No. 855,069. PATENTED MAY 28, 1907.

S. B. SHELDON.

PROCESS OF COKING COAL.

APPLICATION FILED OCT. 2, 1906.

6 SHEETS—SHEET 1.

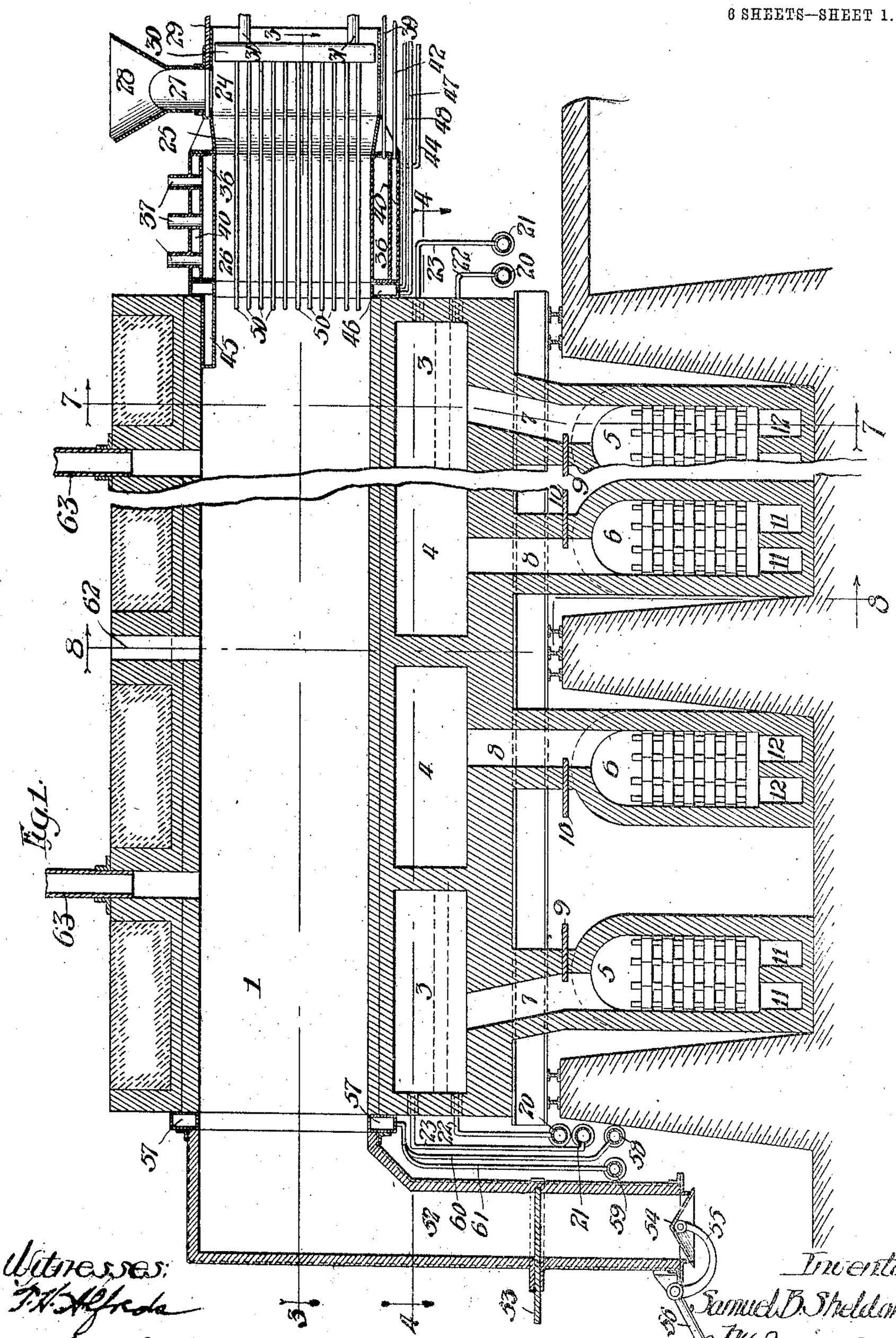

Fig. 1.

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6 SHEETS—SHEET 2.

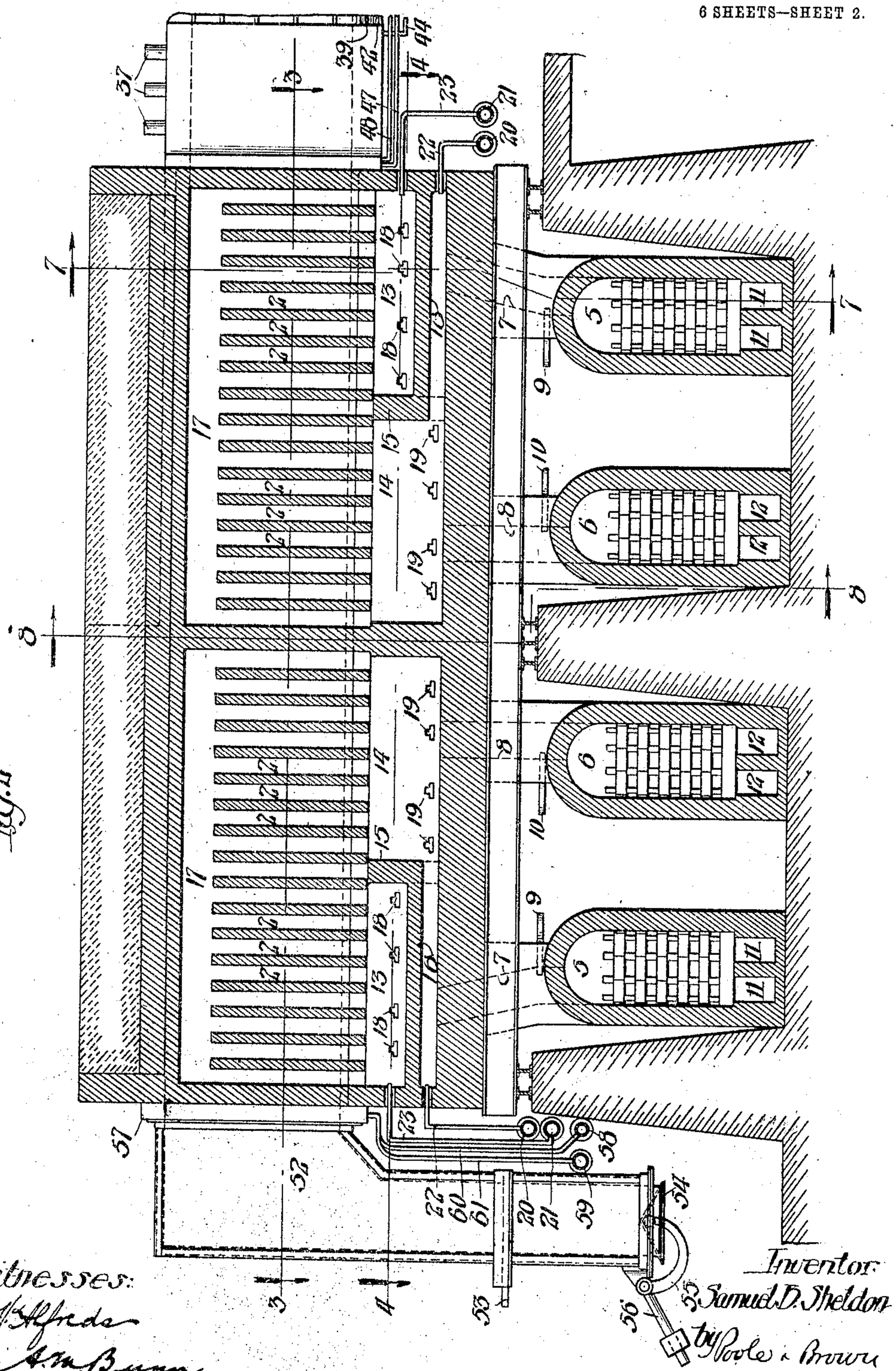

Fig. 2.

