No. 688,364.

Patented Dec. 10, 1901.

E. R. TAYLOR.

ELECTRIC FURNACE.

(Application filed Dec. 21, 1899. Renewed Apr. 18, 1901.)

(No Model.)

3 Sheets—Sheet 1.

Fig. 1.

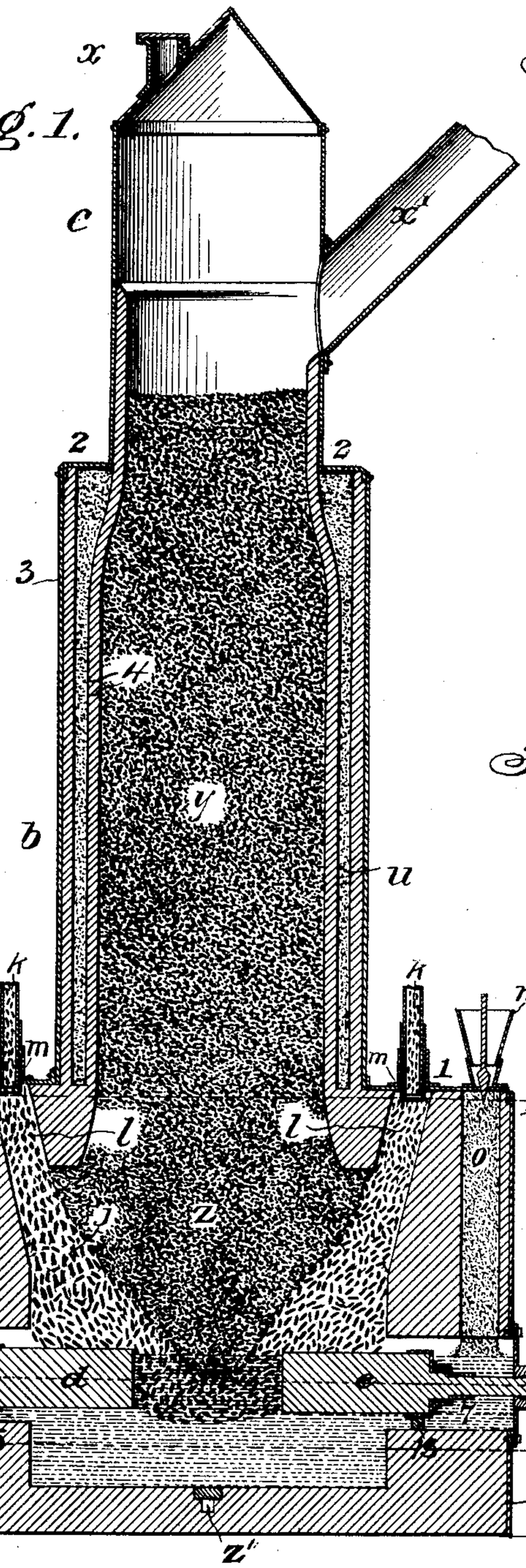


Fig. 3.

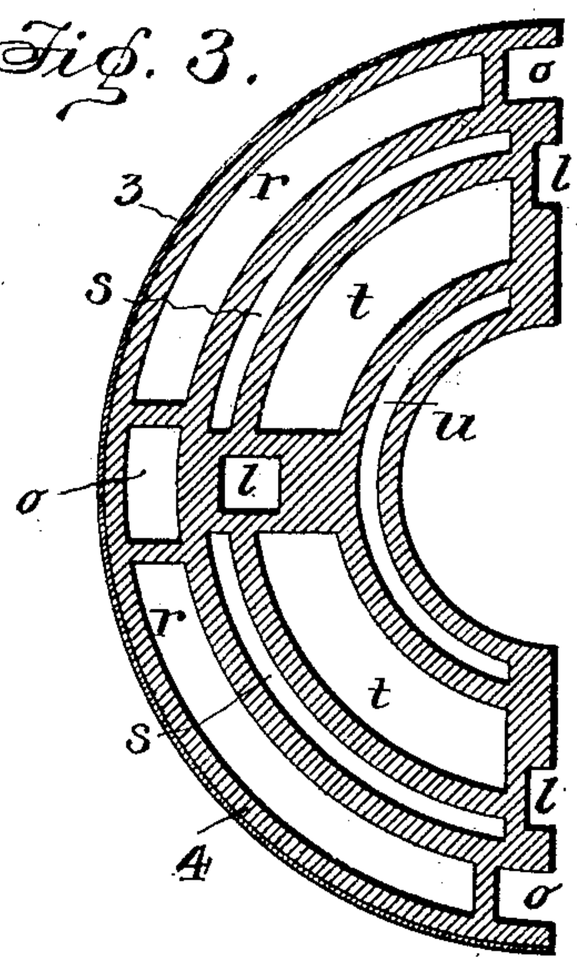
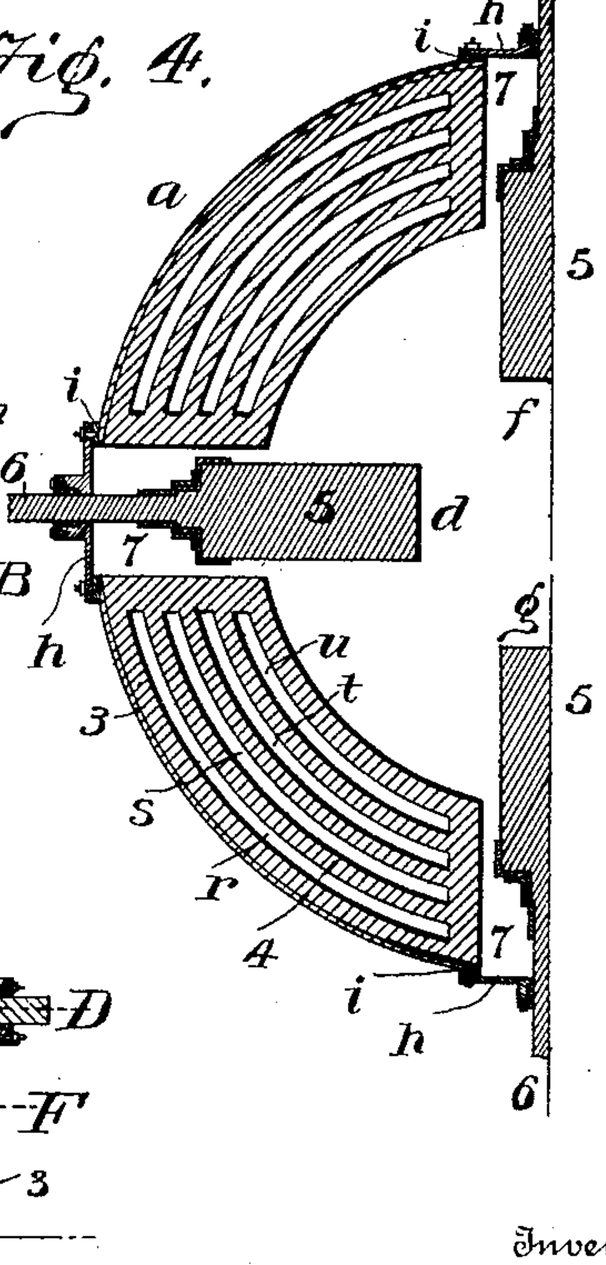


