Sept. 6, 1938. A. O. ROSS 2,129,479

MEANS FOR MAKING SEAMLESS METALLIC CONTAINERS BY ELECTRODEPOSITION

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FIG. I.

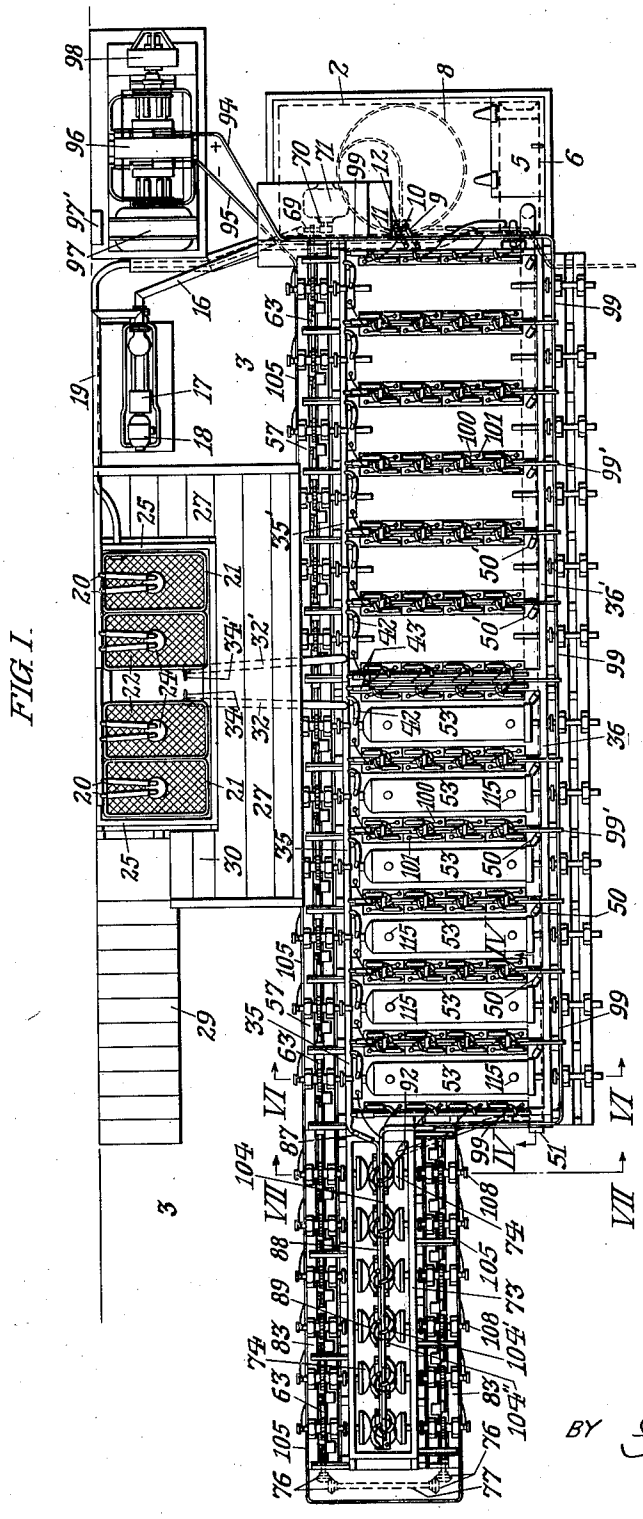


FIG. II.

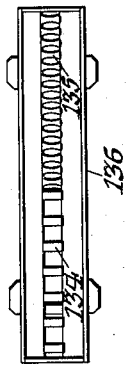
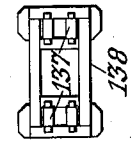


FIG. III.



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FIG. IV.

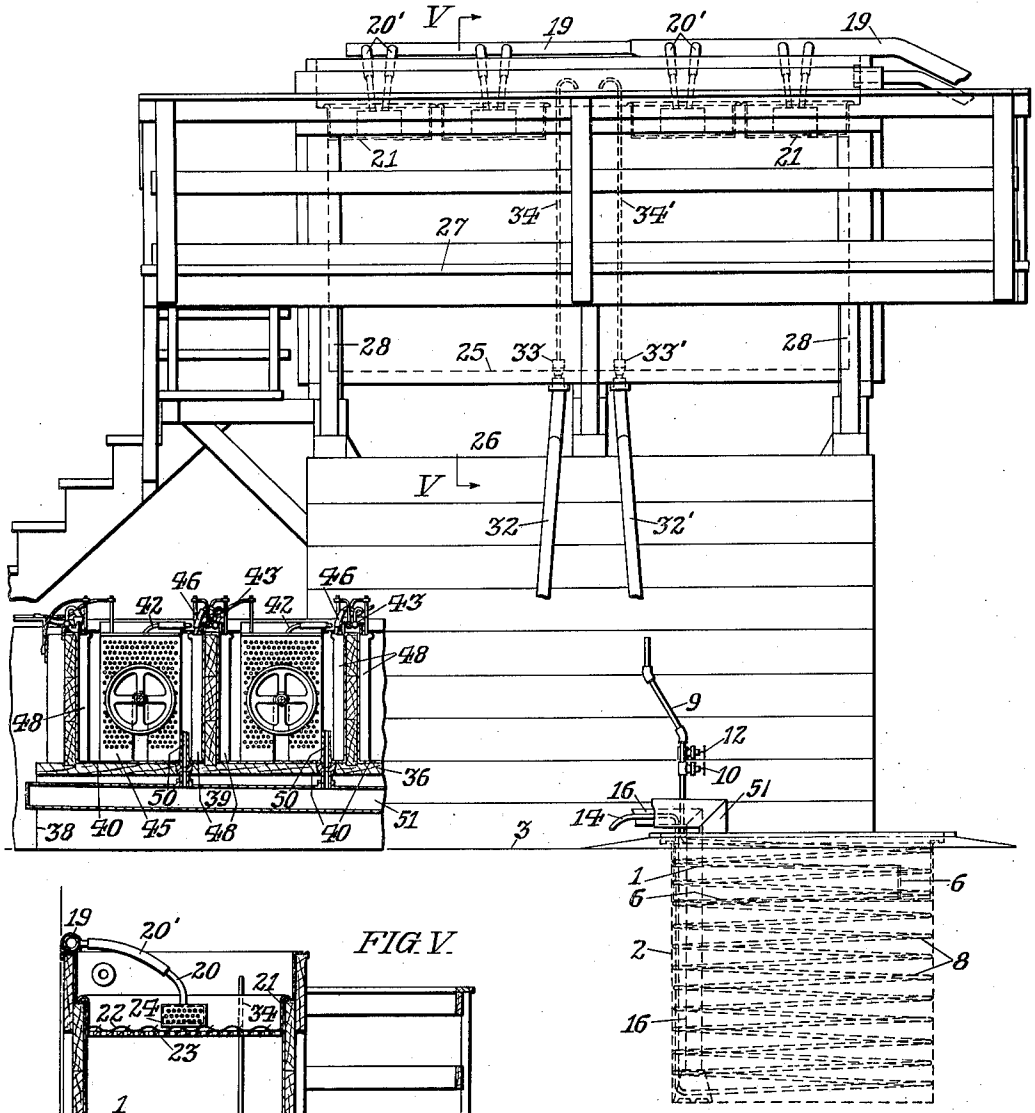
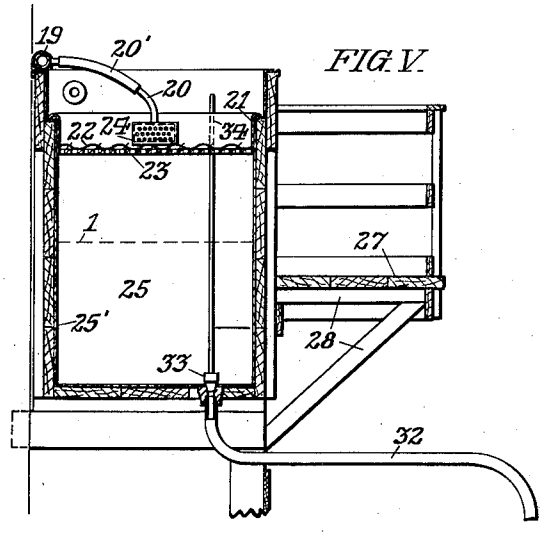


