

July 26, 1938.

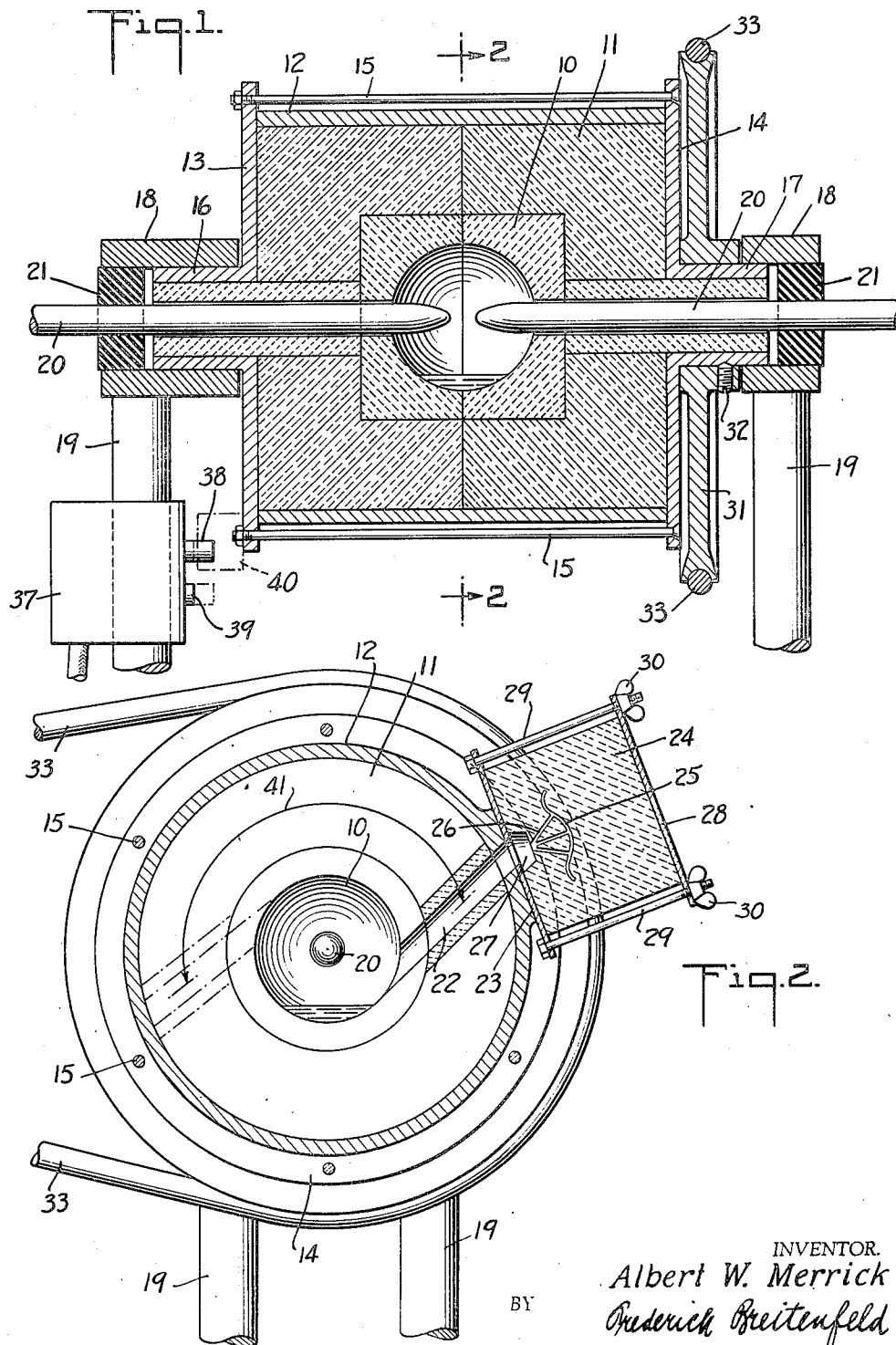
A. W. MERRICK

2,125,080

FOUNDING APPARATUS AND METHOD

Filed May 13, 1937

2 Sheets-Sheet 1



INVENTOR.
Albert W. Merrick
BY
Frederick Breitenfeld
ATTORNEY.