Fig. 4.



Witnesses
Fenton S. Pelt,
Allan W. Huss.

Inventor
Edward R. Taylor
by Jno. L. Ewin,
Attorney

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(No Model.) 3 Sheets—Sheet 2.

Fig. 2.

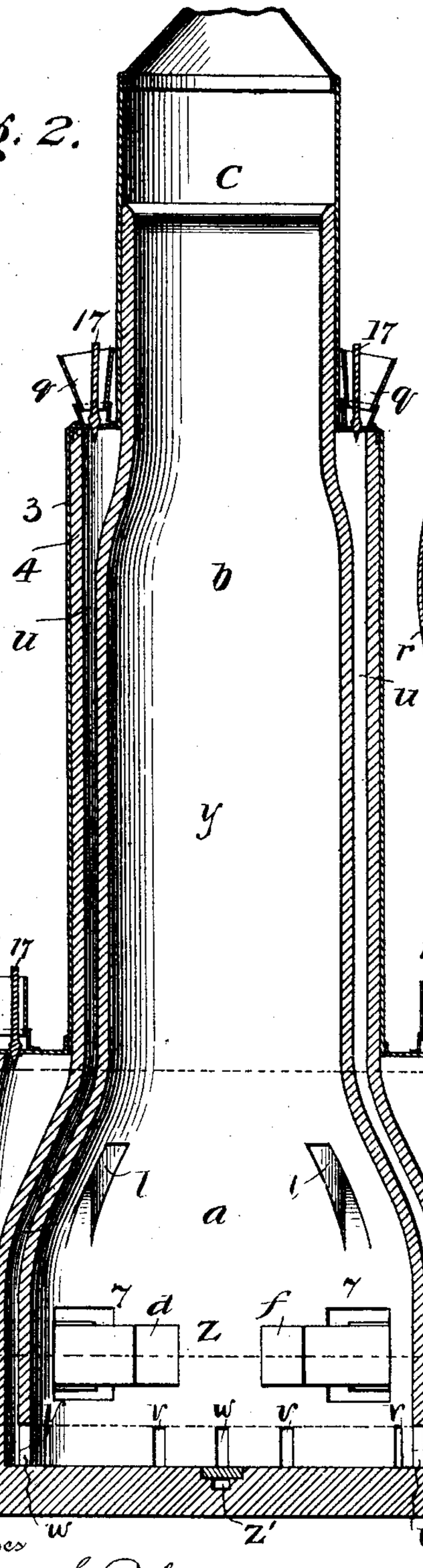
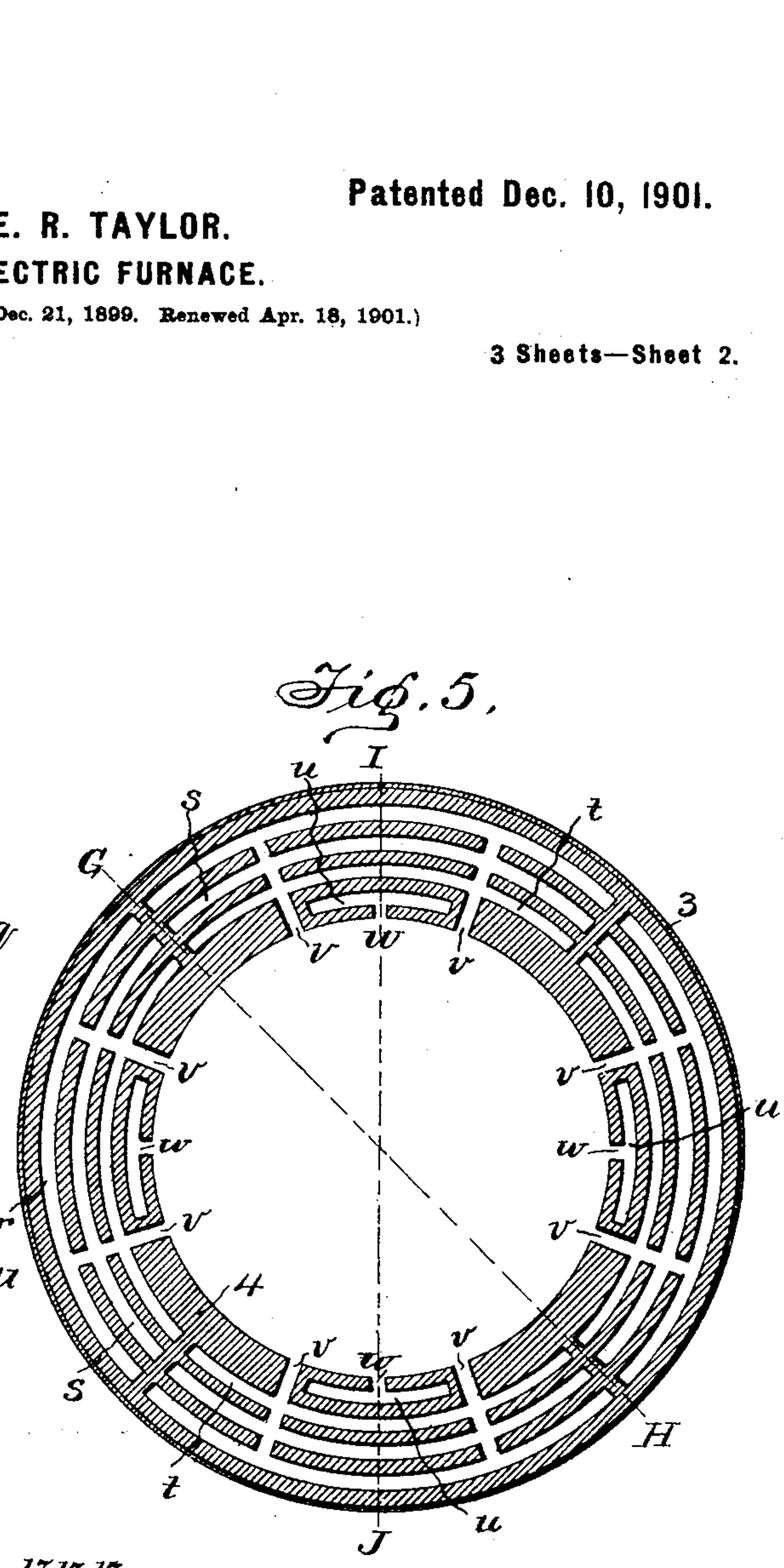


