June 23, 1931. W. J. HAWKINS 1,810,913

METAL LINING CRUCIBLE

Filed May 1, 1929

Fig. 1.

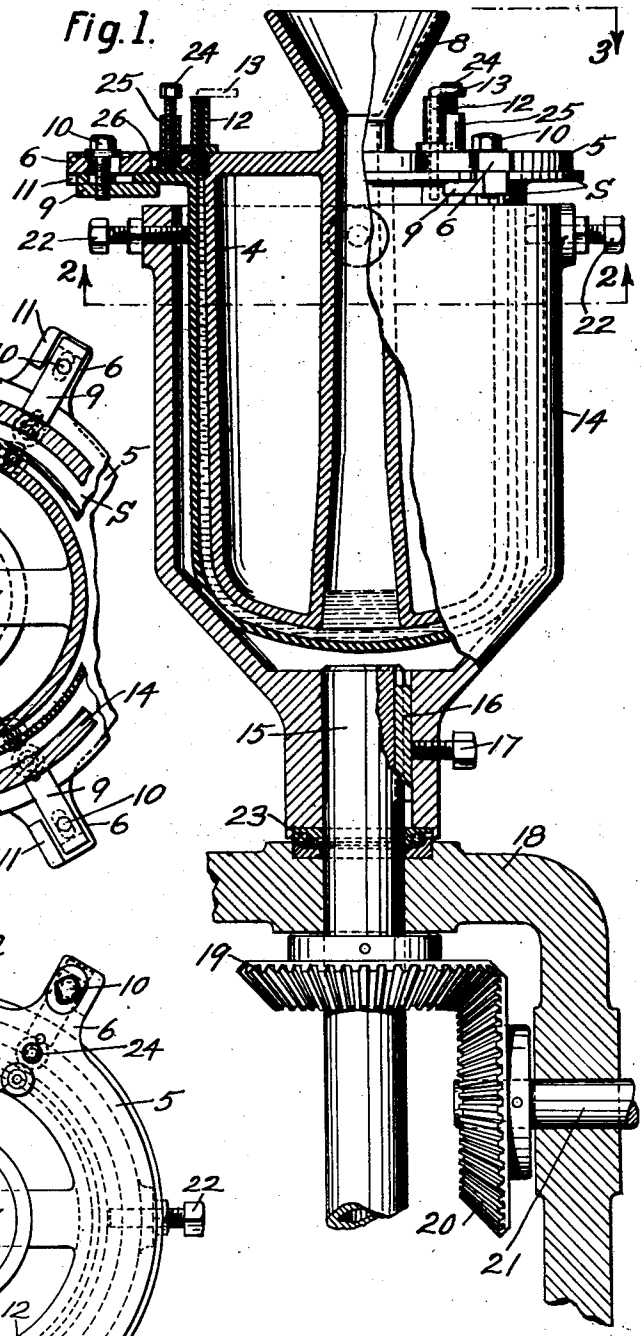


Fig. 2.

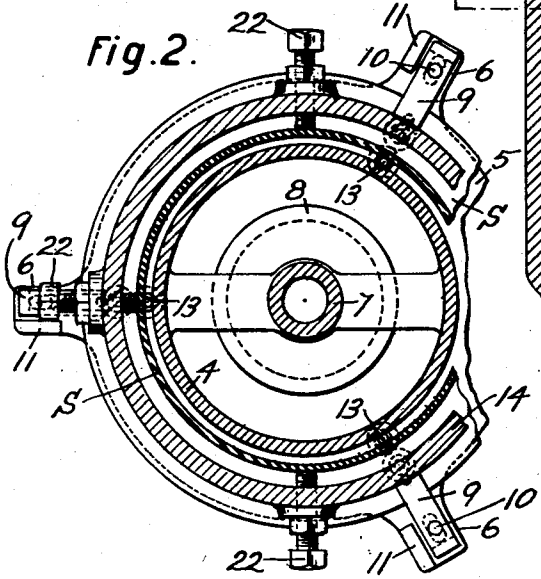
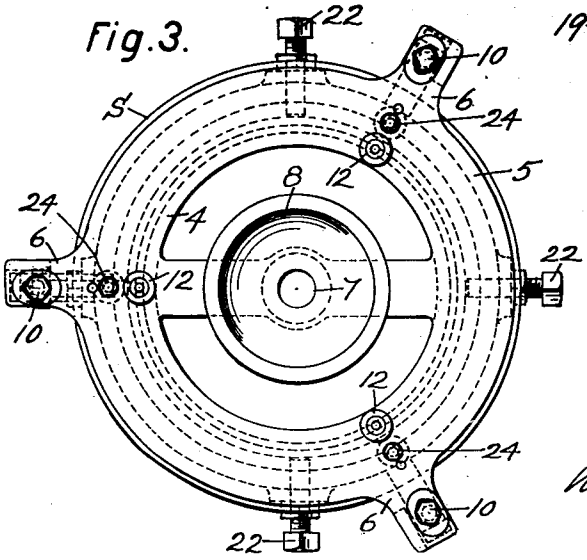


Fig. 3.



