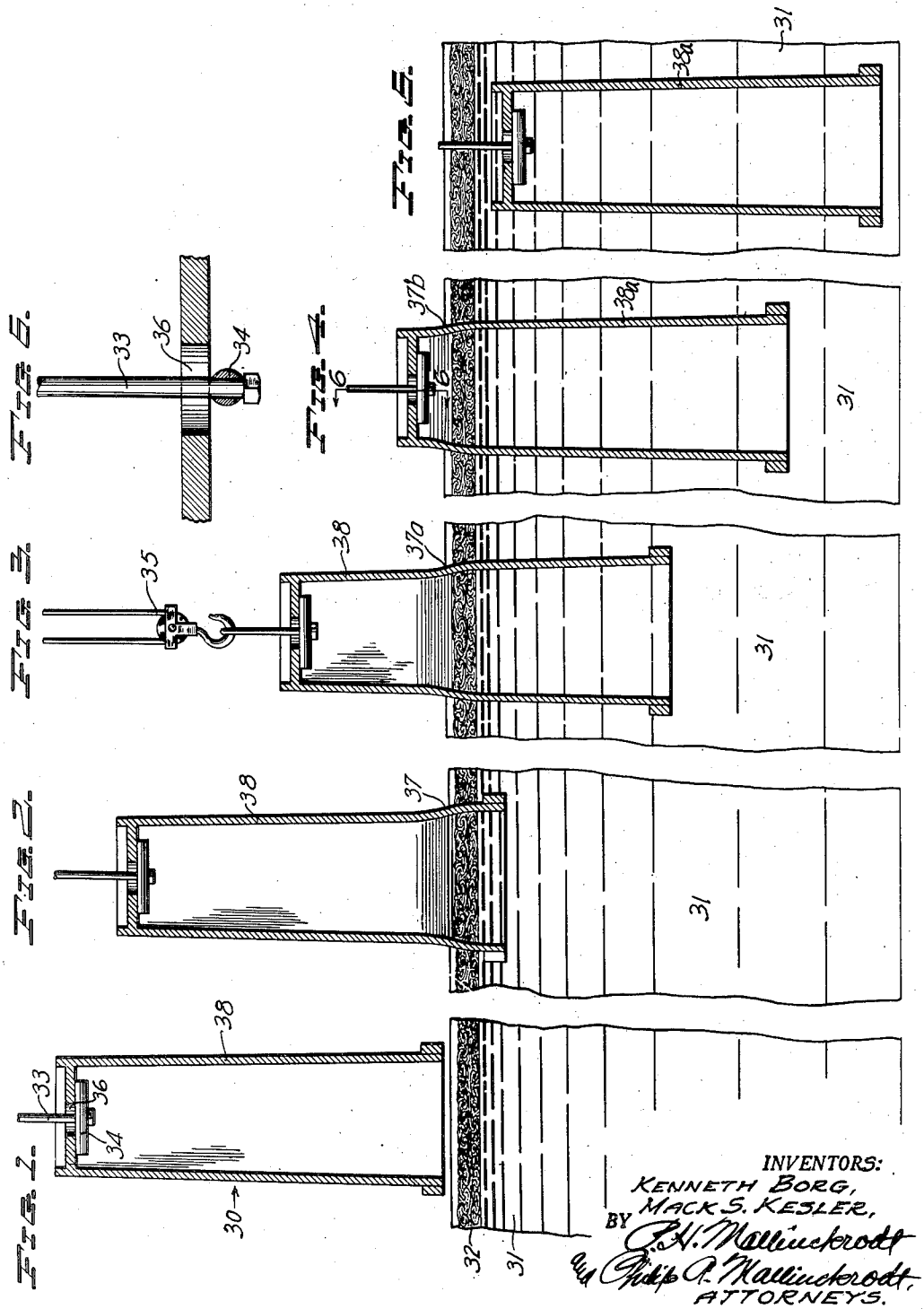
Aug. 2, 1949. K. BORG ET AL 2,477,684

METHOD AND APPARATUS FOR GALVANIZING SHEET METAL VESSELS

Filed May 17, 1945 4 Sheets-Sheet 1



INVENTORS:
KENNETH BORG,
MACK S. KESLER,
BY C. H. Mallinckrodt
and Philip A. Mallinckrodt,
ATTORNEYS.

