L. L. SUMMERS.

COKING PROCESS.

APPLICATION FILED FEB. 9, 1909.

935,175.

Patented Sept. 28, 1909.

7 SHEETS—SHEET 1.

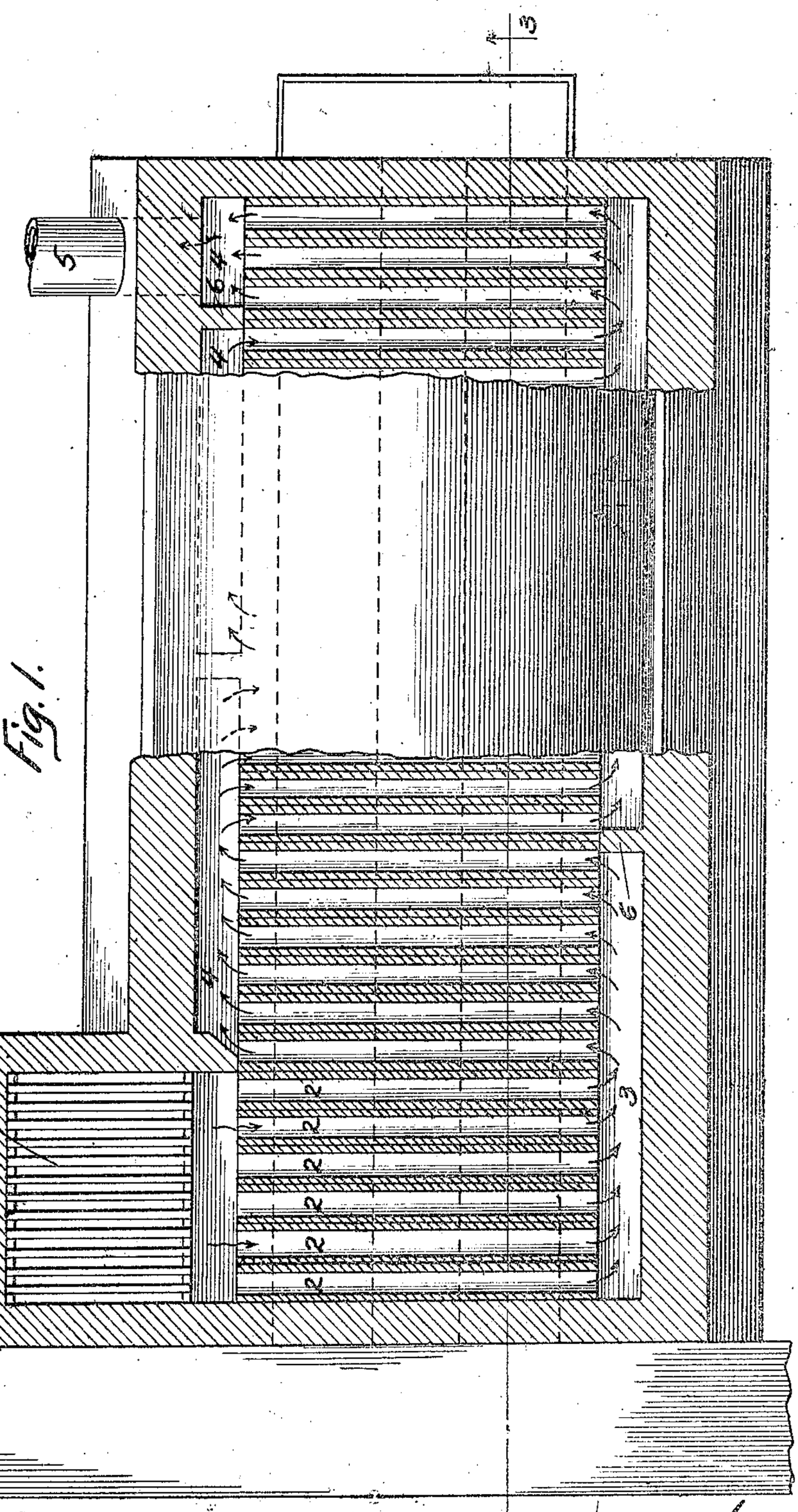

Fig. 1.

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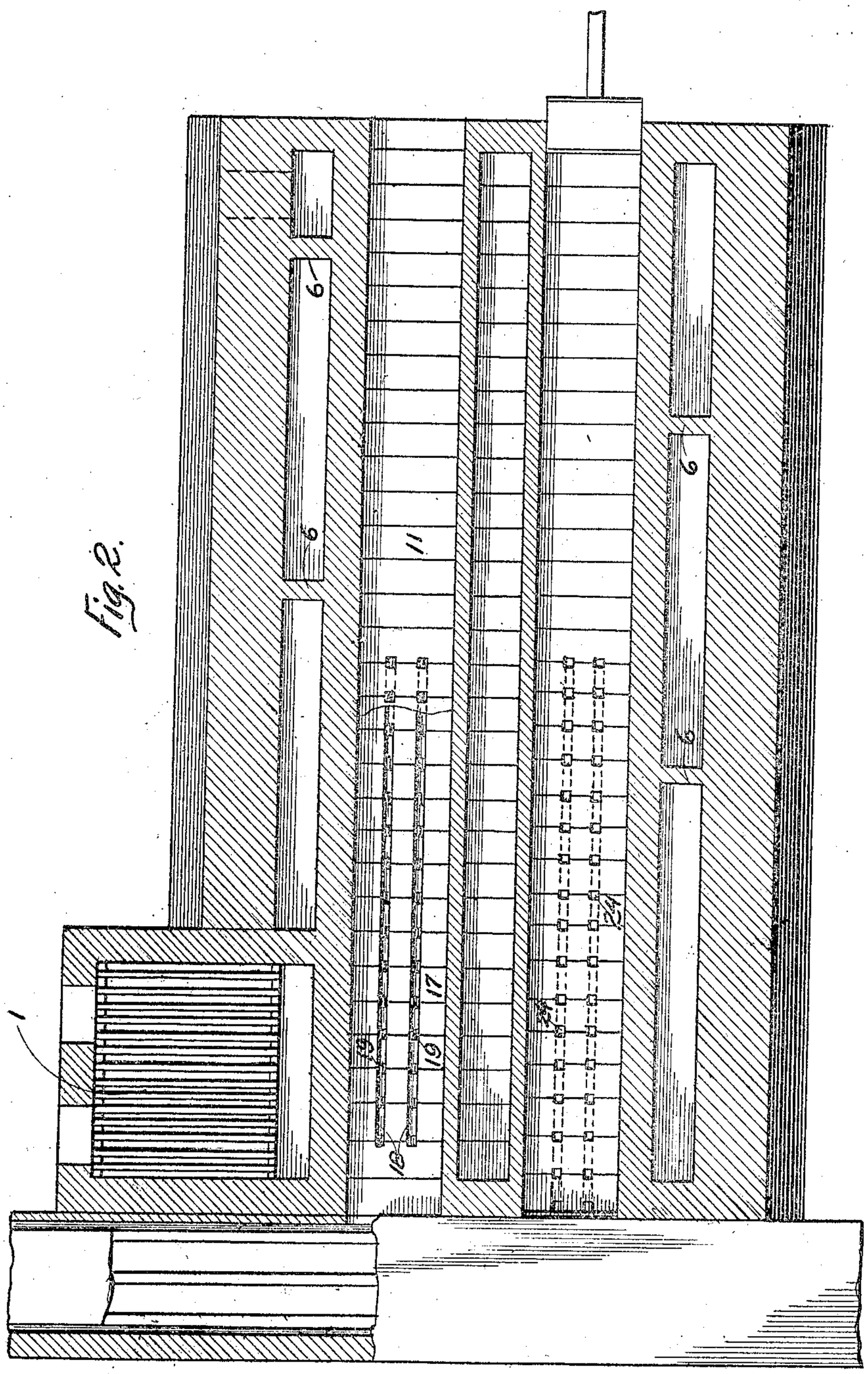
7 SHEETS—SHEET 2.

