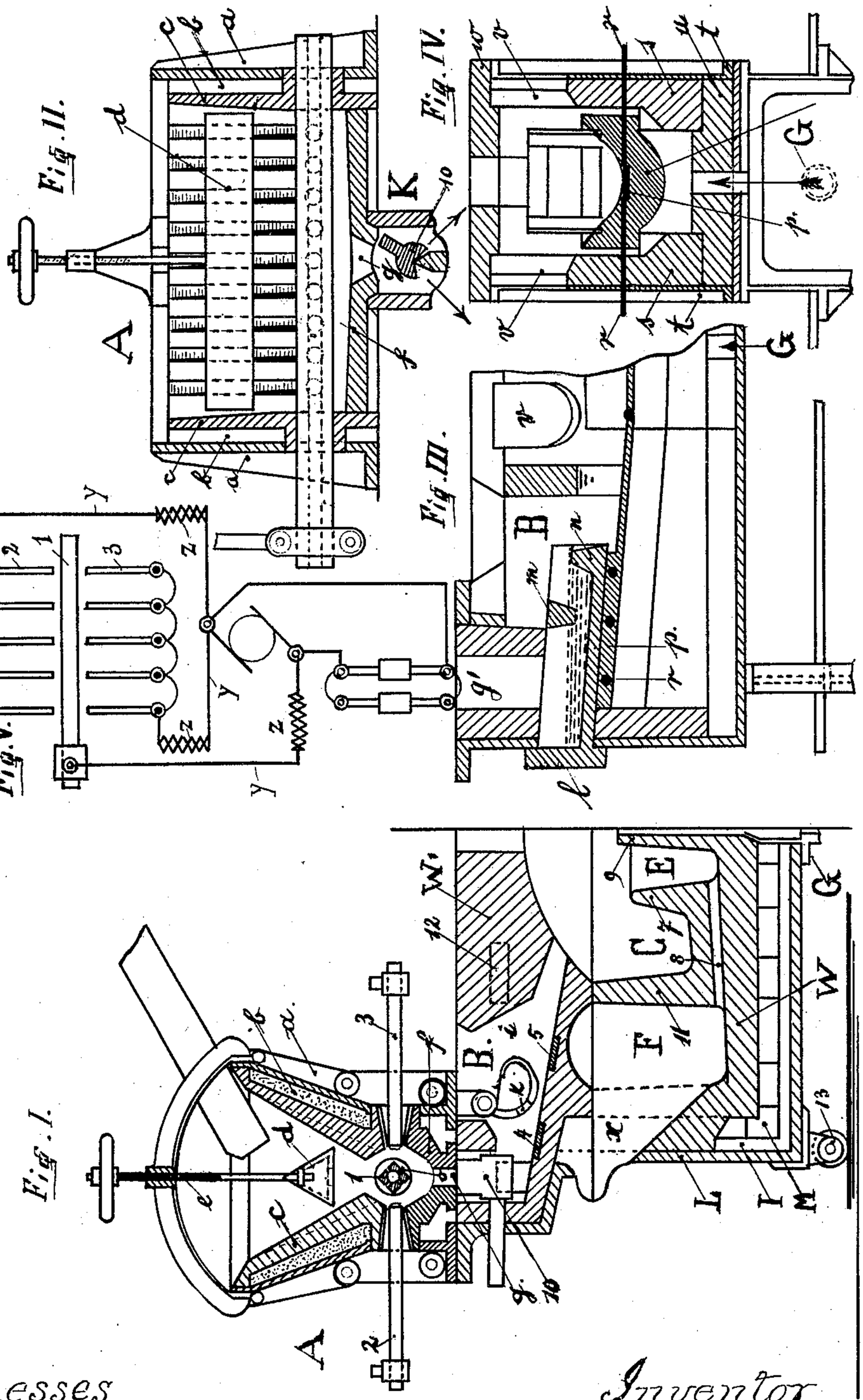
No. 698,981. Patented Apr. 29, 1902.

J. LÜHNE.

ELECTRIC FURNACE FOR MAKING GLASS, &c.

(Application filed Dec. 26, 1899.)

(No Model.)



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ELECTRIC FURNACE FOR MAKING GLASS, &c.

SPECIFICATION forming part of Letters Patent No. 698,981, dated April 29, 1902.

Application filed December 26, 1899. Serial No. 741,637. (No model.)

To all whom it may concern:

Be it known that I, JOHANN LÜHNE, engineer, a subject of the German Emperor, residing at Aachen, Germany, have invented certain new and useful Improvements in Electric Furnaces for Making Glass and other Analogous Substances; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to an electric smelting-furnace for the production of glass and like substances, the object of the invention being to generally improve the construction and operation of such furnaces.

With this object in view the invention consists in the improved construction, arrangement, and combination of parts hereinafter fully described, and afterward specifically pointed out in the claims appended hereto.

