July 12, 1938. R. D. PIKE 2,123,659

MAKING BEARINGS

Original Filed Nov. 26, 1934 2 Sheets-Sheet 1

Fig. 1.

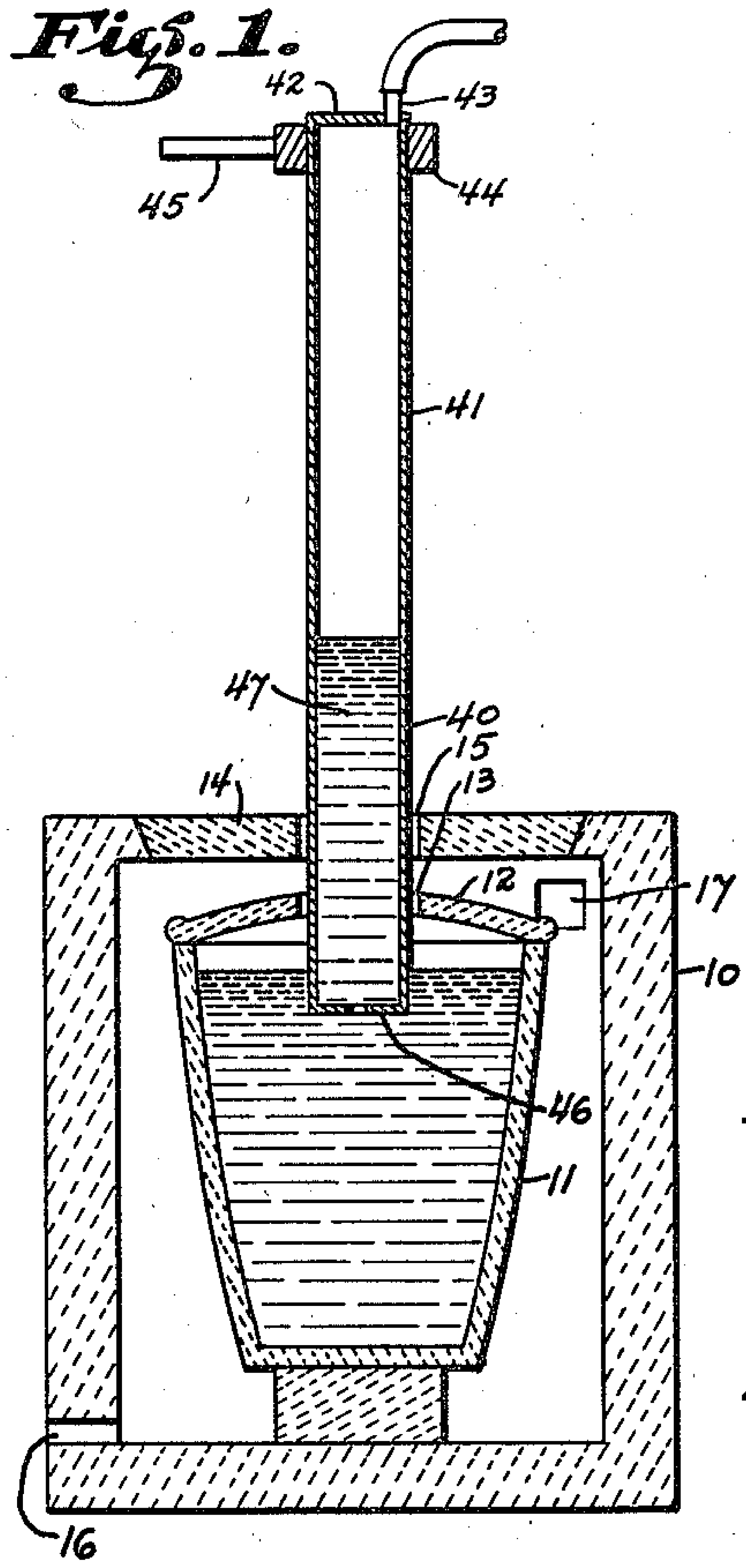


Fig. 2.

