Jan. 2, 1923.

1,440,515.

H. G. WELLMAN ET AL.

MELTING FURNACE.

FILED MAY 17, 1920.

3 SHEETS-SHEET 1.

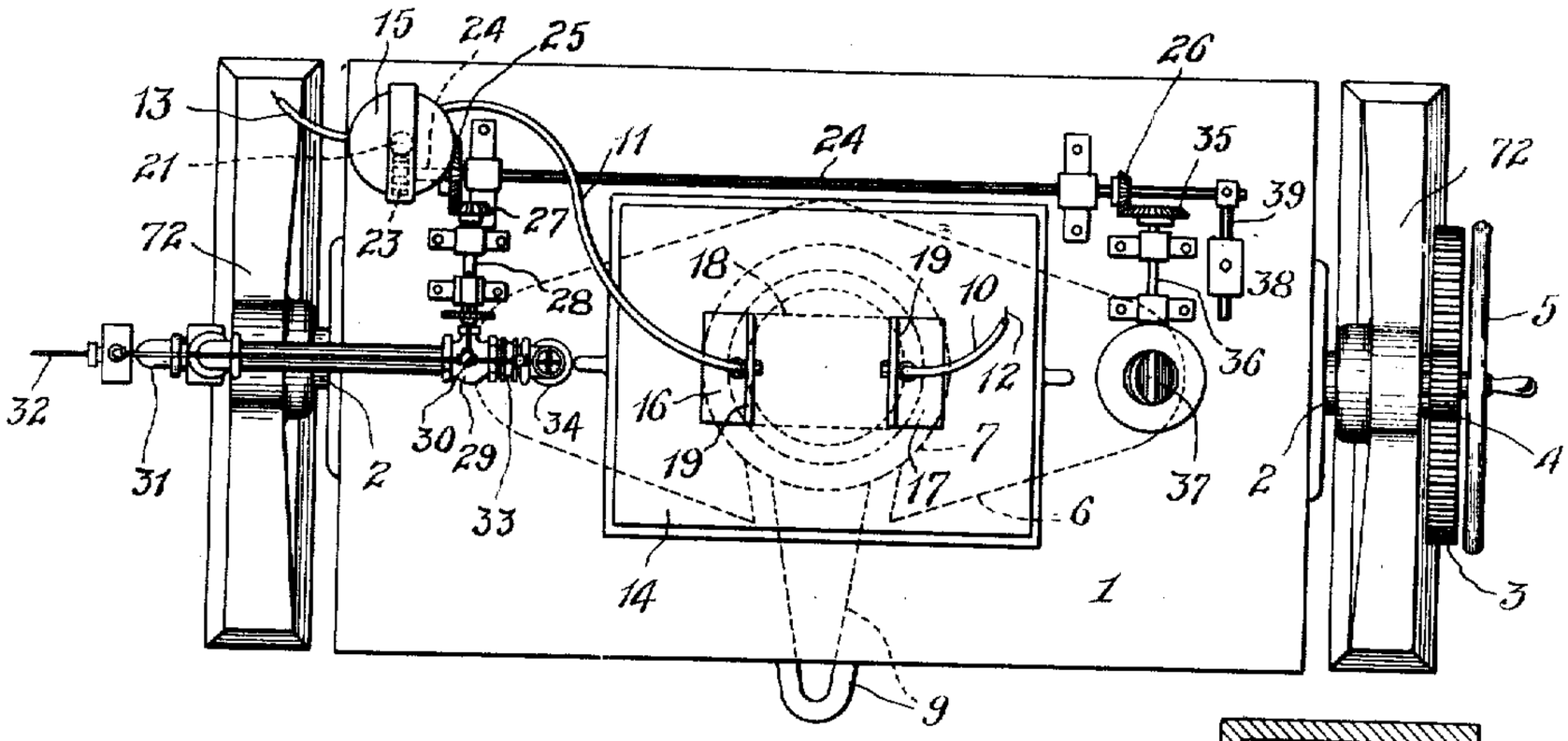

Fig. 2

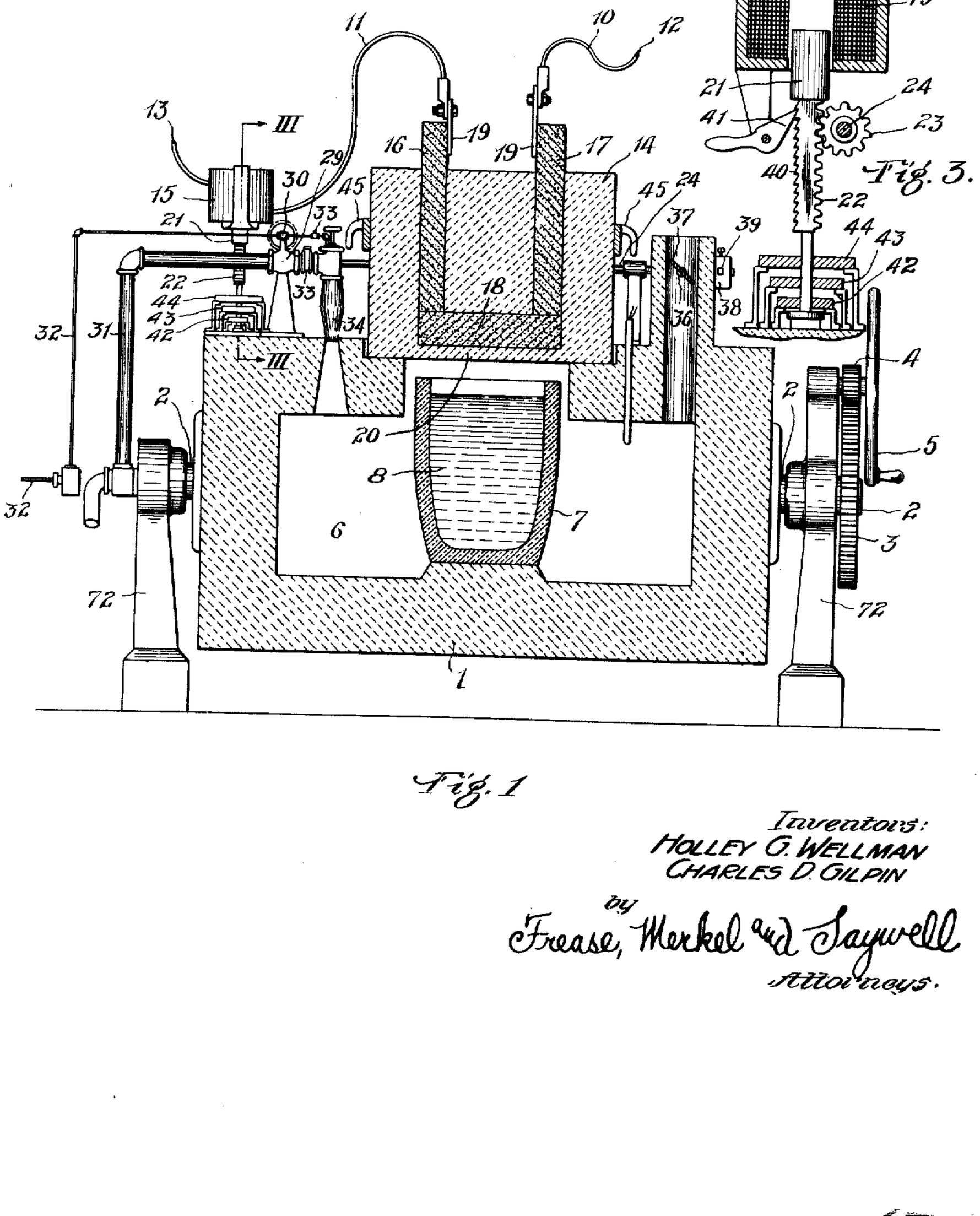

Fig. 1

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3 SHEETS—SHEET 2.

