May 9, 1933. F. PUENING 1,908,538

# LOW TEMPERATURE DISTILLATION APPARATUS

Filed May 22, 1928 7 Sheets-Sheet 1

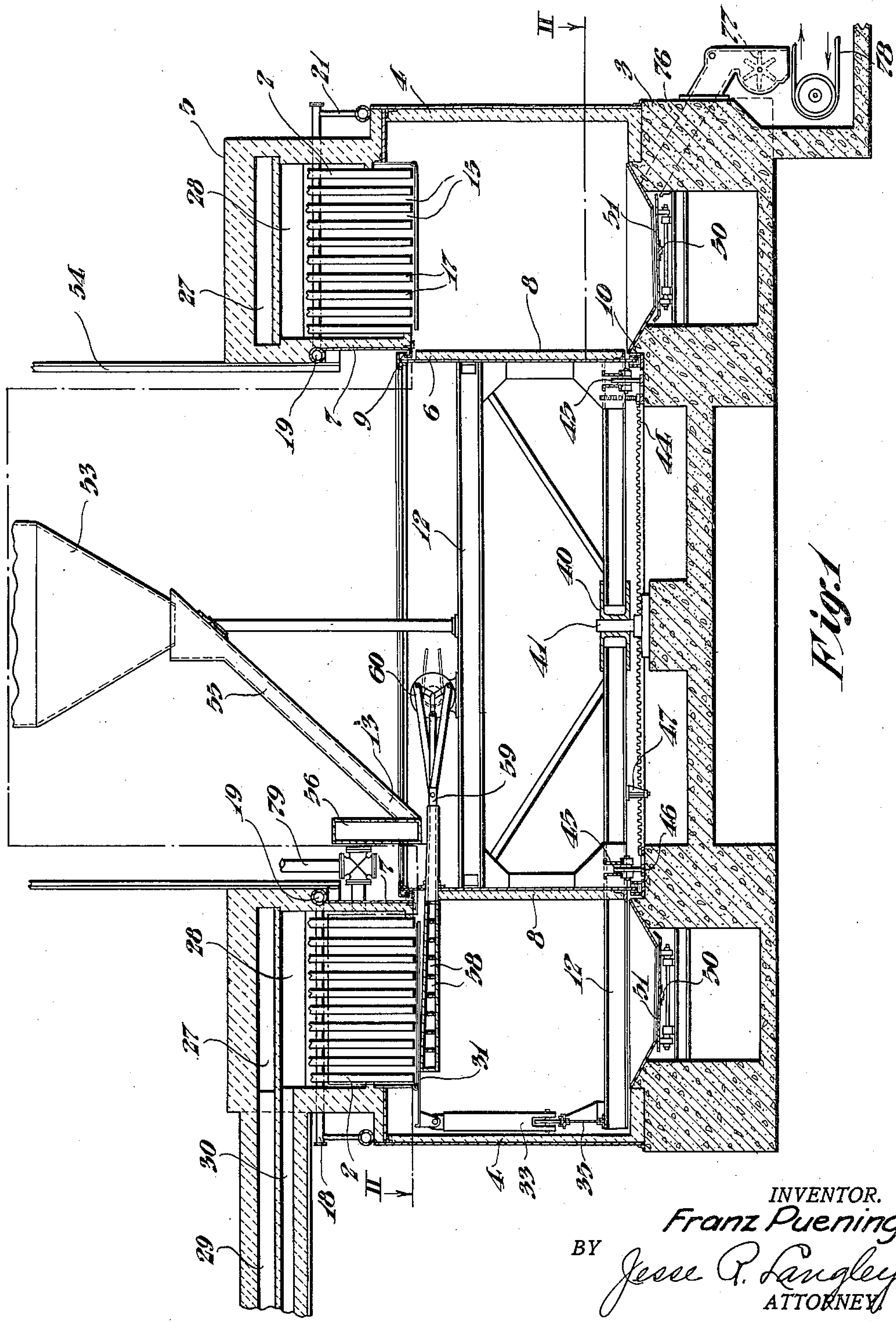

Fig. 1

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LOW TEMPERATURE DISTILLATION APPARATUS

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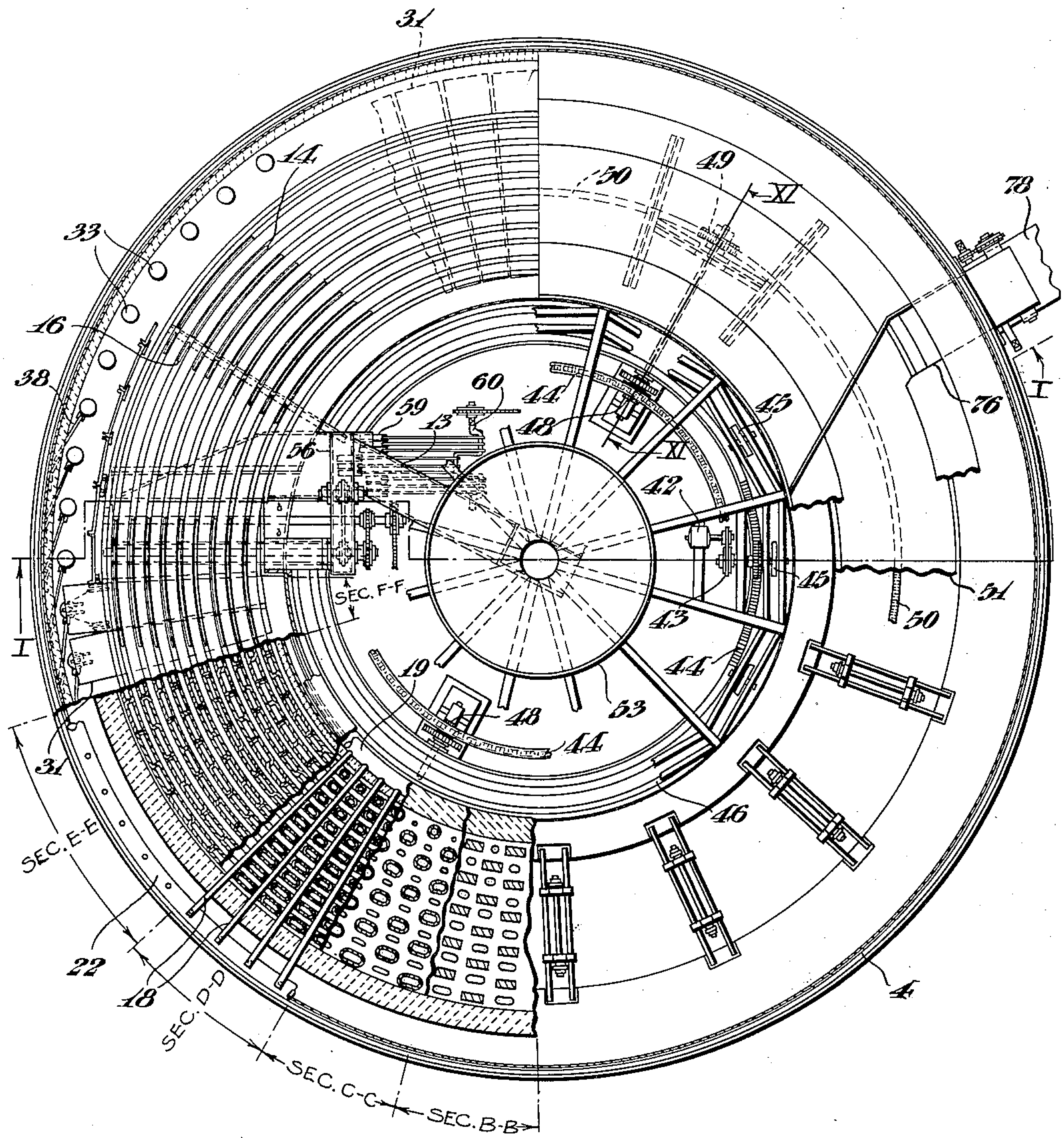