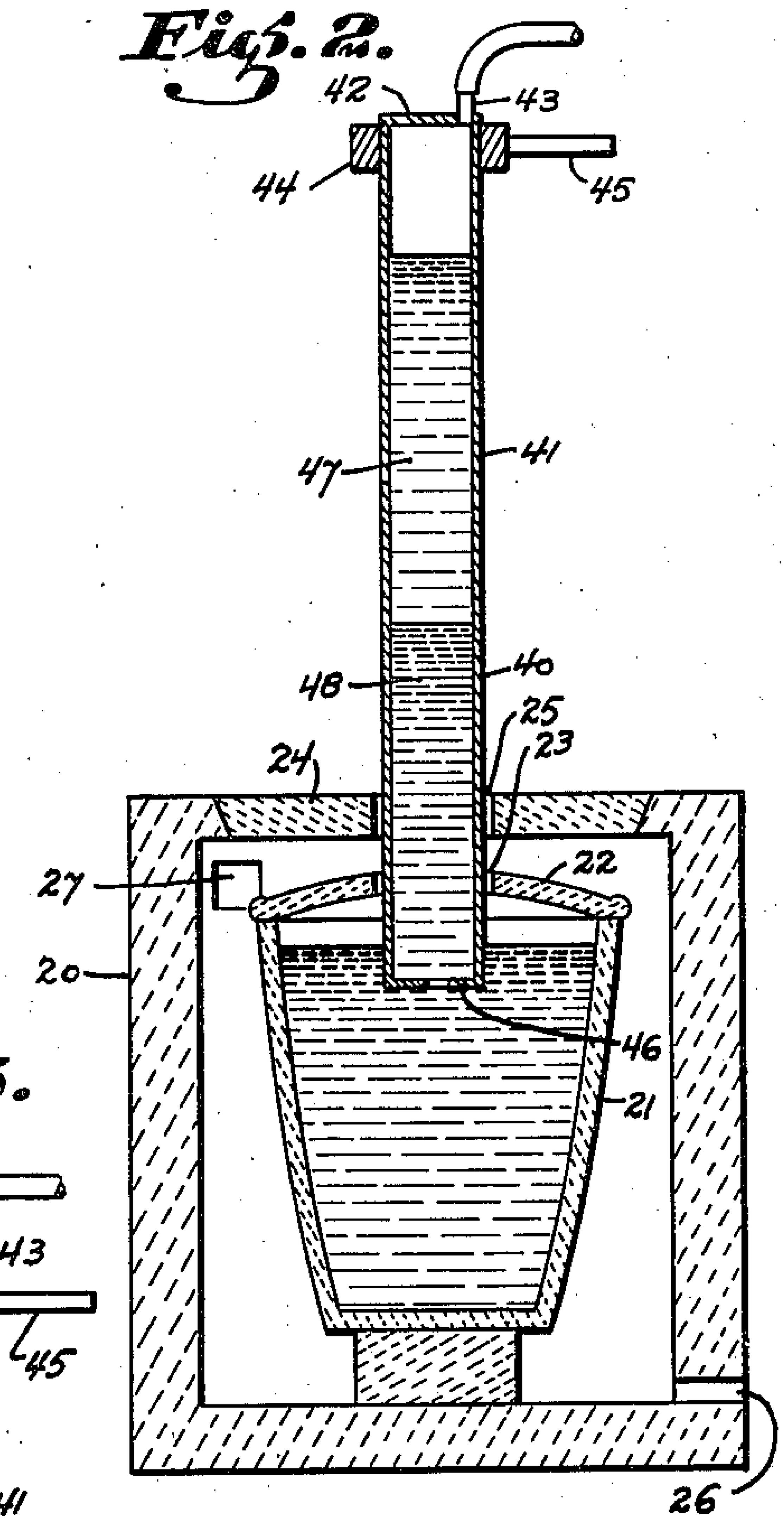
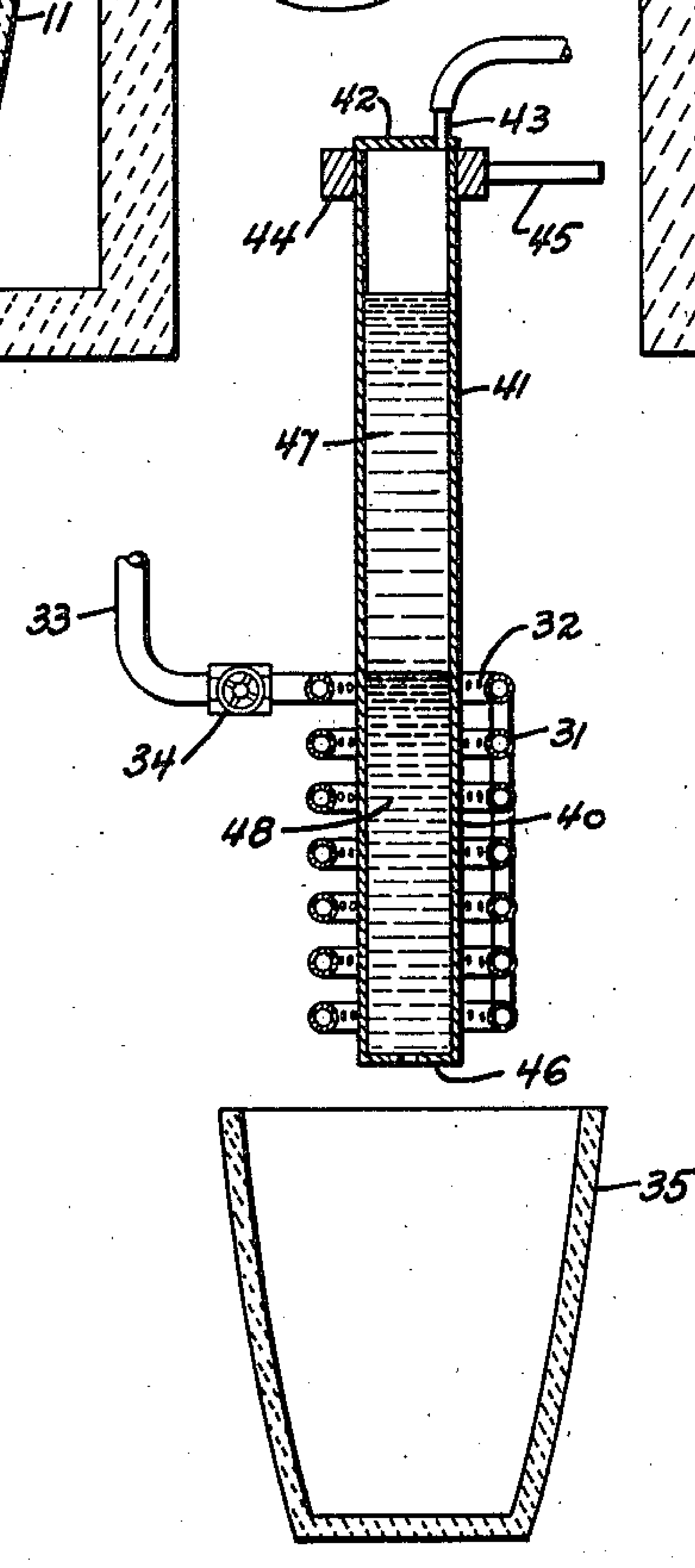


Fig. 3.



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MAKING BEARINGS

Original Filed Nov. 26, 1934 2 Sheets-Sheet 2

Fig. 4.