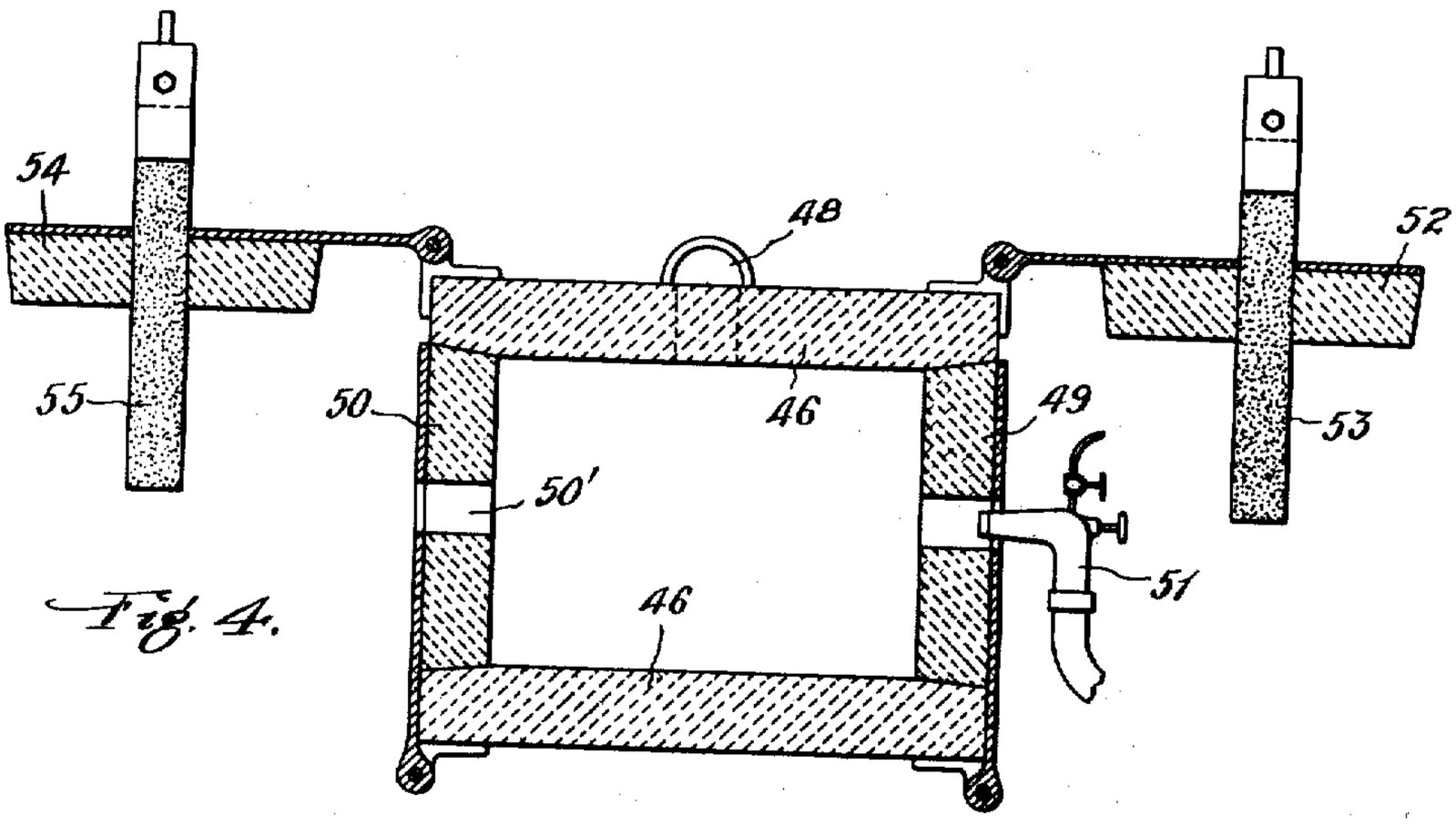

Fig. 4.

