May 29, 1923.

1,457,040

J. A. McMANUS

CASTING MACHINE

Filed Oct. 11, 1919

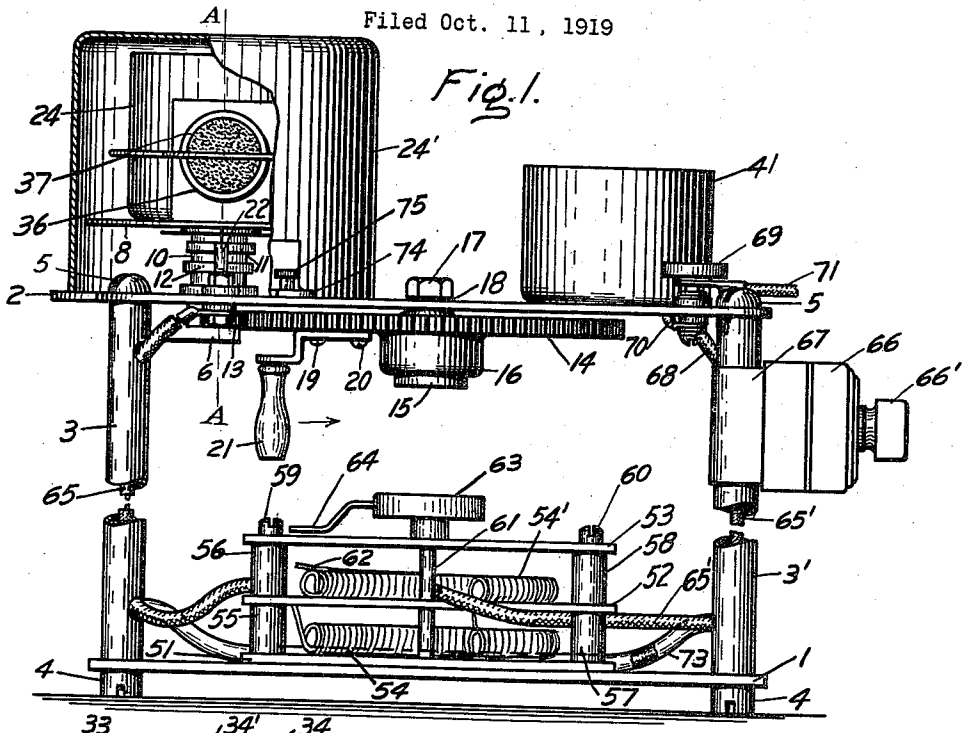


Fig. 1.

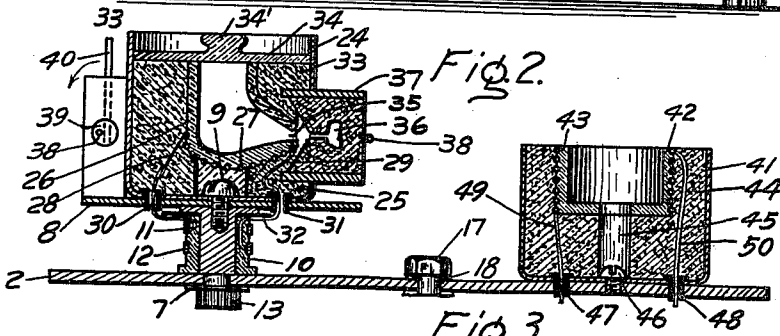


Fig. 2.



Fig. 3.

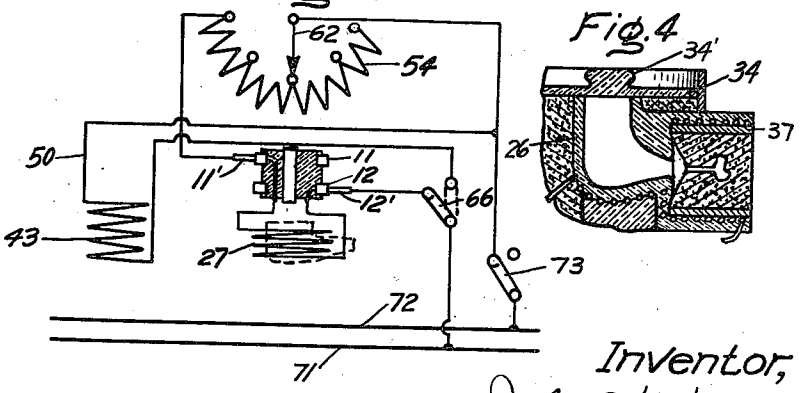


Fig. 4.