FIG. V.



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MEANS FOR MAKING SEAMLESS METALLIC CONTAINERS BY ELECTRODEPOSITION

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FIG. VI.

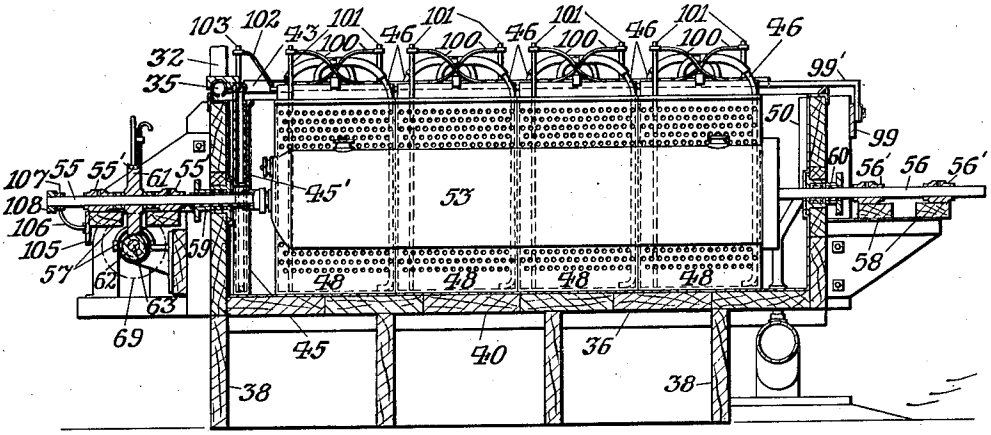


FIG. XI.

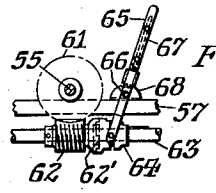
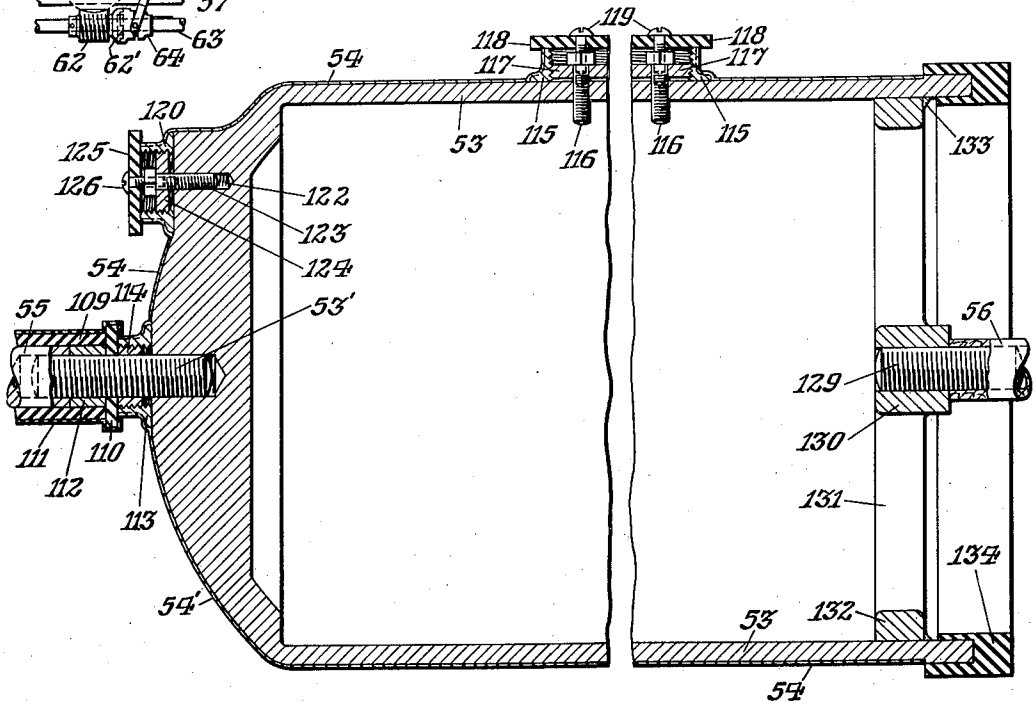


FIG. VIII.



