C. H. FULTON.

ELECTRICAL DISTILLING APPARATUS.

APPLICATION FILED DEC. 7, 1916.

1,242,337

Patented Oct. 9, 1917.

3 SHEETS—SHEET 1.

Fig. 1.

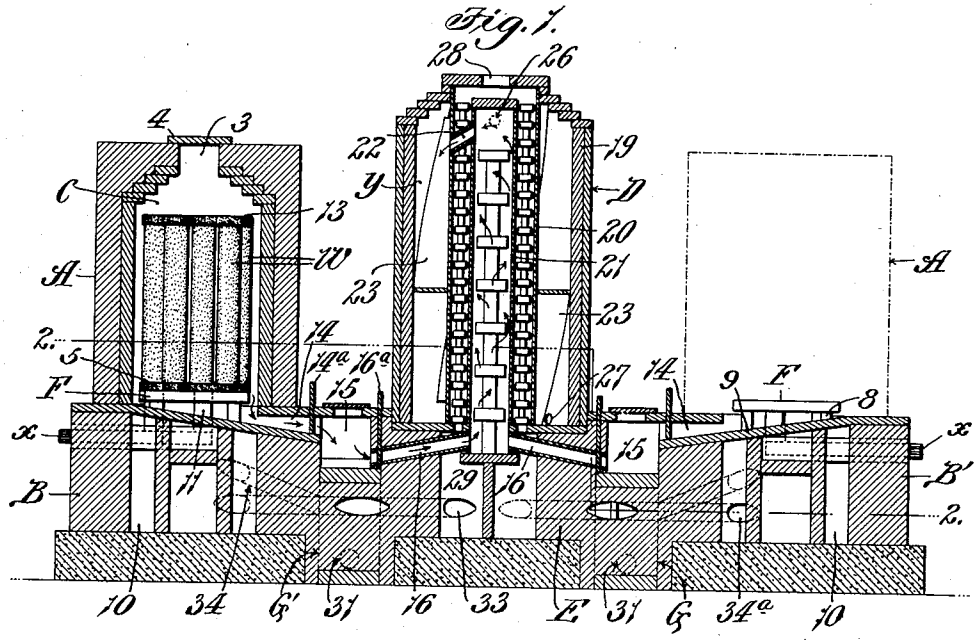


Fig. 2.

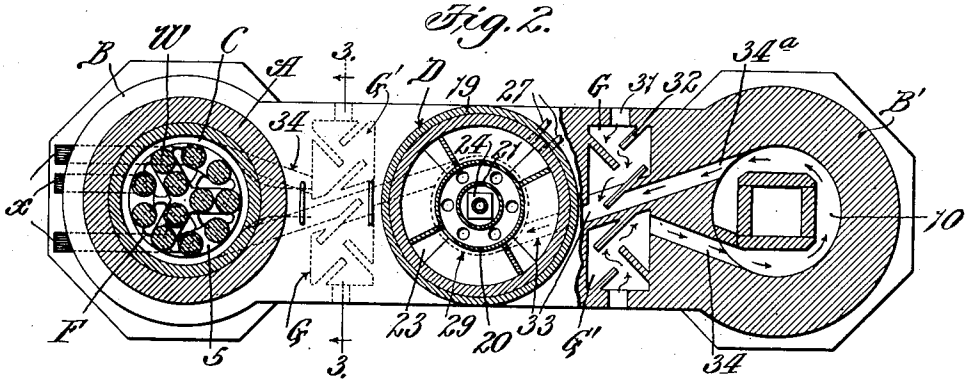
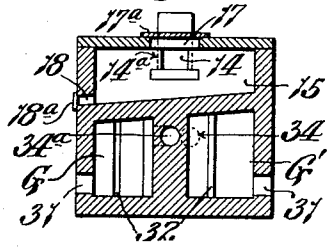


Fig. 3.



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3 SHEETS—SHEET 2.

Fig. 4.

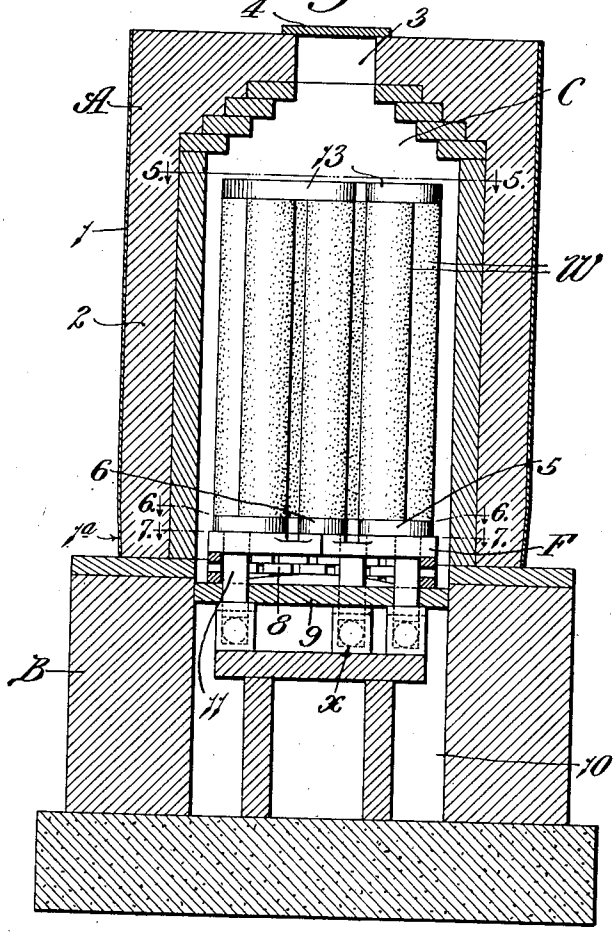


Fig. 5.