Fig. 5.



Witnesses
Fenton S Pelt,
Allan W Fuss.

Inventor
Edward R. Taylor
by Chas. L. Lewis,
Attorney

No. 688,364. Patented Dec. 10, 1901.

E. R. TAYLOR.

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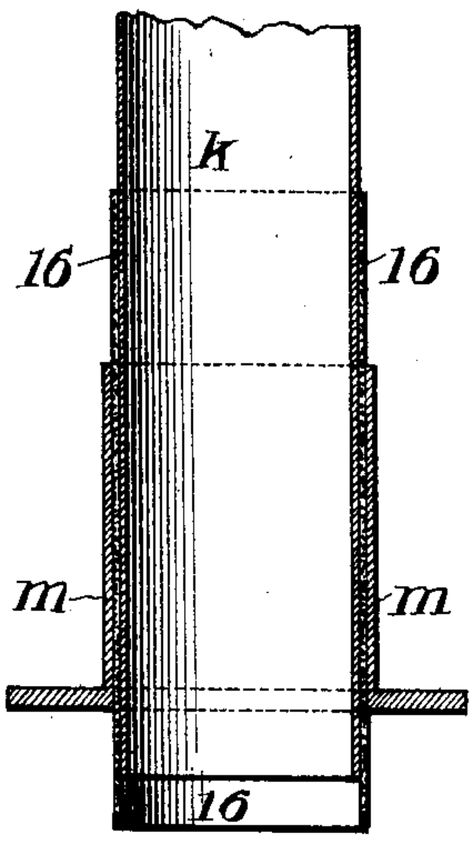
(No Model.) 3 Sheets—Sheet 3.

Fig. 6.