Aug. 2, 1949. K. BORG ET AL 2,477,684

METHOD AND APPARATUS FOR GALVANIZING SHEET METAL VESSELS

Filed May 17, 1945 4 Sheets-Sheet 2

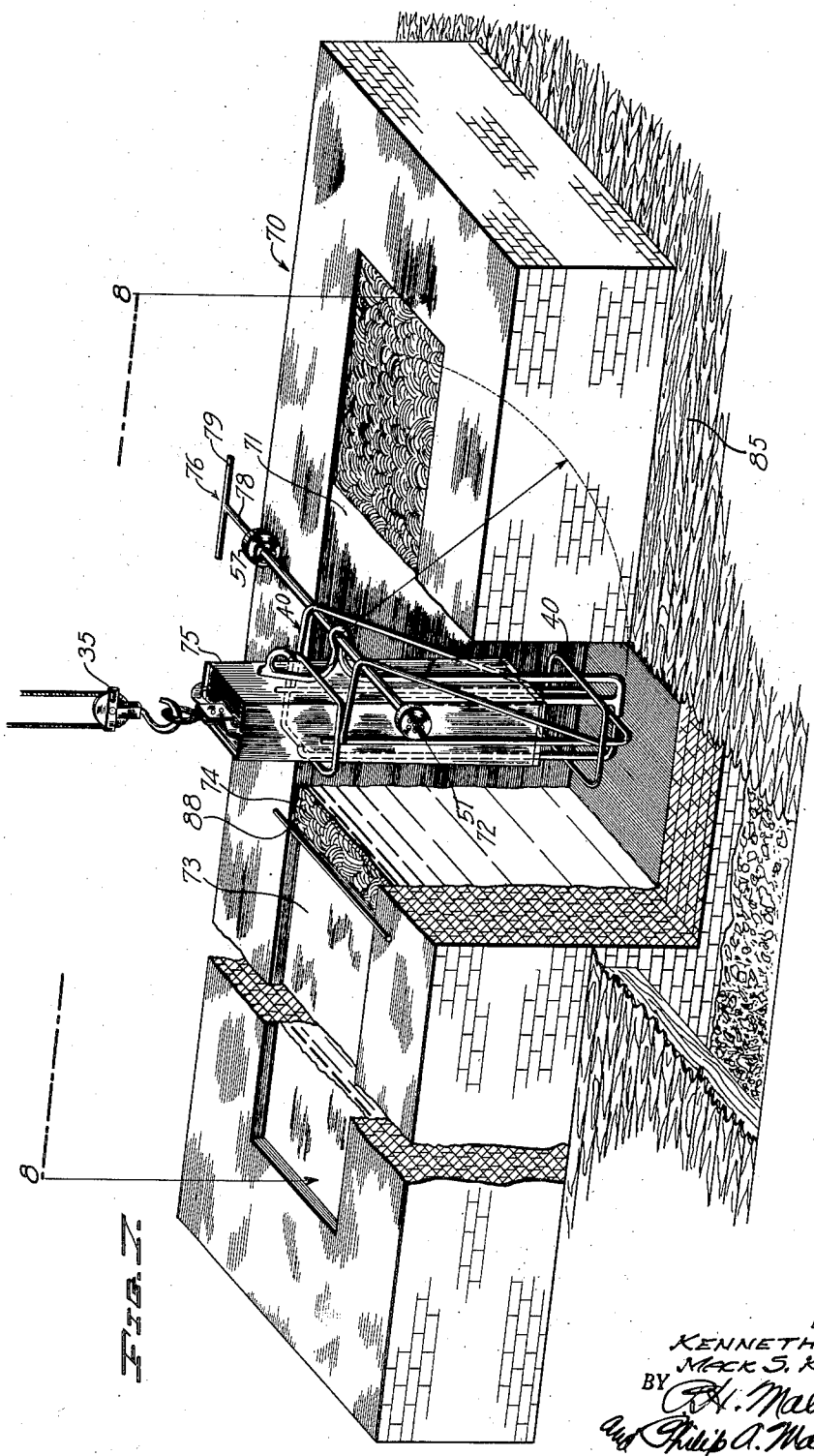


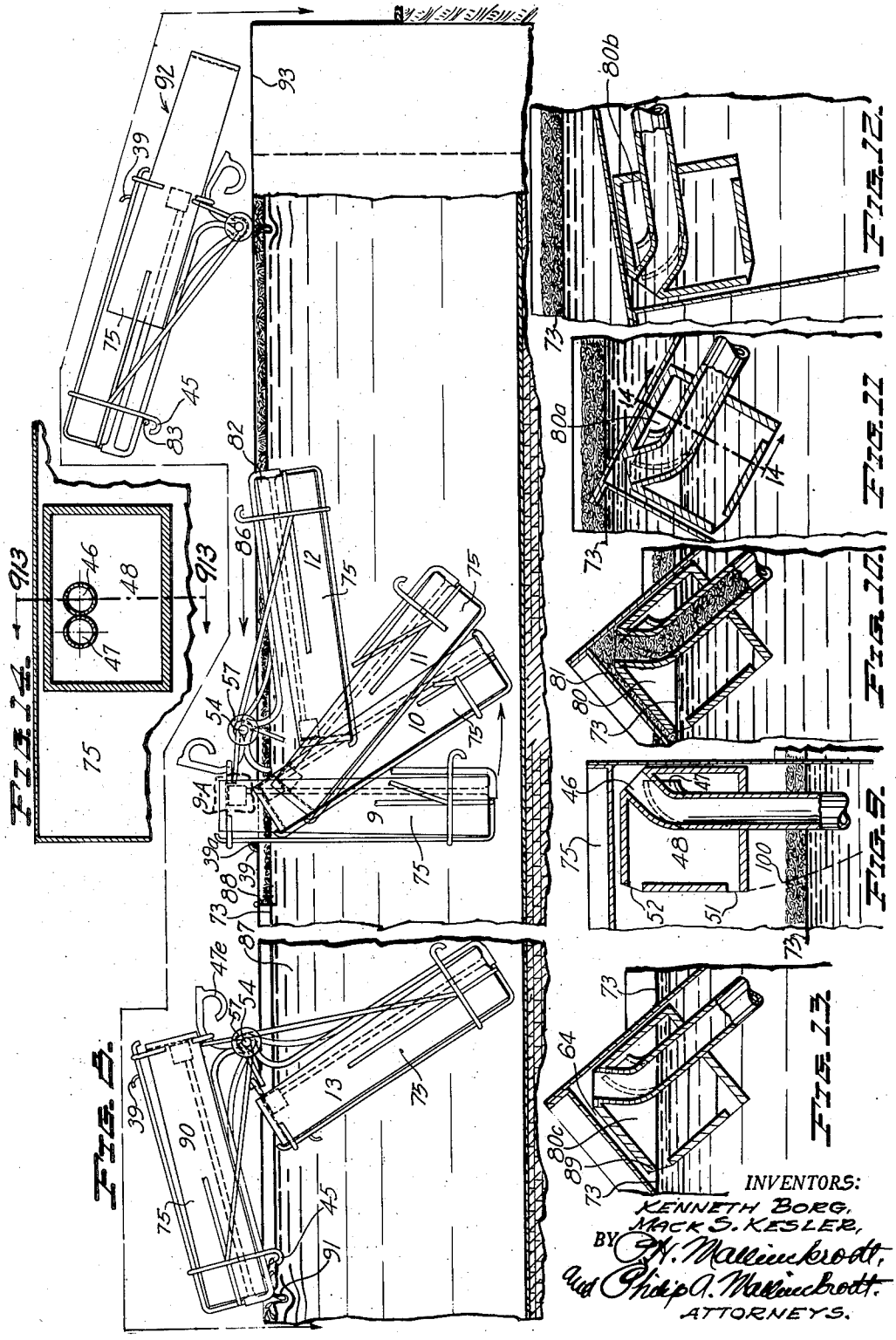
Fig. 7.

INVENTORS:
KENNETH BORG,
MACK S. KESLER,
BY H. Mallinckrodt,
and Philip A. Mallinckrodt
ATTORNEYS.

