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(54) **Continuous method for preparing steel parts for resin coating.**

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PROCESS CONTROL AND AUTOMATION, vol. 13, no. 2, February 1966, pp. 40-41; "versatile automatic plating plant"

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Description

This invention relates to the application of protective coatings to refrigerator racks, particularly successive layers of zinc, chromate, and synthetic resin.

Steel parts such as refrigerator racks which are subjected to corrosive conditions are commonly provided with protective coatings. Such coatings may include a zinc layer applied by electroplating, a chromate layer over the zinc, typically applied by immersing the zinc-coated part in a chromating solution and final coating with a synthetic resin.

The sequence of successive zinc, chromate, and resin coatings has been used commercially for various products including refrigerator racks. For example, this sequence is disclosed in US-A- 3,808,057 and US-A-4,003,760. As there described, the chromate coating is applied by immersion of the zinc-plated part in a chromating solution. Other methods of application of chromate layers have been suggested, such as spraying, brushing, swabbing or electrolytic methods: Eppensteiner and Jenkins, "Chromate Conversion Coatings", Metal Finishing Guidebook and Directory 1990, pages 433-447, at page 433. "Process Control and Automation", Vol. 13, No. 2, February 1966, pages 40 to 41, "Versatile Automatic Plating Plant" describes a machine for zinc and cadmium plating comprising three parallel treatment lines, a zinc line, a cadmium line and a cleaning line, wherein, in the zinc line, after plating, racks are rinsed and then immersed either in a bright dip which produces a bright zinc finish having a bluish tinge, or in an acidic chromate solution which produces an iridescent passive film conferring a maximum corrosion resistance.

The application of protective coatings to steel refrigerator racks or similar parts is believed to have been carried out by interrupting the coating procedure after the zinc electroplating. At a later time and in a separate production line, the zinc-coated parts have been subjected to chromating and thereafter to resin coating. As far as it is known, no continuous production method has been developed in which a steel part, such as a refrigerator rack, can be sequentially processed without interruption to apply successive zinc, chromate, and synthetic resin coatings.

It is the object underlying the present invention to provide a novel method for preparing resin coated steel parts, namely refrigerator racks without interruption wherein the parts are successively electroplated with zinc and chromated with a high rate of production.

In accordance with the present invention the object is achieved with a method for applying a sequence of protective coatings to exterior surfaces of refrigerator racks in which the sequence includes a first zinc coating, an intermediate chromate coating, and a final synthetic resin coating, comprising:

(a) a continuous conveyor system including hanger means for carrying the refrigerator racks through successive zinc, chromate, and resin coating operations, said parts remaining on the same hanger means throughout said coating operation;

(b) applying said first zinc coating to said refrigerator racks by immersion into alkaline non-cyanide zinc electroplating, the coating consisting of metallic zinc and having a thickness from 1.27 to 5.08 μm (0.05 to 0.2 mils);

(c) subsequent water washing of the zinc-coated refrigerator racks and while the refrigerator racks are still wet spraying them with an aqueous chromating solution containing chromic acid together with nitric acid and at least one salt providing activator anions, said chromating spraying wetting the exterior surfaces of said refrigerator racks and being completed in not more than 60 s with the formation of a yellow chromate layer on the parts; and finally

(d) water rinsing and drying the chromate-coated parts, applying a synthetic resin coating by electrostatic powder spray application, followed by oven baking of the applied resin coating, said refrigerator racks remaining on said hanger means until the completion of said oven baking.

In carrying out the chromating it was further found to be important to minimize transfer times between the final water rinsing after the zinc-plating and the application of the chromating spray. More specifically, the rinsed zinc-coated rack should be transferred to the spray chromating operation without drying, that is, while still wet from the rinse water. This procedure assures that the zinc-coated surface will be fresh, bright and reactive. Then rapid spreading and reacting of the chromating solution on the zinc-coated racks is obtained.

