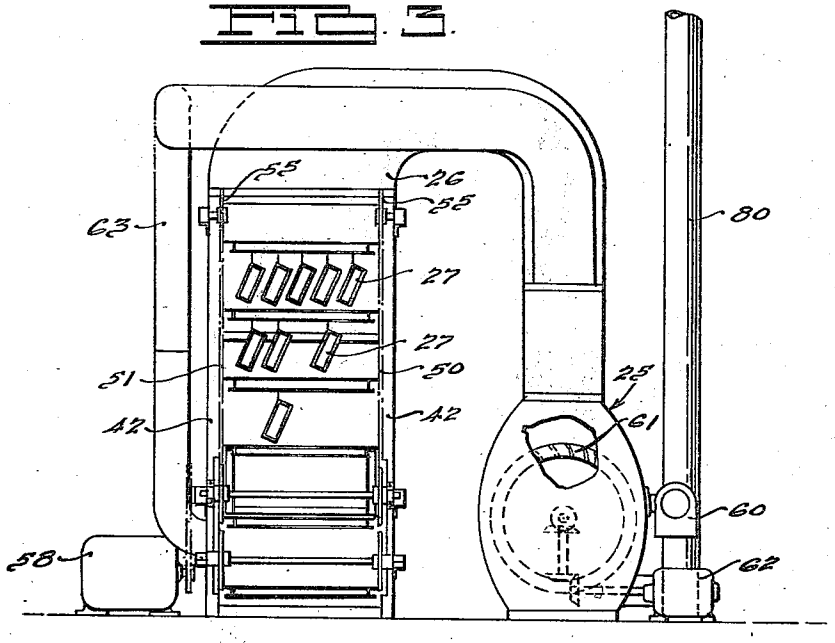


FIG. 4.

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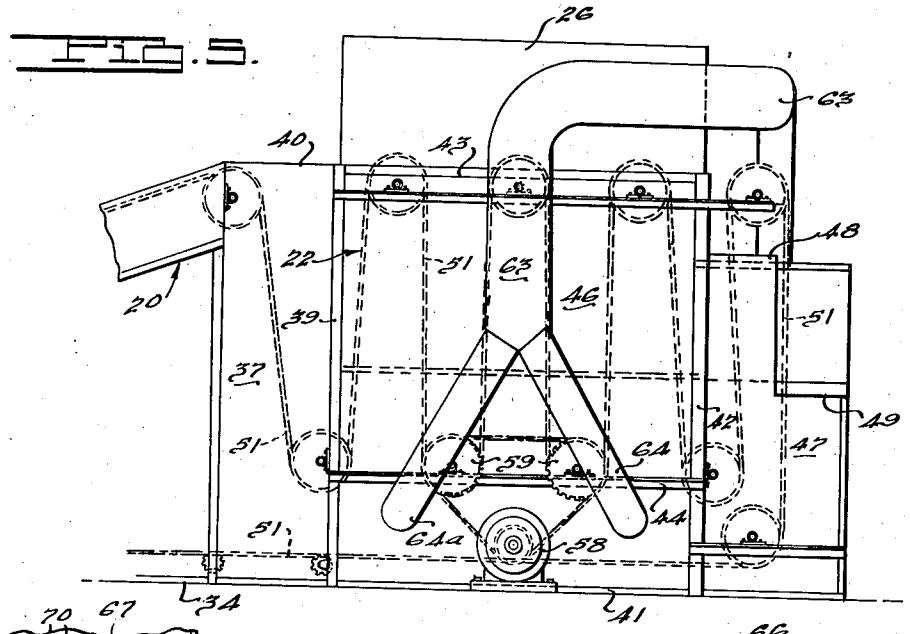


FIG. 5.

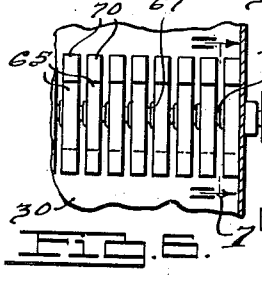


FIG. 6.

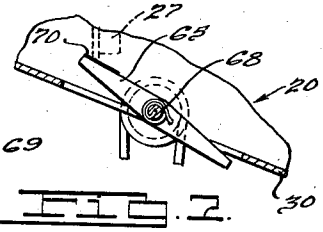


FIG. 7.

