No. 706,128. Patented Aug. 5, 1902.

E. R. TAYLOR.

ELECTRIC FURNACE.

(Application filed Apr. 4, 1901. Renewed Jan. 2, 1902.)

(No Model.) 2 Sheets—Sheet 1.

Fig. 1.

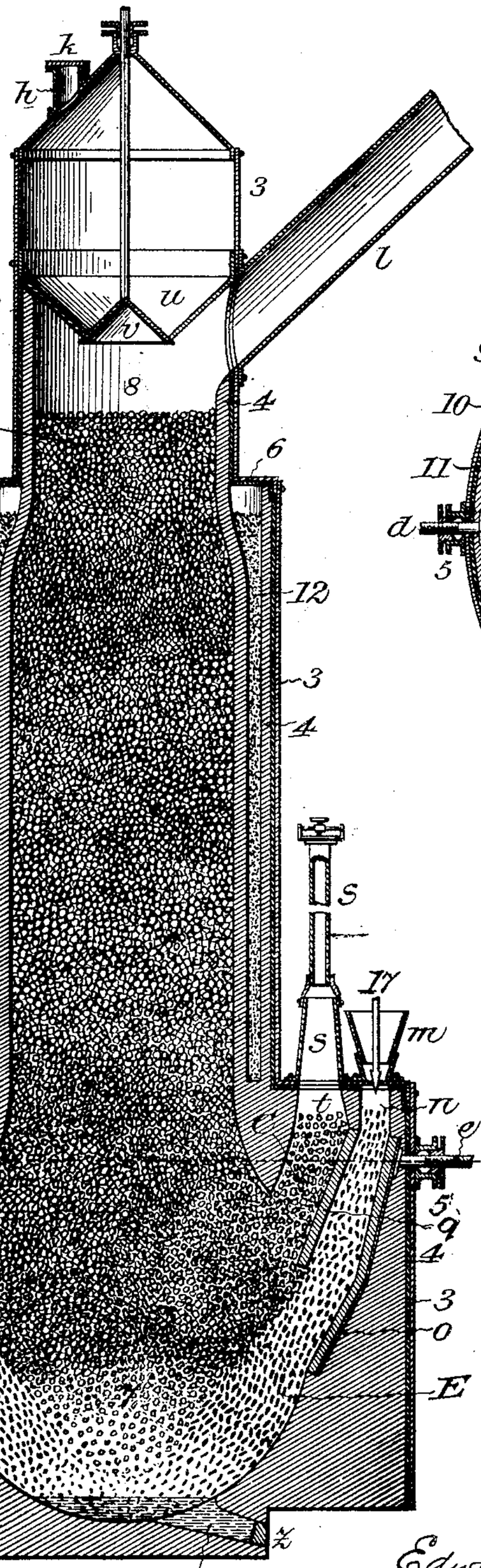


Fig. 3.

