6 Sheets—Sheet 1.

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Zinc-Furnace.

No. 220,831. Patented Oct. 21, 1879.

Fig I

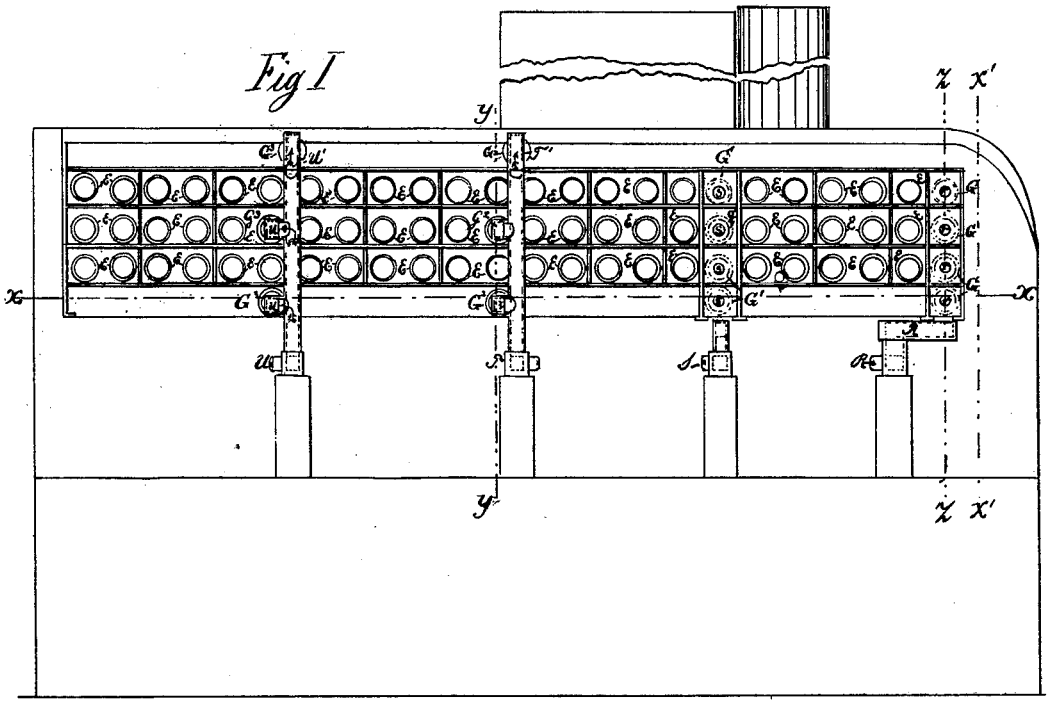
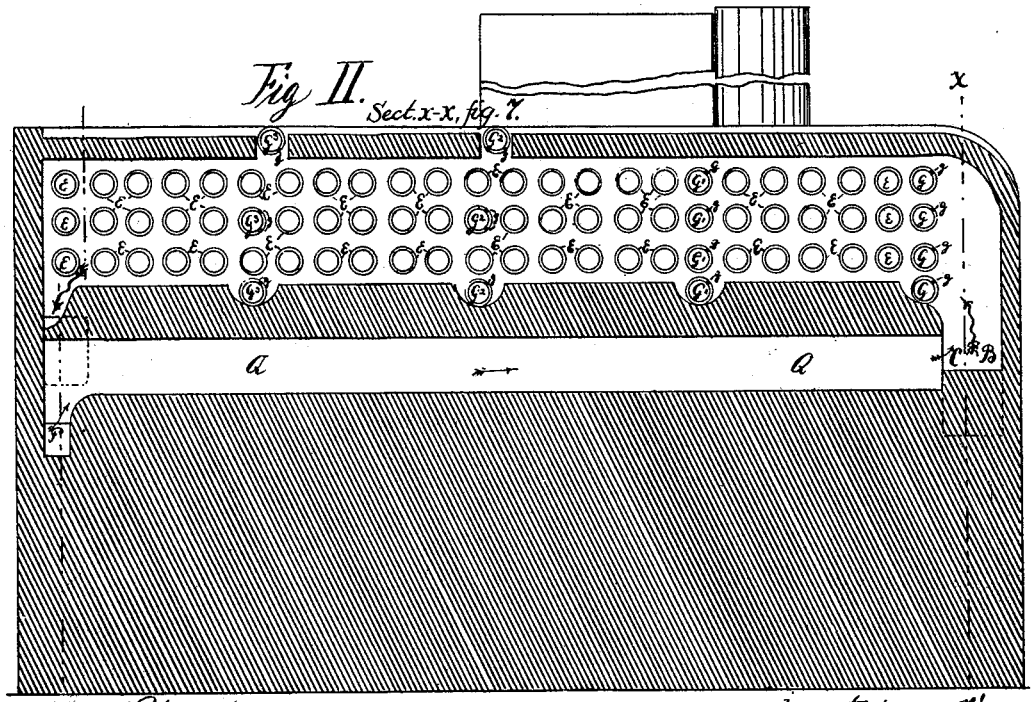


Fig II. Sect. x-x, fig. 1.



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x'

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Zinc-Furnace.