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Fig. 3.

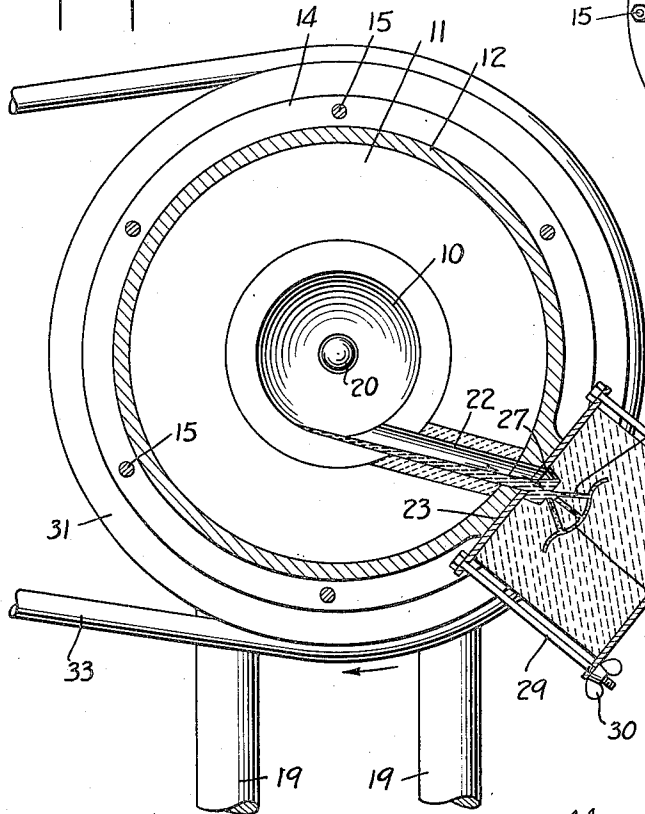
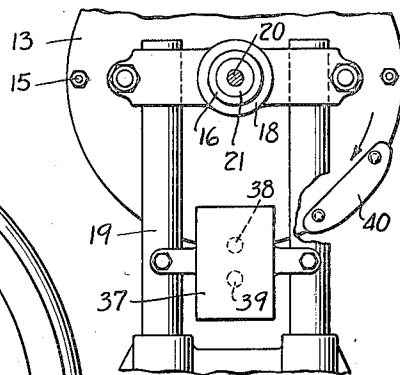


Fig. 5.

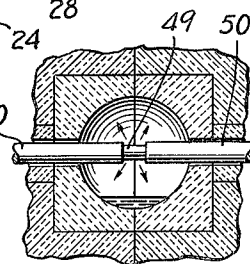


Fig. 4.

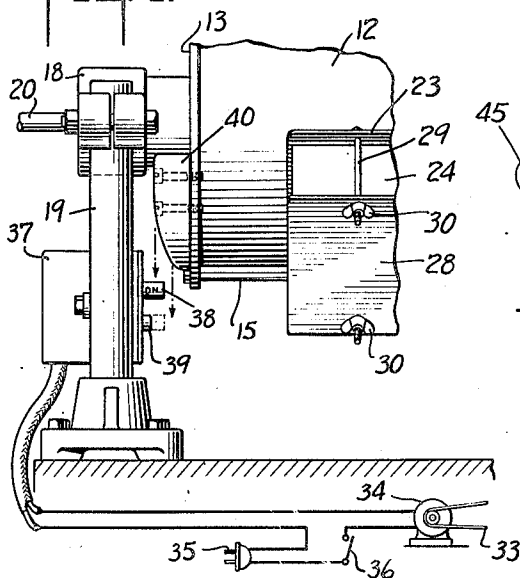
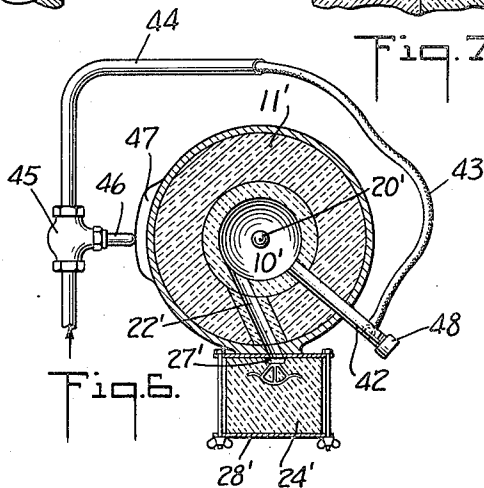


Fig. 7.

