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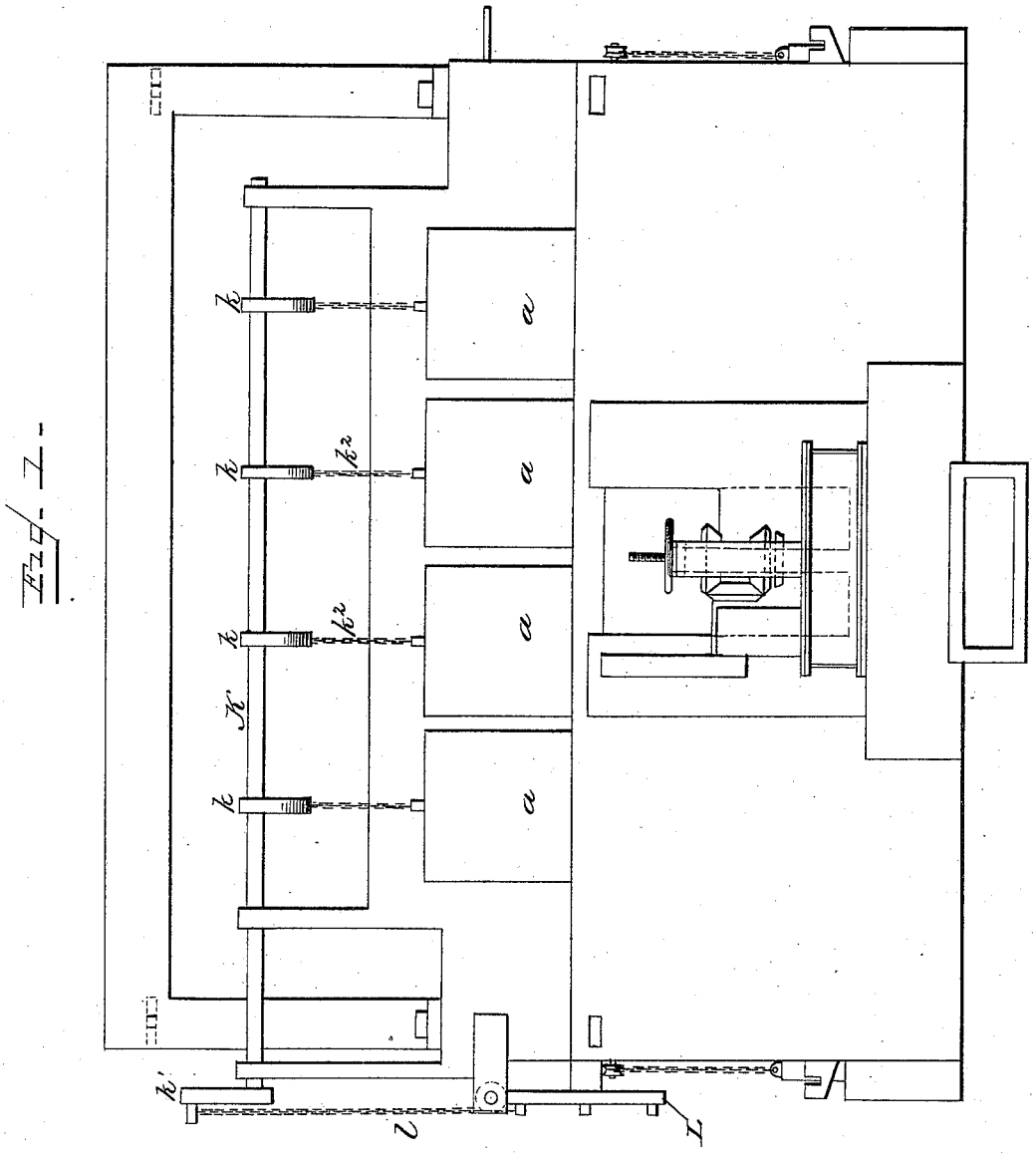
I. HAHN.

FURNACE FOR THE MANUFACTURE OF GLASS, IRON, &c.

No. 302,724. Patented July 29, 1884.



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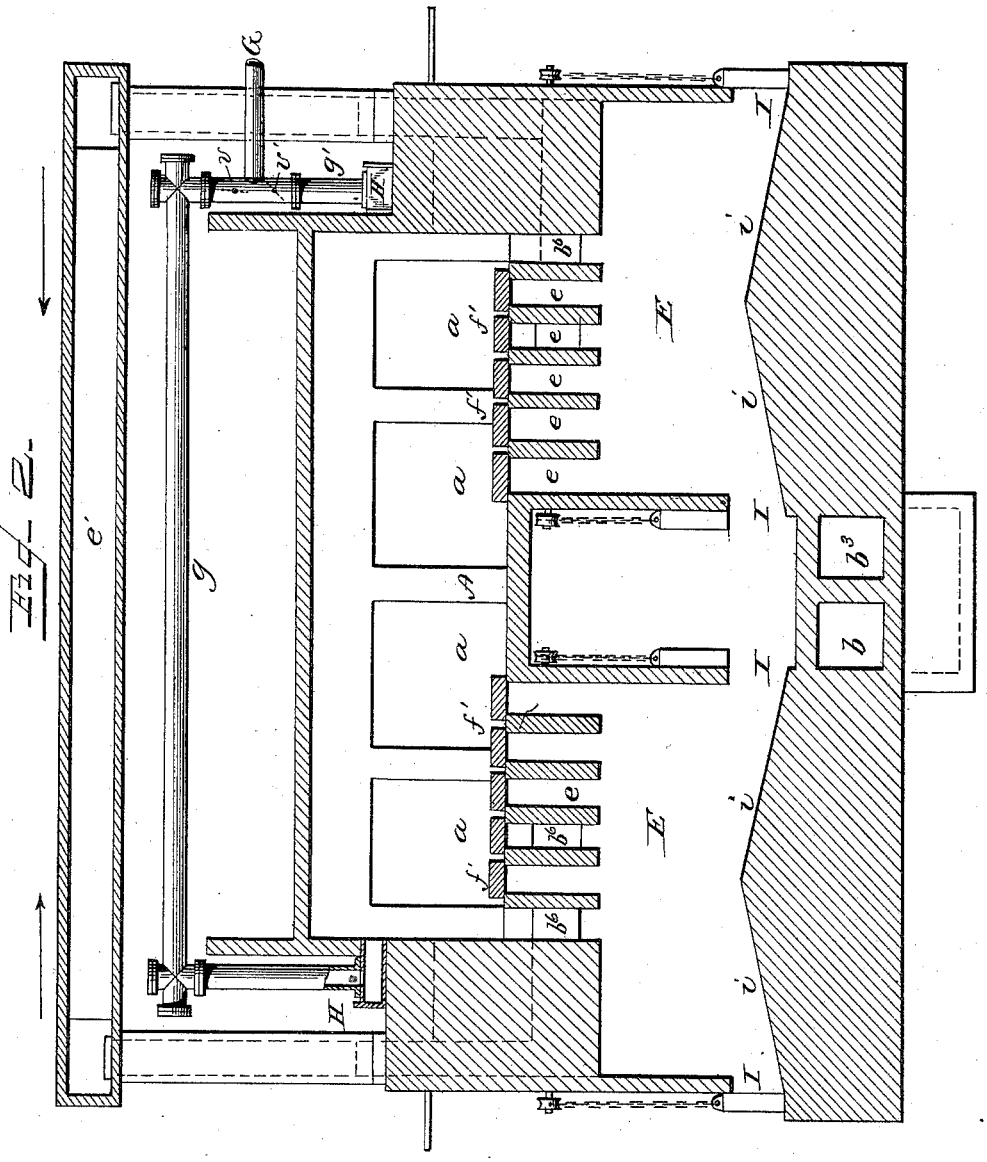