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Fig. III

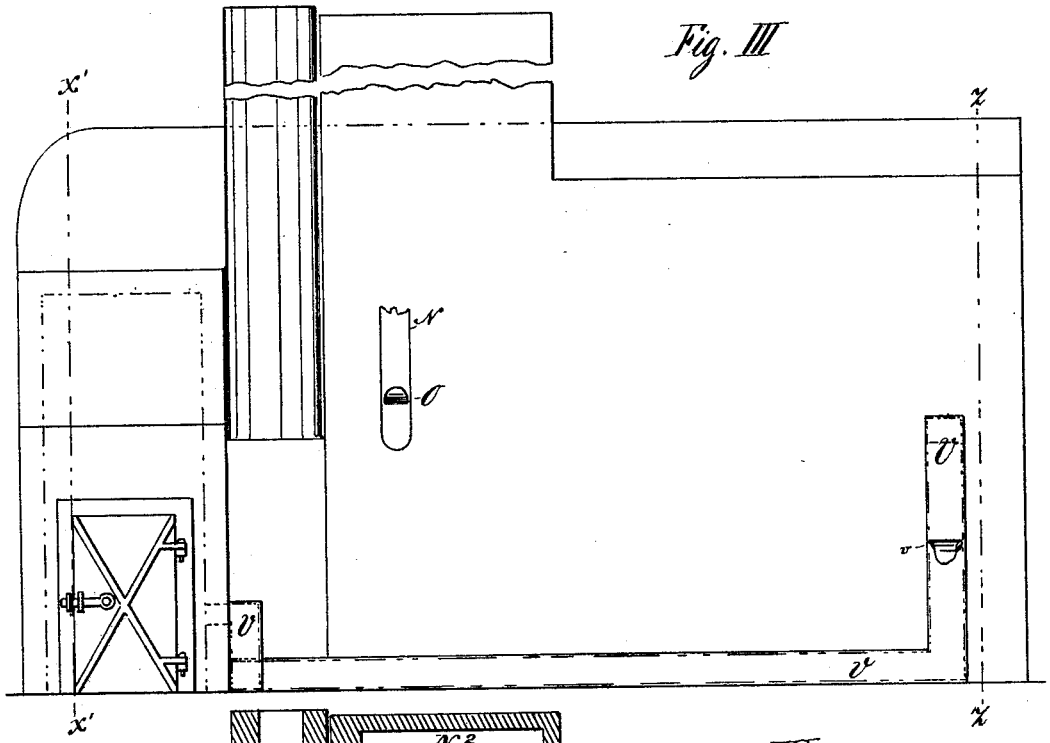
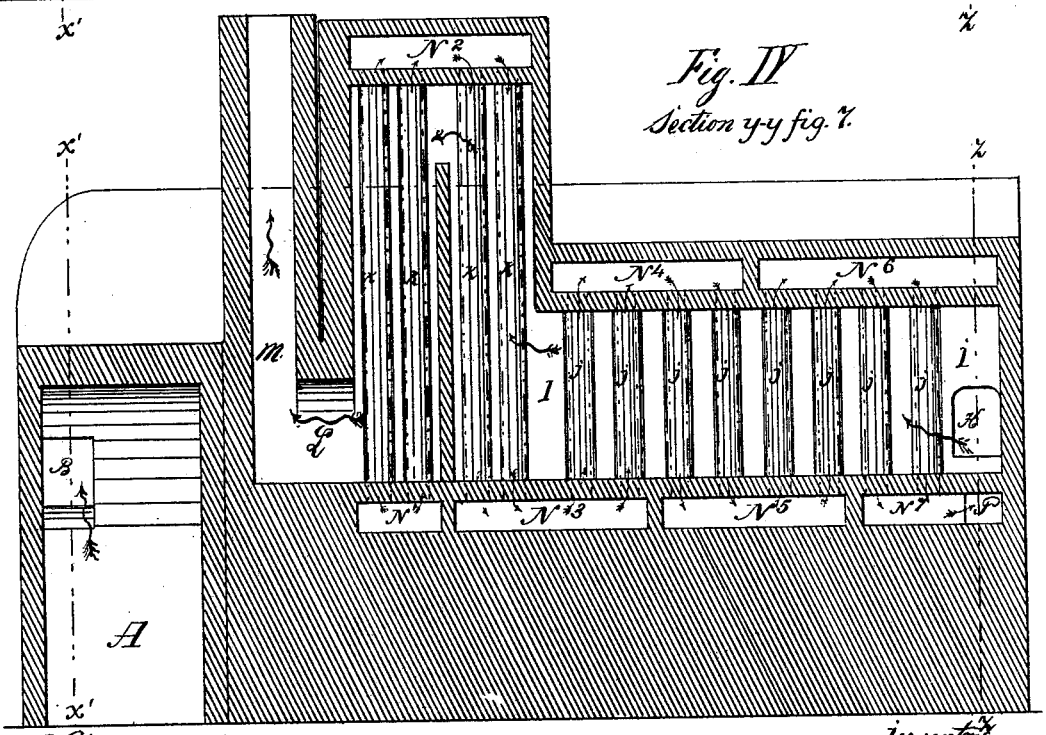


Fig. IV

Section y-y fig. 7.



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Zinc-Furnace.

