No. 702,117. Patented June 10, 1902.

E. R. TAYLOR.

ART OF PRODUCING CHEMICALS IN ELECTRIC FURNACES.

(Application filed Oct. 6, 1900. Renewed Nov. 16, 1901.)

(No Model.) 4 Sheets—Sheet 1.

Fig. 1.

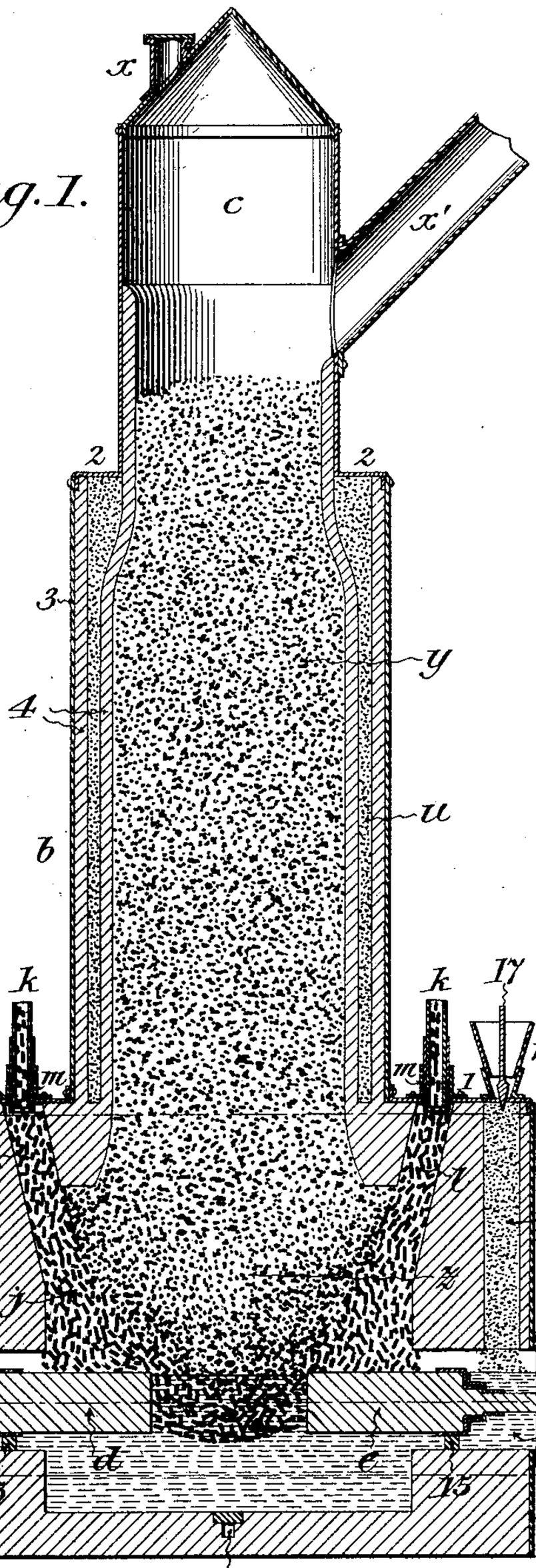

Fig. 3.

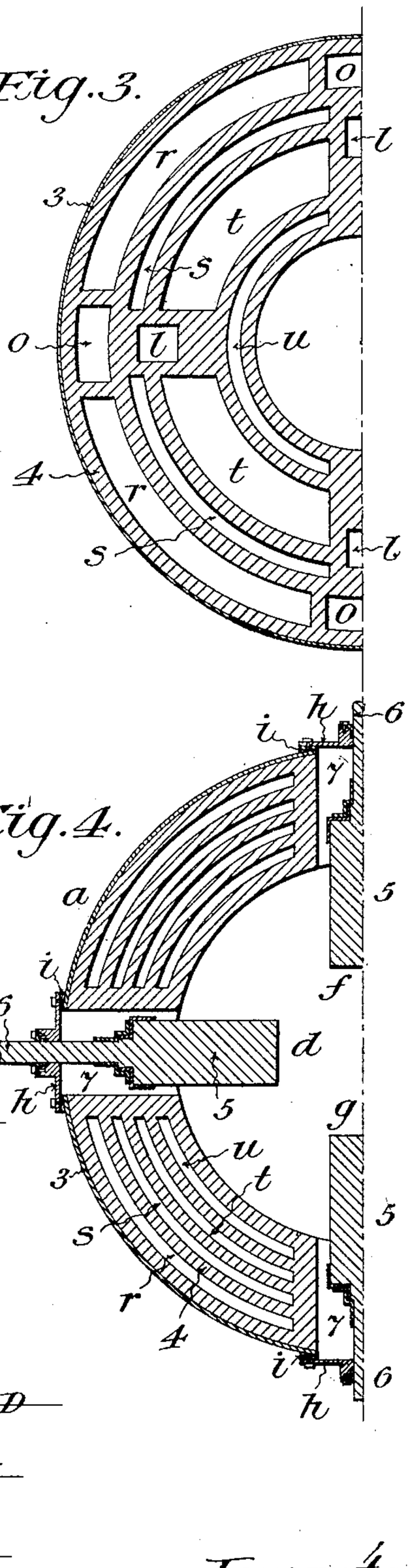

Fig. 4.