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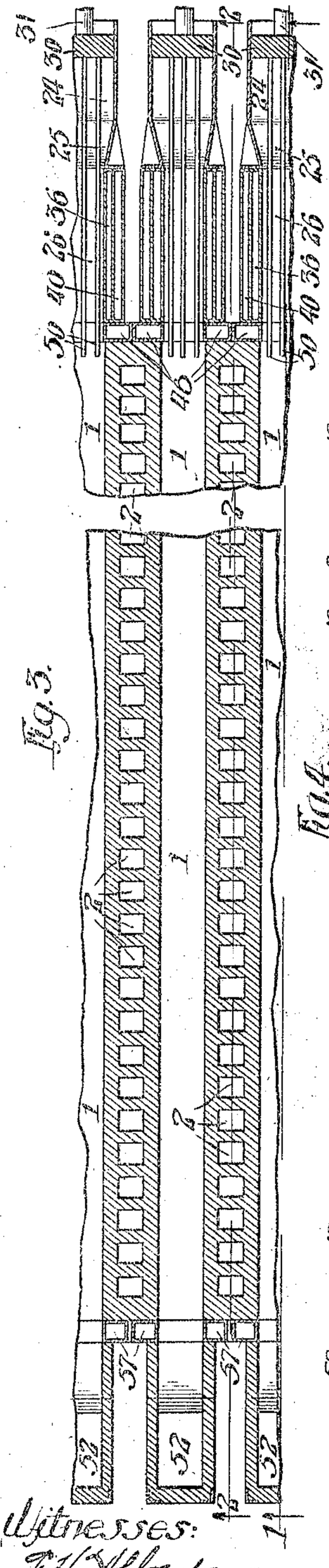

Fig. 3.

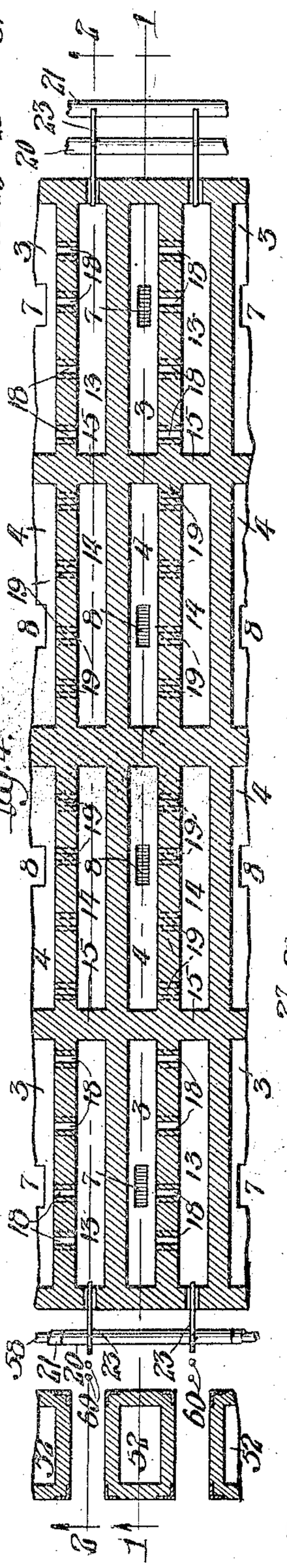

Fig. 4.

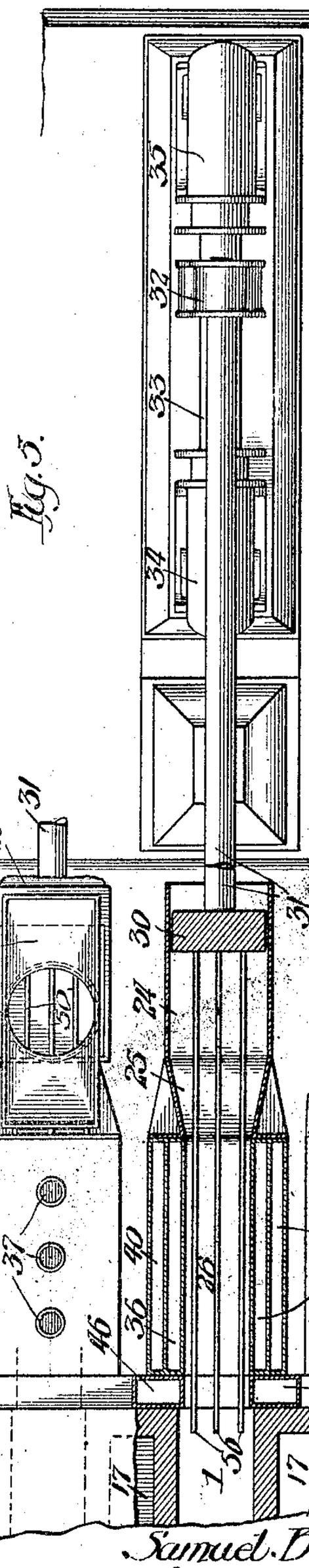

Fig. 5.

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6 SHEETS—SHEET 4.

Fig. 6.

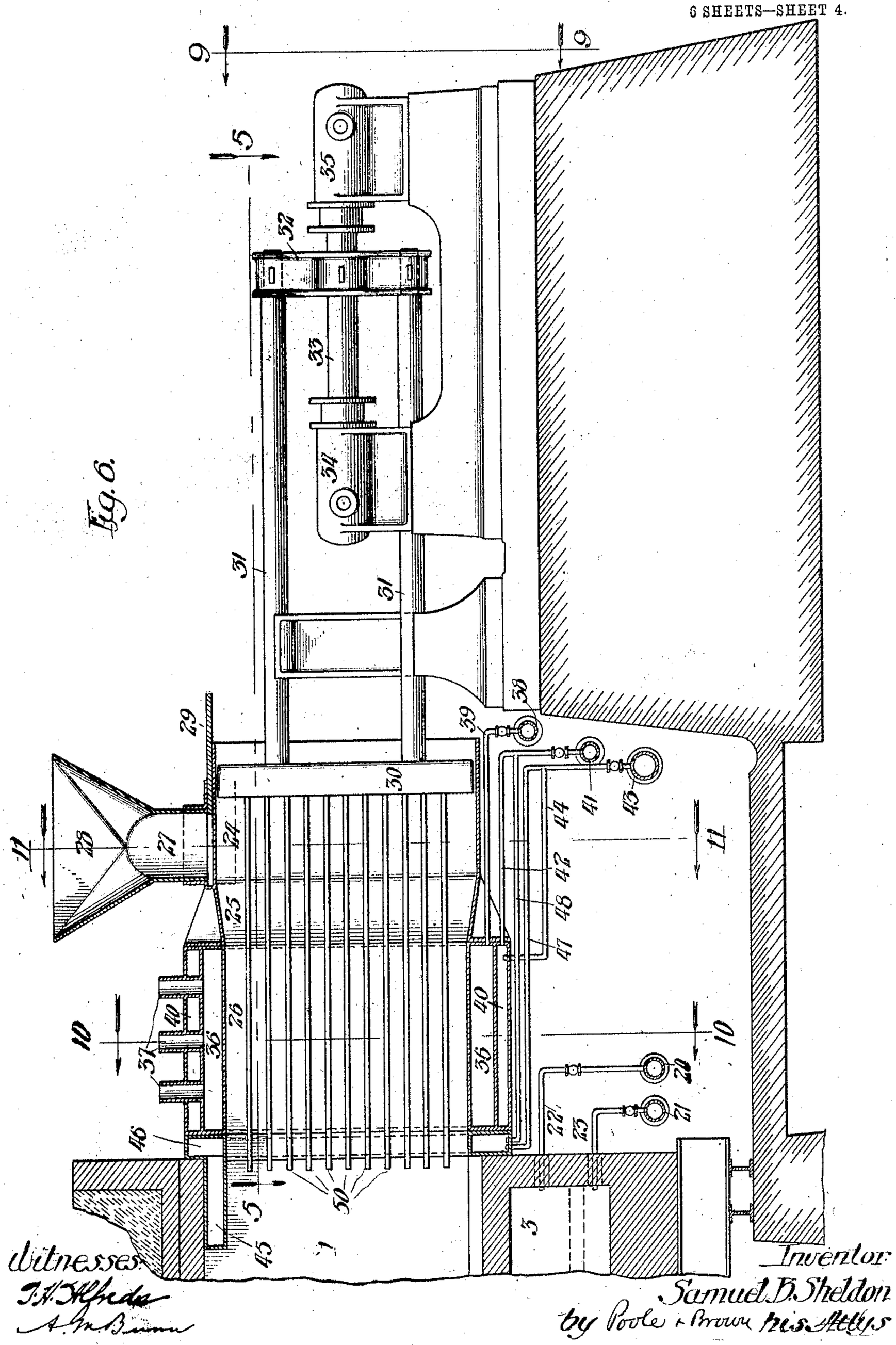

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Fig. 9.