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FIG. VII.

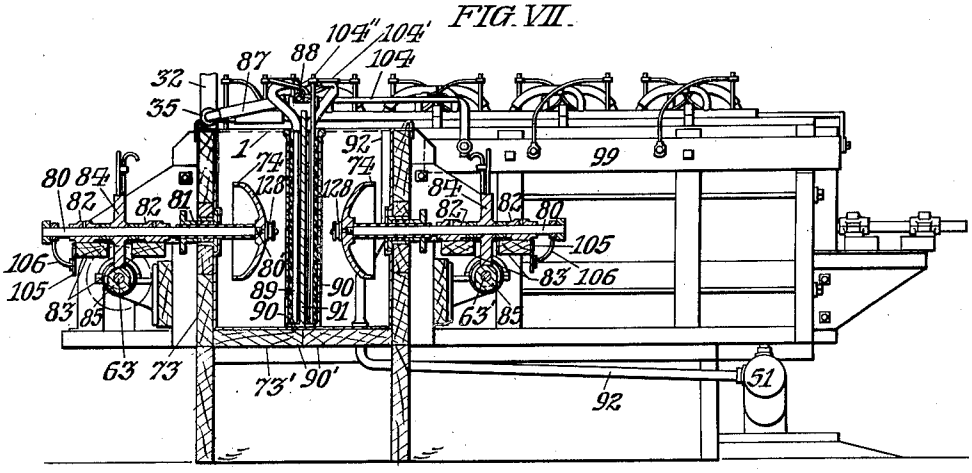


FIG. IX.

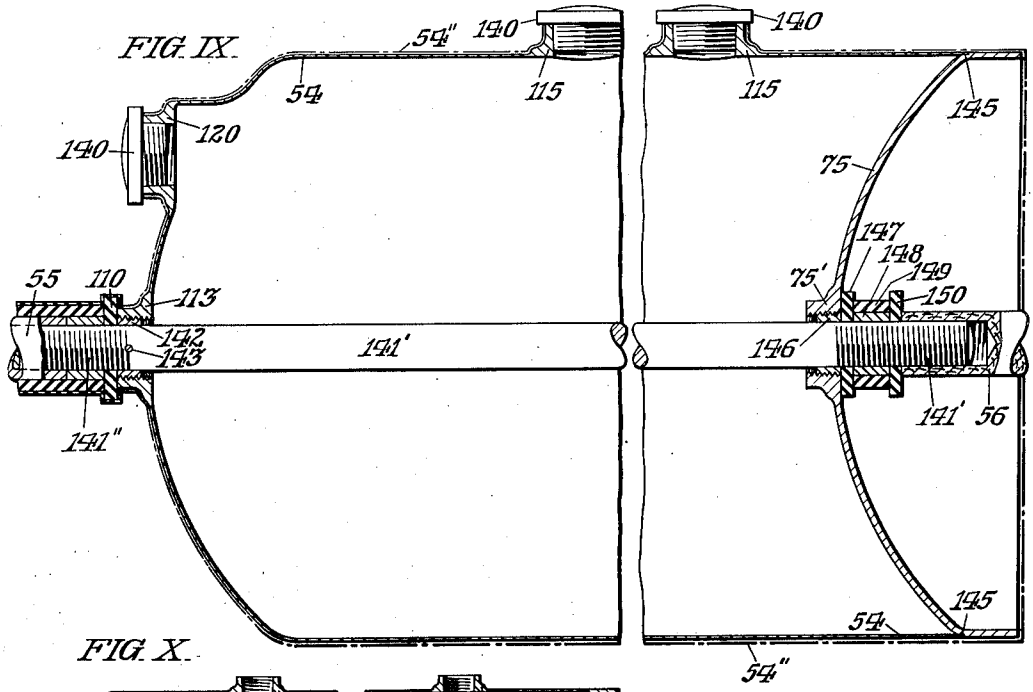
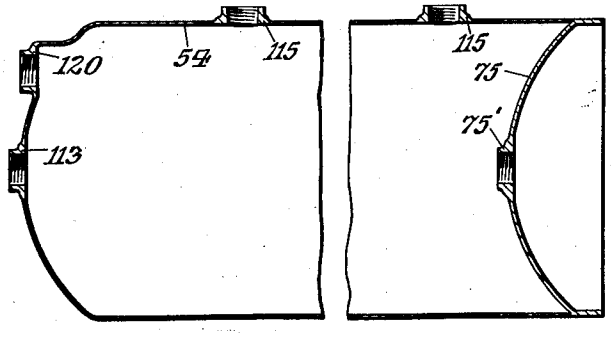


FIG. X.



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Patented Sept. 6, 1938 2,129,479

UNITED STATES PATENT OFFICE

2,129,479

MEANS FOR MAKING SEAMLESS METALLIC CONTAINERS BY ELECTRODEPOSITION

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Application January 7, 1937, Serial No. 119,494

5 Claims. (Cl. 204—5)

My invention is particularly applicable for the production of containers for hot water under pressure, of the type known to the trade as "range boilers." Such a container has a body formed of a cylindrical shell with an outwardly convex head at its upper end and an inwardly convex head at its lower end and screw threaded openings for conduit connections respectively located axially in each head and also screw threaded openings for conduits in the circumference of said shell.

As hereinafter described, such seamless containers are produced by electrodeposition of copper upon mold forms while they are continually rotated upon horizontal axes in a tank in which they are submerged in an electrolyte including an aqueous solution of sulphate of copper containing foraminous receptacles for scrap copper. Said molds are included as cathodes in a direct current electric circuit which includes said solution and scrap copper anodes with the effect of dissolving the latter in said solution and depositing copper from said solution upon said molds.

Said electrolyte is conveniently circulated by pump means from a subjacent sump tank through elevated filters from which it gravitates into tanks in which the electrodeposition is effected and overflows into conduits through which it is returned to said sump tank.

My invention includes the various novel features of construction, arrangement, and method of operation hereinafter more definitely specified.