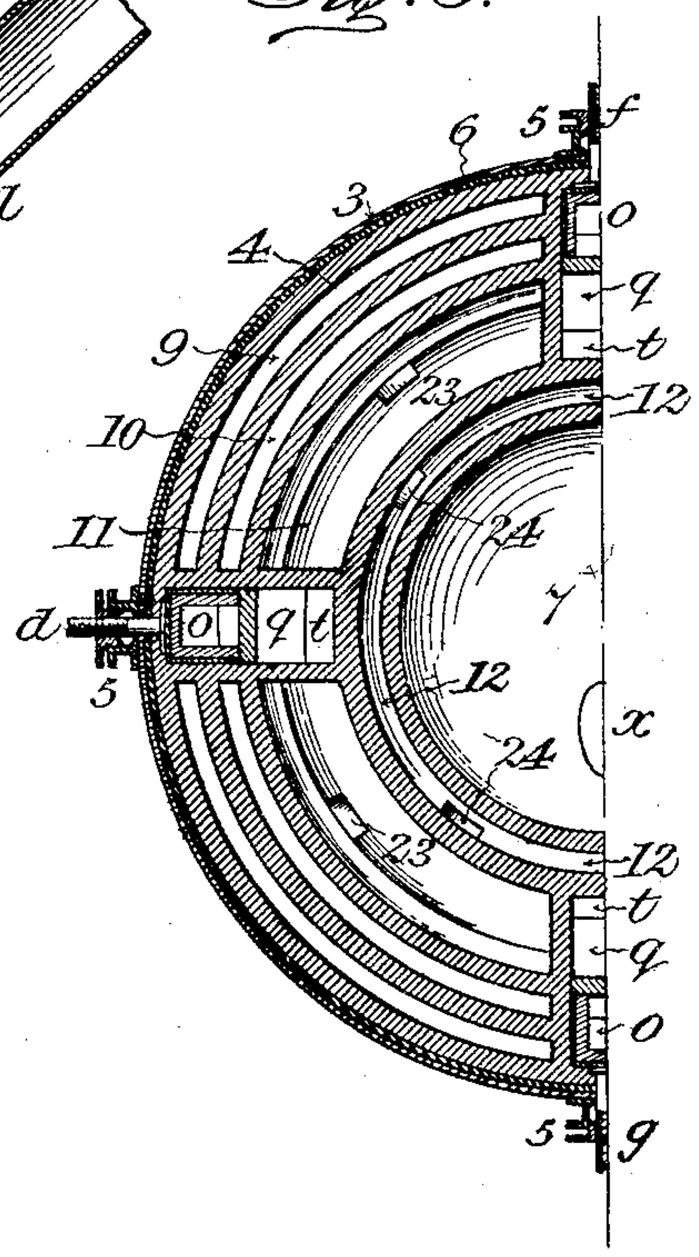
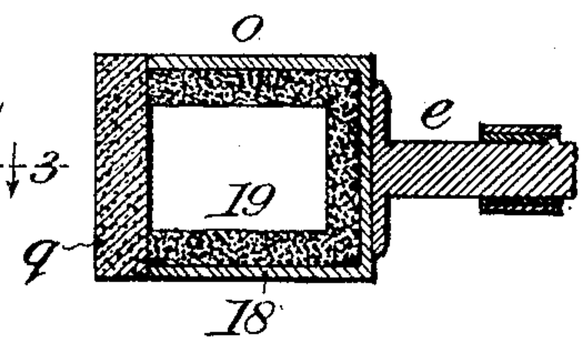


Fig. 5.



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(No Model.) 2 Sheets—Sheet 2.

Fig. 2.

