July 6, 1937. E. G. TOUCEDA ET AL 2,086,483

MEANS FOR MELTING AND MOLDING MATERIALS

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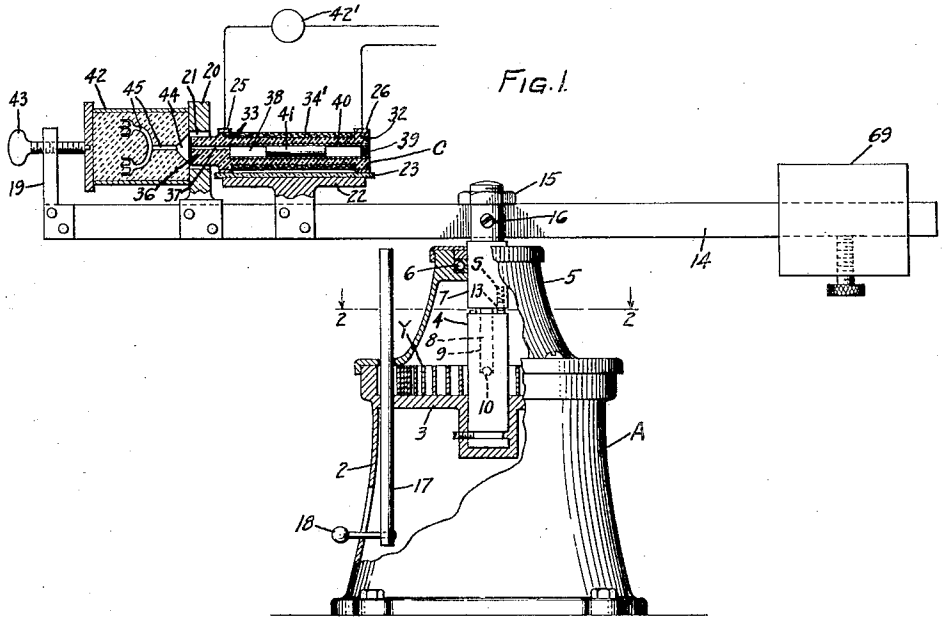


FIG. 1.

FIG. 2.

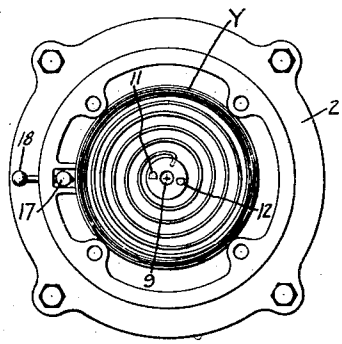


FIG. 3.

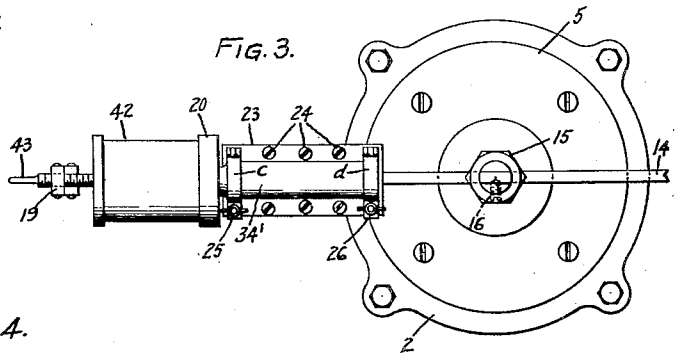
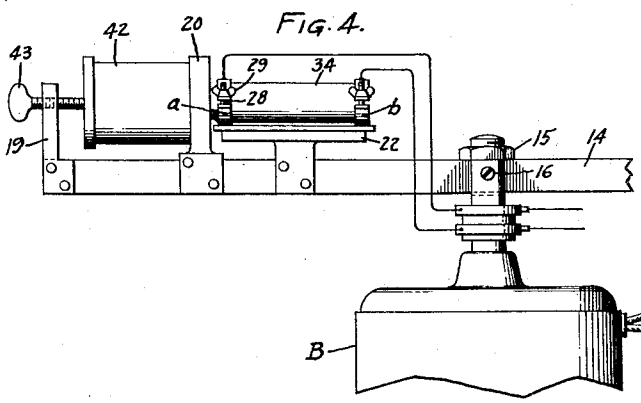


FIG. 4.