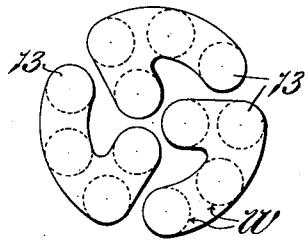


Fig. 6.

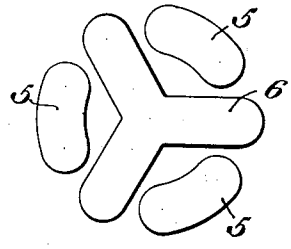


Fig. 7.

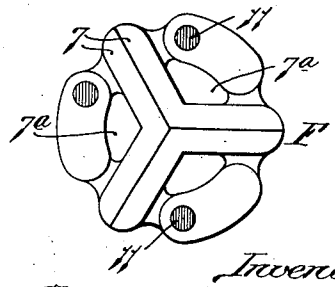
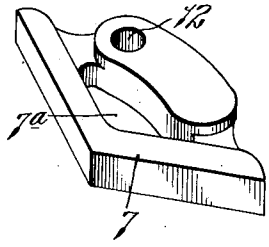


Fig. 8.



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3 SHEETS—SHEET 3.

Fig. 9.

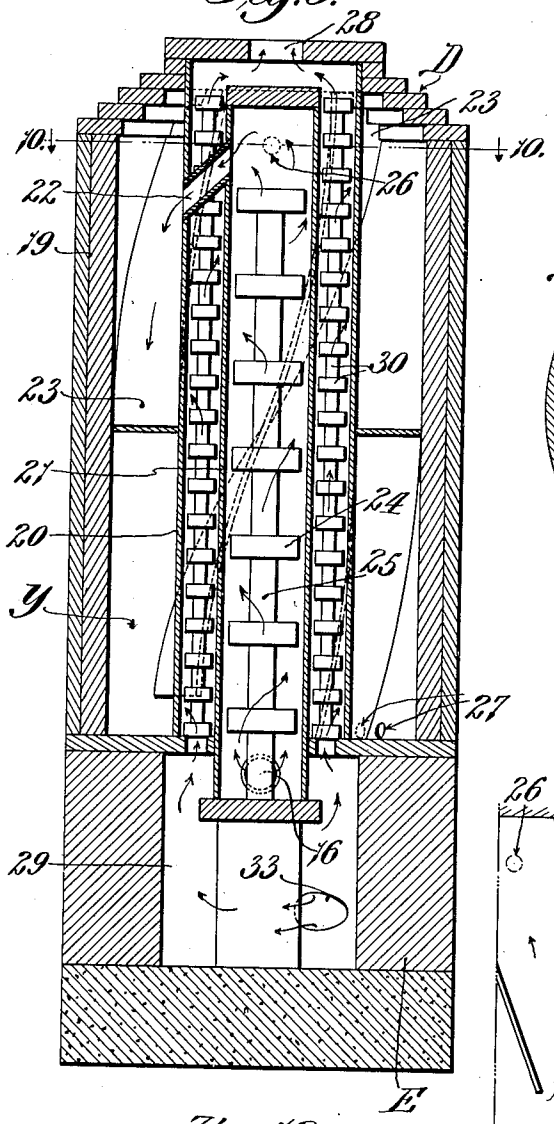


Fig. 10.

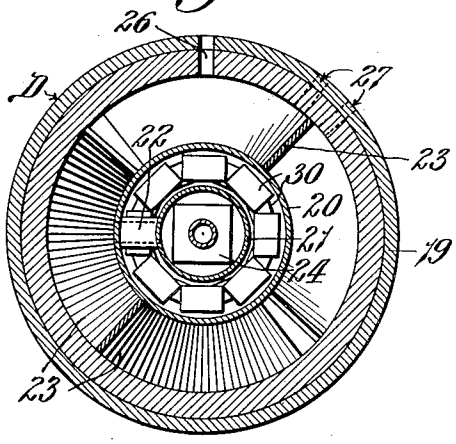


Fig. 11.

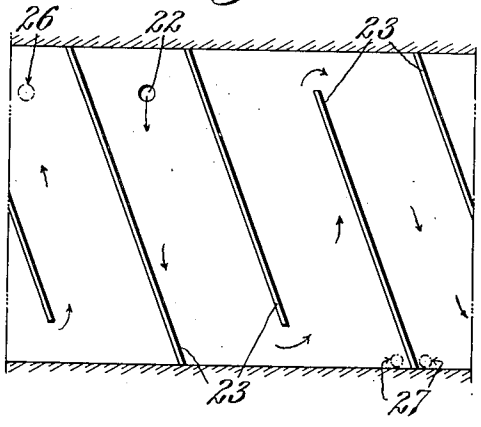
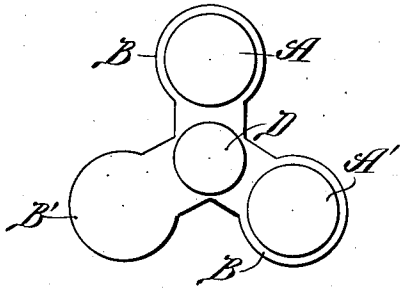


Fig. 12.