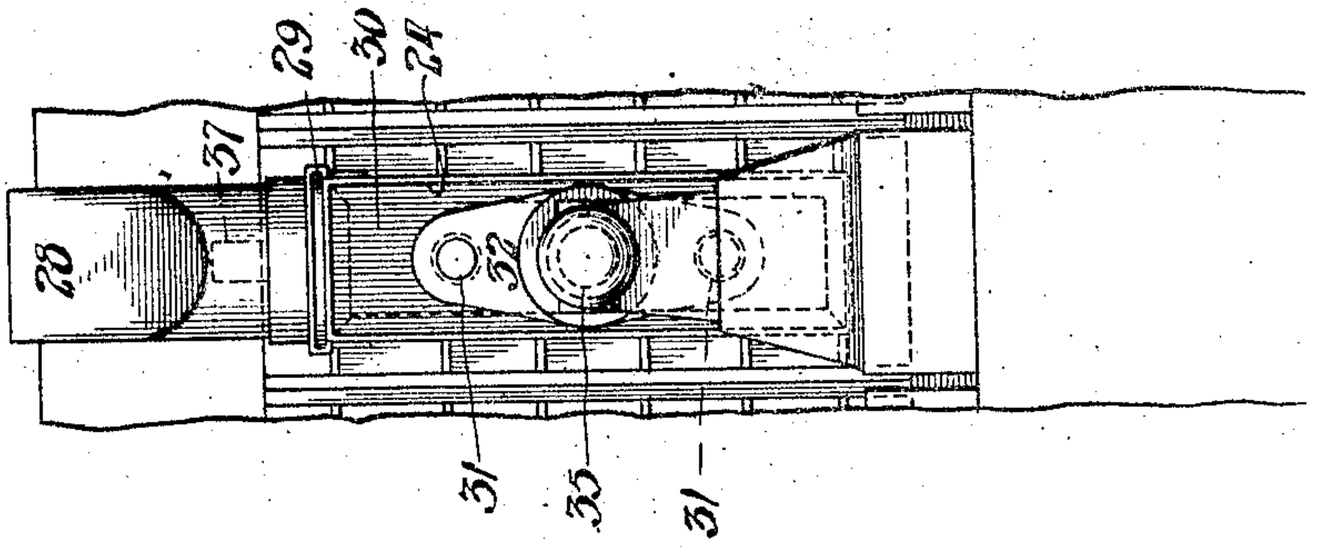


Fig. 8.

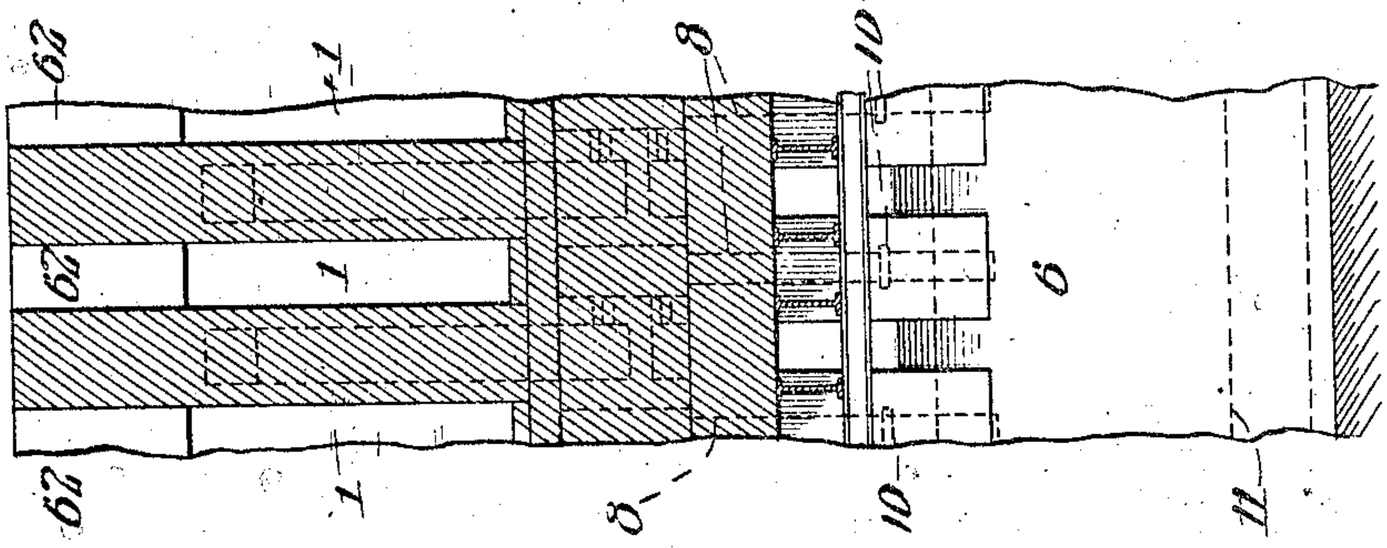
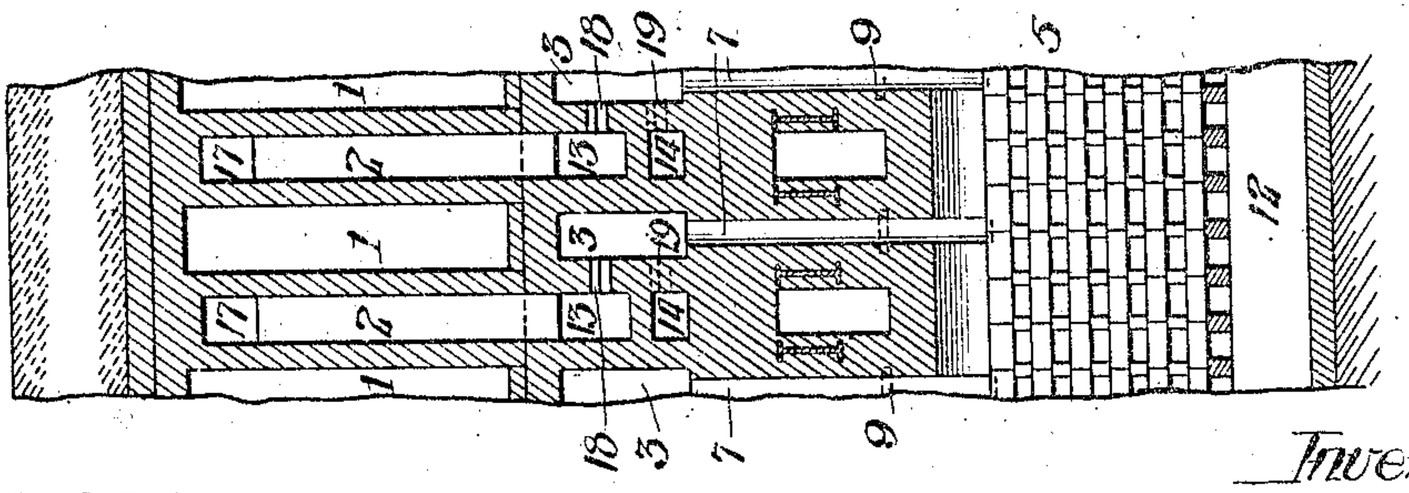


Fig. 7.



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S. B. SHELDON.

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6 SHEETS—SHEET 6.

Fig. 12.