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Fig. 5.

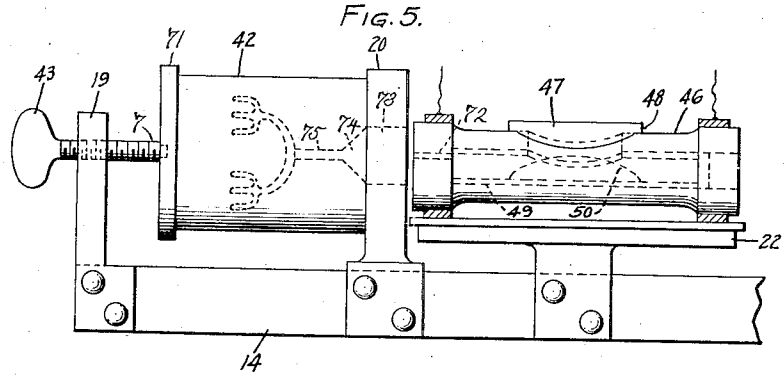


Fig. 6.

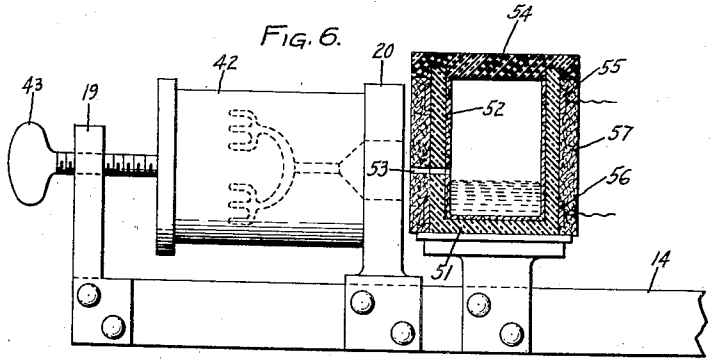


Fig. 8.

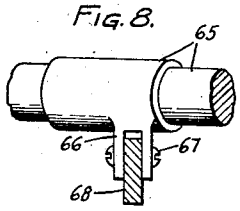
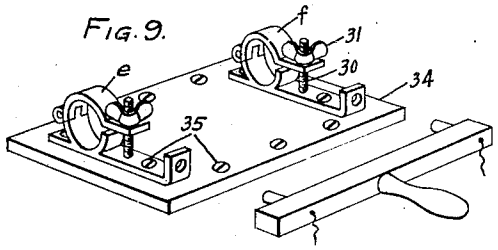


Fig. 7.

Fig. 9.



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UNITED STATES PATENT OFFICE

2,086,483

MEANS FOR MELTING AND MOLDING MATERIALS

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Application November 20, 1933, Serial No. 698,766

4 Claims. (Cl. 22—65.1)

Our invention relates to means for and to methods of melting, by the use of electricity, materials of various sorts having high melting points such as tungsten, platinum, gold, chromium, molybdenum, manganese, tantalum and their alloys, as well as quartz and clays, such as those used in the fictile arts and in the field of ceramics, and the like; and it also relates to means for and to methods of casting from such molten materials, of various sorts. Our invention is especially adapted for casting dental accessories including inlays, crowns, fixed bridge work, partial or full restorations and the like, our invention is especially adapted for melting the materials indicated, in a crucible and casting the same in an adjoining mold both forming a unit on a centrifugal machine and for projecting the molten material directly from the crucible into the molds by centrifugal force, an operation that, as far as we are aware, has never before been achieved nothwithstanding a long felt desire by those versed in this art, for the possibility of such achievement.