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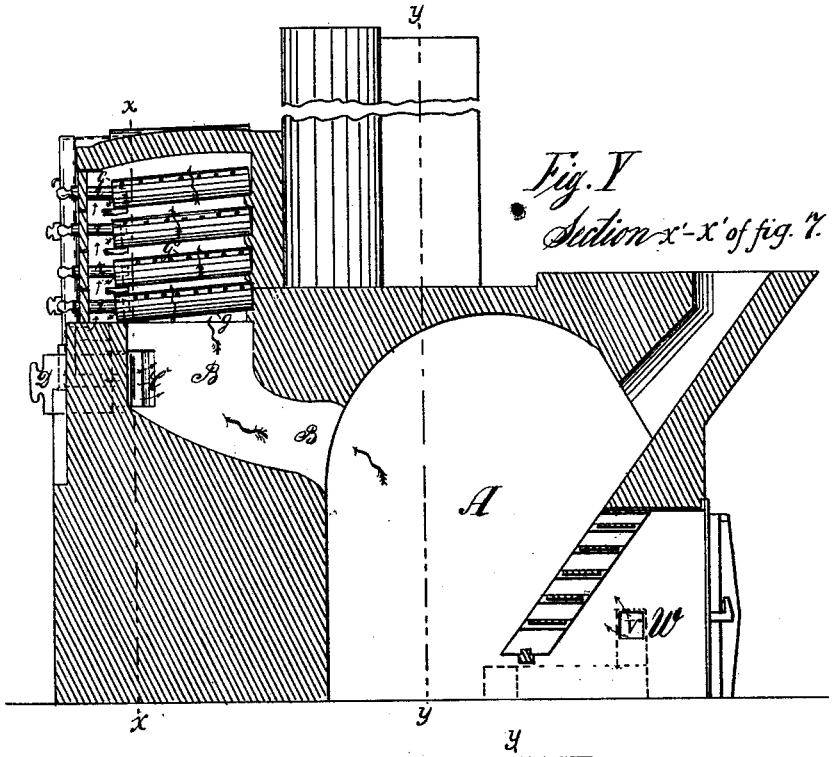

Fig. V
Section x'-x' of fig. 7.

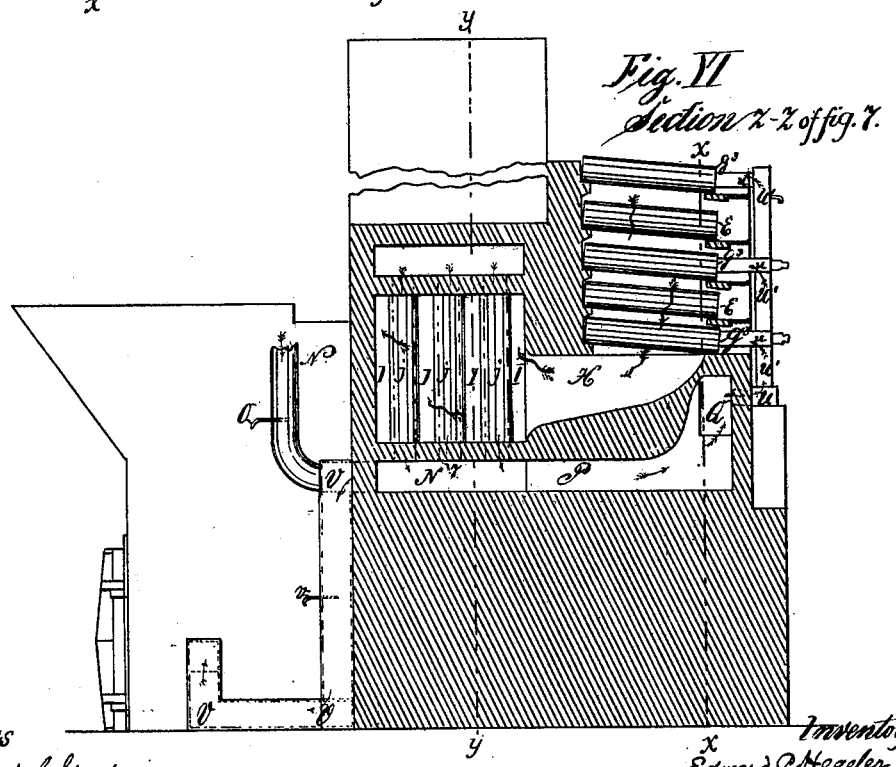

Fig. VI
Section z-z of fig. 7.

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Zinc-Furnace.

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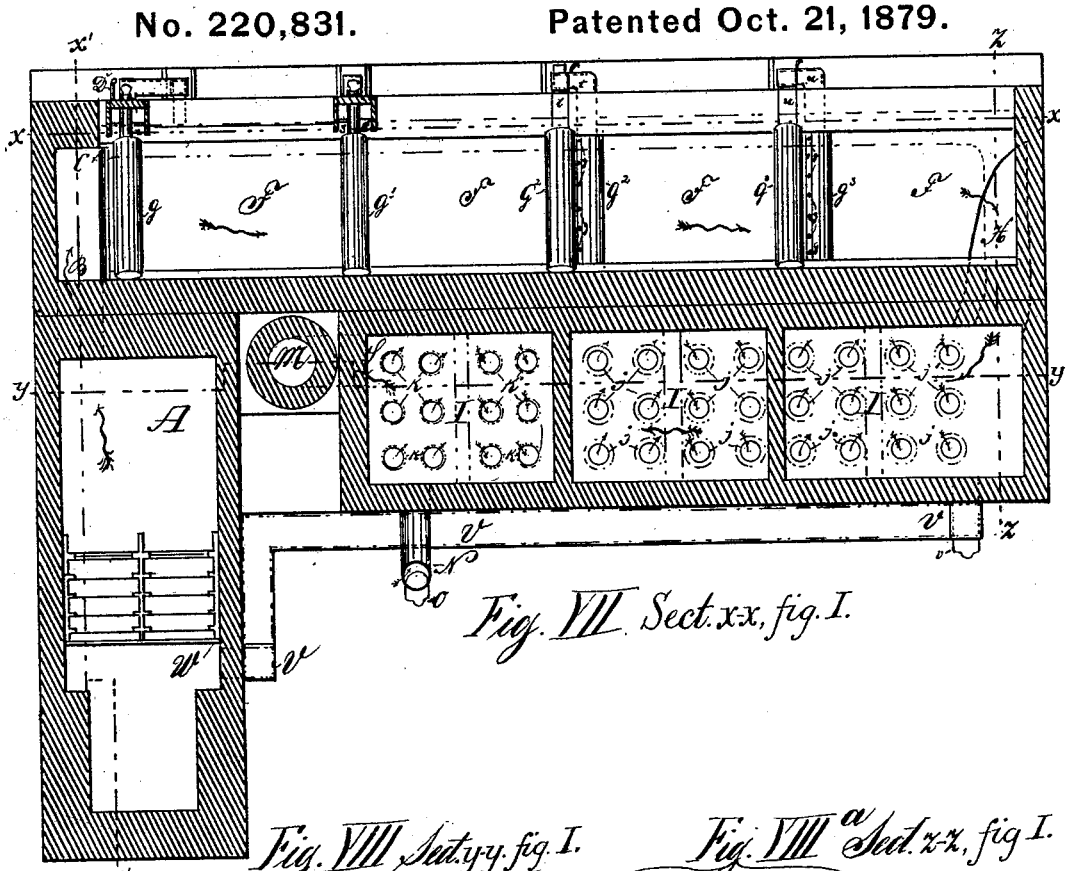