Aug. 2, 1949. K. BORG ET AL 2,477,684

METHOD AND APPARATUS FOR GALVANIZING SHEET METAL VESSELS

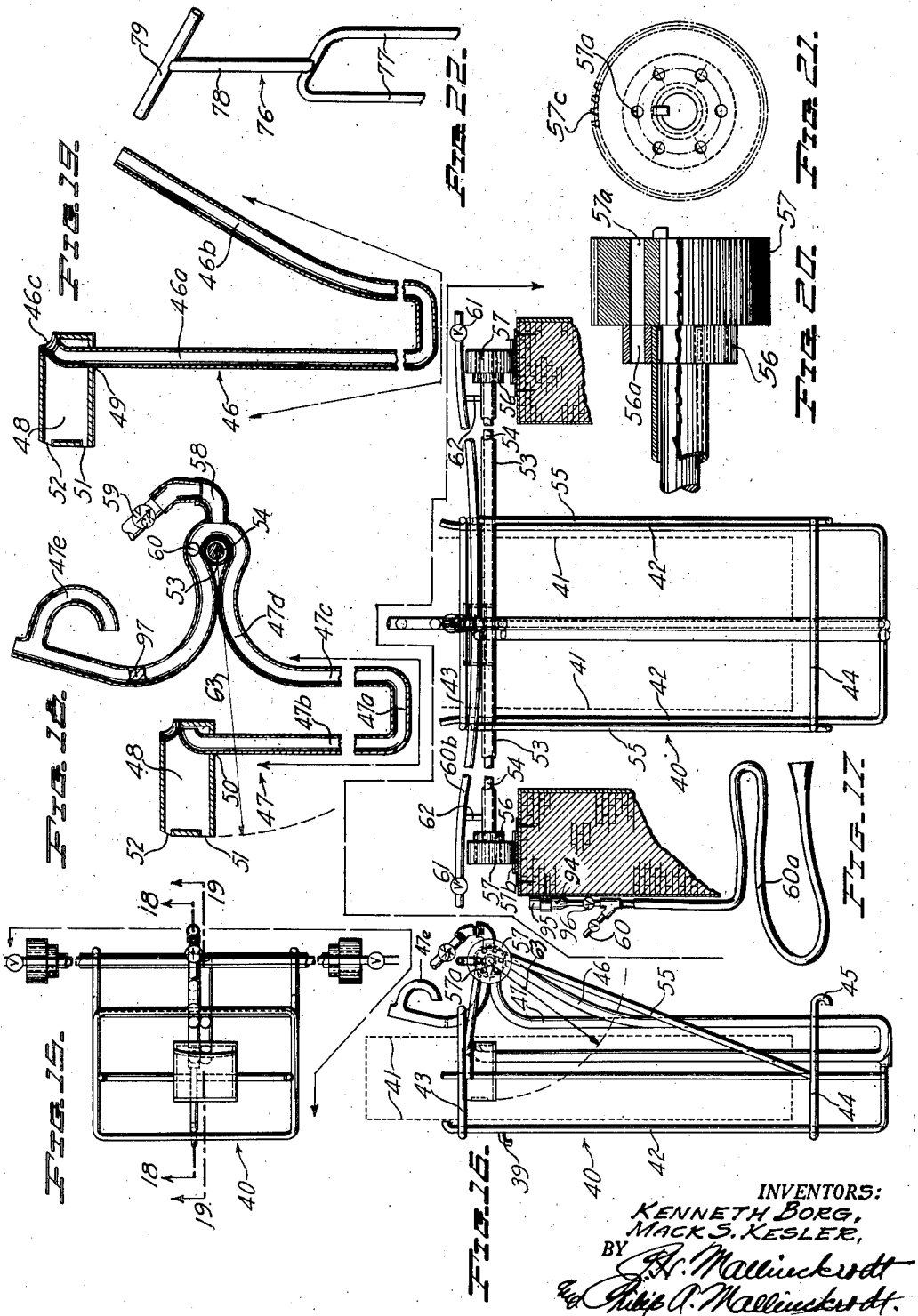
Filed May 17, 1945 4 Sheets-Sheet 3



Aug. 2, 1949. K. BORG ET AL 2,477,684

METHOD AND APPARATUS FOR GALVANIZING SHEET METAL VESSELS

Filed May 17, 1945 4 Sheets-Sheet 4



INVENTORS:
KENNETH BORG,
MACK S. KESLER,
BY
J. H. Mallinckrodt
and Philip A. Mallinckrodt.
ATTORNEYS.

Patented Aug. 2, 1949 2,477,684

UNITED STATES PATENT OFFICE

2,477,684

METHOD AND APPARATUS FOR GALVANIZING SHEET METAL VESSELS

Kenneth Borg and Mack S. Kesler,
Salt Lake City, Utah

Application May 17, 1945, Serial No. 594,274

12 Claims. (Cl. 117—97)

1

This invention relates to a method of galvanizing, and more particularly to a method of galvanizing metal vessels of different kinds, but especially open top vessels having considerable depth, as for example, the metal cans used in freezing cakes of ice in the artificial ice industry.

This invention also relates to the art of smoothing out irregularities in sheet metal articles of manufacture and preventing formation of irregularities and buckling, which are inherently incident to and occur during the processes of hot-coating or galvanizing sheet metal vessels as ordinarily practiced, by dipping into molten metal in a so-called kettle.

The ordinary manner of galvanizing a vessel of the kind mentioned, is to suspend it over the galvanizing kettle in nearly a horizontal position; lowering one edge or corner of the open end into the bath of molten metal and then lowering the closed end so that the vessel can fill and sink below the surface of the bath similar to the way one would fill a glass with water from a pond. In removing the vessel from the bath the edge or corner of the open end is first raised above the surface; then the closed end is raised as the vessel empties, and finally the vessel is entirely removed from the molten bath with the open end down so that it can drain into the galvanizing kettle and cool. This way of carrying out the galvanizing operation results in buckling the side walls of the vessel, often to the extent of ruining the vessel.