Using the above-described sequence of steps, it was found not only that transfer times from the final water rinse after zinc-coating to the chromating spray coating should be made very short but that the chromating spraying, while still obtaining the formation itself could be of very short duration while still obtaining an effective chromate layer over the zinc layer. Namely the transfer time of the rinsed rack preferably is less than 60s, preferably 30s, and the chromating spraying is completed in not more than 60s, while forming yellow chromate layers. In an optimized embodiment, the transfer time for the wet rack is about 15 s, and spraying time for the chromating solution is about 30 s. Such fast sequences facilitate the

fully continuous method of operation.

The method of this invention is illustrated in a preferred embodiment in the accompanying drawings in which:

Fig. 1 is a block diagram flow sheet of the sequence of operations or stages in which bare steel parts are continuously processed to form coated parts having successive layers of zinc, chromate and synthetic resin;

Fig. 2 is a fragmentary enlarged view of a portion of the flow sheet of Fig. 1, illustrating particularly the processing of the parts through the zinc plating dip tank followed by two rinsing stages, the chromating stage, and a subsequent rinsing stage;

Fig. 3 is an enlarged view of a carrier rack on which four parts such as the refrigerator rack are supported;

Fig. 4 is a plan view of a refrigerator rack as illustrated in elevation in Fig. 3; and

Fig. 5 is a elevational view of a chromate spraying apparatus, illustrating the exposure of the parts to multiple sprays, as the parts move through the chromating stage.

In accordance with the method of this invention, refrigerator racks are continuously processed to obtain a sequence of zinc, chromate and resin layers. The zinc coating is preferably carried out by electroplating, using an immersion-type alkaline, non-cyanide plating solution. Suitable electroplating baths and methods of operation are described in US-A-4,135,992, US-A-3,856,637 and US-A-3,833,486. Alkaline, non-cyanide zinc plating is also described in literature references. See Geduld, Metal Finishing, August, 1973, pages 45-60; and Eckles, PF Directory 1990, pages 188-194.

Zinc plating baths may be prepared by dissolving zinc anodes in caustic soda, or, alternatively, by dissolving zinc oxide in caustic soda. In using such aqueous plating baths, a temperature range of 21-32 °C (70-90 °F) can be maintained, with a zinc metal concentration in the range from 5.2 to 9.0 g/l (0.70 to 1.2 ounces per gallon) and a caustic soda (NaOH) concentration of from 67.4 to 82.4 g/l (9.0 to 11.0 ounces per gallon). A brightener may be included in the solution such as polyamine reaction products that are cationic in nature. Such brighteners are attracted to the cathodes along with the zinc ions and co-deposit with the zinc. For example, the Lea Ronal "Ronazinc T®" brightener can be used at 0.50% by volume. The current density is not highly critical. For example, the anode can be operated at about 108 As/m^2 (10 $amps/ft^2$) and the cathodes at about 269 As/m^2 (25 $amps/ft^2$).

In the continuous coating operations of the present invention, it has been found satisfactory to employ a somewhat thinner than usual zinc coating. For example, instead of applying the zinc coating to a more typical thickness of 7.6 to 12.7 μm (0.3 to 0.5 mils), it is preferred to apply the zinc coating to a thickness of from 1.27 to 5.08 μm (0.05 to 0.2 mils), such as, for example, substantially 2.54 μm (0.1 mil).

Chromating solutions of the kind useable in the method of the present invention were described by Brumer, PF Directory 1990, pages 201-206; and in Eppensteiner and Jenkins, cited above. These solutions contain chromic acid (H_2CrO_4) which provides hexavalent chromium. The solution may also contain an inorganic acid such as nitric acid, and providing a strongly acid pH, such as below 2.5, for example, around pH 2.0. In addition, such solutions should include one or more salts providing activator anions, which may include acetate, formate, sulphate, fluoride, nitrate, or phosphate anions. For example, sodium sulphate and sodium chloride may be employed in combination as activator salts together with the chromic acid and nitric acid. A suitable formulation is set out below.

Chromating Reagents	
Ingredients	Quantities g(lbs.)
Chromic Acid (HCrO)	1579.9 (3.48)
Nitric Acid (42 ° Be')	540.3 (1.19)
Sodium Sulfate (Na_2SO_4)	172.5 (0.38)
Sodium Chloride (NaCl)	27.2 (0.06)

The formulation of chromating reagents set out above can be used to form an aqueous chromating solution with concentrations of from 0.5 to 2% by volume. Spray application of the chromating solution can be carried out with solution temperatures of from 16 to 38 °C (60 to 100 °F), and spraying times of not more than 60, such as from 15 to 45 s.