Fig. VII Sect. x-x, fig. I.

Fig. VIII Sect. y-y. fig. I.

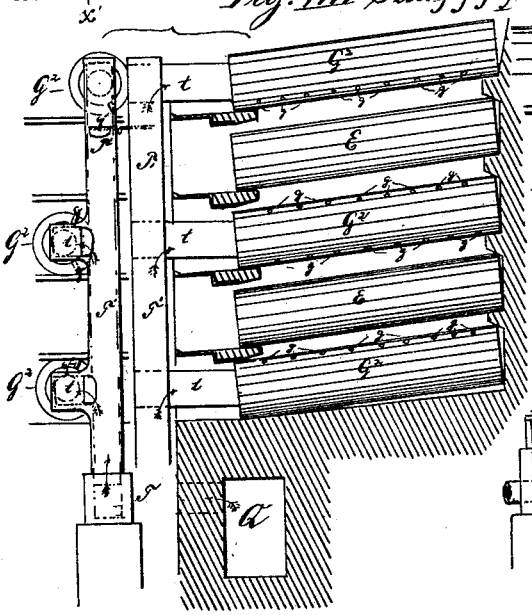
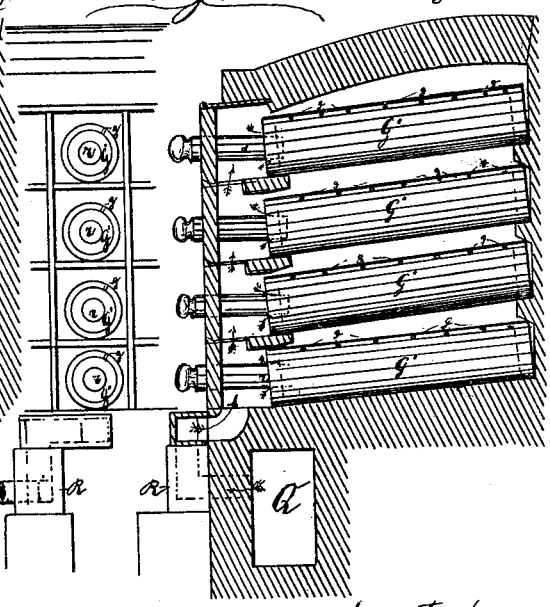


Fig. VIII a Sect. z-z, fig I.