Fig: 2

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LOW TEMPERATURE DISTILLATION APPARATUS

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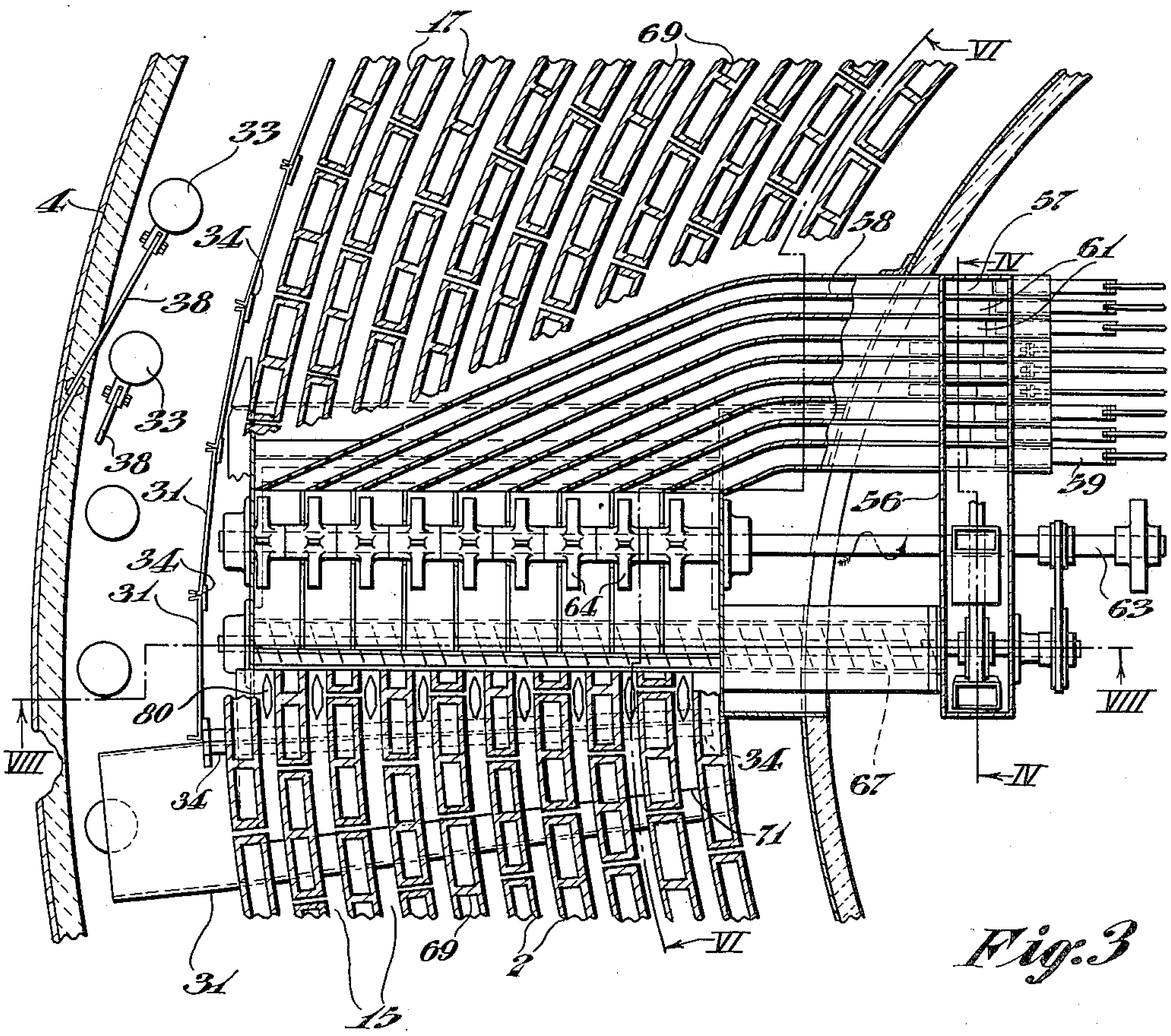