Inventor,

John A. McManus

Patented May 29, 1923.

1,457,040

# UNITED STATES PATENT OFFICE.

JOHN A. McMANUS, OF LYNN, MASSACHUSETTS.

## CASTING MACHINE.

Application filed October 11, 1919. Serial No. 330,151.

*To all whom it may concern:*

Be it known that I, JOHN A. McMANUS, a citizen of the United States, residing at Lynn, in the county of Essex and State of Massachusetts, have invented certain new and useful Improvements in Casting Machines, of which the following is a specification.

The present invention relates to casting machines of the electrical type and embodies certain improvements, both mechanical and electrical, over the construction shown in my previous inventions, the subjects of Patents Nos. 1,015,818 and 1,015,819, respectively, both of which patents were issued January 30, 1912.

While the machine illustrated in this application and those illustrated in my former patents have been designed more with a view to their utilization in connection with the making of dental castings, such as for inlays, crowns, bridges, porcelain work, etc., the same principle, with slight modifications in the structure of the apparatus, may be equally as well applied to the casting of jewelry, such as gold rings, small trinkets, etc., where metal or other dies or moulds may be used to be filled by centrifugal casting methods, and, of course, if larger scale operations are desired, suitable modifications in design will readily adapt the apparatus to such purposes.

The machine of the present invention is more particularly an improvement over the previous design illustrated in my Patent No. 1,015,818, in that in the resistance furnace type of centrifugal casting machine I have succeeded in producing a machine which is adaptable to both alternating and direct current supply circuits; and which at the same time is light in weight and more simple in operation. In the machine shown in Patent No. 1,015,818, an alternating current transformer was necessary to furnish current to the crucible or furnace at about 4 or 5 volts and about 100 amperes. The machine was limited in its application to alternating current circuits only. A motor was also employed to rotate the machine. The whole equipment, therefore, machine, transformer, and motor was relatively heavy. In the present improvement I have succeeded in making a machine which is not only adaptable to both alternating or direct current supply circuits, but one which eliminates the need of a transformer or other current changing device and also of a motor, and is, therefore, light in weight and simple in its construction and operation, the whole outfit weighing approximately only 9½ pounds, as against about 50 pounds for the previous machine. One of the essential factors contributing to the success of such a machine is the employment of a crucible or furnace having suitable refractory properties, chemical inertness where precious metals are fused therein and for other special applications, and which is adaptable to being heated without the necessity for using an unduly heavy current or large energy input in proportion to the work to be performed. While the carbon crucible of my previous patents has the other desirable properties it requires to be run at a high current density. I, therefore, after a number of years of patient research and failures in the enduring qualities of the furnace heating means, have succeeded in producing a crucible of such material and proportions of winding as to successfully fulfill the objects to be attained. A successful crucible or furnace element was finally made by using a crucible of "alundum" suitably grooved around the sides and bottom for the reception of a winding in the nature of a platinum coil wound into a helix. This helix is formed by winding the platinum wire on a mandrel of suitable size and then stretching the coil thus formed to avoid any possibilities of short circuiting between adjacent turns of the helix. The helix is then wound into the grooves, covered in by "alundum" cement and allowed to harden and gradually sintered by slow heating with the electric current passed through the helix up to the working temperature. Many adjustments as to length of helix, section of platinum wire, and distribution of the wire around the working portion of the crucible had to be made before the proper relations could be established and a crucible produced which would have a long life. In fact, the experiments involved covered a period of several years of construction and testing, before long

lived crucibles were obtained, which would give efficient results with the least expenditure of money, when dealing with such an expensive resistance wire as platinum, or the like.