In the accompanying drawings, Figure I represents a view in vertical section of a furnace constructed in accordance with my invention. Fig. II represents a view in vertical section of the preliminary-smelting furnace, the section being on a plane at right angles to that of Fig. I. Fig. III represents a modification in vertical section of the lower parts of the furnace, a small portion being broken away on the right hand of the figure. Fig. IV represents a vertical sectional view of the parts shown in Fig. III on a plane at right angles to that of said Fig. III. Fig. V represents in diagram the electrodes and electrolytes and their electric connections.

The exterior envelop of the smelting apparatus A is composed of a casing *a*, the side walls of which are inverted downwardly, as shown in Fig. I, and the inner surface of the casing is provided with a fireproof lining in such a manner that between the casing *a* and the fireproof lining *c* a space *b* remains, which is filled with a material non-conducting the heat, such as kieselguhr, ashes, or glass-wool.

In the lower part of the smelting apparatus the electrodes are arranged in the following manner: The negative electrode 1 is embedded in an opening through the fireproof material parallel to the longitudinal axis of the apparatus and is insulated at both ends, while the positive electrodes 2 and 3 are embedded at right angles to the negative electrode, passing through fireproof twyers and projecting through the casing in a horizontal direction from both sides. More or less positive electrodes 2 and 3 can be placed side by side in parallel lines, depending on the length of the smelting apparatus. The upper part of Fig. V shows the mode of connection of the electrodes. Preferably the ends of the positive electrodes on one side are connected, thus forming positive groups, which are connected with the positive pole of the source of electricity by means of a conductor *y*. The negative electrode 1 is connected to the other pole of the source of electricity by means of a similar conductor *y*. In order to regulate the amount of current in the conductors *y*, resistances *z* are placed into them. The channel surrounding the negative electrode leaves sufficient space around the latter, so that the material can pass between the walls *c* and the electrode 1 and can fall between the electrodes 1 and 2 on one side and between the electrodes 1 and 3 on the other side, so as to come in contact with the arc formed between the different electrodes. The bottom of the channel is inclined toward the middle, as shown in Fig. II, and is provided with an opening *g*. The negative electrode is made hollow and is of a square cross-section on the outside. A number of holes *o* are drilled through the walls, establishing a communication between the inner space of the electrode with the surrounding space. The negative electrode is preferably so positioned that two of its diagonally opposite longitudinal edges are right in front of the ends of the positive electrodes, thus facilitating the formation of the arc. One end of the hollow negative electrode is closed, while the other end is provided with a joint, through which hydrocarbon gas can be admitted.

The space of the smelting apparatus *a* above the electrode 1 is crossed by a prismatic body *d*, of fireproof material, such as a suitable clay, extending longitudinally and parallel to the electrode 1 through said space and being of triangular cross-section, as shown in Fig. I. Said body *d* is made adjustable vertically by means of a screw-spindle *e*, so

that the descending of the material in the hopper may be regulated at will. The inner fireproof sides *c* are provided with channels extending vertically, as shown in Figs. I and II. The bottom of the channels is indicated in Fig. I by a dotted line.

Below the opening *g* in the bottom of the smelting apparatus a valve 10 is arranged for a purpose which will be hereinafter explained.

The space B below the smelting apparatus has an inclined bottom, into which conductors of second degree, 4 and 5, are embedded, composed in a well-known manner of oxids of Be, Ca, Zn, Ti, or analogous materials, the ends of which are connected with the poles of a source of electric energy, as indicated in the lower part of Fig. V.

In the space or channel B a device *i* serves to accumulate impurities gathered on the top of the liquid glass. This device consists of a trough arranged in hinges having in its lower part openings or slots. When the masses of glass descend in the channel B, the impurities resulting from carbon of the electrodes or other sources being lighter than the glass remain on the surface of the mass and glide the slit-opening K of the trough *i* into the same and are removed therefrom laterally by a tool, such as a hook. The mass flows into the space C over the ring-wall 7 into space E, and hence through channels 8 into space F.

The devices for gathering the impurities from the surface of the glass and the devices for maintaining the temperature may be modified, as indicated in Figs. III and IV. In these figures the molten mass flows into an adjustable vat *l*, coöperating with a bridge *m*. By bringing the rear wall *n* of the vat almost in contact with said bridge all the impurities will be retained and only clear glass will flow out at the lower end. By pushing the vat into the position Fig. III the accumulated slags may then be allowed to run out. The vat rests on the bottom *p*, composed of a material being a conductor of second class and in which conductors *r* of metal are embedded. The conductors *r* project outwardly through the side walls *s* and are connected with each other on each side, the group on one side being connected with the positive pole and the group on the other side with the negative pole of the source of electricity, as shown in Fig. V. The conductors *r* receive no current as long as the apparatus is cold; but when the molten glass descends into the space B or heating-air is led over the bottom *p* the latter will be strongly heated and the material composing the bottom becomes a conductor, and the current will pass through the conductors *r* from one side of the apparatus to the other side. However, the material of the bottom *p*, even in a heated state, offers to the passage of the electric current a comparatively great resistance, and thereby a corresponding amount of electric energy is transmitted into heat, which is now made use of to maintain the liquid glass at an elevated temperature, such as is desirable for the work.