In opposition to the usual procedure we suspend the vessel vertically over the galvanizing kettle with the open end pointed downward, so that the first contact of the vessel with the molten metal is in the form of a band or zone of substantially uniform width around the open end. Since the air inside the vessel will not allow the molten metal to enter, we vent this air space either through an aperture in the vessel bottom or through a U-shaped pipe extending from the interior of the vessel down through the bath of molten metal and to the air outside. As the dipped zone rises in temperature, its yield point diminishes far below the yield point of the contiguous metal zone of cooler metal immediately above. As a consequence, as the metal in the dipped perimetral zone rises in temperature, it begins to expand, but the cooler metal in the undipped adjacent zone constrains that expansion in direct proportion to the then existing moduli of elasticity in the cooler and the hotter zones.

Ordinarily the term "galvanizing" means that an article of metal such as iron or steel is coated

2

with another metal having a much lower melting point, such as zinc. It is convenient herein, by way of illustration, to describe the invention with respect to that particular purpose, but without thereby necessarily limiting its scope.

In specifically applying the general principles previously stated, it is to be realized that in dipping a can to be galvanized into a bath of molten zinc, there is not really a complete discontinuity of temperature change between the colder and the hotter zones, and that the temperature gradient can be made sufficiently abrupt by regulating the speed at which the can is lowered into the molten zinc so that the yield point in the hotter zone is passed and internal stresses are distributed in the hotter zone while the more rigid metal in the contiguous cooler zone preserves the shape of the can.

If the metal in the can is relatively thin, the dipping may proceed rather rapidly or even at discontinuous increments until the can is covered. This speed and the size and frequency of increments may be determined by observing that portion of the can immediately above the surface of the molten zinc. As long as the sides of the can bulge outward above the surface, immersion may continue. But this bulge must travel ahead of the line of immersion in order to prevent buckling or reverse curvature from occurring. Finally the can is raised vertically out of the zinc bath as rapidly as expedient.

In practicing the invention, it has been found advantageous to employ a novel apparatus comprising a holder or so-called "jig" for holding a can during the galvanizing operation. The jig and its mode of use will presently be described in detail.

The principal objects of the invention are summarized as follows:

(*a*) To vertically suspend an open-ended vessel or article over a galvanizing kettle with the open end pointed downwardly, that is to say, inverting the vessel.

(*b*) So lowering the article that the first contact with the molten zinc is in the form of a band or zone around the open end, and suitably continuing the immersion.

(*c*) So using the energy of the heat of expansion that the internal stresses within a hot zone where the yield point of the metal is low, are uniformly distributed, while the general shape of the article is maintained by the metal in the contiguous and cooler zones in which the yield point is sensibly higher.

(*d*) To provide a convenient means for lower-

ing an open top vessel of considerable depth, in an inverted position, into a galvanizing bath of molten metal.

(*e*) To securely hold the vessel vertical during the galvanizing operation.

(*f*) To effectively evacuate the air from the interior of a vessel having an open end and a closed end, as it is being lowered into the bath with the open end down, and to control the evacuation of air in a predetermined manner.

(*g*) To provide apparatus for causing the advantageous manipulation of the vessel while in a bath of molten metal, as well as to allow the advantageous removal of the vessel from the bath.

(*h*) To cause the flux which ordinarily floats on top of a galvanizing bath, to be so influenced that the proper distribution of the galvanizing metal upon the inside surface of the vessel results.

(*i*) To effect economies in the handling of vessels during the galvanizing process.

(*j*) In the phase of the invention where the jig is used, to start the removal of the vessel from the molten metal bath by blowing dry compressed air into the interior of the vessel above the plane of immersion for the purpose of expelling the molten metal from the inside of the vessel and at the same time exerting a positive pressure against the inside surface of the sidewalls of the immersed vessel, thereby removing any danger, because of the possibility of a partial vacuum within the vessel, of partial collapse of the heat-weakened sidewalls before rigidity due to cooling has begun to set in. This also provides buoyancy for the vessel and eases the rotative load of the vessel during its transit toward the draining position.

Other objects will become apparent during a reading of the description of the invention that follows.

In the accompanying drawings, which illustrate several ways of practicing the process of the invention,

Figs. 1 to 5 each represent one and the same fragmentary vertical section taken through a kettle and its molten galvanizing metal content, where a thin metal ice-freezing can is being lowered into the hot galvanizing bath; the successive steps in immersing the can in the bath are represented in the respective figures which serve to indicate the progress of the ensuing bulge along the walls of the can from where the can has just entered the bath as in Fig. 2, to the point where it is fully immersed in the molten bath as in Fig. 5;

Fig. 6, a fragmentary section taken on the line 6—6 in Fig. 4;

Fig. 7, a view in perspective of a usual galvanizing kettle with portions broken away to show clearly a more perfected manner of practicing the process than that represented in Figs. 1 to 5, the molten metal immediately surrounding the can being omitted for convenience; representation includes a jig;

Fig. 8, a diagrammatic vertical section taken along the plane indicated by the line 8—8 in Fig. 7 to show in succession various positions of the jig and the can it holds for galvanizing, during the progression from the initial immersion to the point of final deposit of the fully galvanized can on the unloading platform, portions of the jig being omitted for the sake of clarity;

Figs. 9 to 13, one and the same vertical section of that portion of the jig enclosed by line 9—A in Fig. 8, the section being taken along a vertical plane represented by the line 913—913 in Fig. 14; and illustrating various changes taking place within the vessel during respective stages of the process;

Fig. 14, a section on line 14—14 in Fig. 11;

Fig. 15, a top plan of the jig alone;

Figs. 16 and 17, a side elevation and a front elevation respectively, corresponding to Fig. 15;

Figs. 18 and 19, detailed vertical sections taken respectively on the lines 18—18 and 19—19 in Fig. 15, drawn to an enlarged scale, parts being broken away for convenience;

Fig. 20, a fragmentary elevation, partly in section, showing a minor detail;

Fig. 21, an end elevation corresponding to the showing in Fig. 20, and

Fig. 22, a special spanner wrench for sometimes rotating the axle on which the jig is supported, as shown in Fig. 7 where the spanner wrench is drawn to a reduced scale.

Referring to the drawings, Figs. 1 to 6, the numeral 30 indicates a usual freezing can for artificial ice, the can being made of relatively thin sheet steel, for example, No. 12, the size of the can being approximately 12 by 18 inches at the top, which is open, and 11 by 17 inches at the bottom, which is closed. The cans are usually about 58 inches high.