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UNITED STATES PATENT OFFICE.

CHARLES H. FULTON, OF ST. LOUIS, MISSOURI, ASSIGNOR, BY MESNE ASSIGNMENTS, TO METALLURGICAL LABORATORIES, INCORPORATED, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

ELECTRICAL DISTILLING APPARATUS.

1,242,337. Specification of Letters Patent. **Patented Oct. 9, 1917.**

Application filed December 7, 1916. Serial No. 135,631.

To all whom it may concern:

Be it known that I, CHARLES H. FULTON, a citizen of the United States, residing at St. Louis, Missouri, have invented a certain new and useful Improvement in Electrical Distilling Apparatus, of which the following is a full, clear, and exact description, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to an apparatus for electrically distilling ores and metal bearing materials.

In my pending application Serial No. 109,724, filed July 17, 1916, I have described a novel method of electrically distilling zinc ore for the recovery of spelter or oxid, which method, briefly described, consists in forming pulverized ore, a reducing agent and a suitable binder into ore briquets of the character described in my U. S. Patent No. 1,193,680, dated August 8, 1916, interposing the briquets as a continuous, fixed resistor between electrodes in a closed retort furnace and passing through them an electric current of such strength as will cause the briquets to be heated to a distilling temperature, and thereafter, recovering the zinc vapors of distillation in the form of spelter or zinc oxid.

One object of my present invention is to provide an efficient apparatus for practising the method described in my pending application above referred to.

Another object is to provide an apparatus for electrically distilling ore and other metal-bearing materials and recovering the metal content of same, which is so constructed that the charge and the residue can be handled more conveniently and at a lower labor cost than is possible with any distilling apparatus now in general use, thereby materially reducing the cost per ton of distilling ores and metal-bearing materials.

Another object is to provide an apparatus of the character referred to that can be operated practically continuously.

And still another object is to provide an electric furnace for distilling ores and metal-bearing materials which is so constructed that the heat losses are reduced to a minimum and the distillation can be accurately controlled. Other objects and desirable features of my invention will be hereinafter pointed out.

My complete apparatus consists of an electric furnace provided with a closed chamber or retort and constructed in such a manner that ore or metal-bearing material in the form of ore electrodes or briquets can be heated in said chamber to a distilling temperature by passing an electric current through said ore electrodes or briquets, and a condenser arranged in such a manner that the product of the distillation of the charge will pass from the closed chamber of the furnace into the condenser. Means is provided for accurately controlling or regulating the temperature of the condenser, and if desired, said means can also be utilized to heat the base of the furnace. The particular construction of the furnace and condenser is immaterial, so far as my broad idea is concerned, and the particular arrangement of the condenser with relation to the furnace is also immaterial, so long as said elements are arranged in close proximity to each other. In the apparatus herein shown, which is intended to be used for electrically distilling zinc ores or material containing zinc in the metallic form, the complete apparatus in its simplest form comprises a condenser, a pair of retort bases, on either of which the charge in the form of briquets or ore electrodes can be arranged and a hollow member that is adapted to be set on the base containing the charge, so as to form a retort or closed distilling chamber. While said charge is being distilled another charge is set up on the second retort base, and at the completion of the distilling operation said hollow member or retort is removed by a crane or other suitable device from the base on which it rests, and thereafter arranged in operative position on the second retort base on which the second charge has been set up. If it is desired to have the apparatus operate practically continuously, the complete apparatus will comprise a condenser, a plurality of retorts or hollow members and one more retort base than there are retorts, thus giving one base

on which the electrodes or briquets can be quenched at the completion of the distilling operation and a new charge set up while the other charges are being distilled in the retorts. The condenser also preferably comprises a base that is combined with the retort bases, and said various bases are provided with ducts or passageways through which a heating medium can be circulated, so as to heat the condenser and the retort bases, or a cooling medium can be supplied to the condenser, so as to maintain the condensing surfaces of the condenser at the proper temperature.

It is essential to the successful operation of my apparatus that the ore or metal-bearing material be in the form of briquets or ore electrodes having certain characteristics at the time the charge is introduced into the retort in which it is distilled, one of said characteristics being that the briquets or ore electrodes will not break down or disintegrate in the course of the distilling operation, and another characteristic being that said briquets or ore electrodes will preserve their form and volume and will not shrink away from the conductors or electrodes of the furnace, thus causing arcs, due to imperfect contact. In distilling zinc ore the briquets or ore electrodes are formed in the manner described in my patent previously referred to, for example, from hard coal tar pitch, or any other suitable binder in a finely ground condition, which is mixed with pulverized ore and coke until a uniform mixture of the three is obtained. The mixture is then heated to the melting point of the pitch, which melts and softens in place and thoroughly coats each particle of ore and coke. The mixture is then formed into ore electrodes or briquets of any desired shape, preferably cylindrical shape, in suitable molds in which they are subjected to a high pressure, preferably upward from 500 pounds to the square inch, to solidify the mixture and form it into as firm and compact a mass as possible. Instead of forming the ore electrodes or briquets in the manner above described, they can be formed by dry mixing ore and coke and then adding molten pitch and mixing prior to briqueting. Thereafter, the ore electrodes or briquets are preheated or dried, so as to drive off the volatile hydrocarbons of the binder, and thus produce a briquet or ore electrode that consists of a large number of ore particles embedded in a coke matrix, which briquet or electrode will maintain both its form and volume during the distilling operation and serve as a proper resistor-conductor of the electric current between the electrodes of the electric furnace in which the distilling operation is carried on.

