J. A. WARD.

ELECTRIC ORE FURNACE.

APPLICATION FILED APR. 12, 1917.

1,252,635.

Patented Jan. 8, 1918.

2 SHEETS—SHEET 1.

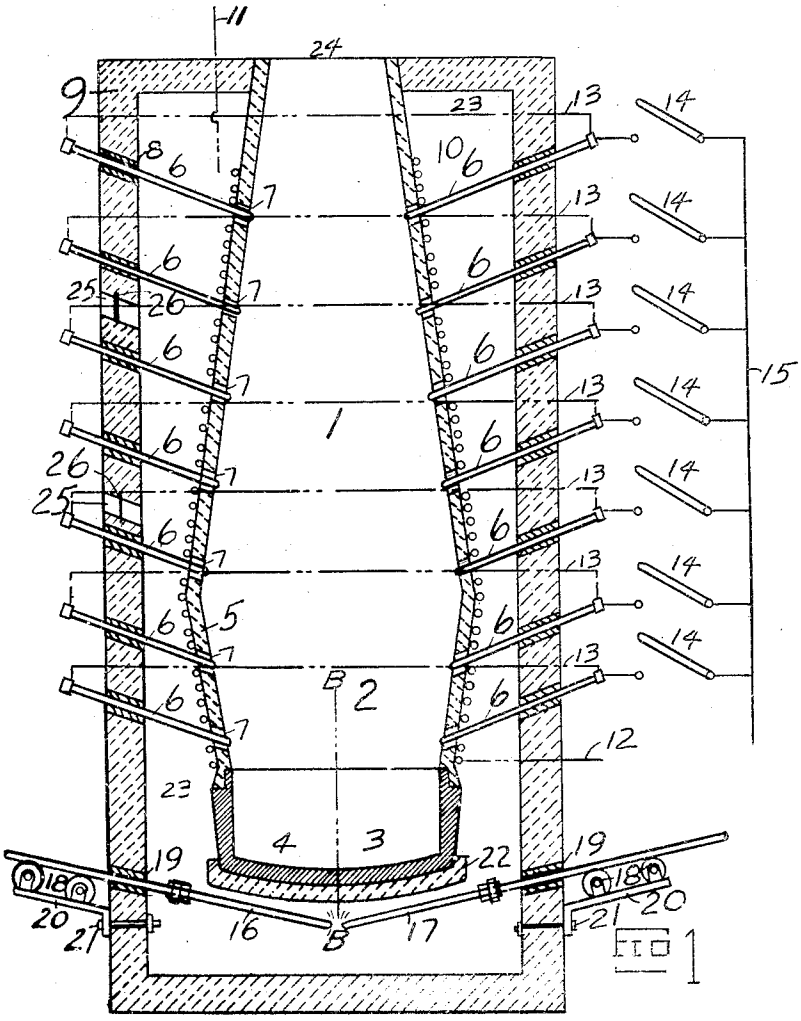


FIG 1

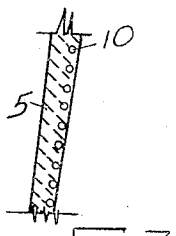


FIG 3

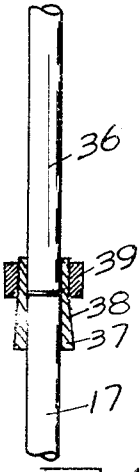