The numeral 31 indicates a portion of a bath of molten metal having sufficient depth to receive the can, and 32 a layer of flux floating on top of the molten metal 31, this layer being usually several inches in thickness.

In Fig. 1 the can is suspended from, for example, a rod 33 intersecting a crossbar 34 on the inside of the can, the rod 33 hanging from a suitable support such as an ordinary hoisting block 35. The can, which has previously been punctured, for example by forming a hole 36, and inverted and placed on the suspending rod 33, is now in a position to be lowered to the point where it is just about to contact and pass through the flux into the galvanizing bath.

In Fig. 2 the can has been gradually lowered into the position where the rim of the can is just being submerged in the bath. In Fig. 5, the can has been completely immersed in the bath after having passed through the successive stages indicated in Figs. 3 and 4.

In Fig. 2, the effect of having immersed the rim of the can in the bath has been to expand the metal and create a bulge 37, this bulge gradually crawling upward on the can through the stages 37*a*, Fig. 3, and 37*b*, Fig. 4, until finally the can has been completely submerged as indicated in Fig. 5. During the progress of the upward travel of the bulge 37, the effect upon the can will have been to smooth, or iron out, any wrinkles or distortions that may have existed in the wall 38 of the can before immersion, so that when the can is finally drawn out of the molten bath from the position in Fig. 5, the can will have been substantially restored to its original perfect shape. The vent opening in the can is sealed afterwards.

In order to facilitate the galvanizing action as just described, it is desirable that it be performed by means of a special holder or jig which has been developed with regard to the peculiar conditions arising during the galvanizing operations. There will now be described, first, the construction of the jig, and then the method of using it, it being understood that this jig is, in the present instance, designed primarily for ice

freezing cans, as hereinbefore particularly mentioned. It will, therefore, be understood further that other special holding structures can be worked out in accordance with the teachings hereof, to suit any peculiar requirements and to attain any particular object.

Referring now to Figs. 15 to 21, the jig comprises a framework **40** suitably constructed of light members made of a suitable metal, in this instance iron or steel. The jig is so designed that an ice freezing vessel can gradually be inserted therein somewhat as indicated by the dotted lines **41** in Figs. 16 and 17. The exact procedure of bringing the can down into the final position in the jig will be described hereinafter with respect to Figs. 8 to 14. At this point it is sufficient to state that the framework **40** is composed of vertical members **42** connected to one another by means of transverse perimetral members **43** and **44**, and is disposed to travel the length of a kettle.

Rigidly mounted in this structure are two pipes **46** and **47**. Pipe **46** comprises the substantially vertical portion **46***a* and the inclined portion **46***b*, Fig. 19. At the upper terminus of the portion **46***a* is an air control box or cell **48**, the cell being rigidly connected to the pipe at its mouth **46***c*, the pipe and the bottom of the cell being securely welded together at the point **49**. The cell **48** is also rigidly connected to the pipe **47** at a point **50**, Fig. 18. Thus the cell **48** is rigidly supported by the two pipes **46** and **47**. The cell is airtight all around except at the two slots **51** and **52** which extend across one end of the cell as indicated in Figs. 18 and 19. The inclined portion **46***b* of the pipe **46** has its upper extremity in free communication with the atmosphere. The pipe **47** has a U-bend **47***a* at its lower extremity from which the two branches **47***b* and **47***c* extend upwardly. The branch **47***c* has the return bend **47***d*, forming a loop in which is rigidly mounted a tubular casing **53** within the latter is rotatably mounted an axle **54**. The tubular casing **53** is also rigidly connected to the bracket members **55** forming part of the framework. These bracket members form a brace for the framework.

At the opposite extremities of the tubular casing **53** are rigidly mounted collars **56**, Figs. 17 and 20, and adjacent these collars are traction wheels **57** rigidly mounted on the axle **54**; thus the wheels and axle are freely rotatable with respect to casing **53**. At certain times it is desired to hold the wheels **57** stationary with respect to the jig frame, and, for this purpose, holes **57***a* are provided in the traction wheels, these holes being in registry with other holes **56***a* that extend through the collars **56**. The purpose of the registering holes will be presently explained in connection with the operation of the jig.

The pipe **47**, with respect to the air control cell **48**, has its upper end, though closely adjacent a wall of the cell, in free communication with the interior of the cell. Near its outer extremity, the pipe **47** is provided with an air inlet **58**, Fig. 18, controlled by a check valve **59** that permits atmospheric air to flow into the pipe **47**, but at the same time prevents egress of air from the pipe. Instead of atmospheric air, an alternative construction provides compressed, dry air from a suitable source (not shown). According to this alternative construction, a supply line **60**, Fig. 17, has connected to it a flexible conduit, for example, a rubber hose **60***a*, the flaring end of which is in turn arranged for slipping onto either end of a conduit **60***b*, which, in this instance, is supported on uprights **62** rising from the member **53**. Thus, by means of the flexible conduit, the compressed-air connection can be kept intact in all the positions of the jig in its travel along the kettle.

The particular functions of the air-control cell **48** and its appurtenances will presently be made clear while describing the operation of the jig.

The jig, with respect to its travel along the kettle, is supported on the axle **54** and its wheels **57**, Figs. 7 and 8, the wheels having their traction on the top of the kettle side walls. It is frequently desirable that the wheels **57** be in the form of toothed pinions as indicated as **57***c* in Fig. 21, and that these be in mesh with toothed racks **57***b*, so that any slippage along the line of traction is prevented. In order to provide, in this instance, for the manipulation of the jig in the kettle, a handle having the shape of a gooseneck **47***e* extending from the pipe **47** is found advantageous. Hooks or lugs **39** and **45** are positioned at convenient points on the jig frame **40** for purposes that will be explained later herein. Flow of compressed air through the system is conveniently regulated by valves **61**. The jig swings about axle **54** as indicated by the radius **63**, Figs. 16 and 18.

The manner of using the jig in practicing this process is clearly indicated in Fig. 7 where **70** indicates the kettle, this being frequently built of fire brick with a lining of sheet iron or steel as indicated at **71**. The kettle is of suitable dimensions to accommodate the class of work that may be done in a particular shop. In this instance, the kettle has considerable length and sufficient width to conveniently accommodate the jig with its load as indicated in Fig. 7, the depth of the kettle being not quite equal to the height of the jig. The kettle, however, has considerable length for the reason that the jig and its load, in accomplishing the desired operation, must travel a certain longitudinal distance back and forth through the hot metal bath.