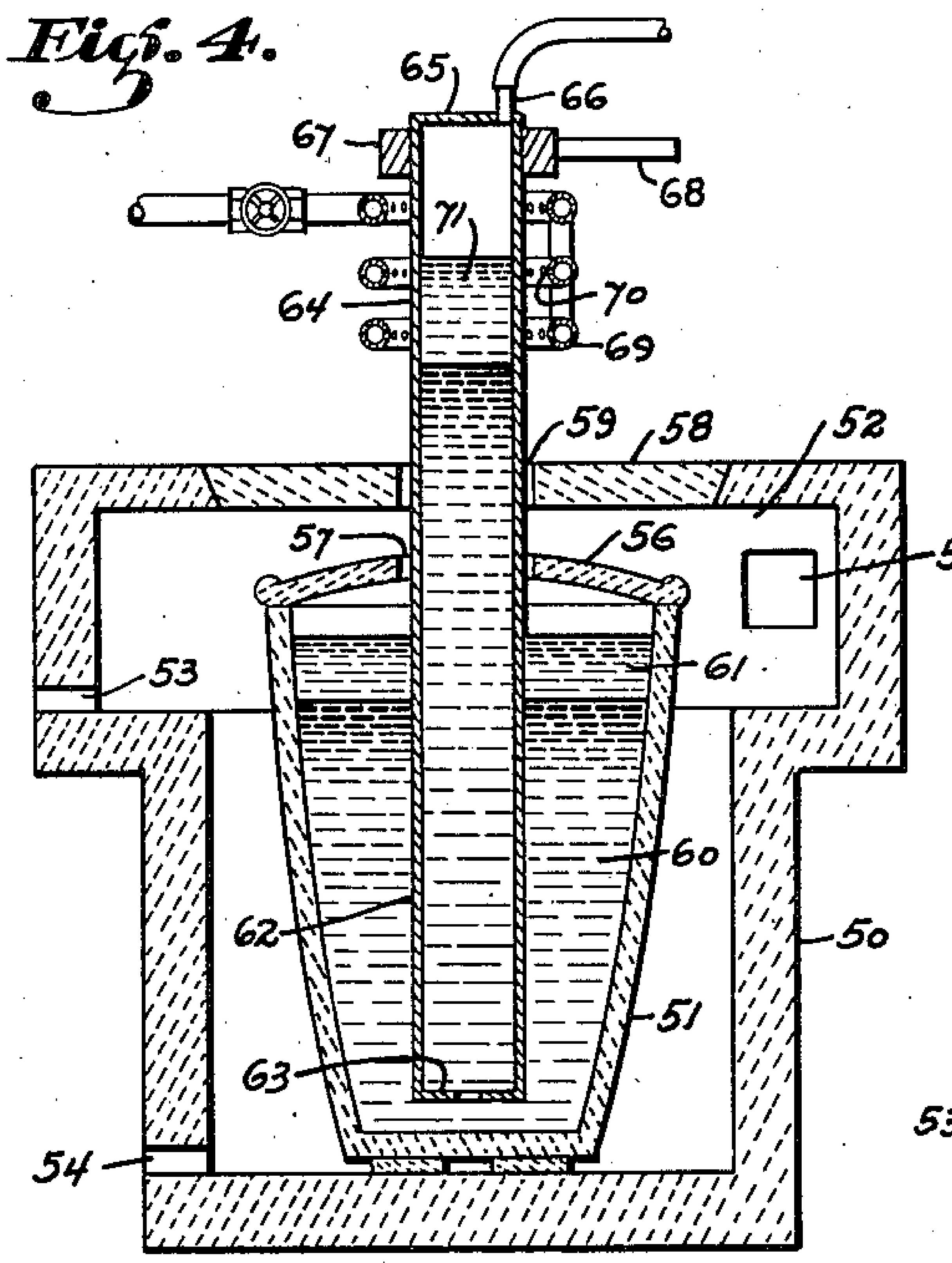


Fig. 5.

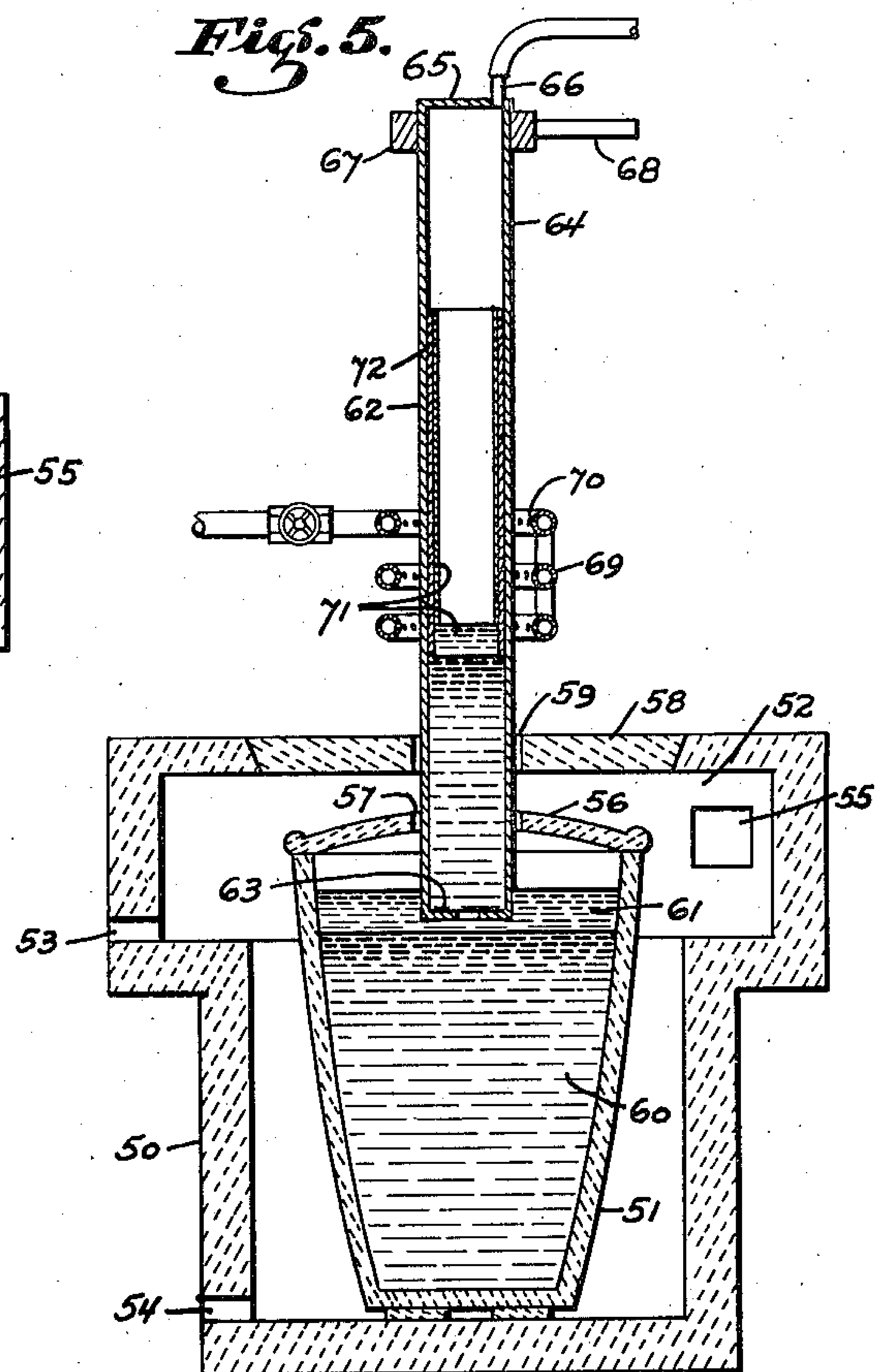


Fig. 7.

