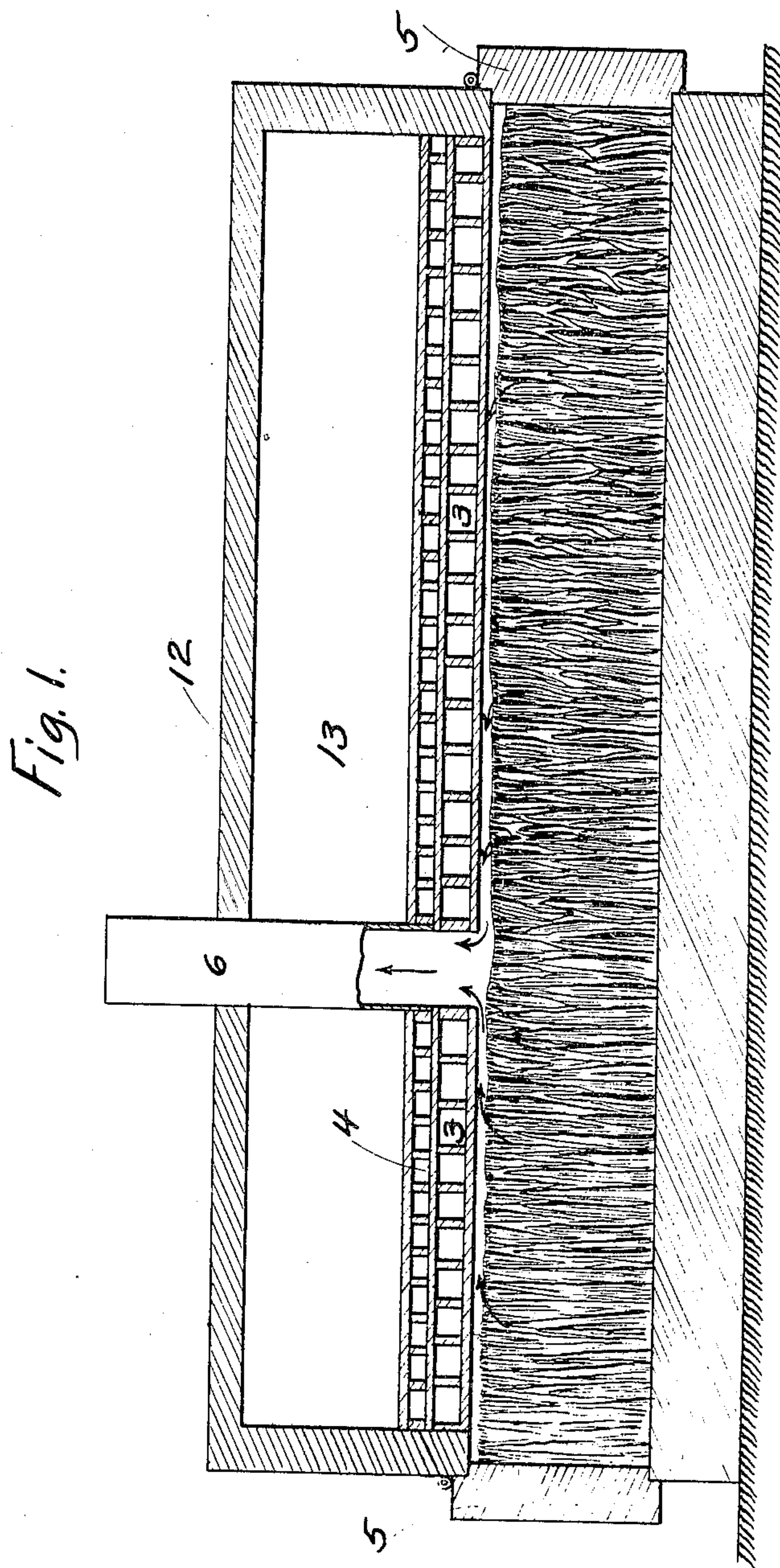


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L. L. SUMMERS.  
COKING PROCESS.  
APPLICATION FILED APR. 26, 1909.

Patented Mar. 8, 1910.  
4 SHEETS—SHEET 1.