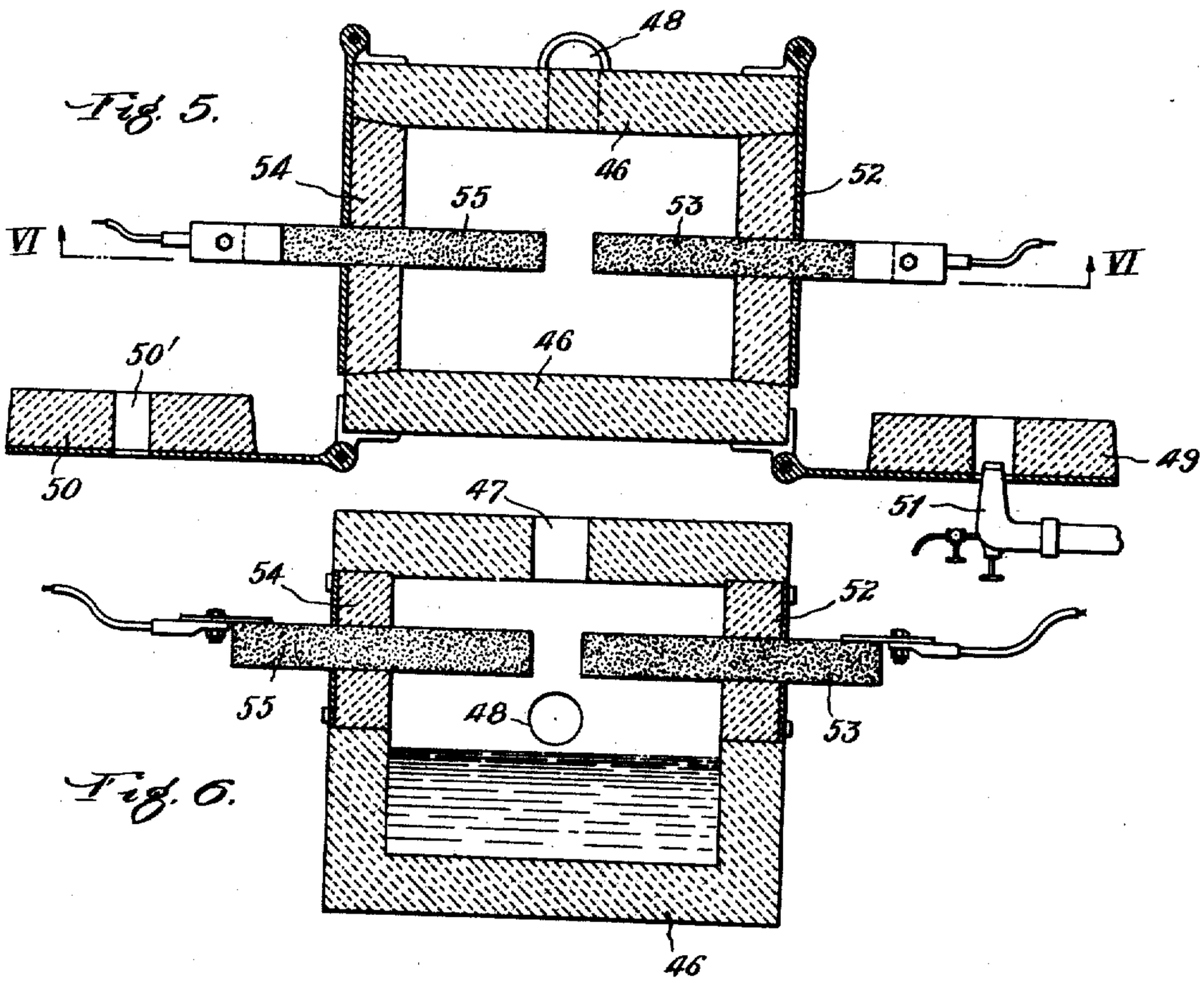

Fig. 5.

Fig. 6.

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3 SHEETS—SHEET 3.