INVENTOR.
Albert W. Merrick
BY
Frederick Breitenfeld
ATTORNEY.

UNITED STATES PATENT OFFICE

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FOUNDING APPARATUS AND METHOD

Albert W. Merrick, Schenectady, N. Y., assignor to
Austenal Laboratories, Inc., New York, N. Y.,
a corporation of New York

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16 Claims. (Cl. 22—65)

My present invention relates generally to founding, and has particular reference to an improved founding apparatus and method.

It is a general object of my invention to provide a founding apparatus which is particularly useful for small-scale founding operations, and which is unusually efficient in permitting metals and alloys—including those which are extremely susceptible to oxidation—to be melted in clean and oxide-free condition.

The present invention is of particular utility in the founding procedures involved in the manufacture of metal dentures and denture parts, or similar small castings, but it will be understood that certain phases of my invention are not necessarily restricted to any specific casting operation.

The molds used in the manufacture of dentures and denture parts are relatively small, and the mold charges are correspondingly small, thus presenting certain problems which do not arise in connection with large-scale casting operations. One of the customary procedures is to place the small charge of metal in the sprue of the mold; reduce it to a molten state by a blow torch or the like; and then force the molten metal into the mold by rotating the mold and driving the charge into it by centrifugal force.

Certain alloys commonly employed for dentures and the like require a more uniform heating than that which is capable of accomplishment by this relatively crude method; and certain alloys manifest their desirable qualities to a better extent if they are shielded from contact with the atmosphere during the melting and casting procedures. Moreover, in working with relatively small mold charges, it is sometimes extremely difficult, by ordinary methods, to introduce minor ingredients where such ingredients are of low melting point and readily susceptible to oxidation.

In accordance with my present invention, I am enabled to provide an apparatus and a method which accomplishes a more efficient melting of the metal under non-oxidizing conditions; which permits an unusually accurate control of temperature; and which effects a more uniform heating of the molten charge. My present apparatus and method also permits minor ingredients, even of the readily oxidizable types, to be introduced into the melt in accurately controllable quantities. Of outstanding importance is the possibility, by my present invention, of introducing and driving the molten charge into the mold without undesirable contact with the atmosphere

and at the most propitious moment so far as the temperature, uniformity, and cleanliness of the charge is concerned.

One of the features of my invention lies in the employment of a closed crucible which is heated from the midportion thereof and adapted to be rocked around an axis which passes through the crucible. This subjects the metal charge, in the most efficient manner, to the action of the applied heat, and permits the charge to be gently agitated so as to subject it to the heating action of successive portions of the crucible wall. Preferably, but not necessarily, the crucible has a spherical interior and is capable of rocking and rotation around one of its diameters as an axis. This type of rocking furnace is not new, per se, but my present invention provides for certain improvements whereby the use of such a furnace, for small-scale work and in a complete founding operation, is made possible.

In accordance with my invention, a carbon monoxide or other non-oxidizing atmosphere is maintained within the crucible during the melting procedure; and means are provided for feeding the molten charge directly into the sprue of a mold while maintaining such atmosphere around the charge, the latter being finally impelled into the mold.

One way of carrying out the invention lies in providing a passage in the crucible from the interior to the exterior thereof; providing a means for removably securing a mold to the crucible with the sprue of the mold in registry with said passage; and causing the molten charge to be driven into the mold by a blast of gas pressure introduced into the crucible, and thence through the passage to the sprue, at the proper moment.

Another and preferred method of carrying out the present invention lies in the provision of an arrangement for rotating the crucible bodily around an axis that passes through the crucible at a speed which is sufficiently great to impel the molten charge into the mold by centrifugal force. Such bodily rotation of the crucible is effected at the proper time, i. e., after the molten charge has been introduced into the sprue of the mold.