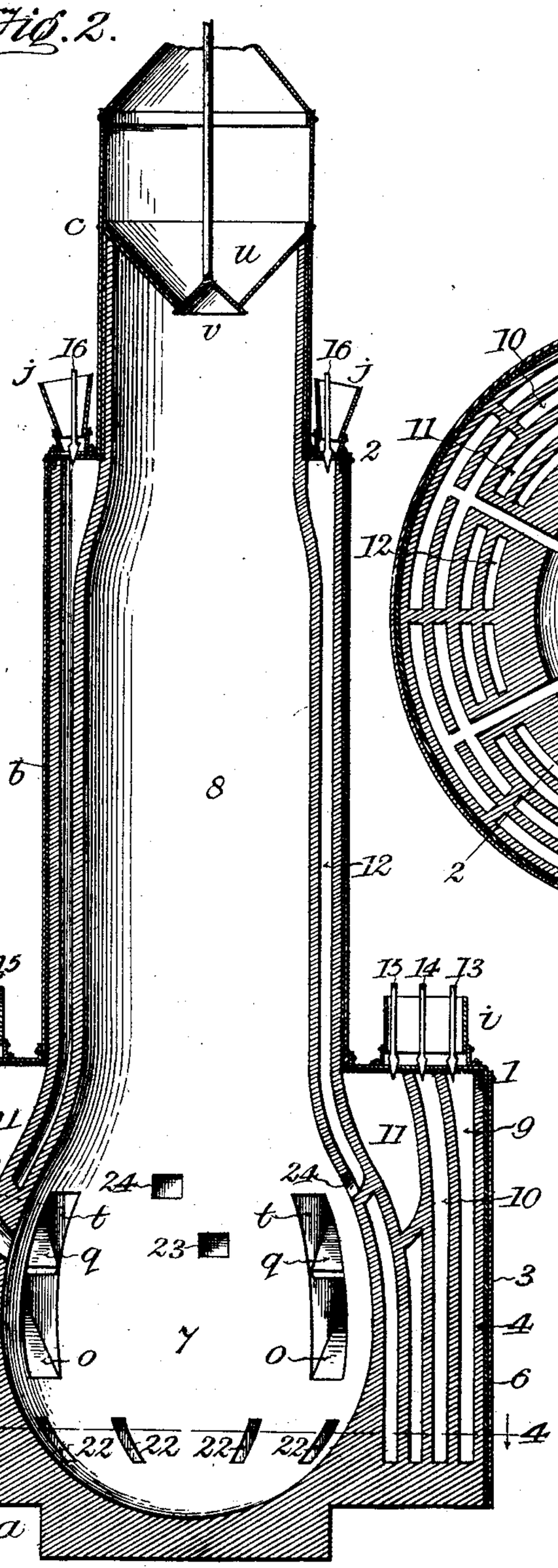


Fig. 4.

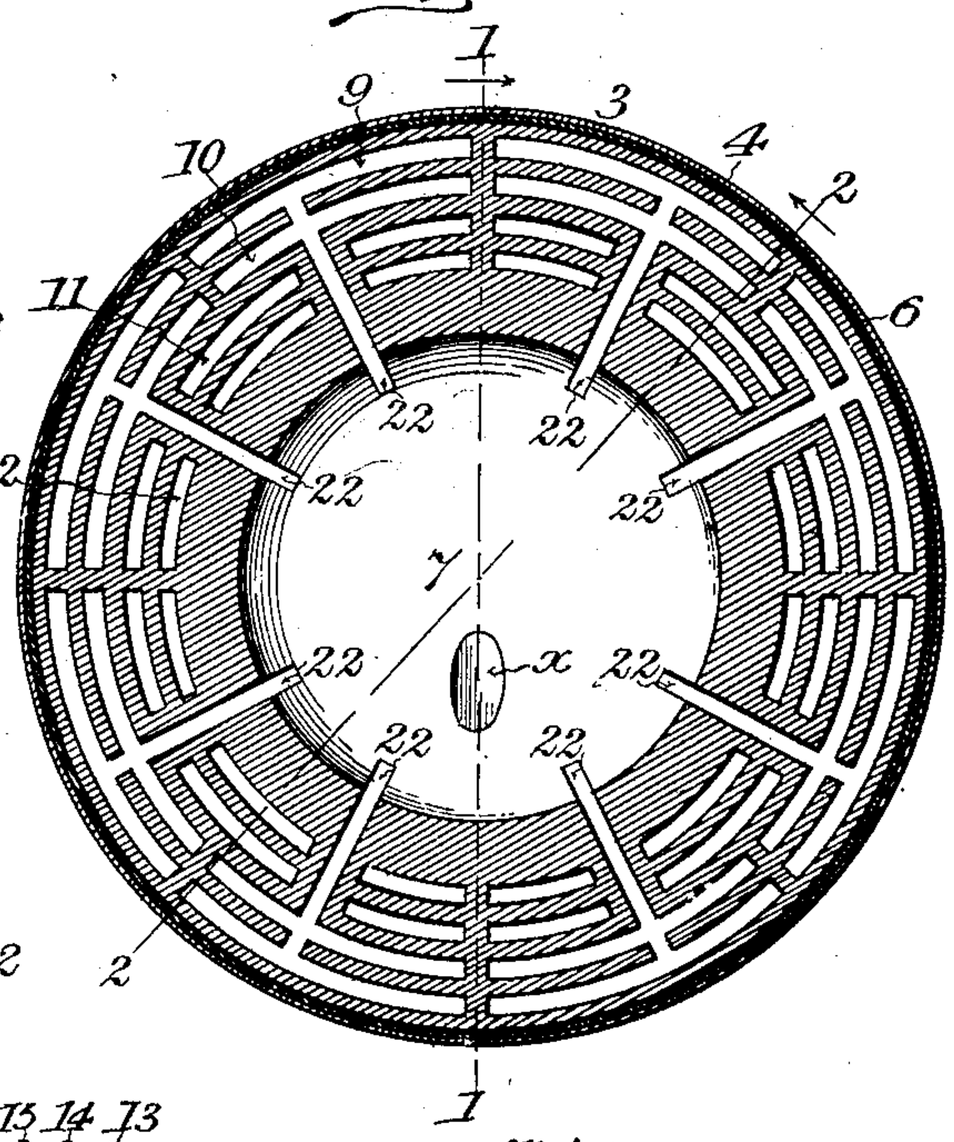
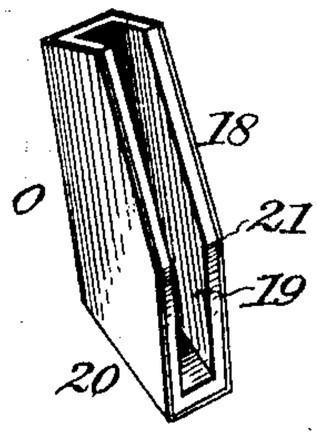