Fig. 2.



Witnesses:
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7 SHEETS—SHEET 3.

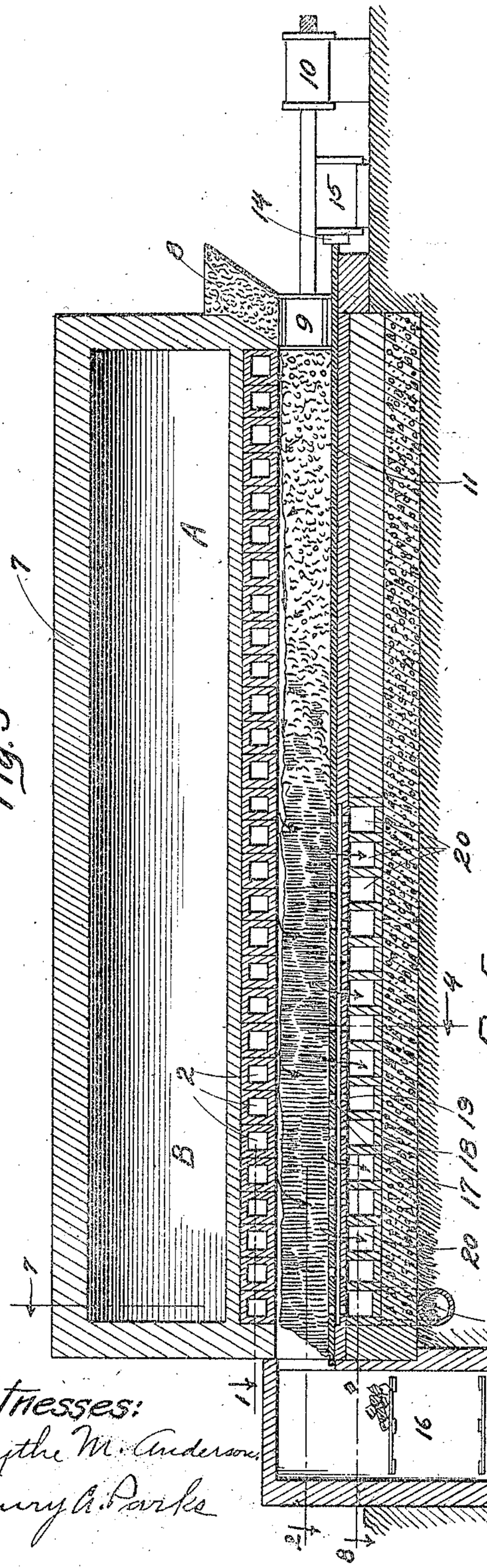

Fig. 3

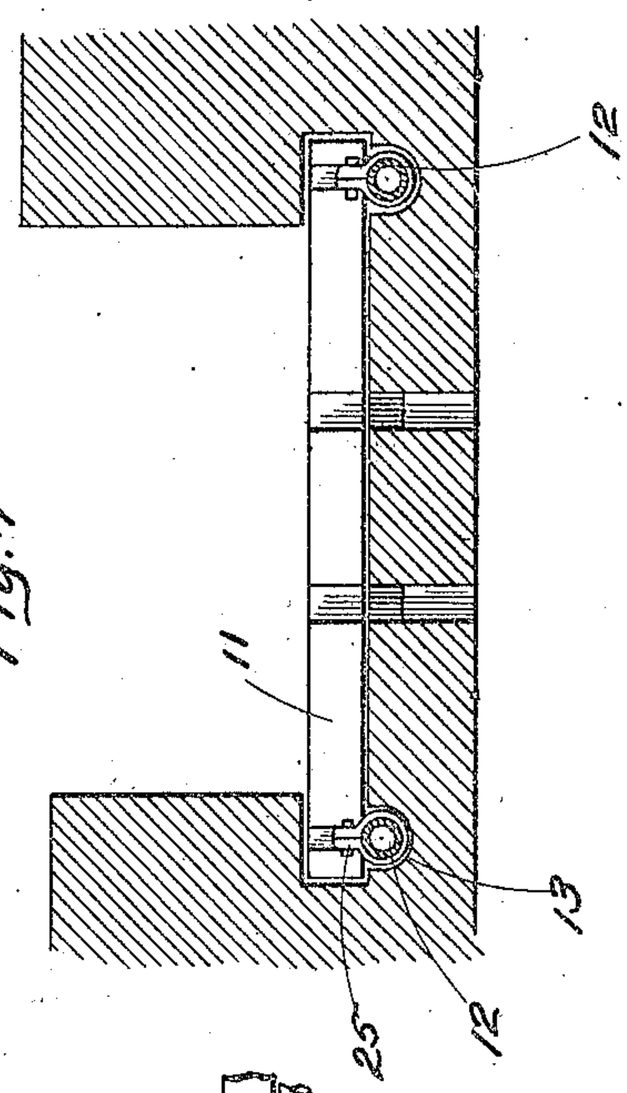

Fig. 4

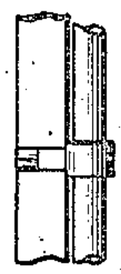

Fig. 6.