Another object of the invention, also, is to provide a resistance type of furnace, wherein the furnace itself is mounted on the central axis of rotation, thus enabling the machine to be made of minimum dimensions, and at the same time to allow a high speed of rotation to be quickly attained. This can be done very readily by means of a suitable hand drive, such as by a gear and pinion, by means of releasing a coiled spring, or any other suitable means. This central disposition of the crucible also has the advantage that the metal or material which is fused therein will not leave the crucible to enter the mould until a sufficient force has been developed by the rotation of the crucible to cause the molten material to be forced into the mould under an appreciable pressure, which in turn produces a sound homogeneous casting, after the latter has cooled; free from blow holes, etc.

By the use of a crucible wound with conducting wire of relatively high resistance, such as platinum, for example, I am able to produce the necessary heating effect of the current to fuse the desired metals to be cast, and at the same time eliminate the use of a transformer or alternating current circuits, or to dispense with other current changing devices where direct current is employed. While platinum is at present somewhat expensive, the amount used for the particular work to which the machine is applied is not prohibitive; and the elimination of a transformer or other special devices, and the ease and facility of operation of my improved machine, warrant its use. Also, for lower temperature work, where gold or silver is not employed as the casting material, resistance wire of cheaper grade may be used with which to wind the crucible, such as "nichrome," or "calorite" resistance wire. For certain high temperature applications, such as for the reduction of high fusing porcelain in the furnace, it may be desirable to use a resistor having a higher melting point than platinum and in such case means for heating the mould may also be desirable. I have shown a modification in the accompanying drawing employing such means.

While I have in the present embodiment of my invention elected to use centrifugal force to transfer the fused material from the furnace into the mould, I do not limit myself entirely to dependence upon centrifugal means to make this transfer. The same result could be accomplished, for example, by shocking the molten material into the mould, such as by releasing a spring attached to the furnace in a manner to displace the fused material and cause it to move through the furnace opening into the flask and mould, or by using my electrically heated crucible or muffle in conjunction with a vacuum machine and sucking the casting material into the mould after it has been fused.

In the specific form of my invention, as adopted by me, I have used crucibles of "alundum," but "zircite," quartz, or any other refractory material, suitably shaped and wound, may be used, provided it meets the requirement of chemical inertness where such property is desirable.

Still another object of my invention is to combine in my improved casting machine an electrical heating means for melting or evaporating out the disappearing wax model invested in the casting flask.

In the application of my machine to the casting of dental inlays, particularly, I have found that the melting out of the so-called "disappearing wax model" electrically gives far better results than any other method heretofore used. Ordinarily, this model or pattern is melted out by putting the flask containing the same into or over a gas flame and endeavoring to regulate the amount of heat and the time consumed in the process by adjusting the gas flame. In the melting out of these wax models it is very essential that the result be accomplished slowly and evenly, in order that the contour or margins may not be broken down, but may be retained sharp, clean-cut, and true to the original. This result is very difficult to accomplish by ordinary gas flame heating. It is quite obvious that with an electrically heated baking cup the winding can be properly proportioned, or the control of the heating be almost perfect by means of a rheostat or taps taken from the winding. Thus the wax model or pattern may be gradually absorbed by the investment material, or evaporated.

The specific embodiment of the desirable features of my improved electrical casting machine will be more clearly illustrated by reference to the accompanying specification and drawings, in which Fig. 1 represents a side elevation of my improved casting machine with the furnace cover partly broken away and the hollow supporting posts broken away to show the method of wiring; Fig. 2 represents a vertical section on the line *a*—*a*, Fig. 1 showing the construction of the crucible, or furnace, and the wax dissolving device; Fig. 3 is a diagram of the electrical connections; and Fig. 4 a modification showing the heating of both the crucible and mould.

Referring more in detail to the drawings. 1 and 2 represent suitable plates of thin sheet steel supported by four hollow steel posts 3, one at each corner of the plates 1 and 2, the