Around the parts W and W′ the gases may circulate through the channel 12, as well as feed-air.

M is a heating-channel.

L is the metallic casing of the furnace, and I is a fireproof lining therefor.

G is a ring or nipple through which pipe 9 passes into the furnace.

The above-mentioned second-class conductors 4 and 5 are intended for the same purpose.

In cases of production of ordinary impure glass the mass can be allowed to flow from the rear wall *n*, Figs. III and IV, into the space B, whence it is taken through the openings *v* by the glass-blowers. It is evident that also here the glass may be maintained electrically at a suitable high temperature, or to this end the introduction of heating-gases may be employed, as explained below.

The mode of operation of the apparatus is as follows: The raw material is allowed to pass through a spout into the hopper, Fig. I, or smelting apparatus A, being open at the top. Then the material passes out between the regulator *d* and the walls *c*, going, preferably, through the channels or grooves in the walls *c*. Then it comes between electrodes 1 and 2 and 1 and 3, where it becomes molten by the electric arcs. Hydrogen gases or a mixture of hydrogen and air are admitted simultaneously into the hollow space of the negative electrode 1, and the gas escapes through the openings *o*, where it is ignited by the arcs. Thus the electrode 1 is prevented from being cooled by the descending mass and by the cool gases, and a greater heat is produced in the smelting zone. Moreover, the resistance between the electrodes is increased, and thus greater length of arc is obtained. It is not necessary that all particles of the material should pass through the electric arcs, for the intense heat of the arcs and the heat produced by the combustion of the hydrogen is fully sufficient to melt the material passing out between two arcs. The liquid mass gathers on the bottom *f* and escapes through the opening *g* into the space B, where it comes in contact with the second-class conductors 4 and 5, embedded in the bottom, thus heating the same, whereupon an electric current circulates through these conductors. While the mass is flowing down along the inclined bottom of the space B, the trough *i* rests on the glass and allows all the impurities on the top of the same to pass through the lower slots. Thus the impurities, pieces of carbon resulting from the electrodes, slags, &c., collect in the trough and can be easily removed without disturbing the work or action of the furnace.

When a vat *l*, Figs. III and IV, is employed, the action is somewhat similar to the above explained.

The electrical smelting apparatus A can melt considerable quantities in a short time. Therefore it is of advantage to provide the same with two working vats, and to this end the valve 10, as indicated in Figs. I and II, is made use of to allow the liquid mass to pass either into one or into the other of the two vats or simultaneously into both by placing the valve 10 into respective positions, which will be understood without further explanation.

The temperature in the vats can be maintained by leading combustible gases through the opening *g* into the furnace and by pouring the same in a suitable space provided under the vats. The hot productions of combustion may be used also to heat the walls of the furnace and the spaces and channels through which the liquid glass is flowing.

An automatic advance of the positive electrodes is effected in any well-known manner—such, for instance, as in arc-lamps.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent of the United States, is—

1. In an electric smelting-furnace, the combination of a smelting-chamber having a longitudinal discharge-opening and a single negative electrode longitudinally arranged in said discharge-opening with a plurality of transversely-arranged positive electrodes in the same horizontal plane on each side of the negative, substantially as described.

2. In an electric smelting-furnace, the combination with a hopper-shaped smelting-chamber having a longitudinal bottom opening, and provided with vertically-extending corrugations in the inner surfaces of its side walls, of a single horizontal electrode lying longitudinally in the said opening, and a plurality of transverse electrodes in the same horizontal plane ending near the longitudinal electrode and located in the vertical planes of the grooves of the corrugated sides, substantially as described.

3. In an electric smelting-furnace, the combination of a smelting-chamber having a longitudinal discharge-opening and a single negative electrode arranged longitudinally in said discharge-opening, with a plurality of transversely-arranged positive electrodes in the same horizontal plane on each side of the negative electrode, the negative electrode being prism-shaped in cross-section and presenting opposite sharp corners toward the positive electrodes, substantially as described.

4. In an electric smelting-furnace, the combination of a smelting-chamber having a longitudinal discharge-opening and a single negative electrode longitudinally arranged in said discharge-opening, with a plurality of transversely-arranged positive electrodes in the same horizontal plane on each side of the negative electrode, the negative electrode being bored longitudinally and transversely for the passage of air and gas, substantially as described.

5. In an electric smelting-furnace, the combination of a smelting-chamber having a longitudinal discharge-opening and a single negative electrode longitudinally arranged in said discharge-opening, with a plurality of transversely-arranged positive electrodes in the same horizontal plane on each side of the negative electrode, the negative electrode being bored longitudinally, having one end of the said bore closed, and there being provided side outlets from the bore, whereby gas and air may be passed through, substantially as described.

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

J. LÜHNE.

Witnesses:
H. REUTERS,
C. E. BRUNDAGE.