Fig. 3

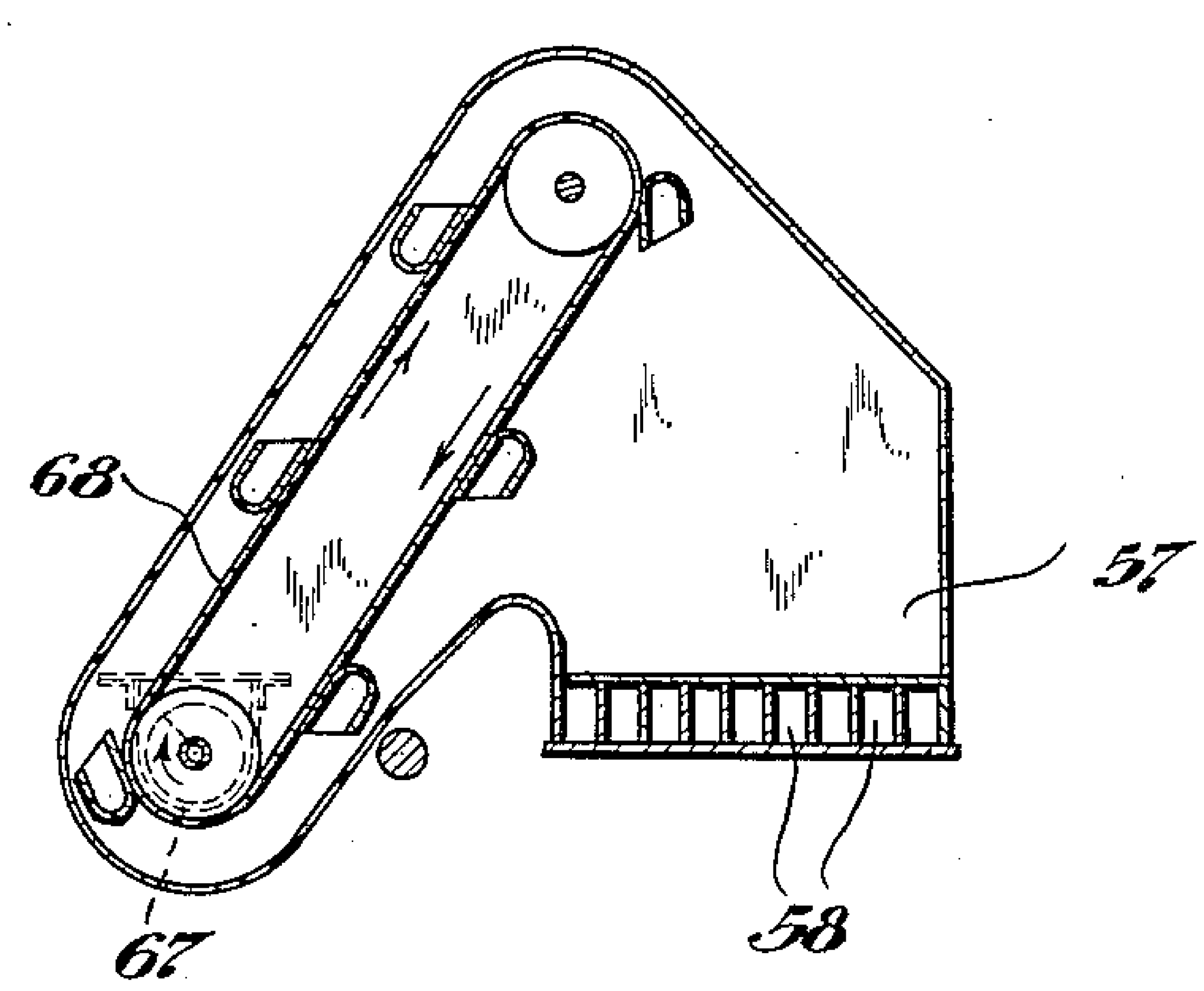


Fig. 4

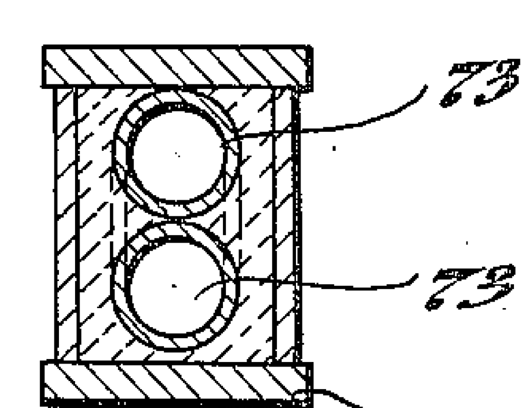


Fig. 5

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LOW TEMPERATURE DISTILLATION APPARATUS

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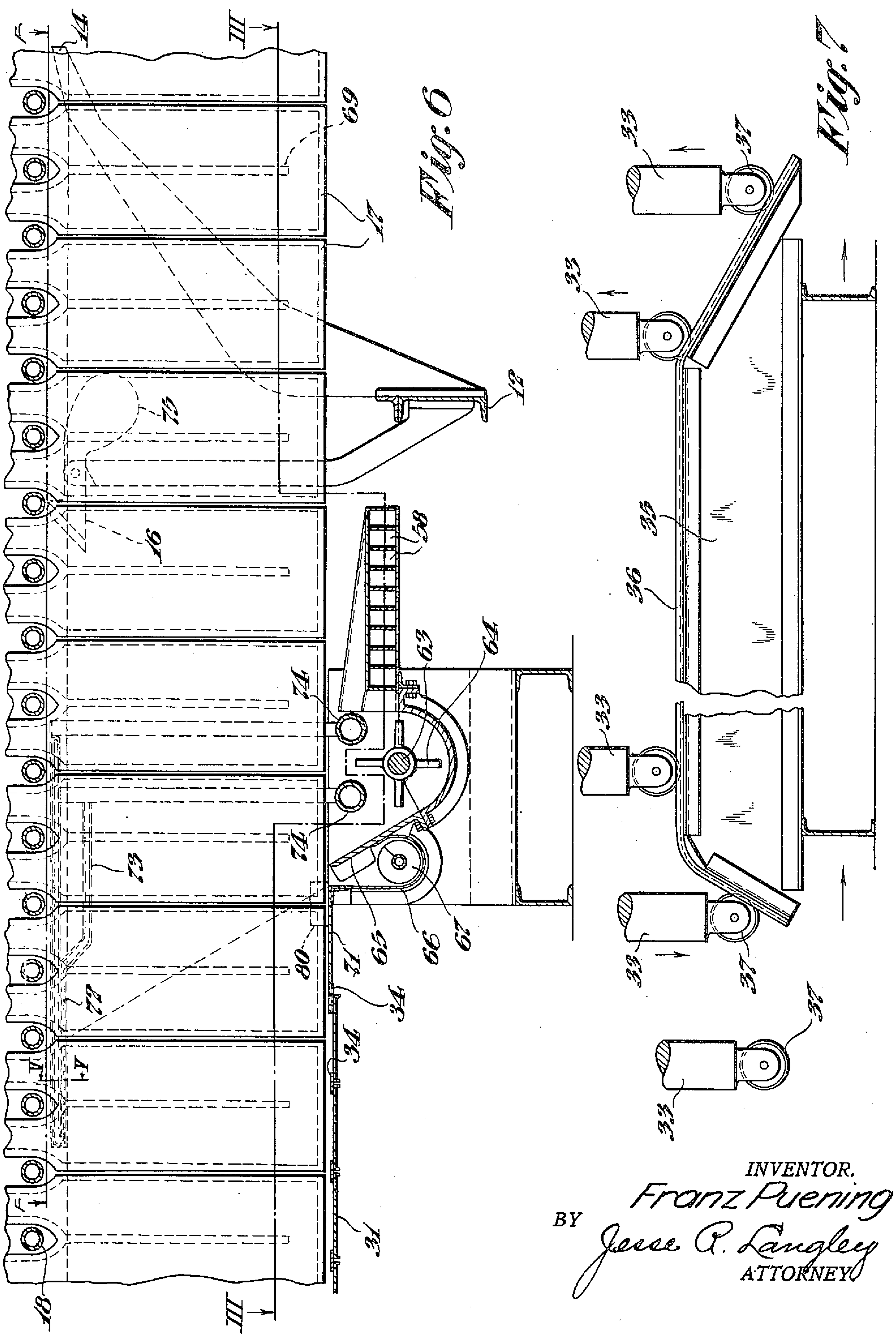


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LOW TEMPERATURE DISTILLATION APPARATUS