Witnesses:  
C. Durnap  
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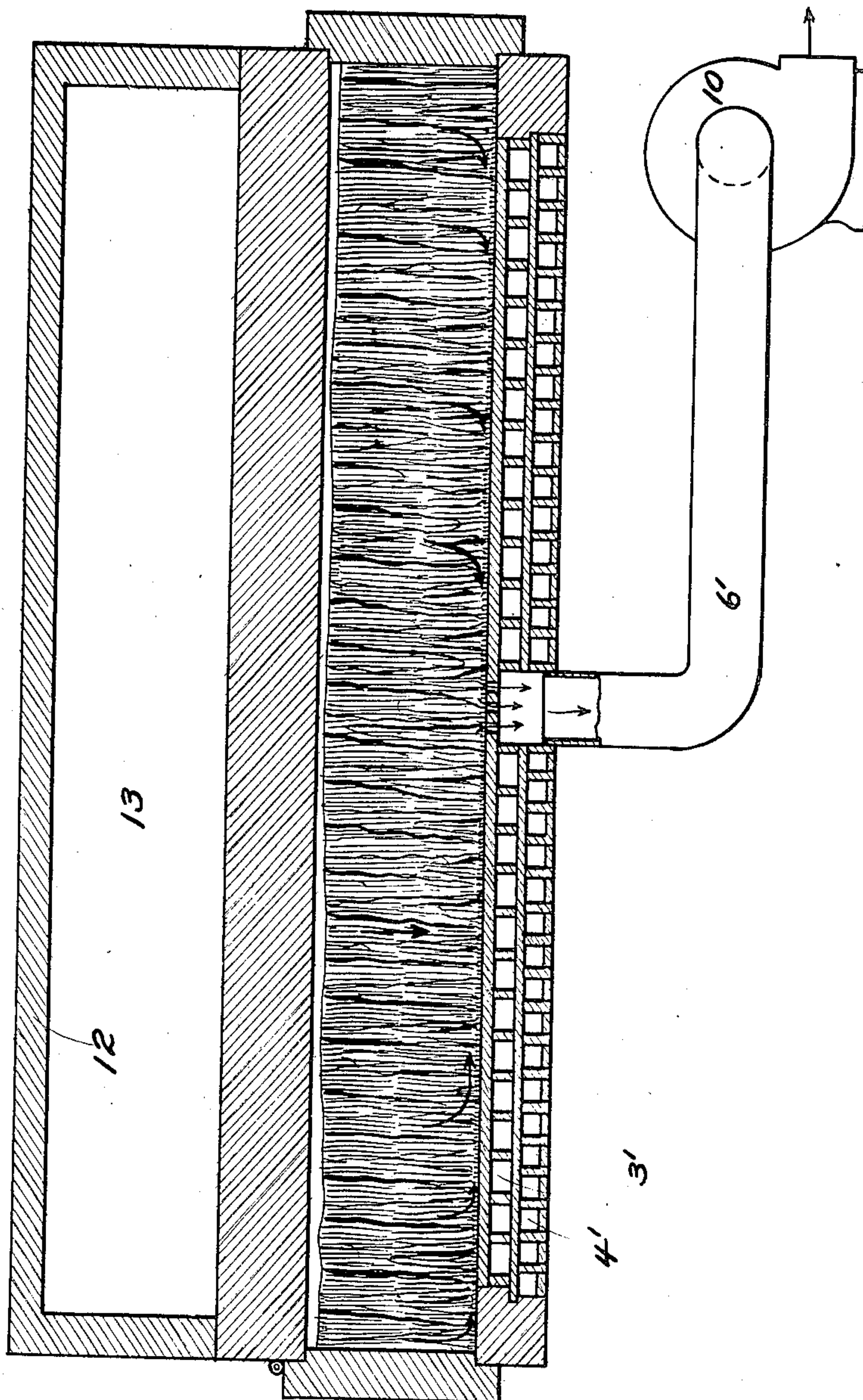
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Fig. 2.