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(No Model.) 4 Sheets—Sheet 2.

Fig. 2.

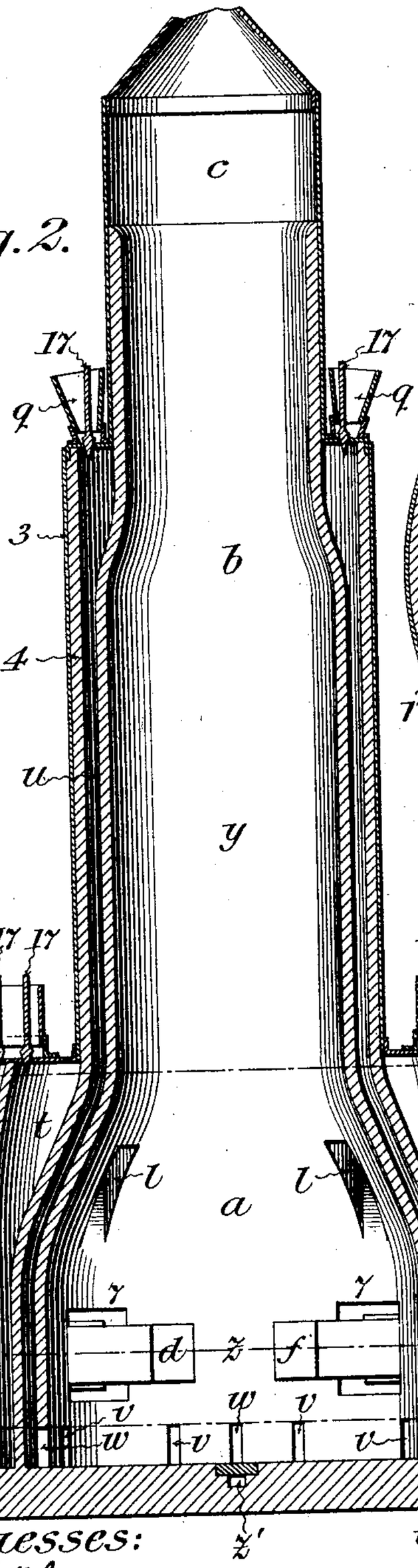
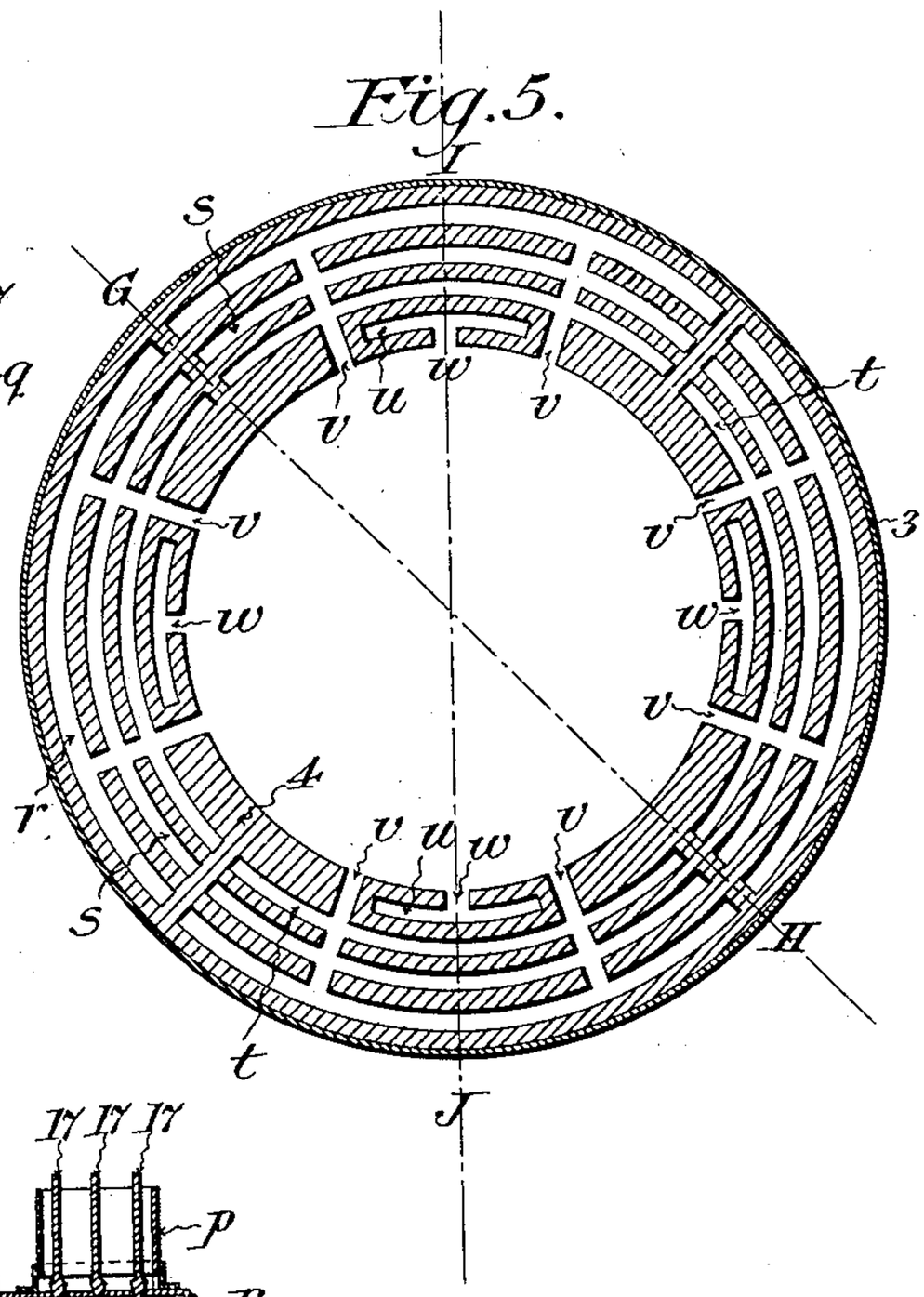