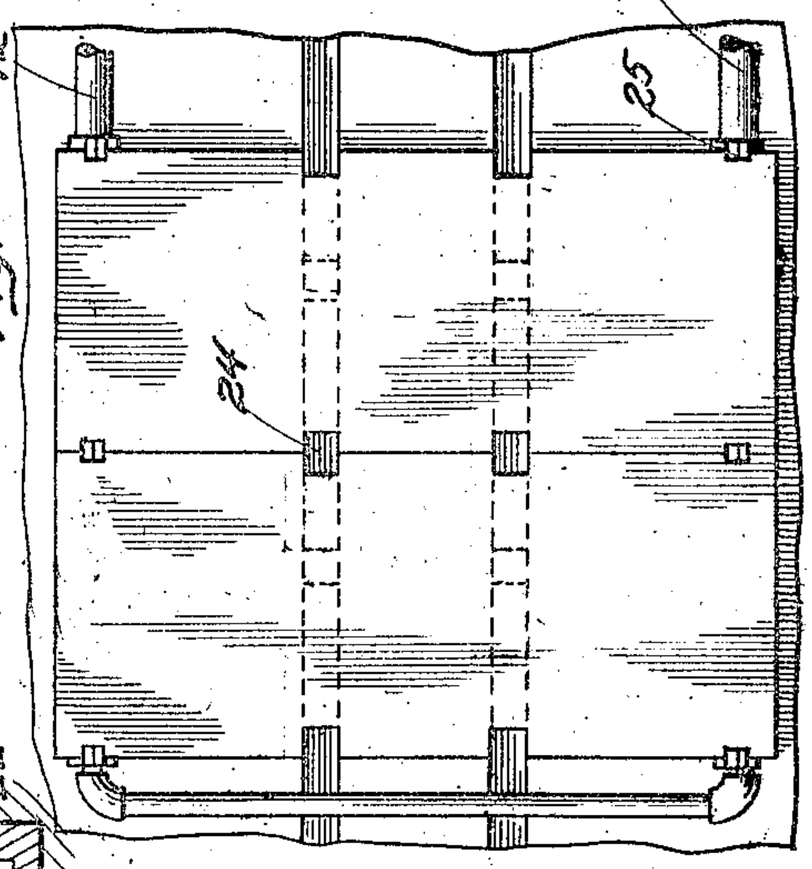

Fig. 5

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7 SHEETS—SHEET 4

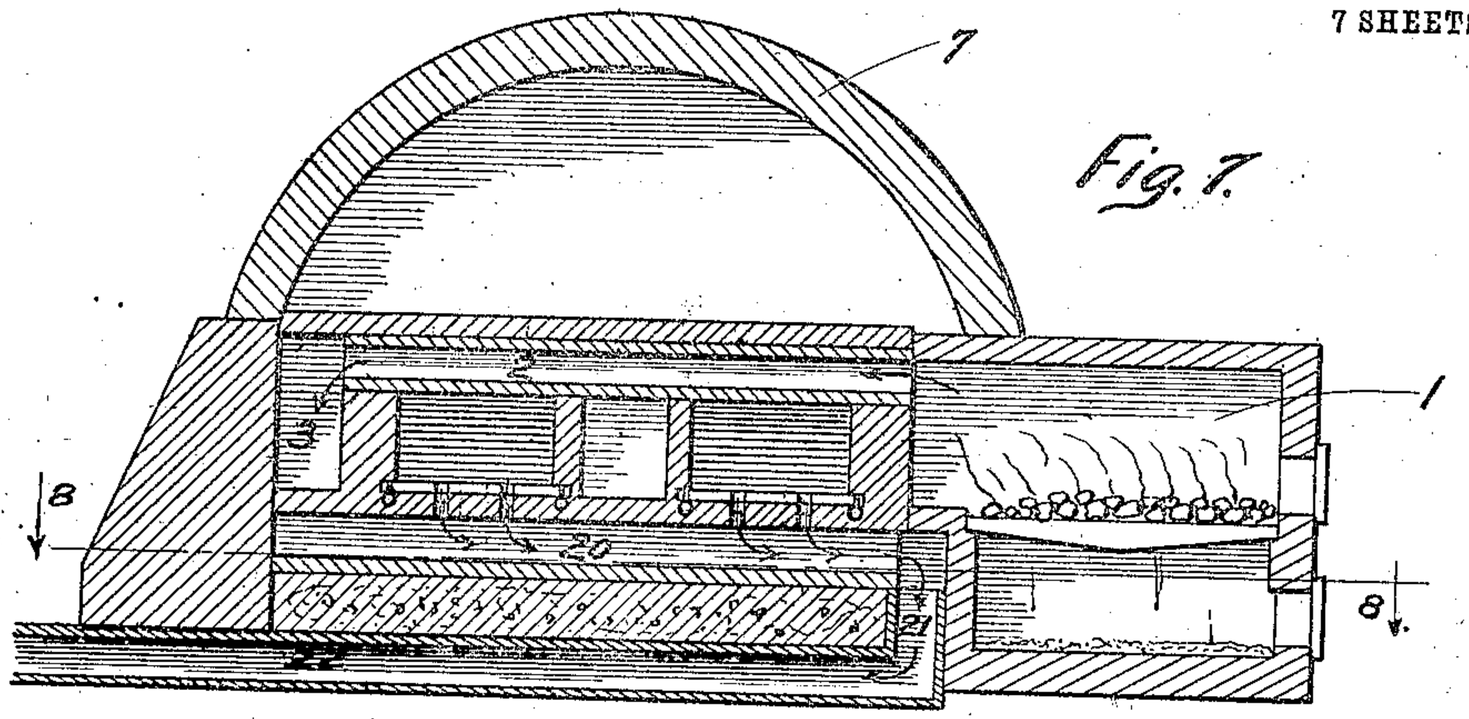

Fig. 7.