posts 3 extending into holes in the plates. The posts 3 are tapped to receive filister head screw-threaded feet 4, or if desired these feet may be made of insulating material. The posts are secured at the top plate by means of the screws 5. Supported in the bearing block 6 is a shaft 7 which shaft extends through the plate 2, and is suitably secured at the top to a flat disk or plate 8 by means of a screw 9 and lock washer, or by any other obvious means to secure the shaft and disk against relative movement. Mounted on the shaft 7 is a block of insulating material 10, which may be made of some suitable wood, such as maple, or better still, of the well-known electrical insulator "bakelite." Moulded into the insulator block 10 are two collector rings of relatively thin copper or brass 11 and 12. The collector rings may be given a coat of silver plating, in order to prevent corrosion and poor contact. If the collector rings 11 and 12 are not moulded into the insulating block 10, or rather, if the insulating block 10 is not moulded about them, they may be made jointed, provided a good silver-soldered joint is obtained. Suitably mounted on the lower part of the shaft 7 is a small pinion 13 spaced from the bearing block by a thrust washer (not shown). Meshing with the pinion 13 on the under side of the plate 2 is a large gear 14 having a ratio of about 10:1 in relation to the pinion. This gear is supported by means of the shaft 15 and hub 16, the shaft 15 extending through a hole in the plate 2 and secured at the top of the plate by a nut 17 and lock washer 18. Secured to the gear 14 by screws 19 and 20, or other suitable means, is a handle 21 for turning the gear by hand and consequently enabling the furnace or crucible element to be rotated at a fairly high speed. While I have used a gear drive, of course, any suitable driving means may be used, such as a wound-up clockspring attached to the shaft 7. Also mounted on the plate 2 are two brush holder studs, one of which is shown at 22, which carry thin copper or bronze brushes for engaging the collector rings 11 and 12. 24 represents a furnace or crucible container which may be made of a spinning of thin sheet metal, such as sheet steel, and made in the form of a cup having a closed bottom and open top. This cup may be secured to the disk or plate 8 by means of the same screw 9 which secures the shaft 7 to the disk 8, or the cup and disk may be made in one piece, as desired. A cradle 25 of insulating material, such as "bakelite" or asbestos board is laid on the bottom of the cup 24 and serves as a support for the crucible 26, the latter being made of any suitable material which will stand the temperatures involved. In the present instance I have made this crucible of "alundum," a trade product of the electric furnace, which is practically pure fused alumina, and furnished in desired shape, upon request, by the manufacturers of such materials, the material being formed and sintered at high temperatures, thereby having a very negligible expansion coefficient and subject to very little tendency to cracking. The crucible, however, may also be made of such materials as "zircite," fused quartz, or other materials somewhat analogous in refractory and chemical properties. One of the desirable characteristics of such a crucible for dental applications is that it be chemically inert to silver and gold of relatively high karat quality (22 karat for example), as it is desirable that the casting materials used do not combine chemically with the material of which the crucible is composed, or with the platinum winding, when platinum is used as the resistance wire. Moulded or ground into the bottom of the crucible 26, and a short distance up the sides thereof, are suitable grooves for the reception of a helix of high resistance wire 27. In the present instance I have chosen platinum as the wire of which to make the helix, on account of its relatively high resistance and high melting point. This helix is wound on a suitable mandrel until a length of the required proportions has been obtained, the section of wire also being chosen which will give long life, without burnouts. When the helix is slid off the forming mandrel, the adjacent turns are carefully stretched to give them a set which will avoid short circuiting of the turns, or the helix may be wound on the mandrel by means of a spacer wire between the turns. The helix is then laid into the grooves formed in the crucible, and wound therein, being secured temporarily by an elastic band. A number of coatings or paintings of insulating cement, such as "alundum" cement, is then spread over the wire, each coat being allowed to dry before the next one is applied, etc., until a sufficient thickness has been obtained. Leads 28 and 29 are then secured to the ends of this helix, which leads I choose to make about twice the section of the helix itself, in order to have a long life. This has been found by experiment to be desirable. While I also make these leads of platinum of relatively short length and thick section, it is conceivable that heavy leads of cheaper material than platinum may be employed, such as heavy copper leads, for example. Electric current is then passed through the leads and helix slowly increasing in value up to the working temperature, in order that the insulating cement may be sintered or rendered relatively homogeneous with the crucible itself. Insulating bushings 30 and 31 are inserted through the cup 24 and disk 8, through which bushings the leads 28 and 29 are passed and connected to the collector rings. An insulating disk of mica or other