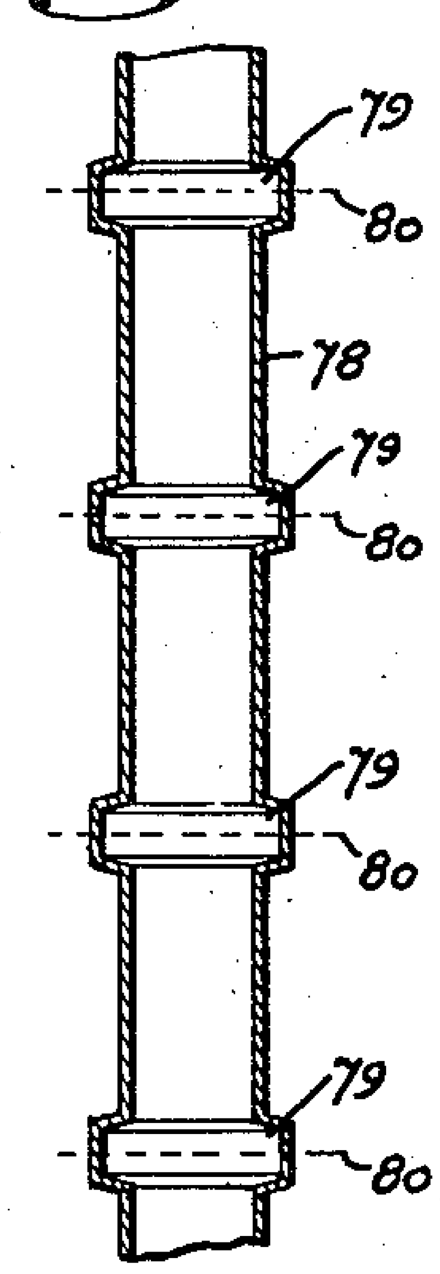


Fig. 8

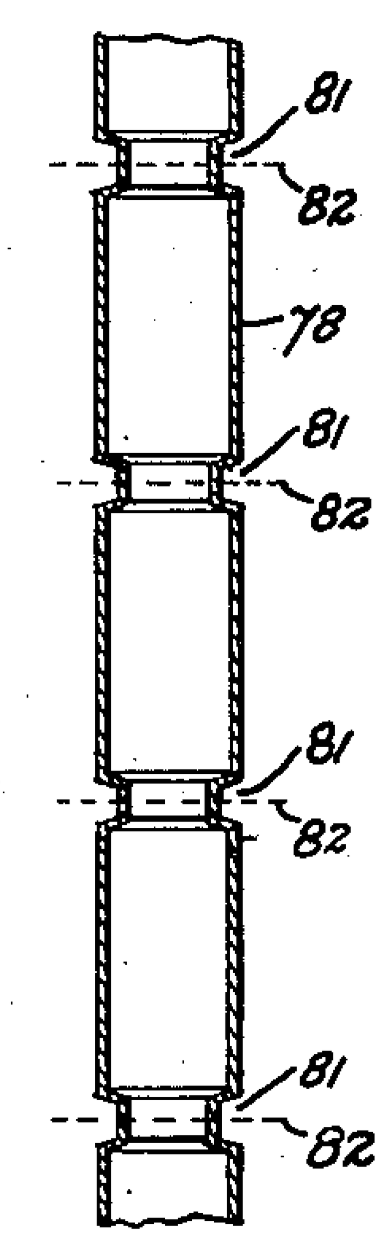


Fig. 6.

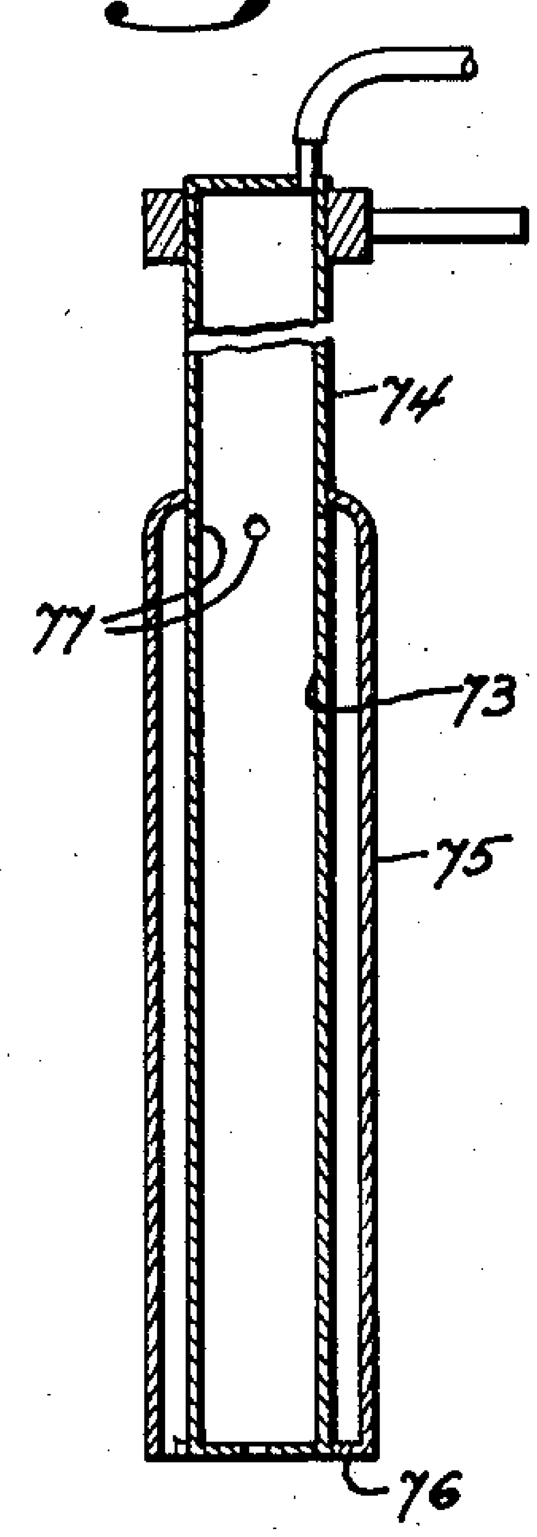
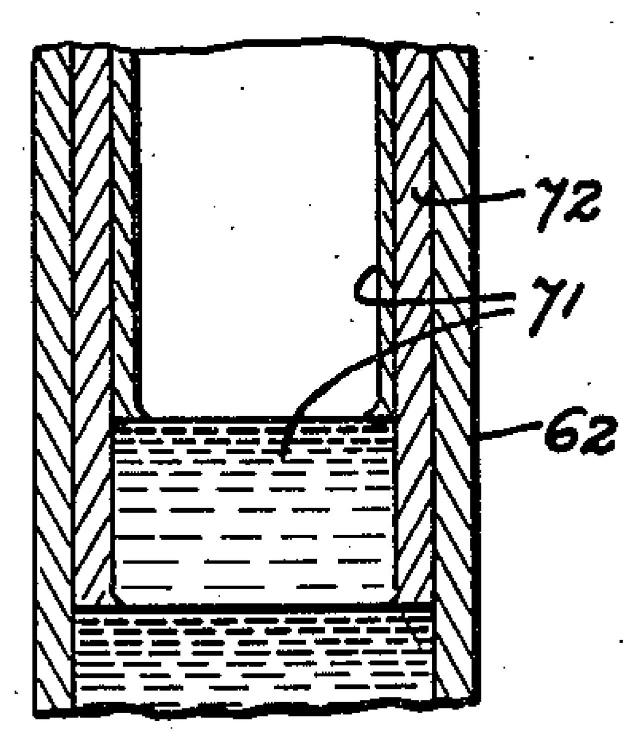