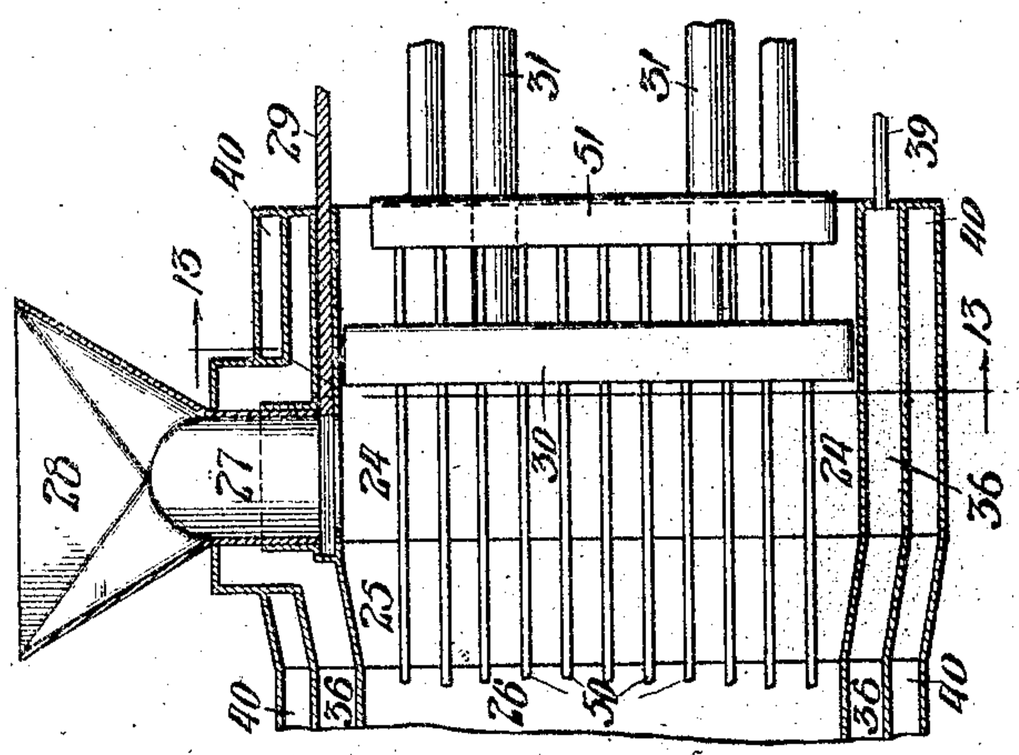


Fig. 13.

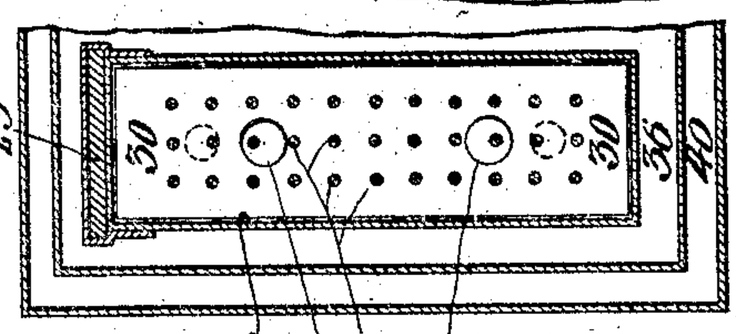


Fig. 11.

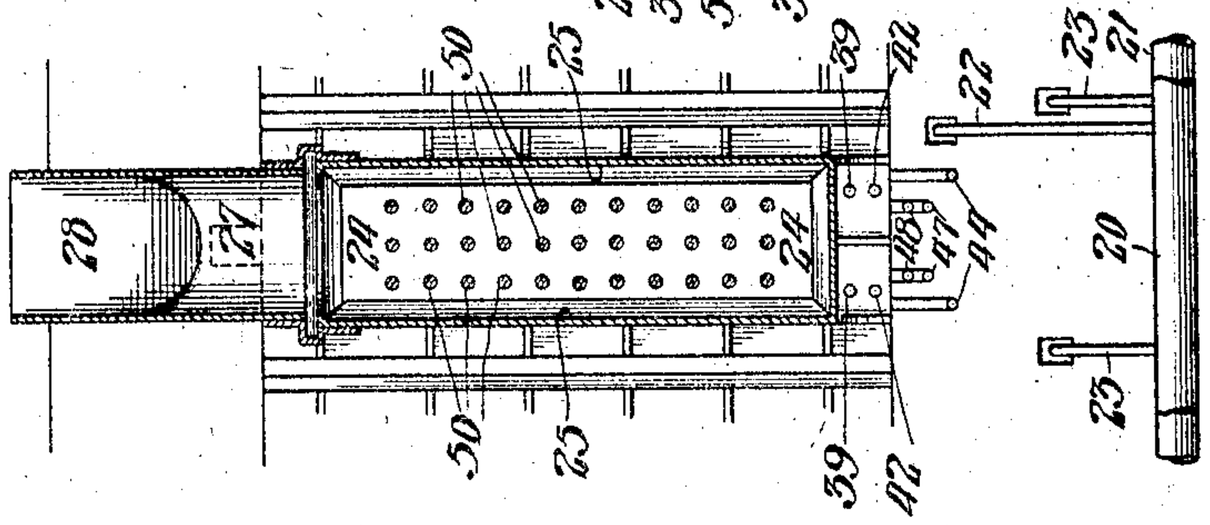
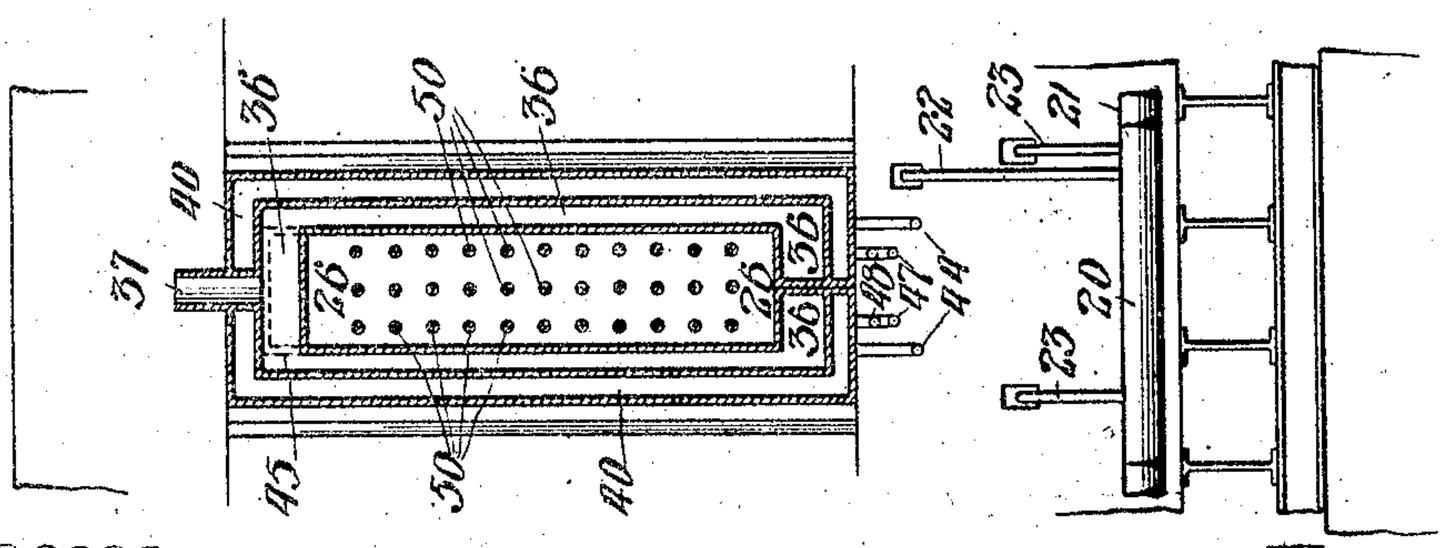


Fig. 10.



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A. D. Brown

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UNITED STATES PATENT OFFICE.