suitable insulator 32 is inserted over the collector ring block, and this effectively prevents any possibility of the leads 28 and 29 coming in contact with any metal parts as they are carried to the collector rings. One lead, such as the lead 28, for example, is carried through the bushing 30 under the insulating ring 32 and silver-soldered, brazed or otherwise properly secured to the top ring 11. The lead 29 is passed through the bushing 31, under the insulating ring 32, and down through a hole in the collector ring block to the lower collector ring 12, where it is also properly secured to the latter. While the connection of the heavy leads 28 and 29 is shown as being made inside the container 24 in a temporary manner, as by small nuts and washers, a permanent joint may be made at the helix itself, and a temporary joint made outside, that is, underneath the container 24, where the joint will be more accessible in case a repair should be necessary. A packing of insulating material, such as asbestos wool, silicon, monoxide, or other suitable heat non-conductor 33 surrounds the crucible 26 in the container 24, in order to thermally insulate the crucible and minimize loss of heat. An insulating cover 34, with a little knob or handle 34′, is provided to lie over the top of the crucible for the same reason. This cover can be removed at will to inspect the condition of the casting material in the crucible, and determine when said material becomes fused or melted. The crucible 26 is formed with a mouth or spout 35 and with gradual rise from the bottom of the crucible to the spout, in order that a certain minimum effect of centrifugal force will be generated before the gold or other casting material will leave the crucible prior to entering the mould 36 in the flask 37. This ensures that a certain initial force is involved before the casting material starts to enter the mould. The flask 37 may be the conventional casting ring used in dental inlay casting, that is, a cylindrical shell, open at both ends, and previously prepared and filled as described in my former patents above mentioned. In order to retain the casting ring or flask in place, in operative relation with the crucible 26, a hole is provided in the cup 24, of suitable dimensions to receive the flask 37 and a bail wire 38 extends around the cup 24 and flask 37 in a manner to retain said flask from flying out by the action of centrifugal force. The bail wire 38 is tightened and loosened at will by means of an eccentrically disposed cam 39, through which the wire 38 extends. This cam is operated by means of a lever 40, which may be pushed up or pulled down in the direction of the arrow.

Referring to the wax dissolving device, 41 represents a thin shell of sheet steel spun into the form of a cup, in which cup is mounted a core of suitable insulating material, such as soapstone, or artificial composition held together with a binder and fused or baked at the proper temperature. This core, which is represented at 42, has formed in its outer surface a spiral groove for the reception of a helix 43. This helix is previously formed on a mandrel in a similar manner to the platinum helix 27, but is made of "nichrome," "calorite," or other high resistance alloys suitable for moderate temperatures, and in this case suitable for producing a temperature sufficient to melt the wax model or pattern by conduction or radiation of heat into the flask 37, when the latter is inserted to rest in the core 42. Surrounding the core 42 and helix 43 is a body of insulating material 44, which may be either a solid block into which fits the core 42, or this insulating material may be powdered or granular, packed into place. Assuming that it is solid, which is the preferable form, an opening 45 is cut or bored through the core 42 and block 44, large enough so that a small screw-driver can be inserted through the core 42 from the top and thus the cup 41 and block 42 secured to the plate 2 by means of the screw 46. Two insulating bushings 47 and 48 are inserted through the bottom of the cup 42 and holes formed in the block 44, through which the leads 49 and 50 are taken out.

On the lower plate 1 is mounted a small rheostat comprised of the three insulator plates, 51, 52 and 53 between which is suitably supported a coil of high resistance wire 54, 54′. Again, this coil is made of "nichrome," "calorite," or any other well-known resistance wire which will withstand temperatures up to a low red heat, the coil being fastened to the insulator plates and the upper portion 54′ being continuous with the lower portion 54. A hole in the plate 52 permits the coil to be strung through to the compartment between the plates 52 and 53. The plates 51, 52 and 53 are spaced apart by means of the insulator bushings 55, 56, 57 and 58, and four corresponding bushings at the back corners of the plates (not shown). Through these bushings extend studs 59, 60 and the two rear studs (not shown). The studs are screwed into tapped holes in the plate 1 to receive them. A shaft 61 is journalled in the plates 51, 52 and 53, to which shaft is attached a contact spring member or arm 62, which has a sliding contact engagement with the upper portion of the coil 54′. A hard rubber handle 63 is suitably fastened to the shaft 61 and this handle carries an indicator needle or pointer 64, in order to determine the position of the contact arm 62 and consequently to indicate the amount of resistance which is cut in or out of circuit. The insulated conductor of copper wire 65 is connected to