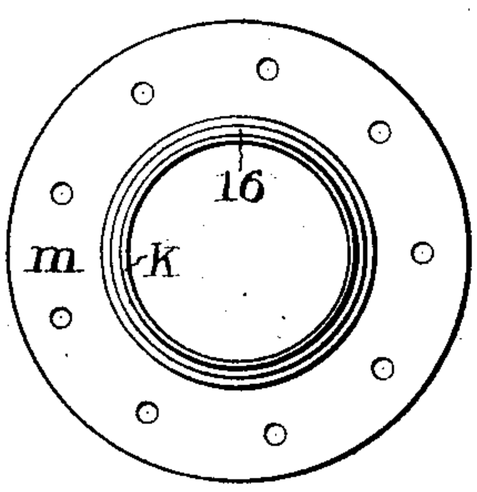
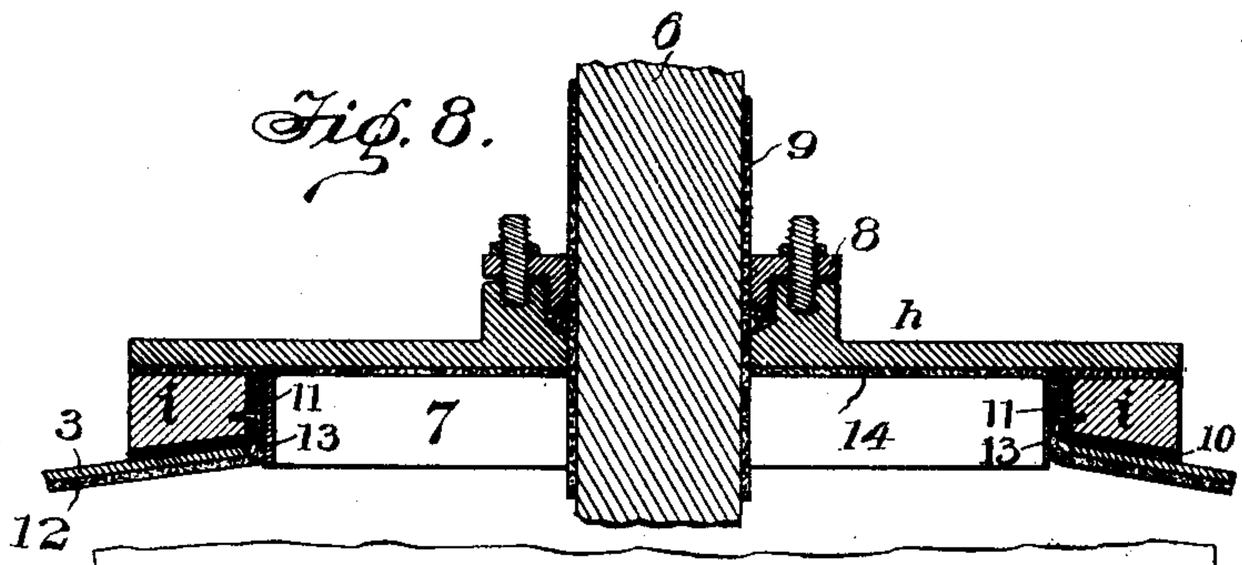


Fig. 7.

Fig. 8.



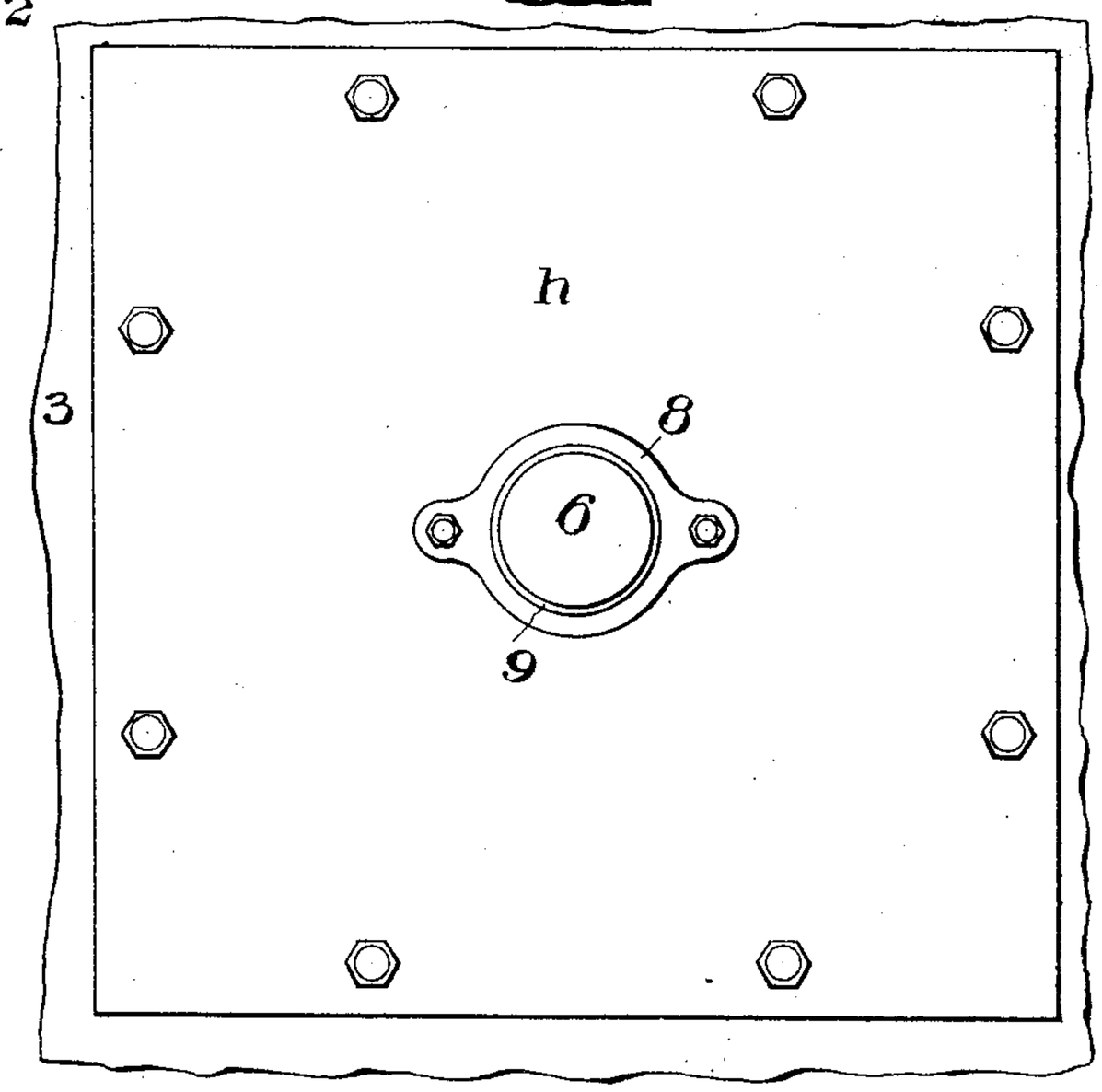
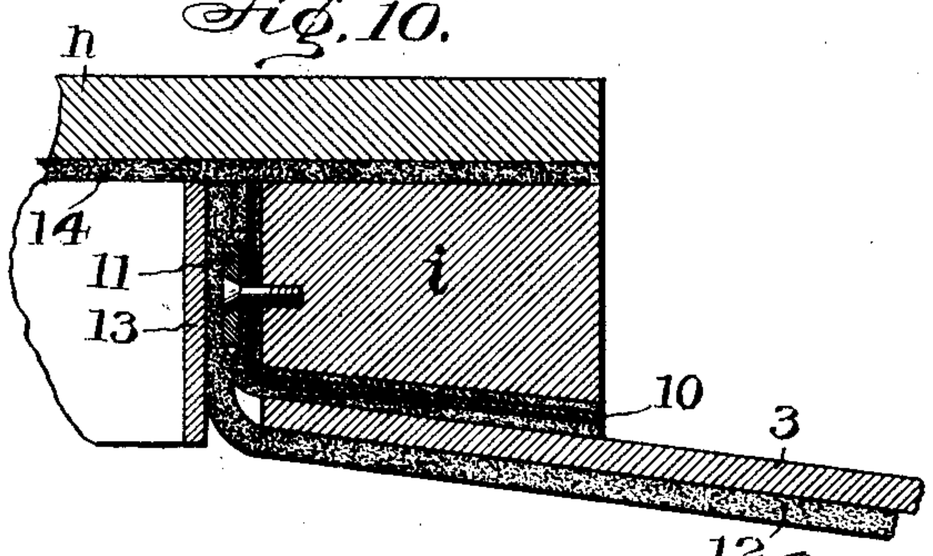