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UNITED STATES PATENT OFFICE

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METAL LINING CRUCIBLE

Application filed May 1, 1929. Serial No. 359,665.

This invention relates to an improvement in acid resistant crucibles of the type used in certain metallurgical and chemical processes.

Heretofore, crucibles constructed entirely of lead, or of a stronger metal lined with lead, have been used for this purpose. The former are too weak to withstand the pressure when used in processes involving employment of a vacuum, and the latter are not sufficiently durable to be economically satisfactory, because the lead lining is riveted to the outer shell of steel at separated points, buckles inwardly between the rivets when used in vacuum processes, and the rivets sometimes fail to hold. Such linings are thin and easily damaged in ladling substances out of the crucible.

The main object of the present invention is the production of an improved crucible of this type which is free from structural weakness and ladling damage, and from inward buckling when used in vacuum processes, and which is more acid resistant because free from porosity. With this end in view, the improved crucible comprises an outer shell of steel or other suitable material, and a thick inner lining, the shell and lining being held together by their cohesion throughout their contacting surfaces, no other fastening means being necessary, and no inward buckling being possible at the pressures developed in vacuum processes. The lining is of a non-corrosive metal known as amaloy. The principal ingredient of this metal is lead. It contains, however, a small quantity of tin and a sufficient quantity of phosphorus to deoxidize a stronger metal when applied in a molten state to a clean surface thereof, and thereby produce a strong cohesive action of the two metals. This metal is formed by fusing phosphor-tin or a phosphide or compound containing phosphorus in a bath of lead in the proportions of approximately 3 pounds of phosphor-tin and 97 pounds of lead. The lining may be thicker, but a thickness of $\frac{5}{16}$ of an inch has been found sufficient to guard against ladling damage.

Another object of the invention is the production of a simple method of applying the lining metal to the outer shell of stronger metal, none adapted for the purpose having been found.

Still another object of the invention is the production of simple apparatus for carrying the method into practice, none adapted for the purpose having been found.

With these and other objects not specifically mentioned in view, the invention consists (1) in certain characteristics of an improved product, (2) in a certain method of making the new product, and (3) in certain constructions and combinations employed in new apparatus for carrying the new method into practice.

In the accompanying drawings, in which like characters of reference indicate the same or like parts, Fig. 1 is a side elevation, mainly in section, of apparatus constructed in accordance with the invention; Fig. 2 is a cross section taken on the line 2—2 in Fig. 1; and Fig. 3 is a plan view as seen from the line 3.

In carrying the invention into effect, there is provided a crucible comprising an outer shell and a thick inner lining held together by their cohesion throughout their contacting surfaces. Preferably, the lining is of amaloy which is non-corrosive, and also slightly compressed to avoid porosity.

The method of making such a cricible preferably consists in whirling the shell and directing molten metal for the lining to the inner side of the crown of the shell to enable the centrifugal force developed by the whirling shell to spread the lining metal over the inner surface of the shell. This surface must be first thoroughly cleaned, as by pickling and fluxing, so that the phosphorus in the molten lining metal will deoxidize the metal of the shell and produce cohesion of the two metals, of sufficient strength to prevent separation and buckling of the lining when the crucible is used in a vacuum process. Preferably, the shell is whirled on a vertical axis, and the centrifugal force is sufficient to cause the molten lining metal to be spread upwardly over the inner surface of the whirling shell. The molten metal for the lining is introduced while the shell is whirling.

For carrying the method into practice, an apparatus is provided which includes a core

4 the diameter of which is determined by the diameter of the crucible to be lined and by the thickness of lining desired. The core 4 is provided with a flange 5 having three lugs 6 spaced equi-distantly about the circumference of the flange 5. The core is also provided with a central conduit 7 through which the molten metal for the lining is poured when the apparatus is in action. The conduit 7 is provided with a flaring mouth 8 to facilitate the entrance of the molten metal.

For the purpose of securing the core 4 to a crucible shell S having a flange underlying the core flange 5, there are provided three clamps 9 which are held by screws 10 projecting through slots in the lugs 6. The lugs 6 are provided with downwardly projecting ribs 11 to prevent rotation of the clamps 9 while the screws 10 are being tightened.

For the purpose of permitting the escape of air from the space between the core 4 and the shell S while molten metal is being poured through the conduit 7, there are provided three vent tubes 12 secured to the core flange 5. These vent tubes are also used for another purpose. When the core is to be assembled with a shell to be lined, bent pins 13 are inserted in the bore of the vent tubes. These pins project below the core flange 5 and engage the wall of the bore of the shell at three points, thus centering it before the clamps 9 are brought into action to hold it in centered position. The space between the core 4 and the shell S equals the thickness of the lining to be formed. Ordinarily, it is about $\frac{5}{16}$ of an inch at the crown of the core and shell, and tapers slightly towards the top of the shell.