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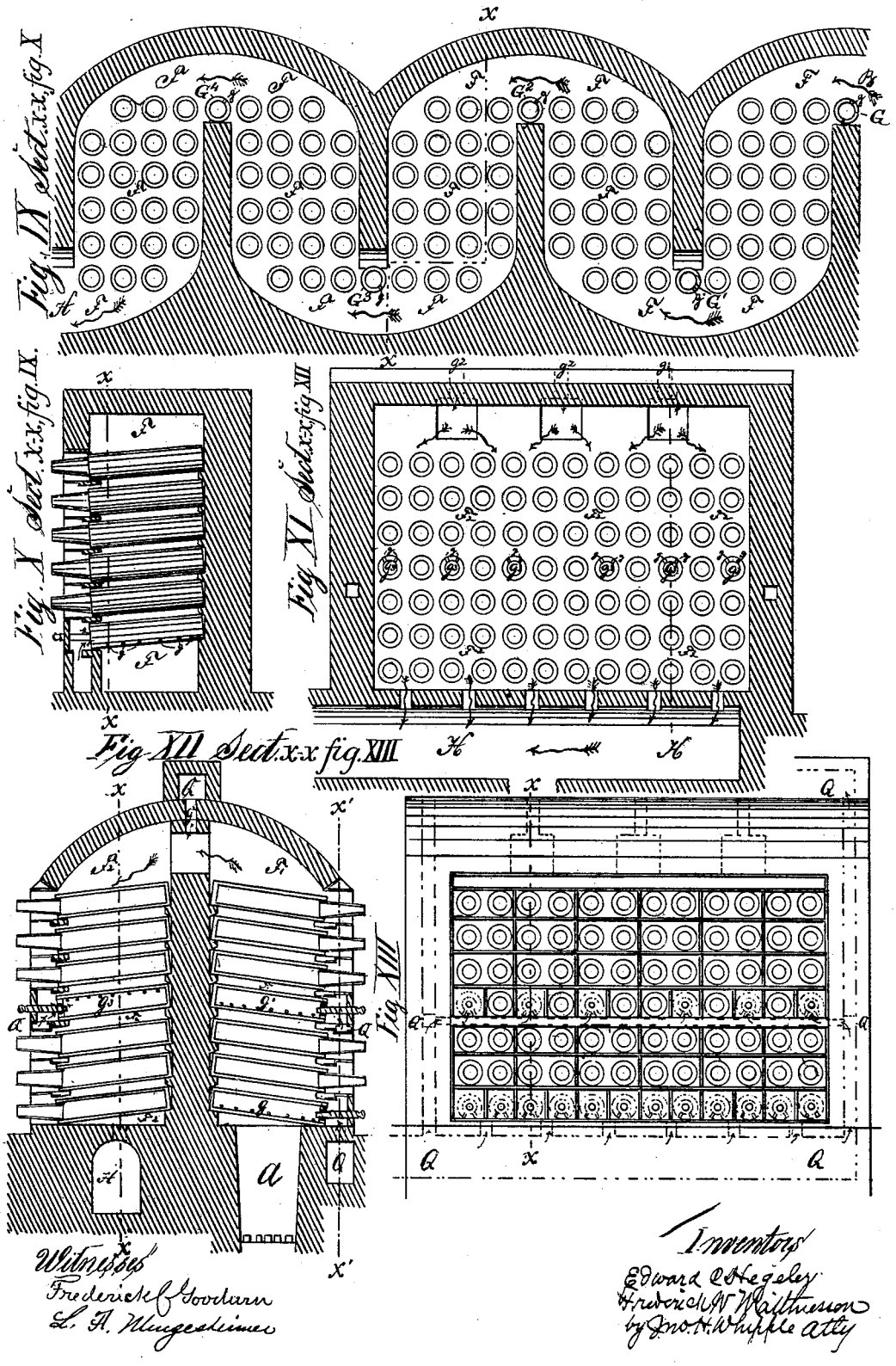

6 Sheets—Sheet 6.

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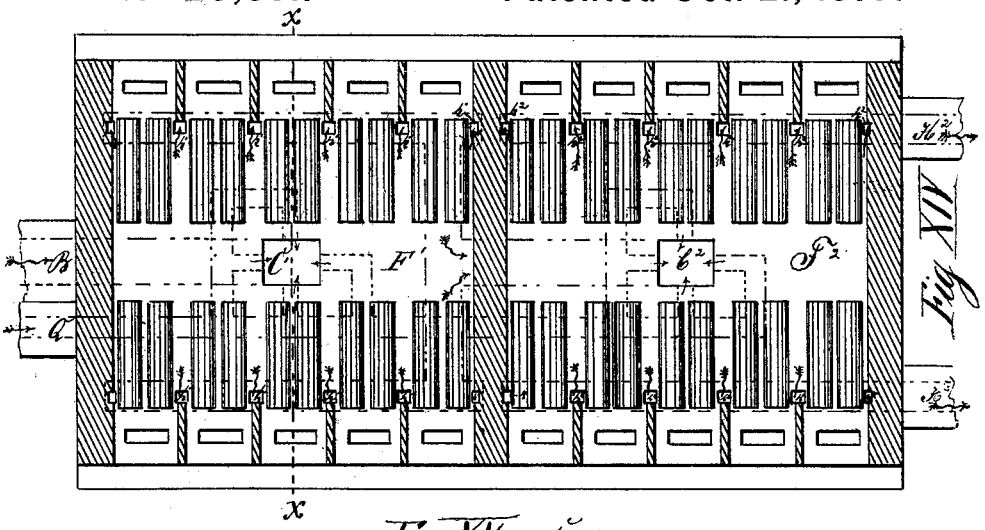


Fig XIV

Fig XV Sect. x-x, fig. XVI.

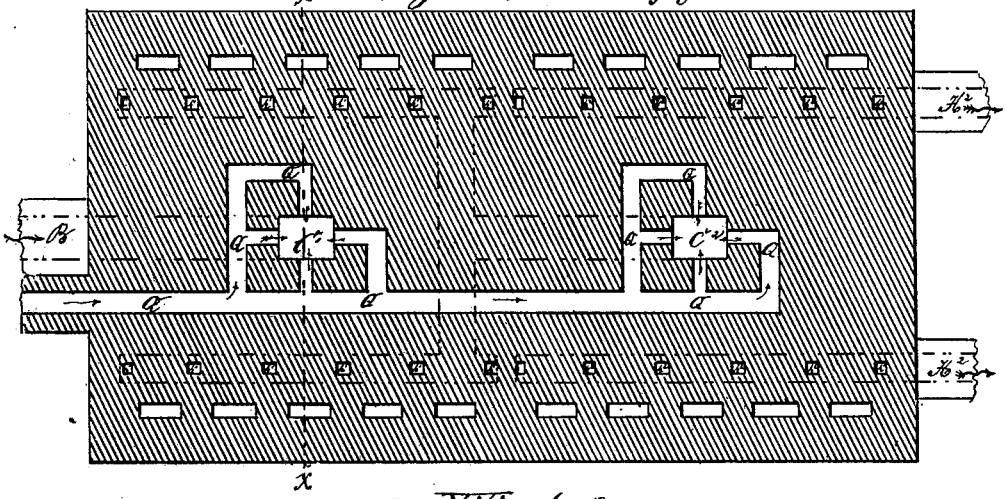
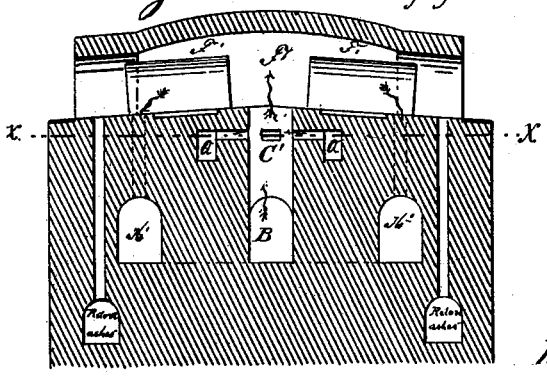


