April 2, 1935. F. PUENING 1,996,649

COKING APPARATUS

Filed Feb. 13, 1929 6 Sheets-Sheet 1

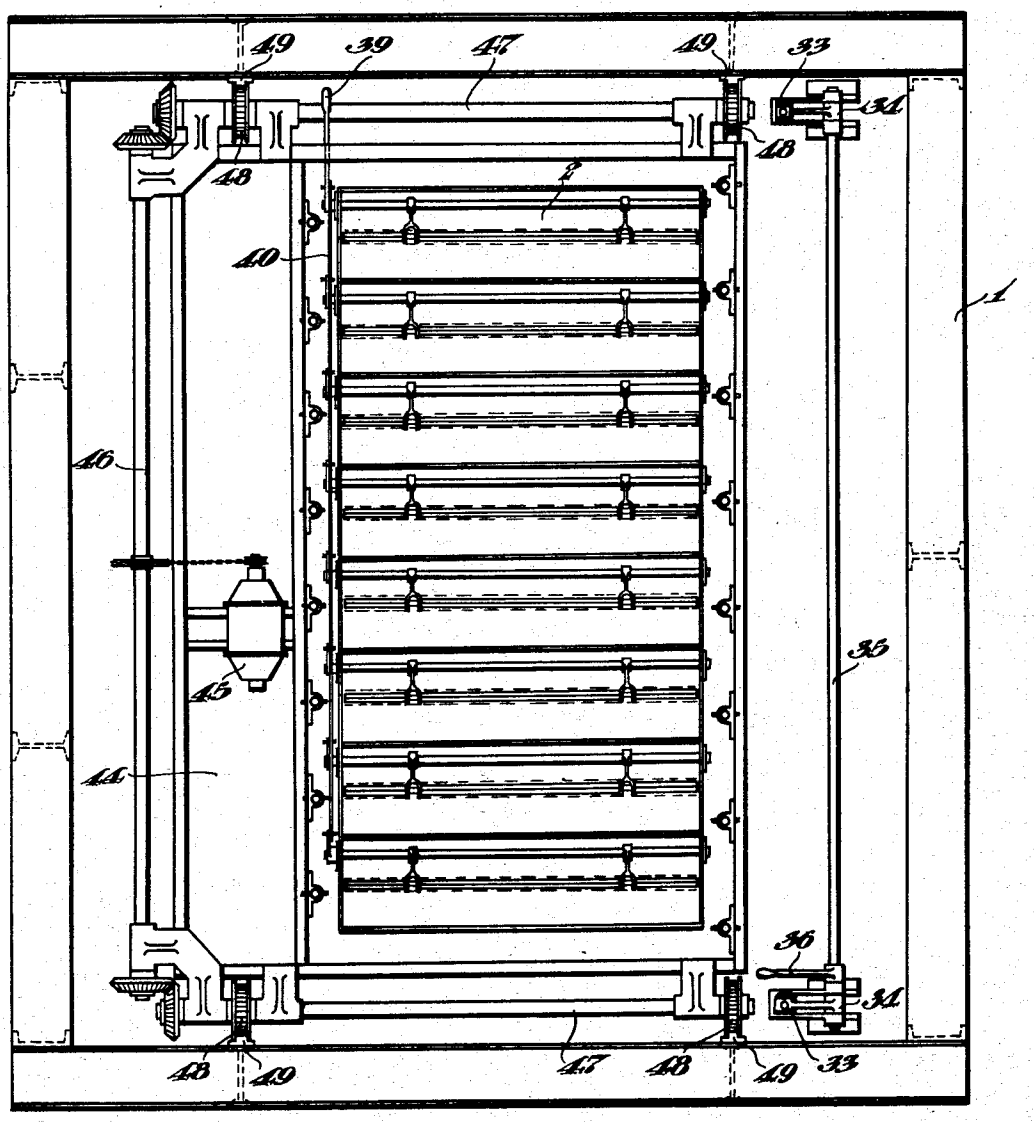

Fig. 1

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COKING APPARATUS

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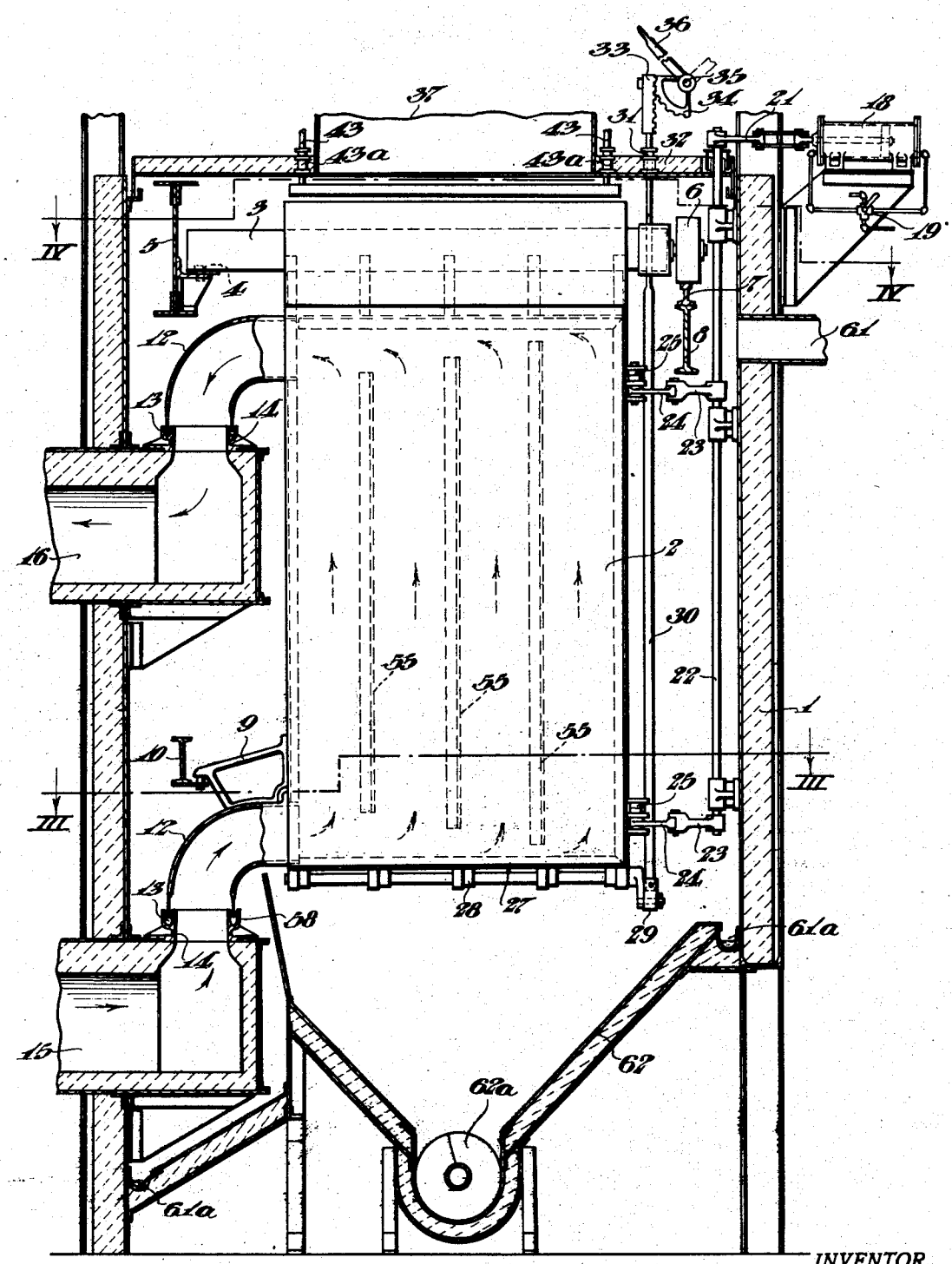