Fig. 6.



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UNITED STATES PATENT OFFICE.

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ELECTRIC FURNACE.

SPECIFICATION forming part of Letters Patent No. 706,128, dated August 5, 1902.

Application filed April 4, 1901. Renewed January 2, 1902. Serial No. 88,042. (No model.)

To all whom it may concern:

Be it known that I, EDWARD R. TAYLOR, a citizen of the United States of America, and a resident of Penn Yan, in the State of New York, have invented a new and useful Improvement in Electric Furnaces, of which the following is a specification.

This invention relates, primarily, to the production of bisulfid of carbon by a continuous process; but the improved electric furnace and novel features thereof may be used for effecting other reactions and reductions.

The present invention consists in certain novel features of construction and combinations of parts hereinafter set forth and claimed.

A leading object of this invention is to provide an electric furnace with self-renewing electrodes adapted to perpetuate themselves in the continuously-working furnace and to feed themselves by gravity.

Another leading object is to fuse within the furnace and to discharge in fused condition the residue from the carbon and sulfur in the process of making bisulfid of carbon and like difficultly-fusible materials that are liable to accumulate in the bottom of the working chamber of an electric furnace.

Other objects of the invention are to provide an adequate electric contact between the fragmentary conductive material which constitutes the aforesaid self-renewing electrodes of the working furnace and the conductors by which the same are connected with a suitable generator of electricity; to construct conductive conduits for that purpose presenting so large a surface for the contact of the fragmentary conductive material that it makes a practically free passage for the electricity from the conduits to the fragments without the conversion of an important portion of the current into heat at this point; to protect metallic main portions of such conduits against wear; to prevent or resist the passage of electricity from said conduits directly from side to side of the working chamber by protective walls; to cool such protective walls or to supplement the same by the introduction of conductive or non-conductive material in contact therewith; to facilitate the control of the operation of the furnace by introducing conductive or non-conductive materials at will without interrupting the continuity of such operation; to continuously supply the working chamber of an electric furnace with fusible material in such a manner as to heat the same by heat that would otherwise be lost by radiation and to cool and preserve the inner walls therewith by causing it to flow downward to the heat zone in contact with such walls; to so fuse and utilize the sulfur for the bisulfid reaction, and to introduce such fused or fusible material in the plane of the heat zone and at the same time at one or more levels above the same.

Two sheets of drawings accompany this specification as part thereof.