FIG 4

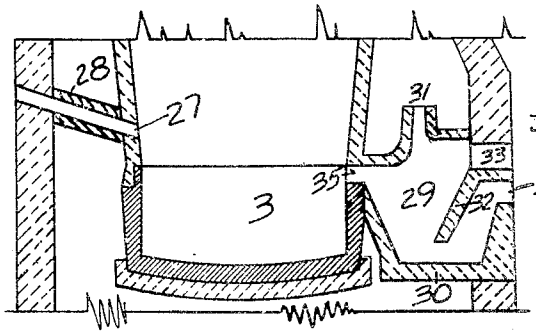


FIG 2

SECT. B-B

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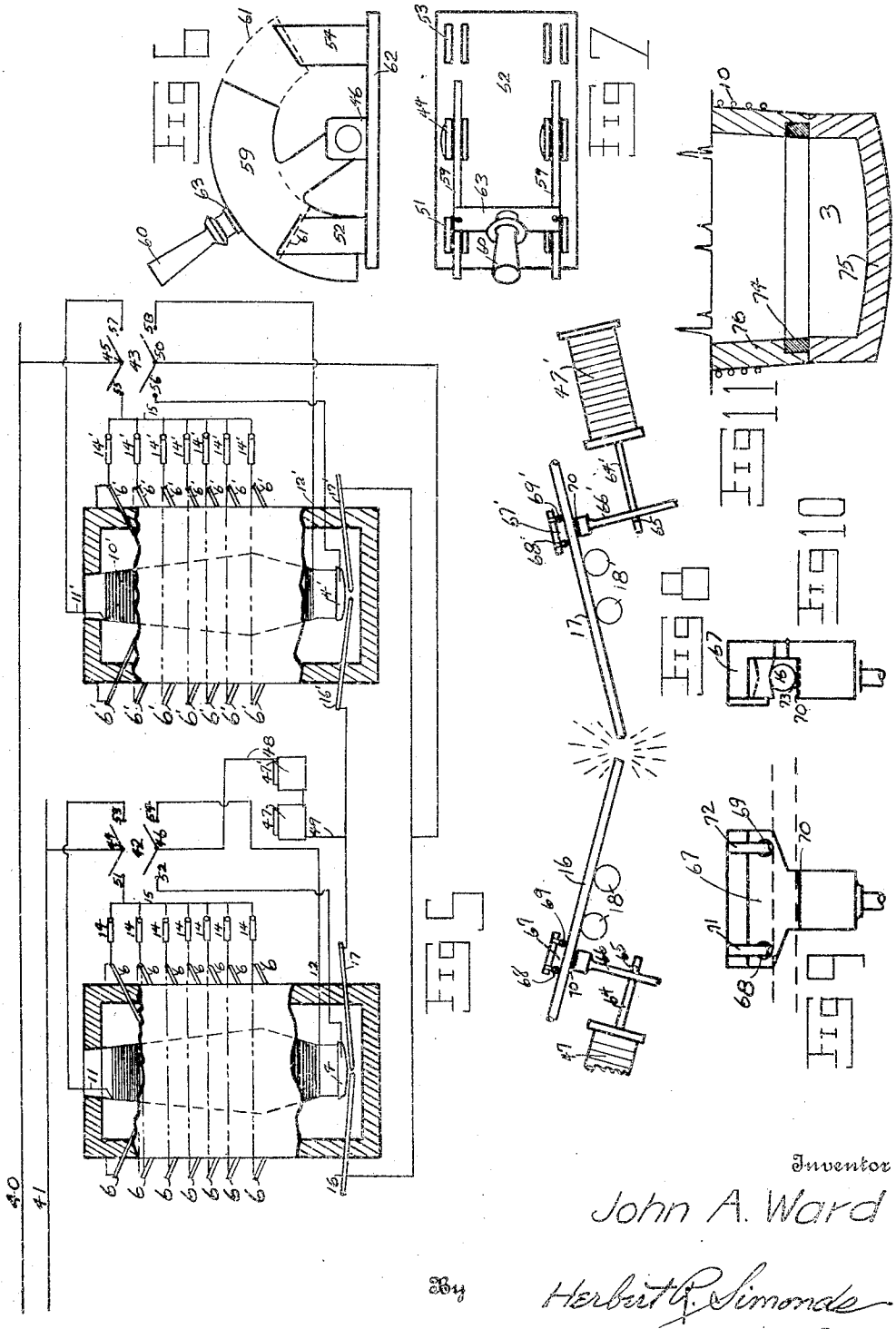
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UNITED STATES PATENT OFFICE.