Fig XVI Sect. x-x, fig. XIV.



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UNITED STATES PATENT OFFICE.

EDWARD C. HEGELER AND FREDERICK W. MATTHIESSEN, OF LA SALLE, ILLINOIS.

IMPROVEMENT IN ZINC-FURNACES.

Specification forming part of Letters Patent No. **220,831**, dated October 21, 1879; application filed March 6, 1879.

To all whom it may concern:

Be it known that we, EDWARD C. HEGELER and FREDERICK W. MATTHIESSEN, of La Salle, in the county of La Salle and State of Illinois, have invented a new and useful Improvement in Furnaces for Manufacturing Spelter or Metallic Zinc, of which the following specification is a full, clear, and exact description, reference being had to the accompanying drawings and the letters of reference marked thereon.

This invention relates to that class of furnaces in which the zinc is manufactured in fire-clay retorts, or muffles of any form. In furnaces of this class, in which the retorts are heated from the outside, it is desirable to give a uniform heat to a large number of retorts in the most economical way, and at the same time have these retorts easily accessible to the manual labor of charging and cleaning them and taking the zinc from the condensers, &c.; and the object of this invention is to accomplish these ends better and more fully than the furnaces now known and used.

The invention consists, first, in a series of retort-chambers, or, preferably, of a flue-like chamber, arranged vertically, up and down, or zigzag, or horizontally, through which the partially-burned gases from a gas-generator or direct thick grate-fire enter and pass along for the purpose of being burned to heat the retorts, being further burned on their passage along through the series of chambers or long flue-like chamber by air admitted between the chambers or at intervals along the long flue-like chamber, or both, so that such gases shall be completely burned at or in the last chamber or extreme end of the flue-like chamber; and, second, in the use of hot air admitted at intervals into the retort-chamber for the combustion of the gases in the furnace, and admitted into the fire under the gas-generator for their production in the gas-generator, which is made practicable for these purposes, especially the former, without destructive effect on the retorts by this invention.

The arrangement of the retorts in a long flue being made practicable by the gradual combustion of the gases by installments, it is a separate part of our invention to arrange the long flue-like chamber horizontally, thereby making the retorts easily accessible for charging and cleaning from one floor, as the comparatively greater velocity of the gases in the direction of the flue's axis (caused by its narrow interior profile when compared to its length) will cause them to pass along in the flue-like chamber, when arranged horizontally, nearly as rapidly at its bottom as at its top side. As the heating of the air used for the burning of the gases in the furnace, as well as their production in the gas-generator, can be done by a separate fire, or by the burned gases after passing from the last chamber or extreme end of the long flue-like chamber, a great saving of fuel can be obtained by utilizing them in the manner herein shown.

The invention also further consists in the use of perforated retorts, instead of ordinary openings in the wall, for the introduction of air into the retort-chamber of a zinc-furnace between the retorts charged with ore, thereby avoiding the local cooling effect in said retort-chamber through said air. The use of ordinary wall-openings has heretofore made impracticable the introduction of air into the fire-gases, especially in the upper part of the Belgian zinc-furnace, for the combustion of the gases there.

We are aware that open retorts or "canons," so called, are used on the dividing-line between the fire-chamber and the retort-chamber of the Belgian zinc-furnace to protect the retorts charged with ore from the direct action of the fire, and also that air is admitted through them into the fire-gases before these fire-gases come in contact with the surface of the retorts charged with ore.

The improvement obtained by the use of perforated retorts for the introduction of air into the fire-gases in a retort-chamber of a zinc-furnace over the introduction of such air through plain holes in the outer walls consists in a quicker and more perfect mixture of the said air and fire-gases, and consequent combustion, thus preventing a local cooling effect in the retort-chamber, which takes place when the air is introduced by holes in the outer walls, so much as to make it usually impracticable.