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I. HAHN.

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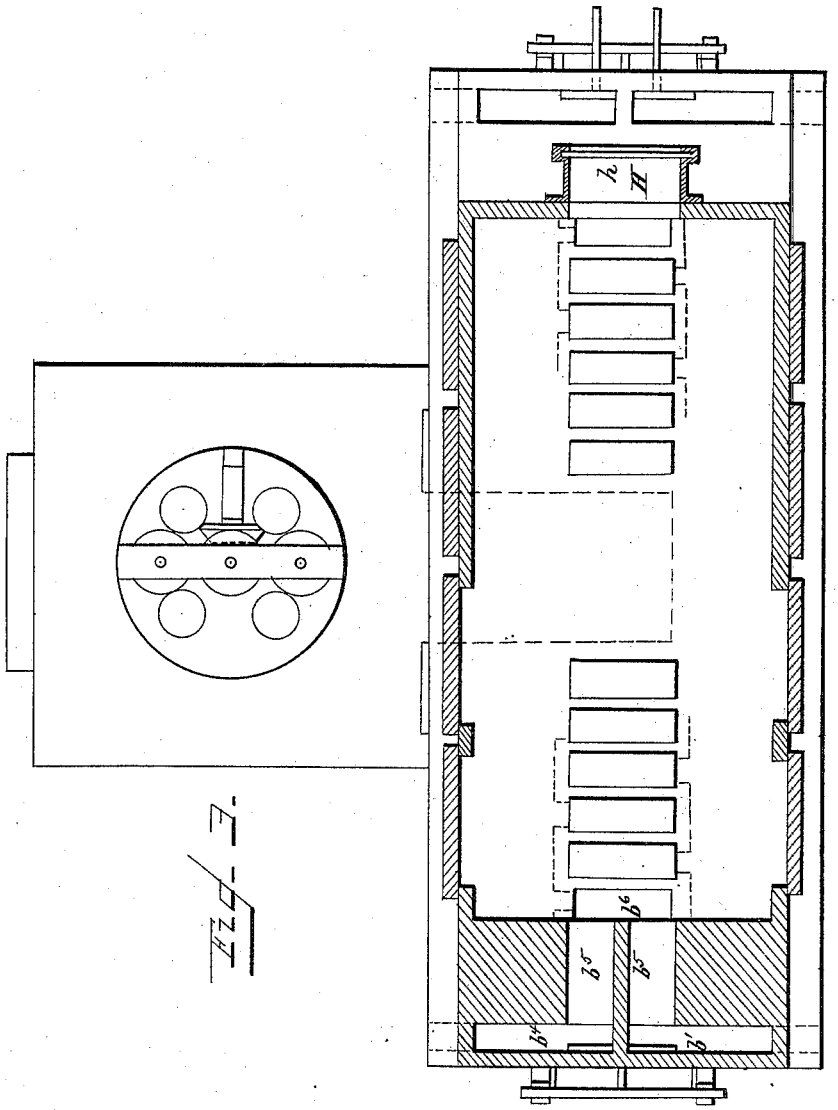

Fig. 3.

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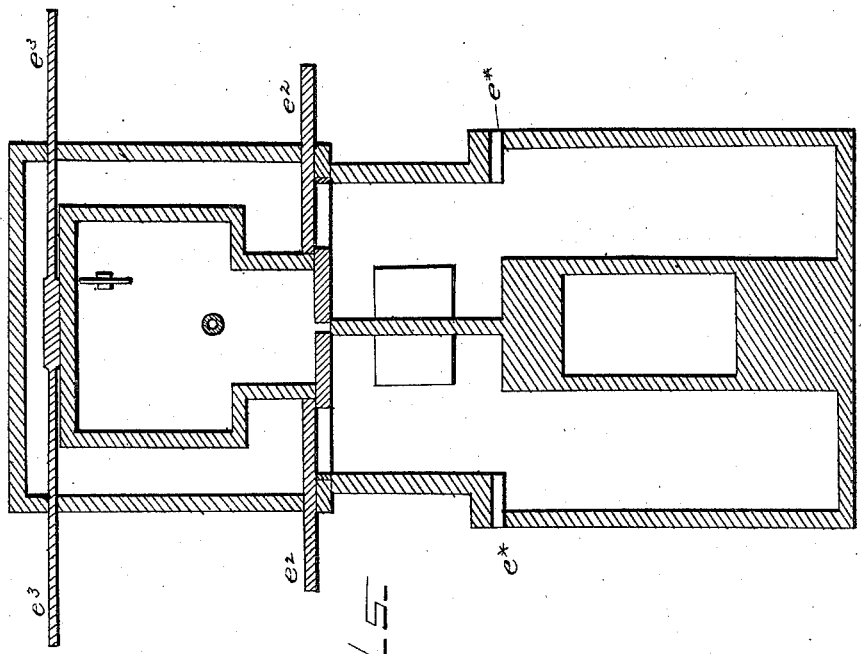

Fig. 5.