Fig. 5.



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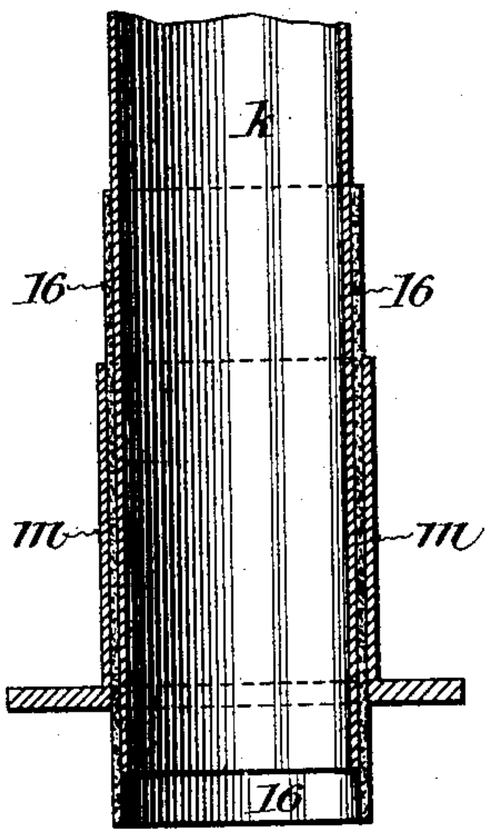
(Application filed Oct. 6, 1900. Renewed Nov. 16, 1901.)

(No Model.) 4 Sheets—Sheet 3.

Fig. 6.



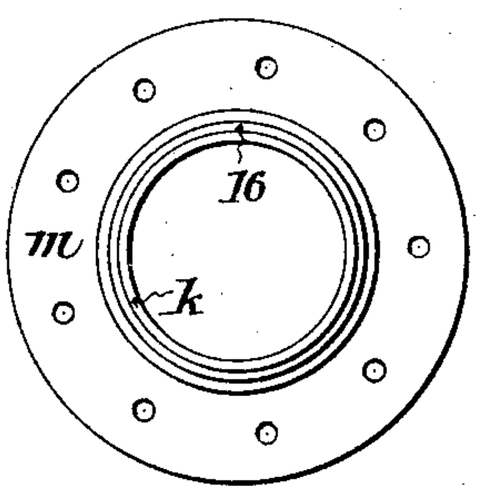
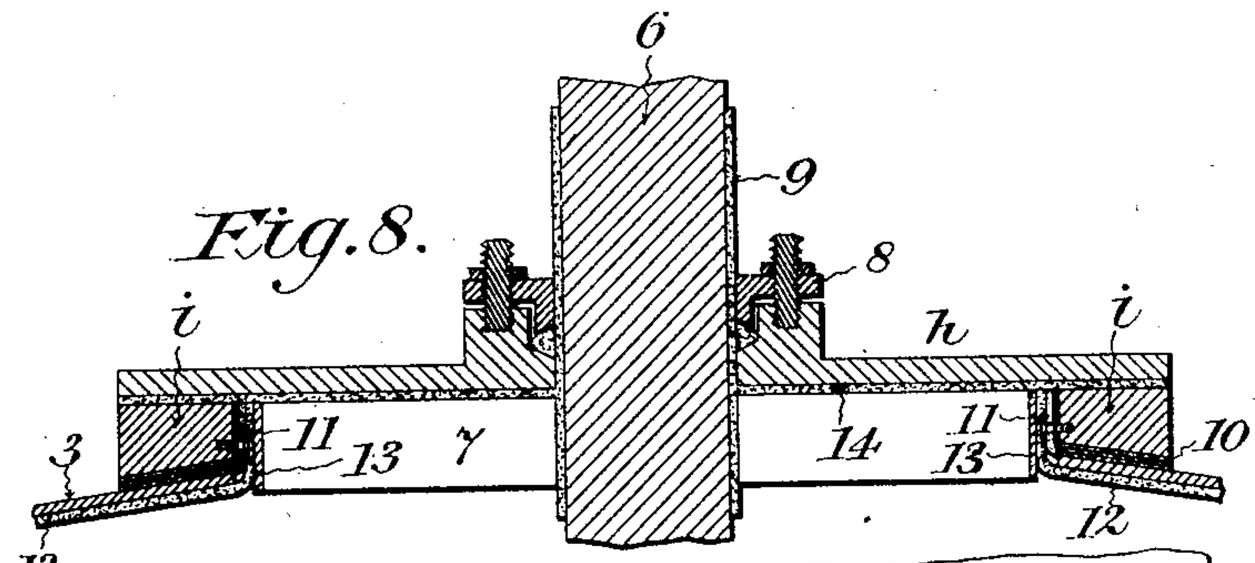