Fig. 2

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COKING APPARATUS

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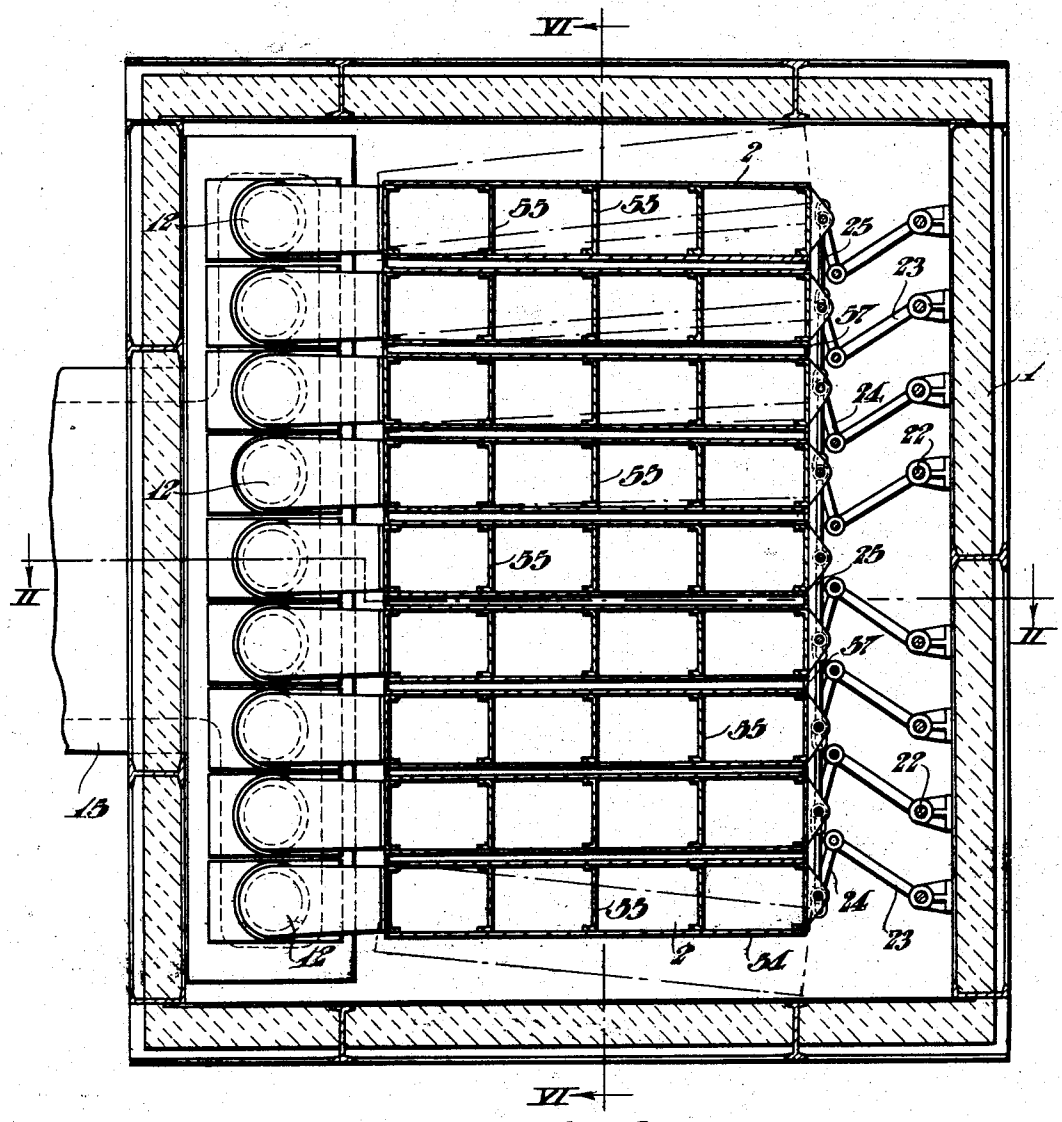