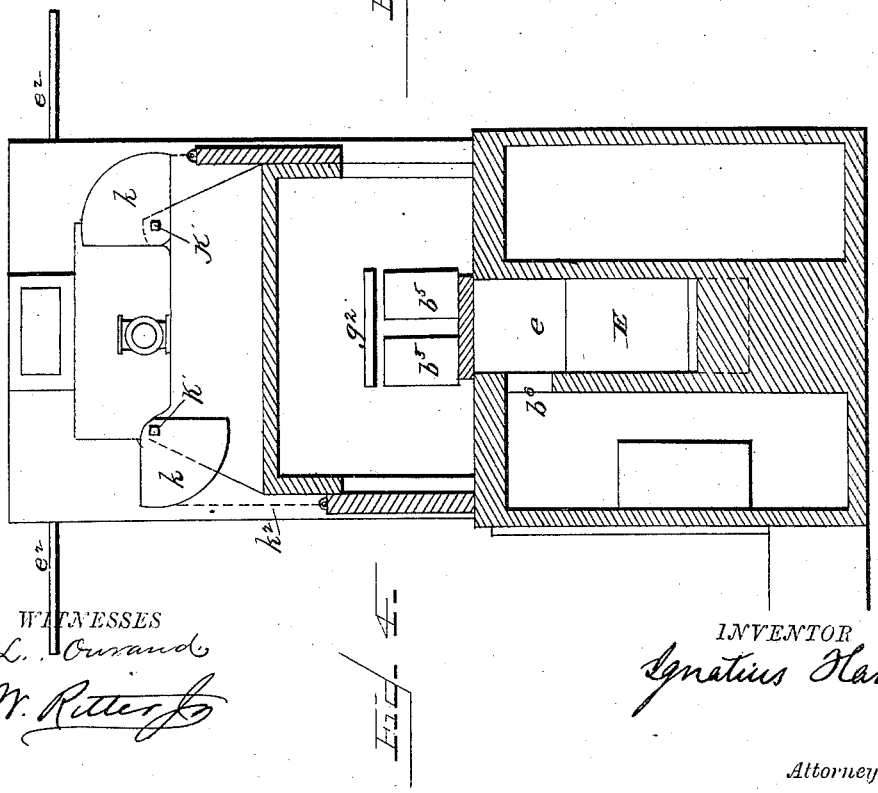

Fig. 6.

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Fig. 6.

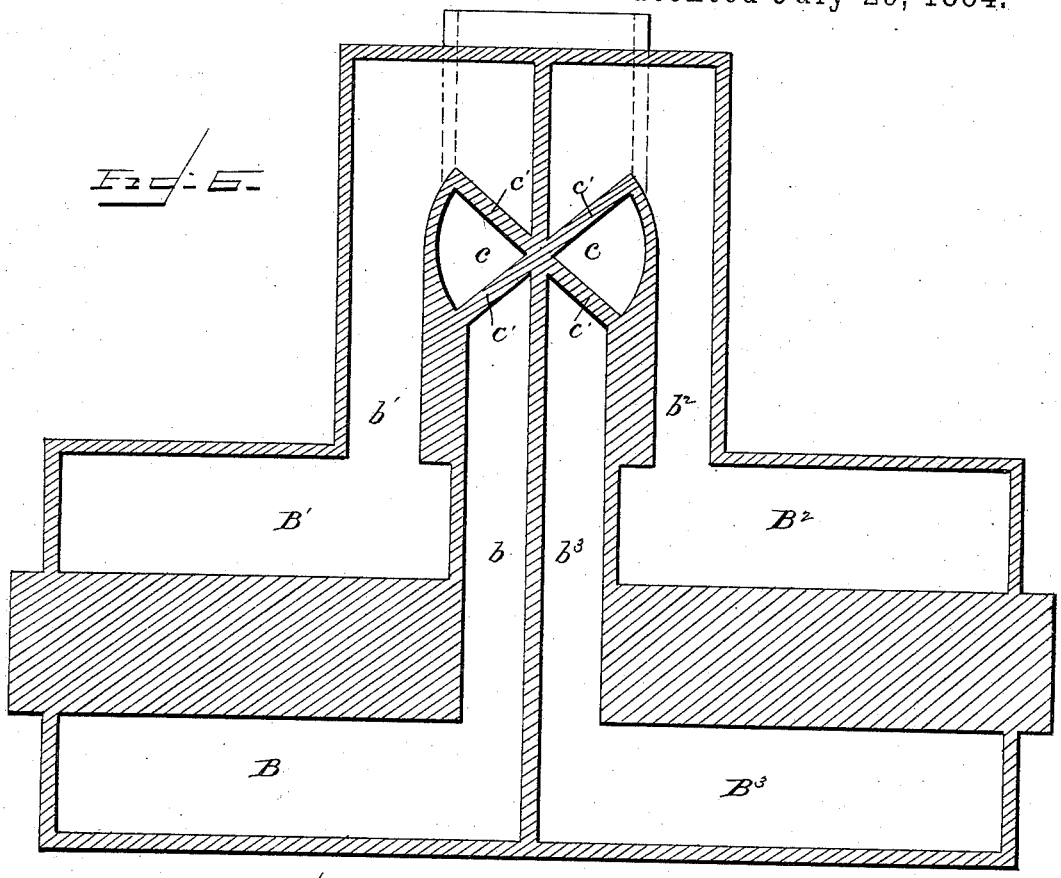

Fig. 7.