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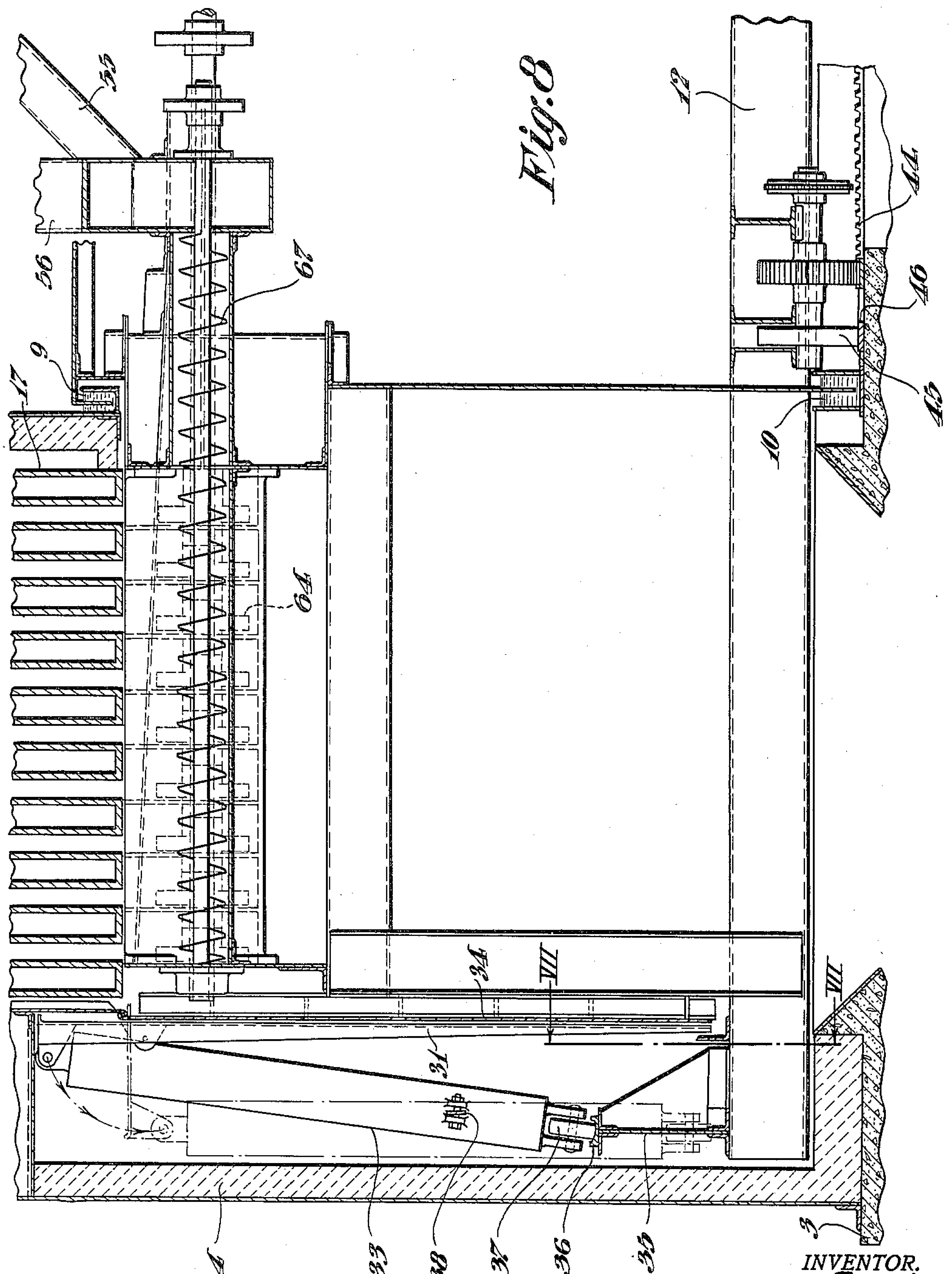


Fig. 8

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LOW TEMPERATURE DISTILLATION APPARATUS

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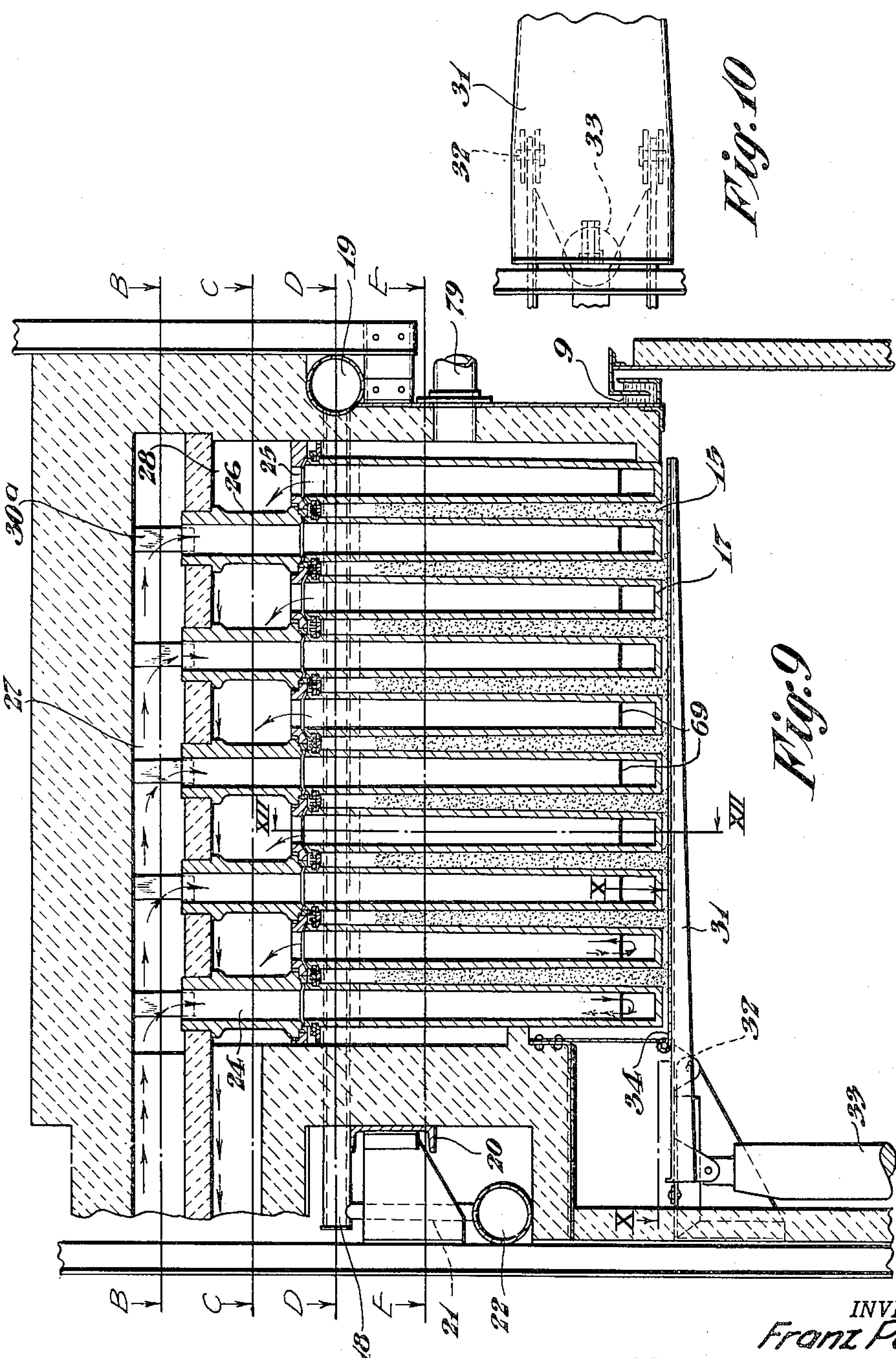


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LOW TEMPERATURE DISTILLATION APPARATUS