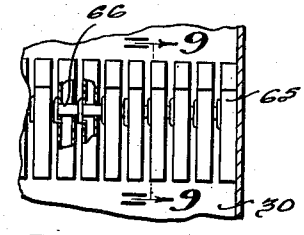


FIG. 8.

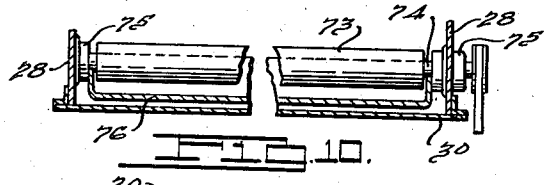


FIG. 10.

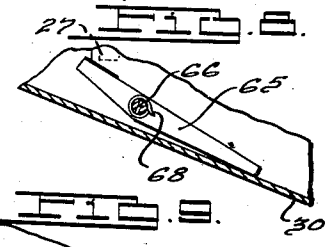


FIG. 9.

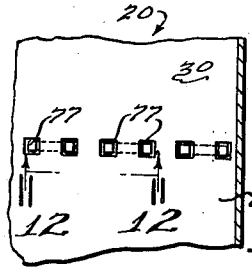


FIG. 11.

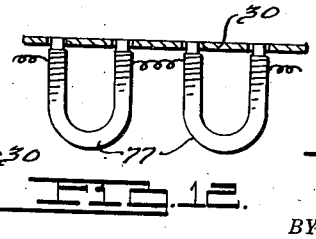


FIG. 12.

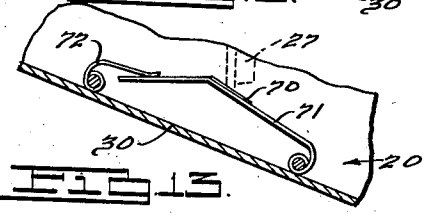


FIG. 13.

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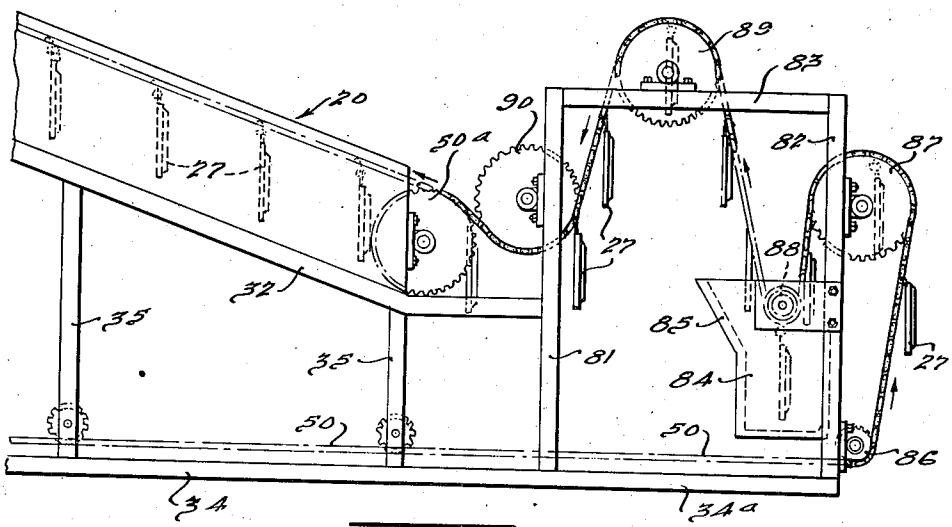


FIG. 14.