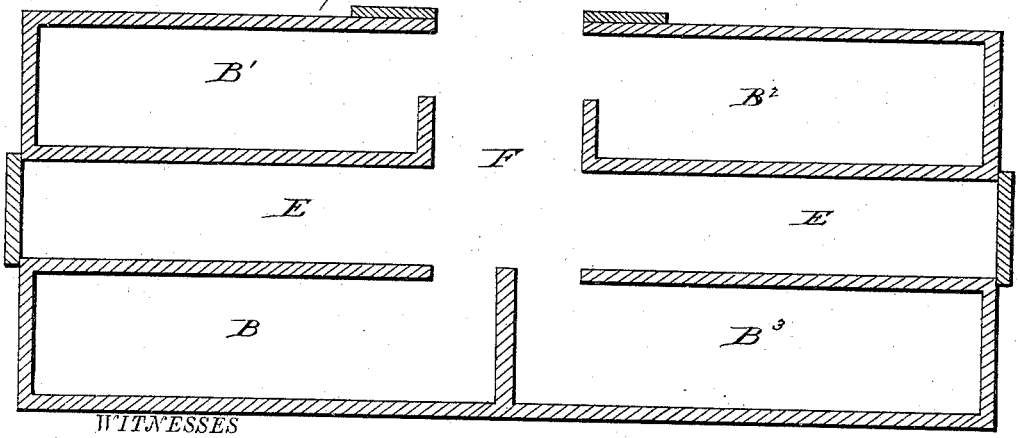

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Fig. 8.

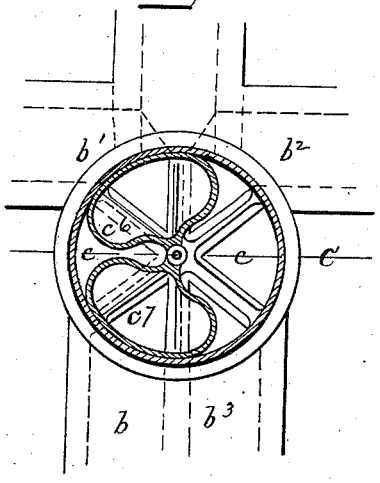

Fig. 9.

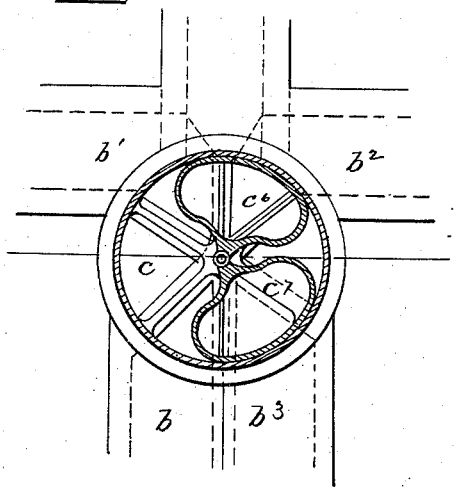

Fig. 10.

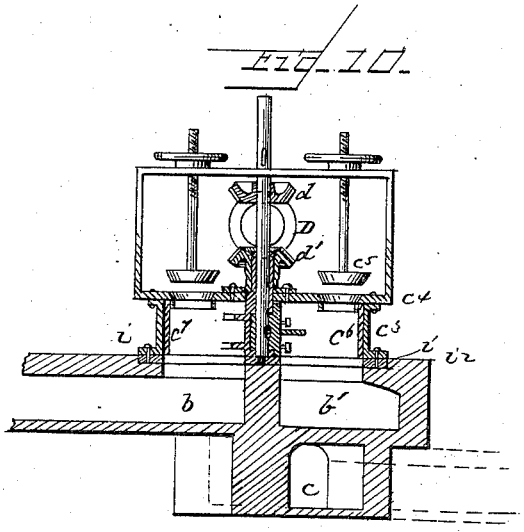

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Fig. 11.

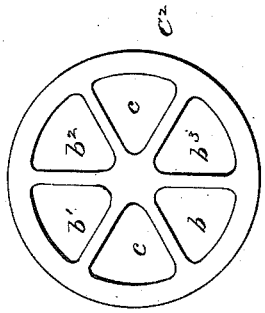


Fig. 13.

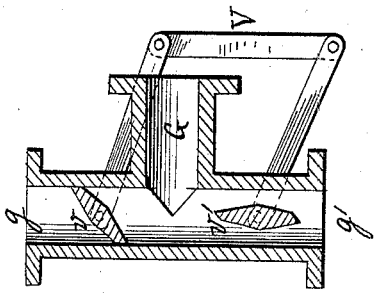
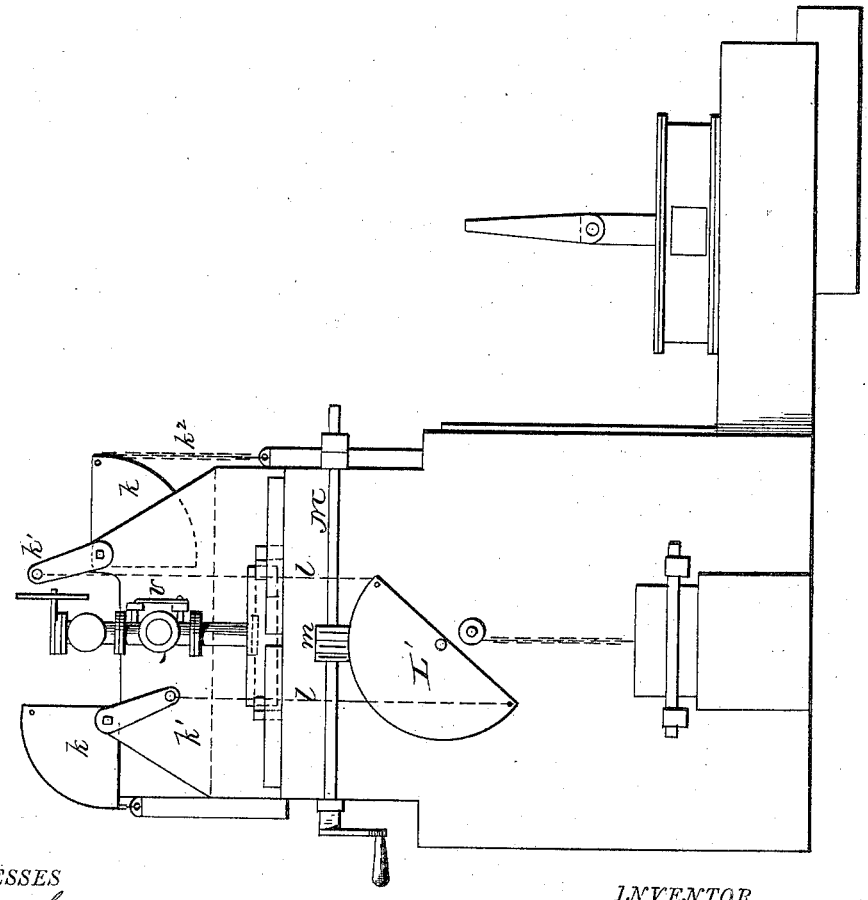