The foregoing and other objects of our invention will be understood in detail from the following description of the principles and methods involved, of the elements of said means, and of their arrangements and modes of operation, reference being had to the accompanying drawings, in which:—

Fig. 1 is a view in side elevation of one form of device of our invention showing a horizontal arm and a spring motor for spinning said arm about a vertical axis, which arm carries with it a mold flask on one side of said axis, a counterweight on the opposite side and a crucible adjoining, said crucible being connected in an electric circuit over which current is supplied for directly heating the crucible. In this figure a portion of the frame of the motor is broken away for illustration and both the crucible and the flask are shown in section.

Fig. 2 is a plan view of the spring motor. In this figure the cap of the motor is omitted, as well as all parts of the device of Fig. 1 above line 2—2.

Fig. 3 is a plan view of the device of Fig. 1 with the counterweight side of the horizontal arm broken away.

Fig. 4 is a view similar to Fig. 1 showing an electric motor, for spinning the horizontal arm, substituted for the spring motor. In this figure the circuit to the crucible, over which the heating current is supplied to the crucible is completed through suitable collector rings on the shaft of the motor.

Fig. 5 shows the left portion of the rotating arm of Fig. 1, and a modified form of crucible in side elevation.

Fig. 6 is a similar drawing to that of Fig. 5 showing still another form of crucible.

Fig. 7 is a plan view of the same portion of the apparatus as that shown in Figs. 5 and 6 with still another form of crucible, the longitudinal axis of which latter is placed at about sixty degrees with that of the rotating arm, to which latter the crucible is attached by a bracket device, a portion of which is shown in Fig. 8, which bracket comprises a pair of auxiliary parallel arms clamped by a thumb bolt to a combined clamp and holder, a portion of which is shown in Fig. 8.

Fig. 8 is an end view in elevation of the rotating arm of Fig. 7, as viewed from right to left, showing a portion of the clamp and holder of Fig. 7.

Fig. 9 is a view in perspective of one form of combined crucible holder and electric terminal.

Referring now more in detail to the drawings the invention comprises a motor of any suitable type, such as a spring motor A, Figs. 1, 2, and 3, or an electric motor B, Fig. 4.

The spring motor may be of the usual type such as a phonograph spring motor, which as shown comprising a frame 2 with a transverse head or platform 3, in the center of which there is provided a well, extending along the longitudinal axis of the motor, which well receives a short shaft 4 attached to the inner end of a coiled spring Y, the outer end of which spring is anchored to the frame 2.

The motor frame is provided with a cap 5, having a ball bearing 6, through which a stud shaft 7 extends, the lower portion 8 of which, being comparatively small in diameter, extends into a central bore 9 of small diameter in the shaft 4, along the longitudinal axis, that is, the axis of rotation, of shaft 4. The lower end of shaft 7, and therefore of the portion 8, rests and rotates on a ball 10, at the bottom of the bore 9, to enable the said shaft (shaft 7) to easily rotate about its longitudinal axis. On the top end of shaft 4 there is provided a pair of pins 11 and 12, each having its longitudinal axis in a cylindrical surface generated about the said axis of rotation of shafts 4 and 7, parallel to said axis of rotation. Each of these pins has its top end wedge shaped, each wedge having a face sloping across its longitudinal axis mentioned,

said faces of said pins facing in a clockwise direction along a circle in said cylinder perpendicular to said axis of rotation. The stud shaft 7, on the other hand, is provided with a pin 13 on the lower end in operative relation to said pins 11 and 12, the central axis of which pin extends parallel to the said axis of rotation of shaft 7 in said cylinder. This pin 13 has a cushion spring *s* behind it, normally pressing said pin downwardly into the path of rotation of pins 11 and 12.