Fig. 3

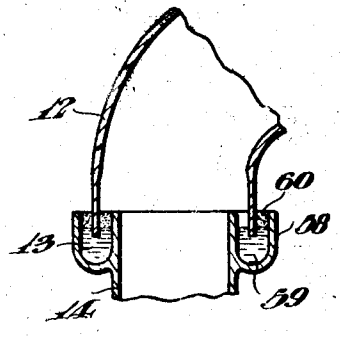

Fig. 3a

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COKING APPARATUS

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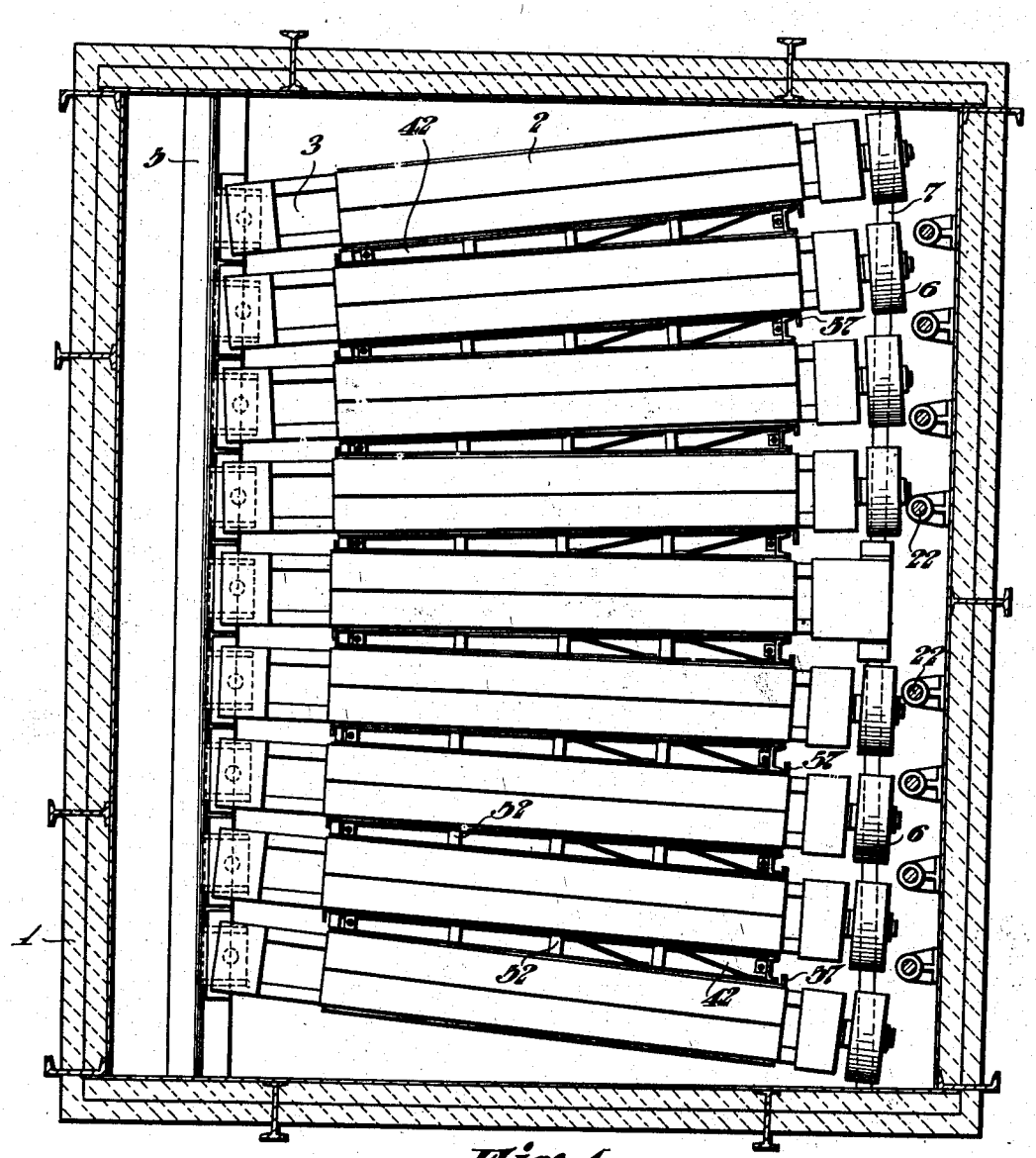