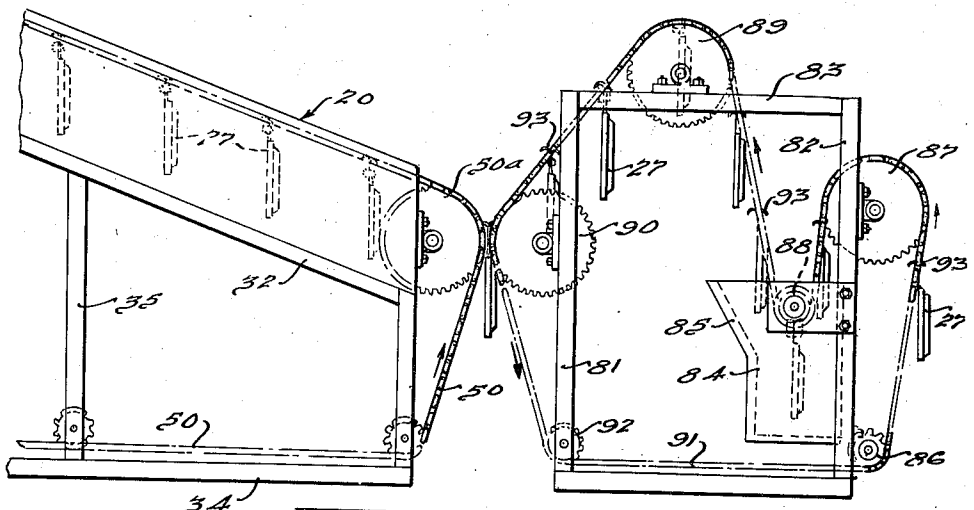


FIG. 15.

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2,375,173

UNITED STATES PATENT OFFICE

2,375,173

APPARATUS FOR DRYING METALLIC ARTICLES

Albert L. Bunting, Dearborn, and Arthur C. Schultz, Detroit, Mich.; said Schultz assignor to said Bunting

Application April 10, 1942, Serial No. 438,408

1 Claim. (Cl. 34—69)

The present invention relates to apparatus for drying metallic articles, relating more particularly to apparatus for baking or hardening protective coatings on articles fabricated from metals subject to rusting or corrosion.

In applying most protective coatings to articles formed of steel or similar metals subject to corrosion, it is necessary to carefully control a baking and/or drying operation in order to provide a properly hardened coating effective to protect the article. Such careful control is especially necessary if the coating is to protect an article subjected to handling, abrasive or wearing operations, or to relatively great temperature changes. For example, such control of the baking and/or air drying operations is necessary for protective coatings for ice trays utilized in refrigerators. In addition, coatings for articles of the aforesaid character should be pleasing in appearance. Coatings completely satisfying all of the aforesaid conditions have not been produced to date chiefly because of ineffective or faulty coating apparatus—especially because of ineffective or faulty baking and drying operations attempted to be carried out by such apparatus.

It is, therefore, one object of the present invention to provide improved apparatus for drying metallic articles, said apparatus being adapted to effectively air dry and/or bake coatings such, for instance, as coatings comprising polymerized resinous products or enamel-like coatings for protecting articles subject to rusting or corrosion.

It is another object of the invention to provide apparatus of the aforesaid general character in which an air-drying operation may be followed by a baking operation, both of these operations being adjustable and controllable in an improved manner, especially as to temperatures and times of treatment, in order that the optimum conditions may be provided for the particular coating utilized.

Another object of the invention is to provide apparatus for air drying and/or baking protective coatings for the aforesaid articles and which is adapted to provide an even, smooth finish coating, free from wrinkles, sags and blisters and to provide such a finish coating whether the initial coating material utilized prior to the drying and/or baking operations be applied by painting, dipping or spraying methods.

Still another object of the invention is to provide apparatus of the aforesaid character which is automatic in operation and adapted to operate on a mass production basis.

Other objects and advantages of this invention will appear in the following description and appended claim, reference being had to the accompanying drawings forming a part of this specification, wherein like reference characters designate corresponding parts in the several views.

In said drawings:

Fig. 1 is a side elevation of one form of apparatus embodying the present invention. For present purposes, that portion of the apparatus shown at the right side of Fig. 1 is referred to as the front of the apparatus, while that portion shown at the left side of Fig. 1 is designated as the rear.

Fig. 2 is a partial cross-sectional view taken along the line 2—2 of Fig. 1 in the direction of the arrows, parts being broken away to show the interior of the apparatus.

Figs. 3 and 4 are, respectively, front and rear elevational views of the form of the apparatus shown in Fig. 1.

Fig. 5 is a side elevation of a part of the apparatus shown in Fig. 1, but shows the opposite side from that shown in Fig. 1.

Fig. 6 is a detailed view of a part of the air tunnel utilized in connection with the present invention and shows in particular one form of a device for removing drops from the article to be coated by the apparatus.