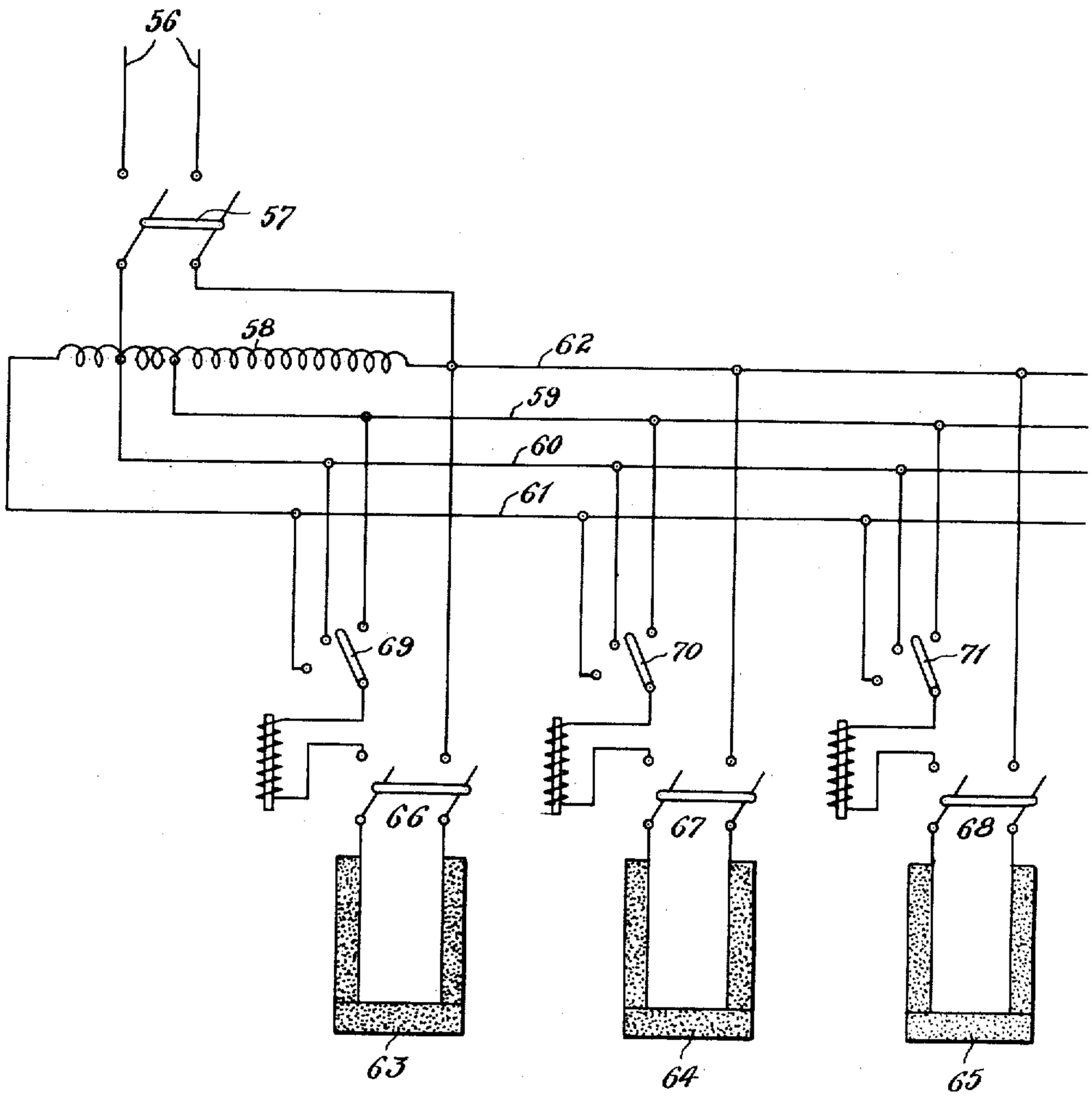

Fig. 7.

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Patented Jan. 2, 1923. 1,440,515

UNITED STATES PATENT OFFICE.

HOLLEY G. WELLMAN AND CHARLES D. GILPIN, OF CLEVELAND, OHIO.

MELTING FURNACE.

Application filed May 17, 1920. Serial No. 382,062.

To all whom it may concern:

Be it known that we, HOLLEY G. WELLMAN and CHARLES D. GILPIN, citizens of the United States, residents of Cleveland, county of Cuyahoga, and State of Ohio, have invented new and useful Improvements in Melting Furnaces, of which the following is a specification, the principle of the invention being herein explained and the best mode in which we have contemplated applying that principle, so as to distinguish it from other inventions.

Our invention relates to furnaces, and particularly to devices of this character adapted to melt non-ferrous metals for making bronze, brass and similar castings. The purpose of the invention is to provide a furnace in which gas or oil can be utilized as the heating medium, combined with electrical heating. The object is to secure the economy of installation and operation possible in gas or oil heating, and also, at the necessary stage in the melting, secure the neutral or reducing atmosphere in the furnace and the ease of control in the heat supply, possible through electric heating. Specifically, we heat the charge to a point where it approaches the oxidizing temperature by means of the gas or oil heating, and then finish the melting by means of electric heating. Also, we utilize the heating effect of the gas or oil not only to raise the temperature of the charge, but also to bring an electric heating element to a temperature which will require a much smaller variation in voltage than is usually required for the operation of a furnace of the resistance type.

The annexed drawings and the following description set forth in detail certain means embodying our invention, the disclosed means, however, constituting but one of the various mechanical forms in which the principle of the invention may be applied.

In said annexed drawings:

Figure 1 represents a vertical, longitudinal section of our improved furnace;

Figure 2 represents a plan view of the same;

Figure 3 represents a fragmentary transverse, vertical section taken in the plane indicated by the line III—III, Figure 1;