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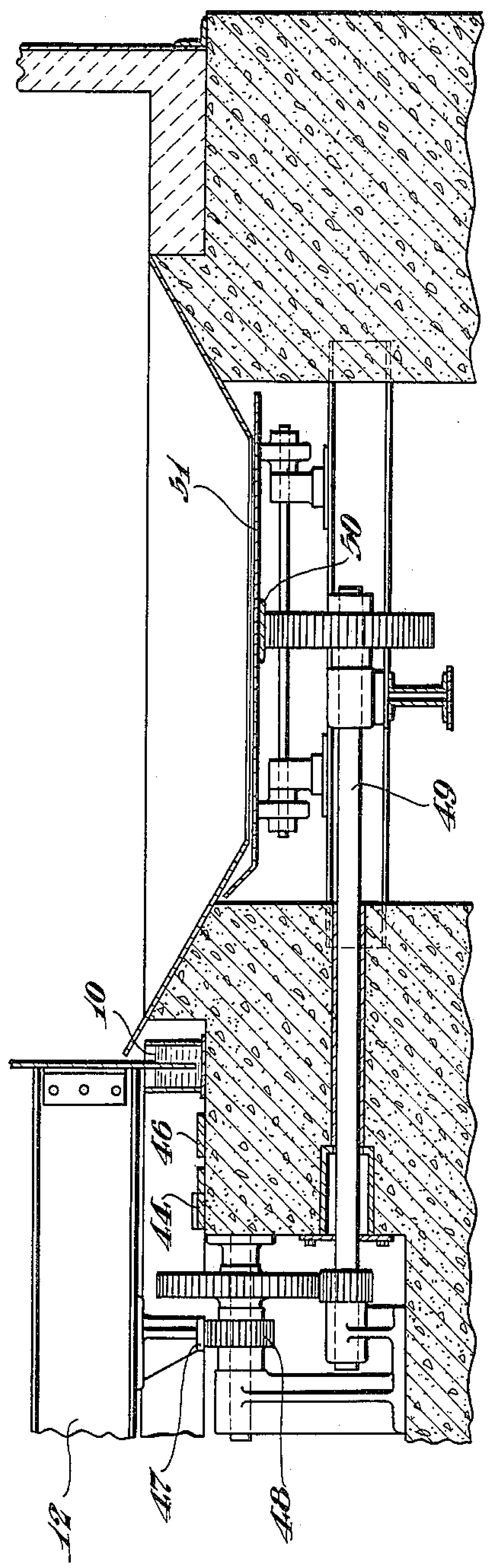


Fig. 11

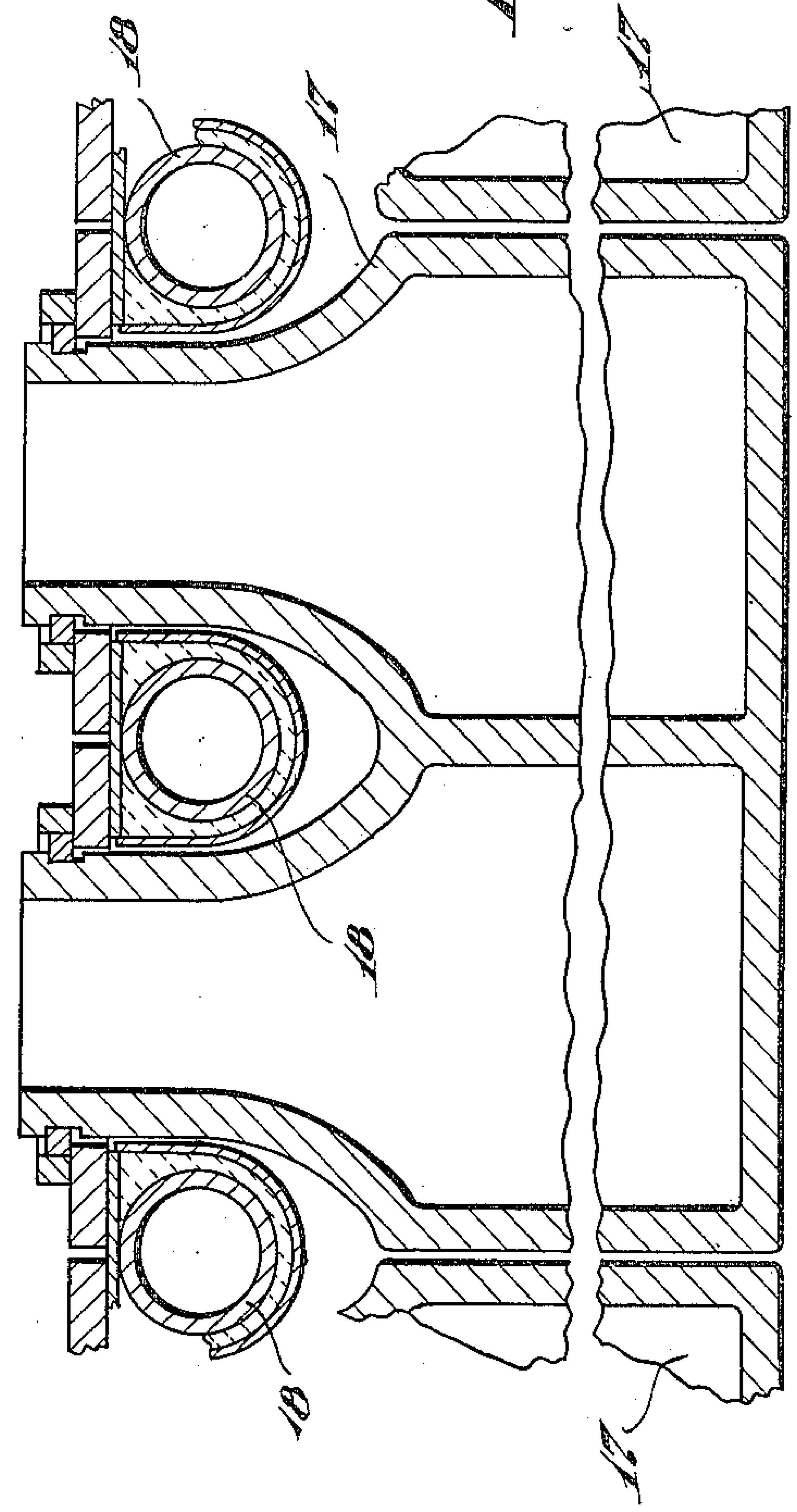


Fig. 12

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Patented May 9, 1933

1,908,538

# UNITED STATES PATENT OFFICE

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## LOW TEMPERATURE DISTILLATION APPARATUS

Application filed May 22, 1928. Serial No. 279,725.

My invention relates to low-temperature distillation apparatus and particularly to apparatus for producing low-temperature coke.

An object of my invention is to provide improved apparatus for low-temperature coking that operates continuously through a definite cycle to distill coal or other carbonaceous materials.

A further object of my invention is to provide a substantially circular metallic structure for producing low-temperature coke that will maintain the vertical alinement of the walls within which heat is stored or through which heat is transmitted to the material being treated.

A further object of my invention is to provide coking apparatus in which great quantities of coal or the like can be carbonized at low temperatures with a minimum of investment cost, labor and maintenance charges.

A further object of my invention is to provide improved apparatus for low-temperature coking that operates continuously in a steady advance in a circular path without the necessity of stopping and "spotting" the charging and discharging devices for individual retorts.

It is a further object of this invention to provide an apparatus in which coal is coked in narrow spaces of considerable height whereby dense and strong coke is produced.

It is another important object of this invention to build coking apparatus in which the peculiar behavior of metals at coking temperatures is taken into consideration whereby the heating walls of the coking chambers will remain in alinement regardless of the tendency of the metals to flow slowly at elevated temperatures.

It is a further object to provide apparatus of such type that its coking chambers can be easily and completely emptied of coke, and in which also carbon deposits are automatically removed from the gas spaces above the coke.

It has become common knowledge that in the low-temperature coking of coal and the like, the best coke and the highest efficiency of the coking apparatus are obtained when the coal is coked in narrow chambers or retorts of considerable height. Oblong retorts have been used heretofore with a width of from 3 to 6 or 8 inches. Also cylindrical retorts of from 4 to 9 inches in diameter have frequently been used. Retorts of such diameters or widths have only a small volumetric capacity for coal, and as a result great numbers of these retorts were required resulting in heavy charges for investment and for labor in the many operations of charging and discharging the retorts.