Fig. 7 is a cross-sectional view taken along the line 7—7 of Fig. 6 in the direction of the arrows.

Fig. 8 is a view generally similar to Fig. 6 but shows a modification of the device shown in Fig. 6.

Fig. 9 is a cross-sectional view taken along the line 9—9 of Fig. 8 in the direction of the arrows.

Fig. 10 is another detail view of a different form of a device for removing the drops from the articles to be coated.

Figs. 11, 12 and 13 depict still other means for removing said drops, said figures being detail views and showing said devices when utilized in connection with the aforesaid air-drying tunnel.

Fig. 14 is a side elevation of the front part of the apparatus showing one form of mechanism for automatically dipping the metallic articles.

Fig. 15 is a view similar to Fig. 14 but showing another form of automatic dipping mechanism.

Before explaining in detail the present invention it is to be understood that the invention is not limited in its application to the details of construction and arrangement of parts illustrated in the accompanying drawings, since the invention is capable of other embodiments and of being practiced or carried out in various ways. Also it is to be understood that the phraseology or terminology

employed herein is for the purpose of description and not of limitation.

For convenience in understanding, at the outset, the principal elements of the embodiment of the invention shown in the drawings, a brief general explanation of these elements follows, details thereof being set forth hereinafter. Referring to said drawings, and especially to Fig. 1, the reference numeral 20 indicates an inclined air-drying enclosure or tunnel which opens at its upper or inner end into a generally vertically positioned enclosure or chamber 21 also utilized in connection with the air-drying operation. The reference numeral 22 indicates in general an oven utilized for the baking operation. As best shown in Fig. 2, the oven 22 is separated from the chamber 21 by a suitable partition 23 and communicates with said oven by means of an opening 24 extending across the width of the oven and the chamber 21, said opening being positioned near the bottom of the apparatus. The oven 22 is heated by hot air supplied by a heating and blowing unit indicated in general by the reference numeral 25 (Figs. 3 and 4), the hot air supplied by said unit being conducted to the oven by means of a duct 26. As best shown in Fig. 1, a continuous chain conveyor is provided in the apparatus and is adapted to conduct the articles to be coated through the air-drying tunnel 20, the chamber 21 and thence through the oven 22. After being so conducted through the air-drying tunnel, the chamber and the oven, the articles are conducted by the chain conveying system out of the oven at the rear of the apparatus (see Fig. 4) and may then be removed from the apparatus. The various devices shown in Figs. 6 to 13 inclusive for removing drops from the objects to be coated are positioned in the air tunnel 20 preferably, but not necessarily, at the lower front end thereof. The structure and operation of these devices is explained fully hereinafter.

Referring to the aforesaid apparatus in greater detail, the air-drying tunnel 20 is dimensioned and shaped to receive the object or objects to be coated. For instance, in the form of the invention shown in the accompanying drawings the air tunnel 20 is generally rectangular in cross section as best shown in Fig. 2 and its height is arranged so that the ice trays 27 may be received within the tunnel 20 and carried therethrough by the chain conveyor system explained hereinafter. The width of the air tunnel 20 is such that a plurality of these ice trays may extend across the width of the tunnel in the manner clearly indicated in the drawings in Figs. 3 and 4. The air tunnel 20 is formed of sheet metal or the like. For instance, it may comprise sheet metal side members 28—28 (Fig. 2), a sheet metal top member 29 and a sheet metal bottom member 30. These side, top and bottom members are suitably attached to and supported by a framework such as that best illustrated in Fig. 2. As there shown, this framework comprises a pair of generally longitudinally extending top angle irons 31—31 and a pair of similar longitudinally extending bottom angle irons 32—32, said top and bottom angle irons being held together and separated by suitable generally vertically positioned spaced side angle irons or supports 33—33. In the particular form of the tunnel 20 shown in the drawings, especially Fig. 2, it will be noted that the bottom member 30 is placed over the lower supporting longitudinal angle iron 32—32 so that the side angle iron 33—33 extends through openings in the bottom member 30. We have found this to be a desirable construction and it will be understood that the tunnel 20 may be formed of suitable top, side and bottom members supported by and attached to a suitable framework in several satisfactory ways which will readily occur to one skilled in the art.