Figure 4 represents a horizontal section of another form of our improved furnace; one of the arc design, in which electrodes are used for the electric heating; and in which view the arrangement is shown during the heating by gas or oil;

Figure 5 represents a view similar to that of Figure 4, showing the conditions during the electric heating;

Figure 6 represents a vertical section of the form of furnace shown in Figures 4 and 5, taken in the plane indicated by the line VI—VI, Figure 5;

Figure 7 is a diagrammatic view, showing the adaptation of the invention, when utilized for several small units grouped on one transformer, auto-transformer or generator, for making different alloys at the same time.

Referring to the annexed drawings: There is indicated by the ordinal 1 a furnace body of heat-resisting material rotatably mounted in bearings 72 by means of trunnions 2, the rotation or tilting of the furnace being effected through a suitable gear 3, pinion 4 and hand wheel 5. The furnace 1 is formed with a chamber 6 within which is disposed a crucible 7 adapted to hold the charge 8. When it is desired to discharge the contents of the crucible 7, the same is effected through the spout 9. We do not wish, however, to limit ourselves to the use of a crucible, since, if desired, the metal can be melted upon a hearth. Two flexible conductors 10 and 11 are shown connected respectively at the points 12 and 13 with any suitable main circuit. A removable top 14 is provided for the furnace 1, which is disposed adjacently the top of the crucible 7, the electric circuit passing through said top and also through the field of a solenoid 15. The conductors 10 and 11 have sufficient slack to allow for the necessary movements of the furnace 1 and the top 14. The specific path of the circuit through the top 14 includes two carbon electrodes 16 and 17, a heating element 18 and two terminals 19 connecting the electrodes, respectively, to the conductors. The heating element 18 is preferably a carbon compound having a negative temperature resistance coefficient so that its ohmic value is greater when cold than when it is hot. The top is removed to one side of the furnace when charging, by means of attaching the chains of a crane to hooks 45. It will be noted that the heating element 18 is disposed in the vicinity of the chamber 6, so as to be heated by the gas or oil, but is protected from oxidization by any suitable means, the means herein shown being a

small section 20 of the top 14, which top is built of refractory material.