The top shaft 7 is slotted transversely as indicated in Fig. 3, to receive the arm 14, which arm is secured in said slot by a nut 15 and set screw 16. When thus secured to said shaft, arm 14 may be used to wind the motor spring Y, manually. This may be done by rotating arm 14 clockwise, Fig. 3, whereupon shaft 7 will be likewise rotated, causing pin 13 to engage one of the pins 11 or 12, and causing also the like rotation of shaft 4. When the spring Y has been sufficiently wound, a rod 17, (which is vertically mounted in the frame of the motor, to slide up or down, and which may be manually operated up or down by the lever 18 attached to the lower end thereof, as shown in Fig. 3,) is raised into the path of rotation of said arm 14, to hold the motor arm 14 in its wound condition, until it is desired to release said arm, to spin the same about the axis of rotation of shaft 7 by the motor spring, as for example, when a casting is to be made. When it is decided so to spin said motor arm, the lever 18 is depressed until it disengages said arm, whereupon the said spring will spin said arm in a counterclockwise direction by rotating the shaft 4. When the shaft 4 rotates it will carry shaft 7 with it as long as the spring unwinds, whereupon the shaft 4 will stop, but the shaft 7 and its arm will persist in rotating for sometime thereafter, due to the momentum acquired by the motor arm and the counterweight, the mold and crucible attached thereto inasmuch as the pin 13 will pass over the slanting faces of the pins 11 and 12, due to the action of the cushion spring *s* as long as the counterclockwise rotation of the arm continues.

At the left end of the motor arm 14 there is securely attached thereto a flange 19 which projects upward, as in Fig. 1. Further along the same arm toward the right there is another flange 20 also securely attached to said arm as shown in the same figure. The flange 19 is provided with a thumb screw 43, the longitudinal axis of which lies parallel to the longitudinal axis of the arm 14. Opposite said thumb screw the flange 20 has a circular aperture 21 about a horizontal axis which latter is an extension of the longitudinal axis of said screw, and behind the flange 20, that is to the right thereof, we provide a platform 22 for supporting the crucible C, which platform is also secured to the arm 14. This platform is indicated as being metallic, but it may be made of nonconducting material if desired. When said platform is made of metal, it is covered with a plate 23 of insulating material thereby insulating the crucible from the frame of the device. Said plate may be secured to said platform, for example, by means of screws 24. See Fig. 3.

The crucible C is preferably held in place by electric terminal holders 25 and 26. Each of these holders, 25 and 26, has a base section *a* and *b* respectively, see Figure 4, and a corresponding cover section *c* and *d* respectively, the cover *c* being hinged to the base *a* and the cover *d* being hinged to the base *b*. Each base *a* and *b* is secured to the plate 23 in any suitable manner, as for example, in the manner indicated in Fig. 9, where the elements generally designated *e* and *f*, are secured to the plate 34 of insulation material (corresponding to plate 23,) by screws 35. For locking the cover elements *c* and *d* to their base elements, we provide screws 28 and thumb nuts 29, as in Fig. 4, or 30 and 31, as in Fig. 9.

The crucible C of Fig. 1 consists of a carborundum body, having, preferably, enlarged terminal heads 32 and 33 and a comparatively restricted hollow body section between said heads. Also preferably the restricted portion is covered with a heat insulating material 34' such as asbestos. The left end of the crucible extends out to form a nozzle 36 which projects into the aperture 21 in the flange 20. This nozzle has an outlet duct 37 which connects through head 33, with the cavity 38 in the hollow body of the crucible, as shown in Fig. 1. The opposite end, that is the right end of the crucible, has an inlet aperture that is provided with a removable plug 39, said aperture communicating through the other head 32 with the cavity 38, said aperture serving as an inlet for charging the cavity of said crucible with any material that is to be melted therein. The inside of the cavity 38 may be lined with a suitable refractory material in the form, for example, of a tube 40 separate from the crucible and removable therefrom by way of the outlet terminal on the right, which is normally closed by plug 39. However, the inner side of the crucible may be permanently lined. As a lining, we prefer to use alundum, quartz, magnesia, crome cement, and the like.