Figure 1 is a vertical section of the improved furnace, showing the same charged and in operation; and Fig. 2 is a vertical section through the improved furnace empty in a plane at an angle of forty-five degrees to that of the plane of Fig. 1. Fig. 3 represents a horizontal section through one side of the empty furnace on the broken line 3, Fig. 1. Fig. 4 represents a horizontal section through the empty furnace on the broken line 4, Fig. 2, indicating the planes of Figs. 1 and 2, respectively, by the broken lines correspondingly numbered. Fig. 5 represents a section through one of the electrode-conduits on a larger scale, and Fig. 6 is a perspective view of one of the electrode-conduits detached.

Like letters and numbers refer to like parts in all the figures.

The improved furnace has some preferred features of construction and mode of operation that are common to it and to the electric furnace set forth in my previous specification, forming part of an application for United States Patent filed the 21st day of December 1899, Serial No. 741,195. (See also application for patent for process filed the 6th day of October, 1900, Serial No. 32,283.) Such common features of construction comprise a preferred upright or stack form, with three diameters at successive heights, as shown in Figs. 1 and 2; a round (or equivalent) shape in cross-section, as represented by Figs. 3 and 4, with horizontal shoulders 1 and 2 connecting the base *a*, body *b*, and dome *c;* an iron shell 3 common to all; a chambered refractory lining 4, of fire-brick or its equivalent, extending upward to a sufficient

extent above the top of said body *b;* stuffing-boxes 5 in diametrically opposite pairs on the shell 3, through which insulated conductors *d*, *e*, *f*, and *g* extend into the furnace from a suitable generator of electricity; suitable insulation 6 between the shell 3 and lining 4 throughout; a central working chamber 7 within the base *a;* a commodious feeding-chamber 8, extending downwardly to the working chamber and in free communication therewith; an inlet *h* to said feeding-chamber through the dome *c;* passages or spaces 9, 10, 11, and 12, concentric with said feeding and working chambers and with each other, within the fire-brick lining of the walls; hoppers *i* and *j*, Fig. 2, upon said shoulders 1 and 2, respectively provided with plugs 13, 14, 15, and 16, which respectively open and close the inlets into said spaces 9, 10, 11, and 12 for the admission of fusible material for a given reaction or reduction; a cap *k*, Fig. 1, to open and close the inlet *h* into the dome *c* for an infusible or less fusible material for the reaction or reduction, and an outlet *l* leading from said dome for the discharge of gaseous material.

The shoulder 1 of the present furnace is further provided with hoppers *m*, Fig. 1, above the several stuffing-boxes 5, provided with plugs 17 for the admission of fragmentary conductive material adapted to constitute self-renewing electrodes in the working furnace, as represented at D and E, Fig. 1, and passages *n* extend downwardly from such inlets within the brickwork of the base *a*.

Conduits *o*, (shown in detail by Figs. 5 and 6,) constructed of conductive material, are arranged in continuation of the passages *n* within the brickwork of the base *a*, and electrically attached, as in Fig. 5, to the several conductors *d*, *e*, *f*, and *g*. Each of these conduits is preferably composed of a trough-shaped casting 18, Fig. 5, of suitable metal, forming back and side walls, and a lining 19, Fig. 5, of carbon brick, and is further constructed with the lower part 20, Fig. 6, of its back wall and the lining thereof at an angle to retard the descent of the fragmentary conductive material through the conduit and to direct the same inwardly toward the middle of the working chamber, the several conduits being arranged at the sides of the furnace, as shown in Figs. 1 and 3, and preferably with the upper portions of their back walls slightly inclined inward, as in Fig. 1.

To prevent or resist the passage of the electric current directly from side to side of the furnace or to aid in thus confining the current to the electrodes at this point protective walls *q*, Figs. 1, 2, and 3, and Fig. 5, of non-conductive material, such as fire-brick, are interposed between the several conduits *o* and the middle of the furnace and are preferably and conveniently directly superposed, so as to bridge the open side of each conduit, as in Fig. 5, from its upper end, where the electric conductor is attached to its back to the upper limit of its outlet, where the face of the conduit recedes, as shown at 21 in Fig. 6, to conform it to the spheroidal shape of the working chamber. (Compare Fig. 1.) Feeding themselves by gravity the electrodes D E descend into the bottom of the working chamber from the outlets of the conduits *o* and flow toward each other, as represented in Fig. 1, being naturally thinnest where they come together, and thus affording the necessary resistance at this point to convert the electricity into heat. The heat zone of the furnace is thus located at the bottom.