Fig. 9.



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Patented July 12, 1938

2,123,659

UNITED STATES PATENT OFFICE

2,123,659

MAKING BEARINGS

Robert D. Pike, Piedmont, Calif., assignor to Kalif Corporation, Emeryville, Calif., a corporation of Delaware

Application November 26, 1934, Serial No. 754,757
Renewed June 7, 1937

11 Claims. (Cl. 22—204)

This invention relates to the manufacture of bearings having an iron or steel backing or supporting member with a layer of plastic bronze to form the bearing surface, autogenously, firmly, uniformly and integrally welded to the backing.

Plastic bronze is a type of bronze the essential constituents of which are either copper or an alloy high in copper, together with lead, the lead content running in practice anywhere from about 15% or 20% up to 40% or 45% or higher. Metals in addition to the copper and lead are frequently present, generally for the purpose of forming a copper alloy, and these in practice are generally present in amounts running from a fraction of 1% perhaps up to 5%, more or less, the additional metals usually being tin or nickel, although others may be used.

In my co-pending applications, Serial No. 554,785 (Case AA), filed August 3, 1931, for Compound article and method of making the same, and Serial No. 709,713 (Case PP), filed February 5, 1934, for Making bearings, I have described methods of cast-welding plastic bronze onto an iron or steel backing. According to such methods the iron or steel back is heated to the neighborhood of 1700° F., and the plastic bronze is heated to the neighborhood of 2000° F. to 2200° F. Superheated flux at a temperature of about 2550° F. to 2750° F. is then poured into a space defined at least in part by the surface of the steel back to be welded and maintained in contact therewith for a short time, and the molten plastic bronze at the temperature mentioned is then poured into the flux thereby displacing it and thereby contacting with the surface of the steel back to which it unites with a very strong weld.

It is desirable not to have the iron or steel back nor the molten plastic bronze to be cast-welded thereto too hot, and according to said prior applications I have maintained the temperatures of these metals below that at which a weld would form. The welding or bonding temperature is thought to be about 1925° F. and with the masses of the two metals used according to said prior applications and the temperatures indicated therein, the average temperature after heat interchange may perhaps not be as high as the bonding temperature. Bonding is practically instantaneous on contact at the bonding temperature, and such bonding temperature is attained and perhaps even exceeded at the surface of the iron or steel backing to be welded by the temperature imparted by the superheated flux, at least for a short time, that is, a time long enough to effect bonding. There are disadvantages in maintaining the contact interface between the two metals above the bonding temperature for a long time.

As described in my former applications above mentioned, the superheated flux performs the functions of a flux on the iron or steel surface, wets it and raises it to the bonding point, while contact should be of long enough duration to get the desired effects, yet it is desirable, of course, not to leave the flux too long in contact with the iron or steel in order to prevent unnecessary heat interchange. The plastic bronze, likewise according to my former applications above mentioned, displaces the flux and, in turn, wets the iron or steel surface, and thus forms the bond therewith.

According to this present invention I can work with substantially the same temperatures as described in my prior applications above referred to. I thus make use of the superheated flux principle, that is, I heat the iron or steel and the plastic bronze to temperatures generally insufficient to cause the best weld and then supply the temperature necessary for the best weld by means of the superheated flux, and I also make use of the principle of the bronze displacing the flux, both of these in turn wetting the iron or steel; but I vary the method of contacting the superheated flux and the molten plastic bronze with the surface of the iron or steel to which the plastic bronze is to be welded.

A backing of iron or any suitable composition of steel may be used, but I generally prefer one made of a soft or mild steel, say with a carbon content less than 0.2%. The invention is likewise applicable to any plastic bronze, but I prefer one having a composition of about 70% of copper and 30% of lead. Any suitable flux may be used, the preferred being made of—

	Per cent
Anhydrous borax	80
Cryolite	10
Boric acid	10

as stated in my applications aforesaid, wherein a flux of 90% of anhydrous borax and 10% of cryolite is also referred to as more or less practical.

An object of my invention is to simplify the cast-welding of plastic bronze to iron or steel when using the methods, operating conditions and materials described in my aforesaid applications.

Another object of my invention is to provide a method for cast-welding to an iron or steel backing a layer of plastic bronze in such manner that the thickness of said plastic bronze layer may be controlled and varied without changing any of the casting apparatus used.