Fig. 4

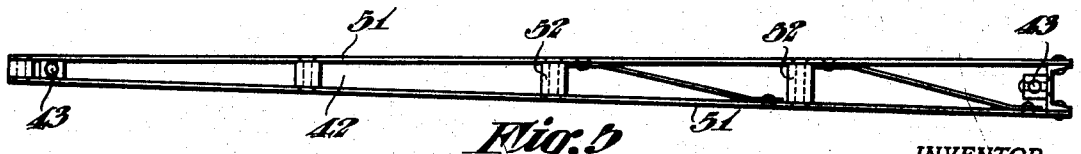

Fig. 5

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COKING APPARATUS

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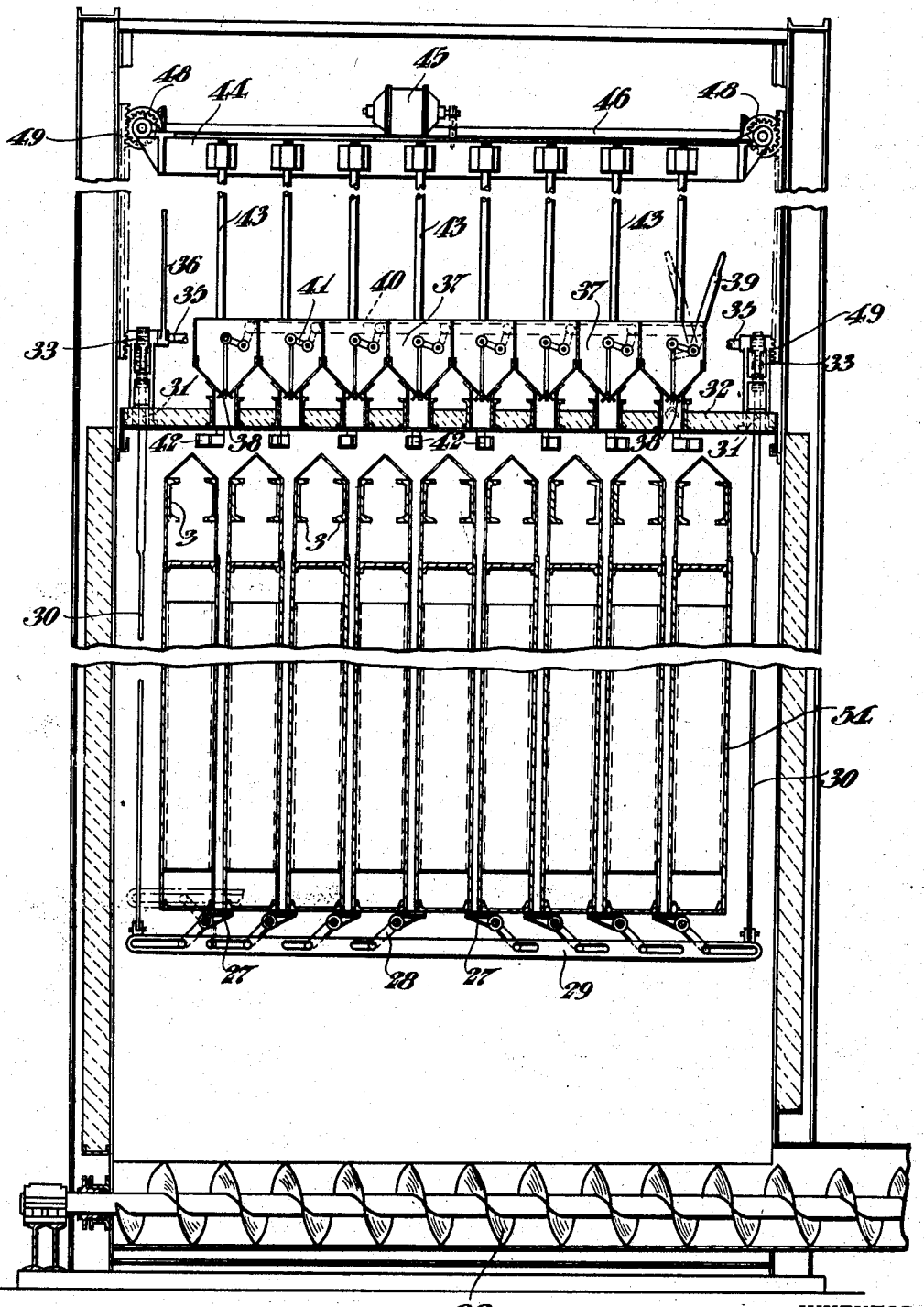

Fig. 6

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COKING APPARATUS

Filed Feb. 13, 1929 6 Sheets-Sheet 6

Fig. 7

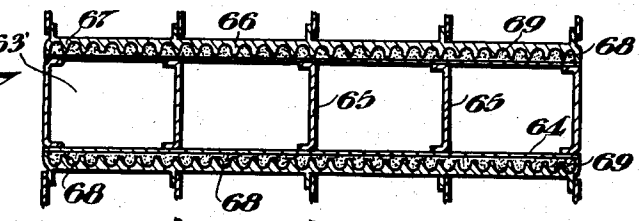


Fig. 8

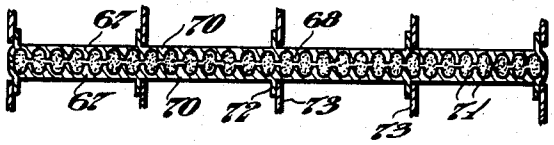


Fig. 9

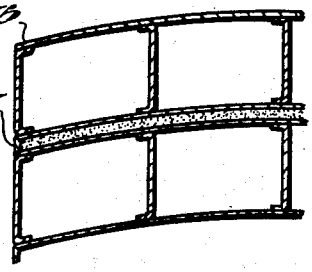


Fig. 10

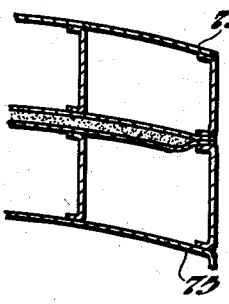


Fig. 11

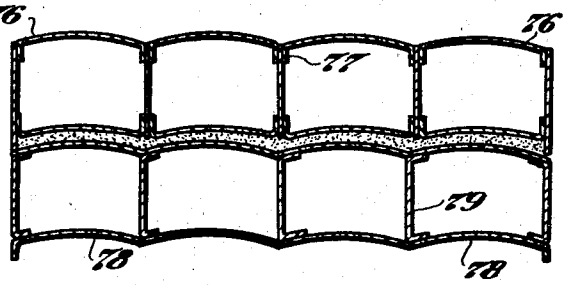


Fig. 12

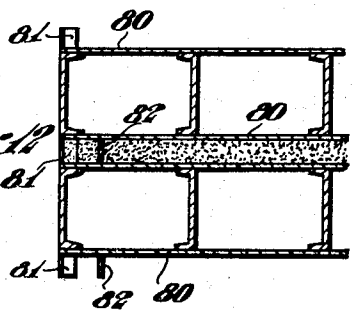


Fig. 13

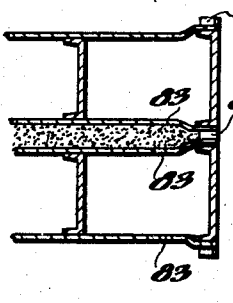


Fig. 14

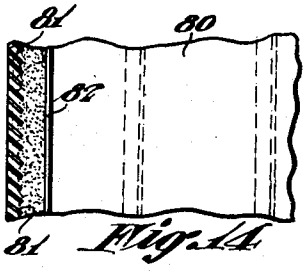
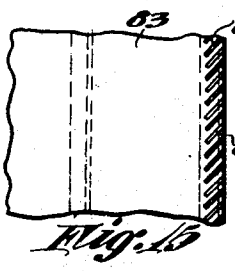


Fig. 15



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Patented Apr. 2, 1935 1,996,649

UNITED STATES PATENT OFFICE

1,996,649

COKING APPARATUS

Franz Puening, O'Hara Township, Allegheny County, Pa.