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ELECTRIC ORE-FURNACE.

1,252,635. Specification of Letters Patent. Patented Jan. 8, 1918.

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To all whom it may concern:

Be it known that I, JOHN A. WARD, a citizen of the United States, residing at Spokane, in the county of Spokane and State of Washington, have invented a new and useful Improvement in Electric Ore-Furnaces, of which the following is a specification.

This invention relates to improvements in electric ore furnaces, and has for one of its objects to provide a means for closely and continuously regulating the heat of electric coils used in such furnaces.

A further object of the invention is to provide a means for using the ore body itself as the electric heating element.

A further object is to utilize the heat generated by the controlling device, thus eliminating a usual source of waste in electric furnaces.

Still further objects and features of the invention will be more fully described in connection with the accompanying drawings and will be more particularly pointed out in and by the appended claims.

In the drawings:

Figure 1 is a section through the furnace showing the arrangement of carbon contacts and the arc control.

Fig. 2 is a part section taken on line B—B of Fig. 1, and shows the method of taking off the metal and the slag from the furnace.

Fig. 3 is a section of the inner wall of the furnace showing a modified form of construction with coils embedded.

Fig. 4 is a section showing detail of arc carbon holder.

Fig. 5 is a wiring diagram showing diagrammatical arrangement of two furnaces connected on one circuit.

Fig. 6 is a side elevation of a switch used in the connections of Fig. 5.

Fig. 7 is a plan view of the same switch.

Fig. 8 is an elevation showing arc adjusting mechanism.

Fig. 9 is an enlarged view of one of the clutches shown in Fig. 8.

Fig. 10 is an enlarged side elevation of the same clutch.

Fig. 11 is a section of the furnace crucible showing a modified construction.

Like numerals refer to the same parts throughout the various figures of the drawings.

Describing in detail, in Fig. 1, 1 is the shaft of the furnace proper. This is where the progressive heating of the ore takes place or the low temperature and roasting as the case may require. The bosh or reduction portion of the furnace is the zone 2, and 3 indicates the furnace crucible or the portion of the furnace where the molten metal accumulates. This portion of the furnace has for its base a conducting plate 4. The lining 5 of the bosh and shaft of the furnace is composed of a refractory and non-conducting material, and through this, inserted at regular intervals are conducting pencils 6. These fit snugly in the openings 7 of the furnace lining 5 and project far enough into the furnace to make electrical contact with the ore body. Pencils 6 also pass through openings 8 in the outer wall 9 to permit of their insertion or withdrawal from the outside. Pencils 6 are arranged in diametrically opposed pairs, each pair being connected together electrically by wires 13 and also connected to one side of each of the switches 14. These switches 14 are single pole, single throw switches, the other sides of which are all connected together by a bus wire 15. Wrapped around the furnace wall 5 is a resistance coil 10 with its terminals taken out at 11 and 12. Below the crucible 3 are the arc forming contacts 16 and 17. These are slidably supported on the rollers 18 and are normally held together by gravity. They pass easily through openings 19 in the outer wall 9. The rollers 18 are in turn supported by brackets 20 fastened to the outer wall by bolts 21. Above the arc formed between contacts 16 and 17 and between it and the base plate 4 is inserted the wall 22 composed of a refractory and nonconducting material. Surrounding the furnace proper is an air space 23 provided as a means of heat insulation. The top or receiving part of the furnace is shown at 24. Openings 25 are provided through the outer wall 9 for the purpose of watching the temperature of the coil 10. In these openings are inserted mica sheets 26 to permit vision, and at the same time prevent the escape of heat.

In Fig. 2 an opening 27 and its surrounding refractory wall 28 is provided, slightly inclined to the horizontal, for the purpose of removing slag. Numeral 29 is a refining crucible which is arranged for the treatment of certain ores. Its base 30 and general design is of such a nature that an auxiliary source of heat may be applied to its contents

if necessary. Its stack portion 31 may be connected to a flue if required. The barrier 32 serves to separate any additional slag which may be in the refining crucible 29 from the molten metal. The opening 33 is provided for removing such slag. The opening 34 is where the metal is drawn off. The metal and some slag from the crucible 3 flows through the opening 35 into the refining crucible 29.