I achieve the foregoing objects, and such other objects as may hereinafter appear or be pointed out, in the manner illustratively exemplified in the accompanying drawings, wherein—

Figure 1 is a cross-sectional elevation through a furnace constructed in accordance with the present invention;

Figure 2 is a cross-sectional view taken sub-

stantially along the line 2—2 of Figure 1, showing a mold in association with the crucible;

Figure 3 is a view similar to Figure 2, showing the parts in the relationship they assume at the moment when the molten charge is fed directly to the sprue of the mold;

Figure 4 is a fragmentary elevational view taken substantially in the direction of Figure 1, showing a detail of the automatic furnace-rotating mechanism;

Figure 5 is a fragmentary view taken from the left of Figure 4;

Figure 6 is a view similar to Figure 3, illustrating a modification; and

Figure 7 is a fragmentary view similar to the midportion of Figure 1, illustrating a further modification.

In accordance with my invention, a crucible 10 is mounted for rotation about a horizontal axis. In the illustrated embodiment, I have shown the crucible with a substantially spherical interior, mounted for rotation about a horizontal diameter. The crucible proper is surrounded by a mass 11 of heat-insulating material, the latter being enclosed within a substantially cylindrical metal shell 12. At its ends, the shell 12 abuts against metal end walls 13 and 14, the latter being rigidly secured together by the tie rods 15. The end walls 13 and 14 have portions 16 and 17 which serve as journals mounted for rotation within suitable bearings 18. The latter may be supported in any suitable or desired manner upon rigid stanchions or pedestals 19 or the like.

In accordance with my invention, a focal source of heat is arranged at a midportion of the crucible. Preferably, but not necessarily, the heating instrumentality projects into the crucible 10 along the axis of rotation. In all of the figures, except Figure 7, I have shown the preferred construction consisting of opposed carbon electrodes. These electrodes are designated by the reference numeral 20 in Figure 1. They are not intended to rotate, and they are, therefore, preferably mounted within insulating bushings 21 which are secured against rotation. For example, the bushings 21 may be securely engaged with the bearings 18, either by a frictional drive fit or by any other convenient method of assembly.

The electrodes form the elements of a carbon arc, and suitable means (not shown) not only secures the electrodes against rotation, but permits the electrodes to be moved toward and away from each other so as to produce the desired arc. The source of heat for the crucible is thus located at a midportion of the crucible, preferably at the approximate center of the crucible, and this is a highly desirable condition. Extending from the interior of the crucible 10 to the exterior of the shell 12 (this entire unit being referred to hereinafter and in the appended claims as "the crucible") is a passage 22 which is arranged substantially in a plane transverse to the axis of rotation. This passage is preferably tangential with respect to the interior of the crucible, and it terminates at its outer end in a plate 23 to which a mold 24 may be applied.

I have illustrated a denture mold 24 of typical character, the same being a substantially cylindrical body, with the mold cavity 25 and the gates or passages 26 converging toward a sprue 27.

Means are provided to secure the mold 24, removably, to the crucible itself, and I have illustratively shown one way of accomplishing this. A plate 28 is applied to the outer end of the mold

24, and threaded bolts 29 extend between the plates 23 and 28 so as to permit the tightening of wing nuts 30 to press the plates toward each other.

Before describing the founding procedure in its entirety, I will point out that the crucible is adapted to be rotated by means of a pulley 31 secured, as at 32, to one of the journal portions 17, a pulley belt 33 extending to a suitable driving source such as a motor 34 (Figure 4). The motor derives its power from an electric circuit which includes the connection plug 35, the main switch 36, and the auxiliary switch 37. The latter switch is preferably provided with the switch buttons 38 and 39, the former serving to establish the circuit, the latter serving to disconnect the circuit.

In accordance with my invention, the switch 37 is preferably secured to the framework 19 of the furnace, in a position which cooperates with a cam 40 carried by the end wall 13 of the crucible. This cam is shaped substantially as shown in Figures 4 and 5, and is so positioned that when the crucible is rotated into a predetermined angular position, the cam contacts with the button 38 and actuates the latter so as to establish the desired electric circuit.