SAMUEL B. SHELDON, OF BUFFALO, NEW YORK.

PROCESS OF COKING COAL.

No. 855,069. Specification of Letters Patent. Patented May 28, 1907.

Application filed October 2, 1906. Serial No. 337,055.

To all whom it may concern:

Be it known that I, SAMUEL B. SHELDON, a citizen of the United States, residing at Buffalo, in the county of Erie and State of New York, have invented certain new and useful Improvements in Processes of Coking Coal; and I do hereby declare that the following is a full, clear, and exact description thereof, reference being had to the accompanying drawings, and to the letters of reference marked thereon, which form a part of this specification.

This invention relates to improvements in the art of coking or distilling coal for the manufacture of coke and the production of gas, and more especially to a novel process for effecting the coking or distillation of coal, and at the same time saving the gases produced in the operation, in order that the same may be utilized for heating or other purposes and valuable by-products produced in the distilling or coking operation recovered.

An apparatus is illustrated in the accompanying drawings like that shown in my prior application, Serial Number 313,072, filed April 21st, 1906, and which is adapted for carrying out my novel process. Said apparatus embraces general features of construction as follows: For effecting the coking or distillation of the coal, a coking oven is employed of the kind generally known as "by-product" oven, or one in which the coal, during the coking operation, is contained within a closed chamber and is subjected to the action of heat transmitted thereto through the walls of said chamber.

I have shown in the drawings and prefer to use the type of oven commonly known as the "Otto Hoffmann" oven, in which the coking chamber is arranged horizontally or is horizontally elongated, and is adapted for the introduction of coal at one end thereof, and the discharge of the coke from the opposite end thereof; the coal during the coking operation being advanced along or through the oven and said oven being closed against access of outside air and provided with delivery ducts or passages through which pass the gases produced during the coking operation. The oven illustrated, moreover, consists of two parts or sections arranged end to end to form a continuous coking chamber, said sections being provided with separate or independently controllable heating means, so that the part or section of the oven into which the coal is first introduced may be maintained at a higher temperature than the section adjacent to the discharge end of the oven, for a purpose hereinafter stated. In connection with said oven, at the receiving end thereof, are located means for forcing the coal into and through the oven, means for compressing the coal preparatory to its introduction into the oven, and means for pre-heating the coal after it is compressed and before it enters the oven. The coal feeding, compressing and pre-heating means embraces generally, a receiving chamber, a pre-heating chamber, and a tapered passage connecting said receiving and pre-heating chambers, and which is larger at its receiving than at its delivery end. The said receiving chamber, the tapered passage and pre-heating chamber are connected with each other so as to constitute a continuous passage, which, at the delivery end of the pre-heating chamber, opens into the receiving end of the oven.

The receiving chamber is provided at its top with an opening through which the coal, preferably in pulverized form, may be introduced into said chamber, and in said receiving chamber is located a horizontally reciprocating plunger operating in its advance movements to force the charges of coal, introduced into the chamber at the front of said plunger, through said tapered passage and the pre-heating chamber into the coking chamber. The tapered sides of the said passage constitute, in connection with said plunger, the means for compressing the coal; the inclined or tapered sides of said passage serving to effect compression of the coal laterally or from the outside toward the center of the mass of coal, as the latter is forced through said passage by the action of the plunger. The walls of the pre-heating chamber are preferably made of relatively thin metal, and are surrounded by a combustion chamber, in which is burned gaseous or other fuel; the heat produced being transmitted through the said metal walls to the mass of coal within the chamber. The compacted mass of coal, which enters the pre-heating chamber from the said tapered passage in which it is compressed, is subjected in its passage through the pre-heating chamber to any desired degree of heat. Within said passage formed by the receiving chamber, the tapered passage and the pre-heating chamber are located a series of metal rods arranged parallel with the path of the coal

and projecting from the inner face of said plunger. Said rods serve to form continuous perforations or channels extending longitudinally through the compressed mass of coal, as said mass is advanced toward and into the oven; the coal being compressed between or around the said rods in the advance movements of the plunger, and the rods extending such distance toward or into the oven that the longitudinal passages or perforations formed by the action of said rods will not be closed by lateral pressure on the mass after the latter passes the free or advance ends of the rods. The passages or perforations so formed in the mass of coal by the rods referred to, serve to facilitate the escape of gases and volatile matters from the coal and to thereby aid in the coking operation, while giving more uniform results in the coking of the mass and especially the central part thereof. At the discharge end of the coking chamber, means are provided for permitting the discharge of coke without the admission of air, the same preferably consisting of a depending delivery pipe or passage provided with two valves, only one of which is opened at a time during the discharge of the coke.

The operation of the apparatus described in carrying out the process is practically continuous, and the coking or distilling operation takes place without the admission of external air to the oven. The entrance of air to the receiving end of the oven is prevented by the solid mass of compressed coal which fills the tapered compressing passage and the pre-heating chamber, and access of air into the delivery end of the oven is prevented by the double valves in the discharge duct, as hereinbefore described. The compressed and pre-heated mass of coal is advanced from the pre-heating chamber into the oven by an intermittent or step-by-step movement produced by the reciprocation of the feeding and compressing plunger, and such mass is advanced along or through the oven as the coking operation takes place; the gases generated being withdrawn continuously from the coking chamber. When the coking chamber is made in parts or sections as above described, it is intended that the coking operation shall take place mainly in the section in which the coal is received, or that adjacent to the receiving end of the oven, and the section adjacent to the delivery end of the oven is maintained at a lower temperature, so that a partial cooling o the mass of coke will take place before the discharge of the same from the oven.

My novel process and the apparatus devised for carrying it into effect may be more readily understood by reference to the accompanying drawings, in which,—

Figure 1 is a view of an apparatus embodying my invention in longitudinal, vertical section taken on a plane passing through the center of the coking chamber of the oven, on the line 1—1 of Fig. 3. Fig. 2 is a like section taken on a plane passing through the heating flues of the oven, on the line 2—2 of Fig. 3. Fig. 3 is a horizontal section, taken on the line 3—3 of Figs. 1 and 2. Fig. 4 is a horizontal section, taken upon line 4—4 of Figs. 1 and 2. Fig. 5 is a plan view of the parts located at the receiving ends of two of the ovens shown in Figs. 3 and 4, the parts for feeding, compressing and pre-heating the coal employed in connection with one of the ovens being shown in horizontal section, taken on the line 5—5 of Fig. 6. Fig. 6 is a view of the parts at the receiving end of one of the ovens, showing said parts partially in side elevation and partially in central vertical section, on the line 1—1 of Fig. 3. Fig. 7 is a cross-section, taken on line 7—7 of Figs. 1 and 2. Fig. 8 is a cross-section, taken on line 8—8 of Figs. 1 and 2. Fig. 9 is an end view of the parts associated with one of the ovens, taken upon line 9—9 of Fig. 6. Fig. 10 is a cross-section, taken upon line 10—10 of Fig. 6. Fig. 11 is a cross-section, taken upon line 11—11 of Fig. 6. Fig. 12 is a detail sectional view of the compressing and pre-heating device, showing a modified form thereof. Fig. 13 is a cross-section, taken upon line 13—13 of Fig. 12.

The coking oven illustrated in the accompanying drawings is provided with a series of coking chambers 1, 1, 1, which are arranged side by side, as common in the construction of "Otto Hoffmann" ovens. Each of the said coking chambers is equipped with coal feeding, compressing and pre-heating devices at the receiving end thereof, and with a delivery device at its exit or discharge end; the drawings illustrating in full only one of said coking chambers and its associated parts. In the walls of the oven which separate the coking chambers from each other are formed vertical flues or heating passages 2, 2, 2, The coking chambers 1, 1, 1 are continuous, but the oven, as a whole, consists in effect of two sections arranged end to end, and each of which is provided with complete heating means, separate from the heating means of the other section, so that the temperature maintained in the two sections may be independently or separately controlled. Each section of the oven, therefore, corresponds with a complete "Otto Hoffman" oven or, in other words, the two sections together constitute two complete "Otto Hoffmann" ovens placed end to end with their coking chambers joined to form in effect one continuous coking chamber.