The entire tunnel structure 20 comprising top, side and bottom members 28, 29 and 30 and the framework consisting of the angle irons 31, 32 and 33, is supported by a suitable supporting framework in the manner best indicated in Fig. 1. As there shown, this supporting framework comprises generally longitudinal horizontally extending side frame members 34 to which is fixed a number of spaced generally upright supporting members 35 which are also fixed to the bottom supporting rail 32 of the tunnel 20. As indicated in Fig. 1, the supporting members 35 are so arranged with respect to their height that the tunnel 20 is maintained at an upward inclination.

The tunnel 20 communicates with or leads into the generally upright enclosure or chamber 21. This chamber 21 is formed by side panels 36 and 37 (Figs. 1 and 5) formed of sheet metal or the like. The front of the chamber or enclosure 21 comprises a generally similar panel 38 (Fig. 2) and the rear of the chamber 21 is formed by a similar panel 23 which separates the chamber 21 from the oven 22. As pointed out hereinbefore, this partition does not extend to the bottom of the device, thereby providing an opening 24 to permit communication between the oven 22, chamber 21 and tunnel 20. As best indicated in Figs. 2 and 5, the side walls 36 and 37 are supported by and attached to supporting members 35 (Fig. 2) at the front and to generally similar supporting members 39 (Figs. 1 and 5) at the rear. The front panel extends between the spaced members 35—35 (Fig. 2) while the rear panel extends between the spaced members 39—39. The top of the chamber is closed by a suitable top member shown at 40 (Figs. 1 and 5). As indicated in the drawings and in particular in Fig. 1, the framework for the enclosure 21 is supported by and is attached to the longitudinally extending rails 34—34.

The oven 22 includes a framework consisting of angle irons or generally similar supporting members and the laterally spaced members 39—39 form the front upright members of this framework. These members are attached to suitable longitudinally parallel and spaced bottom frame members 41—41. At the rear of the oven there is provided a pair of laterally spaced upright frame members 42—42 (Fig. 4) and a pair of top frame members 43—43 (Figs. 1 and 5) extending between the upright frame members 39 and 40 completes the outline of this framework. Suitable cross frame members such as those shown at 44 (Fig. 1) may be utilized to strengthen the framework and for the purpose of attaching various working parts of the present apparatus in the manner indicated hereinafter. The oven is enclosed by providing sheet metal sides 45 and 46 and the partition or wall 23 serves to form the front wall of the oven and separate the oven from the enclosure or chamber 21 in the manner indicated hereinbefore.

As best shown in Figs. 1 and 5, the oven 22 is formed at the rear to provide a stepped section indicated in general at 47. This section 47 is formed of suitable sheet metal side and end pieces supported by and attached to suitable frame members in the same general manner as the other side and end pieces of the oven described in detail hereinbefore. As also shown in Figs. 1 and 5, the top of the stepped section is left open.

In fact a portion of the stepped section shown at 48 provides an open top part for the chain conveyor system explained hereinafter to emerge from the oven and the open top part of the stepped section shown at 49 permits the chain conveyor system to reenter the apparatus. The objects carried through the apparatus by the chain conveyor system may be removed from the apparatus when they have been carried down the chain conveyor after it has emerged from the point marked 48 and before it reaches the point marked 49.

Referring in greater detail to this chain conveyor system, it will be noted that it is arranged on sprockets placed throughout the device. This chain conveyor system in general possesses two continuous parallel spaced chains running over the sprockets, said chains being connected by bars or supports from which the objects to be carried through the apparatus are hung or suspended in the manner best shown in Fig. 3. Thus, this chain conveyor comprises chains 50 and 51 running over suitable sprockets (not shown) in the air tunnel 20, continuing through the tunnel and over a sprocket 52 located at the top thereof. After passing over the sprocket 52 the chain conveyor continues downwardly throughout the chamber 21, passes over the sprocket 53 and thence over a series of sprockets arranged so that the chain conveyor passes up and down several times through the oven in the manner clearly shown in Fig. 1. After passing about the last sprocket in the oven, which is the sprocket shown at 54, the chain conveyor passes around the sprocket 55 which is located immediately above the opening 48 whereby the chain emerges from the oven, passes about the sprocket 55 down through the opening shown at 48 and thence about the sprocket 56. Thereafter it continues in the manner clearly shown in Fig. 1 until it again passes around the sprocket 52 whereupon the cycle is repeated. It will be understood that this chain is a continuous system. The chains 50 and 51 are kept taut by a spring sprocket shown at 57 (Fig. 1) which comprises a sprocket arranged to slide relative to a support such as the support 35 against the tension of a spring in order that the chain will at all times be kept taut to insure smooth and proper operation of the chain conveyor system. This chain conveyor system is driven by suitable means such as the motor 58 (Figs. 3, 4 and 5) which may drive the chain conveyor system through suitable gears 59. If desired a gear reduction means such as a reducing gear box may be interposed between the motor 58 and the driving gears 59 of the chain conveyor system, if it is desired to reduce the speed of the chain conveyor.