In carrying out a founding procedure, the furnace is first heated up by establishing the necessary connections to the electrodes and adjusting the latter so that a carbon arc is produced and maintained. At the proper time, the metal to be melted is fed into the crucible through the passage 22, the exact amount being dependent upon the ultimate casting to be made.

The crucible is then gently rocked to-and-fro and, if desired, depending upon conditions, this may be accomplished either by hand or otherwise. The operator might, for example, grasp the belt 33 and by moving the latter thus cause a gentle rocking of the crucible. This rocking is effected through approximately 180°, the approximate extent being designated by the curved arrow 41 in Figure 2. This rocking subjects the molten charge to a gentle agitation, and the charge is brought successively into contact with different portions of the crucible wall, thereby becoming uniformly heated and utilizing the heat of the crucible with maximum efficiency.

Either before, during, or after the melting procedure, the mold 24 is secured to the crucible so that it assumes the relationship shown in Figure 2.

After the charge has been melted to the satisfactory extent, the crucible is swung gently into the position of Figure 3, at which time the charge flows through the passage 22 into the sprue of the mold. As soon as this has been accomplished, the crucible is set into rapid rotation by connecting the circuit of the motor 34, and thereupon the molten charge is driven into the mold by the centrifugal force that is engendered.

In order that the rapid rotation of the crucible may be initiated at exactly the right time, with a minimum of manipulations on the part of the operator, the cam 40 is so positioned with respect to the switch 37 that as the crucible reaches the position of Figure 3, the switch 37 is automatically closed; whereupon the crucible automatically starts to rotate at the desired relatively rapid rate.

After the casting has been completed, which may be a matter of about ten seconds or so, the main switch 36 of the motor is manipulated to disconnect the circuit, and the crucible thereupon

comes to a stop. The mold may then be removed and the casting withdrawn therefrom in the usual way.

The apparatus is then ready for a subsequent operation of similar character.

The advantages of this procedure will be obvious to those skilled in the art. Where carbon electrodes are used, a carbon monoxide atmosphere is automatically developed and maintained within the crucible notwithstanding the relatively small communication, through the passage 22, with the external air. The molten charge is thus constantly shielded from any oxidizing influence, and there is no opportunity for cooling or for oxidation between the time that the charge is properly melted and the time when it is introduced into the sprue of the mold and then impelled into the mold itself.

If desired, it will be understood that any other neutral non-oxidizing atmosphere may be maintained within the crucible, although the carbon monoxide atmosphere is preferable because of its automatic production by the carbon electrodes.

The process may be slightly modified, as shown in Figure 6, by replacing the rapid rotation of the crucible by the action of gas pressure. In the apparatus illustrated in Figure 6, the reference numerals correspond to those heretofore employed, and it will be understood that the crucible is capable of rocking, as before. In this construction, however, a tube or conduit 42 extends into communication with the interior of the crucible, at a point preferably alongside of the passage 22'. After the metal has been suitably melted, and after the crucible has been rocked into a position which introduces the molten charge into the sprue 21', a blast of gas under pressure is fed through the tube 42, and this gas pressure forcibly impels the molten charge from the sprue 21' into the mold cavity.

The gas that is employed is preferably of carbon monoxide or similar neutral non-oxidizing character. However, its contact with the molten charge is so brief, since it immediately drives the charge forcibly into the mold, that ordinary air may usually be used for this purpose without any injurious oxidizing effect.

The introduction of the high-pressure gas through the conduit 42 is preferably caused to be effected automatically, and I have illustratively shown one method of accomplishing this object. Communicating with the conduit 42 is a flexible tube 43 connecting with a conduit 44 through which the gas is fed. A valve 45 is mounted in the conduit 44, and the opening and closing of the valve 45 is controlled by a handle or rod 46 which may be pushed in or out, relative to the valve. By mounting a cam 47 on the crucible, in the proper position, it is possible to effect a movement of the rod 46 to open the valve 45 at exactly the right time. The cam 47 is preferably so arranged that it will start to operate upon the rod 46 just before the mold reaches the bottom position shown in Figure 6. At this time, the molten charge is already in the sprue of the mold, and the subsequent introduction of the gas forcibly impels the molten charge into the mold while the latter is in the position of Figure 6. Preferably, the end of the conduit 42 is provided with a cap 48 having a transparent portion through which the interior of the crucible may be viewed during the melting procedure. If desired, ingredients of the charge may be introduced through the conduit 42 by removing the cap 48.