In said drawings, Fig. I is a plan view of apparatus conveniently adapted for the purpose of my invention.

Fig. II is a plan view of a truck having supporting wheels upon which it may be manually propelled with respect to the apparatus shown in Fig. I. Said truck is provided with a series of rollers at its top to facilitate movement of the mold longitudinally with respect to the truck.

Fig. III is a plan view of a truck which is similarly supported to be manually propelled, but provided with pairs of rollers at its top adapted to support a mold or tank between them to facilitate manual rotation of a mold or tank thereon.

Fig. IV is a fragmentary elevation of part of the apparatus shown in Fig. I, including the elevated filters and the tanks in which they are contained, and indicating the subjacent sump tank, and including a fragmentary section of the apparatus taken on the line IV, IV, in Fig. I, in the direction of the arrows on said line.

Fig. V is a fragmentary vertical sectional view taken on the line V, V, in Fig. IV and showing the internal construction of one of the filter units and its tank, and conduit connections therewith.

Fig. VI is a fragmentary sectional view of the apparatus shown in Fig. I, taken on the line VI, VI, in the direction of the arrows on said line, showing a mold for the body of a tank and means for axially supporting and rotating it.

Fig. VII is a sectional view, taken on the line VII, VII, in Fig. I, showing molds for the bottom heads of the tanks and means for rotating them.

Fig. VIII is a fragmentary longitudinal sectional view of the mold shown in Fig. VI and its axial supports, and with the initial deposit of copper on said mold to form the body shell of a tank.

Fig. IX is a fragmentary longitudinal sectional view of said body shell with a bottom head, preformed by a deposit upon one of the molds shown in Fig. VII, inserted in said shell and with axially extending means for rigidly connecting said shell and head for rotation during the electrodeposition of an outer layer of copper in integral relation with said shell; said outer layer being indicated by dot and dash lines in said figure.

Fig. X is a fragmentary longitudinal section of a tank completed in accordance with my invention.

Fig. XI is a fragmentary elevation of one of the shaft driving units, including worm gearing and a clutch, as seen from the left of Fig. VI.

In said drawings, the electrolyte 1 is initially deposited in the sump tank 2 which is conveniently extended below the lever of the floor 3, as indicated in Fig. IV, and, as indicated in Fig. I, is provided with the trap door 5 for access to its interior. Immediately below that door is a receptacle 6 in which chemical constituents of the electrolyte may be initially deposited to be dissolved in the electrolyte. Said tank contains the coil of pipe 8 through which a temperature controlling fluid may be circulated; for instance, cold water or steam. Cold water may be introduced through the pipe 9 under control of the valve 10, indicated in Figs. I and IV, and steam may be introduced through the pipe 11 under control of the valve 12, as indicated in said figures. The temperature controlling fluid may be discharged from said coil at its upper end outlet 14, shown in Fig. IV. The electrolyte 1 or other liquid contained in said tank 2 may be

elevated through the intake pipe 16, indicated in Figs. I and IV, which is connected as shown in Fig. I, with the pump 17 operated by the electric motor 18.

Said pump 17 discharges the electrolyte from the tank 2 through the pipe 19, shown in Figs. I and IV, provided with branches 20 overhanging four unit filter receptacles 21. Each of said receptacles 21 contains, a filtering medium, conveniently a layer of woolen cloth 22 supported by a grill 23, which forms the bottom of each receptacle 21. As shown in Figs. I and V, the perforated box 24, which rests on the filter cloth 22, receives, and distributes, the streams of electrolyte from said branches 20. I find it convenient to make the portion 20' of said conduit 20 of flexible rubber tubing so that said boxes 24 may be lifted aside to permit insertion and removal of said filtering mediums.

The electrolyte gravitates through said filter units in the receptacles 21 into the subjacent tank 25 which is mounted upon the base 26, as shown in Fig. IV, so as to be elevated a desired distance above the floor 3, as indicated in Fig. IV. As indicated in Fig. V, said tank 25 is formed of wood, but has a sheet lead lining 25'. As indicated in Figs. I, IV, and V, the operator's platform 27 is supported, by the frame 28, adjoining said tank 25, and is accessible by the two flights of steps 29 and 30 extending to said floor 3.

Said tank 25 is thus supplied with electrolyte 1, preferably an aqueous solution of copper sulphate maintained at from 20° to 22° Baumé, from which solid impurities, for instance, dross from scrap copper dissolved therein, have been removed by its passage through said filter units.

The electrolyte 1 may be permitted to gravitate from said tank 25 through either or both of the two pipes 32 and 32' which are controlled by respective plug valves 33 and 33', shown in Figs. I and IV, valve 33 being also shown in Fig. V. Said plug valves may be independently manually lifted to open said pipes 32 and 32' by means of the respective handles 34 and 34' which extend above the level of the electrolyte in the tank 25 and may be reached from said platform 27. As shown in Fig. I, said pipes 32 and 32' respectively lead to axially alined but separate pipes 35 and 35' which overhang respective tanks 36 and 36', which are supported in spaced relation with said floor 3 by a series of girders 38, as shown in Figs. IV and VI. As indicated in the fragmentary section of the lower portion of Fig. IV, said tanks 36 and 36' are divided in series of similar compartments by vertical partitions 39. Each of said compartments has a separate lining of sheet lead, as indicated at 40 in Figs. IV and VI. I have found it convenient to form said tanks of wood, as indicated, but, of course, they may be made of any suitable material.

As shown in Fig. I, each compartment of said tanks 36 and 36' is supplied with electrolyte through two branches 42 and 43 from its respective supply pipe 35 or 35', of which a portion is a flexible rubber tube to facilitate manipulation thereof. As shown in Fig. I, each supply pipe 42 leads into a perforated sheet lead basket 45, each of which is of inverted U shape, and straddles a mold driving shaft. As indicated in Fig. VI, each of said baskets 45 has a muslin lining 45' to prevent escape of any copper scrap through the perforations. As indicated in Fig. I and better shown in Fig. IV, each pipe 43 leads through branches 46 into respective rectangular perforated sheet lead baskets 48; there being a series of four of the latter upon each of the opposite sides of each compartment in said tanks 36 and 36'. Each of said baskets 45 and 48 holds a mass of scraps of copper to be dissolved by the electrolyte 1 and, in order to insure efficient circulation of the electrolyte with respect to said scraps, I extend the pipes 46 to the bottom of their respective baskets 48, as indicated in dotted lines in Fig. VI. The electrolyte normally overflows from each of the compartments in said tanks 36 and 36' through respective pipes 50 and 50'. However, the lower ends of said pipes form tapered plugs, as indicated in Fig. IV, and they may be lifted to entirely drain said tanks.