To provide for further protection to the conduits *o* and for the regulation or control of the operation of the furnace without interfering with the continuity of such operation, feed-pipes *s*, Fig. 1, are mounted on the shoulder 1 of the furnace between the hoppers *m* and the body *b*, and passages *t* are formed in the shoulder portion of the iron shell and in the brickwork of the base *a*, leading from said pipes *s* into the working chamber, as shown in Figs. 1 and 2. Either conductive or non-conductive material of any suitable kind that will feed through the pipes *s* or their equivalent may be supplied thereto and fed by gravity through the passages *t* into the working chamber immediately in front of each or any of the electrodes at will. Such supplemental material is represented in Fig. 1 at C.

A and B, Fig. 1, represent, respectively, the carbon, such as charcoal or coke, and the crushed sulfur for the bisulfid-of-carbon reaction. The introduction of the carbon into the working furnace is conveniently facilitated by a hopper and bell *u v* within the dome *c* above the gas-outlet *l*. The crushed sulfur introduced into the spaces 9, 10, 11, and 12 is fused therein by heat of the furnace that would otherwise be lost by radiation, such spaces surrounding the working chamber 7, as in Figs. 3 and 4, and descends by gravity toward the heat zone, where it is vaporized simultaneously with the heating of the carbon, and the reaction is thus continuously effected.

Instead of discharging uniformly beneath the heat zone, as in my other furnace, the spaces 9 and 10 in the present arrangement discharge into the working chamber in the plane of the heat zone through passages 22, Figs. 2 and 4, and the spaces 11 and 12 discharge above the heat zone at different heights through outlets 23 and 24, Fig. 2, arranged in different vertical planes, so that the fused sulfur may run down the inner walls of the furnace toward the heat zone in separate streams, and thus distribute its cooling and preserving effect.

Owing to the location of the heat zone in the bottom of the working chamber, the residue from the carbon and sulfur that would otherwise accumulate there as an ash is fused by a sufficient current therethrough, and other like difficultly-fusible matter may be fused

in like manner. A tap-hole *x*, Figs. 1, 3, and 4, normally closed by a stopper *z*, provides for periodically discharging such fused residue or product.

The tap-hole *x* may preferably be arranged in a different plane instead of beneath one of the electric conductors, where it is shown for convenience of illustration, the furnace may be square or of other shape in cross-section, the spaces 9, 10, 11, and 12 may be increased or reduced in number, there may be but one pair of electrodes or more than two pairs, and other like modifications will suggest themselves to those skilled in the art.

Having thus described said improvement, I claim as my invention and desire to patent under this specification—

1. An electric furnace having, in combination, a working chamber, means for continuously supplying the same with material for a given reaction or reduction, conduits constructed of conductive material and arranged to discharge into the working chamber by gravity, means for feeding into and through said conduits fragmentary conductive material adapted to constitute self-renewing electrodes in the working furnace, and means for connecting said conduits with a suitable generator of electricity.

2. In an electric furnace, the combination of a working chamber, means for continuously supplying the same with material for a given reaction or reduction, conduits constructed of conductive material and arranged to discharge into the working chamber by gravity, means for feeding into and through said conduits fragmentary conductive material adapted to constitute self-renewing electrodes in the working furnace, means for connecting said conduits to a suitable generator of electricity, passages opening into the working chamber in front of said conduits and above their outlets, and means for feeding either conductive or non-conductive material through said passages at will.

3. In an electric furnace, the combination of a working chamber, means for continuously supplying the same with material for a given reaction or reduction, conduits constructed of conductive material and arranged to discharge into the working chamber by gravity, means for feeding into and through said conduits fragmentary conductive material adapted to constitute self-renewing electrodes in the working furnace, means for connecting said conduits with a suitable generator of electricity, a dome provided with means for the removal of gaseous material from the working chamber, and a suitable tap-hole at the bottom of the working chamber for the removal of fused material.