Figure 1, Sheet 1, of the drawings, is a longitudinal front elevation of our improved furnace, Fig. 7, Sheet 4, being a horizontal plane of same on line *x x*, Fig. 1. Fig. 2, Sheet 1, is a vertical longitudinal section on a plane indi-2ated by line *x x*, Fig. 7, Sheet 4. Fig. 3, Sheet c, is a longitudinal rear elevation of the furnace. Fig. 4, Sheet 2, is a vertical longitudinal section on a plane indicated by line *y y*, Fig. 7, Sheet 4. Fig. 5, Sheet 3, is a vertical cross-section on a plane indicated by line *x' x'*, Fig. 7, Sheet 4, showing an end view of the furnace and gas-generator with the outer wall removed. Fig. 6, Sheet 3, is a vertical cross-section on a plane indicated by line *z z*, Fig. 7, Sheet 4, showing the opposite end view of the furnace with the outer wall removed and the rear wall of the gas-generator. Fig. 7, Sheet 4, is a horizontal plane on line *x x*, Fig. 1, Sheet 1, showing the air-retorts in perspective and the ore-retorts omitted. Fig. 8, Sheet 4, is a vertical cross-section on line *y y*, Fig. 1, Sheet 1. Fig. 8ª, Sheet 4, is a vertical cross-section on line *z z*, Fig. 4, Sheet 1. Fig. 9, Sheet 5, is a vertical longitudinal section on a plane indicated by line *x x*, Fig. 10, Sheet 5, showing the long retort-chamber arranged in zigzag form. Fig. 10, Sheet 5, is a vertical cross-section on the line *x x*, Fig. 9, Sheet 5. Fig. 11, Sheet 5, is a vertical longitudinal section on line *x x*, Fig. 12, Sheet 5. Fig. 12, Sheet 5, is a vertical cross-section on line *x x*, Fig. 13, Sheet 5. Fig. 13, Sheet 5, is a front or side longitudinal view of Fig. 12, Sheet 5, on a plane of line *x' x'* of said Fig. 12. The figures 11, 12, and 13, Sheet 5, show a common Belgian furnace altered to apply our invention. Figs. 14, 15, and 16, Sheet 6, show a common Silesian muffle-furnace altered to apply our invention, Fig. 14 being a top view with the arch removed, to show the retorts or muffles, Fig. 15 a horizontal plane on line *x x*, Fig. 16, and Fig. 16 a vertical cross-plane on line *x x*, Fig. 14.

Like letters of reference indicate like parts in the several figures of the drawings.

A is a gas-generator. B is a gas-flue, into which sufficient air is admitted from air-flue C at valve D to increase, by combustion, the temperature of the gas nearly to the degree required at the outside of retorts E, being those charged with ore. F is the horizontal flue-like retort-chamber, in which the retorts E G G' G^2 G^3 are supported at one end on steps in the back wall and at the other on shelves in front.

As the partially-burned gases enter chamber F they first pass over and between air-retorts G, having the perforations *g g*, through which perforations a sufficient amount of additional air is admitted to raise, by further combustion, the temperature of the gases to the full degree required on the outside surface of a portion of the nearest retorts, E, charged with ore, to reduce the ore within. The heat of the gases being partially absorbed by such retorts through the chemical process of reduction and evaporation of zinc taking place inside of them, the temperature of the gases is gradually reduced on their forward march between the retorts E, so that, arriving at air-retorts G', an increase of their temperature is desired. This is reached by a small amount of heated air entering through perforations *g g* in the retorts G'. The gases pass along between a farther portion of retorts E, charged with ore, gradually decreasing in temperature, as before described, meeting in G^2 an additional amount of hot air entering through the perforations *g g* in air-retorts G^2, causing the further combustion of the gases and again increasing their temperature, which is again reduced by their passing through another set of retorts charged with ore, and again increased by another admission of hot air from another set of air-retorts, G^3, and so on, repeating the operation as long as the progressing fire-gases contain any combustible gases.

H is a flue, through which the worn-out fire-gases are conducted from the extreme end of the flue-like retort-chamber F to chamber I of the air-heating apparatus, passing in said chamber I, over the outside surfaces of fire-clay pipes J and iron pipes K, contained within said chamber I, and thence into and through flue L, into chimney M, from which they are finally discharged.

The gas-generator A, gas-flue B, retort-chamber F, flue H, chamber I, flue L, and chimney M are connected, respectively, with each other in the order here stated, so as to form a continuous open way for the fire-gases to pass from the gas-generator A to and through the furnace, and thence to and through the air-heating apparatus and to the chimney, to be discharged, as stated. (See Figs. 5, 6, 7.) The forward course of the fire-gases is indicated in the drawings by the serpentine arrows.

N, Figs. 3, 6, 7, is a pipe with valve O, through which cold air or blast (from a fan) enters the iron pipes K, and passes upward through a part, and downward through another part, as shown in the drawings by the straight or curved arrows, being heated therein to a considerable degree, and passing on into fire-clay pipes J, and through them, as shown by such arrows, where it is heated thoroughly to a high degree of heat.

The pipes K and *j* are open at each end, and extend through the walls or floors which support them at their ends, into the open space above and below, which open space is partitioned off into compartments N' N^2 N^3 N^4 N^5 N^6 N^7, as shown in Fig. 4, Sheet 2, in such manner as to cause the air to be blown or drawn through the pipes from the first compartment, N', into which the cold air from pipe N is emptied, up through two of the said pipes K, into compartment N^2 above, and down through the other two pipes K into compartment N^3 below, and so on through pipes *j*, until it reaches compartment N^7, as shown. Flue P is connected with this last compartment N^7, and conveys the hot air therefrom to the flue Q, which extends along the entire length of the furnace and is located below the front ends of the air-

retorts G G′ G² G³. (See Figs. 2, 6, 8.) Out of flue Q a portion of the hot air is carried by the branch flues R S T U, extending from Q up in front of or near the said air-retorts, respectively. These branch flues have smaller flues *r s t u*, connecting with each of the said air-retorts, and at the junction of the branch flues R S T U with flue Q are valves R′ S′ T′ U′, by which the amount of hot air admitted into the branch flues may be regulated, and the smaller flues *r s t u*, connecting the said air-retorts, also have valves *r′ s′ t′ u′*, by which the amount of hot air admitted into each of the said air-retorts is regulated, so that the hot air may be entirely shut off from some of said air-retorts and left onto others wholly or only partially, as the operator may desire; and the hot air thus admitted into the air-retorts passes out through the holes *g g* into the furnace for the burning of the fire-gases, as before described. (See Figs. 1, 8, 8ª.) The flue Q is also connected with the gas-flue B by a short flue, C, which has a valve D, (see Figs. 2 and 7,) by which a regulated amount of the hot air from Q may be introduced into said gas-flue B, as and for the purpose before described.