Fig. 9.

Fig. 10.



Witnesses
Fenton St Pelt,
Allan W Fuss.

Inventor
Edward R. Taylor
by Chas. L. Lewis,
Attorney

UNITED STATES PATENT OFFICE.

EDWARD R. TAYLOR, OF PENN YAN, NEW YORK.

ELECTRIC FURNACE.

SPECIFICATION forming part of Letters Patent No. 688,364, dated December 10, 1901.

Application filed December 21, 1899. Renewed April 18, 1901. Serial No. 56,512. (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 to the art of reducing mineral substances and effecting chemical reactions and conversions demanding heat by the aid of electricity, and more particularly to the apparatus used in such art.

The invention consists in certain novel features of construction and combinations of parts in an electric furnace for use as above, as hereinafter set forth and claimed.

The leading objects of the invention are to protect the electrodes against excessive wear, to regulate the electric action within the furnace, to provide for the use of constant-current electrolysis where this action is desirable, as well as resistance heating and the arc, to prevent the leakage of electricity with reference to securing the maximum heating or electrochemical effect of the current, to keep the electric conductors cool, to intercept and carry back into the furnace heat that would otherwise be lost by radiation, to avoid cooling the more highly-heated inner part of the furnace by the sudden introduction of cold material, and to insure the continuity of the operation.

Another object of the invention is the production of bisulfid of carbon on a large scale with economy.

Three sheets of drawings accompany this specification as part thereof.

Figures 1 and 2 of the drawings are sectional elevations of the improved electric furnace, and the former illustrates its operation. Fig. 3 represents a horizontal section through one side of the furnace on the line A B, Figs. 1 and 2. Fig. 4 represents a horizontal section through the same side of the furnace on the line C D, Figs. 1 and 2. Fig. 5 represents a horizontal section on the line E F, Figs. 1 and 2. Figs. 6 and 7 are respectively a vertical section and a plan view on a larger scale of one of the pipes for feeding fragmentary conducting material to the electrodes shown in Fig. 1. Figs. 8 and 9 are respectively a sectional detail and a face view on the same scale as Figs. 6 and 7 of the closure-plate and its appurtenances at one of said electrodes, and Fig. 10 represents an enlargement of a portion of Fig. 8.

The broken lines G H and I J, Fig. 5, indicate the planes of section in Figs. 1 and 2, respectively.

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

The improved furnace is preferably and conveniently of an upright or stack form and of three diameters at successive heights, as shown in Figs. 1 and 2, and round in cross-section, as represented by Figs. 3, 4, and 5, with annular horizontal shoulders 1 and 2, connecting the base *a*, body *b*, and dome *c*, and it comprises an iron shell common to all and a chambered refractory lining of fire-brick or its equivalent extending upward to a sufficient extent above the top of said body *b*, as indicated respectively at 3 and 4.