Another object of the invention is to cast-weld plastic bronze on the inside of a small but long tube of iron or steel.

Another object of my invention is to cast-weld as aforesaid a thin liner of the bronze inside of an iron or steel tube without the use of a core.

Another object of the invention is to cast-weld as aforesaid a layer of said bronze which is thinner than the casting space into which it was cast.

Other objects of the invention will become apparent on reading this specification.

The general new principle involved in my invention comprises causing a flow of superheated flux along the surface of the iron or steel to which the plastic bronze is to be welded, this flow being followed either immediately or after an interval by a flow of plastic bronze; then chilling the composite layer, preferably from the free side of the iron or steel, up to the point of freezing the desired thickness of plastic bronze, and permitting the balance of the plastic bronze which is in molten condition to run off.

It also involves causing a flow through a hollow steel or iron body, of a column of superheated flux followed by a column of plastic bronze.

I will now refer to alternative exemplifications which are illustrative of my invention.

Referring to the accompanying drawings, which are a part of this specification,—

Figs. 1, 2 and 3 are vertical sections each more or less diagrammatically illustrating different steps in one exemplification of my invention;

Figs. 4 and 5 are similar views illustrating different steps in another exemplification;

Figs. 6, 7 and 8 are each a similar view of a modification useful with either exemplification; and

Fig. 9 is a sectional view of a completed bearing blank.

Referring to Figs. 1, 2 and 3, a furnace **10** of any suitable design supports a crucible **11** therewithin for the purpose of heating the flux to the desired temperature indicated above. The crucible **11** is provided with a cover **12** having an opening **13** therein. The furnace has a removable top **14** and an opening **15** therein registering with the opening **13**. A suitable number of burner openings, such as **16**, are provided in the furnace, which is also provided with a flue **17** for the escape of products of combustion. The method of heating this crucible, as well as those hereinafter referred to, is, however, not material, provided they are heated and maintained at the desired temperatures.

Another furnace **20**, which may be similar to the furnace **10**, is provided for supporting and heating a crucible **21** similar to the crucible **11**, and it likewise has a cover **22** having an opening **23** therein. The furnace has a cover **24** similar to the cover **14**, which likewise has an opening **25** therein registering with the opening **23**. The furnace **20** is likewise provided with sufficient burner openings **26**, and a flue **27**.

A cooling coil **31** is provided which has openings **32** to direct cooling medium to the center of the coil, the cooling medium being introduced into the coil by a supply pipe **33** having a control valve **34** therein. The cooling medium may be water atomized in air, or any other suitable material. A crucible **35** is provided for receiving surplus flux and metal.

According to this modification of my invention, I weld a layer of plastic bronze thick enough to form a bearing lining onto the inside of the steel tube **40**. With this in view I join this tube, as by welding, to an adapter tube **41** which is preferably somewhat longer than the tube **40**, the adapter being closed at the top **42** in which is an outlet **43** connected to a source of vacuum (not shown). The adapter is held in a clamp **44** on an arm **45** which is provided for the purpose of raising, lowering and transporting the tube to be welded as well as to hold it in any desired position.

I generally partially close the tube to be welded at its bottom with a perforated plate **46**, in which the perforations are small enough to prevent the metal or flux dripping out of the tube when held therein by the vacuum. This plate is generally preferable, although it may not in all cases be necessary, depending on the conditions of operation.

Before dipping the tube **40** in the heated flux in the crucible **11**, it may be pre-heated to about 1700° F. in any suitable furnace to speed up the action of the flux, preferably leaving the adapter tube attached thereto as cool as is economically possible. This tube, which is preferably but not necessarily heated, is lowered through the openings **15** and **13**, the bottom projecting a few inches below the surface of the flux in the crucible **11**, as shown on Fig. 1. Vacuum is then applied to the outlet **43** whereby superheated flux is drawn up into the tube **40** up to the point where it joins the adapter **41**. The rise of the flux is discernible by the heating up of the tube **40** if it is at a temperature, as it should be, substantially below that of the flux when the flux is applied thereto. Having filled the tube **40** with superheated flux, it is removed with the flux therein, as indicated at **47**, from the crucible **11** and furnace **10** and inserted through the openings **25** and **23** into the position shown on Fig. 2 with the bottom thereof below the surface of the plastic bronze in the crucible **21**. It is preferable to have the flux in contact with the inside of the tube **40** preferably for thirty to sixty seconds before displacing the flux with the molten bronze, although the time may be longer or shorter; and vacuum is then again applied to a sufficient extent to draw the molten plastic bronze to fill the tube **40** with plastic bronze **48**, the flux **47**, which was previously in the tube, being now in the adapter tube **41**. After the metal has been drawn up into the tube, as illustrated in Fig. 2, the tube is lifted out of the crucible **21** and the furnace **20**, and it is then lowered into place centrally within the cooling coil **31** as shown in Fig. 3, whereupon the cooling medium is turned on and impinges on the outside of the tube **40**. This causes the formation of a layer of solid bronze which is securely welded to the inside face of the tube **40**. Such a layer, under the conditions of operation mentioned, forms very quickly and in ten to twenty seconds, more or less, will be from twenty to thirty thousandths of an inch thick. The rate of formation of the solid welded-on bronze will, of course, depend upon the nature of the cooling medium used, the pressure at which it is applied, the number of sprays, and other factors; but with any given set-up the operator will speedily learn as a matter of operating technique, the rate at which the layer of solid bronze builds up.

When the solid bronze layer inside the steel tube 40 is thick enough for the particular bearings being manufactured, the vacuum is broken and then the remaining molten bronze and, thereafter, the molten flux flow out through the perforations in the plate 46 and are caught in the crucible 35, whence they may be removed and returned to their respective crucibles 11 and 21 for further use. As some seconds must elapse from the time the vacuum is broken until all of the liquid metal has drained out of the tube 40, the layer of welded bronze will be thicker at the bottom of the tube 40 than at the top thereof. This variation in thickness can be compensated to some extent by lowering the pressure in the cooling coils while the metal is draining out so that the remaining cooling effect is just sufficient to prevent the soft hot bronze from being eroded away from the back, and the draining away of the metal may be speeded by applying pressure at the outlet 43. After the flux and surplus metal have run out of the tube 40, completion of the cooling may be effected in any desired manner, either faster or slower than or at the same rate as it is cooled by the coil 31, as may be desired. It may be dropped into cold water to bring it down to room temperature.