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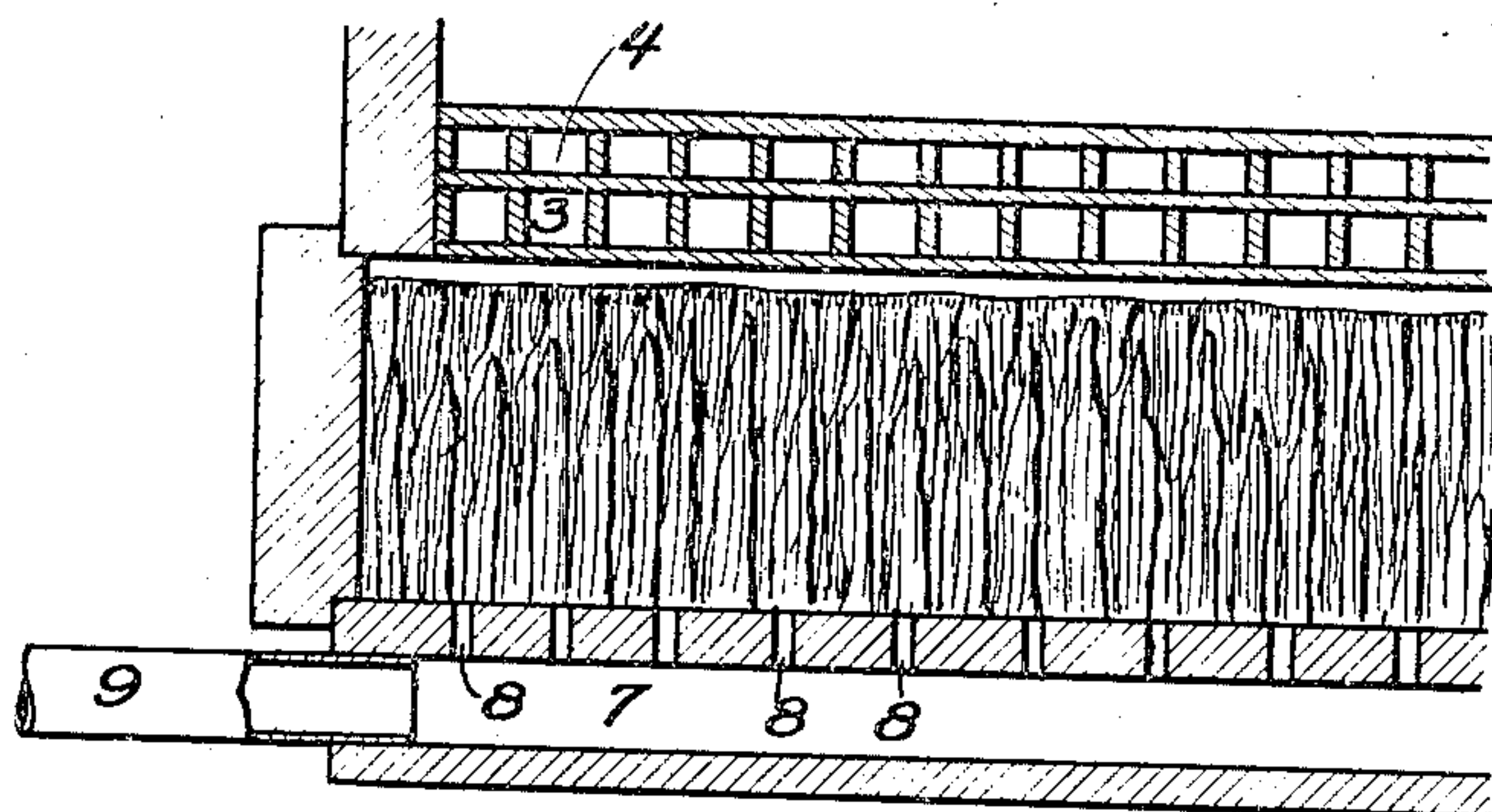
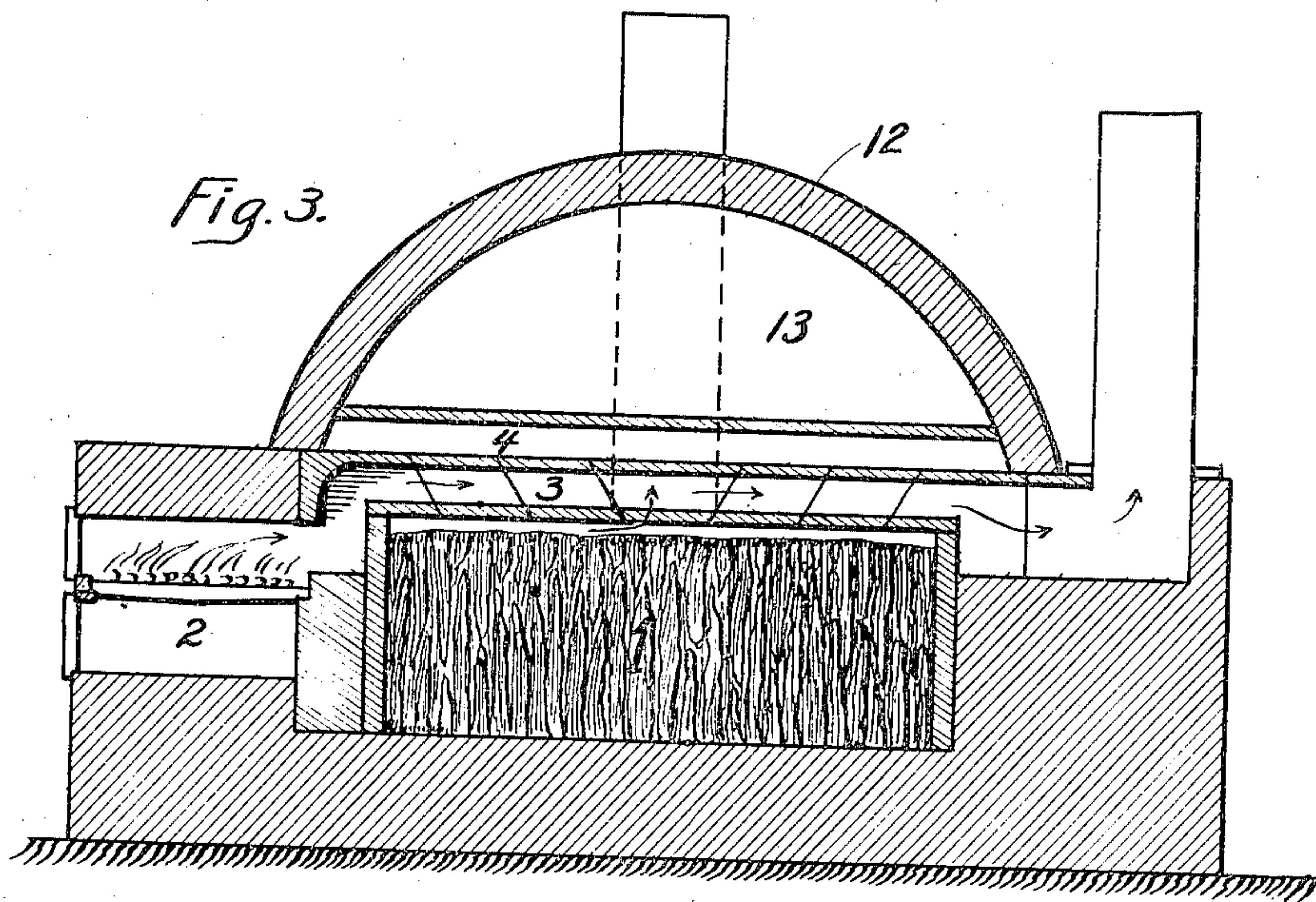