In order to improve these conditions, it has been proposed in several instances to arrange the small retorts in a circular path, so that the movement of the charging and discharging devices might be simplified and the labor connected therewith be reduced. However, such arrangement still necessitates the accurate registering of the charging and discharging devices over the small retorts and these machines must, therefore, advance in small steps, a performance which requires much personal attention and supervision.

It has been proposed to use apparatus in which coal is deposited continuously upon horizontal annular ledges or trays and coke is removed continuously. However, the layer of coke on the horizontal trays is shallow and as a result the coke is fragile and spongy and useful mainly for pulverization.

If dense and strong coke is to be produced for industrial or domestic purposes, the coal must be coked while it is pressed or wedged in between heated surfaces. Any means for exerting pressure upon the coal would have to be applied during the entire coking period until formation of coke has taken place, and such means would be an undesirable complication and the maintenance of which would be expensive.

Another objection to horizontal trays or ledges is the fact that their horizontal extension or width must necessarily be small because of the behavior of the metal, of which these projecting trays are usually made. Hot metals at elevated temperatures behave like very viscous liquids in that they actually flow.

It is quite well known, for instance, that the annealing temperatures of iron and most of its alloys lie from 1200° F. upward. This means that relaxation of internal stresses takes place at these temperatures; therefore, when horizontal trays are projected outwardly from a vertical cylinder to a useful extent or width, bending stresses are set up, which at the elevated temperatures are sufficient to cause a gradual flow of the molecules in the iron, with the result that the trays sag downwardly. These distortions soon begin to interfere with the proper operation of the carbonizing machine and finally stop it. In order to somewhat overcome this drawback, horizontal trays must not be made wide and this condition for a given carbonizing capacity necessitates a greater number of trays with a corresponding increase in the number and expense of coal charging and coke-removing devices.

The older machines with horizontal trays or containers for coal are less advantageous also for the reason that it is more difficult to remove all coke from the horizontal surfaces. It is quite necessary that all larger pieces of coke and even the fine coke dust should be removed from the coking surfaces by scraping or brushing for the reasons that otherwise heat transmission is restricted and the quality of the coke is lowered. However, scrapers cannot contact with the coking surfaces at every point due to variations of heat expansion, and especially because some of the horizontal surfaces usually become warped and some others have begun to sag and as a result some of the coke remains on the horizontal surfaces to interfere with good operation upon the next following carbonizing cycle when new coal is again placed upon these heating surfaces.

In the apparatus embodying my invention, the foregoing disadvantages of prior art devices are avoided. The coal or other carbonaceous material is coked between a series of concentric circular walls that are internally heated and are spaced to provide annular concentric coking spaces. These walls are stationary as are the furnace for supplying heated gases to the walls and certain housings for enclosing the apparatus.

The heating walls are vertical and are composed of numerous individual elements, each suspended from its top and hanging vertically, thus eliminating the possibility of the development of bending stresses. All individual elements are suspended from a framework of pipes that is artificially cooled and insulated and therefore not subject to the distortions caused by elevated temperatures to which the individual heating elements will be raised.

The shape of the annular coking spaces is therefore secure against disturbance, and since the stresses in the individual heating elements are only slight tension stresses caused by the weight of the element, the structure is much superior in permanency and reliability to apparatus of the prior art.

The revolving parts of the apparatus comprise the lower portion of an inner circular housing that is connected to stationary parts by water seals. The coal-handling mechanism is mounted to revolve with this inner housing. Suitable coke-pushing and scraping devices travel around the walls at such speed as to make one revolution during a complete cycle of operation of the apparatus.

The coke is continuously removed from the circular spaces between the stationary walls by means of the traveling pushers and scrapers. The coking spaces are progressively filled by suitable coal-throwing mechanisms which follow the coke-removing devices at a relatively short distance. The entire mechanism is continuously operative with the exception of the segment of the stationary walls between the moving coke-removal apparatus and the filling apparatus.

The stationary hanging walls are, in general, composed of a series of castings, each having two ports that communicate, respectively, with chambers for heating gases, one of which is under pressure and the other of which is under suction whereby a circulation of hot gases through the heating walls is insured.

The quality of the coke is greatly superior to that made upon horizontal or inclined surfaces upon which coal is placed in a shallow layer.

The vertical suspension of the heating elements also guarantees continued vertical alinement of the elements because internal stresses, remaining in the castings from the foundry or other influences which might tend to warp the elements, will gradually disappear due to the action of the annealing temperature to which the castings are exposed, and the fact that they are suspended vertically. Castings that are even slightly bent in the beginning will therefore become straight in this apparatus and the only effect which the gradual flow of the metal at the high temperatures can have is the gradual lengthening of the elements, which change, however, is not serious because of the arrangement of other details of this new machine.

The details of my invention will be described in connection with the accompanying drawings in which similar numerals designate corresponding parts.

Figure 1 is a vertical sectional view taken on line I—I of Fig. 2 of distillation apparatus embodying my invention;

Fig. 2 is a horizontal sectional view taken partially on line II—II of Fig. 1, partially on lines B—B, C—C, D—D and E—E of Fig. 9, and partially on line F—F of Fig. 6;

Fig. 3 is a horizontal sectional view taken on line III—III of Fig. 6 of a portion of the apparatus of Fig. 1, parts being broken away;

Fig. 4 is a vertical sectional view taken on line IV—IV of Fig. 3;

Fig. 5 is a vertical sectional view taken on line V—V of Fig. 6;

Fig. 6 is a vertical sectional view taken on line VI—VI of Fig. 3;

Fig. 7 is a vertical sectional view taken on line VII—VII of Fig. 8 of a portion of the door-controlling mechanism;

Fig. 8 is a vertical sectional view taken on line VIII—VIII of Fig. 3;

Fig. 9 is an enlarged sectional view of a portion of the apparatus of Fig. 1;

Fig. 10 is a horizontal sectional view taken on line X—X of Fig. 9;

Fig. 11 is a vertical sectional view taken on line XI—XI of Fig. 2; and

Fig. 12 is a vertical sectional view taken on line XII—XII of Fig. 9.

Low-temperature coking apparatus 1 constructed in accordance with my invention comprises a plurality of stationary concentric heated hanging walls 2 that are enclosed by a foundation 3, an outer housing 4 of refractory material, a roof 5 of similar material, and an inner housing 6 consisting of an upper stationary portion 7 and a lower rotatable portion 8. The rotatable portion 8 of the inner housing 6 is connected by water seals 9 and 10 to the stationary portion 7 and to the foundation 3.

A central rotatable framework 12, to which is secured the rotatable portion 8 on the inner housing 6, supports a coal-handling mechanism 13 for supplying coal or other material to be treated to the coking spaces between the hanging walls 2. The framework 12 also carried with it coke pushers 14 corresponding in number to the circular coking spaces 15 and suitable scrapers 16 for removing carbon deposits from the upper portions of the coking chambers.

Each of the circular coking walls 2 consists of a comparatively large number of relatively narrow castings 17 that are supported at their tops by radially extending beams 18 that are water-cooled and are heat-insulated from the castings 17. The details of the connection of the castings 17 to the beams 18 are best shown in Fig. 12. The beams 18 are secured at their inner ends to a circular header 19 and their outer ends are supported on an annular channel 20. The outer end of each of the beams 18 is connected by a pipe 21 to a second circular header 22 whereby water may be circulated through the beams.