The electrodes in pairs are shown at *d* and *e* and at *f* and *g* in Figs. 1 and 4. Each of them comprises a body portion 5 and a conductor-rod 6, and each is supported within a side opening 7 in the furnace-wall by a metallic closure-plate *h*, attached to a metallic frame *i*. (Compare Figs. 8, 9, and 10.) Each closure-plate is constructed with a packing-gland 8, with openings in the gland and plate large enough to permit the conductor-rods 6 to be wrapped with insulating material 9, Figs. 8 and 9, so as to be insulated therefrom against the leakage of electricity. The insulation 9 preferably consists of alternate layers of mica and asbestos, and like insulation 10, Figs. 8 and 10, is interposed between the shell of the furnace and said frame *i* and within this frame, where it is held in place by a metallic inner frame 11, Fig. 10. The inside of the furnace-shell 3 is also preferably provided throughout with a flexible lining 12, Figs. 8 and 10, of asbestos or other suitable insulating material, held in contact with the shell by the refractory lining 4, of fire-brick or the like, and the same is extended within the frames *i* and secured by metallic inner frames 13. A sheet 14, Figs. 8 and 10, of asbestos or other suitable insulating material, also covers the whole inside face of each closure-plate *h*, extending between the same and the frames *i* and 13 behind it, and thus

insulating the plate from said frames and separating therefrom any materials that may work back to the plate from the interior of the furnace. When the electrode and closure-plates are in place, the sockets of the glands 8 are packed with asbestos or the like and are then screwed tight, thus sealing the conductors against the escape around them of liquid or gaseous contents of the furnace and against the admission of air. Bolsters 15, Fig. 1, within the side openings 7, assist to support the terminals in horizontal position inside the furnace.

In operation the electrodes preferably coact with broken or scrap conducting materials, (represented at *j* in Fig. 1,) which may preferably be coke or scrap carbon broken into fragments of suitable size to feed through pipes *k*, Figs. 1, 6, and 7, and passages *l*, Figs. 1 and 3, leading from said pipes, without clogging said pipes and passages. Each of the pipes *k* is held upright in a curb *m*, Figs. 6 and 7, attached to the furnace-shell on the shoulder 1, as in Fig. 1, and insulated therefrom by a sleeve 16, Figs. 6 and 7, of asbestos or other suitable material. Said fragmentary conducting material *j*, Fig. 1, falling upon and over the electrodes protects the latter from excessive wear, and by regulating and arranging the same within the furnace it may also be made to perform the office of regulating the current of electricity supplied to the furnace, so as to obviate moving the electrodes for this purpose. The streams of fragmentary conducting material from the several pipes may be fed in and arranged to fall together over and between the electrodes, so that the electricity will at the thinnest points be converted into heat by reason of the greater resistance opposed to its passage, or they may be regulated to so fall that a series of electric arcs shall be produced and the electricity converted into heat in that manner, or they may be regulated so that both of these conditions may obtain, if this be deemed best for the work to be accomplished.

The shoulder 1 of the furnace is further provided with hoppers *n*, Fig. 1, from which passages *o*, Figs. 1 and 3, extend vertically downward to the side openings 7 above the conductor-rods 6 of the electrodes for the purpose of keeping said conductor-rods covered with material required for or that will not interfere with the main operation that is to take place in the furnace and which will melt at a moderate temperature and in melting will have a tendency to keep said conductor-rods cool.

The shoulders 1 and 2 are provided, respectively, with hoppers *p* and *q*, Fig. 2, of another class, each of the former communicating with three concentric passages *r*, *s*, and *t*, Figs. 2 to 5, and said hoppers *q* communicating with a passage *u*, Figs. 2 to 5, that surrounds the interior of the body *b* and extends downward within the base *a*, concentric with said passages *r*, *s*, and *t*. The object of these hoppers and passages in common is to surround the interior of the furnace with walls of an easily-fusible material or materials, such as above described with reference to the hopper *n* and passage *o* above each side opening 7, so that the same will intercept and carry back into the interior of the furnace the heat that has sought to escape through its sides and that would otherwise be lost by radiation. The discharge from said passages *r*, *s*, *t*, and *u* into the interior of the furnace is through ducts *v* and *w*, Fig. 5, affording direct communication between each part of each passage at bottom and said interior.

The hoppers *n*, *p*, and *q* are in common riveted fast upon the furnace-shell 3 and provided with feed-regulating plugs 17, Figs. 1 and 2, fitted to holes in said shell that communicate with their respective passages, and said passages *l*, *o*, *r*, *s*, *t*, and *u* in common are formed in the process of building the lining 4 or lining up the furnace with fire-brick or its equivalent, as aforesaid. The fusible material introduced by way of said hoppers *n*, *p*, and *q*, passages *o*, *r*, *s*, *l*, and *u*, and ducts *v* and *w*, is at the same time melted or fused preparatory to its taking its part in the reactions provided for within the working chamber *z*, and this is accomplished so gradually that the inner part of the furnace where the reactions are actively in progress is not cooled by the introduction of the cold fusible material. In certain cases said fusible material may thus be partly or wholly vaporized before the hottest part or heat zone of the furnace is reached, and under these circumstances it reaches the point of most active chemical combination under the most favorable conditions, having at the same time derived almost or quite its entire heat from the intercepted heat that would otherwise have been lost from the furnace by radiation.