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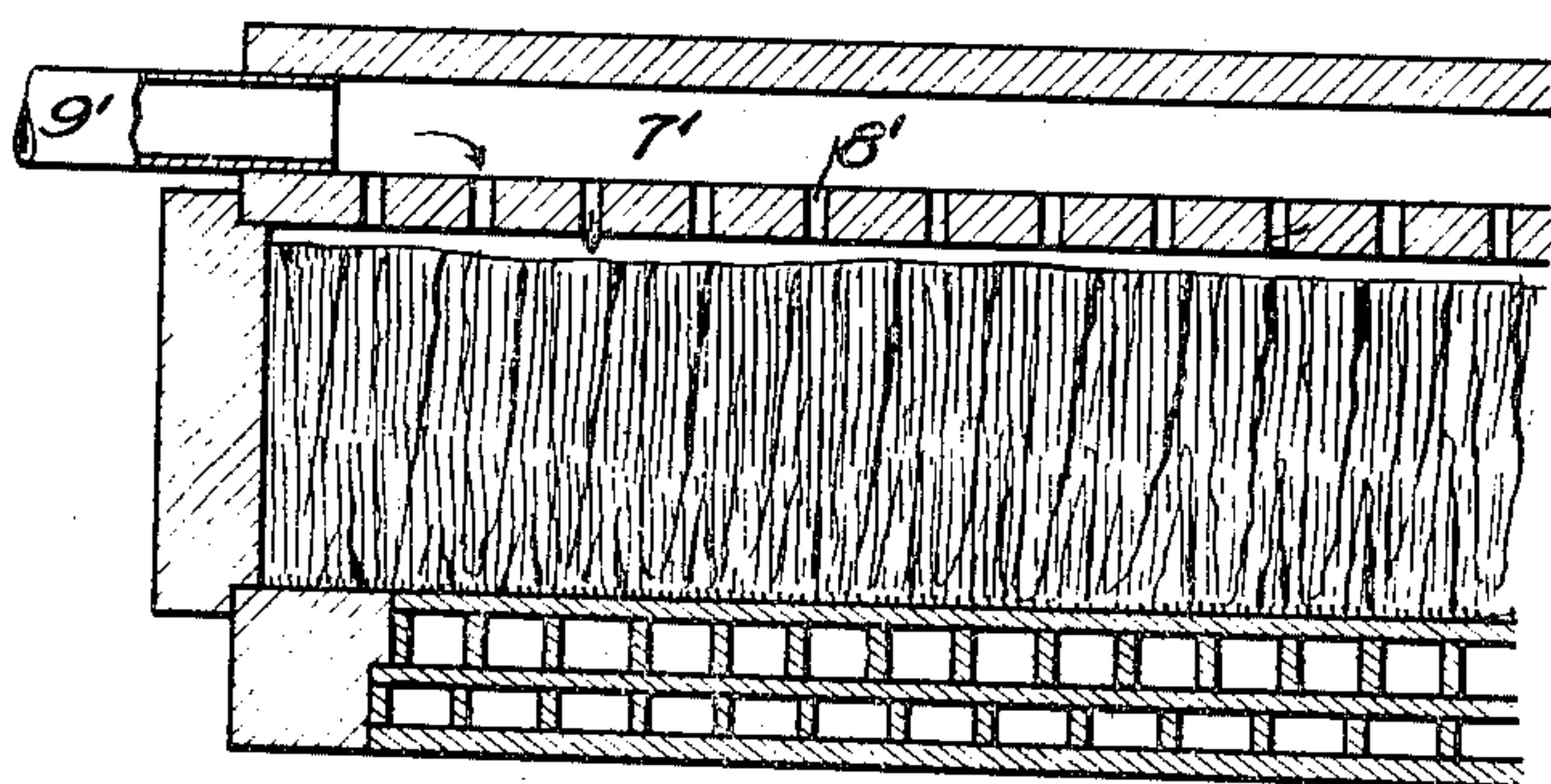
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4 SHEETS—SHEET 3.