When it is desired to cast a mold of any of the metals mentioned or their alloys or of any of the other of said materials mentioned, the plug 39 is removed from the inlet and a pellet or charge 41 of such metal or material is inserted in the crucible by way of said inlet after which the plug is restored. Thereafter the terminals of any suitable source of current, such as a battery or generator, are applied to said terminals 25 and 26, as for example, under the thumb nuts 29, thus setting up a current circuit through the crucible by way of said terminals 25 and 26. In this circuit, in series with the crucible, we insert an ammeter 42'. It will be found that when a constant potential is maintained at the current source the current flow through the crucible will rise as the temperature in the crucible rises and with a given size of pellet or charge 41, of a given metal, such pellet or charge will melt when a given current flow is indicated in the ammeter. Therefore, the current reading at the ammeter may be used as an index of such temperature and as an indication of the physical condition of the pellet or charge, that is whether it is molten or solid. The ammeter will indicate when the desired crucible temperature has been attained and therefore indirectly when the metal is molten and in proper condition to be cast, at which point the current is cut off from the crucible and the casting operation initiated, thus ensuring against overheating the charge. This arrangement therefore enables us to use a closed crucible, which we do in order to exclude the air from the crucible chamber when the crucible becomes heated thus preventing any chemical action with oxygen. Even in the type of crucible of Figure 6 the air is practically excluded by way of the outlet duct, as soon as the tempera-

ture begins to rise to any considerable degree, for all ordinary purposes.

In order to prevent the molten metal from spilling out of the duct **37**, until the time of casting, the axis of the duct is elevated above the axis of the cavity **38** as much as possible and as indicated in Fig. 1.

When it is desired to produce a casting from the molten metal or other material, a suitable mold, such as mold **42** Fig. 1, is clamped between the flanges **19** and **20**, by means of the thumb bolt **43**, with the port **44** of the mold opposite the opening **21** in the flange **20**, as indicated in Fig. 1. The port **44** is connected by suitable ducts, such as duct **45**, with cavities in the mold. The apparatus being thus lined up, the spring of the motor having been wound up as previously described, and locked by rod **17**, and the metal having been inserted in the crucible, the current is turned on until the ammeter gives the proper indication, whereupon the lever **18** is pressed down to release the arm **14**, whereupon the spring F spins the arm **14** with its crucible and mold thereon. The centrifugal force set up by the rotation of the arm shoots the molten metal through the duct **37** across the space **44** into the duct or ducts **45** and finally into the depths of the cavity or cavities in the mold producing the casting desired.

It will be understood that crucibles of different types, as indicated in the drawings, may be used and also different sizes of each type, depending upon the size and nature of the object to be cast.

Referring to Fig. 5, crucible **46**, is a modification of the one shown in Fig. 1, in that it has, in addition to the outlet duct on the left and the inlet aperture on the right (both as in Fig. 1) on the top side under the plug **47** another aperture for inspection of the crucible cavity, as for example, to determine if it is charged, before a melting operation is started. The plug **47**, which may be made of carbon or of any suitable refractory material, such as quartz, and the like is made with a flange cap **48** curved on the under side to conform to the curvature of the outer surface of the crucible and is seated thereon as indicated in Fig. 5. The tube lining **49** is also correspondingly perforated, the two perforations, the one in the side of the crucible and the one in the lining, being in alinement in order that the crucible may be examined by removing the plug **47**. Or, if quartz is used, for the plug, the examination may be made through the plug itself without its being raised. In Fig. 5, for convenience, the heat insulating material, corresponding to the material **34** in Fig. 1, has been omitted. Otherwise the device of Fig. 5 is the same as that of Fig. 1.

Referring to Fig. 6, the crucible **51** is made in the shape of a cup with an upper opening through which the crucible is charged, which opening is kept closed by a cover **54**. It also has a lining **52**, also in the shape of a cup. The outlet duct **53** normally stands above the molten material to prevent the latter from running out of duct **53** under the force of gravity but when the crucible is spun the centrifugal force produced carries the molten material toward the left side piling it up above the port opening of the outlet duct **53** and forcing it out through the outlet. The crucible cover **54** may be secured in place in any suitable manner to maintain the crucible chamber closed after the charge has been put in the chamber. This crucible and its cover are made of the same material as the crucible of Fig. 1, and the electrode terminals **55** and **56** for conveying the current to the crucible are preferably located on the outside of the cup as shown in the figure. These electrodes may be in the shape of plane copper rings which tightly fit the outside of the cup and which may also be held in place by the heat insulating jacket **57**. Otherwise the mechanism is substantially the same as that in Figs. 1 and 5. The cover **54** may be made of the same material as plug **47**, Fig. 5.