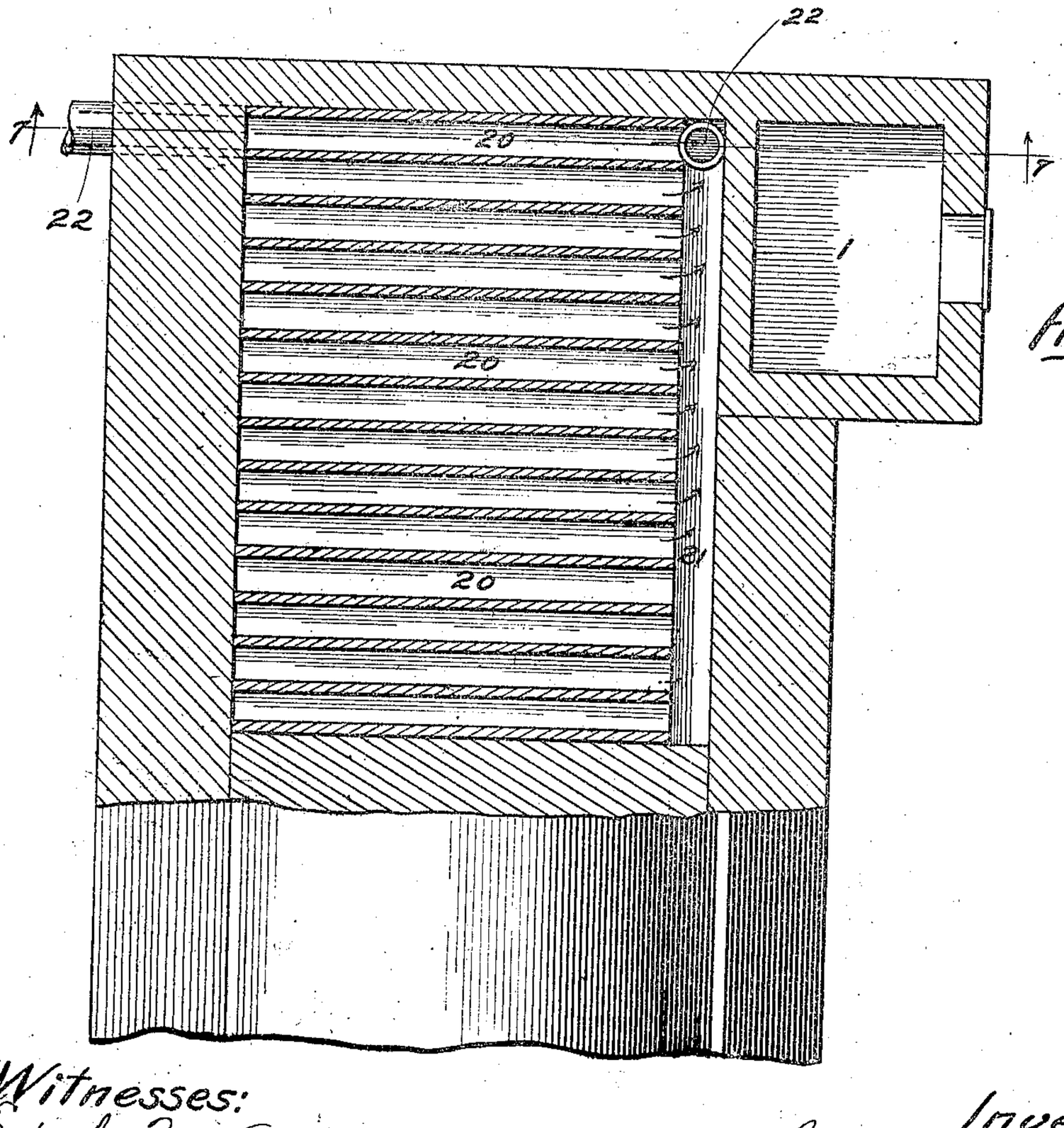

Fig. 8.

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7 SHEETS—SHEET 5.

Fig. 9.