The position of the jig **40** with respect to the kettle in Fig. 7 is the one in which it is receiving the can **75**, the descent of the can into the jig being attended with process features and galvanizing results similar to those previously described in connection with Figs. 1 to 5, the exception being that the air from the inside of the can is being evacuated by means of the pipe **46**. It is convenient hereinafter to refer to this pipe as the "zinc" pipe or conduit, while the pipe **47** is referred to as the "air" pipe or conduit. The position where the can finally comes to rest in the jig is indicated by the numeral **9** in Fig. 8.

The molten zinc bath in the kettle is designated as **72** and its upper surface as **73** with the layer of flux **74** floating thereon. In the position shown in Fig. 9, the molten zinc will have entered the can, the level of the zinc within the can being even with the level of the bath in the kettle, the air having meanwhile been evacuated through the zinc pipe **46** so that the air control cell **48** stands approximately in the position indicated in Fig. 9 while the level of the bath stands substantially at **73**, somewhat below the cell.

During the operation of lowering the can **75** into the jig as just mentioned, the latter is held in an upright position by means of a rod **39***a*, Fig. 8, engaging the hook **39** and resting on the sidewall of the kettle. A spanner wrench **76**, Figs. 7 and 22, having the prongs **77**, the stem **78**, and the handle **79** is then brought into a posi-

tion where the prongs can be pushed through two diametrically opposed poles 57*a* of wheels 57 which, in turn, are brought into registry with two respective holes 56*a* of collars 56, whereby the jig is held in approximately the position shown in Fig. 7, by a workman (not shown) holding the two ends of the handle 79. As soon as the can 75 has been lowered into the position 9 in Fig. 8, the workman, by means of the spanner wrench, turns the jig, in this instance in the direction of the arrow, so that the can comes successively into the respective positions 10, 11 and 12 in the same figure, during which time the air pipe 47 and the zinc pipe 46 in conjunction with the air control cell 48 function as follows: In moving from the position 9 to the position 10, Fig. 8, the upper portion of the can lowers until the air control cell reaches the position shown in Fig. 10 where the zinc has flowed into the cell through the slot 51 and where the cell, relatively to the surface 73 of the zinc bath, stands substantially as shown. Meanwhile the flow of zinc through the slot 51 will have forced a portion of the air, together with such flux as may have been present, out through the slot 52. At the same time the flux, which previously was on the top of the zinc in the can as the latter descended, will have been crowded up by the rising metal into and through the space 81 between the air control cell and the closed end of the can 75, the path followed by the evacuating flux finally leading into the mouth of the zinc pipe 46, much of the flux for the moment being retained in the zinc pipe.

In the position of the air control cell indicated in Fig. 11, the cell has been lowered into the zinc bath so that the relative rising of the zinc in the cell has acted to compress the original volume of the air in the space 80 into the upper part of the air control cell and back into the air pipe 47 and against the check valve 59 which acts to prevent escape of the compressed air, the space 80 having by this time been reduced to the space 80*a*. Although the volume of space 80 has been decreased on account of the increased pressure, that volume has tended also to increase because of the higher temperature, these two circumstances in a measure offsetting each other.

In the position of the can shown in Fig. 11, the can will have been lowered into the bath substantially to the extent shown, where the can is practically submerged in the molten bath. Meanwhile, the rising zinc will have forced the flux, floating on the zinc surface within the can, through the mouth 46*c* into the zinc pipe 46, and will have followed the flux into the zinc pipe, thereby forcing the flux through the zinc pipe and back into the bath and sealing off any further passage of air or flux through the pipe 46 with a dam of molten zinc.

In Fig. 12 the jig is so located that the open end of the can is at a higher elevation than the closed end, this being for the purpose of allowing the last small remnants of the flux and the air to escape from the can at the point 82 Fig. 8. In Fig. 12, the air space 80 in the air control cell of Fig. 10 is shown contracted in the space 80*b*.

In moving the jig and the can from the position 12 in Fig. 8, a second workman projects an iron bar 83 into and through the hook 45 (conveniently omitted in this position of the jig); the first workman removes the spanner wrench and grasps the other end of the iron bar and the two workmen, walking on opposite sides of the kettle and on the floor 85 in Fig. 7, roll the jig in the direction of the arrow 86, Fig. 8, towards the far end of the kettle 70 where there is no flux, the flux being normally stopped off by a conveniently located dam 88. The jig comes to rest at a suitable point where the workmen release the handle 47*e* (conveniently omitted in this position of the jig) and allow the jig and the can to swing on the axle 54 into substantially the position 13 where the common center of gravity is directly below the axle 54.

In the position of the can designated 13 in Fig. 8, the condition in the control cell is clearly indicated in Fig. 13. Here the cell is in a position where the lip 89 has just risen slightly above the surface 73 of the zinc bath thereby having released the air from the space 80*c*, allowing it to flow into the can and around the control cell and causing all the liquid zinc in the can and the pipe 46 to subside to the level 73 of the bath in the kettle, the air in the space 64, Fig. 13, having been supplied from the air space 80*c* which latter space in turn is supplied with air through the air pipe 47 and the check valve 59 or through the dry compressed air line 60.

The first workman now swings the can around the axle 54, by means of the spanner wrench, to the position 90, where any remaining portion of the molten zinc in the can is drained off at the open end thereof, as indicated at 91. After draining at the position 90, the jig and the can are further rotated by the first workman sufficiently to allow the second workman to thrust the bar through the hook 45 and let the bar come to rest across the top of the kettle. The first workman now removes the spanner wrench from the traction wheel and grasps the far end of the bar, after which the two workmen together further rotate the jig with the can by means of the bar, permitting the molten dam in the zinc pipe to drain out into the kettle while they walk forward and push the jig and the can into the position 92, Fig. 8, where the can is in the act of sliding out of the jig onto the delivery platform 93.

The primary purpose of the air control cell 48 is to prevent either flux or molten zinc from entering the air vent pipe 47, since that pipe must always be available for drawing air through the check valve 59 into the interior of the can as it emerges from the zinc bath. In every cycle of operation, the jig must be brought into the position where the pipe 46 is emptied of its residual zinc content, for example, position designated by the numeral 92 in Fig. 8, so as to be ready for the next cycle.