Application February 13, 1929, Serial No. 339,521

14 Claims. (Cl. 202—105)

My invention relates to coking apparatus and particularly to such apparatus as is adapted to produce low-temperature coke.

My invention has for one of its objects to provide apparatus for producing low-temperature coke of relatively high specific gravity and that is suitable for domestic use.

A further object of my invention is to provide apparatus for producing coke of the character described above that is adapted to maintain the coal being carbonized under certain pressure and which is capable of operation to freely remove the coke from the carbonizing chambers.

A still further object of my invention is to provide coking apparatus that is adapted to produce low-temperature coke that is of relatively large size and of high specific gravity and in which the walls are adapted for relative movement whereby the coke may be easily discharged from the coking spaces therebetween.

The ideal coke for domestic use should be as heavy as possible and have a specific gravity that approaches that of anthracite coal. It should have a content of gases of between 8 to 14% in order that it may be easily ignited and combustion maintained and it should also be free from tar and be smokeless.

Such coke, when intended for use in central heating plants, should be in bodies of approximately two inches in diameter. In case, however, such coke is intended for open fireplaces, the bodies of coke should be from two to six inches in diameter. Coke of this character can be produced economically only by continuous uniform supply of heat at low or medium temperatures over a period ranging from two to six hours.

This operation can be accomplished practically only by a continuous supply of hot gases to the heating wall with which the coal is in contact. The process of manufacturing coke of this character differs materially from that in which coke is rapidly manufactured in thin layers of ¼ or ½ inch in thickness and which coke is intended for combustion in power plants.

The principal difficulty in the production of hard, dense low-temperature coke has been in the discharge of the coke from the retorts in which it has been produced. In accordance with approved practice, the temperature of the metal retorts for producing such low-temperature coke should not exceed approximately 1100° to 1300° F. At such temperatures, coke shrinks very little and it is difficult to discharge it from the retorts.

This condition exists by reason of the fact that during the coking operation the material assumes a plastic condition that is succeeded by a rigid state but while the material is in a semi-fluid state, the outer layer thereof is forced with considerable pressure into contact with the walls of the retort and is molded into the irregularities of the surfaces of the latter. When the coke adheres to and interlocks with, the irregularities of the surfaces of the retorts, it will be readily understood that it offers relatively great resistance to its being forced from the retort.

The foregoing difficulties increase when, for the purpose of making the resultant coke heavier, the coal is preheated or when pulverized low-temperature coke or low volatile coke is mixed with the coal to be carbonized. The discharging becomes still more difficult when the coal mixture is tamped or otherwise compressed into the retorts before coking begins. In such case, discharge of the heavy low-temperature coke from retorts having stationary walls becomes almost impossible. This difficulty is not materially diminished by tapering the retort and, in addition, the increased width retards the coking at the wider or discharge end or side of the retort.

It has been proposed heretofore to increase the space between the walls of carbonizing apparatus prior to the removal of the coke but such apparatus has been suitable only for relatively thin coke such as is suitable only for use in power plants. Such walls have, in general, been solid walls that operate in the manner of regenerators in that heat is stored therein before the coal comes in contact with them and the coal is coked by the stored heat. The amount of heat required to be stored in such bodies for the production of coke that is contemplated by the apparatus of the present invention is so great that such bodies would necessarily be of enormous weight and their cost would be economically prohibitive.

In accordance with the present invention, I provide apparatus that is adapted to produce coke of such size and such quality as is suitable for domestic use. The coking chambers are provided between hollow walls that are spaced apart in accordance with the desired thickness of the resultant coke. These walls are suspended in such manner that they may be moved relatively to each other to increase the spaces therebetween whereby the coke may be readily removed by mechanical means.

The walls, which are hollow, are adapted to be supplied continuously with hot gases at any de-

sired temperature whereby the coking operation proceeds uniformly and at maximum speed. The walls are so connected to the source of hot gases that the latter are entirely separated from the products of distillation and in such manner, also, that the continuity of flow is not interfered with by the swinging movement of the walls.

The details of my invention will be described in connection with the accompanying drawings, in which

Figure 1 is a plan view of apparatus constructed in accordance with my invention;

Fig. 2 is a vertical sectional view, taken on the line II—II of Fig. 3;

Fig. 3 is a horizontal sectional view taken on the line III—III of Fig. 2;

Fig. 3*a* is an enlarged sectional view of one of the molten metal seals.

Fig. 4 is a horizontal sectional view taken on the line IV—IV of Fig. 2 illustrating the heating walls in the extended positions;

Fig. 5 is an enlarged plan view of one of the coke pushers;

Fig. 6 is a vertical sectional view taken at right angles to Fig. 2, parts being broken away;

Fig. 7 is a horizontal sectional view illustrating modified forms of adjacent heating walls, parts being broken away;

Figs. 8, 9, 10 and 11 are similar views of further modified forms of construction of heating walls;

Fig. 12 is a similar view of a further modification in which certain of the walls are provided with louvers for the escape of distillate gases;

Fig. 13 is a similar view of a modification of the structure of Fig. 12; and

Figs. 14 and 15 are enlarged vertical sectional views illustrating the details of the louvers for the walls of Figs. 12 and 13.

Referring to the drawings, coking apparatus constructed in accordance with my invention comprises a housing 1 of suitable refractory material that is of substantially rectangular shape and within which are supported for swinging horizontal movement a series of hollow walls 2. As best shown in Figs. 2 and 4, each wall 2 is supported by a horizontal beam 3 that is pivotally connected at one end by a pin 4 to a beam 5 extending transversely to the beam 3 and that is supported by suitable framework of the housing 1.