Figure 1 of the drawings is a vertical sectional view of an apparatus constructed in accordance with my invention and provided with two retort bases and a single retort.

Fig. 2 is a horizontal sectional view, taken on the line 2—2 of Fig. 1.

Fig. 3 is a vertical cross-sectional view, taken on the line 3—3 of Fig. 2.

Fig. 4 is an enlarged vertical sectional view of the furnace consisting of the retort and the retort base.

Figs. 5, 6 and 7 are horizontal sectional views, taken on the lines 5—5, 6—6 and 7—7, respectively, of Fig. 4.

Fig. 8 is an enlarged perspective view of one section of the supporting structure that carries the conductors or electrodes on which the charge rests during the distilling operation.

Fig. 9 is an enlarged vertical sectional view of the con lenser.

Fig. 10 is a horizontal sectional view, taken on the line 10—10 of Fig. 9.

Fig. 11 is a development of the tubular member that forms the outer shell of the condenser, illustrating the arrangement of the baffles arranged on the inner side of said member; and

Fig. 12 is a top plan view of an apparatus constructed in accordance with my invention and provided with two retorts and three retort bases.

Referring to Fig. 1 of the drawings, which illustrates one form of my invention, A designates a retort or a vertically-disposed hollow member that is arranged on a base B, so as to form the distilling chamber C of an electric furnace, said retort A being removably mounted on the base B, so that it can be lifted therefrom by a crane or other suitable device (not shown) and arranged in operative position on a second retort base B′. A condenser D, which is provided with a base E, is arranged between the retort bases B and B′, said retort bases and condenser base being built up of refractory material and preferably combined as a single or integral structure, as shown in Fig. 1. Instead of providing the apparatus with two retort bases and a single retort, as shown in Fig. 1, the complete apparatus may comprise three retort bases arranged symmetrically around the condenser D and two retorts A and A′, as shown in Fig. 12, so as to enable the apparatus to be operated practically continuously, as hereinafter described, the particular number of retorts and retort bases being immaterial, so long as there is one more retort base than there are retorts.

The retort A can be constructed in various ways without departing from the spirit of my invention, but I prefer to construct it from a steel shell 1 heavily lined with refractory and non-conducting material 2, and having its lower end portion 1ª con-

tracted slightly, as shown in Fig. 4, so as to retain the material 2 in the shell when the retort is being transferred from one retort base to the other. The lower end of said retort is open, and at the upper end of the retort is a discharge opening 3 that is normally closed by a cover 4 formed of refractory material. The retort base B is provided with a perforated supporting structure F of the form shown in Fig. 7, on which conductors or electrodes 5 and 6 are mounted, said supporting structure F being preferably composed of a plurality of sections 7 of refractory material, so as to enable it to be molded from fire clay and handled conveniently when the furnace is constructed to receive ore electrodes or briquets of large size. The supporting structure F is so formed that numerous holes, spaces or passageways are provided through same and at the periphery of same through which the products of the distillation can escape from the distilling chamber C, and said supporting structure is in turn carried by a checkerwork formed from fire brick 8 that rest upon an inclined plate 9 which forms the top wall of an annular passageway 10 in the retort base B through which a heating medium can be caused to circulate, as hereinafter more fully described. If the furnace is designed for use with a three-phase alternating current connection of the Y type, the electrode or conductor 6 will consist of a three-arm neutral point electrode or conductor, and the conductors 5 will consist of substantially segmental-shaped electrodes that are arranged between the arms of the neutral point conductor 6, the conductors or electrodes 5 and 6 being formed from graphite, or an ore-coke-pitch mixture, substantially the same as in an ore briquet. The supporting structure F is provided with raised portions on which said conductors 5 and 6 rest, and each section 7 of said supporting structure is provided with an opening 7^a that extends clear through same, so as to permit the products of the distillation to escape freely from the distilling chamber. The graphite conductors x that supply electric current to the conductors 5 and 6 are led into the retort base B through openings therein, and each of said electrodes is connected at its inner end to a plug 11 of conducting material that is arranged in an opening 12 in the supporting structure F, the upper ends of said conducting plugs 11 contacting with the conductors 5 that rest upon the supporting structure F.