4. In an electric furnace, the combination of a working chamber, an inlet into the working chamber for material for a given reaction or reduction, inlets for fragmentary conductive material adapted to constitute self-renewing electrodes in the working furnace, conduits constructed of conductive material and arranged to receive said fragmentary conductive material and to discharge the same into the working chamber by gravity, and means for connecting said conduits with a suitable generator of electricity.

5. In an electric furnace, the combination of a working chamber, an inlet into the working chamber for material for a given reaction or reduction, inlets for fragmentary conductive material adapted to constitute self-renewing electrodes in the working furnace, conduits constructed of metal lined with carbon brick and arranged to receive said fragmentary conductive material and to discharge the same into the working chamber by gravity, and means for connecting said conduits with a suitable generator of electricity.

6. In an electric furnace, the combination of a working chamber, an inlet into the working chamber for material for a given reaction or reduction, inlets for fragmentary conductive material adapted to constitute self-renewing electrodes in the working furnace, conduits, in communication with the inlets last named, arranged for the descent of said fragmentary conductive material therethrough by gravity, and constructed with conductive back walls having inclined lower portions to retard and direct the flow of said fragmentary conductive material, and means for connecting said conduits with a suitable generator of electricity.

7. In an electric furnace, the combination of a working chamber, an inlet into the working chamber for material for a given reaction or reduction, inlets for fragmentary conductive material adapted to constitute self-renewing electrodes in the working furnace, downwardly-extending passages, in communication with the inlets last named, and conduits constructed of conductive material leading from said passages, adapted to contain together a supply of such fragmentary conductive material, and arranged to discharge the same into the working chamber by gravity, and means for connecting said conduits with a suitable generator of electricity.

8. In an electric furnace, the combination of a working chamber, an inlet into the working chamber for material for a given reaction or reduction, inlets for fragmentary conductive material adapted to constitute self-renewing electrodes in the working furnace, conduits constructed of conductive material and arranged at the sides of the furnace for the passage therethrough of said fragmentary conductive material into the working chamber by gravity, means for connecting said conduits with a suitable generator of electricity, and protective walls of non-conductive material between said conduits respectively and the middle of the furnace.

9. In an electric furnace, the combination of a working chamber, an inlet into the working chamber for material for a given reaction or reduction, inlets for fragmentary conductive

material adapted to constitute self-renewing electrodes in the working furnace, conduits, in communication at their respective ends with the inlets last named and with the working chamber, each having back and side walls of metal provided with a refractory conductive lining and arranged at the sides of the furnace, means for connecting the metallic walls of the conduits with a suitable generator of electricity, and protective walls of non-conductive material interposed between the open fronts of the conduits respectively and the middle of the furnace.

10. In an electric furnace, the combination of a working chamber, an inlet into the working chamber for material for a given reaction or reduction, inlets for fragmentary conductive material adapted to constitute self-renewing electrodes in the working furnace, trough-shaped conduits, constructed of conductive material, in communication with the inlets last named and with the working chamber at their respective ends, and arranged at the sides of the furnace with their open sides toward its middle, means for connecting said conduits with a suitable generator of electricity, and protective walls of non-conductive material bridging said open sides of the respective conduits.

11. In an electric furnace, the combination of a working chamber, an inlet into the working chamber for material for a given reaction or reduction, inlets for fragmentary conductive material adapted to constitute self-renewing electrodes in the working furnace, conduits, constructed of conductive material, arranged at the sides of the furnace and adapted for the passage therethrough into the working chamber of said fragmentary conductive material, means for connecting said conduits with a suitable generator of electricity, and inlets, adjacent to said conduits, adapted for the admission of material between said conduits respectively and the middle of the furnace.

12. In an electric furnace, the combination of a working chamber adapted for the location of a heat zone within its lower portion, an inlet into the working chamber for material for a given reaction or reduction, inlets for fragmentary conductive material adapted to constitute self-renewing electrodes in the working furnace, conduits, constructed of conductive material, extending indirectly downward toward the bottom of the furnace, and adapted for the descent of the fragmentary conductive material therethrough into the lower portion of the working chamber by gravity, and means for connecting said conduits with a suitable generator of electricity.