Fig. 7.

Fig. 8.



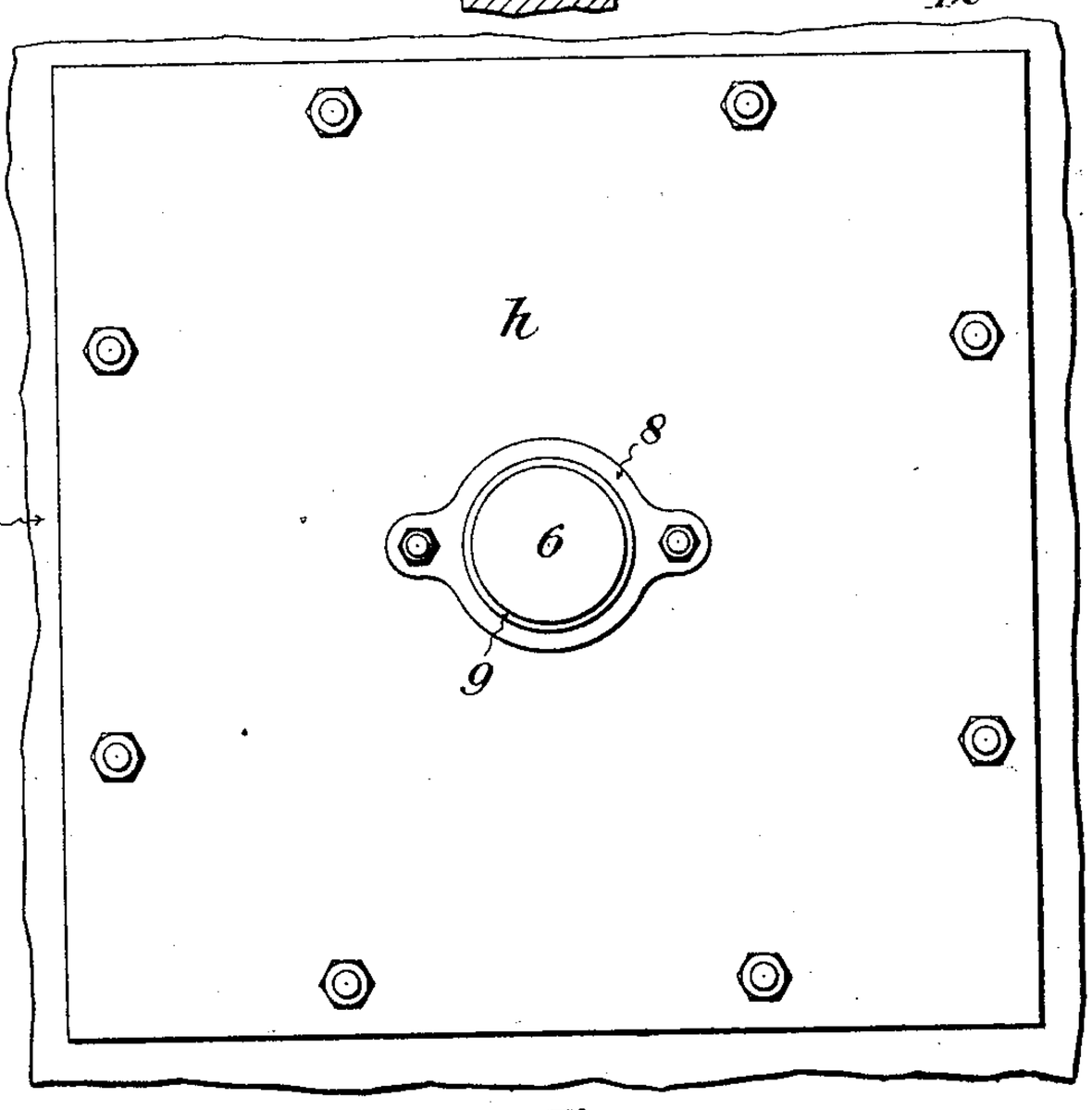
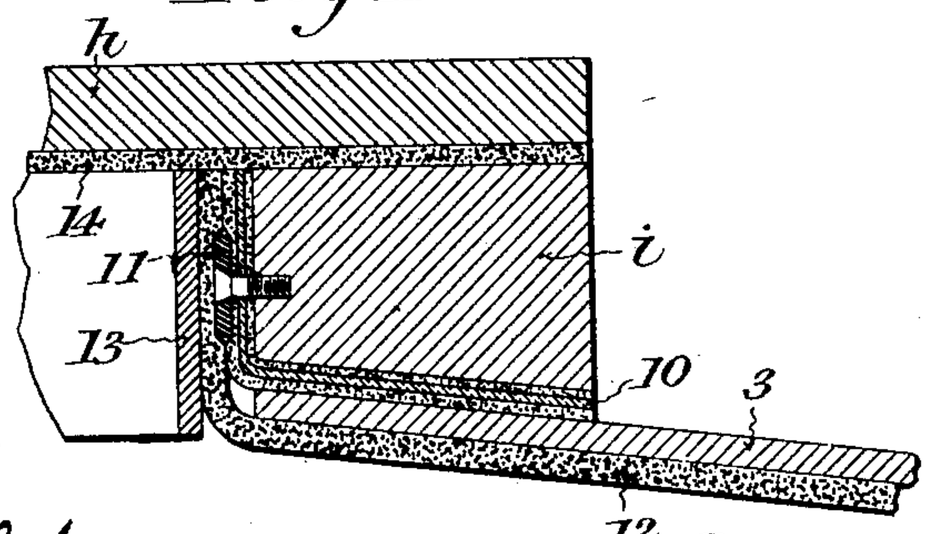