An important feature of the continuous method is the transfer of the zinc-plated rack while still wet from the final rinsing spray before the chromating stage. By application of a chromating spray to the racks with retained surface moisture, a rapid reaction of the chromating solution with the zinc-coated surfaces of the

parts will be obtained.

This invention thereby provides an improved method for the continuous treatment of refrigerator racks to obtain successive coating layers of zinc, chromate and synthetic resin. The zinc layer is applied by electroplating and the rack is washed thoroughly with water prior to the application of the chromate layer. Immediately following the last water washing of the zinc-plated rack and while the racks are still wet, they are sprayed with the aqueous chromating solution, which contains chromic acid together with nitric acid and at least one salt providing activator anions. Chromating spraying is carried out so as to wet the exterior surfaces of the racks. A yellow chromate layer is formed on the racks. The racks can then be continuously coated for synthetic resin coating by water rinsing and oven drying. Continuous resin coating of the thus prepared racks can be carried out using an electrostatic powder spray procedure followed by oven baking of the resin coated racks.

A preferred embodiment of the method of this invention is illustrated in Figs. 1 to 5. Looking first at Fig. 1, the bare refrigerator racks, are introduced onto a continuous conveyor system travelling first to a pre-cleaning stage 1 where the racks are washed with an alkaline spray. For example, the spray may be formed from American Chemco 834 at 2 to 4% by volume in water and applied at a temperature of 66 to 88 °C (150-190 °F). Typically a 3% by volume concentration is used at a temperature of 82 °C (180 °F).

The rack is next continuously conveyed to a second alkaline spray cleaning at stage 2, where the same spraying is repeated as in stage 1. Thereafter water spray rinsing is carried out in stage 3. This removes the alkaline cleaner from the racks. At stage 4 the racks are subjected to immersion acid pickling to remove rust and scale. An aqueous hydrochloric acid (D = 1.18(22 °Be')) may be used at 50% by volume in water.

The pickled racks are next continuously subjected to water spray rinsing at stage 5, and are thereby prepared for the immersion alkaline zinc electroplating at stage 6. The electroplating bath may be maintained at a temperature of 21 to 32 °C (70 to 90 °F), such as around 27 °C (80 °F). The bath contains zinc metal ions at a concentration of 5.2 to 9.0 g (0.7 to 1.2 ounces) of zinc per liter together with sodium hydroxide at a concentration of 67.4 to 82.4 g/l (9 to 11 ounces per gallon). A brightener is also used such as preferably Lea Ronal "Ronazinc T®" at a concentration of 0.5% by volume. The zinc coating is applied to a thickness range of from 1.27 to 5.08 μm (0.05 to .2 mils.) preferably about substantially 2.54 μm (0.1 mil).

In stages 7 and 8, the zinc-coated rack is subjected to water spray rinsing. Stage 8 is the final water rinsing prior to the spray chromating at stage 9. The stage 8 rinsed racks are rapidly transferred to the spray chromating. After the completion of electroplating at stage 6, the water rinsing at stages 7 and 8 can be completed in from 60 to 120 s, such as at about 30 s in each rinsing stage. The damp racks are transferred to chromating stage 9 in not more than 60 s preferably in less than 30 s. For example, such transfer can be made in about 15 s.

A chromating solution thus can be prepared as described above, or a commercially available chromating solution can be used, such as the Frederic Gumm "Du-Chrome 154L®". Chromating spraying in stage 9 is completed in not more than 60 s. For example, the spraying can be for about 30 s. The parts are thereby provided with a yellow chromatic layer, indicating a chromating film has been applied to and reacted with the zinc coating. The spray chromating is carried out at ambient temperature, such as ordinary room temperatures of from 16-27 °C (60-80 °F).