The means for heating the two sections of each coking chamber being alike, the parts or passages constituting the heating means for the two sections are lettered alike in the

drawings, and the same description of said heating means will apply to both of said sections.

Beneath each coking chamber 1 are located two longitudinally arranged passages 3 and 4, separated from each other by a vertical, transverse partition. Connected with said chambers 3 and 4 are two regenerators 5 and 6 by means of passages 7 and 8 provided with gates or valves 9 and 10. Said regenerators 5 and 6 are located below and extend transversely of the coking chambers, and contain the usual checker-work. Connected with the lower parts of the regenerators are passages or flues 11, 11 and 12, 12, which are adapted to be connected either with a stack or chimney or with air inlet passage, as common in coking ovens having two regenerators, as heretofore constructed.

Between the longitudinal chambers or passages 3 and 4 associated with two adjacent coking chambers, are located two longitudinal passages 13 and 14 which communicate with the lower ends of the vertical flues or passages 2, 2 in the walls separating said chambers. Said passages 13 and 14 are separated from each other by a vertical partition wall 15 and by a horizontal partition 16 extending from the bottom of said wall 15 to the external end wall of the oven, so that the lower part of said chamber 14 extends the full length of one section of said oven. The chamber 3 is connected with the chamber 13 by holes or apertures 18, 18, formed in the longitudinal wall between said chambers, and the chamber 4 is connected with the chamber 14 by like holes or apertures 19, 19. Said chambers 13 and 14 constitute combustion chambers in which gaseous fuel is burned, air for supporting combustion being supplied from the chambers 3 or 4 through the passages 19 or 19. As shown in the drawings, 20 and 21 indicate gas supply mains provided with branch pipes 22 and 23 which deliver gas to the outer ends of the chambers or passages 13 and 14, through the end wall of the oven structure.

The operation of the regenerators and associated passages corresponds with that of an "Otto Hoffmann" oven and is as follows: Assuming the regenerator 5 to be connected with a air inlet duct and the regenerator 6 with the stack or chimney flue, air entering the flues 11, 11, of said regenerator 5 passes upwardly through the checker-work therein, which has been previously heated, and much air, in a heated condition, passes through the passage 7 to the chamber 3 from which, through the openings 18, 18, it enters the chamber 13. Fuel gas delivered to said chamber 13 from the pipe 23 is burned therein and the products of combustion rise through the vertical passages 2, 2 above the chamber 13 and passing horizontally along the passage 17 descend through the flues 2, 2, above the chamber 14 from whence they pass through the openings 19, 19 to the chamber 4 and thence through the passage 8 to the regenerator 6 and out through the flues 12, 12 into the stack. After the checker-work in the regenerator 5 has become cooled, and that in the regenerator 6 heated by the passage therethrough of the outgoing products of combustion, the regenerator 5 is connected with the stack and the regenerator 6 with the air supply duct; combustion then taking place in the chamber 14 and the products of combustion pass from said chamber through the flues 2, 2, into the chamber 13 and thence out through the chamber 3 and the regenerator 5 to the stack.

The heating devices for the opposite end portions or sections of the oven being alike and being provided with the usual heat controlling means as the valves in the gas supply pipes 22 and 23, a higher temperature may be maintained in the part or section adjacent to the inlet or receiving end of the coking chamber, than in the part or section adjacent to the outlet or delivery end of said chamber. The provision of means for separately controlling the temperature in the two parts or sections of the coking chamber is of great importance, for the reason that the best results in coking are obtained by first subjecting the coal to temperatures sufficiently high to effectually complete the coking operation, and to thereafter subject the mass of coke to a lower temperature for a considerable period, so as to afford considerable cooling thereof before its discharge from the oven.

Now referring to the coal feeding, compressing and pre-heating devices at the receiving end of the oven, these parts, as shown in the drawings, are made of metal and embrace features of construction as follows:—

24 indicates a coal receiving chamber, 25 a tapered coal-compressing passage, and 26 a pre-heating chamber. Said receiving chamber, the tapered compressing passage, and the pre-heating chamber are connected with each other to form a continuous passage through which the coal is advanced from the receiving chamber to the oven, the bottom wall of the pre-heating chamber being level with the bottom of the coking chamber, while its side walls are parallel with each other and located at a distance apart somewhat less than the distance between the side walls of the coking chamber, so as to give clearance spaces at the sides of the mass of coal advanced from the pre-heating chamber into the oven. The top wall of the preheating chamber is located somewhat below the level of the top wall of the oven, so as to leave clearance space at the top of the oven.

At the top of the receiving chamber 24 is located an inlet or feed passage 27 provided with a hopper 28 and with a horizontal, sliding valve or gate 29, which latter is located

adjacent to the top wall of the receiving chamber. The side and bottom walls of said receiving chamber are parallel with each other and in the said receiving chamber is located a horizontally reciprocating plunger 30 which fits and slides in contact with the side, top and bottom walls of said chamber. Power actuated means for giving reciprocatory motion to the plunger 30 may be of any desired form or construction. The devices for this purpose shown in the drawings, consist of two horizontal rods 31, which are attached to an upright cross-head 32, secured to the center of a double-ended piston or plunger 33, the opposite ends of which slide in oppositely arranged hydraulic cylinders 34 and 35 to which fluid under pressure is admitted for advancing and retracting the plunger 30.

The side, top and bottom walls of the tapered passage 25 join the corresponding walls of the receiving chamber 24 and the pre-heating chamber 26, and the inclination of said walls of the tapered passage is such as to give a desired degree of compression to the mass of coal forced therethrough from the receiving chamber by the action of the plunger 30. Such mass of coal, in the advance movement of the plunger 30, is forced by said plunger from the receiving chamber through said passage 25 into the pre-heating chamber 26; the oblique side, top and bottom walls of said passage serving to compress the mass laterally in all directions or from the exterior thereof toward the center of same.

The side, top and bottom walls of the pre-heating chamber 26 are parallel with each other and are formed by a metal shell, which is preferably made in two parts, divided on a vertical, longitudinal plane. Surrounding the pre-heating chamber is a combustion space or chamber 36, in which is burned a mixture of gas and air for heating the coal in its passage through said pre-heating chamber. Said combustion chamber 36 is provided at its top with exit tubes or pipes 37, 37, 37 for the exit of products of combustion. Fuel gas is supplied to the bottom of said chamber 36 by means of a fuel supply main 38 provided with supply pipes 39, 39, leading into the bottom of said chamber. The walls of the pre-heating and combustion chambers preferably consist of two hollow shells or sections, joined to each other along the longitudinal centers of the said chambers. The said combustion chamber 36 is shown as water-jacketed, the same being surrounded by an exterior shell forming a water-chamber 40. Water is supplied to said chamber by means of a water supply main 41, connected with the chamber by means of branch-pipes 42, 42; a waste pipe 43, connected with the water-jacket 40 by branch pipes 44, serving to carry away the water after it is circulated through said water-jacket. The chamber 36 is water-cooled in order to prevent injury to the metal of which it is made by the high degree of heat resulting from the burning of gaseous fuel in the said chamber.

45 indicates a hollow, metal, water-cooled apron, which is arranged horizontally beneath the top wall of the oven at the receiving end thereof and the bottom wall of which forms a horizontal extension or continuation of the top wall of the pre-heating chamber. Said apron 45 extends for some distance into the oven and serves to prevent the top of the compressed mass of coal from rising into contact with the top wall of the oven, under the pressure applied, through the plunger 30, to the mass of coal for forcing it through the pre-heating chamber, and into and through the oven. Said water-cooled apron 45 has the form of a hollow metal box, and the same is preferably made to form a part or continuation of a hollow metal water-cooled ring 46, applied between the combustion chamber 36 and the adjacent end of the masonry structure of the oven; said apron and ring being water cooled in order to prevent injury to or destruction of the same by the action of heat transmitted thereto from the highly heated walls of the oven.

47 and 48 indicate water supply and return pipes for the water-cooled ring 46, said pipes being connected with the supply and return pipes 42 and 44 hereinbefore referred to.