Fig. 12.



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UNITED STATES PATENT OFFICE.

IGNATIUS HAHN, OF SHARPSBURG, PENNSYLVANIA.

FURNACE FOR THE MANUFACTURE OF GLASS, IRON, &c.

SPECIFICATION forming part of Letters Patent No. 302,724, dated July 29, 1884.

Application filed September 13, 1883. (No model.)

To all whom it may concern:

Be it known that I, IGNATIUS HAHN, of Sharpsburg, (opposite Pittsburg,) in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Furnaces for the Manufacture of Glass, Iron, Steel, &c., and in devices for operating the same, of which I declare the following to be a full, clear, and exact description.

My invention and its advantages are described herein as applied to a furnace for melting plate-glass in pots, because I lately designed and set into operation one for this purpose which is working very successfully, and embodies most of the improvements herein dwelt upon, using natural gas as fuel, but so arranged that if ever any interruption should occur in its flow the same furnace could be operated as well by the use of artificial gas—*i. e.*, gas produced through human skill per any of the well-known methods. However, I desire to be distinctly understood that my improvements are applicable also to furnaces used in the manufacture of steel, iron, zinc, and other metals, or to vitreous substances; and consist, first, in preventing the decomposition of non-permanent gases, and controlling the temperature by combining at the point of combustion a comparatively cold gas and preheated air, whereby the formation of fixed carbon and loss in volume and quality of the gas is avoided, while the temperature of the flame can be graded by the temperature previously given to the air; second, in so constructing and combining the regenerators with the working-chamber that they may be worked as ordinary reversing-regenerators now are, or that the regenerators of either side or set may be worked as independent reversing-regenerators, while the other set is out of service or being repaired; third, in connecting the working-chamber or hearth and the regenerators by valved conduits, whereby the direct communication of any regenerator with the hearth or working-chamber may be obstructed, so as to reverse the separate regenerators of a set between themselves; fourth, in providing the working-chamber with gas and air flues, which deliver through the bottom of the chamber, and also with similar flues which deliver through the side or end walls, whereby a more thorough and uniform distribution of the gases and heating of the whole working-chamber is obtained; fifth, in arranging the gas-inlets above the air-inlets, whereby, in using a comparatively cold gas with a preheated air, the greater gravity of the gas will facilitate its proper admixture with the air; sixth, in combining with a working-chamber and two regenerators arranged below the working-chamber a waste-chamber interposed between the regenerators, extending the entire length thereof, and provided at each end with clearing-ports, so as to facilitate the removal of any waste glass or metal which may escape from the working-chamber, and thus reduce to a minimum the time the hearth is exposed to cooling-currents of air; seventh, in combining with a working-chamber having two sets of reversing generators arranged below the same a waste-chamber interposed between the regenerators and extending the whole length thereof, said waste-chamber provided at each end with a clearing-port or door, and a transverse tunnel or passage which divides the sets of regenerators either partly or entirely, and intersects the waste-chamber, so as to facilitate access to the waste-chambers for removal of débris, &c.; eighth, in combining with the main gas-supply and the branch pipes leading therefrom to the opposite sides of the furnace coupled valves, whereby, in reversing the direction of the gas the valves may be simultaneously operated, and thus avoid delay or accident; ninth, in interposing between the gas supply and the furnace, at a point near the combustion-chamber, a cooling chamber or box, which shall prevent the superheating of the gas and reduce the tendency to the formation of fixed carbon, and consequent loss of fuel; tenth, in a reversing-valve composed of a casing having suitable ports and hollow cam-shaped valves arranged therein, so that the inflammable gas or atmospheric air will pass into and out of the hollow valve, while the heated waste gases of combustion pass on the outside thereof, whereby the valves are not so liable to become defective from overheating, warping, &c., as in the case of the ordinary construction; eleventh, in combining with a furnace having two or more

doors arranged on the same side, a power-shaft common to all the doors, and devices for detachably attaching the doors to the power-shaft, together with a prime motor for operating the power-shaft, whereby any or all of the doors may be raised or lowered at the will of the operator and without undue exposure of the workmen to the heat of the furnace; and, finally, in details of construction and specific combinations, which will hereinafter more fully appear.

I will now proceed to describe my invention more specifically, so that others skilled in the art to which it appertains may apply the same.