The ore or metal-bearing material to be distilled is first formed into briquets or ore electrodes W, as previously described, and said ore electrodes are then arranged in an upright position on the conductors 5 and 6 of the furnace, said briquets or ore electrodes being either in the form of comparatively short, cylindrical-shaped objects, a number of which can be superimposed one upon the other to form a vertical column, or each ore electrode can consist of a comparatively long object. In practice I prefer to form each ore electrode as a single unit of approximately twelve inches in diameter and six feet in height, weighing approximately 550 to 600 pounds, as ore electrodes of this character can be handled conveniently when setting up the charge and in removing the residue from the base of the furnace. In setting up a charge in a furnace of the design herein illustrated twelve ore electrodes W are arranged in six pairs on the conductors 5 and 6, the neutral point conductor 6 supporting six ore electrodes, and each of the conductors 5 supporting two ore electrodes. Thereafter, conductors 13 of the form shown in Fig. 5 are arranged in engagement with the upper ends of the ore electrodes W, so as to electrically connect the tops of two adjacent pairs of ore electrodes. After the ore electrodes W have been set up and connected together in the manner described, the retort A is arranged in operative position on the base B over said electrodes. When the current is turned on the current conveyed to the pair of ore electrodes W resting on the conductor 5 at the left hand side of Fig. 6 will pass upwardly through said ore electrodes to the conductor 13 at the upper ends of same which electrically connects said ore electrodes to the ore electrodes supported by the lower left hand arm of the conductor 6, thence downwardly through the ore electrodes resting on said arm to the neutral point at the center of the conductor 6. The passage of the current for the other pairs of ore electrodes is similarly all convergent on the neutral point of the conductor 6 which gives the common Y connection of the alternating three-phase current. It will, of course, be understood that it is immaterial, so far as my invention is concerned, how the electric current is supplied to the ore electrodes, so long as the electrical resistance of the ore electrodes is such as to cause a sufficient heat development within the charge itself to practically completely distil the zinc therefrom. By varying the amount of current sent through the ore electrodes W the speed of distillation may be kept under perfect control and the rate of distillation be varied at will. The current is preferably supplied to the furnace through a transformer so designed as to supply current at different voltages. If the current is too great or too small at any given voltage, the voltage of the transformer may be decreased or increased until the proper flow of current is obtained. In starting a new furnace the amount of current passed through the ore electrodes is prefer-

ably at first relatively small, so that the walls of the retort A will be heated rather gradually to about 700° C. or 800° C. by radiation from the ore electrodes. The current may then be rapidly increased and the ore electrodes raised to a distilling temperature. The products of the distillation consisting of practically equal volumes of zinc vapor and carbon monoxid gas pass downwardly through and around the supporting structure F into a duct 14 in the retort base B, thence through a heated passageway 15 in the base E of the condenser and from said heated passageway through a duct 16 into the condenser, as indicated by the arrows in Fig. 1, the ducts 14 and 16 being provided with suitable controlling valves 14^a and 16^a. The heated passageway 15 in the base of the condenser is provided with a clean-out opening 17 that is normally closed by a cover 17^a, and the bottom of said passageway slopes downwardly to a spelter take-off 18 that is normally closed by a cover 18, as shown in Fig. 3. In the condenser D the zinc vapor is condensed as liquid metal and the carbon monoxid escapes from a suitable vent or vents in the condenser and burns.

If the apparatus is provided with two retorts and three retort bases, as shown in Fig. 12, the distilling operation in one retort is started some time after the distilling operation in the other retort is commenced. In practice I prefer to start the distilling operation in one retort about four hours after distillation has started in the other retort. Shortly thereafter a charge is also placed on the third retort base and about eight hours after the first retort that was started has been in operation, the distillation of its charge will be finished. Said retort is then lifted by a crane or other suitable device from its base, and while white hot, is set down over the charge on the third retort base which now starts distillation. The ore charge on the base from which the retort was removed is quenched with a water spray and removed from said base and a new charge set up on said base. As soon as the charge in the second retort is distilled (about eight hours after it has started), said retort is lifted off its base and set over the charge that has been previously set up on the first base. It will thus be seen that in an apparatus of the form shown in Fig. 12 there are always two charges in process of distillation and practically a continuous flow of zinc vapor and carbon monoxid into the condenser is obtained.

The product of the distillation of the ore charge consists of about equal volumes of zinc vapor and carbon monoxid gas which leave the retort through the duct 14 in the retort base at a temperature ranging between 1000° C. to 1300° C., the zinc being in the form of vapor or gas. In order that this zinc gas may be condensed into liquid zinc metal or spelter it must be cooled to below the boiling point of zinc, which is 918° C. in the case of pure zinc vapor, or to about 870° C. when the gaseous mixture consists of equal volumes of zinc vapor and carbon monoxid gas. Said zinc gas must, however, not be cooled to below the melting point of zinc, which is 419° C., for otherwise, it will not condense to liquid metal, but, on the contrary, will be converted into a finely divided solid known as "blue powder." The cooling range, therefore, lies between 870° C. and 419° C., but for practical purposes, in order to obtain a molten metal from the condenser D, the cooling will be carried to only 550° C. or 600° C.

It follows, therefore, that the surfaces in the condenser upon which the metal is to be condensed as liquid spelter must always have the temperature within the limits mentioned. It is also best that the cooling of the gases from the temperature at which they enter the condenser down to 550° C. should be gradual, rather than rapid, and therefore, the condenser surfaces should present a range of temperature from about 870° C. to 550° C. Any condenser whose condensing surfaces are at about the temperature above mentioned will lose heat by radiation into the atmosphere, the amount of heat which is lost into the atmosphere depending upon the surface of the condenser exposed to the atmosphere and the heat conductivity of the material of which the condenser is built. Commonly speaking, the condensation of zinc vapor implies dissipation of heat. In round numbers the condensation of one pound of zinc vapor from a mixture of equal volumes of zinc vapor and carbon monoxid gas liberates 1,051 B. T. U. The amount of heat liberated in any given condenser is therefore a function of the amount of zinc condensed. Now, if the zinc condensed be relatively small and the radiation from the condenser be large, it is evident that in order to obtain the proper temperature within the condenser it is necessary to supply additional heat to the condenser. If, on the other hand, the amount of zinc condensed be relatively large, the heat liberated by its condensation may be so great that ordinary radiation may not be sufficient to maintain the surfaces in the interior of the condenser at the proper temperature, thus making it necessary to cool the condenser.