Fig. 9.

Fig. 10.



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ART OF PRODUCING CHEMICALS IN ELECTRIC FURNACES.

(Application filed Oct. 6, 1900. Renewed Nov. 16, 1901.)

(No Model.) 4 Sheets—Sheet 4.

Fig. 11.

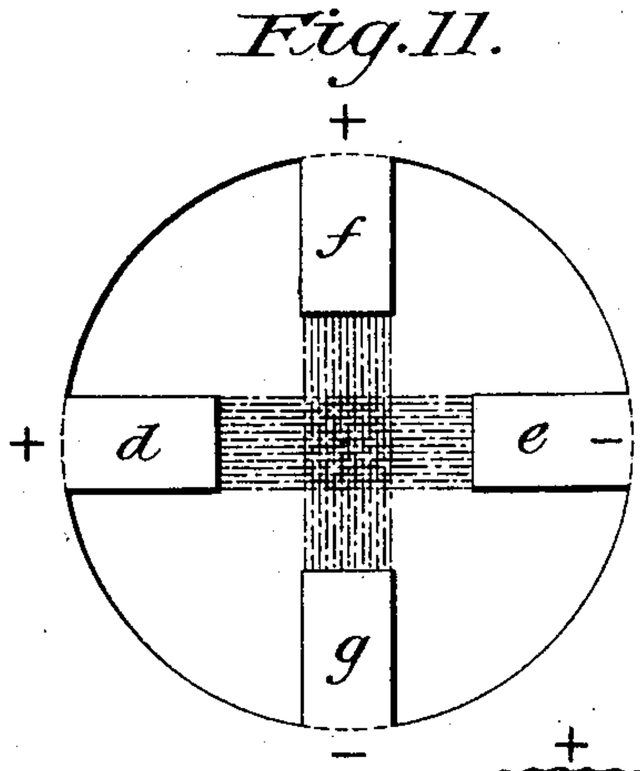


Fig. 12.