Referring to Fig. 7, the crucible **58** is the same as that in Fig. 1 except that the outlet duct **59** is inclined at about 60°, more or less, to the longitudinal axis of the crucible. Consequently, the crucible itself, has to be shifted to the same extent about a vertical axis crossing the longitudinal axis of the arm **68**, (which latter corresponds to the arms **14** in Figs. 1, 3, 4, 5, and 6) to line up with port **60** of the mold **61** which latter corresponds to the mold **42** in Figs. 1, 3, 4, 5, and 6, but the port **60** of which is smaller than port **44**. In the device of Fig. 7, the upper left hand corner of the crucible is chamfered to fit the face of the mold (the flange **20** of Figs. 1, 3, 4, 5, and 6 being omitted) so that the mold may be clamped, as shown directly against the face of the crucible **58**, which crucible is clamped in turn between arms **62** and **63** by a thumb bolt **64**, said arm being secured to a bar **65** that has extension arms **66** slotted to receive and to facilitate its being secured to arm **68** by screw **67**. It will be understood that the arm **68** corresponds to arm **14** in the other figures, except for the omission of the flange **20** and of the platform **22** and for the substitution of the supporting element **66**, (a section of which is shown in Fig. 8) for platform **22**.

It will be understood that the crucible of Fig. 6 may be heated also by a high frequency coil or energized by either the frequency coil or by the application of current from a current source as previously described. When a high frequency coil is to be used the open coil of the latter will have to be large enough to permit the high frequency coil being slid into place around the crucible where it is held until the material in the crucible is melted. The coil is then lifted to permit the crucible and mold to be spun as a unit to drive the molten charge into the mold.

Another advantage in using a closed crucible and bringing the crucible outlet port and the mold outlet port into alinement, as in Fig. 1, to form a conduit, through which the molten material may be shot straight through into the mold, is that the thermal conditions of the charge can be more effectively controlled. The provision of the lining also makes it possible (when a carbon crucible is used and when a charge is to be melted which will absorb carbon) to prevent the carbon from being absorbed by such a charge. However, when materials that have no affinity for carbon are used as a charge for the crucible the lining may be omitted.

Instead of the terminals of Fig. 9 for the crucible the flange **20**, Fig. 5, may be insulated from the arm **14** and a duplicate of flange **19** may be applied to the arm **14**, on the opposite side of the crucible **46**, and insulated also from arm **14**, with the screw **43** reversed, that is with the terminal **70** that engages the metal head **71** of the mold **42**, Fig. 5, on the left, and the head of this screw on the right side of the flange, in order that the crucible **46** may be clamped between the flange **20** and the screw **43**. The flange **22** may then be omitted. Preferably a metal plate similar to head **71**, but approximating in size the enlarged

head of the crucible, to which we will refer as the screw plate, may be interposed between the screw and the crucible, just as the head 71 is interposed between the mold and the screw in Fig. 5. Also, if desired, a graphite block may be interposed at one end between the crucible and the flange 20 and on the opposite end between the crucible and plate engaged by the screw. With this arrangement the flanges may be used as electrode terminals, each having a binding post to which one of the leads from the current source may be attached. With this arrangement, the crucible is charged before it is clamped between the insulated flanges. After being charged it is located against the insulated flange 20 with the duct 72 in alinement with the opening 73 in the flange 20 and with the port 74 leading to the mold inlet duct 75. The screw plate is then applied to the right end of the crucible and the screw turned until the crucible is caught and held between the screw plate and the insulated flange 20. After the crucible is thus clamped current may be applied through the crucible by way of the insulated supporting flanges. If desired, the port 74 may be made smaller, for example, of a size the same as the port 60 of Fig. 7 and the opening 73 of the same size. The face of the crucible will then set against the face of the flange somewhat as it is set against the face of the mold in Fig. 7, except that in Fig. 7, the chamfered portion engages the face of the mold.