While the primary function of the air cell is to prevent the zinc or flux from entering the air vent pipe 47, a secondary function is to crowd the flux floating on top of the zinc within the can, into the intake of the zinc pipe 46 so the latter will act as a flux siphon. Therefore, the exterior of the cell should be so configurated that it follows relatively closely the internal contour of the vessel being galvanized, so that, due to its shape, it will act to crowd the flux as just explained.

Moreover, the air cell should be so designed that its slot 51 passes through the flux floating on top of the molten zinc, in a direction such that the flux is sheared off along the plane of the slot as it submerges through the flux and into the zinc, as indicated by the dotted arc 100 in Fig. 9. Also, the slot 52 should be so located and in such a position that it will have the advantage of following the path already piloted by the lower part

of the box through the flux, in order that a minimum of flux will have been allowed to enter the air cell through either of the slots **51** or **52**. By this arrangement a portion of the air in the air cell is forced out through the slot **52** as it passes downward through the flux toward the molten zinc, thereby preventing ingress of the flux. The dimensions of the air cell should be so chosen that the residual air space **80** left within it, as indicated in Fig. 10, is such that the effect on its volume due to increased pressure caused by immersion beneath the molten zinc surface, is principally compensated by the rise in its temperature in passing from without to within the molten zinc bath.

As clearly shown in Fig. 13, the space **64** between an outside surface of the air cell and the inside surface of the can and the interior surface of the can above the surface of the zinc, will already have been filled with hot air at the time the lip **89** at the slot **52** has risen to the elevation of the zinc surface outside the can, thus having prevented any exterior atmospheric pressure from having exerted a collapsing force on the contiguous portions of the can.

As a matter of practical construction, it is convenient to make the assembly of the air cell, the air pipe, and the zinc pipe together to lend strength to the entire mechanism.

In the common and accepted practice in hot galvanizing, it is customary to throw dry flux on the surfaces of a vessel being galvanized, as the vessel emerges from the molten bath, in order to float off all dirty flux spots. Obviously, this is an inconvenient and ineffective way to float off the dirty flux spots from the interior surfaces of a vessel that is relatively tall. As a means of circumventing this faulty practice and implementing a better and more effective practice, it is contemplated according to the invention, to blow a charge of dry flux with dry compressed air through the air pipe **47** at, or a little subsequent to, that point in the process illustrated by Fig. 13. This charge of flux partly sublimes and partly floats on the surface of the zinc inside the can, thereby washing down its interior surfaces progressively as the can emerges from its molten zinc bath.

A device for introducing the flux into the compressed air line **60** is shown at **94**, Fig. 17; in this instance it is a funneled container having a removable, tight closure **95** with a regulable gate **96** to feed the flux into the air line **60** as desired. Accordingly, the flux can be blown through the air pipe **47** in the required manner. A plug **97** (Fig. 18) prevents air from wasting through the outer end of the air pipe.

It has been observed that if one of the flat surfaces of a relatively thin sheet of metal is suddenly raised to a temperature considerably above the temperature of the other flat surface, a mechanical moment is suddenly set up which causes the sheet to bend with the hotter surface on the convex side. To prevent flexure of this kind during the galvanizing process, it is a primary intent of the invention to introduce objects made of sheet metal, into a galvanizing bath in such a way that the corresponding points on both sides of a sheet portion thereof, are raised in temperature at the same instant in so far as this is practicable. In line with what has just been stated it can be seen that during the successive steps of this process as set forth in Figs. 1 to 5, the principal strains are calendered from the open end toward the closed end of the can so that the internal stresses created at the perimeter of contact between the molten zinc and the can have been distributed uniformly along the line of the perimeter, or in other words, have been made to approach zero as a limit. The residual strain which will be left in the closed end of the can is relatively unimportant in that it does not interfere with the extraction of a frozen ice block from the can when in use.

It is here to be noted that the permanent buckling created in the walls of a large percentage of ice freezing cans when galvanized by faulty ordinary methods, render such cans unusable because ice blocks can not be easily removed from the cans. Such cans represent a total loss as touched upon earlier in this specification.

The particular advantage of the invention is that it permits successful galvanizing of vessels made of black iron with welded seams. Competitive with this advantage is a method in common use which consists in making vessels of galvanized sheets, in which the seams are welded, and afterwards metalized where the original galvanizing was burned off. This method entails the additional expense of metalizing. Another common but older method is to construct the can of galvanized sheets and rivet them together. Here it is necessary to put a lead gasket between formed sheets along the marginal portions to be riveted so that the mutually contiguous sheets shall be drawn tightly against the lead gaskets in order to make the seams watertight. By means of the invention it is possible to rivet the metal sheets together without any gasket, because the space between the sheet margins is thus made so small that subsequent galvanizing seals the seams.

The process of the invention is especially useful in its application to the ice-freezing cans dealt with specifically in the foregoing. This is so because the substantially plane side walls thereof readily wrinkle and otherwise deform inwardly of the can during an ordinary galvanizing procedure. Similarly, other hollow articles having plane side walls are particularly susceptible to undesirable deformation by ordinary methods of galvanization. Pursuant to the invention, deformation of the plane side walls is so controlled during the galvanizing process as to leave no undesirable final deformation.

The various phases of the process are beneficially applied to a wide variety of sheet metal bodies which are dipped or immersed in a hot metal bath in the manner described by the provisions of the invention. Whatever the exact shape of a sheet metal body may be, the immersing procedure is conducted in such a way that a perimeter at which the initial contact with the molten metal bath takes place, lies, just before the initial contact occurs, as nearly as possible in a plane substantially parallel to the mirror surface of the molten bath.

The use of the dry compressed air to expel the molten metal from a can **75**, when starting the withdrawal of the can from the bath, can be visualized by referring to Figs. 8 and 13. In Fig. 8 the position of the can just as its withdrawal starts, is denoted by the numeral **13**, and the conditions within the can at that time, are represented in Fig. 13. The compressed air enters the can through the air pipe **47**, its rate of entry being controlled by one of the valves **61**, Fig. 17, in accordance with the observed behavior of the can structure as it rises above the surface of the bath and moves toward the position denoted by the numeral **90**.