The water cooling of the combustion chamber 36, the apron 45 and ring 46 will have no detrimental effect, so far as the preheating of the coal is concerned, because such water cooling will have the effect only of keeping the metal parts, which are subject to the heat of the combustion taking place in the said combustion chamber 35 and of the heat from the oven walls, at such low temperature as to prevent said metal parts being heated to an injurious extent, without reducing the amount of heat transmitted to the coal below that necessary for the proper preheating thereof.

Extending from the inner face of the plunger 30 are a plurality of rods 50, 50, arranged parallel with each other and parallel with the sides of the receiving and pre-heating chambers. In the form of constructon illustrated in Figs. 1 to 11, the rods 50, 50, are attached to and move with said plunger 30, and extend from the face of said plunger forwardly through the receiving chamber 24, the tapered passage 25 and the pre-heating chamber 26. Said rods are preferably made long enough to extend some distance into the coking oven when the plunger is advanced. The coal, which is introduced in pulverized form into the receiving chamber in advance of the plunger, surrounds said rods, and in the advance movement of the plunger the coal is packed

solidly around the rods, so that said rods form in the mass of coal a plurality of longitudinal passages, openings or perforations. As the mass of coal is forced through the tapered passage 25 it is compressed or solidified, and the effect of the heat to which the said mass is subjected in the pre-heating chamber being to produce coherence between the particles of coal in the mass so that it retains its solid form when it enters the coking chambers, it follows that the longitudinal passages or perforations formed by said rods will remain in the mass after the same has been advanced beyond the free ends of said rods.

In Figs. 12 and 13 I have shown a modified construction in the perforating and pre-heating devices. In this instance, the rods 50, 50 pass through holes in the plunger 30 and are attached to a reciprocating cross-head 51. Said cross-head 51 is moved rearwardly far enough to bring the rear ends of the rods flush with the inner or working face of the plunger 30 and is retained in this position during the introduction of the supply or charge of coal to the receiving chamber. After a charge of coal has been introduced, the cross-head 51 will be advanced so as to carry the rods 50 forwardly through the fresh coal and into the longitudinal passages previously formed in the mass of coal and the plunger and cross-head will then be advanced together. In said Figs. 12 and 13, the combustion chamber 36 is shown as extended so as to surround the compressing passage 25, the receiving chamber 24, and the feed passage 27. This construction gives increased efficiency in the pre-heating means, since the pre-heating is effected at relatively low temperature and the longer the coal is exposed to heat before entering the coking chamber, and the larger the area of heating surface to which it is exposed, the greater will be the quantity of heat transmitted to the coal.

Now referring to the means at the exit end of the oven for discharging the coke therefrom, the same consists of a vertically arranged discharge pipe 52, the upper end of which is connected with the discharge end of the oven, and the lower part of which extends below the floor of the oven and is provided with two vertically separated valves 53, and 54. The valve 53 preferably consists of a horizontally sliding gate, while the valve 54 embraces a conical closure adapted to fit against a circular seat at the bottom of the pipe 52 and is attached to an operating and supporting lever 55 which is pivoted to the pipe and has a weighted arm 56 adapted to hold the valve closure normally in contact with its seat. The discharge pipe 52 preferably consists of an exterior shell or casing of sheet metal provided with a lining of refractory material. A water-cooled ring 57 is preferably introduced between the pipe 52 and the adjacent end of the masonry end wall of the oven. Means illustrated for securing a circulation of water in said cooling ring, consist of supply and return mains 58 and 59, connected with the said hollow ring by pipes 60 and 61.

The two valves 53 and 54 in the discharge end of the pipe 52 are for the purpose of permitting the coke to be discharged from the furnace without admiting air thereto. As the body or mass of coke reaches the discharge end of the oven, the same, being partially cooled, disintegrates and the fragments of coke fall through the ducts 52 and accumulate upon the valve 53, which is normally closed. When a considerable quantity of the coke has accumulated on the upper valve 53, the latter is withdrawn so as to allow the accumulated coke to fall upon the lower valve 54. The valve 53 is then closed and the valve 54 opened to permit the discharge of the coke from the lower end of the pipe.

In the operation of the apparatus described, assuming that the plunger 30 has been previously advanced to force the charge of coal from the receiving chamber into the tapered passage 25 and the pre-heating chamber 26 and then withdrawn, a space will have been left between the said plunger and the rear face of the mass of coal previously forced into or compressed within the passage 25. The space in advance of the plunger is then filled by a new charge of pulverized coal, introduced through the inlet passage 27. In the next succeeding advance movement of the plunger the charge of coal within the receiving chamber is forced from the same into or through the tapered passage 25, while the mass of coal in said passage, in advance of the newly introduced charge, is advanced through the pre-heating chamber and the coking chamber. As the mass of coal is forced through the tapered passage, the walls thereof serve to compress the mass both vertically and laterally, so that the mass entering through the pre-heating chamber is closely compacted and will possess the desired degree of solidity. The effect of the heat transmitted to the mass of coal through the walls of the pre-heating chamber is to melt or soften the bituminous constituents of the coal, or to produce partial coking of the mass, so that the particles of coal in the mass cohere and the mass will, in its subsequent advance movement into and through the coking chamber, retain the form given it by being forced through the tapered compression passage and through the pre-heating chamber.

In first starting the oven in operation the oven will be filled with coal from the top through an opening 62 provided for the purpose. Heat will then be applied in the ordinary manner, and the mass of coal within the coking chamber will be coked. In the mean-

time the receiving chamber will have been filled with coal through the inlet opening in its top, the plunger or pusher 30 being withdrawn for this purpose. The coking chamber will then be filled with coke, and the extension of the oven formed by the pre-heating chamber and the compressing chamber filled with coal compressed therein by the action of the plunger; the coal acting as a seal which prevents the escape of gas from the receiving end of the coking chamber and also keeps out the atmospheric air. It will, of course, be understood that the gas generated in the oven passes therefrom to an exhauster so that the coking chamber is subject to internal pressure not greater than that of the atmosphere. Each oven is provided with outlet passages 63, 63 through which may be discharged products of the coking operation.

In the operation of the oven the pusher will be worked at any desired speed. For illustration; a 33 foot oven produces four and two-tenths tons of coke in 24 hours. The movement through the oven would, in this case, be equivalent to about one-fourth inch per minute. During the coking operation, the ordinary coking process proceeds in the coking chamber from the sides and bottom thereof, and the pre-heated coal is forced into the oven against the incandescent coke therein, so that as the pre-heated coal enters the coking chamber, the coking proceeds in an endwise direction or from the incandescent portion of the mass toward the incoming uncoked portion thereof. Manifestly, in the operation, the production of gas will be continuous and at a uniform rate, as will be the production of coke, while a large amount of heat will be saved owing to the fact that the oven is never opened and emptied. By making the oven in two parts or sections equipped with separably controllable heating means, the receiving portion or end of the oven may be run at a very high heat, while the discharge end or portion thereof containing the coke may be kept at a much lower temperature, thereby effecting a partial cooling of the coke before it leaves the oven and consequent large saving of the gas.

In the process of coking as heretofore without pre-heating, the coking operation proceeds from the outside toward the center of the mass, as well as from the sides of the mass inward, the interior of the mass being quite cool during a considerable portion of the operation so that tar and pitch tend to condense in the center of the mass. The center being the last portion coked, in case of an oven of the usual cross-sectional form and dimensions, that is to say, from about 15 inches to 22 inches wide and about 5 feet in height, a vertical cleavage line is produced. On either side of this cleavage line, the coke resulting from the final distillation of the tar or pitch which has been deposited in this vicinity, on account of the low temperature of the center of the mass, will be very porous. By the pre-heating of the coal when in compact mass, and during the advance movement of the mass toward and into the oven, the tendency to condensation of the tar and pitch in the center of the mass will be greatly lessened, so that the pre-heating tends to produce equality in the character of the coke throughout the mass.

The formation of longitudinal holes or passages in the body of the coke, will also tend to prevent such condensation of tar and pitch in the center of the mass and give uniformity to the product, while at the same time making more rapid the operation of coking because facilitating the escape of gases and volatile constituents of the coal from the interior of the mass during the coking operation.