We also contemplate, when the crucible is thus supported, substituting a crucible without the enlarged heads, attaching graphite plates to the faces of the insulated supporting flange 20 and of the screw plate next to the crucible which crucible instead of engaging the flange 20 and screw plate directly will engage the graphite plates as electrodes instead, the insulated flanges, the screw and screw plate, the graphite plates and the crucible, being in a series circuit with the source of current.

It will be understood that our invention is of broad application, that while for the purposes of illustration we have described specific means and application of the principles involved, we do not wish to be so limited since such application and means may be modified or varied without departing from the principles involved.

For example we contemplate another form of construction in which we omit the plug 47 of Fig. 5 and having the crucibles slotted from one head 76 to the other 77, the slot being just wide enough to permit the lining tube 78, (corresponding to lining tube 40) being dropped in place between said heads, the tube in this case being closed from one end to the other as tube 40 of Fig. 1. This modification can also be used in the form of device described, in which the insulated flanges, the screw plate and the crucible between said plates are connected in series with the source of current. With this arrangement the lining tube is first charged and then dropped in place in the slot between said plates, the end openings of the tube being sufficiently closed by said plates, the head plates, to keep the air out.

What we claim is:—

1. A crucible comprising a body of carborundum having a pair of terminal heads and having an internal cavity located between said heads, an opening in said crucible leading to said cavity whereby said cavity may be charged therethrough, a cross section of said body across said cavity enclosing a smaller area than a cross section of either of said heads taken parallel to said cross section of the body, whereby when electric terminals are applied to said heads and a flow of current is caused to pass through said body between said heads by way of said terminals and the temperature of said body is raised sufficiently to melt the charge, the said heads are maintained comparatively cool.

2. A crucible comprising an integral body of carborundum having a pair of terminal heads and having an internal cavity located between said heads, an opening in said crucible leading to said cavity whereby said cavity may be charged therethrough, a cross section of said body across said cavity enclosing a smaller area than a cross section of either of said heads taken parallel to said cross section of the body, whereby when electric terminals are applied to said heads and a flow of current is caused to pass through said body between said heads by way of said terminals and the temperature of said body is raised sufficiently to melt the charge, the said heads are maintained comparatively cool, and a duct extending through one of said heads and connecting with said cavity through which latter the molten charge may be forced out of said cavity, the port of said duct in the cavity being located substantially above the lower level of the cavity whereby the molten charge is prevented from being forced out of the duct by gravity.

3. A crucible comprising an integral body of carborundum having a pair of terminal heads and having an internal cavity located between said heads, an opening in said crucible leading to said cavity whereby said cavity may be charged therethrough, a cross section of said body across said cavity enclosing a smaller area than a cross section of either of said heads taken parallel to said cross section of the body, whereby when electric terminals are applied to said heads and a flow of current is caused to pass through said body between said heads by way of said terminals and the temperature of said body is raised sufficiently to melt the charge, the said heads are maintained comparatively cool, a duct extending through one of said heads and connecting with said cavity through which latter the molten charge may be forced out of said cavity, a refractory lining in said cavity interposed between the charge and the cavity walls, the port of said duct in the cavity being located along the upper inside level of the lining, whereby the molten charge is prevented from being forced out of the duct by gravity.

4. A centrifugal casting machine of the class having a mold flask element and a crucible element with communicating ports through which material fused in the crucible may be discharged into the mold by a casting moment of centrifugal force applied to said elements, said crucible being characterized by a conductive member formed of a body of material having a negative resistance characteristic, such as carborundum, said body constituting a resistor of sufficient mass to form a self-sustaining entity, connected in an electric circuit with a source of electric current, and an indicator of current strength, whereby, upon change of resistance in said negative resistance crucible member accompanying attainment of the critical fusion point by the material being heated, a signal of an attention arresting character is provided by said indicator for the guidance of the operator in applying said casting moment.

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