When the tube 40 and the adapter tube 41 are sufficiently cool, the adapter is cut away from the tube 40 and used anew. The tube 40 with the layer of plastic bronze welded to the inner side thereof may then be machined into bearings.

In the method illustrated on Figs. 4 and 5, I use only one crucible which contains both the molten plastic bronze and the superheated flux floating thereabove. In such figures, 50 represents a furnace adapted to support and heat the crucible 51. The upper part of the furnace is enlarged to form the combustion chamber 52 where preferably the larger portion of the fuel is burned, and for this purpose a suitable number of burner openings 53 are provided which lead into the combustion chamber 52; and one or more burner openings 54 leading into the lower part of the furnace may be provided where it appears necessary to heat the lower part of the crucible in addition to the heat derived from the combustion at the upper part of the furnace. A flue 55 is provided to conduct away products of combustion. Crucible 51 is provided with a top 56, like the tops 12 and 22 previously referred to, and similarly thereto it has an opening 57 therein. The furnace 50 has a removable top 58, like the furnace tops 14 and 24 previously referred to, and similarly thereto it also has an opening 59 therein which registers with the opening 57. The crucible contains molten plastic bronze 60 and a layer of superheated flux 61 floating thereon. The steel tube 62 to which the plastic bronze is to be welded may be almost closed at its lower end by a perforated plate 63, similarly to the plate 46 previously described.

The heating of the furnace is so conducted that the temperature of the flux is kept somewhat hotter than that of the metal, the temperatures of the flux and of the metal being preferably those above referred to. This is accomplished by causing the major part of the combustion to take place above the level of the bronze.

The tube 62 is welded to an adapter tube 64, which may be shorter than but otherwise of the same structure as the adapter tube 41, like it being closed at the end 65 and being provided with an outlet 66 which is connected to a source of vacuum (not shown). A holder 67 is attached to the upper part of the adapter tube and this holder is carried by an arm 68, similar to the arm 45, for the purpose of maintaining the tube to be treated in any desired position or for moving it in any desired manner. A cooling means, such as a hollow coil 69, similar to but not necessarily as long as coil 31, and having perforations 70 similar to the perforations 32, is held in relatively fixed position so that the tube to be treated can be drawn therethrough and progressively cooled. Here, again, the cooling material may be a liquid such for example as water, atomized in air.

I may first weld the tube 62 onto the adapter tube 64 and then heat the tube 62 to about 1700° F. in such a manner as to leave the adapter tube 64 relatively cool. The tube 62 may then be dipped into a molten bath of flux, whereupon I may secure the adapter tube 64 to the holder 67 and then connect the outlet 66 to the source of vacuum; or I may secure the adapter while cold in the holder 67 and connect to the vacuum and then heat the tube 62 which is attached to the adapter and flux it, whereupon it is to be positioned above the center of the coil 69 and openings 59 and 57. The tube is then quickly lowered into the position shown on Fig. 4 where, as shown, the connection between the tube 62 and the adapter tube is just below the cooling coil, and the tube 62 extends to approximately the inside bottom of the crucible. The vacuum is then applied and the metal is thus raised to the point where the tube 62 is connected to the adapter tube. As the metal rises to this level it is preceded by the superheated flux 71 within the tube and adapter, which prepares all of the inside surface of the tube 62 to form the desired welded union and so that it is plated instantaneously by the molten plastic bronze as it rises in the tube under the effect of the vacuum.

I next start to raise the tube slowly out of its initial position, simultaneously turning on the cooling spray in coil 69. The tube is thus raised to the position shown on Fig. 5 and the rate of rise is such that the time required to assume that position is preferably from thirty to sixty seconds, although it may be longer or shorter than this. As the tube 62 slowly rises through the superheated flux 61, the heat of the latter causes an intimate and secure plating of the inside face of the tube with the molten bronze which is therewithin; and as the tube continues to rise the zone which has previously passed under the influence of the superheated flux next comes under the influence of the cooling means, which causes a layer of bronze of appreciable thickness to adhere to the previously referred to plated on bronze so that a substantial thickness of bronze is securely welded to the tube. The thickness of the adherent layer of bronze will depend on the speed of rise of the tube, and on the rate of cooling and, possibly also, on other factors. The slower the speed of rise and the faster the rate of cooling, the thicker will be the solid layer of bronze; and it is practical to make such layer as thick as one-eighth of an inch or as thin as a few thousandths of an inch, at will, these figures being merely illustrative. The effect of the cooling coil should be such that the adherent layer of bronze is completely solidified for the desired thickness as the adherent layer rises above the upper edge of the cooling means. Such solid layer of bronze thus continues to rise through the flux pocket 71, which coats the newly solidified metal and thus protects it as shown on Fig. 9. The perforated plate 63 prevents the too rapid efflux of the liquid metal out of the tube 62 when it is in the position shown on Fig. 5, and by proper adjustment of the size and number of the perforations in the plate 63, the entire inside face of the tube 62 will receive a firmly welded-on layer 72 of the bronze as it finally and completely rises above the cooling means. The tube may then be completely cooled by plunging into water and it may then be severed from the adapter. The adapter tube may then be re-used and the dual metal tube may be machined into bearings.

The bronze may be welded onto the outside of the tube, if desired, with the use of the device shown in Fig. 6. Here 73 denotes the tube to which the bronze is to be welded; 74, the adapter; and to the tube 73 is welded a thin-walled steel hollow cylinder 75 outside of the tube 73, the two being held concentrically by welded steel strips 76 at the bottom. Holes 77 are provided to permit the vacuum to cause rise of material between the two tubes as well as within the inner one. The outer steel tube may be machined off to make the finished bearing. It is understood, of course, that coating outside as well as inside may be accomplished with either exemplification of the invention above described.

The invention has so far been described with respect to straight bearings, but it will be understood that the steel tubes to which the bronze is to be welded may be formed with recesses for flanges, and these may be tapered to prevent trapping of flux therein. As shown on Fig. 7, the tube 78 is formed with outwardly projecting recesses 79 to form flanged bearings when the bearings are cut along the lines 80. On Fig. 8, the tube 78 is provided with inwardly projecting recesses 81 which likewise will form flanged bearings when cut along the lines 82.