Connected with the flue P, at or near its junction with the compartment N⁷, is a flue, V, with a valve, *v*, (see Figs. 3 and 6,) by which flue and its valve a regulated amount of hot air is carried into the chamber W, Fig. 5, under the gas-generator A, to be admitted into the fire in the gas-generator and used instead of cold air in generating the gases. The air-pipes N K *j*, compartments N′ to N⁷, and pipes P Q R S T U V are so connected with each other, respectively, as to form an open way from the mouth of N, where cold air is admitted to and through the various valves described, when open, into the furnace and the fire in the gas-generator in regulated quantities in the manner described, there being sufficient air-pressure, caused by the draft of the furnace, or by a blast-fan, to make the hot air flow into the furnace at any point, or into the fire in the gas-generator, when the proper valves are open.

The particular devices described for conducting the hot air, or cold air instead, to and regulating its introduction into the air-retorts G G′ G² G³ may, as a matter of course, be varied and otherwise adapted to accomplish the ends sought; and so far as relates to the use of the series of chambers or long flue-like chamber, considered without reference to whether hot or cold air is to be used, the whole hot-air apparatus may be dispensed with, as well as blast substituted by the draft of a chimney, and cold air introduced through ordinary apertures in the wall or in the projecting ends of the perforated air-retorts, which in the latter case need not lie in the regular rows necessitated by the blast or hot-air pipes.

As before stated, Figs. 9 and 10, Sheet 5, show the cross-sections of a furnace built with application of our invention in zigzag shape. The fire-gases from a grate-fire, or the partially-burned gases from a generator, enter the zigzag-shaped retort-chamber F at B, receiving through the perforations *g g* * * of air-retort G a small amount of additional air, then after passing along downward through the retorts contained in the first compartment of chamber F, receive through air-retorts G′ another installment of air, then passing upward to the second compartment, receive through air-retort G² another installment of air, then passing downward again through the third compartment, through G³, another installment of air, and so on until they pass at H out of the zigzag retort-chamber F, and pass to the chimney or an air-heating apparatus, as before described.

Figs. 11, 12, and 13, Sheet 5, show a pair of common Belgian furnaces altered to apply our invention, being thereby heated by one fire instead of two. The fire-gases from the grate A, or, instead, a gas-flue connected with a generator, enter the one furnace-chamber F′ from the bottom, meet in it additional air passing in through the perforations in the air-retorts *g*, pass farther upward, and again receive air through air-retorts *g′*, pass farther upward and under the arch spanned anew over both furnaces, meeting additional air introduced through openings *g²* in the top of the arch, then passing downward through the other furnace-chamber, F², meeting through air-retorts *g³* another installment of air, then passing farther downward to the escapement-flue, and farther to the chimney or air-heating apparatus. With Q are marked the flues leading the cold or hot air to the air-retorts.

Figs. 14, 15, and 16, Sheet 6, show a double Silesian muffle-furnace altered, so as to apply our invention, the use of heated air being assumed for the combustion of the gases. The gases from a generator come through flue B to the muffle-chamber F′, meeting before entering it, at C′, the heated air coming through flue Q from an air-heating apparatus in such quantity as only partially to burn them, but so much as to produce in chamber F′ the required heat, then pass through flues *h′ h′ h′* * *, and H′ H′ to the other muffle-chamber, F², meeting, previous to their entrance, in C², an additional amount of air, so as to burn them completely; then passing out through flues *h²* *h²*, * *, and H² H² to an air-heating apparatus. In the same manner a third muffle-chamber could be heated, depending on the perfection of the air-heating apparatus.

We do not claim, generally, the combination of several retort-chambers in one zinc-furnace; nor, generally, the construction of the retort-chamber of a zinc-furnace in the form of a (more or less) long flue; nor, generally, the construction of air-inlets into the retort-chamber of a zinc-furnace; nor, generally, the connection of an air-heating apparatus with a zinc-furnace to heat the air used in the generation and combustion of the gases heating the same; nor the admission of air through the open retorts or

canons lying on the dividing-line between the fire-chamber and retort-chamber of the Belgian zinc-furnace; but,

Having thus described our invention, what we claim, and desire to secure by Letters Patent, is—

1. In a zinc-furnace, several retort-chambers in a connected series, through which the fire-gases successively pass, in combination with intermediate inlets for the admission of air, substantially as set forth.

2. In a zinc-furnace, a flue-like retort-chamber, through which the fire-gases pass in the direction of its greatest extension, in combination with inlets at intervals throughout its length for the admission of air, substantially as and for the purpose specified.

3. In a zinc-furnace, a flue-like retort-chamber, through which the fire-gases pass in the direction of its greatest extension, the greatest extension of said flue-like retort-chamber being in a horizontal line, in combination with inlets at intervals of its length for the admission of air, substantially as and for the purposes specified.

4. In a zinc-furnace, a retort chamber or chambers having intermediate air-inlets of the character specified, in combination with an air-heating apparatus, substantially as set forth.

5. In a zinc-furnace, a retort-chamber having retorts, in combination with interposed perforated retorts, serving as inlets for air into the fire-gases after said fire-gases have passed over the surface of a portion of the ore-retorts, substantially as specified.

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