In the drawings, Figure 1 is an elevation of a furnace embodying my invention, and of the reversing-valve chamber. Fig. 2 is a longitudinal vertical central section of the same through the working-chamber and the waste-chambers. Fig. 3 is a horizontal section through the working-chamber, the section on the left being lower down than on the right, so as to show the end air-ports on the left and the gas-port and cooling-box on the right. Fig. 4 is a transverse vertical section of the furnace, showing the arrangement of the air and gas ports in the end walls and how the regenerators communicate with the waste-chamber. Fig. 5 is a similar view showing the arrangement of gates or valves for cutting out the regenerators when reversing through the side regenerators. Fig. 6 is a horizontal section near the base of the furnace, showing the regenerators and the passages leading therefrom to the reversing-valves. Fig. 7 is a similar section somewhat higher up, so as to show the relation of the regenerators, the waste-chambers, and the intersecting tunnel. In the several figures, for the sake of clearness, the checker-work has been omitted from the regenerators, as it has nothing peculiar in it, but may be of any approved character. Fig. 8 is a horizontal section of the reversing-valves and a diagram of the flues leading to and from the regenerators. Fig. 9 is a similar section showing the valves reversed. Fig. 10 is a vertical section of the valves and valve-chamber. (Shown in elevation in Fig. 1.) Fig. 11 is a detached view of the spider or bottom of the valve-chamber, which rests upon the brick-work at the juncture of the flues leading to and from the regenerators. (See Fig. 6.) Fig. 12 is an end view of the furnace, showing the arrangement of the power devices for operating the doors. Fig. 13 is a sectional view of the valves in the gas-pipe.

Like letters refer to like parts wherever they occur.

In the drawings, A indicates the working-chamber of the furnace, provided on the sides with suitable doors, *a a*, which can be operated singly or collectively by mechanism hereinafter described. Below the furnace-bed are arranged two sets of regenerators, (see Figs. 6 and 7,) B B′ and B^2 B^3, which are filled with checker-work or other regenerating appliances, in the usual manner, and from said regenerator-chambers lead the flues or passages *b b′* b^2 b^3 to the valve-chamber C.

The reversing-valve and valve-chamber, which are of novel construction and adapted to reverse either through the sets of regenerators or through the regenerators of one or the other set, will next be described.

Where the flues *b b′* b^2 b^3, leading from the regenerators, meet, they are divided from each other and from the flues *c c*, which lead to the stack by cross-walls *c′*, and upon the cross-walls *c′* rests a spider or plate, c^2, Fig. 11, having ports corresponding in number to the flues leading from the regenerator and to the stack. This spider or plate c^2 forms the bottom of the valve-chamber C, (see Figs. 8, 9, and 10,) which chamber in the present instance consists of a cylindrical casing, c^3, closed above by a cover, c^4, having ports controlled by mushroom or equivalent valves c^5, which may be operated by hand or by well-known mechanism, as preferred. Within the cylindrical casing are arranged two hollow valves, c^6 c^7, of segmental form in cross-section, one of said valves being keyed to the shaft c^8, and the other journaled on the shaft by means of a sleeve or equivalent devices, and both sleeve and shaft being provided with bevel-gearing *d d′*, which mesh with a bevel-gearing, D, whereby, in reversing, the valves are caused to move simultaneously in opposite directions. The connection of the valves c^6 and c^7 with the shaft and sleeve should, however, be such that either c^6 or c^7 may be operated separately when required, for purposes which will hereinafter appear.

I would here indicate a modification of the valve which may be employed, if desired, viz: The receiving and discharge ports for air, &c., may be all on one side or in the bottom of the valve-case, (instead of as shown at c^5;) and the valves c^6 and c^7 in that case would be cups receiving and discharging on the same side, instead of tubes receiving at one end and discharging at the other.

By reference to Figs. 8, 9, and 6 it will be noticed that when the valves are in the position shown in Fig. 8 the air entering through the mushroom-valves will pass through valves c^6 and c^7 into flues *b b′*, and through regenerators B B′, while the waste products from B^2 B^3 will pass, by flues b^2 b^3, outside the valves c^6 and c^7, through flue *c* to the stack. When the valves are reversed or brought into position, (shown in Fig. 9,) the waste products, which pass through regenerators B B′ and flues *b b′*, will rise into the cylindrical casing c^3, outside the valves, and pass into flue *c*, while the air entering through the mushroom-valves c^5 will pass through the valves c^6 and c^7 and enter flues b^2 and b^3, leading to regenerators B^2 B^3.

To return to the description of the regenerators, these regenerators B B′ B^2 B^3, (see Fig. 7,) which are arranged below the furnace, are not built close together with walls common to two or more regenerators, as is commonly

done, but each regenerator has its own walls, and the several regenerators are separated by a waste-chamber, which extends the entire length of the regenerators and furnace-bed, and by a transverse passage or tunnel, F, which may extend clear through or only far enough to intercept the waste-chamber E, as desired. The several regenerators communicate with the hearth by flues or gas-channels b^4 (see Fig. 3 and dotted lines in Fig. 2) and ports or flues b^5, which deliver through the end (or side) walls and below the gas-ports, and also by ports b^6, which enter flues e in the top of the waste-chamber E, which deliver into the bottom of the hearth.

The regenerators, as thus far described, are only capable of reversing in the usual manner—that is to say, by reversing the direction of the flame—but it is often desirable to work with the regenerators of one side while the other set is out of service for repairs, &c. For the purpose, I construct the regenerators so that I can work with two or more of a side, and reverse the air through the regenerators while using a continuous flame. In order to do this, I connect the vertical flues b^4, leading from the regenerators by a cross-flue, e', (see Figs. 2 and 5,) and provide a series of changeable valves or gates, e^2, (see Fig. 5,) which, when the regenerators are working in the usual manner of reversing-regenerators, occupy the upper position or that shown in Fig. 5, so as to close the cross-flue e'; but when it becomes necessary or desirable to cut out one set of regenerators and reverse only on the other set the gates or valves e^2 are transferred to the lower position, (marked e^{2*},) on the side that is to be cut out. Consequently the products of combustion, after crossing the hearth and entering the ports b^5 of that side, must rise into the cross-conduit e' and return to one of the regenerators of the side which is in service. To which one of said regenerators the products of combustion pass will of course depend upon the way the valves e^3 (see Fig. 5) of the cross-flues e' are set on that side. In order that this reversing between the regenerators of a side may be better understood, I will again refer to Figs. 8 and 9. Remembering that the valves c^6 and c^7 are so connected to the power that one may be moved independently of the other, I will suppose that regenerators B^2 B^3 are out of service, and I wish to reverse through regenerators B and B′, I release one of the valves and use only the other—as, for instance, c^7. This valve will be moved so as to cover flue b, (while the valve c^6 stands back out of the way to the right,) and the air will pass through valve c^7 into flue b, and thence to regenerator B, through flue b^4 and ports b^5 b^6 of that side, into the furnace, the products of combustion crossing the working-chamber out by port b^5 of the opposite side, into cross-conduit e', back to flue b^4 of the regenerator B′, through said regenerator and its flue b', into the valve-casing c^3, and out through flue c, to the stack. When it is desired to reverse, the valve c^7 is moved to the left, so as to cover flue b', and the air takes its direction through regenerator B′, while the products of combustion escape through regenerator B, &c., as before specified.