Means are provided for whirling the shell and core after they have been assembled and clamped together, and this means includes a support 14 secured to a vertical shaft 15 by means of a key 16 and a set screw 17. The shaft 15 is journaled in a bracket 18. The shaft 15 is driven by a bevel gear 19 fast thereto, which in turn is driven by a second bevel gear 20 carried by a shaft 21 journaled in the bracket 18 and which is the prime mover of the apparatus.

The lower end of the shell S rests on a tapered surface of the support 14, and its upper end is centered and held by four set screws 22 carried by the support and engaging the outer surface of the shell. The support continues to whirl until the molten metal for the lining has spread over the inner surface of the shell and has solidified. The centrifugal force developed by the whirling support, core, and shell, drives the molten metal up between the walls of the core and the shell and slightly compresses it axially or makes it more dense than it would be if simply cast in position. This avoids porosity due to drossing.

The shaft 15 may be made hollow to permit air to be blown into the support 14 for cooling the lining after the molten metal L has filled all portions of the space between the core and the shell.

A ball bearing 23 serves to take up the vertical thrust due to the weight of the whirling support, shell, core, and lining metal.

By cooling the applied lining while the apparatus is still whirling rapidly, the lining metal will be in a state of slight radial compression from the shell as well as in a state of slight axial compression, when the whirling ceases.

After the lining has been thus applied and has cooled in position, the centering screws 22 are backed away, and the crucible, now lined, and with the core still clamped to it, is lifted from the support 14. The clamps 9 are then released, and the core is withdrawn from the lined crucible, by means of the screws 24 working in stationary nuts 25 secured to the core flange 5 by means of rivets 26.

To insure proper cohesion of the steel shell and amaloy lining, the inner surface of the shell must be thoroughly cleaned just before use of the apparatus, but the outer surface of the core 4 should be left dirty, and, if necessary, coated with grease, to prevent development of cohesion as between it and the lining metal. After the core is removed from the lined crucible, the central butt due to surplus metal in the lower part of the conduit 7 is cut away; and the inner surface of the lining may then be burnished if desired.

The core may be omitted where the lining is to be applied to crucibles or other vessels in which the height of its sides is such that the hydrostatic head of the side lining is equal to or less than the centrifugal effort of the metal lining covering the bottom of the vessel.

Changes and variations within the scope of the claims may be made in the product, the method, and the apparatus. The invention, therefore, is not to be restricted to the precise details of that which is shown and described.

What is claimed is:

1. The method of making a crucible comprising an outer shell and a thick inner lining held together by their cohesion throughout their contacting surfaces, which consists in introducing a core within the shell, whirling the core and shell and directing molten metal for the lining through the core to the inner side of the crown of the shell to enable the centrifugal force developed by the whirling shell to spread the molten metal over the inner surface of the shell.

2. The method of making a crucible comprising an outer shell and a thick inner lin-

ing held together by their cohesion throughout their contacting surfaces, which consists in introducing a core within the shell, whirling the core and shell on a vertical axis and directing molten metal for the lining through the core downwardly to the bottom of the shell to enable the centrifugal force developed by the whirling shell to spread the molten metal upwardly over the inner surface of the shell.

3. An apparatus for applying a thick lining to the inner surface of a crucible, comprising a crucible support, means for whirling said support, a core within and whirling with a crucible carried by said support, and means for directing molten metal for the lining to the space between the crown of the core and the crown of the crucible.

4. An apparatus for applying a thick lining to the inner surface of a crucible, comprising a crucible support, means for whirling said support, a core within and whirling with a crucible carried by said support, and means for directing molten metal for the lining to the space between the crown of the core and the crown of the crucible, said support having means for centering and holding a crucible therein.

5. An apparatus for applying a thick lining to the inner surface of a crucible, comprising a crucible support, means for whirling said support, a core within and whirling with a crucible carried by said support, and means for directing molten metal for the lining to the space between the crown of the core and the crown of the crucible, said core having means for clamping it to a crucible carried by said support.

6. An apparatus for applying a thick lining to the inner surface of a crucible, comprising a crucible support, means for whirling said support, a core within and whirling with a crucible carried by said support, and means for directing molten metal for the lining to the space between the crown of the core and the crown of the crucible, said core having means for withdrawing it from a crucible carried by said support.

7. An apparatus for applying a thick lining to the inner surface of a crucible, comprising a crucible support, means for whirling said support, a core within and whirling with a crucible carried by said support, and means for directing molten metal for the lining to the space between the crown of the core and the crown of the crucible, said core having a series of clamps for securing it to a crucible carried by said support, and a series of screws for withdrawing it therefrom.

8. An apparatus for applying a thick lining to the inner surface of a crucible, comprising a crucible support, means for whirling said support, a core within and whirling with a crucible carried by said support, and means for directing molten metal for the lining to the space between the crown of the core and the crown of the crucible, said directing means including an axial conduit in said core.

In testimony whereof, I have signed my name to this specification.

WILFORD J. HAWKINS.