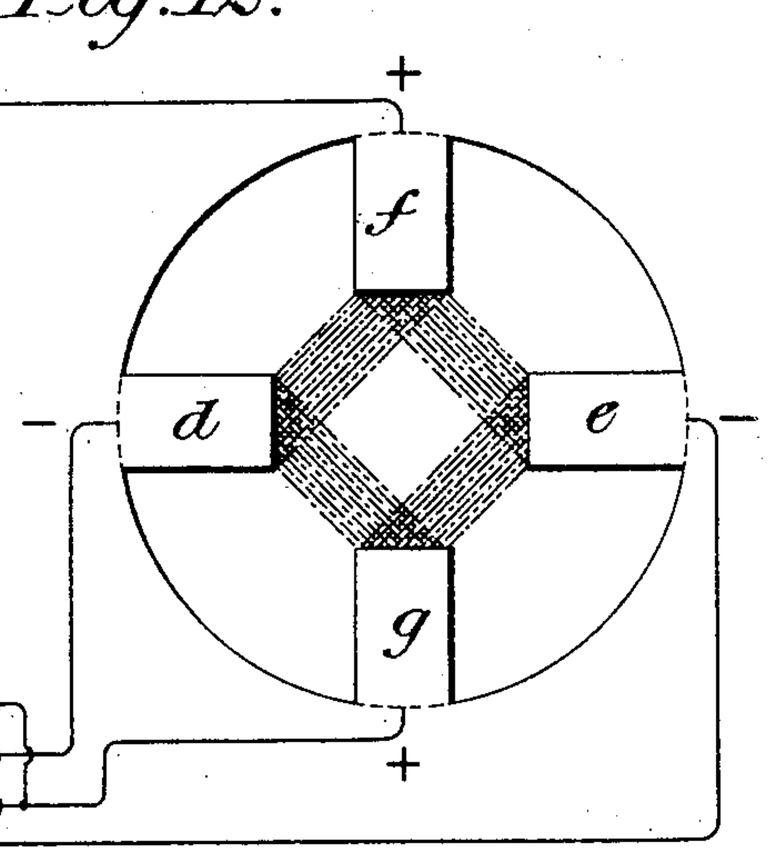
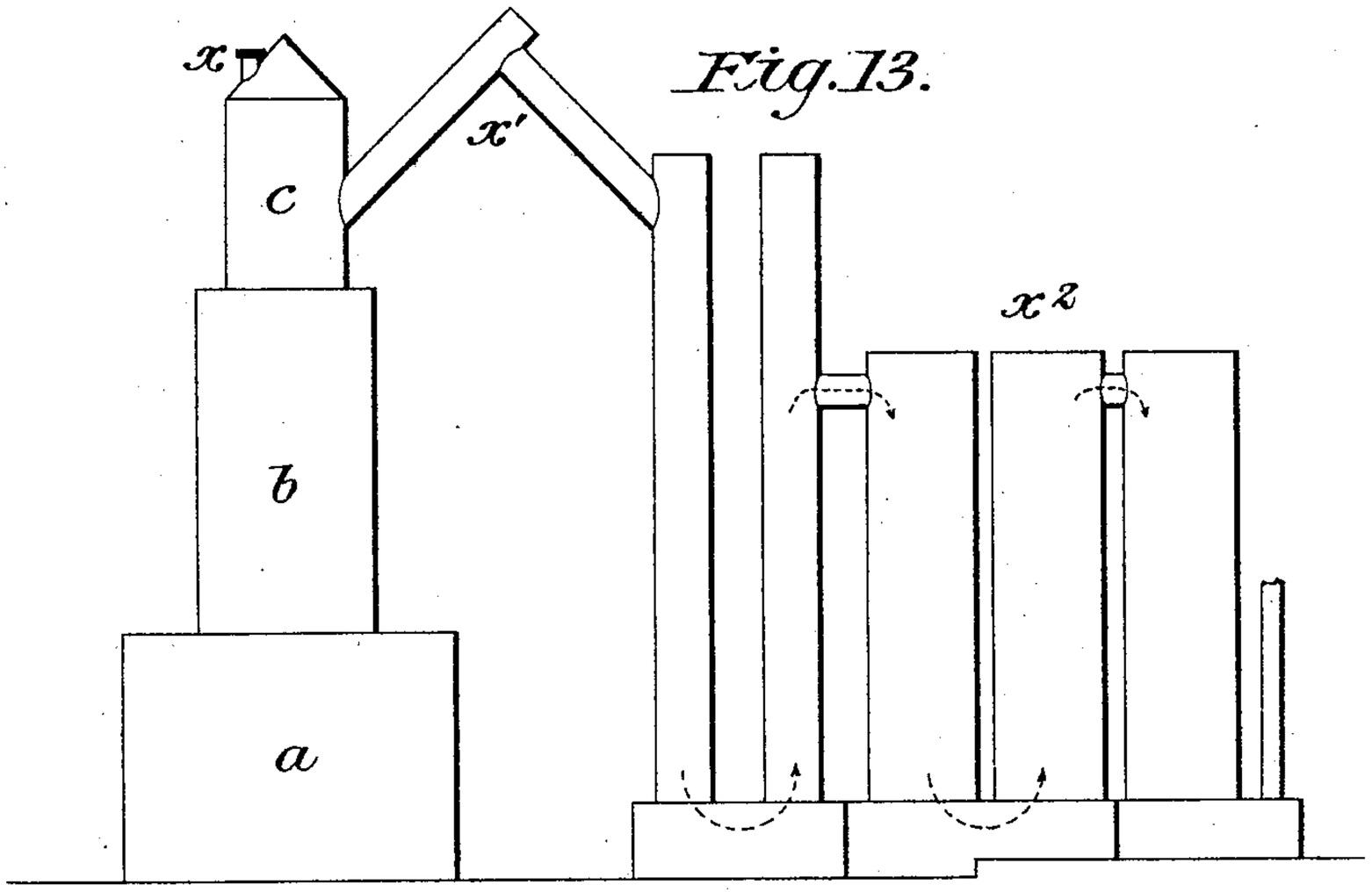


Fig. 13.