One of the advantages of my invention is that I can choose the thickness of the bronze to be welded onto the tube so that very little bronze turnings will be made in the machining operation.

I have shown certain exemplifications and modifications of my invention by way of illustration thereof and not as a limitation thereof, since changes can be made in my invention without departing from the spirit thereof, the scope of which is defined in the appended claims.

Having described my invention, what I claim and desire to secure by Letters Patent is—

1. The method of autogenously welding a layer of plastic bronze on iron or steel which comprises dipping a tube of said iron or steel into superheated flux bath, causing said flux to rise in and contact said tube, removing said tube from said bath with the flux therein, dipping it in a bath of molten plastic bronze at a temperature below the welding temperature if said flux be not superheated, causing said metal to rise in and contact said tube before substantial heat losses occur thereby to replace the superheated flux and move it upwardly, cooling the outside of said iron or steel to solidify said bronze progressively away therefrom, and removing remaining liquid when sufficient bronze has solidified.

2. The method of autogenously welding a layer of plastic bronze on iron or steel which comprises dipping a tube of said iron or steel into superheated flux bath, causing said flux to rise in and contact said tube, removing said tube from said bath with the flux therein, dipping it in a bath of molten plastic bronze at a temperature below the welding temperature if said flux be not superheated, causing said metal to rise in and contact said tube within about one-half to one minute from the time of causing said flux to rise in said tube thereby to replace the superheated flux and move it upwardly, cooling the outside of said iron or steel to solidify said bronze progressively away therefrom, and removing remaining liquid when sufficient bronze has solidified.

3. The method of autogenously welding a layer of plastic bronze on iron or steel which comprises dipping a tube of said iron or steel into a bath of molten plastic bronze having a layer of superheated flux floating thereon, said molten plastic bronze being at a temperature below the welding temperature if said flux be not superheated, whereby a layer of said flux and a column of said bronze enter and contact said tube, causing said column and said layer to rise in said tube by creating a vacuum at the top of said tube, raising and simultaneously cooling said tube while maintaining said vacuum to solidify said bronze progressively away therefrom, and removing remaining liquid when sufficient bronze has solidified.

4. The method of making bearings by cast-welding plastic bronze onto an iron or steel tube by heating said tube then treating the surface thereof to be welded with a molten flux and then replacing said flux with said bronze in molten condition, the temperatures of said tube and said bronze being insufficient to cause the maximum firmness of weld, the flux being superheated to a temperature at which heat is imparted to the surface of the tube to be welded to increase the firmness of the weld, said superheated flux and said molten bronze being sucked within said tube, said flux being above and preceding said bronze.

5. The method of making bearings by cast-welding plastic bronze onto an iron or steel tube by heating said tube then treating the surface thereof to be welded with a molten flux and then replacing said flux with said bronze in molten condition, the temperatures of said tube and said bronze being insufficient to cause the maximum firmness of weld, the flux being superheated to a temperature at which heat is imparted to the surface of the tube to be welded to increase the firmness of the weld, said superheated flux and said molten bronze being sucked within said tube, said flux being above, and preceding said bronze, cooling the outside of said iron or steel to solidify said bronze progressively away therefrom, and removing remaining liquid when sufficient bronze has solidified.

6. The method of making bearings by cast-welding plastic bronze onto an iron or steel tube by heating said tube then treating the surface thereof to be welded with a molten flux and then replacing said flux with said bronze in molten condition, the temperatures of said tube and said bronze being insufficient to cause the maximum firmness of weld, the flux being superheated to a temperature at which heat is imparted to the surface of the tube to be welded to produce the maximum firmness of weld, said superheated flux and said molten bronze being sucked within said tube, said flux being above and preceding said bronze.

7. The method of making bearings by cast-welding plastic bronze onto an iron or steel tube by heating said tube then treating the surface thereof to be welded with a molten flux and then replacing said flux with said bronze in molten condition, the temperatures of said tube and said bronze being insufficient to cause the maximum

firmness of weld, the flux being superheated to a temperature at which heat is imparted to the surface of the tube to be welded to produce the maximum firmness of weld, said superheated flux and said molten bronze being sucked within said tube, said flux being above and preceding said bronze, cooling the outside of said iron or steel to solidify said bronze progressively away therefrom, and removing remaining liquid when sufficient bronze has solidified.

8. The method of making bearings by cast-welding plastic bronze onto an iron or steel tube by heating said tube, then sucking molten flux and molten plastic bronze by application of a vacuum along the surface to be welded, said bronze progressively replacing said flux, the temperatures of said tube and said bronze being insufficient to cause the maximum firmness of weld, the flux being superheated to a temperature at which heat is imparted to the surface of the tube to be welded to produce a better weld, cooling the outside of said iron or steel to solidify said bronze progressively away therefrom while maintaining said vacuum, and breaking said vacuum to permit remaining liquid to flow out when sufficient bronze has solidified.

9. The method of making bearings by cast-welding plastic bronze onto an iron or steel tube by heating said tube, then sucking molten flux and molten plastic bronze by application of a vacuum along the surface to be welded, said bronze progressively replacing said flux, the temperatures of said tube and said bronze being insufficient to cause the maximum firmness of weld, the flux being superheated to a temperature at which heat is imparted to the surface of the tube to be welded to produce a better weld, cooling the outside of said iron or steel to solidify said bronze progressively away therefrom while maintaining said vacuum, and breaking said vacuum to permit remaining liquid to flow out when sufficient bronze has solidified while decreasing the degree of said cooling.

10. The method of welding bearing metal on to a tubular metal backing which comprises dipping the tubing into a fluid flux and drawing flux into the tubing and retaining it therein by suction, then dipping the tubing into molten bearing metal and drawing the bearing metal into the tubing by suction to displace the flux therein, then causing the bearing metal to solidify adjacent the tubing to produce a coating of desired thickness and removing the unsolidified metal.

11. The method of welding bearing metal on to a tubular metal backing which comprises dipping the tubing into a fluid flux and drawing flux into the tubing and retaining it therein, then dipping the tubing into molten bearing metal and drawing the bearing metal into the tubing by suction to displace the flux therein, then causing the bearing metal to solidify adjacent the tubing to produce a coating of desired thickness and removing the unsolidified metal.

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