The oven 22 is heated by a flow of heated air provided by a suitable heater and blower unit such as the unit shown in general at 25. In the form of the apparatus shown in the drawings, this unit 25 includes an oil burner 60 which may be of any suitable design. This unit also includes a suitable blowing mechanism such as that shown at 61 which is driven by the motor 62 (Fig. 4). The stack 80 is provided for use in connection with the oil burner 60. Air is drawn into the heating and blowing unit by means of the blower 61, is heated by means of the oil burner 60, and is conducted to the oven by means of the air duct 26.

The reference numeral 63 indicates a return air duct whereby air introduced into the oven 22 goes through or spreads throughout the interior of the oven and thence is removed through said air duct 63 and returns to the heating and blower unit 25 where it is reheated and recycled back through the oven 22. It will be noted that the return air duct 63 enters the oven at the bottom portion thereof at two different points 64 and 64a (Figs. 1 and 5) and accordingly that the air duct 63 is divided into two sections in the manner clearly indicated in the drawings and in particular in Fig. 5.

It will be understood that the air introduced into the oven 22 from the heater and blower unit 25 not only serves to maintain the oven at the desired temperatures but some of this heated air flows outwardly through the opening 24 (Fig. 2) between the oven 22 and the chamber 21, and flows upwardly through the chamber 21 and thence downwardly throughout the inclined tunnel 20. Thus, but a portion of the air is recycled through the return air duct 63.

It will be understood that the temperature of the oven 22 is readily controlled at suitable thermostats located in the oven and/or within the air duct 26 so that the heater or blower unit is operated as desired to produce a flow of heated air into the oven at the desired temperatures and in the desired amounts.

The operation of the present apparatus is believed to be clear from the foregoing description of this apparatus. However, it will be readily understood that the object to be treated in the present apparatus, such as the ice trays 27, are hung from the bars or supports between the chains 50 and 51 in the manner best shown in Figs. 1 and 3. They are then conveyed through the air drying tunnel 20, through the chamber 21, thence several times through the oven 22 out of the oven 22 at the point 48 and are removed from the chain conveyor, by suitable means, when traveling from the sprocket 55 to the point 49. It will thus be understood that the said objects are first air dried by traveling through the tunnel 20 and the chamber 21 and afterwards are baked in the oven 22. By controlling the rate of speed of the chain conveyor system, it is possible to control the length of the air-drying operation and of the baking operation. Furthermore, it is possible to further control these operations by controlling the heater and blower units so that the temperature of the oven and of the air-drying tunnel 20 and chamber 21 may be suitable for the particular coating utilized for protectively coating the objects carried through the apparatus.

Referring now to the various devices for removing drops from the objects carried through the apparatus and which are shown in Figs. 6 to 13 inclusive, these devices are preferably located in the air-drying tunnel 20 preferably within the bottom thereof. For example, the device shown in Figs. 6 and 7 may be positioned within the bottom 30 of the air-drying tunnel 20. This device consists of a plurality of generally flat topped elongated finger-like members 65—65 which are spaced relatively closely together side by side on a shaft 66. Between these elongated members 65 are washers 67 and the elongated members 65 are free to move relative to the shaft 66, but due to the washers and the spring 68 (Fig. 7) are frictionally held on the shaft. Accordingly, when the shaft 66 is driven, as by the motor 69, the fingers are tipped upwardly in the manner shown in Fig. 7 and are maintained in that position since the shaft is free to turn rela-

tive to the fingers when the motion of the fingers is stopped by contact with the bottom 30 of the tunnel 20 (Fig. 7). However, when the object is carried through the tunnel 20 by the chain conveying system, it strikes the upwardly projecting portion of the fingers 65, as shown in Fig. 7, tipping the fingers downwardly and removing drops which may accumulate upon the objects. If desired, the top surfaces of the fingers 65 may be covered with a suitable absorbing material 70 such as paper or the like. After the fingers 65 have been contacted by the trays moving through the tunnel 20, they are returned to their initial upwardly extending position by means of the rotating shaft 66.