*Fig. 4.*



*Fig. 5.*

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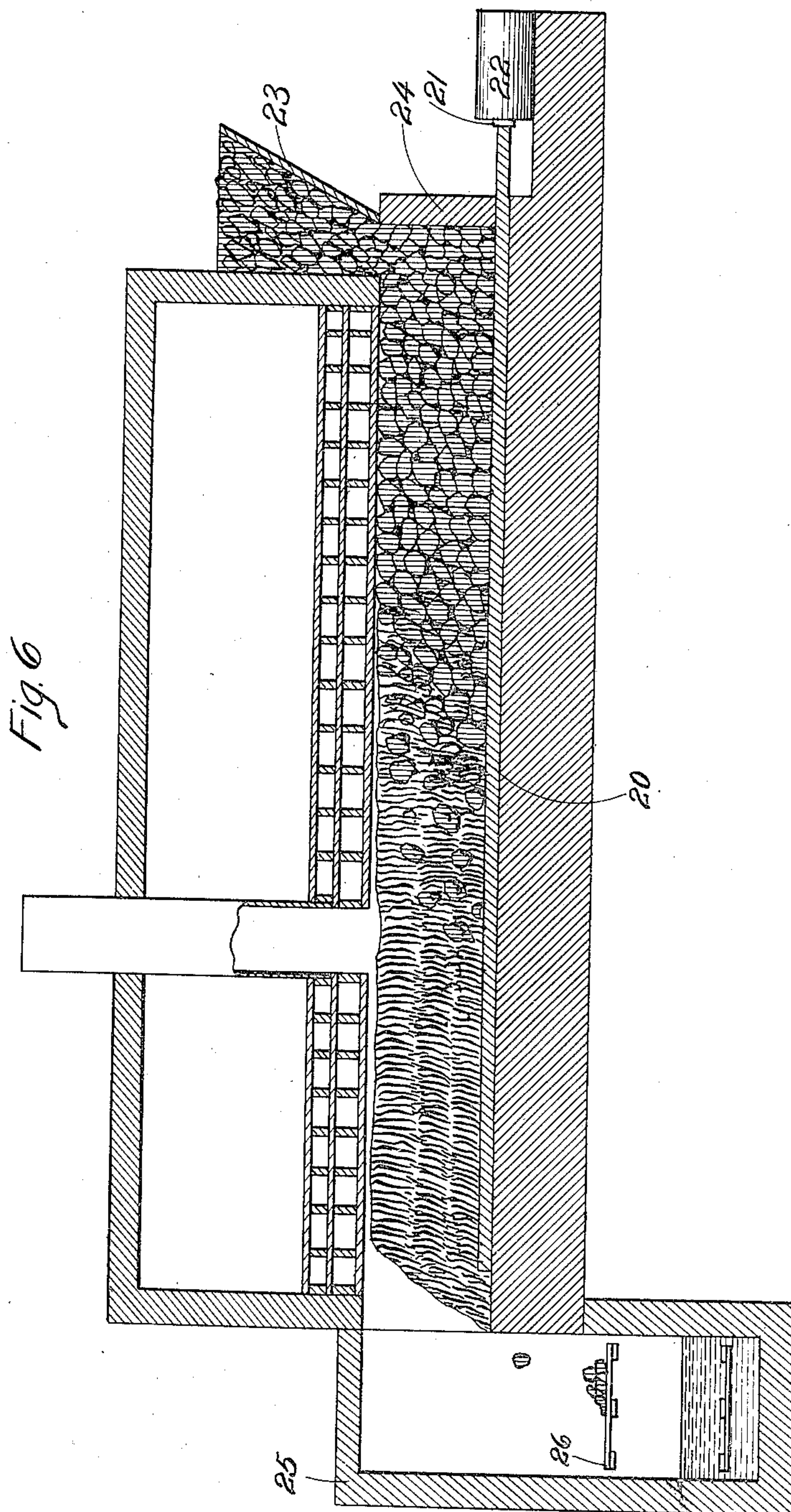
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# UNITED STATES PATENT OFFICE.