Although in Fig. IV pipes 50 are indicated as broken off a short distance above the bottom of the linings 40 to avoid confusion with the outlines of the baskets 45; in fact the upper ends of all of the pipes 50 and 50' terminate just below the top of the baskets 45 and 48, as indicated at 50 in Fig. VI, so that said baskets are almost entirely submerged in the electrolyte during the operation of electrodeposition herein contemplated. As shown in Fig. I, said overflow pipes 50 are branches of the main drain pipe 51 which, as shown in Fig. I, extends beneath both of said tanks 36 and 36' and downwardly into said tank 2, as indicated in Fig. IV. As indicated in Fig. I, the overflow pipes 50' from the compartments of the tank 36' are also branches of said drain pipe 51, so that the electrolyte overflowing from all of the compartments in both of said tanks 36 and 36' gravitates back into said sump tank 2 from which it may be repeatedly recirculated by said pump 17 during the continuance of the electrodeposition.

As shown in Fig. I, each of the six compartments in the tank 36 contains a mold form 53 upon which the container shell is to be electrodeposited. Each of said forms is tapered, so slightly as not to be perceptible in the drawings, but sufficient to permit the mold to be withdrawn axially from the shell 54 deposited thereon, as indicated in Fig. VIII. As shown in Fig. VI, and indicated in Fig. I, each of said mold forms is mounted for rotation upon its axis by respective connection of its opposite ends with axially alined shafts 55 and 56. Each shaft 55 is journaled in two bearings 55' supported by frame members 57 in rigid relation with the side walls of said tanks 36 and 36'. Each shaft 56 is similarly journaled in bearings 56' supported by frame members 58 in rigid relation with the side walls of said tanks 36 and 36'. Said shafts 55 and 56 extend through respective stuffing boxes 59 and 60 mounted in the opposite side walls of said tanks and which permit rotation of said shafts with respect to said walls without escape of the electrolyte from the tanks.

Each of said shafts 55 has, rigidly connected therewith, a worm gear 61, as indicated in Fig. VI, which prevents its axial movement. However, each of said shafts 56 is axially movable manually, as hereinafter described. Said gears 61 are respectively engaged with individual worms 62 carried by the shaft 63, as shown in Fig. VI.

Each of said worms is loosely mounted on said shaft 63 but has at one end crown clutch projections 62' adapted to be engaged by similar projections on a clutch sleeve 64 which is slidable axially upon said shaft 63 but connected with the latter by a spline, so that when its clutch members are engaged, each of said worms

62 is turned by said shaft 63 to drive its respective gear 61. Each of said clutch sleeves is adapted to be manually operated by means of levers 65 fulcrumed at 66. Each of said levers 65 carries a slide bolt 67 for engagement with a ratchet 68 to hold said lever in either position of engagement or disengagement of the clutch in which it may be set by the operator.

As shown in Fig. I, said shaft 63 is provided with the gear 69 in mesh with the gear 70 on the armature shaft of the electric motor 71 by which said shaft 63 is driven continuously during the electrodeposition.

As shown at the left in Fig. I and Fig. VII, said shaft 63 is continued alongside of the tank 73 wherein mold forms 74 are detachably mounted for rotation during electrodeposition thereon of the container heads 75 shown in Figs. IX and X. The similar shaft 63' extends parallel with said shaft 63, upon the opposite side of said tank 73, and is connected so as to be turned simultaneously therewith, by the bevel gears 76 and countershaft 77, shown at the left in Fig. I. Said tank 73 is lined with sheet lead, as indicated at 73' in Fig. VII, and has two longitudinally extending series of said molds 74, each including six, as indicated in Fig. I. Each of said molds 74 is detachably connected with a shaft 80 by which it may be rotated, and provided with appurtenances as hereinafter described, whereby said heads 75 are provided with screw threaded conduit fittings 75' indicated in Figs. IX and X. The connection of each of said mold forms 74 with its shaft 80 is made by screw threaded engagement of said mold as a nut upon the threaded end 80' of its shaft. Each of said shafts 80 extends through a stuffing box 81 in the side wall of the tank 73 and is journaled in two bearings 82 supported by frame members 83 in rigid relation with the side walls of said tank 73. Each of said shafts 80 has, rigidly connected therewith, a worm gear 84, as indicated in Fig. VII. Said gears 84 are respectively engaged with individual worms 85 carried by said shafts 63 and 63', and provided with coupling means, as shown in Fig. XI.

The construction and arrangement above described are such that each of the shafts adapted for turning the mold forms 53 and 74 may be simultaneously rotated during electrodeposition on said molds, by the single electric motor 71 shown in Fig. I, or, at the will of the operator, any one of said mold shafts may be rendered idle by disconnection of its clutch exemplified in Fig. XI.

As indicated in Figs. I and VII, the left hand end of said pipe 35 through which electrolyte is supplied is flexibly connected by rubber hose 87 with a pipe 88 having branches including flexible rubber hose sections 89 through which electrolyte is supplied to the interior of the perforated sheet lead baskets 90, muslin linings 90', and are like the baskets 48, but disposed in pairs; the contiguous back walls of each pair being fused together, as indicated at 91 in Fig. VII. As indicated in the left hand basket 90 in Fig. VII, each pipe 88 extends to the bottom of its basket, like the pipes 46 in the baskets 48. Likewise, said baskets 90 holds scraps of copper which are dissolved in the electrolyte 1 during the electrodeposition.

As shown in Figs. I and VII, said tank 73 is provided with the pipe 92, extending nearly to the top thereof, through which the electrolyte overflows into said main drain pipe 51, as indicated in Fig. VII, and gravitates therethrough back into the sump tank 2.