the brush-holder stud 22 and passes through the hollow supporting post 3 to the rheostat where it is connected to one side of the latter in series, the other side of the conductor 65′ being connected to the opposite end of the rheostat from which it is carried through the corresponding hollow supporting 3′ to a switch 66 mounted on the switch plate 67, the latter being supported on the right hand supporting posts. From the switch a connection 68 is carried to the under side of the binding post 69 and still another connection 70 is connected to the lead 49 of the wax dissolving unit carried in the cup 41. A similar connection (not shown) is connected to the lead 50 to another point on the switch 66. 71 and 72 represent the main supply wires connected to the binding post 69 and its corresponding binding post in the rear (not shown). From this latter binding post is carried a conductor, which is strung through its corresponding hollow supporting post and through the hollow tube 73 in the rear of the machine, and from thence to the rear brush-holder stud, the current passing through the brush, through the collector ring and crucible to the opposite brush to the conductor 65, through the rheostat and out through the main 71. The diagram of connections, Fig. 3, will illustrate more clearly the paths of the current in the respective circuits. 71 and 72 represent supply mains for supplying a source of A. C. or D. C. current at preferably 110 volts. 73 represents a switch in the main supply circuit for entirely shutting off the supply of current to the machine. 66 represents the switch Fig. 1 mounted on the machine itself, which switch, in the present instance, controls only two circuits, one through the crucible and rheostat, and the other through the wax dissolving unit. It is to be understood, however, that this switch may have another point giving an "off" position, and thus dispensing with the need for the outside switch 73. In the diagram, 26 represents the crucible and 43 the wax heater, as in the other figures, and 54 the regulating rheostat. 62 represents the spring contact arm on the rheostat and 11 and 12 the slip rings on the collector. 11′ and 12′ represent the brushes bearing on these respective slip rings.

I will now describe the operation of my improved casting machine:

Assuming that the flask 37 has been prepared in the usual way and the wax pattern 36 inserted therein, this flask is then inserted in the core 42 of the cup 41. The knob 66′ of the switch 66 is then turned until it brings the label "wax" before a window opening in the switch. Assuming that the switch 73 is closed, the switch 66 will now be in the dotted line position in the diagram and current will flow from main 71, through switch 66, through the lead 49 of the wax heater, through the wax heater coil 43, out through the lead 50 to the supply line 72. The flask is left in the wax heater until the pattern is dissolved and thoroughly evaporated, when the flask is taken out and inserted in place in operative relation with the crucible 26. The bail wire 38 is pulled up into position to retain it in place, as shown in Fig. 2, and the cam lever 40 tightened. The snap switch 66 is now again turned until the label "gold" appears before the window. This opens the wax heater circuit and closes the crucible circuit. The switch 66 is now in the position shown in full lines in the diagram. The insulating cover 34 is lifted off the cup 24 by means of the knob 34′ and gold or other cold casting material dropped into the crucible 26 and the cover again replaced. The current is now flowing from the main 71, through the brush 12′, collector ring 12, through the crucible winding 27, through the collector ring 11, brush 11′, through the regulating resistance 54, out through the contact arm 62 and finally through the switch 73 and supply main 72, thus completing the circuit. The current is allowed to flow through this circuit until the casting material is fused or molten, which can be determined by occasionally removing the cover 34 and instantly replacing it to prevent loss of heat. A little practice enables one to determine quite readily about the length of time required in accordance with the particular setting of the rheostat for fusing the casting materials. With 22 karat gold, for this particular type of crucible and the resistance all in circuit, the average time is from two to four minutes. When the casting material has become fused or molten, the cover or hood 24′ is placed over the rotatable furnace and fastened to the plate 2 by means of lugs 74 and thumb screws 75. This prevents any possibility of danger of rotating parts in case any such should become detached, which occurrence, however, is quite unlikely if the parts are properly made. Conditions are now favorable for casting, and the handle 21 is gripped with the hand and a good vigorous turning of the same for from 15 to 30 seconds (preferably in the direction of the arrow) will cause the crucible 26 and flask 37 to rotate together and cause the casting material in the bottom of the crucible 26 to rise up the incline in the latter and enter the mould 36 with considerable force while in the plastic state, filling the mould under pressure and displacing air bubbles, etc. The current is now turned off by opening the switch 73, and when the rotor is at rest, the cover 24′ is removed, the bail wire 38 is released, and the hot flask 37 is withdrawn from its seat by a suitable tool and plunged in water. The finished casting is then taken out and will be found to be a sound, homo-