The infusible or less fusible material or materials may be fed in through an inlet *x*, Fig. 1, in the upper part or dome *c* of the furnace, or a suitable opening otherwise located, if preferred, into an upper chamber *y*, communicating at bottom with the working chamber *z*, and these materials, descending upon the fragmentary conducting material *j* or upon the electrodes *d e* and *f g*, become heated to a temperature adapted to make them combine with said fusible material or materials fed in through the hoppers *n*, *p*, and *q*, as aforesaid. The infusible or less fusible materials may also be heated by the direct action of the current owing to the resistance they offer to its passage through the mass and may thus be a factor in the conversion of electricity into heat in the furnace, or they may be acted on by constant-current electrolysis, as aforesaid.

To operate the furnace, the electrodes *d e* and *f g* are properly set in their positions and electrically connected with a dynamo or dynamos of sufficient power. A quantity of the

more fusible material to be used in the reaction is filled in below and beyond the electrodes as high as may be deemed desirable, and the passages *o*, *r*, *s*, *t*, and *u* are filled with the same. A suitable supply of the fragmentary conducting material *j* is next arranged, as desired, around and upon the electrodes, and the pipes *k* are filled with the same as far up as is deemed advisable. A supply of the infusible or less fusible material or materials is then placed upon the conducting material *j* and the electrodes and the furnace wholly or partly filled with the same, as may be desired. The current may then be turned on. As work proceeds fresh materials are added from time to time, as required, through the respective hoppers and openings provided for that purpose, and are fed automatically toward the heat zone by gravity, thus insuring the continuity of the operation. The gases and vapors make their way out of the furnace through a pipe *x'*, Fig. 1, which may be connected to condensers or other suitable apparatus to utilize such gases and vapors.

The lower part of the working chamber *z* constitutes the ash-pit of the furnace, which may be cleaned out through one of the side openings 7, when this becomes necessary, by removing its closure-plate and electrode. Beneath the floor of the ash-pit a drainage-duct *z'*, covered by loose bricks, extends to one side of the furnace for draining off the liquid contents of the ash-pit when the operation of the furnace is to be suspended long enough to make such drainage desirable.

A specific example of the usefulness of this furnace is afforded by the manufacture of bisulfid of carbon. In this case sulfur is placed in the bottom of the working chamber *z* of the furnace and as far up around the electrodes as may be deemed desirable. The fragments *j* of broken carbon or coke are then placed upon and between the electrodes *d e* and *f g*, and charcoal or such other form of carbon as may be used for conversion (hereinafter spoken of simply as "charcoal") is placed upon the whole in the body of the furnace to keep the fragments *j* from packing too thick, which would enable the electric current to find its way too easily through the furnace. As the filling proceeds the pipes *k* are filled with the fragments *j* and the shaft or upper chamber *y* of the furnace is filled with the charcoal. Sulfur is then or meanwhile filled into the chambers *r*, *s*, *t*, and *u* and into the passages *o* through their respective hoppers, and the electricity is applied through the electrodes *d e* and *f g*. The alternating current is preferably employed in this reaction. The sulfur within the working chamber *z* soon becomes melted, and its level rises more or less nearly to the top of the electrodes. Being a non-conductor of electricity, the sulfur itself thus becomes a regulator of the electric current in a most effective manner. As it approaches the heat zone the top of the molten mass of sulfur becomes vaporized and the vapor rises through the subjacent charcoal. The charcoal in due time becomes sufficiently heated to combine with the sulfur vapor, with the formation of bisulfid-of-carbon (CS_2) vapor, which ascends through the charcoal above it, finally passing out through the pipe *x'* to any suitable condenser adapted to condense the same to liquid. Charcoal and sulfur and the fragments *j* are fed into the furnace from time to time as required through the inlet *x* and through the pipes *k* and hoppers *n*, *p*, and *q*, and so the operation is made continuous.

The term "iron" is herein used for iron or steel. The furnace may be oval or elliptical in cross-section as the equivalent of "round," and valves of any suitable form are considered equivalents of the "plugs" 17.

One pair or more than two pairs of electrodes may be provided. The passages *r*, *s*, *t*, and *u* may be more or less than four in number, 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 metallic shell, a working chamber within the same, means for supplying said chamber with material for treatment and for discharging the product, electrodes opposed to each other within said chamber, conductors connecting said electrodes with a suitable generator of electricity, means for sealing and insulating said conductors, downwardly-extending passages located and discharging above and upon said electrodes respectively, and metallic pipes, attached to and insulated from said shell, communicating with said passages at top, and adapted for supplying the same by gravity with carbon fragments for directing and regulating the electric current.

2. An electric furnace having, in combination, a metallic shell, a refractory lining, a working chamber surrounded and in part overhung by said lining, means for supplying said chamber with material for treatment and for discharging the product, electrodes opposed to each other within said chamber, conductors connecting said electrodes with a suitable generator of electricity, means for sealing and insulating said conductors, downwardly-extending passages within said lining located and discharging above and upon said electrodes respectively, and metallic pipes, attached to and insulated from said shell, communicating with said passages at top, and adapted for supplying the same by gravity with carbon fragments for directing and regulating the electric current.

3. An electric furnace having, in combination, a working chamber, means for supplying the same with material for treatment and for discharging the product, electrodes opposed to each other within said chamber, conductors connecting said electrodes with a suitable gen-

erator of electricity, a metallic shell having openings to admit said electrodes, metallic frames surrounding said openings and attached externally to said shell, metallic closure-plates attached externally to said frames and having means for sealing said conductors, and insulation between said shell and frames and between said frames and plates.