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COKE COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF MAINE.

## COKING PROCESS.

951,786.

Specification of Letters Patent.

Patented Mar. 8, 1910.

Application filed April 26, 1909. Serial No. 492,126.

*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, to provide a means for depositing carbon or carbonaceous matter in coke from carbonaceous gases, principally from part of the coal which is being coked; but gases derived from other sources may also be used in some instances. I accomplish this result, preferably, by utilizing an oven in which the hydrocarbons distilled from the coal or introduced into the coal are forced to pass through highly heated coal while being coked and having a temperature sufficiently high to decompose the hydrocarbon, causing a deposit of carbon cementing carbonaceous substance to form and adhere to the highly heated coal or coke. The cause of the coking action in coal has long been a subject of controversy, it having been demonstrated, however, that coals containing a high percentage of oxygen do not form coke or cohere when heated, but simply result in a powdered mass of amorphous carbon.

The coking action of coal has been ascribed to many causes, it being generally held that a coal which coked "fused", while a coal which did not coke simply lacked a fusing element. "Bitumen" has been held by many to be present in the coking coals and not present in the non-coking coals. Again, many authorities have held that a "hydrogenated" coal or a coal which had a surplus of disposable hydrogen after providing for the oxygen in the coal to form water constituted a coking coal.

As a result of several hundred experiments and analyses, I have discovered that the coking or non-coking of coal is due to the presence or absence of cementing carbon or carbonaceous matter which is caused to be deposited in the particles of amorphous carbon, thereby cementing them together. In order to cement the carbon particles together, they must be heated to a high temperature, at which temperature they are capable of uniting with atomic or gaseous carbon or hydrocarbon of high molecular constitution, such as those liberated from hy-

drocarbon gases at the instant they are decomposed, thereby freeing the hydrogen. If oxygen be present in the coal, the well-known affinity between oxygen and carbon will cause the carbon to unite with the oxygen, rather than be deposited in the fixed carbon of the coal or coke, and if the oxygen is present in excess, cementing carbon or carbon compounds is prevented from being deposited in the interstices of the coal, and the coal will not coke. In proof of this, I have mixed oxygen and oxygen compounds and the products of combustion containing oxygen compounds with coking coals, thereby preventing their coking. I have, on the other hand, mixed with the so-called oxygenated coals hydrocarbon gases, and when at a high temperature these gases being decomposed have united the particles of coal together, thereby forming a hard coke. I have also proved in various other ways that a coke may be formed by decomposing hydrocarbon gases and causing the fixed carbon of the coal to be cemented together. In order to accomplish this result, it is essential that the fixed carbon of the coal be heated to a temperature sufficiently high to cause a union between the liberated carbon or carbon compounds of the gases and the highly heated fixed carbon. For this reason, it is desirable that the gases be caused to pass toward the source of heat at the time the coke is being formed, thereby being continually raised to a higher temperature.

Owing to structural disadvantages, it has been the general practice in the past to heat the oven either with the products of combustion mingling with the coal and mixing with the distilled products, or in those cases where the retort of the oven has been heated independently and externally to remove the gases regardless of their passing through the zones of higher temperature and depositing their carbon before removal. So far as I am aware the passage of gases toward the source of heat, or the introduction of hydrocarbon gases from an external source into highly heated material, has never been utilized, or its advantage as a cementing agent put into practice.

I have discovered that cementing carbon or carbonaceous matter can be deposited only in zones of higher temperature than that in which the hydrocarbon is liberated, or by the introduction into highly heated



material, while it is being coked, of hydrocarbons derived from some source other than the carbonaceous material. If the zone of temperature from which the gas is liberated has reached a temperature sufficient to decompose the gas, the gas will be comparatively free from carbon at the time of liberation.