Each of the hollow castings 17 is provided with an inlet port 24 and an outlet port 25 for the circulation of heated gases therethrough, a vertical flanged pipe 26 constituting an extension of the inlet 24. The inlet ports 24 and the outlet ports 25 are respectively connected to superposed annular heating gas chambers 27 and 28, located above the coking walls. These circular chambers are connected to a furnace or heating plant (not shown) through ducts 29 and 30. As best shown in Fig. 9, the flanged pipes 26 extend upwardly through the lower chamber 28 to support the floor of the chamber 27 and the outlet ports 25 are directly connected to the roof chamber 28. The roof or upper horizontal wall of the chamber 27 is supported by posts 30*a* which rest on the floor of that chamber.

The coking walls 2 may be of any desired number, ten being shown by way of example. The castings are slightly tapered whereby the annular coking chambers 15 between the walls are slightly wider at the bottom than at the top in order that coke may be more easily removed therefrom.

The bottom openings of the coking chambers 15 are normally closed by hinged doors 31 that are hinged at 32 (Figs. 8 and 9) and are normally held in closed position by elongate counterweights 33 that are pivotally secured to the outer ends of the doors.

The joints between the doors 31 are covered by relatively narrow hinged doors 34 each of which is retained in closed position when either of the coacting doors 31 is in closed position. The several doors 34 open when both of the coacting doors 31 are open.

The vertical positions of the counterweights 33 and, accordingly, the positions of the doors 31 are controlled by a ramp 35 that is secured to the rotatable framework 12 and which operates to raise and lower the counterweights 33 to open and close the corresponding doors. The ramp 35 is provided with a track 36 that co-operates with rollers 37 on the bottom of each of the counterweights 33. As best shown in Fig. 3, each of the counterweights 33 is pivotally connected to the outer housing 4 by a tie rod 38 in order to prevent swinging movement of the counterweights from their proper upright position.

The rotatable framework 12 is provided with a central hub 40 that is journalled on a stationary post 41. The framework 12 and its associated mechanisms and parts are driven by a motor 42 that is mounted thereon and which is connected by means of a chain-and-sprocket mechanism 43 to a circular stationary rack 44 that is mounted on the foundation 3. The framework 12 is provided with wheels 45 that operate on a stationary circular track 46 supported by the foundation 3.

A circular rack 47 that is secured to the lower portion of the framework 12 is connected to two oppositely disposed pinions 48 that are connected to gear mechanisms 49 and a circular rack 50 for driving an annular coke pan 51 that is located beneath the coking walls 2. The gear mechanism is so arranged as to drive the coke pans at a rate of speed materially higher than that of the framework 12.

The coal-handling mechanism that is mounted upon the framework 12 and rotatable therewith comprises a hopper 53 that is adapted to be supplied from any suitable bin (not shown) that may be supported upon the superstructure 54. An inclined chute 55 carries coal from the bottom of the hopper 53 to a rectangular hopper 56 that is mounted over a coal-feeding device 57.

The coal-feeding device 57 comprises a series of horizontal pipes or chutes 58 extending through the movable housing 8, through which the coal is forced by pistons or plungers 59 that are actuated by a motor-driven crank shaft 60, the pistons being actuated at different portions of the cycle of the crank shaft. Inasmuch as more coal is required for the outer coking chambers than for the inner ones, by reason of their differences in length, the cross-sections of the openings 61 between the pipes 58 and the hopper 56 are progressively larger for the several coking chambers in accordance with their positions from the inner one.

The coal-feeding mechanism 57 supplies the coal through the pipes 58 to a charging mechanism comprising a radially-extending shaft 63 having a series of star wheels 64 that correspond in number and spacing to the several coking chambers 15. These star wheels 64 are operated at high speed and throw the coal upwardly along an inclined floor 65 into the corresponding coking chambers 15. In order to be certain that the coking chamber 15 will be completely filled, a surplus of coal is provided and such surplus falls into a housing 66 of a screw conveyor 67 by means of which it is conveyed to an elevator 68. The elevator 68 returns the surplus coal to the rectangular hopper 56.

It may be assumed that the heating plant is supplying properly heated gases through the ducts 28 and 29 to the corresponding superposed heating chambers 26 and 27 and that the chamber 26 is under pressure while gases are exhausted from the chamber 27 in order to insure a circulation of gases through the several hollow castings 17 of the coking walls 2. The direction of the gases through the castings 17 is vertical since they are each provided with a vertical partition 69. It may be assumed further that the framework 12 with its associated parts is being rotated by its driving motor 42 and coal is continuously supplied from the hopper 53 through the chute 55 to the feeding mechanism 57.

The star wheels 64 of the coal-throwing mechanism operate to fill the coking chambers 15 progressively as the framework 12 rotates. The ramp 35, which as best shown in Fig. 7, operates to lift certain of the counterweights 33 and to open the corresponding doors 31 and 34, permits the counterweights to be lowered successively and to close the corresponding doors 31 and 34 to retain the coal that is placed in the coking chambers 15.

However, in order to retain the coal in the coking chambers during the interval between the passing of the throwing mechanism and the closing of the door, which latter cannot be completed until the throwing mechanism has passed, a false door 71 that is carried by the coal-throwing mechanism bridges the varying gap between the last door 31 that has been closed and the coal-throwing mechanism. The last door to close and the false door 69 may overlap temporarily but each door 31 will close completely when the false door 71 is withdrawn beyond the area of the corresponding door 31.

Since the coal-throwing mechanism operates at high speed, it is necessary to provide means for preventing the coal from being thrown beyond the upper level of the coking chamber and accordingly each of the coking chambers 15 is provided with a curved coal guard 72 which regulates the upper height of the body of coal. The coal guards 72, which are carried by the coal-throwing mechanism, are water-cooled by means of pipes 73 that communicate with headers 74 which also are carried by the coal-throwing mechanism. The operation of filling the coking chambers will continue as described, the rotation of the framework 12 being regulated to make one revolution during the time that is required to effect low-temperature distillation of the coal.

When the first revolution of the apparatus is nearly completed, the coke that has been previously formed is removed by the coke pushers 14, the doors 31 and 34 corresponding to the position of the coke pushers having been opened progressively by the ramp 35, as indicated in Fig. 7. The scrapers 16, which are pivotally mounted and provided with a counterweight 75, operate to remove any carbon deposits from the upper surfaces of the coking chambers 15.

The process of removing coke and filling the coking chambers 15 proceeds simultaneously, the coal-throwing mechanism following the coke-discharge mechanism at a relatively short interval, as is indicated in Fig. 6.

The coke that is discharged from the bottoms of the several coking chambers 15 falls into the rotating coke pan 51 from which it is removed through a discharge chute 76 and, after being suitaby quenched in the usual manner, it is discharged by a star wheel 77 upon a carrier belt 78. By reason of the high speed of the rotating coke pan 51, the depth of the coke therein is relatively low.

The gases of distillates evolved during the low-temperature distilling process described above pass radially through the openings between the inlets and outlets of the several castings 17 to the spaces between the inner wall 2 and the stationary portion 7 of the inner housing and are withdrawn through pipes 79 to any suitable storage means.

The alinement of the castings 17 of the heating walls 2 is maintained during the charging operation by means of tapered spacing blocks 80 which are mounted on the false door or plate 71 and that move between the bottom portions of the castings substantially on the progressing line of the angle of repose of the coal, as is shown in Fig. 8.