In Figure 7 I have illustrated a modified construction in which the heating instrumentality is in the form of a relatively high-resistance element 49 supported between two electrodes 50. The portion 49 may or may not be integrally formed with respect to the electrodes 50. For example, if the electrodes 50 and the portion 49 were integral, they may be composed of silicon carbide or the like, and the portion 49 may be of reduced cross-sectional area. Alternatively, the electrodes 50 might be composed of graphite or the like, and the portion 49 may be a separate block or element held in position between the two electrodes; and in such an event the block 49 is of suitable high-resistance material. The result in either case is to produce a focal source of heat at the center of the crucible, the heat emanating from this source in the direction of the arrows of Figure 7.

Under certain circumstances, flame heating may be resorted to, providing a focal point of heat at the midportion of the crucible. Another possibility lies in employing carbon-arc electrodes which are introduced into the crucible, side by side, or at an angle to each other, or in any convenient and suitable manner. These electrodes may be completely dissociated from the crucible structure and mounting, and may be introduced into the crucible through the passage 22 or through any other suitable opening.

The present furnace and the present mode of procedure are unusually efficient. So far as I am aware, no small-scale apparatus has ever before been successfully constructed which permits such accurate and uniform heating and the production of such clean and oxide-free charges. Merely by way of example, I will point out that the present invention has been successfully employed with a variety of alloys having iron, nickel, or cobalt bases, and including as ingredients such readily oxidizable metals as chromium, tungsten, molybdenum, vanadium, aluminum, and beryllium.

Since these ingredients are introduced in relatively small lumps, it is inevitable that a certain amount of surface oxide is introduced into the crucible along with the charges. By carefully controlling the temperature, this oxide may be successfully reduced. In the case of a chromium cobalt alloy, for example, the actual melting point of the alloy (about 2400° F.) is lower than the temperature at which the oxide is reduced. The interior of the crucible may, however, be continuously inspected, and the heating may be caused to continue until the oxide is all eliminated. At such time, the molten charge presents a clean surface to view, and by the use of an optical pyrometer the temperature of the charge can be accurately determined at any instant. The non-oxidizing atmosphere that is maintained around the charge during the melting procedure eliminates the necessity for any flux or slag blanket, and the molten charge is thus in the purest and cleanest condition and at an accurately observable temperature when it is introduced into the sprue of the mold and then immediately impelled into the mold itself.

The present furnace permits me also to introduce relatively small quantities of minor ingredients, notwithstanding the fact that such ingredients may be of extremely oxidizable character, such as magnesium, boron, aluminum, or beryllium. The introduction of such ingredients to a charge that is melted in the open air is an extremely difficult procedure, because of the low

melting point and the susceptibility to oxidation. By means of the present invention, an accurately measured quantity of any such ingredient may be added to the molten charge without difficulty.

5 The present furnace and process are also of particular value in the melting and casting of the precious metal alloys, especially where the resistor type of heating element is employed, because of the uniformity and accurate control of
10 the heating, and the complete absence of contamination from products of combustion. Also, the agitation of the alloys by rocking the present furnace avoids segregation of the lighter ingredients, which is an undesirable phenomenon which
15 commonly takes place.

In general, it will be understood that changes in the details, herein described and illustrated for the purpose of explaining the nature of my invention, may be made by those skilled in the art
20 without departing from the spirit and scope of the invention as expressed in the appended claims. It is, therefore, intended that these details be interpreted as illustrative, and not in a limiting sense.