In order to secure the most advantageous results the cementing carbon or carbonaceous matter should be deposited from the hydrocarbon gases in the carbonaceous material during the progress of the coking action, as distinguished from making the deposit of cementing carbon in material in which the coking action has been carried to completion. For this reason it is desirable if hydrocarbon gases from an external source be used that they be introduced into the cooler part of the coking mass in order that they may be thoroughly diffused through the mass before coming in contact with the highly heated material when they are decomposed, thus insuring the deposit of the cementing carbon throughout the mass. The same result is attained when only the gases generated in the carbonaceous mass are relied on, as they become thoroughly diffused prior to their escape from the most highly heated part of the oven.

Owing to the fact that coal is not instantaneously heated when deposited in a retort, but can only be heated by causing the heat to be transmitted through layers of coal, the layer situated adjacent to the heated surface transmits its heat in turn to the next adjacent layer, eventually causing the retort to assume a uniform temperature. The progressive heat, therefore, results in zones of varying temperature, the highest temperature being adjacent to the heated surface or source from which the heat is obtained, and the lowest temperature being in that portion of the charge most remote from the heated surface. Owing to this gradual transmission of temperature, gases are liberated from the carbonaceous material being coked, before this material has assumed a temperature sufficient to decompose the gases, and if these gases are not decomposed previous to being removed from the retort, a considerable proportion of carbon is removed with the gases, and no cohesion of the coke can be made unless the coal possesses a very high carbon content in gases, and more particularly gases that are decomposed at practically the temperature at which they are distilled. If the gases distilled from coals at lower temperature are caused to pass through the coal of high temperature, the decomposition is readily brought about and the carbon or carbonaceous solids of the gases is deposited in such a form as to make a coking coal. By the introduction of carbonaceous gases into the

cooler portions of the carbonaceous material in a retort and causing these gases to travel toward the zones of high temperature, decomposition of these gases will result as the coke is formed and a coal may be made to coke in this manner. Again, it is possible in using a coal high in oxygen to distil the products from the coal, and thus deprive the coal of its oxygen which may be deposited externally to the oven in the form of water. The hydrocarbon gases may be reintroduced into the oven at a point of lower temperature and caused to be decomposed at a higher temperature than that at which they were formed and in the presence of the material from which the oxygen has been eliminated. In this manner a coal may be readily coked. Owing to the affinity of oxygen for carbon, it is necessary that my process be conducted under circumstances which prevent the access of oxygen during the coking operation, and for this reason the retort is tightly closed either by suitable seals or doors, or in a continuous coking oven by the carbonaceous material itself at the inlet end and by a suitable seal at the discharge end.

In the drawings—Figure 1 is a longitudinal section of a retort in which my improved process, as above described, may be carried out. Fig. 2 is a longitudinal section of another form of retort. Fig. 3 is a cross section of the retort shown in Fig. 1. Fig. 4 is a fragmentary view, showing means for carrying out my process when hydrocarbon gases from an external source are injected into the cooler portion of the retort, this view showing a modification of the structure illustrated in Fig. 1. Fig. 5 is a view similar to Fig. 4, but applicable to the structure shown in Fig. 2. Fig. 6 is a view similar to Fig. 1, but showing the retort provided with a conveyer.

Referring to Figs. 1 and 3, the retort 1 is heated by means of a furnace 2, the products of combustion from which pass through the flues 3 extending across the top of the retort. The furnace 2 may be of any desired form and adapted for the combustion of either solid, gaseous or liquid fuel. Above the fire flues 3 is an air insulation space which may consist of a series of tiles provided with air passages 4. The retort is provided with doors 5 and may be charged and discharged therethrough. One or more outlets 6 are provided for the escape of the gases distilled from the carbonaceous material within the retort.

It will be obvious that when the furnace is charged the upper layers of coal, or other carbonaceous material, will be heated first, and will be most intensely heated throughout the greater part of the coking operation, there being no source of heat at the under side of the retort. The gases of distillation when formed will rise to the upper part



of the retort and then find their way to the outlet pipes, which may lead either to the atmosphere or to treating or storing apparatus. The gases distilled at the lower part of the retort, most remote from the source of heat, will be rich in hydrocarbon, but these gases before escaping from the retort pass upward through the more highly heated material near the source of heat at the top of the retort and are there decomposed by the intense heat. The free carbon or carbonaceous solids liberated by the decomposition of the hydrocarbon gases will deposit in the more highly heated coal in the upper part of the retort and act as a cementing agent to cause the formation of coke in firm and solid masses.

When desirable, on account of the composition of the coal or the character of product required, gases, or liquids rich in carbon may be introduced from an external source, being derived from petroleum or from any other suitable source. In Fig. 4, which corresponds to the lower left-hand part of the structure shown in Fig. 1, I have shown a duct 7 extending beneath the floor of the retort and connected to the interior thereof by apertures 8. Extending from the end of the duct 7, a pipe 9 leads to a source of hydrocarbon gases, and these gases entering through the pipe 9 pass into the interior of the retort through the apertures 8, and are there decomposed, depositing cementing carbon or carbonaceous solids in the same manner that the gases generated in the cooler part of the retort deposit carbon in the hotter part thereof.