Following the chromating stage 9, the coated racks are subjected to water spray rinsing at stage 10 then to oven drying at stage 11. The oven may be operated at a temperature of 121 - 203 °C (250-400 °F), such as around 177 °C (350 °F). The racks are thereby completely dried prior to powdering in stage 12. Electrostatic powder spray coating is carried out in stage 12 to apply resin powder to the coated racks. Average temperature are maintained in stage 12 of from about 18-24 °C (65-75 °F). For example, an epoxy-polyester resin may be applied in admixture with fluidizing ingredients. For example, the spray coating powder may comprise "Glidden 3W108®". Standard spray coating procedures and equipment are used, as described, for example, by Richert, PF Directory 1990, pages 52-58.

Following powder coating, the racks are baked in an oven at stage 13 to fuse the resin coating. Bake temperatures of around 191 °C (375 °F) can be used. Following baking, the completed racks are ready for use.

In Fig. 2, stages 6 to 10 are illustrated in further detail. The rinsed racks in stage 5 are passed through a zinc plating dip tank 20, making a loop around a central electrode 21.

The continuous conveyor for the transfer of the refrigerator racks may include hangers as illustrated in Fig. 3 and 5. These hangers are designated generally by the letter 23. They includes a central vertically extending rod 24 which provides a hook 25 for attachment to the conveyor. Two cross bars 26 and 27 are provided, one at an intermediate position on rod 23 and the other at its lower end. The cross bars terminate in recesses 26a and 27a for receiving upper cross bars 28 of the refrigerator racks 29, as illustrated in Fig.

4. In addition to the upper and lower end bars 28 and 30 and a central cross rod 31, the racks can include a plurality of connecting rods 32, which provide the refrigeration shelf. It will be understood, of course, such refrigerator racks may have various constructions and configurations.

The racks 29 supported on the hangers 23 are conveyed through a spray chromating apparatus as illustrated in Fig. 5. A battery of spray nozzles 22 are provided in vertically spaced relation along spray arms 32 and 33. Sprays direct multiple streams, as indicated by the arrow lines, to rapidly and completely expose the parts to the chromating solution. The chromating solution is supplied under pump pressure through pipe 34 for distribution to the spray arms 32 and 33.

In typical installation the times required for the stages described above are summarized below.

Stage	Time
1	30 s
2	90 s
3	30 s
4	120 s
5	30 s
6	5 min
7	30 s
8	30 s
transfer 8 to 9	15 s
9	30 s
10	30 s
11	15 min
12	90 s
13	20 min

Claims

1. Method for applying a sequence of protective coatings to exterior surfaces of refrigerator racks in which the sequence includes a first zinc coating, an intermediate chromate coating, and a final synthetic resin coating, comprising:

(a) a continuous conveyor system including hanger means for carrying the refrigerator racks through successive zinc, chromate, and resin coating operations, said parts remaining on the same hanger means throughout said coating operation;

(b) applying said first zinc coating to said refrigerator racks by immersion into alkaline non-cyanide zinc electroplating, the coating consisting of metallic zinc and having a thickness from 1.27 to 5.08 μm (0.05 to 0.2 mils);

(c) subsequent water washing of the zinc-coated refrigerator racks and while the refrigerator racks are still wet spraying them with an aqueous chromating solution containing chromic acid together with nitric acid and at least one salt providing activator anions, said chromating spraying wetting the exterior surfaces of said refrigerator racks and being completed in not more than 60 s with the formation of a yellow chromate layer on the parts; and finally

(d) water rinsing and drying the chromate-coated parts, applying a synthetic resin coating by electrostatic powder spray application, followed by oven baking of the applied resin coating, said refrigerator racks remaining on said hanger means until the completion of said oven baking.

2. The method of claim 1 in which immediatley after said zinc coating operation said refrigerator racks are water washed and transferred to the chromate coating operation, the transfer time from said water washing into the sprayed chromating solution being less than 30 s.