All of said molds 53 and 74 are cathodes in a direct current electric circuit which includes said electrolyte 1 and the anodes comprising the scrap copper in the lead baskets 45, 48, and 90, with the effect of dissolving said copper in said electrolyte and depositing copper from said electrolyte upon said molds. As shown in Fig. I, said circuit comprises the positive conductor 94 and the negative conductor 95 connected with the electric generator 96 which is arranged to be rotated by the electric motor 97, controllable by switch means 97'. Said motor also rotates the generator exciter 98.

Said conductor 94, which is preferably an insulated cable, is connected with the bus-bar 99 which is rigidly attached to the right hand end wall of said tank 36' and extends along the side walls of said tank 36' and the tank 36 and along the left hand end wall of the latter tank, as indicated in Figs. I and VI. Said bus-bar 99 has a series of branch conductors 99' connected therewith respectively extending along the top of the partitions between the compartments in said tanks 36' and 36 and having flexible conductor branches 100 each having a rod terminal 101 extending in electrical connection with the lead baskets 48 and their scrap copper contents, as indicated in Fig. VI. Each of said positive conductors 99' also has a flexible conductor branch 102 at its distal end with a rod terminal 103 extending in electrical connection with the local lead basket 45 and its scrap copper contents, as indicated in Fig. VI.

As shown in Figs. I and VII, said positive bus-bar 99 has the branch 104 extending over the top of the tank 73 with individual conductor branches 104', each having a terminal rod 104'' extending in a basket 90, in electrical connection with such basket and its scrap copper contents.

Said conductor 95, which is preferably an insulated cable, is connected with the bus-bar 105 which is rigidly secured to the timber frame member 57 in the position shown in Fig. VI, and, as shown in Figs. I and VII, said bus-bar 105 extends around the tank 73 in rigid connection with the timber frame 83. As shown in Figs. I and VI, each of the shafts 55 and 80, by which said molds 53 and 74 are supported and rotated as above described, is electrically connected with said bus-bar 105 by individual flexible conductors 106 and collars 107, which latter have a rubbing fit on said shafts. Collars 108 are respectively rigidly connected with said shafts to prevent accidental displacement of said collars 107. Each of said molds 53 and 74 is thus connected with said negative conductor 95 and constituted a cathode in the electric circuit energized by said generator 96.

The apparatus above described is designed to make containers having an internal diameter of eleven and sixty-three-sixty-fourths of an inch at the smaller end and twelve inches at the larger end, and one-sixteenth of an inch thick.

By a long series of experiments, I have determined that the maximum electrodeposition of copper of satisfactory density and tensile strength, at the rate of one pound per hour for each mold form, is effected with the apparatus above described when it is energized with an electric current of two hundred and seventy amperes at from two and one-half to three volts, and said molds 53 and 74 are turned at the rate of fifteen seconds per revolution, i. e., at a cir-

cumferential speed slightly in excess of one-fifth of a foot per second.

As shown in Fig. VIII, the shaft **55** by which the mold **53** is rotated, as above described, is detachably connected with said mold by the axial screw stud **53'** which is rigidly connected with said mold **53** and detachably connected with a screw threaded socket in said shaft **55**. Said shaft **55** is provided with an insulating covering comprising a hard rubber tube **109**, washer **110**, and thin soft rubber tube **111**, the end of which overlaps and engages the perimeter of said washer, as shown in Fig. VIII. Said washer **110** is backed by the metal collar **112** screwed as a nut on said axial screw stud **53'**. Said stud **53'** also carries the screw threaded conduit fitting **113** held in coaxial relation therewith by the screw threaded metal collar **114** on said stud and clamped against axial movement and rotation by the detachable screw threaded engagement of said stud **53'** with said shaft **55** in the position shown in Fig. VIII; so that the deposit of copper from the electrolyte **1** forms the cylindrical shell **54** closed at the left hand end in concavo convex form **54'**, as shown in Fig. VIII, and in unitary relation with said fitting **113**.

Said mold form **53** being designed for electrodeposition of container shells for use as what are known to the trade as "range boilers", to wit, tanks to be connected with means for heating water to be stored therein, it is desirable to provide the circumferential surface of said shell **54** with two additional screw threaded conduit connections, as respectively indicated at **115**, **115**, in Figs. I and VIII. That may be conveniently effected by providing said mold form with screw threaded holes to receive respective tap bolts **116** carrying screw threaded washers **117** which engage said fittings **113** in coaxial relation with said bolts, and said fittings are rigidly held upon said mold **53** by respective insulating washers **118**, which may be hard rubber or Bakelite, detachably but tightly held by respective screws **119** in axial engagement with said tap bolts **116**. Said container end shell **54'** may also be provided with a scew threaded conduit fitting **120** in eccentric relation with the axis of said shell, by providing the closed end of said mold **53** with the screw threaded hole **122** for engagement with the tap bolt **123** which carries the screw threaded washer **124** in coaxial engagement with said fitting **120**; the latter being detachably rigidly held on said mold **53** by the insulating washer **125** secured by the screw **126** in coaxial engagement with said tap bolt **123**.

All of the mold forms **53** and **74** are preferably made of stainless steel having highly polished exterior surfaces upon which the electrodeposition is to be effected.

As shown in Fig. VIII, said mold form **53** is connected with said shaft **56** by the screw stud **129** which is rigidly mounted in the hub **130** connected by spokes **131** with the perimetral ring **132** which is rigidly connected with said form, conveniently by a metal welded fillet **133**, as indicated in said figure. Said shaft **56** is preferably formed of insulating material such as Bakelite or vulcanized fiber having a screw threaded socket engaged as a nut with said screw stud. The interior surface of said mold form **53** is insulated by a coating of wax or varnish so as to avoid any electrodeposition thereon, and the right hand end of said mold **53** is protected from electrodeposition by the ring **134** preferably formed of slightly resilient rubber which is push fitted on said mold to the position shown and there remains during the electrodeposition of the shell **54** on said mold, to the thickness shown in Fig. VIII; so that the right hand open end of said shell has a finished surface determined by the configuration of the outer cylindrical recessed surface of said mold form **53**. Thereupon, the rotation of the completed shell **54** and its mold **53** is stopped by shifting the respective clutch lever **65**, and the mold **53** carrying said shell **54** and appurtenances thereof, as shown in Fig. VIII, is detached from its shafts **55** and **56** by turning said form backward to unscrew its stud **53'** from the shaft **55** while said form remains supported by its connection with the shaft **56**, and then unscrewing said shaft **56** from the stud **129** of the hub **130** of the ring **132**. Thereupon, said mold **53** carrying the shell **54** may be lifted out of its compartment in the tank **36** and laid upon the rollers **134** and **135** in the top of the truck **136** shown in Fig. II to facilitate its further manipulation. Thereupon, the screws **119**, tap bolts **116**, washers **117**, screws **126**, tap bolts **123**, and washers **125** are removed from the position shown in Fig. VIII so as to permit said shell to be withdrawn from said mold **53** by relative longitudinal movement of the shell and mold on said rollers of the truck **136**.