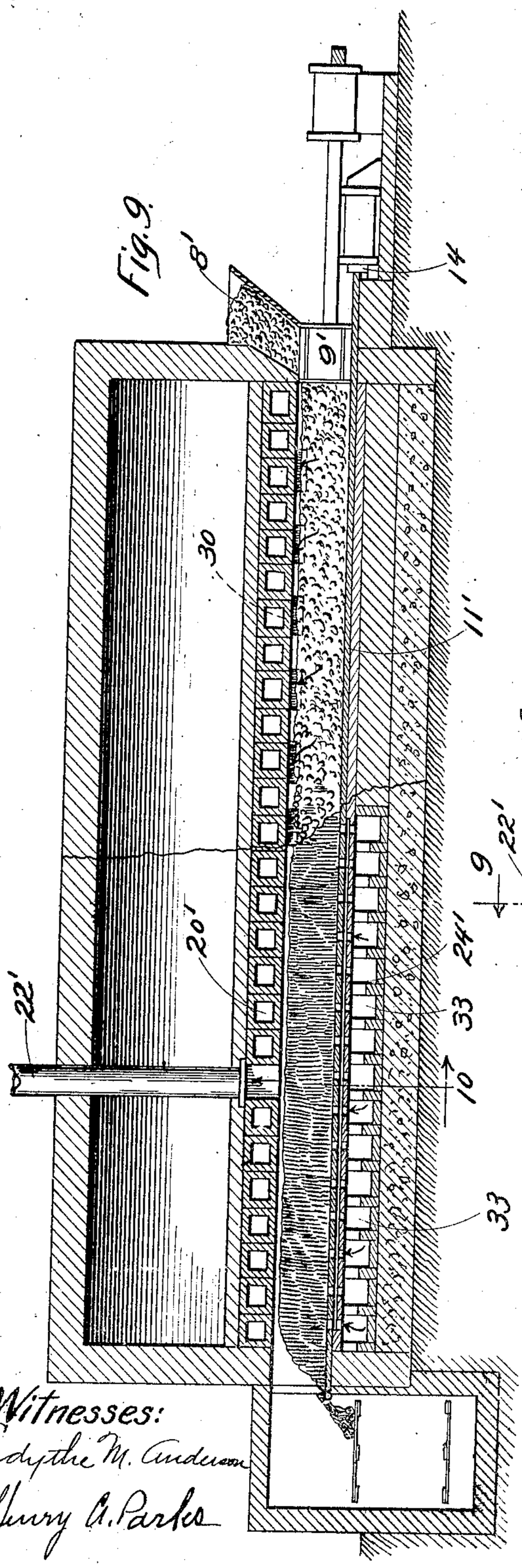
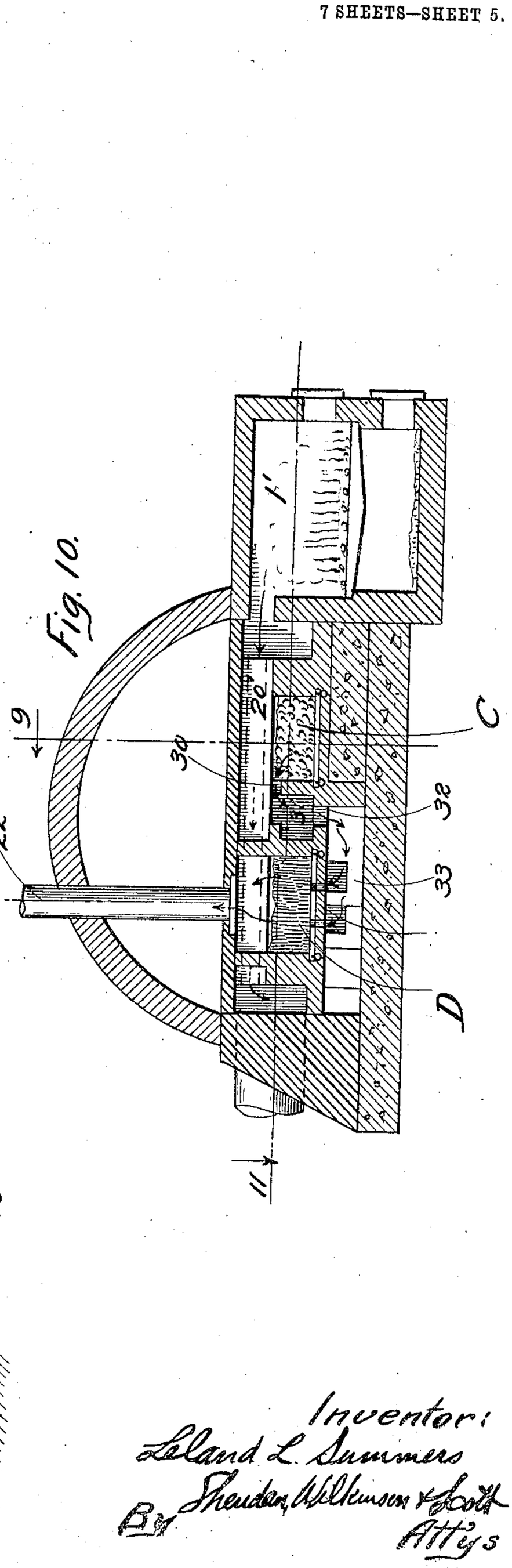


Fig. 10.



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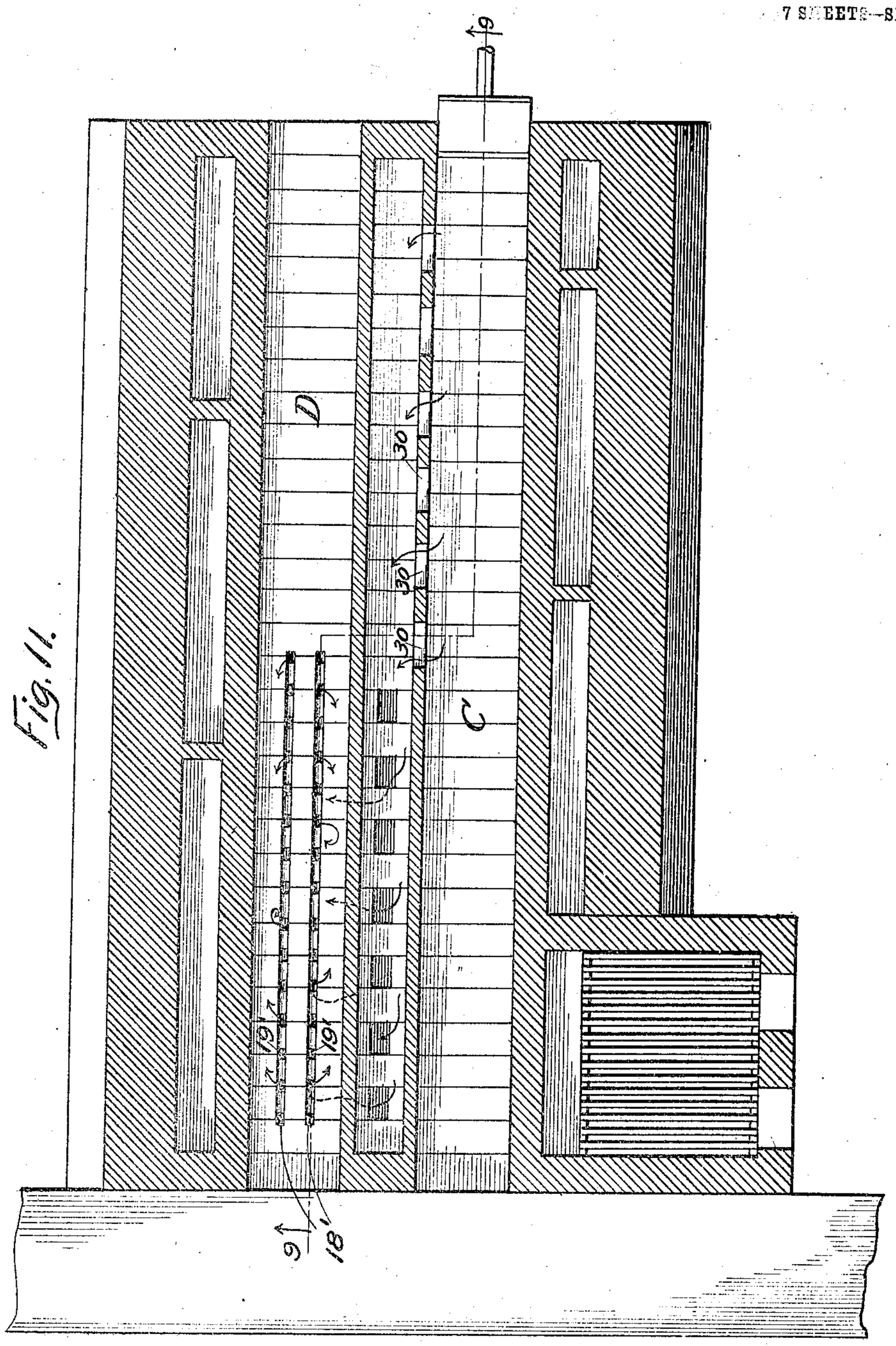
7 SHEETS—SHEET 6.