4. An electric furnace having, in combination, a working chamber, means for supplying the same with material for treatment and for discharging the product, electrodes opposed to each other within said chamber, conductors connecting said electrodes with a suitable generator of electricity, a metallic shell having openings to admit said electrodes, metallic frames surrounding said openings and attached externally to said shell, metallic closure-plates attached externally to said frames and provided with glands through which said conductors extend, insulation between said shell and frames and between said frames and plates, and insulating-wrappings for said conductors extending through said glands.

5. An electric furnace having, in combination, suitable walls, a working chamber surrounded and in part overhung by said walls, means for supplying said chamber with material for treatment and for discharging the product, electrodes opposed to each other within said chamber and composed of body portions and conductor-rods, side openings in said walls for the admission of said electrodes, and downwardly-extending passages in said walls in communication with said side openings, adapted for the admission thereto of fusible material which in melting will cool said conductor-rods.

6. An electric furnace having, in combination, suitable walls, a working chamber surrounded and in part overhung by said walls, means for supplying said chamber with material for treatment and for discharging the product, electrodes opposed to each other within said chamber and composed of body portions and conductor-rods, side openings in said walls for the admission of said electrodes, downwardly-extending passages in said walls in communication with said side openings, adapted for the admission thereto of fusible material which in melting will cool said conductor-rods, external hoppers for the introduction of such fusible material, and means for regulating the feed of such material.

7. An electric furnace having a working chamber, walls surrounding said chamber, means for supplying said chamber with material for treatment, comprising downwardly-extending passages within said walls, surrounding said chamber and in communication therewith, whereby when filled with fusible material said passages form a non-conducting jacket for the furnace and serve as heat-economizers, electrodes opposed to each other within said chamber, conductors connecting said electrodes with a suitable generator of electricity, and means for discharging the product of the furnace.

8. An electric furnace having a working chamber, walls surrounding said chamber, means for supplying said chamber with material for treatment, comprising two or more passages one within another within said walls, each extending downwardly and around said chamber, and having separate communication therewith, and adapted to feed material to the heat zone of the furnace, and when filled with such material to successively intercept the heat radiating from said chamber and to return the same to said chamber, electrodes opposed to each other within said chamber, conductors connecting said electrodes with a suitable generator of electricity, and means for discharging the product of the furnace.

9. An electric furnace, having a working chamber, walls surrounding said chamber, means for supplying said chamber with material for treatment, comprising two or more concentric passages within said walls, each extending downwardly and around said chamber, and having separate communication therewith, and adapted to feed material to the heat zone of the furnace, and when filled with such material to successively intercept the heat radiating from said chamber and to return the same to said chamber, electrodes opposed to each other within said chamber, conductors connecting said electrodes with a suitable generator of electricity, and means for discharging the product of the furnace.

10. An electric furnace comprising base and body portions, round in cross-section, having shouldered walls, a working chamber within said base, means for supplying said chamber with material for treatment, including two or more concentric passages within said walls, each extending downwardly and around said chamber, the innermost of said passages surrounding said body portion, means for feeding such material into the respective passages at top, ducts connecting the respective passages at bottom with said chamber, electrodes opposed to each other within said chamber, conductors connecting said electrodes with a suitable generator of electricity, and means for discharging the product of the furnace.

11. An electric furnace having, in combination, shouldered walls, a working chamber within said walls, means for supplying said chamber with material for treatment comprising downwardly-extending passages within said walls, surrounding said chamber, shoulder-supported hoppers for the introduction of fusible material into said passages at top, ducts between said passages at bottom and said chamber, electrodes opposed to each other within said chamber, conductors connecting said electrodes with a suitable generator of electricity, and means for discharging the product of the furnace.

12. An electric furnace comprising base and body portions having shouldered walls, a working chamber within said base, means for supplying said working chamber with materials for treatment including an upper chamber within said body portion and passages within said walls extending downwardly and around said working chamber, means for feeding such materials into said upper chamber and into said passages at top, ducts connecting said passages at bottom with said working chamber, electrodes opposed to each other within said working chamber, conductors connecting said electrodes with a suitable generator of electricity, and means for discharging the product of the furnace.

13. An electric furnace comprising base and body walls and a dome, a working chamber and ash-pit within said base-walls, a charcoal-chamber within said body-walls in communication with said working chamber, downwardly-extending sulfur-passages within said walls, means for introducing the respective materials into said charcoal-chamber and into said sulfur-passages at top, ducts connecting said passages at bottom with said working chamber, electrodes opposed to each other within said working chamber, conductors connecting said electrodes with a suitable generator of electricity, and suitable pipe connections, leading from said dome, whereby the gaseous products may be removed and collected.

14. An electric furnace having, in combination, a working chamber, means for supplying the same with material for treatment and for discharging the product, electrodes opposed to each other within said chamber, conductors connecting said electrodes with a suitable generator of electricity, a metallic shell, a flexible lining of insulating material, and a refractory lining, within said insulating-lining, serving to hold said insulating-lining in contact with the inside of said shell, and forming the walls of said working chamber.

15. An electric furnace having, in combination, a working chamber, means for supplying the same with material for treatment and for discharging the product, electrodes opposed to each other within said chamber, conductors connecting said electrodes with a suitable generator of electricity, a metallic shell having openings to admit said electrodes, metallic frames surrounding said openings and attached externally to said shell, an insulating-lining of said shell extended within said frames, metallic inner frames holding the edges of said lining in place within the frames first named, metallic closure-plates attached externally to said frames first named, and insulation between said shell and first-named frames and between the latter and said plates, substantially as hereinbefore specified.

EDWARD R. TAYLOR.

Witnesses:
M. F. HOBART,
O. M. HOBART.