While specific embodiments of the invention are herein disclosed, it is limited only by the terms of the following claims.

Having fully described our invention what we claim is:

1. A method of galvanizing open-top metallic vessels of considerable depth, comprising positioning a vessel-receiving jig in a molten metal bath; inserting the vessel with the open end down substantially vertically in bulge-controlled stages in the jig until the vessel is almost completely submerged in the molten metal bath; gradually rotating the jig in a given direction until the lower end thereof reaches a point in proximity to the free surface of the bath, thereby completely submerging the vessel; reversing the rotating operation of the jig until the lower end thereof again reaches a point in proximity to the free surface of the bath; continuing the reversed rotation of the jig until the entire vessel emerges from the bath; and removing the galvanized vessel from the jig.

2. A method of galvanizing open-top sheet metal vessels of considerable depth, comprising positioning a receiving jig substantially vertically in a bath of molten metal; suspending a vessel in an inverted position above the jig; lowering the vessel into the jig and into the molten bath until the vessel is largely submerged in the molten bath, meanwhile causing the air to be evacuated from the interior of the vessel during the lowering operation; tipping the jig until the vessel is completely submerged in the molten bath; reversing the tipping operations previously enacted and continuing the reversed tipping operations until the jig with its vessel emerges from the surface of the bath, during which operation any excess of the galvanizing metal is cleared from the vessel; and removing the vessel from the jig.

3. A method of galvanizing open-top sheet metal vessels of considerable depth, comprising positioning a vessel-receiving jig in a receiving position in a molten bath of galvanizing metal; suspending a vessel in an inverted position above the jig; lowering the vessel by bulge-observed, graduated stages into the jig; evacuating the air from the interior of the vessel through suitably disposed conduits; tipping the jig with its contained vessel so that the lower end of the jig rises in the bath to a point in proximity to the surface of the bath; reversing the tipping operation until the lower part of the jig again rises to a point in proximity to the surface of the bath but this time in the reversed position of the vessel; removing any residual substances from the vessel and raising the vessel out of the bath.

4. A method of galvanizing according to claim 2, wherein the bath of molten metal has floating on its top surface a layer of fluxing material; wherein the vessel as it lowers into the bath has floating within it a portion of the fluxing material; and wherein is included the step which comprises expelling the fluxing material from the vessel after the said fluxing material has contacted the inside portion of the closed end of the vessel.

5. A method of galvanizing according to claim 1, wherein flux is floated on the surface of the molten metal bath and wherein after rotation of the vessel has started from the almost-submerged position thereof, the step which comprises entrapping a segregated quantity of atmospheric air to prevent flux or molten metal from subsequently interfering with the entry of breather air into the space of the entrapment.

6. A method of galvanizing according to claim 2, wherein dry, compressed air is introduced into the vessel at approximately the time the final stage of emptying the molten metal from the vessel occurs.

7. In a system of galvanizing for vessels having an open end and a closed end, apparatus including a U-shaped conduit for receiving a vessel to be galvanized, said conduit having one of its branches adapted for insertion within the vessel and the other of its branches adapted to remain outside said vessel; an air-control box at the end of the first-mentioned branch; and an air-check at the end of the second-mentioned branch; said apparatus with said vessel being submersible in a bath of molten metal within which the U-conduit is operative to expel air from the vessel as it is moved into or through the molten bath.

8. A jig for use in galvanizing vessels of considerable depth and having one end thereof open, including in combination a frame adapted to receive a vessel open-end down and to descend into a bath of molten metal having a layer of flux on the surface thereof; a conduit for air supported on said frame, said conduit having one end thereof disposed to be within the vessel and the other end disposed to be without the vessel; an air-control cell at the first-mentioned end operative to evacuate entrapped air from the vessel as molten metal approaches the closed end of the vessel; and a second conduit operative to expel flux from inside the vessel, through the said second conduit being controlled by said cell.

9. A jig for use in galvanizing vessels of considerable depth, said vessels having one end thereof open, the said jig including in combination, a frame having a normally positioned top and bottom adapted to receive a vessel open-end adjacent said bottom; a two-mounted conduit operatively attached to said frame and having one mouth thereof within said frame the other mouth being without said frame; and an air-control cell operatively positioned in communication with the first-mentioned mouth.

10. A jig for use in galvanizing vessels comprising a frame having a top and a bottom adapted to receive a vessel with the open-end thereof down for submerging in a bath of molten metal; a conduit for air having one end within the frame and the other end without the frame; a molten-metal conduit having one end within the frame and the other end without the frame; and an air-control cell operatively connecting the air conduit to the second-mentioned conduit.

11. A galvanizing jig comprising a frame having a top and a bottom disposed to receive a vessel open-top down; an air control cell disposed on the said frame so as to occupy a position within the frame in proximity to the top thereof; a conduit having one end thereof within the air cell and the other end without the frame; another conduit having one end within the frame but outside the air cell in near proximity thereto; means for suspending the jig within a galvanizing kettle; and means for swinging the suspended jig within the kettle.

12. A method of galvanizing sheet metal vessels having an open end and a closed end which comprises the steps enumerated as follows: moving the vessel over a bath of molten metal so that the open end thereof is near and substantially parallel to the surface of the bath; entering the end that is open into the bath and simultaneously causing the liquid metal flowing

into the vessel to expel air from the interior thereof; moving the vessel farther into the bath in successive increments, at a rate in step with the timing of sensible bulge effects appearing in the vessel walls in proximity to the bath surface until the vessel is submerged in the bath; introducing dry, compressed air into the vessel at approximately the time the final stage of emptying the molten metal from the vessel occurs, the dry compressed air being accompanied by a fluxing agent; and removing the vessel from the bath at a rate of speed governed by the desired cooling effect upon the vessel.

KENNETH BORG.
MACK S. KESLER.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
792,028	Harker	June 13, 1905
1,072,372	Van Der Velden	Sept. 2, 1913
1,608,731	Fahlman	Nov. 30, 1926
1,621,016	Jackson	Mar. 15, 1927
2,186,285	Eickmeyer	Jan. 9, 1940
2,237,259	Marland	Aug. 1, 1941
2,310,834	Bullock	Feb. 9, 1943

FOREIGN PATENTS

Number	Country	Date
20,226	Denmark	1915