The solenoid 15 has a plunger 21 formed on one side with teeth 22 adapted to mesh with a pinion 23, keyed to a shaft 24. To this shaft 24 are also keyed upon opposite sides of the furnace 1 two bevel gears 25 and 26. The bevel gear 25 meshes with a bevel gear 27 keyed to a shaft 28. This shaft 28 is connected to a valve 29 controlling the air furnished to the mixer through air line 31. The gas or oil is controlled by the valve 30 having connections with the fuel line 32. Check valves 33 are provided in each of the lines 31 and 32 to prevent air from backing up into the gas or oil pipes, or vice versa, in the event that one of the valves 30 or 29 is closed. The mixer and burner directing the flame into the chamber 6 is indicated by the ordinal 34. The bevel gear 26 meshes with a bevel gear 35 keyed to a shaft 36 which in turn is secured to the waste outlet valve 37.

It is apparent from the foregoing description that the early heating of the charge 8 by the gas or oil from the burner 34 will gradually heat the element 18 decreasing the ohmic value of the same, so that an increasing amount of current can be transmitted through the electric circuit, the solenoid plunger 21 gradually being drawn into the coil 15, which action, through the teeth 22, gear 23, etc., is utilized gradually to turn off the gas or oil at the valve 30 and to close the outlet 36, so that the heating medium gradually changes over from oil or gas to electricity.

We have provided adjustments whereby the amount of increase of current necessary to effect a certain drop in the gas or oil can be varied. Also, it will be noted that we have keyed a crank 39 to the end of the shaft 24, upon which crank is hung a weight 38, whose position can be adjusted. For controlling the drop in the gas heating, we have provided adjacently the bottom of the solenoid plunger 21 a series of various sized weights 42, 43, 44, etc., which can be picked up at predetermined positions by the plunger 21, whereby the necessary electric force to pull the plunger 21 into the coil 15 can be set as required. Also, the conditions can thus be changed or adjusted so as to require varying amounts of current to lift the plunger 21 through different parts of its stroke. The differential in the pull of the solenoid is equalized by the differential in the pull of the weights. In order that, if the electric current is unexpectedly interrupted, the plunger 21 may not drop away from the coil 15 and thus open up the valves 29 and 30, we have provided a pawl 41 adapted to co-operate with ratchet teeth 40 formed upon the side of the plunger 21 opposite to that upon which the teeth 22 are formed.

Referring particularly to Figures 4, 5 and 6, there is therein disclosed a form of furnace preferably of the rocking type, designed to melt the charge upon a hearth, and in which the electric heating is effected by means of striking and maintaining an arc between two electrodes 53 and 55. The furnace wall is indicated by the ordinal 46 and a feed mouth for the same by the ordinal 47, the discharge spout being indicated by 48. Two sets of doors are provided, 52 and 54, within which are mounted the electrodes 53 and 55 respectively, and 49 and 50, within one of which a gas or oil burner 51 is mounted, and within the other of which is formed a discharge outlet 50′ for the waste gas products. As illustrated in these figures, the necessary heating by gas or oil is effected by means of closing the doors 49 and 50 and then, when it is desired to change over to the electric heating, the doors 49 and 50 are opened and the doors 52 and 54 containing the electrodes are closed. The electrodes are then adjusted to strike the desired arc.

Referring to Figure 7, a diagram of an arrangement is shown whereby several small furnaces may be grouped on one transformer, auto-transformer or generator, to produce different alloys. Due to the diversity feature of the load, it will be possible to make the continuous capacity of the immediate source of power much smaller than the combined peak loads of the various furnaces. There is indicated by the ordinal 56 an alternating current circuit, 57 denoting a switch and 58 an auto transformer, which furnishes differential voltages to the conductors 59, 60 and 61 with respect to the conductors 62. The electric heating elements or resistors are indicated by the ordinals 63, 64 and 65, and the several switches by the ordinals 66, 67 and 68. Regulating switches are indicated by the ordinals 69, 70 and 71, so that any particular furnace can be supplied with voltage 59—62, 60—62, or 61—62. This arrangement readily lends itself to an economical and flexible installation for a group of furnaces.

Our improved furnace will be found of particular service in small plants, where, due to the non-continuity of operations, the shutting down of the electric heating necessitates a re-heating of the furnace before it becomes effective, when next it is desired to utilize the same.

It is not necessary to interconnect the gas and oil and electric heating in the manner which we have described, nor to utilize the electric current during the heating by gas and oil. The two forms of heating may be utilized absolutely separately, as, for instance, illustrated in Figures 4, 5 and 6. The separate and independent heating also would be feasible with the apparatus shown in Figures 1, 2 and 3.