In Fig. 3 numeral 10 represents the heating coil embedded in the wall 5.

In Fig. 4 numeral 36 is a rod of some conducting material. It is of the same diameter as the carbons 16 and 17 and is shown supporting carbon 17. The threaded sleeve 37 fits tightly over the end of 36 and normally loosely over the end of the carbon 17. Its outer surface 38 is slightly beveled, and the carbon holding portion of the sleeve itself is longitudinally slotted so that when the clamping nut 39 is screwed toward the carbon, the carbon is firmly clamped and thus is held in line with, and firmly to, the rod 36.

In Fig. 5 two furnaces are shown, the arrangement of each being practically the same as that shown in Fig. 1. An electric line or source of power is represented by the wires 40 and 41. Double pole, double throw switches are shown at 42 and 43 respectively. The wire 41 is connected at the hinge clips 44 of one side of the switch 42, and the wire 40 is connected at the hinge clip 45 of one side of the switch 43. The other hinge clip 46 of switch 42 is connected to one side of the solenoid pair 47 and 47′ at the terminal 48. The other terminal 49 of solenoid 47 is connected with the contact 17 and also with the contact 16′. The opposing carbons 16 and 17′ are connected to the hinge clip 50 of switch 43. When the switch 42 closes onto the clips 51 and 52, contact is made through 51 with a bus wire 15 which, when the switches 14 are all closed, is in electrical contact with all of the conducting pencils 6. Contact is also made from the hinge clip 46 through clip 52 to the base plate 4. When switch 42 closes onto the clips 53 and 54, contact is made from hinge clip 44 through 53 to the terminal 11 of the coil 10. Contact is also made from hinge clip 46 through clip 54 to the terminal 12 of coil 10. When the switch 43 closes onto the clips 55 and 56, contact is made from hinge clip 45 through 55 to the bus wire 15′ which, when all the switches 14′ are closed, is in electrical contact with all the conducting pencils 6′. Contact is also made from hinge clip 50 through 56 with the base plate 4′. When the switch 43 closes onto the clips 57 and 58, contact is made from hinge clip 45 through 57 with terminal 11′ of coil 10′ and also from hinge clip 50 through 58 with terminal 12′ of coil 10′. In construction the switch 42 is identical with switch 43, but for convenience Figs. 6 and 7 are represented as showing switch 42. In Fig. 6 the blade 59 is shown making connection between hinge clip 46 and clip 52, the contact being severed between blade 59 and the clip 54. A handle 60 provides means for throwing the switch from one position to the other. The dotted lines 61 indicate the central position of the blade 59, and it will be noted that in this position the blade is in contact with both the clips 52 and 54. All clips of the switch are mounted on base 62.

In Fig. 7 clips 53, 44 and 51 are shown in addition to the three clips which appear in Fig 6. A bar 63 of non-conducting material connects the blades 59 and 59′, serving to stiffen them and at the same time to support the handle 60.

In Fig. 8 the solenoid pair 47 and 47′ is shown divided and arranged slightly inclined to the horizontal. The armature 64′ of solenoid 47′ has mounted near its lower end a pin 65′ which projects past the stem 66′ of the clamp 67′. The rollers 68′ and 69′ rest on the upper surface of the contact 17 and normally the knurled surfaces 70 are free of the contact 17 which is therefore free to slide over the rollers 18 without changing the position of the clamp 67′. The clamp 67 is arranged the same as clamp 67′, being supported on the contact 16 by rollers 68 and 69.

In Fig. 9 is shown the knurled surface 70 of the clamp 67 and the rollers 68 and 69 with their outer support bars 71 and 72.

Fig. 10 shows the clamp 67 hanging in position on contact 16, the surface 70 being free of 16 by the gap 73.