In Fig. 2, I have shown a retort similar to that illustrated in Fig. 1, except that the source of heat is below instead of above the retort, and may consist of fire flues 3' connected to a furnace. Air insulation tiles 4' are provided beneath the fire flues 3', and the distilled gases passed off through an outlet or outlets 6'. In order to induce a proper outward flow of the distilled gases, a proper degree of vacuum may be maintained in the pipe 6' by means of a blower 10, or other means.

In Fig. 5, I have shown the retort of Fig. 2 modified to provide for the introduction of hydrocarbon from an external source, a flue 7' above the retort communicating with the interior of the retort through apertures 8'. Hydrocarbon gases are led in from any suitable source through the pipe 9' and passed thence downwardly through the material in the retort to the outlet or outlets 6', as explained in connection with Fig. 2.

In Fig. 6 of the drawing I have shown a retort in which my process may be conducted continuously. In the apparatus illustrated in this view the retort is provided with a longitudinally movable floor 20, which is reciprocated by means of a hydraulic cylin-

der and plunger 21, 22 or other suitable means. The coal is supplied through a hopper 23. When the conveyer floor 20 is moved inwardly it carries the material resting thereon with it and permits additional fuel to fall from the hopper. Upon the outward movement of the floor 20 the material in the retort is prevented from moving outwardly with it by the wall or stripper 24. The reciprocation of the conveyer floor therefore causes a progressive movement of the material through the retort from the hopper 23 at the charging end to the discharge end. The outward movement of the floor 20 by forcing the material against the wall or stripper 24 and against the superimposed material in the hopper compacts the charge, and the material in the hopper and the charging end of the retort effectually seals the retort at that end. The discharge end of the retort may be closed by a hood 25, opening to the atmosphere through a water seal and provided with a conveyer 26, or other suitable means may be employed for sealing the discharge end.

Each of the furnaces described may be provided with an outer arch 12 to inclose an air space 13, for the purpose of further insulating the retort and holding the heat therein.

It will be obvious that my improved process is equally applicable to a retort in which the material is continuously fed there-through from inlet to outlet, and that my improved principle may also be employed in connection with retorts of other forms than that illustrated. The retort illustrated is heated by means of a horizontal arch above or by means of a series of fire flues below the same, but the same principle may be utilized in connection with a vertical retort heated from the sides. In fact, the application of my improved process is not confined to any particular form of retort, but may be carried out by the use of apparatus of widely differing forms.

I claim:

1. In a coking process, the steps of heating carbonaceous material in a retort from an external source, conveying said material therethrough from end to end, and causing the gases generated from the carbonaceous material to travel through said material simultaneously toward the source of heat, and parallel to the direction of radiation thereof, said process being conducted continuously.

2. In a coking process, the steps of heating carbonaceous material in a retort from an external source, conveying said material therethrough from end to end, and causing the gases generated from the carbonaceous material to travel through said material continuously in contact therewith and simultaneously toward the source of heat and



parallel to the direction of radiation thereof, said process being conducted continuously.

3. In a process for making coke, the steps of heating carbonaceous material in a retort from an external source on one side thereof only, and causing the gases liberated from this carbonaceous material to travel through the same toward the source of heat.

4. In a coking process, the steps of heating carbonaceous material in a retort from which air or products of combustion are excluded, conveying said material there-through from end to end, and inserting hydrocarbon gases in the cooler portions of the carbonaceous material and causing the said gases to pass through the carbonaceous material continuously in contact therewith and toward the source of heat, said process being conducted continuously.

5. In a coking process, the steps of heating carbonaceous material in a retort from which air or products of combustion are excluded, conveying said material there-through from end to end, said carbonaceous

material being heated to a temperature sufficient to decompose hydrocarbons and introducing hydrocarbon gases into the carbonaceous material while so heated, and causing the gases to pass continuously through the carbonaceous material toward the source of heat, said process being conducted continuously.

6. In a coking process, the steps of heating carbonaceous material in a closed retort from an external source on one side only, conveying said material therethrough from end to end, and subjecting said carbonaceous material while being coked to the action of hydrocarbon gases of such composition that they will be decomposed by the heat of said material while being coked and deposit therein the liberated carbonaceous matter, said process being conducted continuously.

In testimony whereof, I have subscribed my name.

LELAND L. SUMMERS.

Witnesses:

HENRY A. PARKS,  
ANNA L. WALTON.