The other end of the beam 3 or the right-hand end, as viewed in the drawings, is provided with a relatively wide wheel 6 that is adapted to be supported by a rail 7. The rail 7 is supported by a beam 8 that is connected at its ends to the framework of the housing 1. While the weight of each wall 2 is supported at its top by the beam 3 for movement about the pin 4, the lower part of each wall is anchored by means of a bracket 9 that is pivotally connected to a beam 10. The pivotal connection of each end of the several walls insures that they swing about a vertical axis and that the sides of adjacent walls maintain the same spacing from top to bottom.

Each of the hollow walls 2 is provided at the top and bottom of its edge adjacent the pivotal supports with two elbows 12 that curve downwardly and each is connected by means of a molten metal seal 13 to an upwardly-extending pipe 14. The lower pipe 14 is connected at its lower end to an inlet duct 15 for heated gases and the upper pipe 14 is similarly connected to an outlet duct 16 for the heating gases after they have passed through the wall, as indicated by the arrows in Fig. 2. The axes of the junctions of the elbows 12 and pipes 14 are coincident with those of the pivotal supports for the respective walls.

Normally the heating walls 2 occupy positions corresponding to those illustrated in Fig. 3, but, by reason of their pivotal connections, they may be moved in opposite directions from a center wall to the positions indicated by dotted lines in Fig. 3. The means by which this movement is accomplished comprises a hydraulic piston 18 that is controlled by a 4-way valve 19 and that is connected by a lever 21 to a vertical rod 22, the latter being connected to the corresponding heating wall 2 by means of upper and lower levers 23 and links 24. Each of the walls except the center wall is provided with a similar mechanism for actuating it away from and toward the center or stationary wall.

The distances that are traversed by each of the movable walls from the adjacent inner wall is regulated by a slotted link 25, one of which connects each of the movable walls 2 to each of its adjacent walls. This arrangement insures that upon the movement of the walls to their extended positions, the spaces between them will be equal and that they will always be in a definite position under such conditions.

As best shown in Figs. 2 and 6, the spaces between the walls 2, when the latter are in their normal or coking positions, are closed at the bottom by a series of pivotally-mounted doors 27, each of which is connected by a lever arm 28 to a slotted bar 29. It will be noted that the slots to which the levers 28 are connected are progressively longer outwardly from the center in order to freely permit swinging movements of the walls. The position of the bar 29, which is sufficiently heavy that it operates as a counterweight for the several doors 27, is controlled by vertical rods 30 which extend through stuffing boxes 31 in the roof 32 of the housing. The rods 30 are provided at their upper ends with racks 33 which mesh with segmental gear wheels 34 on a shaft 35 that is rocked by means of a lever 36.

Immediately above each of the spaces between the walls 2 is located a coal hopper 37 extending through the roof 32 and having a gate 38. All of the gates 38 for the several hoppers 37 are controlled by a single lever 39 that is connected to the gates by a horizontal bar 40 and link and lever mechanisms 41. The hoppers 37 are each arranged to contain sufficient coal to charge the respective coking spaces beneath them, the tops of the walls 2 being inclined, as shown in Fig. 6, in order to facilitate the flow of coal into the coking spaces.

Immediately above the spaces between the walls 2, when the latter are in their extended positions, is a series of coke pushers 42 for removing the coke from between the walls when the latter have been separated in the manner previously described. The coke pushers 42 are carried by vertical rods 43 which extend through stuffing boxes 43*a* in the roof 32. The vertical rods 43 are secured to a steel frame 44, the vertical position of which is controlled by a mechanism comprising an electric motor 45 mounted thereon and having a chain-and-sprocket connection to a shaft 46, the latter having a bevel gear connection at each end thereof to a transverse shaft 47 having gears 48 that coact with stationary vertical racks 49 whereby the frame 44 and the rods 43 with the corresponding pushers may be raised or lowered, as desired.

Reference may now be had to Fig. 5, in which

one of the pushers 42 is illustrated in enlarged detail. The pusher 42 comprises two side bars 51 that are connected by a series of spacing members 52 that are progressively longer whereby the side bars 51 are at an angle to each other which corresponds to the angles between the walls 2 when the latter are in their extended positions. This arrangement insures that the pushers 42 will engage the sides of the adjacent walls simultaneously in order to remove any coke that may adhere thereto.

Each of the heating walls 2 shown in Figs. 1 to 6 comprises two side walls 54 having plane surfaces and that are spaced apart by flanged baffle members 55 of different lengths, as best shown in Fig. 2, in order to properly regulate the flow of heating gases therethrough. The members 55 also reinforce the side walls 54 in order to resist the pressure of the coal when the latter swells during the coking operation. Each of the walls 2 is also provided with an upper portion 56 having a pointed top, the upper portion 56 enclosing the supporting beam 3 upon which it is mounted for swinging movement.

As clearly shown in Figs. 3 and 4, the vertical edges of the coking spaces are closed by flanges 57, carried by the one or the other of the adjacent walls 2. These flanges 57 also serve to fix the width of the coking chambers when the walls are in their normal positions.

The details of one of the molten metal seals 13 are illustrated in Fig. 3a. The upwardly-extending pipe 14 is provided with an annular flange 58 that is provided with a supply of molten metal, such, for example, as lead, indicated at 59, and into which extends the lower end of the elbow 12. The temperature of the heating gases is sufficiently high to maintain the seal in fluid condition while the apparatus is in operation. In order to protect the upper surface of the molten metal from oxidation, or other action, it may be covered with a layer of clay, sand, or other suitable material, indicated at 60.

The operation of the apparatus of my invention will now be described:

It may be assumed that the walls 2 are in their normal positions in which they are illustrated in Fig. 1, and that hot gases from any suitable source, such as a furnace, are being supplied through the ducts 15 and their connected parts for circulation through the corresponding heating wall 2, as indicated by the arrows in Fig. 2. It may be assumed further that the hoppers 37 are filled with coal. In order to fill the spaces between the several heating walls 2, the lever 39 is actuated from its full-line position, as shown in Fig. 6, to the left, to its dotted-line position to release the several gates 38 and to permit coal to flow into the coking spaces.