3. The method of claims 1 or 2 in which said synthetic resin coating is formed from an epoxy-polyester resin.

Patentansprüche

1. Verfahren zum Auftragen einer Sequenz von Schutzüberzügen auf die Außenoberflächen von Kühlschrankregalen (Regalteilen), wobei die Sequenz einen ersten Zinküberzug, einen mittleren Chromatüberzug und einen Deckharzüberzug umfaßt, umfassend:
   (a) ein kontinuierliches Fördersystem, umfassend eine Hängevorrichtung zum Transportieren der Kühlschrankregale durch aufeinanderfolgende Zink-, Chromat- und Harzbeschichtungsverfahren, wobei die Teile während des Beschichtungsverfahrens auf der gleichen Hängevorrichtung bleiben;
   (b) Auftragen des ersten Zinküberzugs auf die Kühlschrankregale durch Eintauchen in eine alkalische, cyanidfreie elektrolytische Zinkbeschichtung, wobei der Überzug aus metallischem Zink besteht und eine Dicke von 1,27 bis 5,08 µm (0,05 bis 0,2 mil) aufweist;
   (c) anschließendes Waschen der zinkbeschichteten Kühlschrankregale mit Wasser, und während die Kühlschrankregale noch naß sind, Aufsprühen einer wäßrigen Chromatierlösung, enthaltend Chromsäure zusammen mit Salpetersäure und mindestens ein Salz, das Aktivierungsanionen bereitstellt, wobei das Chromatiersprühen die Außenoberflächen der Kühlschrankregale benetzt und in nicht mehr als 60 s mit der Bildung einer gelben Chromatschicht auf den Teilen beendet ist; und schließlich
   (d) Spülen mit Wasser und Trocknen der chromatbeschichteten Teile, Auftragen eines synthetischen Harzüberzugs mittels eines elektrostatischen Zerstäubers, anschließendes Ofentrocknen des aufgetragenen Harzüberzugs, wobei die Kühlschrankregale auf der Hängevorrichtung bleiben, bis das Ofentrocknen beendet ist.

2. Verfahren nach Anspruch 1, wobei sofort nach dem Zinkbeschichtungsverfahren die Kühlschrankregale mit Wasser gewaschen und zu dem Chromatbeschichtungsverfahren überführt werden, wobei die Transportzeit von dem Waschen mit Wasser in die zerstäubte Chromatierlösung weniger als 30 s beträgt.

3. Verfahren nach Anspruch 1 oder 2, wobei der synthetische Harzüberzug aus einem Epoxid-Polyesterharz gebildet ist.

Revendications

1. Procédé d'application d'une séquence de revêtements de protection sur des surfaces extérieures de grilles de réfrigérateur, la séquence incluant un premier revêtement de zinc, un revêtement intermédiaire de chromate et un revêtement final de résine synthétique, comprenant :
   (a) un système de convoyeur continu incluant un moyen de suspension pour supporter les grilles de réfrigérateur au cours des opérations sucessives de revêtement de zinc, de chromate et de résine, lesdites pièces restant sur le même moyen de suspension pendant la totalité de ladite opération de revêtement ;
   (b) l'application dudit premier revêtement de zinc sur lesdites grilles de réfrigérateur par immersion dans un électroplacage de zinc non cyanuré alcalin, le revêtement étant constitué par du zinc métallique et présentant une épaisseur allant de 1,27 à 5,08 µm (0,05 à 0,2 millième de pouce) ;
   (c) puis le lavage à l'eau des grilles de réfrigérateur recouvertes de zinc et tandis que les grilles de réfrigérateur sont toujours humides, la pulvérisation de celles-ci par une solution aqueuse de chromatage contenant de l'acide chromique ainsi que de l'acide nitrique et au moins un sel fournissant des anions d'activation, ladite pulvérisation de chromatage mouillant les surfaces extérieures desdites grilles de réfrigérateur et étant terminée en pas plus de 60 secondes par la formation d'une couche de chromate jaune sur les pièces ; et pour finir
   (d) le rinçage à l'eau et le séchage des pièces recouvertes de chromate, l'application d'un revêtement de résine synthétique au moyen d'une application par pulvérisation électrostatique de poudre, suivie par une cuisson au four du revêtement de résine appliqué, lesdites grilles de réfrigérateur restant sur ledit moyen de suspension jusqu'à la fin de ladite cuisson au four.

2. Procédé selon la revendication 1, dans lequel, immédiatement après ladite opération de revêtement de zinc, lesdites grilles de réfrigérateur sont lavées à l'eau et transférées jusqu'à l'opération de revêtement de chromate, le temps de transfert depuis ledit lavage à l'eau jusque dans la solution de chromatage pulvérisée étant inférieur à 30 secondes.