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UNITED STATES PATENT OFFICE.

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

ART OF PRODUCING CHEMICALS IN ELECTRIC FURNACES.

SPECIFICATION forming part of Letters Patent No. 702,117, dated June 10, 1902.

Application filed October 6, 1900. Renewed November 16, 1901. Serial No. 82,590. (No specimens.)

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 the Art of Producing Chemicals in Electric Furnaces, of which the following is a specification.

This invention relates to utilizing electric furnaces of suitable construction for reducing mineral substances and effecting chemical reactions and conversions demanding heat by the aid of electricity.

The invention consists in certain novel processes by which such furnaces are worked in conjunction with certain materials supplied thereto or fed into the same and with the electric current, 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 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 raw material, to insure the continuity of the operation, and, specifically, to produce in this manner, by a continuous operation, bisulfid of carbon, (CS_2,) whereby the same is adapted to be manufactured on a large scale with economy.

Four sheets of drawings accompany this specification as part thereof.

Sheets 1, 2, and 3 of the drawings correspond with those accompanying my previous specification forming part of my application for patent filed the 21st day of December, 1899, Serial No. 741,195. The peculiar electric furnace there shown forms no part of the present invention, but is the apparatus which I have designed for carrying into effect the aforesaid processes in which the present invention consists.

Figures 1 and 2 on said sheets are sectional elevations of said 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. Figs. 11 and 12, Sheet 4, are diagrammatic plan views of the interior of the furnace, the latter including a current-changer for varying the paths of the electric current, represented by broken lines in these figures; and Fig. 13 is a diagrammatic elevation of the furnace, showing a condenser coupled thereto. The broken lines G H and I J, Fig. 5, indicate the planes of section in Fig. 1 and Fig. 2, respectively.

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

The suitable electric furnace represented by the drawings 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 insu-

lation 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 lining 12, Figs. 8 and 10, of asbestos or other suitable insulating material, 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 electrodes 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 of liquid or gaseous contents of the furnace around them 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*, *t*, 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 or materials 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* or such of them as may be required 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 x^2, Fig. 14, or other suitable apparatus to utilize such gases and vapors.

In beginning the manufacture of bisulfid of carbon according to this invention 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 fragments *j* and the shaft or upper chamber *y* of the furnace is filled with the charcoal. Sulfur in crushed condition 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 superincumbent 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 the condenser x^2, Fig. 14, which condenses 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 feed of the respective chemicals to the heat zone is rendered more absolutely continuous and self-regulating by the existence at all times of a body of relatively fresh charcoal above the working chamber and in free communication therewith and of streams of sulfur in its crushed condition above and in a fused condition lower down descending by gravity to the bottom of the working chamber and thence rising to the heat zone.

To prevent the formation of piers within the working chamber *z* or to burn out piers that may have formed between the electrodes and are preventing the regular descent of the furnace charge, provision is preferably made for varying the paths of the electric current, as illustrated by Figs. 11 and 12, where the broken lines represent the electric current. Ordinarily the electricity is passed between the respective pairs of electrodes, as in Fig. 11. By changing the electric connections it may be made to pass as in Fig. 12. Such change may be manually effected at will by means of a suitable current-changer *c'*, Fig. 12, or it may be automatically effected at given periods by known means in order to prevent the formation of such piers.

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, or there may be a manhole in the side of the furnace for this purpose. Beneath the floor of the ash-pit a drainage-duct *z'*, covered by loose bricks, extends to a discharge-cock (not shown) at 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. Liquid products or by-products may be discharged in like manner by means of the drainage-duct *z'*, made for this use, of sufficient capacity, and solid products or by-products may be removed by means of such manhole.

It will be understood that the processes hereinafter claimed and to which the present invention is confined may be carried into ef-

fect in any electric furnace whatever that may be capable of being so worked, and that the electric furnace above described is claimed in the companion specification hereinbefore referred to.

In regulating the electric current by means of a bath of melted sulfur or an equivalent melted non-conducting substance it will be sufficient—where the electrodes are not horizontal, for example—for the liquid non-conducting substance to be fed into greater or less contact with one of each pair of electrodes, 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. The method of producing chemicals in an electric furnace which consists in introducing a charge into the furnace, passing a suitable electric current through the charge by means of relatively permanent electrodes, continuously feeding upon such electrodes and between the same and the charge fragmentary conducting material, and regulating the electric current by means of such fragmentary material.