In Fig. 11, 74 represents an annular conducting band which may be used as the lower contact in place of the base plate 4, as shown in Figs. 1 and 5. The modified construction as shown, with the use of this band 74, is for the purpose of permitting more direct heat to reach the contents of the crucible 3 from a source beneath the base 75 of said crucible. The base 75 and the walls 76 are composed of a refractory and non-conducting material.

The general operation of two furnaces arranged as a unit and of the different features of each, constituting my invention is as follows: The ore is admitted at the top 24 until the furnace is filled to the desired level. Switch 42 is then closed on clips 53 and 54, and switch 43 is closed on clips 57 and 58. The electric current from the source or line wires 40 and 41 then flows through coil 10, through the solenoid pair 47 and 47′, and then splitting, flows part through the arc formed between 16 and 17 and part through the arc formed between 16′ and 17′, and again uniting flows through the coil 10′ and

back to the source 40. The carbons forming the arcs being held together by gravity to permit the circuit to be complete. The solenoids 47 and 47′ are designed for the correct current for the system to which they are adapted, and when the carbons are in contact the current is of such a strength as to cause the armatures 64 and 64′ to be drawn up into the solenoids. The armatures through the pins 65 and 65′ engage the clamp stems 66 and 66′ and thus tip respectively the clamps 67 and 67′, bringing the knurled surfaces 70 in contact with the carbons and thus causing the carbons to follow the motion of the armatures 64 and 64′ and so be drawn apart. This lengthens the arc and reduces the current flowing, which in turn releases the armatures 64 and 64′, allows the clamps 67 and 67′ to assume their normal position, and thus allows the carbon pencils 16 and 17 to fall by gravity. The carbon pencils 16 and 17 are tipped very slightly to the horizontal and the pull of gravity is just sufficient to overcome the friction of the different rollers. In operation therefore, the carbons come to a position in equilibrium which maintains an even flow of current throughout the circuit. At any time a very slight increase in the amount of current flowing produces a motion of the solenoid armatures 64 and 64′ and thus, as has just been described, immediately reduces the current. Dash-pots may be provided to dampen the movement of the armatures. These are not shown on the accompanying drawings because their use is standard, as is the general method of adjusting the carbons of an arc by means of solenoids.

The current flowing as described is kept constant in the coils 10 and 10′ and the ore gradually brought up to most any desired temperature, depending upon the design of the furnace. If a greater temperature is desired at one portion of the furnace than at another, a modification of the lines of the wall or of the winding of the coils will effect this result. It is often desirable to use the ore body itself as the heating element, making it part of the electric circuit. For this purpose the switches 42 and 43 are thrown in the opposite direction to make contact with the clips 51, 52, 55 and 56. This operation throws out the coils 10 and 10′ and throws in circuit in their place the circuits which are completed from the base plate 4 through the ore to one or more of the pencils 6, and from the base plate 4′ through the ore to one or more of the pencils 6′. The switches used for this operation are constructed as shown in Figs. 6 and 7 so that at no time is the circuit completely broken, the circuits through the ore being closed slightly before the coil circuits are opened. The pair of pencils nearest the base of the furnace in each case will be the ones to receive the main portion of the current. In case the current thus flowing is greater than desired, the lower small switches 14 and 14′ connecting these pencil pairs are opened and the current then flows to the next higher pair of pencils. This process can be repeated as often as desired until the current flowing is of the desired amount.

In the operation of one furnace only, the coil which would be used on the second furnace is wound on the upper part of the one furnace in use, and the connection diagram is otherwise the same as for the two furnaces. In each individual furnace as the ore melts it flows into the crucible as at 3 in Fig. 1. Here it is kept hot by one or more arcs formed, as previously described, and positioned underneath and close to the crucible base. In this way the energy used up in the regulating device (that is, in the arc or arcs) is utilized and the entire process becomes more efficient than in the ordinary method where a rheostat exterior to the furnace is used for the regulating means. For certain methods of construction it is necessary to lengthen the carbons, and a means for doing this has been described and is shown in Fig. 4. Methods of adjusting arc forming contacts have been in use for many years; one form of doing this is shown in Fig. 8 where strengthening the fields of the solenoids 47 and 47′ causes their armatures 64 and 64′ to be drawn in, which movement, through a tilting of the clamp members 67 and 67′ causes the arcs to be drawn apart in the manner as hereinbefore described.