3. Procédé selon la revendication 1 ou 2, dans lequel ledit revêtement de résine synthétique est formé à partir d'une résine époxy-polyester.

Fig. 1

CONTINUOUS METHOD FOR PREPARING STEEL REFRIGERATOR RACKS FOR RESIN COATING

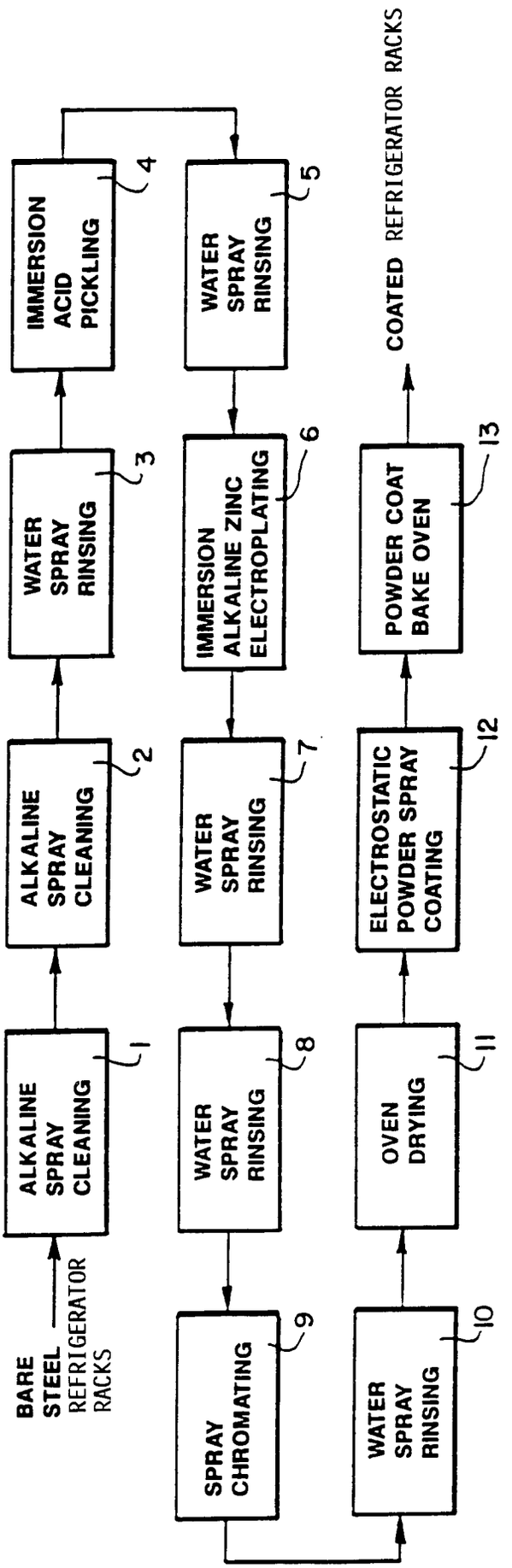
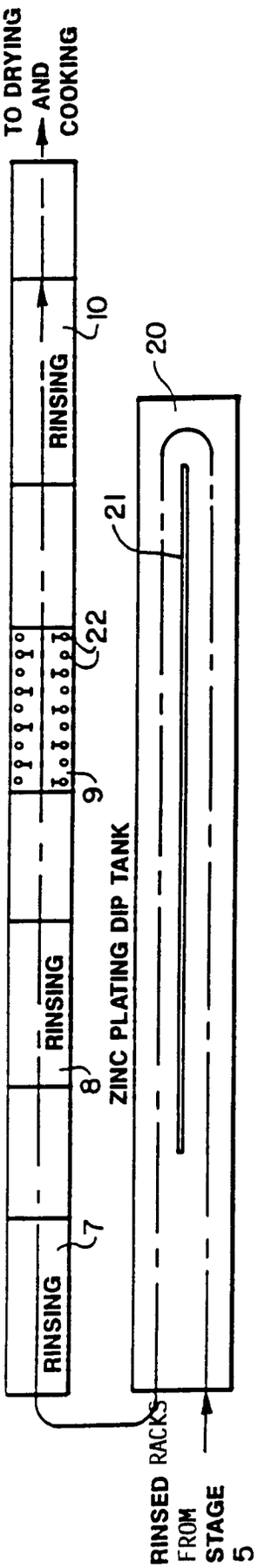