An important feature of my process consists in the step of pre-heating the coal as it is advanced in a compact and continuous mass to the coking retort or oven. With respect to this feature, my process differs from that carried out by the use of an upright or vertically elongated coking chamber to the top of which the coal is fed and from the bottom of which the coke is removed, for the reasons that in operation of such a vertical oven, in which the downward movement of the mass of coal through the oven is effected by the action of gravity and the coke is removed from the bottom of the retort substantially as fast as it is fed to the top thereof, there can be substantially no compression of the coal prior to the first heating thereof because if there be any substantial compression of the mass due to the weight of the coal, such compression does not take place in the upper part of the retort, but necessarily occurs only in the lower part of the retort and is due to the weight of the coal in the upper part of the retort and to the checking of the descent of the coal through the lower part of the retort by reason of its friction against the sides thereof.

In carrying out my process, gravity of the coal is not a factor in the advance and compression thereof, because the mass of coal is moved horizontally toward the oven or retort by pressure on the outer end of the mass, the result being that the coal in the mass is held in a compressed state at the time heat for pre-heating is applied thereto, and the coal is prepared for the coking process being both compressed and preheated to produce adherence of the particles of coal into a solid mass, which is advanced unbroken into the oven.

While the endwise pressure applied to the outer end of the mass of coal as it is advanced into the oven, together with the resistance to the forward movement of the mass, due to its frictional contact with the walls of the

passage surrounding it, will, in some cases or with some kinds of coal, produce sufficient compression of the mass, yet the feature of the lateral compression by which the mass is compressed from its outside toward its center is of great practical importance because insuring the bringing about of such amount of compression as to result in the adherence to each other of the particles of coal in the mass when subjected to the heat employed for pre-heating.

The perforation of the mass when the coal is in its compressed condition and subjected to heat for pre-heating, is also of great importance because the formation of the channels or perforations in the mass when the same is under compression, and when the particles of the mass have been caused to adhere to each other by the heat due to pre-heating, results in the perforations remaining in the mass after the same reaches the oven and is therein subjected to coking heat, and the consequent production of coke of substantially uniform quality throughout the mass.

The direction of movement of the mass of coal in its approach toward the coking oven or retort is herein described as "horizontal" in order to distinguish applicants' process from those in which the coking is effected in an upright retort, and the movement of the coal into and through the retort is effected by the weight or gravity of the coal, but it is to be understood that by the use of such term, I do not limit my process to one in which the path of movement of the coal is strictly horizontal, but intend to cover said process when the direction of movement of the mass of coal is so nearly horizontal that its advance toward and into the coking retort or oven is not effected by gravity, but is produced substantially or mainly by pressure applied endwise to the mass in a manner to both compress the mass endwise and to give the desired movement of same.

I claim as my invention:—

1. The process of coking coal which consists in applying pressure to one end of a mass of coal while confining it laterally to compress the coal and advance the mass horizontally toward and into a coking retort or oven, applying heat to the mass for preheating the coal during its approach toward the retort or oven and applying coking heat to the portion of the mass within the coking retort or oven.

2. The process of coking coal which consists in applying horizontal pressure to one end of a mass of coal to advance the mass horizontally toward and into a coking retort or oven, pre-heating the mass during its approach toward the retort or oven and applying coking heat to the portion of the mass within said retort or oven.

3. The process of coking coal which consists in advancing a mass of coal toward a coking retort or oven, applying lateral pressure to the mass during its movement toward the retort or oven to compress the said mass from the outside toward the center thereof, confining the mass laterally after it is compressed until it enters said retort or oven, advancing the compressed mass into the said retort or oven without admitting air thereto, and applying coking heat to the part of the mass within said retort or oven.

4. The process of coking coal which consists in applying pressure to one end of a mass of coal to advance the mass toward a coking retort or oven and at the same time applying to the mass lateral pressure to compress the same from the outside toward the center thereof, confining the mass laterally after it is compressed until it reaches the said retort or oven, advancing said mass into said retort or oven without admitting air thereto, and applying coking heat to the portion of the mass within said retort or oven.

5. The process of coking coal which consists in applying pressure to one end of a mass of coal to advance the mass toward and into a coking retort or oven, and at the same time applying to the mass lateral pressure to compress the same from the outside toward the center thereof, preheating the compressed mass during its movement toward the retort or oven, and applying coking heat to the portion of the mass within said retort or oven.

6. The process of coking coal which consists in applying horizontal pressure to one end of a mass of coal confined in an inclosing tube or passage to advance the mass through said tube or passage into a coking retort or oven, applying heat to the walls of said passage for preheating the coal during its movement toward the retort or oven, and applying coking heat to the portion of said mass within said retort or oven.

7. The process of coking coal which consists in applying horizontal pressure to one end of a mass of coal confined in an inclosing tube or passage to compress the coal into a solid mass and advance the mass through said tube or passage into a coking retort or oven, applying heat to the walls of said passage for preheating the compressed mass of coal during its movement toward the retort or oven, and applying coking heat to the portion of said mass within said retort or oven.

8. The process of coking coal which consists in applying pressure to one end of a mass of coal confined in an inclosing tube or passage, to advance the mass toward and into a coking retort or oven, applying lateral pressure to the mass during its movement through said tube or passage to compress said mass from the outside toward the center

thereof, applying heat to the inclosing tube or passage for preheating the coal during its movement therethrough, and applying coking heat to the portion of the mass within said retort or oven.

9. The process of coking coal which consists in advancing coal in a compact and continuous mass toward and into a coking retort or oven without admitting air to the latter, perforating the compressed mass, applying coking heat to the portion of the mass within the retort or oven, and removing the finished coke from the oven from time to time without admitting air to said retort or oven.

10. The process of coking coal which consists in applying pressure to one end of a mass of coal to advance the mass toward a coking retort or oven, applying lateral pressure to the mass to compress the same from the outside toward the center thereof, confining the compressed mass laterally during its movement toward the retort or oven, advancing the said compressed mass into the said retort or oven without admission of air thereto, perforating the mass when under lateral pressure, and applying coking heat to the portion of the mass within the said retort or oven.

11. The process of coking coal which consists in applying pressure to one end of a mass of coal while confining it laterally to advance the mass toward and into a coking retort or oven, perforating the mass before it reaches the retort or oven, applying heat to the mass during its approach toward the retort or oven for preheating the same, and applying coking heat to the portion of the mass within the retort or oven.

12. The process of coking coal which consists in applying pressure to one end of a mass of coal to advance the same toward and into a coking retort or oven, applying lateral pressure to the mass to compress the same in a direction from its outside toward its center, perforating the mass while under compression, applying heat to the mass during its approach toward the retort or oven, and applying coking heat to the portion of the mass within said retort or oven.

13. The process of coking coal which consists in applying pressure to one end of a mass of coal confined in an inclosing tube or passage which has direct connection with a coking retort or oven to advance the mass through said passage and from the latter into said retort or oven without the admission of air thereto, perforating the mass longitudinally during its movement through said passage toward said retort or oven, applying coking heat to the portion of the mass within said retort or oven and removing the finished coke from the retort or oven from time to time without admitting air thereto.

14. The process of coking coal which consists in applying pressure to one end of a mass of coal confined in an inclosing tube or passage, applying lateral pressure to the mass during its movement through said tube or passage for compressing the mass from its outside toward its center, perforating the mass longitudinally while under lateral pressure, and applying coking heat to the portion of the mass within said coking retort or oven.

15. The process of coking coal which consists in applying pressure to one end of a mass of coal confined in an inclosing tube or passage, applying lateral pressure to the mass during its movement through said tube or passage to compress the same from its outside toward its center, perforating the mass longitudinally while under lateral pressure, applying heat to the mass during its movement through said tube or passage toward the retort or oven, to preheat the coal, and applying coking heat to the portion of the mass within said retort or oven.

In testimony, that I claim the foregoing as my invention I affix my signature in the presence of two witnesses, this 28th day of September A. D. 1906.

SAMUEL B. SHELDON.

Witnesses:

A. C. BYAM,

A. H. VOGEL.