The apparatus operates continuously in the manner previously described to supply coal to be carbonized at such rate as to completely fill the annular coking chambers. The surplus coal supplied to the feeding mechanism prevents the escape of distillates through the chute 55 since the pipes 58 are subjected to the fluid pressure inside the housings.

The coke will be of good quality because it is produced by stationary coking chambers and is not moved during the coking operation. The small angle between the coke pushers and the filling mechanism insures that the apparatus is always operating at substantially maximum capacity. The coking apparatus is easily regulated as to the time of coking since the coking period may be varied by simply changing the speed of the driving motor.

The heating plant, being separate from the coking apparatus, may be regulated to maintain the heating walls at the desired temperatures which will vary somewhat with the nature and properties of the coal or other carbonaceous material to be treated.

The castings will tend to retain their vertical alinement and to remain in horizontal alinement with each other since they are suspended at their tops and are heated to a substantially constant uniform temperature. Their weights will tend to prevent their warping while heated. Such warping as may occur will be comparatively slight because of the relatively small width of the castings.

The arrangement whereby the coking chambers are filled from the bottom enables the connections between the castings and the heating gas chambers to be placed at the top of the apparatus where they will not interfere with the removal of the coke from the bottoms of the coking chambers. If the coal were fed into the tops of the coking chambers, as by gravity, difficulties in construction would be encountered in providing suitable connections for the movable parts through the top of the housing.

The apparatus of my invention may be operated economically since inexpensive fuel of any desired kind may be used in the separate heating plant to produce hot gases of combustion for heating the castings of the heating walls.

The operation of the plant is accomplished with minimum labor and supervision since power-operated mechanisms perform substantially all of the functions of charging and discharging the apparatus.

The ease and simplicity with which the several operating conditions may be regulated are also distinctive features of the apparatus. The foregoing and other advantages will be apparent to those skilled in the art. My invention is not to be limited except as expressed in the claims.

I claim as my invention:

1. Coking apparatus comprising a plurality of concentric spaced heating walls, each of said walls comprising vertically extending elements suspended from the top portions thereof.

2. Coking apparatus comprising a plurality of concentric spaced heating walls, each of said walls consisting of vertically extending hollow elements suspended from the top portions thereof, and each of said elements being provided with inlet and outlet openings at the top thereof for the circulation of hot gases therethrough.

3. Coking apparatus comprising a plurality of concentric heating walls spaced to provide annular coking chambers about a vertical axis, each of said walls consisting of a plurality of elements each having an inlet and an outlet opening and a passageway for the circulation of heating gases therethrough and said coking chambers having charging and discharging openings.

4. Coking apparatus comprising a plurality of stationary annular concentric coking chambers having heating walls, said coking chambers having bottom charging openings and closures therefor, and means for supplying material to be carbonized to said coking chambers through said bottom openings, said means comprising an impelling device below and in alinement with each of said coking chambers.

5. Coking apparatus comprising a plurality of stationary annular concentric coking chambers having heating walls and movable bottom closures, and means for successively opening and closing said closures and for supplying material to be carbonized through the bottoms of said coking chambers while said closures are open.

6. Coking apparatus comprising a plurality of stationary annular concentric coking chambers having heating walls, means for supplying material to be carbonized to said coking chambers, said means comprising an impelling device below and in alinement with each of said coking chambers for actuating said material upwardly into said chambers to a predetermined height, and bottom closures for said coking chambers for retaining said material therein.

7. Coking apparatus comprising a plurality of concentric annular coking chambers the

axis of which is vertical, said chambers being of substantially uniform vertical cross-sectional area and having heating walls therebetween whereby said coking chambers are of unequal length and impelling devices of unequal capacities and mounted for movement in concentric annular paths for supplying material to be carbonized to all of said chambers simultaneously and at rates proportional to the lengths of the respective chambers.

8. Coking apparatus comprising a plurality of stationary endless continuous annular and concentric coking chambers, the axis of which is substantially vertical, and heating chambers therefor alternating therewith, swinging bottom closures constituting complete closures for said coking chambers, and means for progressively opening said closures to permit the discharge of treated material from the bottoms of said chambers and the recharging of said chambers and for progressively closing said closures to retain the material being treated.

9. Coking apparatus comprising a plurality of endless annular and concentric coking chambers, the axis of which is substantially vertical, and heating chambers therefor alternating therewith, swinging bottom closures for said coking chambers, counterweights for controlling said closures, and a device mounted for continuous movement having inclined portions for progressively actuating said counterweights to open and close the corresponding closures.

10. Coking apparatus comprising a plurality of stationary endless annular and concentric coking chambers, the axis of which is substantially vertical, and heating chambers therefor alternating therewith, charging mechanism for said coking chambers that is adapted to supply material to be treated thereinto from the bottom thereof, and means for collecting the surplus of material over that retained in said coking chambers when supplied thereinto by said charging mechanism and that may discharge therefrom by gravity and for returning the same to said charging mechanism.

11. Coking apparatus comprising stationary and movable portions, the stationary portion comprising annular concentric heating walls, the axis of which is vertical, spaced to provide endless annular concentric coking chambers alternating therewith and the movable portion comprising charging mechanism for said coking chambers mounted for movement in an annular path coaxial with said coking chambers, coke-removing mechanism and a bar in each of said chambers and mounted for movement with said mechanism for limiting the height of the charges in said chambers for providing a gas space for passage of distillate gases.

12. Coking apparatus comprising stationary and movable portions, the stationary portion comprising annular continuous heating walls spaced to provide coking chambers therebetween and being provided with radially extending openings at an upper portion thereof and the movable portion comprising mechanism for charging said coking chambers and a guard for limiting the height of the charge in each of said coking chambers for providing a gas space for the passage of distillate gases in said coking chambers and between said openings, and means for conducting the distillate gases from said apparatus.

13. Coking apparatus comprising a plurality of continuous heating walls spaced to provide coking chambers therebetween, means for charging said chambers to a predetermined height for providing a gas space above a charge in each chamber, and means for removing the treated material from said chambers comprising a bar extending into the upper part of each of said coking chambers at an angle to the horizontal.

14. Coking apparatus comprising a plurality of endless annular concentric heating walls spaced to provide annular concentric coking chambers alternating therewith and a device mounted for continuous movement in each of said chambers for removing deposits from the upper portions of said chambers.

15. Coking apparatus comprising a plurality of endless annular concentric heating walls, the axis of which is vertical, spaced to provide endless annular concentric coking chambers therebetween, charging means for said chambers mounted for continuous movement in an annular path coaxial with said chambers, and spacing members mounted for moving continuously with said charging means and between said walls for maintaining said walls from spreading out of their alinement during the charging of said coking chambers.

16. Coking apparatus comprising a plurality of endless annular concentric heating walls, the axis of which is vertical, spaced to provide endless annular concentric coking chambers therebetween, means mounted for movement in annular concentric paths coaxial with said coking chambers for continuously and progressively charging said chambers and discharging material therefrom and a movable carrier for the discharged material adapted to be operable at a speed materially higher than that of the movable means for discharging said material.

17. Coking apparatus comprising a continuous heating wall consisting of a plurality of pendent individual elements, each of said elements being of metal in the form of a hollow block, and a framework from which said elements are suspended.

18. Coking apparatus comprising a plu-

rality of concentric walls of pendent hollow elements spaced to provide coking chambers therebetween and a framework adapted to be internally cooled and from which said elements are suspended.

In testimony whereof, I have hereunto subscribed my name this 18th day of May, 1928.

FRANZ PUENING.