Fig. 2



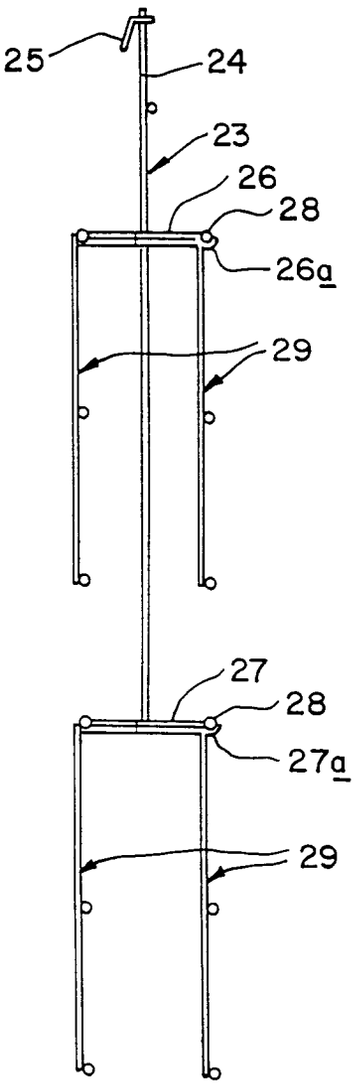


Fig. 3

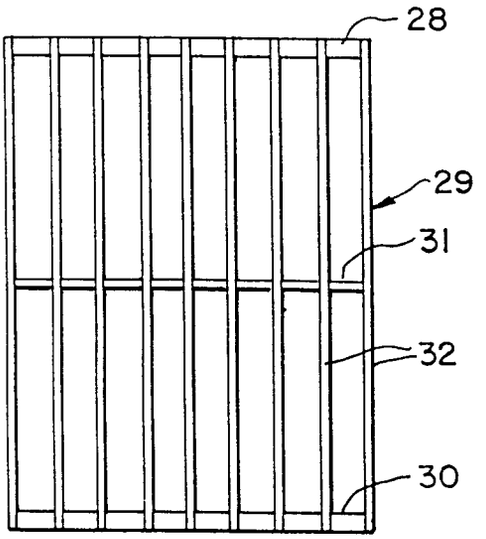


Fig. 4

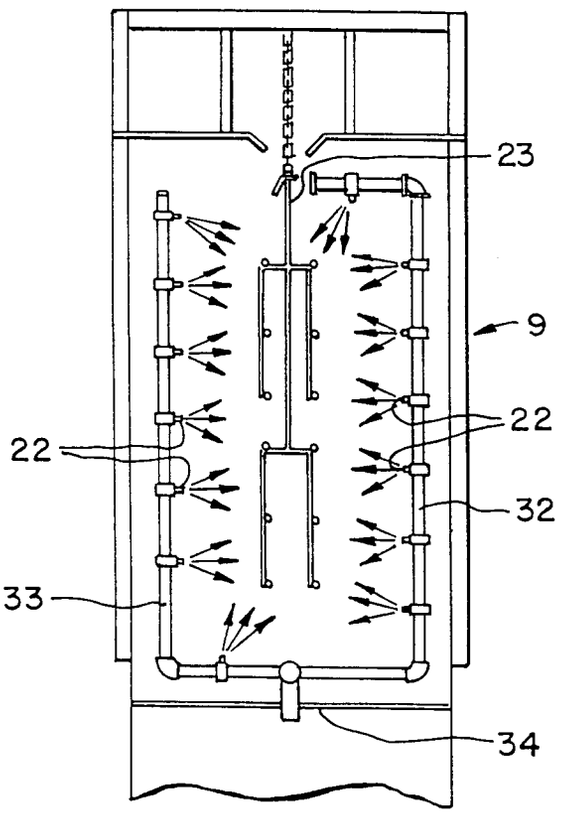


Fig. 5