The heating of the walls 2 continues for a period that varies with the thickness of the coke that is being produced, which may, for example, require a period of approximately six hours to produce coke that is about six inches in thickness. The temperature of the gases employed may be, for example, about 1350° F. upon entering the heating walls and about 1250° F. upon leaving the walls. The comparatively small drop in temperature insures greater uniformity of temperature throughout the coking mass.

However, if greater uniformity is desired, it may be obtained by the reciprocation of hot gases therethrough by means of apparatus constituting the subject-matter of certain of my prior inventions.

Gases of distillation escape through a pipe 61 in a side wall of the housing and may be conducted to any suitable by-product apparatus. Tar drains 61a are provided for collecting tar condensing on the inner walls of the housing 1.

At the end of the coking period, the bar 29 is raised by means of the rods 30 and the operating lever 36. The walls 2 are then swung about their points of pivotal support to their extended positions by means of the hydraulic pistons 18 and the connected mechanisms for actuating the levers 23.

A certain amount of the coke will fall from the spaces upon the spreading of the walls 2 but any coke remaining will be removed therefrom by mechanical means when the pushers 42 are lowered by means of the motor 45. The pushers 42 are retracted after the coke has been removed and the walls 2 are returned to their normal positions. The operation that has just been described is then repeated for successive or intermittent production of coke. The coke that has been removed from the ovens falls into a hopper 62 from which it is removed by a screw conveyor 62a to any suitable storage space.

Reference may now be had to Fig. 7, in which two forms of co-operating heating walls are shown in enlarged detail. The flat side walls 64 of the center heating wall 63 are spaced apart by flange bars 65 for the purpose of increasing the mechanical strength of the walls and, also, for the purpose of insuring the distribution of the hot gases throughout the width of the heating wall, as in the walls 2 hereinbefore described. Each of the adjacent walls 66 is provided with side walls 67 having curved projections 68 whereby, when the walls are in their closed position, a series of vertical spaces or pockets 69 is formed within which the coal is coked. The series of walls may thus be arranged with alternate walls respectively similar to the walls 63 and 67.

As shown in Fig. 8, the adjacent side walls 67 of two adjacent heating walls 70 may each be provided with projections 68 similar to those of the walls 67 of Fig. 7 whereby the pockets or spaces 71 thus formed are correspondingly increased in size. The spacing members 72 of the heating walls in Fig. 8 may be connected in the manner shown, as indicated by the relatively small sections or strips 73, which may be welded to the spacing member 72 and to the side wall 67.

In the constructions shown in Figs. 9 and 10, the respective heating walls 75 are curved. In the arrangement shown in Fig. 9, the one or the other of the adjacent walls 75 is provided with a horizontally-extending flange 57 for closing each outer edge of the coking space between the walls when the walls occupy their coking positions. An alternative means for closing the space at its edges is shown in Fig. 10, in which the space is reduced by tapering the side walls in such manner that the adjacent edges engage each other to form a closure.

In the arrangement shown in Fig. 11, the heating walls 76 are formed either by employing curved flanged sections 77 of the side walls thereof that are connected by the spacing members or continuous side walls 78 may be connected as shown in the lower portion of Fig. 11 by flanged spacing members 79 similar to those of Fig. 7. In these arrangements, either the end walls or the side walls of certain of the heating walls 76 extend transverse to the side wall to form closures for the coking spaces.

In the arrangement shown in Fig. 12, each of two adjacent heating walls **80** is provided with inclined projections **81** which, when the walls are in their coking positions, interleave to constitute louvers for facilitating the escape of gases of distillation from the coking spaces while the coal is being coked, but which operate to retain the coal in position.

One of each pair of adjacent side walls is provided with a vertical strip **82** extending almost across the coking space at each end thereof to form a pocket between the strip and the louvers into which pocket coke dust may be placed. Gas may escape through the layer of coke dust and the louvers.

The arrangement shown in Fig. 13 is similar to that of Fig. 12 except that the space is narrowed at the ends of the walls **83** in order that the width of the coal being coked may be reduced since its speed of coking may be relatively slow because no heat is applied to the edge thereof.

Details of the edges of the walls **80** and **83** provided with projections to constitute the louvers of Figs. 12 and 13 are shown respectively in Figs. 14 and 15.

The apparatus of my invention operates to produce low-temperature coke of desired size within certain limits in a simple and efficient manner. The coke will have a relatively high specific gravity and is easily ignited and will continue to burn without the difficulty that is sometimes present in the combustion of high-temperature coke.

The apparatus is arranged for convenient inspection and repair in that the structure, including the top **32** of the housing, is removable. The gas spaces through the hollow heating walls are preferably of such size as to permit the entrance of a person into the inlet and outlet openings or through a trap door that may be constructed in the bottom or other suitable portion of the wall.

The apparatus is operated at substantially uniform temperatures throughout the entire operation since it is only necessary to regulate the temperature and volume of the heating gases. The amount of labor required in the operation of the apparatus is very small since it is only necessary to charge the coking spaces with coal and discharge coke therefrom at comparatively infrequent intervals. During such periods, the hoppers may be refilled with coal, the coke removed and any minor repairs may be completed. The mounting of the hanging walls for pivotal movement insures that they may be easily actuated into and out of their normal position. The walls are easily lifted out of the surrounding housing in case repair or replacement should become necessary, the replacement of a wall being performed while the metal seal is still in the fluid condition.

The suspension of the walls at their top portions insures that they will retain their vertical alinement since the temperatures employed are sufficient to have an annealing effect on the metal of which they are constructed.

While I have shown and described a preferred embodiment of my invention, it is understood that it is not to be limited thereto except as expressed in the claims.