Another important consideration in the condensation of zinc vapor to liquid metal is the amount of surface that is necessary for the condensation of a given quantity of vapor. In the condensation of zinc vapor to liquid metal, as well as in the condensation of steam into water—so-called "nuclei of condensation"—are necessary. That is,

if there be provided in a space a large number of points or "nuclei" upon which the vapor has condensed into liquid, these small particles of liquid already formed facilitate the further condensation of the vapor. Some surface must be provided for this so-called "nuclei" to gather upon, and if a construction is obtained consisting of surfaces against which the mass of vapor is constantly swept, condensation is greatly facilitated.

In order that the condensing surfaces of the condenser may be maintained at a temperature ranging from 870° C. to 550° C., I have provided the apparatus with means for enabling the condenser to be either heated or cooled, and in order to facilitate the condensation of the vapor, I have constructed the condenser in such a manner that the zinc vapor will have a certain definite velocity of flow over surfaces upon which zinc "nuclei" have been formed. In the form of my invention herein shown the condenser D consists of a tubular-shaped member 19 closed at its upper end and arranged in an upright position on the condenser base E, a tubular-shaped member 20 arranged inside of the member 19 and spaced away from the side walls of same, so as to form a passageway, and a tubular-shaped member 21 arranged inside of the member 20 and spaced away therefrom, so as to form a passageway, as shown in Fig. 9, the members 19, 20 and 21 being preferably formed from refractory material and being of cylindrical shape in cross section. The member 21 is closed at its upper end, and the lower end of said member communicates with the duct 16 in the condenser base, so that the products of the distillation can circulate upwardly through the member 21 to a duct or passageway 22 that leads from the upper end of the member 21 to an annular passageway Y between the members 19 and 20 that contains baffles 23 which are so arranged that they will serve as condensing surfaces over which a mass of zinc vapor constantly sweeps, when the condenser is in operation. Means is arranged inside of the member 21, so as to retard the passage of the zinc vapor through said member, which means preferably consists of a plurality of horizontally-disposed baffles 24 of rectangular form that are arranged one above the other and spaced apart by short struts or uprights 25. The baffles 23 and the annular condensing passageway Y preferably consists of inclined vanes that extend spirally around the member 20 at an angle of approximately 90°, and said vanes are so arranged that the zinc vapor will follow a tortuous path after entering the condensing passageway Y. As shown in Fig. 11, two of the vanes 23 that extend downwardly from the upper end of the passageway Y terminate a short distance from the bottom of said passageway, and one of the two intermediate vanes 23 extends upwardly from the bottom of the passageway Y and terminates a short distance from the upper end of said passageway. The other of said intermediate vanes extends unbrokenly from the bottom to the top of said passageway, thus forming a partition which causes the zinc vapor to follow the path indicated by the arrows in Fig. 11. At the upper end of the condensing passageway Y are one or more ports 26, shown in dotted lines in Fig. 9, through which the carbon monoxid gas can escape, and at the lower end of said passageway are one or more ports 27 through which the spelter can be drawn out of the passageway.

The condensing surfaces of the condenser can be maintained at the proper temperature by supplying either a heating medium or a cooling medium to the annular flue or space between the two tubular-shaped members 20 and 21 of the condenser, the upper end of said flue communicating with the atmosphere through an opening 28 formed in the top of the condenser and the lower end of said flue communicating with a chamber 29 in the base E of the condenser to which heated air or cooled air is supplied. A checkerwork of fire brick 30 is preferably arranged in said annular flue, so as to absorb heat from the products of combustion or heated air that travels through said flue, and thus heat the condensing surfaces of the condenser that are arranged on opposite sides of said flue. One convenient way of supplying heat to the chamber 29 is to form two combustion chambers G in the base E of the condenser, as shown in Fig. 2, at points below the passageways 15 through which the products of the distillation pass in escaping from the retorts to the condenser, each of said combustion chambers consisting of a hollow space in the condenser base, provided in its end wall with a burner port 31 and equipped with baffles 32 arranged zig-zag, or in any other preferred manner. Ducts 33 lead from the combustion chambers G to the chamber 29 in the base of the condenser with which the lower end of the annular flue of the condenser communicates. The condenser base is also preferably provided with combustion chambers G′ that are connected by means of ducts 34 with the annular passageways 10 in the bases B and B′ of the retorts, so that the retort bases may be heated, thereby reducing the consumption of electrical energy when the retorts are in operation, and also facilitating the starting of the apparatus when it is first put into operation. As shown in Fig. 2 of the drawings, each of the retort bases is provided with a return duct 34ª that leads from the annular pas-

sageway 10 into the duct 33 in the condenser base that leads to the chamber 29. The combustion chambers G in the base and the ducts that lead from said chambers to the annular flue of the condenser form a convenient means for heating the condenser, and when it is desired to cool the condenser, the combustion chambers can be connected up with a fan or other suitable device by which cool air can be forced into the annular flue of the condenser.