Thereupon, the container body shell **54** is laid upon the rollers **137** at the top of the truck **138** shown in Fig. III, to facilitate its further manipulation. Removable plugs **140** are then inserted in each of the conduit fittings **115** and **120**, as shown in Fig. IX. The axial shaft **141** which has the screw threaded collar **142** fixed thereon, conveniently by the pin **143**, is then screwed into the fitting **113**, as shown in Fig. IX. The screw threaded conduit fitting **75'** shown on the head **75** of said container **54** in Figs. IX and X is primarily held upon the mold form **74** upon which said head **75** is deposited, by retaining means such as above described with reference to the conduit fittings **115** and **120**, and which means are indicated in Fig. VII at **128**.

One of the heads **75** which has been formed upon a mold **74**, as above described, and is of the configuration shown in Fig. IX, except that it has not the circumferential recess **145** shown in Fig. IX, is machined, conveniently in an ordinary lathe, to form said recess **145** so that said head **75** may be push fitted into said shell **54**, as shown in Fig. IX. Before pushing said head **75** into the position shown in Fig. IX, the loose screw threaded ring **146** is screwed into the axial conduit fitting **75'** of said head **75** so as to afford a slide bearing on said axial shaft **141**. The insulating washer **147**, metal collar **148**, insulating collar **149**, and insulating washer **150** are then fitted over said shaft **141** in the position shown in Fig. IX and the shell **54**, head **75**, and their connecting shaft **141** lifted into one of the compartments of the tank **36'**, and the shaft **56** of that compartment screwed upon the threaded end **141'** of the shaft **141** to the position shown at the right in Fig. IX. Thereupon, the opposite screw threaded end **141''** of said shaft **141** may be screwed into the socket of the shaft **55** in said compartment by turning said shell and shaft **141** by manual rotation of the shaft **56** shown in Fig. IX until the conduit fitting **113** is brought into liquid-tight contact with the insulating washer **110** appurtenant to said shaft **55**.

Thereupon, by shifting the lever **65** local to the compartment in the tank **36'** then containing the

structure shown in Fig. IX, the shaft 55 is operated to rotate said structure in the electrolyte and the operation of electrodeposition resumed and continued until there is added to the shell 54, shown in full lines in Fig. IX, an additional thickness of copper, indicated by the dot and dash lines 54'' in Fig. IX, to form the completed container shown in Fig. X with its body shell 54, head 75, and conduit fittings 75', 113, 115, and 120 all in unitary relation.

Thereupon, the operator stops the rotation of the structure shown in Fig. IX by shifting the local clutch lever 65, and removes the structure shown in Fig. IX, from the tank 36', by reversing the operations above described by which it was assembled and inserted in said tank.

The apparatus above described may be used for continuous commercial production of containers such as shown in Fig. X, at the rate of six every twenty-four hours. Fig. I shows the apparatus in condition to begin such operation. There are twice as many mold forms 74 as there are mold forms 53, for the reason that the heads 75, deposited on said molds 74, are twice as thick as the container shell 54 and its convex end 54' initially deposited on the forms 53. The operation is begun by rotating but six of the forms 74 until the electrodeposits thereon are half as thick as desired. Thereupon, rotation of the other six forms 74 is begun simultaneously with the rotation of the six mold forms 53 in the tank 36. Consequently, when the electrodeposit on the forms 53 is half the desired final thickness, to wit, the thickness shown in full lines in Fig. VIII; and the shells 54 are ready for removal from the six mold forms 53, the first six heads 75 are of the desired final thickness upon the first six molds 74 and are ready for removal and insertion in the shells 54, as above described, preparatory to the final deposit thereon to make complete containers such as shown in Fig. X. Thereupon, the six mold forms 53 are replaced in the tank 36 with conduit fittings 113, 115, and 120 secured thereon as in Fig. VIII, but, of course, without the shells 54 shown in that figure, and rotation of the six driving shafts 55 in the tank 36 resumed with the initiation of rotation of the six shafts 55 in the tank 36' by which the shells 54 with heads therein, as shown in Fig. IX, are rotated during the deposition of the final thickness of the shell 54, 54' thereon, as indicated in dash and dot lines in Fig. IX. By the time that such final deposits are made in the tank 36', the initial deposits 54, 54' are made in the tank 36 upon the mold forms 53, and the second series of six heads 75 are completed in the tank 73 and ready for assemblage with the second set of shells 54, 54' when the latter are removed from the tank 36, as above described. In such manner, the apparatus shown may be continuously operated to produce containers such as shown in Fig. X, which weigh forty-eight pounds each, are one-sixteenth of an inch in thickness at their cylindrical portions, and are designed to withstand a pressure of eighty-five pounds per square inch without distortion; that pressure being considerably in excess of the pressure to which they are normally subjected when used as "range boilers." However, the containers such as shown in Fig. X may be made thicker or thinner, in accordance with the length of time the several steps of electrodeposition above contemplated are continued.

The entire electric circuit including the positive conductor 94 and negative conductor 95 may, of course, be energized or de-energized by respectively starting and stopping the electric generator 96, by starting and stopping the electric motor 97, by operation of the switch controlling means 97'. However, each individual anode may be individually and separately included or excluded with respect to said circuit by connecting or disconnecting its branch supply conductor with respect to the local bus bar. Of course, separate switch means may be provided for each of said branch conductors but I have found it less trouble and expense to directly connect and disconnect the conductors as aforesaid.