Fig. 11.



Witnesses:
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7 SHEETS—SHEET 7.

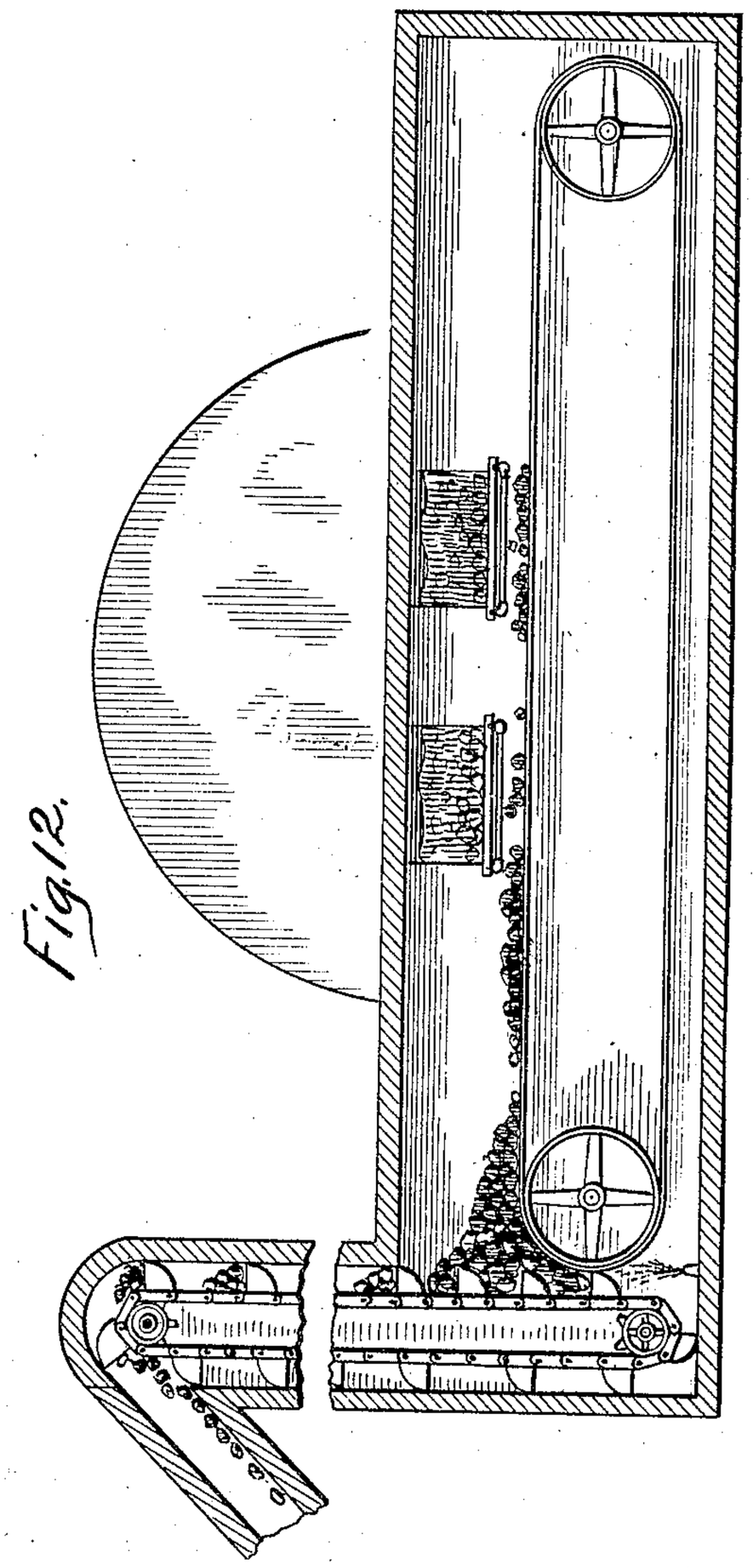

Fig. 12.

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UNITED STATES PATENT OFFICE.

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COKING PROCESS.

935,175. Specification of Letters Patent. Patented Sept. 28, 1909.

Application filed February 9, 1909. Serial No. 476,892.

To all whom it may concern:

Be it known that I, LELAND L. SUMMERS, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Coking Processes, of which the following is a specification.

The object of my invention is to provide an improved coking process, and among other features of construction and operation, to provide a means for depositing the carbon in the coke, which is ordinarily carried away in the hydrocarbon gases or so-called volatile matter. In order to accomplish this result, I construct my oven so that the volatile matter distilled from the coal is forced to pass through incandescent coal or coke having a higher temperature, whereby the volatile matters are decomposed by the high temperature, causing a certain proportion of the carbon to adhere to the highly heated coal or coke, thereby cementing the particles of coal or coke more firmly together.

Preferably, my invention is used in connection with a so-called by-product type of oven in which the gases distilled from the coal in the process of coking are recovered and treated for their by-products. If desired, however, the gases, after passing through the highly heated coal or coke, may be discharged to the atmosphere. In general, I prefer to use a type of oven in which the coal is charged at one end and the coke discharged at the opposite end. The coal, being subjected to a very high temperature throughout its passage in this type of oven will, owing to its prolonged heating, result in a much higher temperature of the coke at the discharge end than the coal will have in the charging end. Preferably, the oven is heated over its entire length.

In the drawings—Figure 1 is a plan view partly in section on the line 1 of Fig. 3, this view showing the arrangement of the heating flues. Fig. 2 is a section of the empty oven on the line 2 of Fig. 3, showing the floor of the retorts and part of the movable tile floor. Fig. 3 is a vertical section on the line 3 of Fig. 1. Fig. 4 is a fragmentary vertical section on the line 4 of Fig. 3. Fig. 5 is a plan view of part of the conveyer tiles at the discharge end of the furnace. Fig. 6 is a detail view of the connection between the conveyer tiles. Fig. 7 is a transverse section on the line 7 of Fig. 3. Fig. 8 is a fragmentary plan view in section upon the line 8 of Fig. 3. Fig. 9 is a broken longitudinal sectional elevation upon the lines 9, 9 of Fig. 10, showing another form of furnace. Fig. 10 is a transverse section on the line 10 of Fig. 9. Fig. 11 is a horizontal section of the empty oven on the line 11 of Fig. 10. Fig. 12 is a fragmentary view of the sealed outlet.