If desired, a generally similar arrangement may be utilized except that the fingers 65 are not motor driven to be returned, but are so arranged that they return by gravity. Such a modification is shown in Figs. 8 and 9. As there shown, particularly in Fig. 9, the fingers 65 are constructed and shaped so that the shaft is placed off center relative to them, whereby the tray 27 will touch the top of the upwardly extending top of the fingers 65, tipping them about the shaft 66. After the fingers 65 have been so tipped, they will return to their normal positions through gravity due to the off-center position of the shaft 66 relative to the points of the fingers 65.

Still another modification of a drop removing means is indicated in Fig. 13. As there indicated, instead of the fingers 65 there is provided a series of spring clips 71 which are retained in a desired upward generally inwardly extending position within the tunnel 20 by means of the retaining clip 72. As the tray 27 passes through the tunnel 20 it contacts the spring clip 71, which is depressed, permitting the tray to pass through the tunnel 20 and at the same time removing excess drops from the tray 27. After this takes place, the spring clip 71 springs back into its original position. As in the other devices shown in Figs. 6 to 9, inclusive, the spring clip 71 may contain a suitable absorbing material 70 at its contact point.

In Fig. 10 there is illustrated still another means for removing drops from the objects or trays conveyed through the air-drying tunnel 20. As there shown, a suitable roller 73 is provided which extends across the air-drying tunnel 20 immediately above the bottom 30 thereof. This roller is placed on a shaft 74 which in turn extends through suitable bearings 75—75 and is driven as by a motor. Also, there is provided a member 76 which is attached in any suitable manner beneath the roller 73, such as being attached to the bearings 78—78 and to the bottom 30 of the air-drying tunnel 20 in the manner indicated in Fig. 10. This member 76 is bent so as to form a tray-like part beneath the roller 73 and may be filled with a solvent for the coating material used on the objects carried through the apparatus. Thus it will be seen that as the objects are carried through the air-drying tunnel 20 by the chain conveying system they are contacted by the rotating roller 73 which removes drops and excessive coating material from said objects. As the material accumulates on the roller, it will be seen that the roller rotates through the solvent carried in the tray formed by the member 76 so that this accumulated material is removed from the roller and may be reclaimed later from the solvent.

In Figs. 11 and 12 there is illustrated still another modification for removing the excess drops on the objects carried through the air-drying tunnel. This device consists of a series of electromagnets 77—77 which are positioned to extend across the width of the bottom 30 of the air-drying tunnel 20 in the manner shown in Fig. 11. Of course, these magnets are connected by suitable conductors to a source of electrical energy. As the metallic objects are carried across the field of the magnets, it will be seen that these magnets cause a vibration of said objects and thereby shake free of the object all excessive coating material or drops therefrom. Due to the inclination of the air-drying tunnel 20 this material will flow down the bottom 30 thereof and may be removed therefrom or collected at the end thereof in any suitable manner. It will be appreciated that the current sent through the electromagnets is preferably alternating current, thereby setting up continuously changing magnetic fields which cause this vibration of the trays as they pass over the magnets.

In place of or additionally to the foregoing means for removing drops or excessive material from the objects, the bars or supports between the chains 50 and 51 may be movable relative to the chains or may be formed of a resilient material. Thus the objects hung therefrom or supported thereby are shaken as they are conveyed through the apparatus. If desired, the chain conveyor may be operated intermittently at an increased or decreased speed to provide a series of jerky movements to aid in shaking said drops or excessive coating material from the objects.

Figs. 14 and 15 illustrate modifications of the present apparatus providing for automatic dipping of the metallic articles, such as the ice trays 27, in a coating material prior to the air drying and baking operations carried out by the present apparatus and described hereinbefore.