While I have described one specific embodiment of my invention, I do not wish to be limited thereto except for such limitations as the claims may import.

I claim:

1. A method of controlling the current flowing through the heating element of an electrical heater by introducing in the circuit a pair of adjustable arc forming electrodes, said electrodes being exterior to the heater itself and thus having independent heat radiating properties.

2. A method of controlling the current flowing through an electric circuit forming the heating element in an ore furnace by inserting arc forming electrodes in said circuit, exterior to the furnace and by providing means of automatically adjusting the spacing of said electrodes so as to oppose and counteract tendencies toward current variation.

3. A method of controlling the heat in an electric ore furnace by means of an adjustable arc, independent of and separate from the furnace, but inserted at some point in the electric heating circuit of the furnace so that the current flowing in said circuit is dependent upon the position of the electrodes of the arc.

4. In an electric ore furnace, a heating element, a plurality of arc forming contacts in series with said heating element, one or more solenoids in series with said heating element and with said arc forming contacts, mechanical means whereby a change in the field strength of the solenoids produces a corresponding change in the position of the arc forming contacts.

5. An electric heating system for ore furnaces comprising the combination of a coil of suitable resistance wire, a pair of arc forming contacts adapted to be placed in series with the resistance wire and one or more solenoids in series with said arc forming contacts and said resistance wire, said solenoid or solenoids having movable armatures mechanically connected with the arc forming contacts so as to regulate the length of the arc and thereby regulate the temperature of said coil of resistance wire.

6. In an electric ore furnace, an electric heating coil of wire surrounding said furnace, a series of conducting pencils piercing the furnace wall so as to be in electrical contact with ore contained in said furnace, a conducting plate so positioned at the base of said furnace as to be in electrical contact with furnace contents, and a switch so constructed as to provide means for opening a circuit through said coil of wire and for closing a circuit through the ore contents of said furnace from said base plate to said conducting pencils, said closing being effected slightly before the opening of said wire coil circuit.

7. In an electric ore furnace, an electric heating coil of wire surrounding said furnace, a series of conducting pencils piercing the furnace wall so as to be in electrical contact with ore contained in said furnace, an annular conducting band surrounding the crucible of said furnace and so positioned as to be in electrical contact with furnace contents and a switch so connected and so constructed as to provide means for opening a circuit through said coil of wire and for closing a circuit through the ore contents of said furnace from said annular conducting band to said conducting pencils, said closing being effected slightly before the opening of said wire coil circuit.

8. In an electrical ore furnace, a heating circuit, a plurality of adjustable arc forming contacts connected in series therewith and positioned exterior to the furnace, means for automatically spreading said contacts with any increase of current in said circuit so as to counteract said current increase and thus to effect a regulation of temperature.

9. In an electric ore furnace, a main heating element consisting of a coil of wire surrounding the furnace, a plurality of adjustable arc forming contacts in series with said coil of wire, and means for automatically adjusting said contacts to effect a regulation of the temperature of said coil of wire.

10. In an electrical ore furnace, a main heating element consisting of a coil of wire surrounding the furnace, a plurality of adjustable arc forming contacts in series with said coil of wire, means for automatically adjusting said contacts to effect a regulation of the temperature of said coil of wire, and means for utilizing the heat generated by the arc or arcs formed between said contacts in aiding the process of ore reduction.

In testimony whereof, I hereby affix my signature in the presence of two witnesses.

JOHN A. WARD.

Witnesses:
O. M. SPARKS,
H. R. SIMONDS.

Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."