The methods of operation would be varied

for melting various kinds of materials, but for making castings out of brass or bronze ingots, the operation would be about as follows:

The charge is placed in the crucible after first moving the top 14 to one side and the oil or gas burner then lighted. A constant potential will be connected to 12 and 13. The proper weights 42. 43, 44, etc., will be placed in the solenoid mechanism, these weights having been determined by past experience in melting the same metal. During the early stages of the heating, the flame will be controlled by the operator by means of valves of the usual kind (not shown). At first, the current through the resistor 18 will be negligible, but as the furnace becomes heated, the ohmic value of the resistor will decrease, thus allowing a greater flow of current, which in turn will still further heat the resistor, allowing more current to flow. If it is desired, the current need not be thrown through the resistor until the latter has been well heated and the charge has nearly reached the melting condition. The solenoid regulating weights, 42, 43 and 44, will be so chosen that as the charge approaches the temperature where oxidation becomes a serious factor, the resistor 18 will have been sufficiently heated to allow the solenoid plunger 21 to be lifted by the resulting current, this lifting being done in one or several stages by the means of one or several of the weights 42, 43, 44, as may prove desirable. This lifting of the plunger 21 will, of course, shut off the air and fuel valves 29 and 30 and close the waste gas valve 37 by one or several steps so that the source of heat will immediately or gradually become entirely electrical and the oxygen from the outside will be cut off. Heating will then proceed as in the case of an ordinary electric furnace of the resistance type.

Almost any combination of automatic control for this electric heating can be installed, ranging from a simple overload circuit breaker, which can be set to interrupt the current when the latter reaches a predetermined point, to a more or less elaborate arrangement of contactors controlled by a pyrometer, and arranged to increase or decrease the voltage by small steps in order to hold the final temperature constant. It should be noted, however, that any such arrangement need cover only a comparatively small range of voltage owing to the pre-heating of the resistor; whereas, in the straight electric furnace using this type of resistor, a voltage range of as high as four to one may be necessary in order to obtain the desired results. This necessary range of voltage greatly increases the cost and complicates the auxiliary apparatus. Of course, it will be well known to those skilled in the art that compressed air and oil or gas are available in most foundries and are in any event readily and economically provided. The automatic control of the fuel supply, as well as of the electric current, may be dispensed with in cases where original cost is a serious item, and where the furnace may readily be kept under supervision. In the event that metals of various melting points are to be combined in the furnace, the original charge can consist of the metal having the highest melting point, and the automatic device may be set for such metal. When it reaches the proper temperature, the cover 14 may be removed and the other metals added, the electric heating being continued as long as may be desired.

The operation of the arc type of combination furnace shown in Figures 4, 5 and 6 will be somewhat similar to that of the resistor type except that the automatic change from fuel to electric heating would require much more complicated apparatus and therefore is probably not desirable. This is due to the fact that the electrodes must necessarily be protected from the flame of the burners unless they be withdrawn by some such device as shown in said figures. The melting of the charge in this furnace, therefore, consists in pre-heating the charge to a desirable point by means of closing the fuel doors 49 and 50, and then replacing said doors with the electrode doors 52 and 54, striking an arc between said electrodes and maintaining the same for the desired period.

Either the type of furnace shown in Figures 1 to 3, or the type shown in Figures 4 to 6 may be operated entirely with fuel or entirely with electricity. This is a very desirable condition, inasmuch as alloys which oxidize slightly may thus, if desired, be melted entirely with fuel, while those which oxidize particularly easily can be melted entirely by electricity. Furthermore, a failure either of the fuel or electric power would still leave the furnace in commission.

Insofar as the desirable features of electric heating are concerned, it should be kept in mind that the electric type of furnace is gradually replacing the crucible and other processes, so that, although until recently used largely for the melting of silver and bearing metal alloys, it is now used for brass of all kinds, aluminum, various alloys and other materials. New non-ferrous combinations and new uses for the common non-ferrous metals and alloys are constantly developed, for which the use of the electric heating feature of our furnace is very desirable, at the same time preserving for the early stages of the melting the low cost of operation possible in gas or oil melting.

We are aware of the fact that it is not new to heat preliminarily by gas and later by electricity in the same furnace or cham-

ber, and we do not make claim to any such combination of apparatus. Our invention relates to fuel and electric heating, and means interconnected so that the operation of one is affected by the other; or the use of an electric heating element having a negative temperature resistance coefficient and disposed within the heating area of gas or oil; or the use of gas and electric heating means so interconnected as to be reciprocably replaceable in the furnace chamber; or the use of a source of electric energy supplying various voltages combined with means for selectively heating charges in various furnaces with the desired voltages from said source of electric energy. We are also advised that gas and electric heating have been combined in a two-furnace method, or in methods in which the hearth is positively removed from an area in which its contents are subjected to gas heating to an area in which it it is subjected to electric heating, but our claims relate to a one-furnace method in which the furnace is maintained in a fixed position.