Referring to Fig. 14, the modification there shown possesses an extension 34*a* of the bottom rails 34, to which upstanding frame members 81 and 82 are attached by suitable means. A cross frame member 83 extends between the members 81 and 82 at the top thereof. To the upstanding member 82 is attached a container 84 having a generally rearwardly extending lip portion 85. As illustrated in Fig. 14, the chain conveyor 50 instead of coming up directly to the sprocket 50*a* and then extending through the air drying tunnel 20, extends along the length of the extended rail 34 past the portion 34*a* thereof, thence about the sprocket 86 upwardly about the sprocket 87 and then downwardly around a sprocket 88 suitably maintained within the upper portion of the container 84. The chain 50 after continuing about the sprocket 88 then continues out of the container 84 upwardly at an angle around the sprocket 89, thence downwardly around the sprocket 90, over the sprocket 50*a*, and continues upwardly through the air drying tunnel 20 as described hereinbefore.

The container 84 is filled, or partially filled as the circumstances dictate, with a coating material to be air dried and baked on the article in accordance with the present disclosure. Accordingly, the article such as the ice trays 27 are conducted by the conveyor in the direction shown on the arrows in Fig. 14, that is, they are conducted about the sprocket 87 downwardly into the container 84 where they are coated with the coating material and thence upwardly on an incline about the sprocket 89 and then into the air drying tunnel 20. It will be noted that the

sprocket 89 is so positioned relative to the sprocket 88 that the articles, such as the ice trays 27, leave the container 84 on an upward incline. This construction prevents one tray from dripping on the next tray which is not desirable. Also the lip portion 85 of the container 84 is so designed that drippings from the trays as they leave the container 84 will be caught and redirected back into the container 84. It will be understood that the chain conveying system may be run at such a speed that the article 27 will be conducted through the container 84 at a desired rate and will remain in said container for a sufficient length of time to be coated suitably. If desired, the sprockets may be so positioned relative to one another that a greater path of travel through the container 84 or a lesser one is effected. Also the length of travel of the articles 27 after they leave the container may be increased if it is desirable to provide a greater draining time than is shown for the devices in the drawings.

The modification of the present apparatus shown in Fig. 15 is similar to that shown in Fig. 14 except that the automatic dipping mechanism is separate from the remaining parts of the apparatus and, if desired, may be rendered portable and moved into position when it is desired to be used. Accordingly, the chain of the principal part of the apparatus shown at 50 goes about the sprocket 50*a* and thence through the tunnel 20 in the manner described hereinbefore and as shown in Fig. 1. There is provided a separate chain 91 and an additional sprocket 92 so that the chain 91 forms a separate continuous chain system running about the sprocket 92 to the sprocket 86, thence to the sprockets 87, 88, 89 and 90. It will be understood that there is a similar chain on the other side of the device and that these chains are connected by spring bars in the manner described hereinbefore. On these spring bars the articles such as the ice trays 27 are hung by a particular type of hook 93. This hook as shown in Fig. 15 is provided with a pair of finger-like portions one of which is utilized to hold the hook onto the spring bar and the other of which extends in the direction of air tunnel 20. Accordingly, when the pans 27 have been carried through the container 84 and coated, they are automatically transferred from a spring bar on the chain 91 to one on the chain 50 of the principal part of the apparatus, in the manner clearly shown in Fig. 15. Of course it will be understood that the chain 91 is driven by a suitable means (not shown) and that the speed of the chain 91 is synchronized with the speed of the chain 50 so that the pans or other articles will be transferred automatically from the chain 91 to the chain 50 and thence conveyed through the remaining parts of the apparatus.

We claim:

Apparatus for air drying and baking a protective coating for metallic articles subject to corrosion, which comprises a relatively elongated air conducting drying tunnel, a plurality of members arranged on a shaft extending across said tunnel for removing excessive coating material from said articles, each of said members being shaped to project into the tunnel for contacting said articles and being movable on said shaft on such contact so that the articles depress the members, an air conducting drying chamber communicating with said tunnel, a baking chamber communicating with said drying chamber, a furnace for producing a flow of heated air, a duct for directing said heated air into said baking chamber, air blowing means for forcing said air through said baking chamber into said drying chamber and into said tunnel, and a continuous conveyor for conducting the articles through said tunnel through said air-drying chamber and thence through said baking chamber, whereby a coating on said articles is air dried and thereafter baked.

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