geneous casting, free from blow holes, and with fine, sharply defined feather edges, where such existed in the original pattern.

Referring now to Fig. 4, I have illustrated therein a construction wherein I heat both the crucible and the mould simultaneously by the same or by separate windings, as desired, that is, both windings may be in series, or they may be in mulitple circuit, and the crucible winding may be of one material, such as platinum, and the flask winding of platinum, also, or of a cheaper and lower melting material, such as "nichrome," or "calorite," as desired.

While I have shown one specific embodiment of my device, I do not wish to be limited thereto, but desire to cover in the appended claims all modifications falling fairly within the scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:—

1. In a casting machine, the combination of an electrical resistance furnace deriving its heat by means of current passed through an electrical resistance wire in operative relation with said furnace, means for delivering electrical energy to said resistance wire, means for controlling the amount of electrical energy supplied to said furnace, and a means for transferring fused material from the furnace to the mould under the action of centrifugal force.

2. In a centrifugal casting machine, the combination of an electrically heated platinum wound resistance furnace or crucible mounted on substantially the axis of rotation of said machine, a suitable casting flask revolvable with the furnace and in cooperative relation therewith, means for delivering electrical energy to said platinum resistance furnace, a thermal insulating packing around said furnace, and means for revolving the furnace and flask in a manner to cause fused or molten material in the furnace to be transferred to the flask by the action of centrifugal force.

3. In a centrifugal casting machine, the combination of an electrically heated platinum wound resistance furnace or crucible mounted on substantially the axis of rotation of said machine, a suitable casting flask revolvable with the furnace and cooperatively related therewith, a container for the furnace or crucible, a thermal insulating packing between the crucible and the walls of the container, suitable slip rings cooperatively connected with the furnace, conducting brushes in operative relation with said slip rings, brush holders for supporting the brushes, conductors delivering suitable electrical energy to the brushes, means for controlling the temperature of the furnace, and means for transferring molten or fused material from the furnace to the flask by the action of centrifugal force.

4. In a casting machine, the combination of an electrical resistance furnace deriving its heat by means of electric current passed through a resistance wire wound on or in operative relation with said furnace, a mould holding flask also in operative relation with said furnace, means for heating the mould, an opening in the furnace communicating with said flask, and means for forcibly transferring the fused or molten casting material from the furnace through the opening into the mould.

5. In a casting machine, the combination of an electrical resistance furnace deriving its heat by means of electric current passed through a resistance wire wound on or about said furnace, a mould holding flask in operative relation with said furnace, investing compound suitably mixed and hydrated in said flask, a pattern dissolvable by heat invested in said compound, a sprue passage or opening leading from the outer surface of the investing compound to the pattern, a gate for the reception of casting material at the outer entrance to the sprue opening or passage, and means for forcibly transferring the fused or molten casting material from said gate through the sprue opening into the mould formed by the dissolved or evaporated pattern material.

6. In a casting machine, the combination of an electrical resistance furnace deriving its heat by means of electric current passed through a resistance element in operative relation with said furnace to heat the latter to the desired temperature to melt or fuse the charge therein, a container for the furnace, a thermal insulating packing between the furnace and the walls of the container, a mould holding flask in operative relation with said furnace, means for heating the flask by passing electric current through a resistance element in cooperative relation with said flask, means formed in the mouth of said flask for the reception of the casting material to be fused or melted by the furnace after said flask has been charged with the mould, a communicating passage in the flask between the casting material and the mould, and means for forcibly transferring the fused or molten material from the mouth of the flask into the mould.

In testimony whereof I have affixed my signature.

JOHN A. McMANUS.