The container product, shown in Fig. X, is advantageous, first, in that its wall is made of homogeneous metal of uniform minimum thickness adapted to withstand predetermined internal pressure, without waste of metal, and, second, in that it is of substantially the same diameter at each end, so that a number of them may be stably stacked, in minimum space, with their axes parallel. However, methods and apparatus in accordance with my invention may be employed to produce containers of different specific construction.

Although I have shown in Figs. VIII and X, the conduit fittings 113, 115, and 120 projecting outwardly from the surface of the shell 54, the polishing of the shell may be more conveniently effected if said fittings are extended inwardly from the outer surface of the shell so that there are no projections from that surface to interfere with the polishing means.

Therefore, although I have herein set forth what I believe to be a preferable method and means for making seamless metallic containers by electrodeposition in accordance with my invention, I do not desire to limit myself to the specific details of said method or apparatus, or said product thereof, as it is obvious that various modifications may be made therein without departing from the essential features of my invention, as defined in the appended claims.

I claim:

1. Means for the electrolytic formation of a fluid pressure container, including a tapered mold form having a polished cylindrical surface, and an axial screw threaded socket at one end, which is closed, the other end being open; an axial screw driving shaft, detachably engaging said socket and carrying a conduit fitting; means cooperative with said shaft and mold, for tightly holding said fitting on said mold; an axial hub and stud screw fixed in the open end of said mold; a second axial screw shaft having a socket engaging said hub screw; a tank for holding an electrolyte; horizontal axially alined journal bearings, at opposite sides of said tank, respectively supporting said two shafts; means, including a driving gear on said driving shaft, for turning and preventing axial movement of that shaft; the other shaft being axially movable, for permitting its release and removal of said mold from said tank; basket means for holding scrap copper in said tank and electrolyte; and electric circuit means, in which said mold is a cathode and said electrolyte and scrap copper anodes; whereby a self-sustaining shell having an open end and a closed end, with said conduit fitting fixed in the latter, is electrodeposited on the polished surface of said mold and removable with the latter from said tank.

2. Means for the electrolytic formation of fluid pressure containers, including the combination with a tank for an electrolyte; of horizontal axially alined journal bearings at opposite sides

of said tank; an axial screw driving shaft mounted in the bearing at one side of said tank; a worm driving gear on said driving shaft, for turning and preventing axial movement of that shaft; a second axial screw shaft journaled in the bearing at the opposite side of said tank and free to move axially in its bearing in axial alinement with said driving shaft; a body for receiving electrodeposition from said electrolyte, having axial screw connections at opposite ends thereof, respectively fitted for connection with said driving shaft and said second shaft; a worm in mesh with said form gear; a worm shaft extending axially through said worm but rotatable independently thereof; clutch means carried by said worm shaft, for alternately engaging and disengaging said shaft in driving relation with said worm; means for rotating said worm shaft during electrodeposition in said tank, including an electric motor, and switch means for energizing and controlling said motor; and electric circuit means, in which said electrolyte and metallic copper are anodes and said body to receive the electrodeposit is a cathode.

3. Means for the electrolytic formation of fluid pressure containers, including the combination with a tank for electrolyte; of horizontal axially alined journal bearings at opposite sides of said tank; an axial screw driving shaft mounted in the bearing at one side of said tank; a worm driving gear on said driving shaft, for turning and preventing axial movement of that shaft; a second axial screw shaft journaled in the bearing at the opposite side of said tank and free to move axially in its bearing in axial alinement with said driving shaft; a body for receiving electrodeposition from said electrolyte, having axial screw connections at opposite ends thereof, respectively fitted for connection with said driving shaft and said second shaft; a worm in mesh with said worm gear; a worm shaft extending axially through said worm but rotatable independently thereof; clutch means carried by said worm shaft, for alternately engaging and disengaging said shaft in driving relation with said worm; means for rotating said worm shaft during electrodeposition in said tank, including an electric motor, and switch means for energizing and controlling said motor; and electric circuit means, in which said electrolyte and metallic copper are anodes and said body to receive the electrodeposit is a cathode; and means for energizing said circuit at 270 amperes at between 2½ and 3 volts.

4. Means for the electrolytic formation of fluid pressure containers, including the combination with a tank for an electrolyte; of horizontal axially alined journal bearings at opposite sides of said tank; an axial screw driving shaft mounted in the bearing at one side of said tank; a worm driving gear on said driving shaft, for turning and preventing axial movement of that shaft; a second axial screw shaft journaled in the bearing at the opposite side of said tank and free to move axially in its bearing in axial alinement with said driving shaft; a body for receiving electrodeposition from said electrolyte, having axial screw connections at opposite ends thereof, respectively fitted for connection with said driving shaft and said second shaft; a worm in mesh with said worm gear; a worm shaft extending axially through said worm but rotatable independently thereof; clutch means carried by said worm shaft, for alternately engaging and disengaging said shaft in driving relation with said worm; means for rotating said worm shaft during electrodeposition in said tank, including an electric motor, and switch means for energizing and controlling said motor; and electric circuit means, in which said electrolyte and metallic copper are anodes and said body to receive the electrodeposit is a cathode; and means for energizing said circuit at 270 amperes at between 2½ and 3 volts; whereby said body may be continuously rotated in said electrolyte during such energization of the latter, and at a surface speed of approximately one foot in five seconds.

5. Means for the electrolytic formation of a fluid pressure container, including a tank containing electrolyte in which electrodeposition is effected; a driving shaft extending horizontally through a side wall of said tank, and having a screw thread at its end within said tank; a body upon which the electrodeposition is effected, having a screw threaded connection for detachable engagement with said shaft end; a screw threaded conduit fitting carried and held on said body by said shaft; means for holding another conduit fitting on said body in spaced relation with said first fitting, including a screw threaded hole in said body, a tap bolt fitted in said hole, and carrying a screw threaded disk engaged in the thread of said fitting, an insulating member at the outer end of said second fitting, and a screw extending through said insulating member in axial alinement with and engaged in said tap bolt; whereby the electrolyte is excluded from the interior of each of said fittings, and said fittings are united with the deposit made on said body.

AYLMER O. ROSS.