What we claim is:

1. In a melting furnace, the combination of a chambered furnace body forming a receptacle for the charge; means for heating the charge with gas or oil including means for controlling said heating; and means for heating the charge electrically including means for controlling said heating, said two sets of controlling means being interconnected.

2. In a melting furnace, the combination of a chambered furnace body forming a receptacle for the charge; means for heating the charge with gas or oil; and means for heating the charge electrically, said two sets of heating means being interconnected so that an effective increase in the electric heating means results in a decrease in the gas or oil heating means.

3. In a melting furnace, the combination of a chambered furnace body forming a receptacle for the charge; means for heating the charge with gas or oil; and means for heating the charge electrically in the same heating area, said two sets of heating means being interconnected so that an effective increase in the electric heating means results in a decrease in the gas or oil heating means.

4. In a melting furnace, the combination of a chambered furnace body forming a receptacle for the charge; means for heating the charge with gas or oil; means for heating the charge electrically, said two sets of heating means being interconnected so that an effective increase in the electric heating means results in a decrease in the gas or oil heating means; and means for varying the ratios between said increase and decrease.

5. In a melting furnace, the combination of a chambered furnace body forming a receptacle for the charge; means for heating the charge with gas or oil; means for heating the charge electrically, said two sets of heating means being interconnected so that an effective increase in the electric heating means results in a decrease in the gas or oil heating means; and means for varying the ratios between said increase and decrease in different portions of the heating range.

6. In a melting furnace, the combination of a chambered furnace body forming a receptacle for the charge; means for heating the charge with gas or oil; an electrical heating element disposed within the heating area of said gas or oil and having a negative temperature resistance coefficient; and means for heating the charge electrically, said element being disposed in the circuit of said electrical heating means.

7. In a melting furnace, the combination of a chambered furnace body forming a receptacle for the charge; means for heating the charge with gas or oil; an electrical heating element disposed within the heating area of said gas or oil and having a negative temperature resistance coefficient; means for heating the charge electrically, said element being disposed in the circuit of said electrical heating means; and means influenced by a gradual effective increase in the electric heating to effect a corresponding decrease in the gas or oil heating means.

8. In a melting furnace, the combination of a chambered furnace body; a crucible disposed therein; a top of refractory material for said body disposed adjacently the top of said crucible; a heating element imbedded in said top adjacently said crucible and having a negative temperature resistance coefficient; an electric circuit within which said element is contained; means furnishing heating gas or oil to said chamber; and means connected to said last-mentioned means and said circuit and adapted to reduce the heating value of said gas or oil corresponding to the increase in the electric circuit.

9. In a melting furnace, the combination of a chambered furnace body; a crucible disposed therein; a top of refractory material for said body disposed adjacently the top of said crucible; a heating element imbedded in said top adjacently said crucible and having a negative temperature resistance co-efficient; an electric circuit within which said element is contained; means furnishing heating gas or oil to said chamber; a solenoid forming part of said electric circuit; valves in the gas or oil line and in the chamber waste outlet; and means connected to said valves and the plunger of said solenoid.

10. In a melting furnace, the combination of a chambered furnace body forming a receptacle for the charge; means for heating the charge with gas or oil; means for heating the charge electrically; means influenced by an effective increase in the electric heating and tending to decrease the gas or oil heating; and adjustable means controlling the functioning of said last-mentioned means.

11. In a melting furnace, the combination of a chambered furnace body forming a receptacle for the charge; means for heating the charge with gas or oil; an electrical heating element disposed within the heating area of said gas or oil and having a negative temperature resistance coefficient; means for heating the charge electrically, said element being disposed in the circuit of said electrical heating means; means influenced by an effective increase in the electric heating and tending to decrease the fuel heating; and adjustable means controlling the functioning of said last-mentioned means.

12. In a melting furnace, the combination of a chambered furnace body forming a receptacle for the charge; means for heating the charge with gas or oil; means for rendering said heating means inactive; means for heating the charge electrically in the same heating area as the gas heating; and means for rendering said electric heating means inactive.

13. In means for melting non-ferrous metals in a plurality of furnaces, the combination of a series of chambered furnace bodies forming receptacles for the charges; a source of electric energy supplying various voltages; and means for selectively heating the charge in each furnace with the desired voltage.

Signed by us this 9th day of April 1920.

HOLLEY G. WELLMAN.
CHARLES D. GILPIN.