With an apparatus of the construction above described, the necessary heat energy to distil the charge is developed within the charge itself, thus cutting down heat losses to a minimum; the amount of energy that can be put into the charge can be varied at will by changing the voltage of the electric current by means of a transformer, thus enabling the distillation to be perfectly controlled; and still another desirable feature of such an apparatus is, that the energy put into the charge can be so adjusted that the distillation period may be reduced to eight hours, or less, as against the twenty-four hours now customary in the ordinary distillation furnace. The fact that the charge is introduced into the furnace in the form of comparatively large briquets or solid electrodes which retain their original form throughout the distilling operation and after said operation has been completed, materially reduces the labor cost of operating the apparatus; enables a practically complete distillation of the zinc to take place and insures the recovery of a greater percentage of zinc than is possible with zinc distilling apparatus of the type now in general use. The apparatus can be built in large sizes; it can be operated practically continuously and it is so constructed that the temperature of the condenser can be accurately controlled.

Having thus described my invention, what I claim, and desire to secure by Letters Patent, is:

1. An apparatus for distilling ores and metal bearing materials, comprising a retort or chamber constructed to receive a charge consisting of fine ore or metal-bearing material and a suitable reducing agent formed into a compact mass that will retain its substantially original form and volume when subjected to a distillation temperature, means for causing an electric current to pass directly through said mass so as to heat same to a distillation temperature, and means for thereafter condensing the products of the distillation.

2. An electric distilling furnace, comprising a distilling chamber, and an electrically-operated heating means in said chamber consisting of a molded structure of substantially cellular formation whose cells contain metal that is to be distilled.

3. An apparatus for distilling ores and metal-bearing materials, comprising an electric furnace composed of a retort and electric conductors between which electrodes containing the substance to be distilled are adapted to be arranged so as to form a continuous resistor, means for causing an electric current to pass through said electrodes so as to heat same to a distillation temperature, and means for condensing the products of the distillation.

4. An apparatus for distilling ores and metal-bearing materials, comprising an electric furnace composed of a retort and electric conductors between which electrodes containing the substance to be distilled are adapted to be arranged so as to form a continuous resistor, said furnace being so constructed that said electrodes can be positioned on the conductors that supply current to same and thereafter arranged in operative position in the retort, a condenser, and means whereby the products of the distillation can pass from said retort into said condenser.

5. An apparatus for distilling ores and metal-bearing materials, comprising an electric distilling furnace, a condenser combined with said furnace in such a manner that the products of the distillation can be admitted from the furnace to said condenser, and means whereby a heating medium can be supplied to the condenser to control the temperature of same and also to said furnace to preliminarily heat the furnace prior to the distilling operation or to diminish the electrical energy required in the distilling operation.

6. An apparatus for distilling ores and metal-bearing materials, comprising an electric furnace, a condenser, a passageway through which the products of the distillation travel from the furnace to said condenser, an air heating means, and ducts leading from said air heating means to said condenser and furnace to heat same.

7. An apparatus for distilling ores and metal-bearing materials, comprising a base or supporting structure, an electric furnace, and a condenser carried by said structure, means for admitting the products of the distillation from said furnace to said condenser, and ducts or passageways in said supporting structure through which a medium can be supplied to modify the temperature of said furnace and condenser.

8. An apparatus for distilling ores and metal-bearing materials, comprising a base or supporting structure, an electric furnace and a condenser carried by said structure, means for admitting the products of the distillation from said furnace to said condenser, a combustion chamber in said supporting structure, and ducts or passageways leading from said combustion chamber to said furnace and condenser.

9. An apparatus for distilling ores and metal-bearing materials, comprising a base or supporting structure, an electric furnace comprising a retort that is removably mounted on said supporting structure, a condenser on said supporting structure, and a passageway through which the products of the distillation can pass from said retort to said condenser.

10. An apparatus for distilling ores and metal-bearing materials, comprising a condenser, a plurality of retort bases, a retort constructed in such a manner that it can be removably mounted on either of said retort bases, means whereby a charge supported by either of said bases can be electrically distilled when said retort is in operative position over said charge, and means whereby the products of the distillation can pass from the retort into said condenser.

11. An apparatus for distilling ores and metal-bearing materials, comprising a plurality of electric furnaces, each of which comprises a base and a retort removably mounted on said base, a separate retort base on which one of said retorts can be arranged, a condenser, and passageways leading from said various retort bases to said condenser for supplying the products of the distillation to the condenser.

12. An apparatus for distilling ores and metal-bearing materials, comprising a plurality of retort bases and a condenser base combined as a single structure, a condenser on said condenser base, a retort constructed in such a manner that it can be arranged in operative position on either of said retort bases, combustion chambers in said structure, and ducts or passageways leading from said combustion chambers to said bases.

13. An electric distilling furnace, comprising a distilling chamber, and an electrode in said chamber that forms part of the electric circuit used to operate the furnace, said electrode consisting of a molded member or a plurality of members that contain metal to be distilled and arranged in such a manner that ample space is provided between the exterior of the conductor and the walls of the distilling chamber to permit the free escape of the vapors evolved in the distilling operation.

14. An apparatus for distilling ores and metal-bearing materials, comprising an electric distilling furnace and a condenser connected by a relatively short passageway through which the products of the distillation pass from the furnace into the condenser, and means for heating said passageway, said passageway having a discharge opening through which any liquid metal that collects in said passageway can be removed.