I claim as my invention:

1. Carbonizing apparatus comprising a plurality of members spaced to receive material therebetween to be carbonized, each of said members extending vertically and being hingedly supported at one vertical edge thereof for horizontal movement about a vertical axis, means for actuating said members about their hinged supports for relative movement with respect to each other, and means for limiting their relative movements.

2. Carbonizing apparatus comprising a series of members in side-by-side relation and extending vertically and each having hinged supports for horizontal movement about vertical axes relatively to each other, said members being spaced apart to receive material to be carbonized therebetween, means for actuating said members toward and away from a central portion of said series, means for applying heat to said members, and means for supplying material to said members to be carbonized.

3. Carbonizing apparatus comprising a series of members mounted side-by-side in vertical planes for swinging movements about substantially vertical axes, said members being spaced apart to receive material to be carbonized therebetween, means for extending the spaces between said members by swinging said members about said axes, and means for removing carbonized material from said spaces when said members are in their extended positions.

4. Carbonizing apparatus comprising a pair of spaced heating walls providing a coking chamber therebetween and formed with passages for heating gases, said heating walls being relatively movable about vertical axes, and means for actuating said walls.

5. Carbonizing apparatus comprising a pair of heating walls spaced to provide a coking chamber therebetween and provided with heating passages and relatively movable about vertical axes to vary the width of the coking chamber.

6. Carbonizing apparatus comprising a pair of spaced heating walls in side-by-side relation having passages therein for heating gases, said heating walls being pivotally supported on vertical axes and movable relative to each other to vary the space therebetween.

7. Carbonizing apparatus comprising a pair of adjacent spaced walls pivoted about vertical axes, each of which is provided with passages for heating gases, means for supplying said passages with heating gases, and means for moving said walls about their pivots.

8. Carbonizing apparatus comprising a hollow heating wall, means for pivotally supporting the wall at one of its vertical edges for movement about a vertical axis, a second hollow heating wall for co-operating therewith to provide a coking chamber therebetween, and means for supplying the interior of the hollow walls with heating gases and for withdrawing the same.

9. Carbonizing apparatus comprising a housing, a plurality of vertical hollow walls in said housing that are spaced to provide coking chambers therebetween, means for pivotally supporting said walls about vertical axes, means for transmitting heating gases to the interiors of said walls and means for simultaneously moving certain of said walls to different degrees about their pivotal supports to vary their relative positions and thus vary the widths of said coking chambers.

10. Carbonizing apparatus comprising a housing, a plurality of vertical hollow walls in said housing that are spaced to provide coking chambers therebetween, means for pivotally supporting said walls about vertical axes, means at least partially coinciding with said axes for transmitting heating gases to and from the interiors of

said walls and means for simultaneously moving certain of said walls through different angles about their respective pivotal supports for correspondingly varying the widths of said coking chambers.

11. Low temperature coking apparatus for intermittent operation comprising, an enclosing chamber, a series of alternate vertical coking chambers and metal vertical pendant flued heating walls therefor arranged side-by-side in a row in said enclosing chamber; a hot gas flue common to all of said heating walls and adapted for supplying previously prepared hot heating gases to the flues of said walls, a second flue common thereto for conveying the used heating gases therefrom, conduits separately connecting the flues of the heating walls with said hot gas flue and said second flue, the flues of the heating walls and said conduits being hermetically sealed from the coking chambers and said enclosing chamber, and each of said heating walls being mounted for swinging movement for being spread apart within said enclosing chamber for downward discharge of finished coke from the coking chamber while in said enclosing chamber.

12. Low temperature coking apparatus for intermittent operation comprising, an enclosing chamber, a series of alternate vertical coking chambers and metal vertical pendant heating walls therefor arranged side-by-side in a row in said enclosing chamber, each of said heating walls having internally heat-insulated metal gas flow flues, a hot gas flue common to all of said heating walls and adapted for supplying previously prepared hot heating gases to the flues of said walls, a second flue common thereto for conveying the used heating gases therefrom, conduits separately connecting the flues of the heating walls with said hot gas flue and said second flue, the flues of the heating walls and said conduits being hermetically sealed from the coking chambers and said enclosing chamber, and each of said heating walls being mounted for swinging movement for being spread apart within said enclosing chamber for downward discharge of finished coke from the coking chambers while in said enclosing chamber.

13. Low temperature coking apparatus for intermittent operation comprising, an enclosing chamber, a series of alternate vertical coking chambers and metal vertical pendant flued heating walls therefor arranged side-by-side in a row in said enclosing chamber, a hot gas flue common to all of said heating walls and adapted for supplying previously prepared hot heating gases to the flues of said walls, a second flue common thereto for conveying the used heating gases therefrom, conduits separately connecting the flues of the heating walls with said hot gas flue and said second flue, the communication of conduits for said hot gas flue and the conduits for said second flue with the flues of the heating walls being one at the top and the other at the bottom and both on the same side of the respective heating walls, internal vertical baffles for controlling the flow through the flues of the heating walls with the baffles nearer the conduits being shorter and the baffles progressively farther away from the conduits being longer, the flues of the heating walls and said conduits being hermetically sealed from the coking chambers and said enclosing chamber, and each of said heating walls being mounted for swinging movement for being spread apart within said enclosing chamber for downward discharge of finished coke from the coking chambers while in said enclosing chamber.

14. Low temperature coking apparatus for intermittent operation comprising, in combination: an enclosing chamber, a series of alternate vertical coking chambers and vertical pendant flued heating walls therefor arranged side-by-side in a row in said enclosing chamber; a hot gas flue common to all of said heating walls and adapted for supplying previously prepared hot heating gases to the flues of said walls; a second flue common thereto for conveying the used heating gases therefrom; conduits separately connecting the flues of the heating walls with said hot gas flue and said second flue; the flues of the heating walls and said conduits being hermetically sealed from the coking chambers and said enclosing chamber, and each of said heating walls being pivoted for swinging movement about a vertical axis for being spread apart within said enclosing chamber for downward discharge of finished coke from the coking chamber while in said enclosing chamber.

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