25 Having thus described my invention, and illustrated its use, what I claim as new and desire to secure by Letters Patent is:

1. In a founding apparatus, a closed crucible mounted for rotation about a horizontal axis
30 passing through the crucible, the cross-sectional configuration of the interior of the crucible, transverse to the axis of rotation, being substantially circular, said crucible having a tangential passage extending from the interior to the exterior
35 thereof, carbon-arc electrodes extending into the crucible along the axis of rotation, a mold, means for removably securing said mold to the crucible with the sprue in registry with the outer end of said passage, whereby a charge
40 of molten metal may be fed directly into said sprue, and means for rotating said crucible at a speed sufficient to impel said molten charge into said mold by centrifugal force.

2. In a founding apparatus, a crucible having a substantially spherical interior, means for mounting
45 said crucible for rotation about a horizontal diameter, said crucible having a tangential passage extending from the interior to the exterior thereof, said passage lying substantially in a plane transverse to the rotation axis, non-rotatable carbon-arc electrodes extending into the
50 crucible along the axis of rotation so as to generate heat at substantially the center of said spherical interior, a mold, means for removably securing said mold to the crucible with the sprue in registry with the outer end of said passage, whereby a charge of molten metal may be fed directly
55 into said sprue, and means for rotating said crucible at a speed sufficient to impel said molten charge into said mold by centrifugal force.

3. In a founding apparatus, a crucible having a substantially spherical interior, means for mounting
60 said crucible for rotation about a horizontal diameter, said crucible having a tangential passage extending from the interior to the exterior thereof, said passage lying substantially in a plane transverse to the rotation axis, heating means extending into the crucible along the axis of rotation and adapted to generate a focal
65 source of heat at substantially the center of said spherical interior, a mold, means for removably securing said mold to the crucible with the sprue in registry with the outer end of said passage, whereby a charge of molten metal may be fed
70 directly into said sprue, and means for rotating

said crucible at a speed sufficient to impel said molten charge into said mold by centrifugal force.

4. In a founding apparatus, a crucible mounted for rotation about a horizontal axis, said
crucible having a passage extending from the interior to the exterior thereof, a mold, means
5 for removably securing said mold to the crucible with the sprue in registry with the outer end of said passage, whereby a charge of molten metal may be fed directly into said sprue, a driving
10 means for rotating said crucible at a speed sufficient to impel said molten charge into said mold by centrifugal force, and means automatically operable when the crucible is swung into a predetermined position for controlling the operation
15 of said driving means.

5. In a founding apparatus, a crucible mounted for rotation about a horizontal axis, said crucible having a passage extending from the interior to the exterior thereof, a mold, means for removably
20 securing said mold to the crucible with the sprue in registry with the outer end of said passage, whereby a charge of molten metal may be fed directly into said sprue, a driving means for rotating said crucible at a speed sufficient to impel said molten charge into said mold by centrifugal force, and means automatically operable when the crucible is swung into the sprue-feeding position for initiating the operation of
25 said driving means.

6. In a founding apparatus, a crucible mounted for rotation about a horizontal axis, said crucible having a passage extending from the interior to the exterior thereof, a mold, means for removably securing said mold to the
30 crucible with the sprue in registry with the outer end of said passage, whereby a charge of molten metal may be fed directly into said sprue, a driving means for rotating said crucible at a speed sufficient to impel said molten charge into said mold by centrifugal force, an electric switch for controlling the operation of said driving means, and a cam carried by the crucible and automatically controlling the operation of said switch when the crucible is swung into a predetermined position.
35

7. In a founding apparatus, a crucible mounted for rotation about a horizontal axis, said crucible having a passage extending from the interior to the exterior thereof, a mold, means for removably securing said mold to the
40 crucible with the sprue in registry with the outer end of said passage, whereby a charge of molten metal may be fed directly into said sprue, a driving means for rotating said crucible at a speed sufficient to impel said molten charge into said mold by centrifugal force, an electric switch for initiating the operation of said driving means, and a cam carried by the crucible and adapted automatically to actuate said switch when the
45 crucible is swung into sprue-feeding position.