G indicates the gas-conduit, having the branch g, leading to one side of the furnace, and the branch g', leading to the other side. In the branches g g' are valves v v', (see Fig. 13,) which are each provided with a crank-arm, said arms being coupled or connected by a link or lever, V, from which a rope, v^2, or other device may lead, for operating the valves. It will be noticed that the planes of the valves are arranged angling, so that when one valve is opened the other is simultaneously closed. This coupling or connecting of the gas-valve precludes any possibility of misplacing the valves. On the gas-conduits, and located just over the air-ports which lead into the ends (or sides) of the furnace, are placed chambers or boxes H, which I term "cooling-boxes," as they have for their object to preserve a low temperature of the gas up to the time it enters the combustion-chamber, so that there shall be as little deposit of carbon as possible. The boxes H are provided at the ends with slide-doors h, (see Fig. 3,) so that should any carbon accumulate in the boxes it can be readily broken up and forced into the combustion-chamber. The gas-ports g^2 (see Fig. 2) enter the combustion-chamber above the air-ports b^5, in order that the non-heated gas, which is heavier than the preheated air, may sink and become intimately admixed with the air.

The next feature to be described is the waste-chamber E. (See Figs. 2 and 7.) This chamber, which is located directly under the working-chamber A, is interposed between and separates the regenerators B B′ B^2 B^3. It extends the whole length of the furnace and regenerators, and is provided at each end with a port, I, which can be closed by a suitable door to prevent the cooling off of the hearth. Where four or more reversing-regenerators are employed, I prefer to run a transverse tunnel, F (see Fig. 7) to intercept the waste-chamber, and I provide additional doors, as well to the tunnel as to the waste-chamber. This tunnel F also forms an admirable means of gaining access to the regenerators, for cleaning and repairing the same. By preference, the waste-chambers have inclined bottoms, which slope from the middle to the clearing-ports I, as at i i, Fig. 2. The top of the waste-chamber E communicates with the combustion-chamber A by means of a series of flues, e, into which the flues b^6 from the regenerators deliver, which flues e may be closed by caps or tile f' when communication between the working-chamber and waste-chamber is not desired. It will be noticed that the regenerators B and B′ do not each communicate by ports b^6 with the same flue f, but with alternate flues, as indicated by dotted lines, Fig. 3. The purpose of these flues e are twofold, viz: First, by removing a tile or cap, f', at any

point air from the regenerator can be admitted to that part of the working-chamber, and the combustion thus controlled, so as to render the operation of the furnace uniform; and secondly, in case a pot of glass should break and the molten glass flow down into the waste-chamber, then one or more of the tiles f' can be removed and the hot gases will pass down the corresponding flue, e, strike upon the molten metal on the bottom of the waste-chamber, and keep up its temperature until it can be removed, while the products of combustion will pass from the waste-chamber E through the ports b^6 into whichever of the regenerators the waste gases or products of combustion are at that time passing through.

I will next describe the devices by which I raise or lower any one or all of the doors of the working-chamber without unnecessarily exposing the workmen to the heat of the furnace, and for that purpose refer, especially, to Figs. 1, 4, and 12 of the drawings, wherein is shown journaled in suitable bearings on the furnace two parallel shafts, K, each provided with segments k, corresponding in number to the doors a of the furnace, and at the extremity with a crank-arm, k'. The segments k are keyed or otherwise secured to their respective shafts, so as to move therewith, and are connected with the doors by chains k^2, which are secured to the segments at one end, (see Fig. 12,) so that when that radius is in a horizontal plane the door will be down in position; and when the shaft K is rotated, so as to bring the same radius into a vertical position, the chain will apply itself to the periphery of the segment k, and the door will be elevated to the position shown at the left of Fig. 12. The connection between the chains and doors or the chains and segments should be such that each or all the doors may be connected to or disconnected from the shaft at pleasure.

Journaled on the furnace is a rocking lever, L, to the opposite extremities of which the crank-arms k' are connected by means of chains l, and these chains are also detachably connected to the rock-bar L, so that the connection can be made with the shaft K of either side, according to the location of the door or doors to be raised. The rocking lever L, in the present instance, is in the form of a segment having gear-teeth on its periphery, or the half of a worm-wheel, and power is applied thereto through a transverse shaft, M, journaled on the furnace, and provided with a screw or worm, m.

In raising or operating the doors a by means of the devices described, any one or more doors of the same side may be connected by its or their chains with the corresponding segments k, and the shaft to which said segment or segments is attached is connected by its chain l with the rock-lever L, which, being oscillated by means of shaft M, will raise and lower the door or doors, as shown in Fig. 12.

The general construction as well as the operation of the special parts having been described in detail, I will now briefly sum up the general operation of the furnace.

This furnace is designed to use either natural gas or manufactured gas. Natural gas contains a large percentage of vapors and of non-permanent gas, vapors, &c., which I have discovered, if subjected to high heat—such as when gas is preheated or regenerated prior to its union with the air which supports combustion—are liable to be converted into fixed carbon or soot, thus clogging the regenerators and resulting in a loss of fuel. Therefore I use this gas without regenerating it, and this is what I mean by "non-preheated," preferring a temperature under 600° or 700° Fahrenheit when it can be obtained. For augmenting or reducing the temperature of the working flame, I rely on controlling the temperature of the air, which I preheat or regenerate more or less according to the temperature I desire in the working-flame.