13. In an electric furnace, the combination of a working chamber adapted for the location of its heat zone at bottom, inlets for fusible material for a given reaction or reduction near the bottom of the working chamber, higher inlets for fragmentary conductive material adapted to constitute self-renewing electrodes in the working furnace, conduits for such electrodes discharging downwardly toward the bottom of the furnace and having conductive walls, and means for connecting said conduits with a suitable generator of electricity.

14. In an electric furnace, the combination of a working chamber adapted for the location of its heat zone at bottom, an inlet for material for a given reaction or reduction, inlets for fragmentary conductive material adapted to constitute self-renewing electrodes in the working furnace, conduits for such electrodes constructed of conductive material and arranged to direct the electrodes downwardly into the bottom of the working chamber and toward each other, means for connecting said conduits with a suitable generator of electricity, and an outlet at the bottom of the working chamber for a liquid product of the furnace.

15. In an electric furnace for making chemicals, the combination of a working chamber adapted for the location of its heat zone at bottom, spaces surrounding said working chamber and communicating therewith through passages in its inner walls at a considerable height above its bottom, means for feeding fusible material into said spaces on its way to the working chamber, and means for passing a suitable electric current through the charge.

16. In an electric furnace for making chemicals, the combination of a working chamber adapted for the location of its heat zone at bottom, spaces surrounding said working chamber and communicating therewith through passages in its inner walls near its bottom and at a considerable height above the same, respectively, means for feeding fusible material into said spaces on its way to the working chamber, and means for passing a suitable electric current through the charge.

17. In an electric furnace for making bisulfid of carbon, the combination of a working chamber adapted for the location of its heat zone at bottom, spaces surrounding the upper portion of the working chamber within its walls and communicating with the working chamber through passages in its inner walls at a considerable height above its bottom, means for feeding crushed sulfur into said spaces, and means for passing a suitable electric current through the charge.

18. In an electric furnace for making bisulfid of carbon, the combination of a working chamber adapted for the location of its heat zone at bottom, spaces surrounding the working chamber within its walls and having their bottoms at different heights, passages connecting the respective spaces with said working chamber in a plane near its bottom and at a considerable height above said plane, means for feeding crushed sulfur into said spaces, and means for passing a suitable electric current through the charge.

19. In an electric furnace for making bisulfid of carbon, the combination of a working chamber adapted for the location of its heat zone at bottom, inlets into said working chamber at top and in a plane near its bottom, adapted respectively for the introduction of carbon and sulfur, inlets at an intermediate height for fragmentary conductive material adapted to constitute self-renewing electrodes in the working furnace, conduits constructed of conductive material and arranged for the passage of said fragmentary conductive material therethrough into the bottom of the working chamber, and means for connecting said conduits with a suitable generator of electricity.

20. In an electric furnace for making bisulfid of carbon, the combination of a working chamber adapted for the location of its heat zone at bottom, inlets into said working chamber at top and through passages in its side walls at different heights, adapted respectively for the introduction of the carbon and sulfur, inlets for fragmentary conductive material adapted to constitute self-renewing electrodes in the working furnace, conduits constructed of conductive material and arranged for the passage of said fragmentary conductive material therethrough into the bottom of the working chamber, and means for connecting said conduits with a suitable generator of electricity.

21. In an electric furnace for making bisulfid of carbon, the combination of a working chamber adapted for the location of its heat zone at bottom, inlets into said working chamber at top and through passages in its side walls adapted respectively for the introduction of the carbon and sulfur, inlets for fragmentary conductive material adapted to constitute self-renewing electrodes in the working furnace, conduits constructed of conductive material and arranged for the passage of said fragmentary conductive material therethrough into the bottom of the working chamber, means for connecting said conduits with a suitable generator of electricity, and an outlet at the bottom of the working chamber for the residue from the carbon and sulfur in fused condition.

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