8. In a founding apparatus, a closed crucible mounted for rocking about a horizontal axis passing through the crucible, said crucible having a passage extending from the interior to the exterior thereof, a mold, means for removably
50 securing said mold to the crucible with the sprue in registry with the outer end of said passage, whereby a charge of molten metal may be fed directly into said sprue, means for introducing a gas under pressure into the crucible for impelling the charge into the mold, and means automatically operable when the crucible is rocked into a predetermined position for controlling the operation of said gas-introducing means.
55

9. The herein-described founding procedure which consists in melting a charge of metal and feeding the molten charge to the sprue of a mold while continuously maintaining a non-oxidizing atmosphere around the charge, and finally subjecting the mold to a rotation sufficiently fast to impel the charge into the mold by centrifugal force.

10. The herein-described founding procedure which consists in melting a charge of metal in a closed crucible heated from the approximate center thereof, rocking the crucible around an axis passing through the crucible so as to agitate the molten charge and subject it to the heating action of successive portions of the crucible wall, maintaining a non-oxidizing atmosphere in said crucible, feeding the molten charge to the sprue of a mold while maintaining said atmosphere around the charge, and finally impelling said charge into the mold.

11. In a founding apparatus, a substantially enclosed crucible, said crucible having a passage extending from the interior to the exterior thereof, a focal source of heat within the crucible for melting a charge of metal within the crucible, a mold, means for removably securing said mold to the crucible with the sprue in registry with the outer end of said passage, whereby a charge of molten metal may be fed directly into said sprue, and means for impelling said molten charge into said mold.

12. In a founding apparatus, a crucible mounted for rotation about a horizontal axis passing through the crucible, the cross-sectional configuration of the interior of the crucible, transverse to the axis of rotation, being substantially circular, said crucible having a passage extending from the interior to the exterior thereof, heating means extending into the crucible and adapted to generate a focal source of heat at substantially the center of said crucible, a mold, means for removably securing said mold to the crucible with the sprue in registry with the outer end of said passage, whereby a charge of molten metal may be fed directly into said sprue, and means for rotating said crucible at a speed sufficient to impel said molten charge into said mold by centrifugal force.

13. In a founding apparatus, a closed crucible mounted for rocking about a horizontal axis passing through the crucible, said crucible having a passage extending from the interior to the exterior thereof, heating means extending into the crucible and adapted to generate a focal source of heat at substantially the center of said

crucible, a mold, means for removably securing said mold to the crucible with the sprue in registry with the outer end of said passage, whereby a charge of molten metal may be fed directly into said sprue, and means for introducing a gas under pressure into the crucible for impelling the charge into the mold.

14. In a founding apparatus, a closed crucible mounted for rotation about a horizontal axis passing through the crucible, said crucible having a passage extending from the interior to the exterior thereof, heating means extending into the crucible along the axis of rotation and adapted to generate a focal source of heat at the approximate center of the crucible, a mold, means for removably securing said mold to the crucible with the sprue in registry with the outer end of said passage, whereby a charge of molten metal may be fed directly into said sprue, and means for rotating said crucible at a speed sufficient to impel said molten charge into said mold by centrifugal force.

15. In a founding apparatus, a closed crucible mounted for rotation about a horizontal axis passing through the crucible, said crucible having a passage extending from the interior to the exterior thereof, heating means extending into the crucible along the axis of rotation and adapted to generate a focal source of heat at the approximate center of the crucible, said heating means comprising a high-resistance element, a mold, means for removably securing said mold to the crucible with the sprue in registry with the outer end of said passage, whereby a charge of molten metal may be fed directly into said sprue, and means for rotating said crucible at a speed sufficient to impel said molten charge into said mold by centrifugal force.

16. In a founding apparatus, a closed crucible mounted for rotation about a horizontal axis passing through the crucible, said crucible having a passage extending from the interior to the exterior thereof, heating means extending into the crucible along the axis of rotation and adapted to generate a focal source of heat at the approximate center of the crucible, said heating means comprising carbon-arc electrodes, a mold, means for removably securing said mold to the crucible with the sprue in registry with the outer end of said passage, whereby a charge of molten metal may be fed directly into said sprue, and means for rotating said crucible at a speed sufficient to impel said molten charge into said mold by centrifugal force.

ALBERT W. MERRICK. 55