While I have illustrated specific embodiments of an oven adapted to the use of my improved process, it will be apparent that the process may be carried out in ovens varying from the specific types illustrated, and that any desired number of ovens may be arranged in series in the manner illustrated in connection with the two parallel ovens shown.

Generally speaking the apparatus illustrated in Figs. 1 to 8 comprises two parallel coke ovens, a furnace, the products of combustion arising from which circulate around the top and sides of the ovens, mechanism for feeding the carbonaceous matter progressively through the retorts or ovens from end to end, and a suitable arrangement of ducts for conducting the gases which distil at the lower temperature end of the retorts through the more highly heated coke adjacent the discharge end.

Referring to Fig. 1 the products of combustion rising from the furnace 1 pass through the ducts 2 over the top of the retorts into the longitudinal passage 3, thence back through the adjoining ducts 2 to the opposite longitudinal passage 4, and so on to and fro across the furnace until they finally escape through the pipe 5. The longitudinal passages 3 and 4, as shown in the drawing, are provided with baffles 6 for the purpose of compelling the products of combustion from the furnace to circulate back and forth over the retorts. Upon reference to Fig. 7 it will be observed that the ducts 3 are separated from the interior of the retort by comparatively thick walls, thus causing the radiation of heat to the retort to be principally in a vertical direction from the ducts 2. For the purpose of conserving the heat the retorts are preferably inclosed within an arch 7. Across the charging end of the furnace is a hopper 8 to receive the coal and a plunger 9 actuated by a hydraulic cylinder 10 serves to force the coal and coke through the retort toward the discharge end.

In order to overcome the difficulty which

sometimes arises in attempting to force a body of coal and coke through a long retort I have provided a conveyer in the form of a movable tile floor 11. The side walls of the retort are preferably undercut at their bases, as shown in Fig. 4, and the conveyer tiles are longer than the width of the body of the retort and project into the undercut spaces at the bases of the side walls. The tiles forming the conveyer are bound together, in the present instance by means of pipes 12. The pipes 12 are joined together at the discharge end of the tile conveyer and are kept cool by the circulation of cooling water therethrough, which in connection with the location of the pipes in the grooves 13 at the bases of the undercut portions of the side walls, affords protection against the heat of the retort. The pipes 12 may engage the conveyer tiles 11 by means of lugs 25 projecting upwardly into grooves in the edges thereof. These lugs may conveniently consist of the projecting ends of bands bolted about the pipes 12.

Coöperating with the tile conveyer floor and secured thereto is the plunger 14 of a hydraulic cylinder 15. In operating the device to feed coal and coke therethrough from the charging hopper 8 to the quenching trough 16, the plungers 14 and 9 are drawn outwardly in the order named, thus permitting coal to drop from the hopper 8 in front of the plunger 9, and drawing back the tile conveyer floor 11, which is secured to the plunger 14. Both plungers are then simultaneously moved inward thereby propelling the material along the retort partially by reason of the direct pressure of the plunger 9 thereon, and partially by the movement of the tile conveyer floor 11. The plunger 14 is then moved outwardly, thus drawing the conveyer floor to initial position, during which operation the plunger 9 remains stationary in its inward position, thus preventing the material from moving outward with the conveyer. The plunger 9 is then moved outward to permit a further supply of coal to descend from the hopper 8 whereupon both plungers are simultaneously moved inward. In this manner the coal is continuously fed forward in the oven without undue pressure being exerted on the walls of the oven, and a continuous feed is obtained without permitting the coal to be disturbed or crumbled, as is the case when a fragile coal is used without some form of conveyer such as the tile conveyer floor above described. It will be observed that the material adjacent the charging end of the retort is under greater pressure than that adjacent the discharge end, owing to the fact that at any point in the retort the pressure is dependent upon the amount of material between that point and the open discharge outlet where the material is relieved of all pressure. By reason of this fact the coke adjacent the discharge end assumes a more open texture thus permitting the gases distilled at the charging end to have intimate access to all parts of the coke adjacent the discharge end.

In order to subject the coke at the high temperature or discharge end of the oven to the action of the gases distilled at a lower temperature from the coal at the charging end I provide the fixed floor 17 for about half its length at the discharge end with longitudinal grooves 18, and from the bases of these grooves apertures 19 communicate with ducts 20 below the stationary floor. The ducts 20, as formed in the specific embodiment of the oven illustrated, open at one end into a header 21 through which they communicate with an outlet pipe 22 which may discharge into the atmosphere or into any suitable apparatus for storing or treating the discharged gases. Preferably a slight suction is maintained in the discharge pipe 22 to induce a circulation of gases downward through the heated coal or coke in the discharge end of the oven.

The forward or discharge portion of the tile conveyer floor is provided with openings 24 registering with the grooves 18 in the stationary floor. By this means continuous communication is provided through the tile conveyer floor and stationary floor from the inside of the oven to the ducts 20 regardless of the position of the tile conveyer floor.

The quenching trough 16 may be equipped with any suitable form of conveyer for carrying away the coke and coal which may be supplied to the hopper 8 from cars or a conveyer. In order to seal the retorts against access of atmospheric oxygen the quenching trough is preferably covered over as illustrated and the conveyer shown in Fig. 12 communicates with the exterior of the trough through a closely fitting conduit The steam arising from the contact of the quenching sprays with the hot coke gives rise to an outward current through the conveyer conduit which effectually prevents access of atmospheric air. I guard against the entrance of air into the retorts for the reason that if atmospheric air were permitted to enter its oxygen would combine with the carbon liberated from the distilled gases thus preventing the deposition of the carbon in the coke and the desired cementing action.