2. The method of producing chemicals in an electric furnace which consists in introducing the ingredients of a charge into the furnace, the less fusible ingredient being introduced from above, passing a suitable electric current through the charge by means of relatively permanent electrodes, continuously feeding upon such electrodes and between the same and said less fusible ingredient fragmentary conducting material, and regulating the electric current by means of such fragmentary material.

3. The method of producing chemicals in an electric furnace which consists in introducing a charge into the furnace, passing a suitable electric current through the charge by means of relatively permanent electrodes and their conductors, fusing in contact with such conductors fusible material on its way to the interior of the furnace, and thereby cooling such conductors.

4. The method of producing chemicals in an electric furnace which consists in introducing a charge into the working chamber, passing a suitable electric current through the charge by means of relatively permanent electrodes and their conductors, fusing upon the conductors a metalloid on its way to said chamber, and thereby cooling said conductors.

5. In the art of producing chemicals in electric furnaces, the improvement which consists in fusing in contact with the electric conductors streams of fusible material in crushed condition on its way to the interior of the furnace, and thereby cooling said conductors.

6. The method of producing chemicals in an electric furnace, which consists in gradually melting fusible material for a given reaction outside the wall of the working chamber by heat of the furnace that would otherwise be lost by radiation, and then vaporizing the same and combining it with less fusible material within such working chamber.

7. The method of producing chemicals in an electric furnace which consists in introducing a charge into the working chamber, passing a suitable electric current through the charge, gradually melting fusible material required for a given reaction within a passage or passages outside of and surrounding the wall of the working chamber by heat of the furnace that would otherwise be lost by radiation, and then combining the same in fused condition with other material within said working chamber.

8. The method of producing chemicals in an electric furnace which consists in gradually melting fusible material required for a given reaction within a passage or passages in the furnace-walls on its way to the inner part of the furnace, and then vaporizing the same and combining it with other material within said inner part of the furnace.

9. The method of continuously producing bisulfid of carbon which consists in feeding carbon and sulfur separately and continuously into the working chamber of a suitable electric furnace and toward a heat zone therein, from above and below such heat zone, there passing through the charge a suitable electric current until the reaction is effected, and carrying off and condensing the CS_2 vapor.

10. The method of continuously producing bisulfid of carbon in an electric furnace which consists in supplying the working chamber with carbon, melting sulfur on its way to the working chamber and feeding it into such chamber beneath the carbon up to a heat zone, there passing a suitable electric current through the charge until the sulfur is vaporized and the reaction is effected, and carrying off and condensing the CS_2 vapor.

11. In the continuous production of bisulfid of carbon in an electric furnace, the method which consists in melting sulfur on its way to the working chamber, there feeding the same upwardly to the heat zone and vaporizing it, feeding carbon downwardly upon the melted sulfur, and passing a suitable electric current through the charge to effect the heating.

12. In the continuous production of bisulfid of carbon in an electric furnace, the method of introducing the carbon and sulfur and regulating the electric current which consists in feeding sulfur upwardly to the heat zone within the working chamber, there vaporizing it, feeding carbon downwardly upon the sulfur, introducing between the two conducting material in fragments, and passing the electricity through the furnace by way of said fragments.

13. In the production of bisulfid of carbon in an electric furnace, the method which consists in introducing carbon and sulfur into the working chamber, passing therethrough a suitable electric current, and feeding a por-

tion of the sulfur upon the electric conductors so as to melt in contact therewith on its way to the working chamber, for the purpose of cooling said conductors.

14. In the production of chemicals within an electric furnace, the method which consists in introducing the charge, passing therethrough a suitable electric current, feeding into contact with more or less of the working surface of an electrode a non-conducting liquid, and regulating the electric current by such contact.

15. In the production of chemicals within an electric furnace, the method which consists in introducing the charge, passing therethrough a suitable electric current, and maintaining at any desired level in the furnace, with reference to an electrode, a bath of a non-conducting melted substance covering more or less of the working surface of said electrode, whereby the electric current is regulated.

16. In the production of chemicals within an electric furnace having horizontal electrodes, the method which consists in introducing the charge, passing therethrough a suitable electric current, and feeding melted sulfur upwardly more or less nearly to the top of the electrodes for the purpose of regulating the electric current.

17. In the production of chemicals within an electric furnace, the method which consists in feeding a fusible ingredient of the charge to the heat zone from beneath upwardly, feeding a less fusible ingredient downwardly to the heat zone, there passing through the charge a suitable electric current, and changing the path of the electric current through the furnace from time to time to burn out any piers of said less fusible ingredient that may prevent its regular descent, and to prevent the formation of such piers.

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