15. An apparatus for distilling ores and metal-bearing materials, comprising a plurality of retort bases and a condenser base combined as a single unit, means on each of said retort bases for supporting a charge of ore or metal-bearing material, a retort constructed in such a manner that it can be arranged on either of said retort bases over a charge thereon, means for electrically distilling the charge inclosed by the retort, a condenser on the condenser base provided with a vertical flue for heating the condensing surfaces of the condenser, means whereby either a heating medium or a cooling medium can be supplied to the flue of the condenser, and passageways leading from said retort bases to the condenser for supplying the products of the distillation to the condenser.

16. An electric distilling furnace, comprising a retort or distilling chamber, electric conductors, and a continuous resistor arranged in engagement with said conductors and consisting of fine ore or metal-bearing material and a suitable reducing agent formed into a compact mass that will retain substantially its original form and volume when subjected to distillation temperatures.

17. An electric distilling furnace, comprising a retort or distilling chamber, spaced electrodes arranged adjacent the opposite ends of said chamber, and a continuous resistor interposed between said electrodes and composed of a plurality of electrodes containing the substance to be distilled and constructed in such a manner that they will retain substantially their original form and volume when subjected to distillation temperatures.

18. An electric distilling furnace, comprising a retort or distilling chamber, a plurality of electric conductors arranged adjacent the lower end of said chamber and adapted to support a plurality of vertically-disposed electrodes that contain the substance to be distilled and which constitute a continuous resistor, and means for electrically connecting the upper ends of said electrodes together.

19. An electric distilling furnace, comprising a retort, means for supporting in said retort and electrically connecting together a plurality of electrodes that constitute a continuous resistor, and means whereby the products of the distillation can escape from said retort.

20. An electric distilling furnace, comprising a retort, electrodes for supporting the charge that is to be distilled, and a supporting means for said electrodes constructed in such a manner that the products of the distillation can escape freely from the lower end of the retort.

21. An electric distilling furnace, comprising a retort constructed to receive a charge consisting of a plurality of electrodes arranged in an upright position in

said retort and containing the substance to be distilled, electric conductors on which said electrodes rest, and a perforated supporting structure at the lower end of said retort for supporting said electric conductors.

22. An electric distilling furnace, comprising a chamber provided with an open lower end, and an electric conducting means arranged adjacent the lower end of said chamber for supporting the charge to be distilled, said chamber and said means being so arranged that one can be moved with relation to the other so as to permit the charge to be set up or removed.

23. An electric distilling furnace, comprising a base or supporting structure, means on said structure for supporting the charge to be distilled, and a retort or chamber having an open lower end that is adapted to be arranged on said structure over the charge.

24. An electric distilling furnace, comprising a base or supporting structure, electric conductors on said structure on which the charge, consisting of electrodes containing the substance to be distilled, can be arranged in an upright position, and a hollow member or chamber constructed in such a manner that it can be mounted on said structure over the charge prior to the distilling operation and removed therefrom at the completion of the distilling operation.

25. An electric distilling furnace, comprising a base or supporting structure, a removable retort mounted on said structure, means carried by said structure for supplying electric current to a charge in said retort, and a duct or passageway in said structure through which the products of the distillation can escape from said retort.

26. An electric distilling furnace, comprising a base or supporting structure, and a removable retort on said structure composed of a metal shell provided with a lining of refractory and non-conducting material, the lower end portion of said shell being contracted so as to hold said lining in the shell when the retort is removed from said supporting structure.

27. An electric distilling furnace, comprising a base, a retort removably mounted on said base, and a perforated supporting structure carried by said base for sustaining electric conductors on which the charge rests during the distilling operation.

28. An electric distilling furnace, comprising a base, a passageway in said base through which a heating medium can circulate, and a retort removably mounted on said base and provided with an open lower end.

29. An electric distilling furnace, comprising a base, a hollow member open at its lower end and so constructed that it can be mounted on said base in an upright position so as to form a retort, a supporting structure on said base for sustaining electric conductors on which the charge rests during the distilling operation, electrical supply conductors in said base, and plugs in said supporting structure that electrically connect said supply conductors with the conductors on which the charge rests.

30. An electric distilling furnace, comprising a base provided with a chamber to which a heating medium can be supplied, an inclined member on said base that forms the top of said chamber, a perforated supporting structure arranged above said inclined member, electric conductors on said supporting structure that sustain the charge being distilled, and a retort constructed in such a manner that it can be arranged on said base over the charge prior to the distilling operation.

31. An electric distilling furnace, comprising a retort or closed chamber, a continuous resistor in said chamber consisting of fine ore or metal-bearing material formed into a compact mass that will retain substantially its original form and volume when subjected to a distilling temperature, and means for causing a current of electricity to pass through said resistor.

32. An electric distilling furnace, comprising spaced conductors, a continuous resistor interposed between said conductors and consisting of fine ore or metal-bearing material formed into a compact mass that will retain substantially its original form and volume when subjected to a distilling temperature, and a retort or chamber for inclosing said resistor.

33. An electric distilling furnace, comprising a distilling chamber, electrical conductors that form part of the circuit used to operate the furnace, and a molded structure in said chamber that establishes electrical connection between said conductors and which is adapted to be heated to a distilling temperature by the electric current which flows through the circuit, said molded structure having combined therewith the substance to be distilled.

34. An electric distilling furnace whose heating means consists of a resistor arranged in the electric circuit used to operate the furnace and having combined therewith metal that is to be distilled, said resistor being so constructed that it will retain its substantially original form and volume after the metal has been distilled therefrom.

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