In operation the furnace 1 will be fired and the products of combustion therefrom passing through the hollow tiles 2 from the discharge end to the charging end of the oven will impart the requisite heat for the coking process. The gases distilled from the coal at the charging end of the oven, designated in Fig. 3 by the letter A, will rise to the upper part of the oven, as indicated by the arrows, and pass along beneath the roof

of the oven toward the discharge end B. Owing to the suction maintained in the pipe 22 and the fact that the discharge end of the oven is closed by a seal or otherwise the gases which are distilled at the low temperature charging end of the oven will after passing along toward the discharge end descend through the highly heated coke in that part of the oven passing through the apertures 24, grooves 18 and apertures 19 into the ducts 20 and thence to the atmosphere or such storing or treating apparatus as may be used. The gases thus pass through the incandescent coke at the discharge end of the furnace in the same direction that heat is radiated thereto. This is important, for the reason that fissures are formed both in the line of heat radiation and the line of movement of the gases. By causing these lines to coincide only a single set of fissures is formed, thus yielding a coke composed of large fingers. When heat is radiated to the coke in one direction and the gases pass through in another direction, a double set of fissures is formed, thus breaking the coke into small pieces. The general action of passing the gases as they are distilled from the coal through coal or coke at high temperature is to break down the higher carbon series into a lower series of hydrocarbons, thus the paraffin series of hydrocarbon have the general formula C_nH_{2n+2} while the olefin series have the general formula C_nH_{2n}. Thus the paraffin series, can be broken down from members having a higher carbon content to members having a lower carbon content and also can be reduced to the olefin series. These various hydrocarbon gases with the continual application of high temperatures can be again split up, the eventual composition being hydrocarbon and methane, H and CH_4. Thus, ethane, C_2H_6, which is readily formed in the higher members of the paraffin series is decomposed as follows—

$$C_2H_6=CH_4+C+H_2.$$

The effect is to liberate atomic or nascent carbon, methane and hydrogen. Thus the percentage of the so-called illuminants, or higher series of hydrocarbons, is diminished by the continued contact with the high temperature coal or coke, and the carbon freed by the decon position of the gases, is deposited in the coal or coke, either in the form of a cementing carbon or as a coating which assumes a graphitic structure upon cooling. The action of thus depositing carbon in the interstices of the highly heated coal or coke is the basis of the so-called coking action and tends to form a coke structure very dense and hard. By the action of the carbon on the highly heated coal or coke, it is possible to form a coherent coke from coals that ordinarily resist coking action, and are therefore termed non-coking coals.

In Figs. 9 to 11 I have illustrated another form of apparatus in which my improved process may be carried out. Generally speaking this form differs from that above described principally in the fact that low distillation products are taken from one oven and conducted to a higher temperature zone in an adjacent oven, instead of conducting the gases from one part to another of the same oven. In this form of apparatus the means for feeding the material through the ovens is similar to that above described, comprising a hopper 8′, plungers 9′ and 14′, and tile conveyer floor 11′. The manner of heating the ovens C and D is also the same as that explained in connection with the oven above described. The oven C adjacent its top and preferably in the side wall is provided with a series of apertures 30 communicating with a longitudinal duct 31, which extends to the discharge end of the furnace. Adjacent the discharge end of the furnace and extending about half its length are a series of openings 32 in the floor of the duct 31 communicating with a series of ducts 33 beneath the floor of the oven D. The ducts 33 communicate with the interior of the discharge end of the oven D through apertures in the stationary floor and in the tile conveyer floor in the manner above explained in connection with the oven previously described, the stationary floor being provided with longitudinal grooves 18′ in the bases of which are apertures 19′. The tile floor is provided with registering apertures 24′. An outlet pipe 22′ communicates with the interior of the oven D adjacent the discharge end. After heating the oven by means of the furnace 1′ the products of combustion from which pass through the flues 20′ the apparatus is charged with coal. As in the form of oven above described the discharge ends of the retorts are preferably sealed by a water seal or otherwise and a slight suction may be maintained in the outlet pipe 22′. The gases distilled at the charging end of the oven C will pass through the apertures 30 into the longitudinal duct 31, thence toward the discharge end of the apparatus downwardly through the apertures 32 into the ducts 33, whence the gases will pass upward through the highly heated material in the discharge end of the oven D and outward through the outlet pipe 22′ to the atmosphere or to storing or treating apparatus as may be desired. Chemically, the action of this oven corresponds with that shown in Figs. 1 to 8, inclusive, the gases distilled at the low temperature end of the oven C passing through the highly heated material at the discharge end of the oven D, where the gases are dissociated and the freed carbon deposited, thereby cementing the coke in the discharge end of the oven D and forming a coherent mass.

Referring to Fig. 11, it will be obvious that the arrangement there shown may be continued indefinitely throughout a series of ovens, instead of using a single pair as shown. For instance the low temperature distillates from the charging end of the oven D might be conducted to the highly heated coke in the discharge end of a third oven, and the gases from the third oven might be conducted to a fourth and so on to the extent desired.

While I have described apparatus wherein I have carried out my improved process successfully I desire to have it understood that the process itself is not restricted to the particular forms of apparatus herein described, and that the process might be carried out in widely different forms of apparatus without departing from the spirit of my original invention. In some instances it may be found desirable to use hydrocarbon gases derived from other sources than the coal being treated for securing the cementing action described, such hydrocarbon gases being used as supplementary to the gases liberated from the coal in the retort. I therefore consider that the use of hydrocarbon gases derived from other sources than the coal in the retorts is included within the scope of my invention.

I claim:

1. The process of coking, which comprises the steps of heating carbonaceous material in a closed retort, feeding said material therethrough from end to end, conducting the gases distilled from the cooler freshly charged material through the hotter previously charged and carbonated material in a direction parallel to the direction of radiation of heat to said material, the movement and coking of said material being conducted continuously and with exclusion of air.

2. The process of coking, which comprises the steps of heating carbonaceous material in a closed retort, feeding said material therethrough from end to end, compelling the gases distilled from the cooler freshly charged material to pass through the hotter previously charged and carbonated material and across the line of travel of said material, the movement and coking of said material being conducted continuously and with exclusion of air.

3. The process of coking, which comprises the steps of heating carbonaceous material in a closed retort by radiation of heat thereto in a vertical direction, feeding said material through said retort from end to end, conducting the gases distilled from the cooler freshly charged material vertically through the hotter previously charged and carbonated material, the movement and coking of said matrial being conducted continuously and with exclusion of air.

In testimony whereof, I have subscribed my name.

LELAND L. SUMMERS.

Witnesses:

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