In operating the furnace, I start with comparatively cold gas, either natural or manufactured, which is admitted through pipes g to one or the other side of the furnace, first passing through cooling-box H, which permits expansion and prevents in a measure undue heating, and then escaping into the furnace through gas-port g^2, (see Fig. 4,) in a sheet above the air-supply, sinks, and becomes intimately mixed with the air as it spreads out in the working-chamber A. The air which enters through ports b^5 and b^6 has been previously preheated to the desired temperature by passing through one or other of the sets of regenerators. The flame crosses the working-chamber A longitudinally, and passes by the opposite ports, b^5, into the opposite sets of regenerators, and thence to the stack, as before specified. It will be seen that the gas and air currents entering by g^2 and b^5 tend to traverse the length of the furnace, while those entering at b^6 cross and intermingle with the horizontal currents. Furthermore, if the combustion becomes less perfect as the flame advances, the covers f' can be removed at different points, and an additional supply of air direct from the regenerators can be introduced through the bottom of the furnace at the desired point.

If a pot should break or molten glass escape, by removing one or more of the tiles or caps f' it will be allowed to escape directly into the waste-chamber E; and by reversing the operation of the regenerators, a portion of the flame and waste products will pass through said flue or flues e, keeping the molten glass or metal in the waste-chamber hot until it can be removed, as hereinbefore set forth, the waste products of combustion from the waste-chamber finally escaping therefrom by ports b^6 into the regenerators, which are then carrying off the waste products.

Having thus set forth the nature and advantages of my invention, what I claim, and desire to secure by Letters Patent, is—

1. The method herein described of preventing the decomposition of non-permanent gases

and controlling the temperature of the flame, which consists in combining, at the point of combustion, gas at a temperature not exceeding 600° Fahrenheit and preheated air, substantially as and for the purposes specified.

2. In a reversing regenerator-furnace, the combination, with the working-chamber, of two sets of regenerator-chambers arranged on opposite sides of the working-chamber, each set of regenerators having valved connection with the hearth, whereby the furnace may be worked continuously by the regenerators of either side, while the regenerators of the opposite side are out of service, substantially as and for the purposes specified.

3. The combination, with a working-chamber, of two regenerator-chambers connected with the hearth by valved conduits, substantially as and for the purposes specified.

4. In a gas-furnace, the combination, with gas and air flues which deliver into the working-chamber through the side or end walls, of one or more flues which deliver into the working-chamber through the bottom thereof, substantially as and for the purposes specified.

5. In a gas-furnace, the arrangement of the gas-inlets above the air-inlets, whereby, in using cold gas, the greater gravity thereof will facilitate its admixture with the air, substantially as and for the purposes specified.

6. In combination with a working-chamber and two regenerators arranged below the same, a waste-chamber interposed between the regenerators, extending the entire length thereof, and provided at each end with a clearing-port or door, substantially as and for the purpose set forth.

7. The combination, with a working-chamber having two sets of regenerators arranged below the same, of a waste-chamber arranged between the regenerators below the working-chamber and extending the entire length thereof, said waste-chamber provided at each end with a clearing-port or door, and a transverse tunnel which entirely or partly divides the sets of regenerators and intersects the waste-chamber, substantially as and for the purposes specified.

8. In a reversing gas-furnace, the combination, with the main gas-supply and the branch pipes leading therefrom to the opposite sides of the furnace, of the coupled valves, whereby, in reversing the direction of the gas, the valves are simultaneously operated, substantially as and for the purposes specified.

9. In a gas-furnace, the combination, with the gas-delivery pipe, of a cooling chamber or box arranged on the pipe at or near the combustion-chamber of the furnace, substantially as and for the purposes specified.

10. In a reversing-valve, the combination of a casing having suitable ports and one or more hollow cam-shaped valves arranged therein, whereby the inflammable gas or atmospheric air will pass into and out of said cam-shaped valves while the waste gases of combustion are passing on the outside thereof, substantially as and for the purposes specified.

11. In a reversing-valve, the combination of a fixed casing having ports, and two hollow segmental movable valves arranged within the casing, one of said valves keyed to and movable with a central shaft and the other valve journaled on the central shaft, whereby the segmental valves may be moved to and fro from each other within the casing, substantially as and for the purposes set forth.

12. In combination with a furnace having two or more doors arranged on the same side, a power-shaft common to all the doors, devices for detachably attaching the doors to the power-shaft, and a worm and worm-wheel for actuating the power-shaft, whereby the several doors may be severally or collectively raised or lowered, substantially as and for the purposes specified.

13. The combination, with a furnace having two or more sets of doors on opposite sides, each set having a power-shaft to which the doors of its set are independently and detachably connected, of a prime motor common to both power-shafts, and detachably connected with both of said shafts, whereby any single door or all the doors of either side may be severally or collectively operated by the same power mechanism, substantially as and for the purposes specified.

14. The combination, with the working-chamber, of one or more regenerators for preheating the air and one or more gas-conduits which deliver the non-permanent gas directly to the combustion-chamber, whereby the air may be highly heated while the gas is delivered at a temperature not exceeding 600° Fahrenheit, the products of combustion passing from the combustion-chamber through the working-chamber to and through the regenerators, substantially as and for the purposes specified.

15. The combination of a working-chamber, two or more reversing-regenerators for preheating the air, and through which the waste products of combustion from the working-chamber pass to the stack, one or more gas-conduits which lead directly to the point of combustion, which is located on the same side of the working-chamber where the air for supporting combustion first reaches the working-chamber at that time, and valves for changing at intervals the delivery of gas from one side of the working-chamber to the other side thereof, substantially as and for the purposes specified.

16. The combination of a working-chamber, two sets of regenerators arranged below the same, and a waste-chamber which partially separates the regenerators of opposite sets, substantially as and for the purposes specified.

IGNATIUS HAHN.

Witnesses:
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W. HEERLEIM.