(No Model.) 3 Sheets—Sheet 1.

J. F. BENNETT.

APPARATUS FOR THE MANUFACTURE OF BITUMINOUS COAL COKE.

No. 282,604. Patented Aug. 7, 1883.

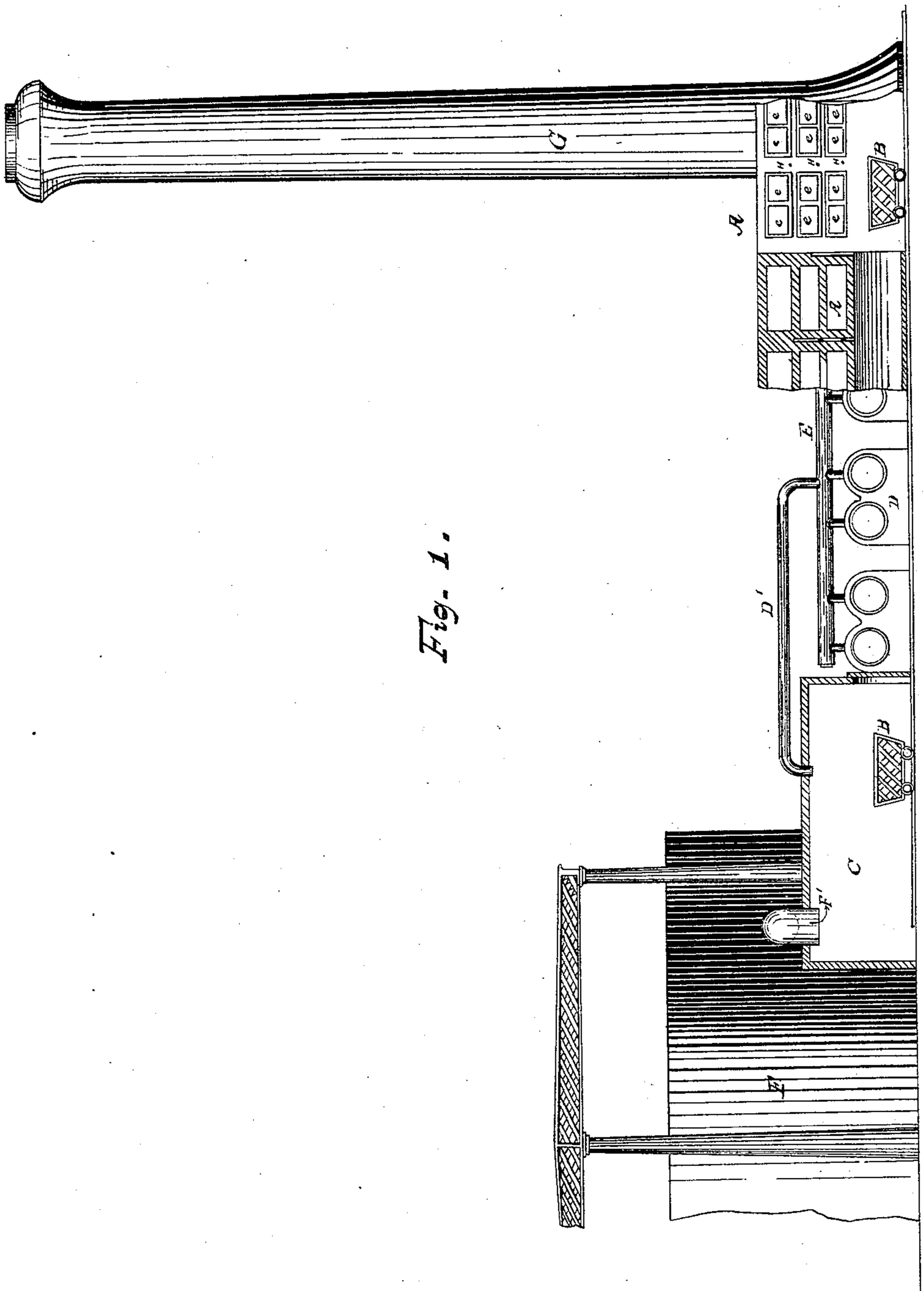

Fig. 1.

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(No Model.) 3 Sheets—Sheet 2.

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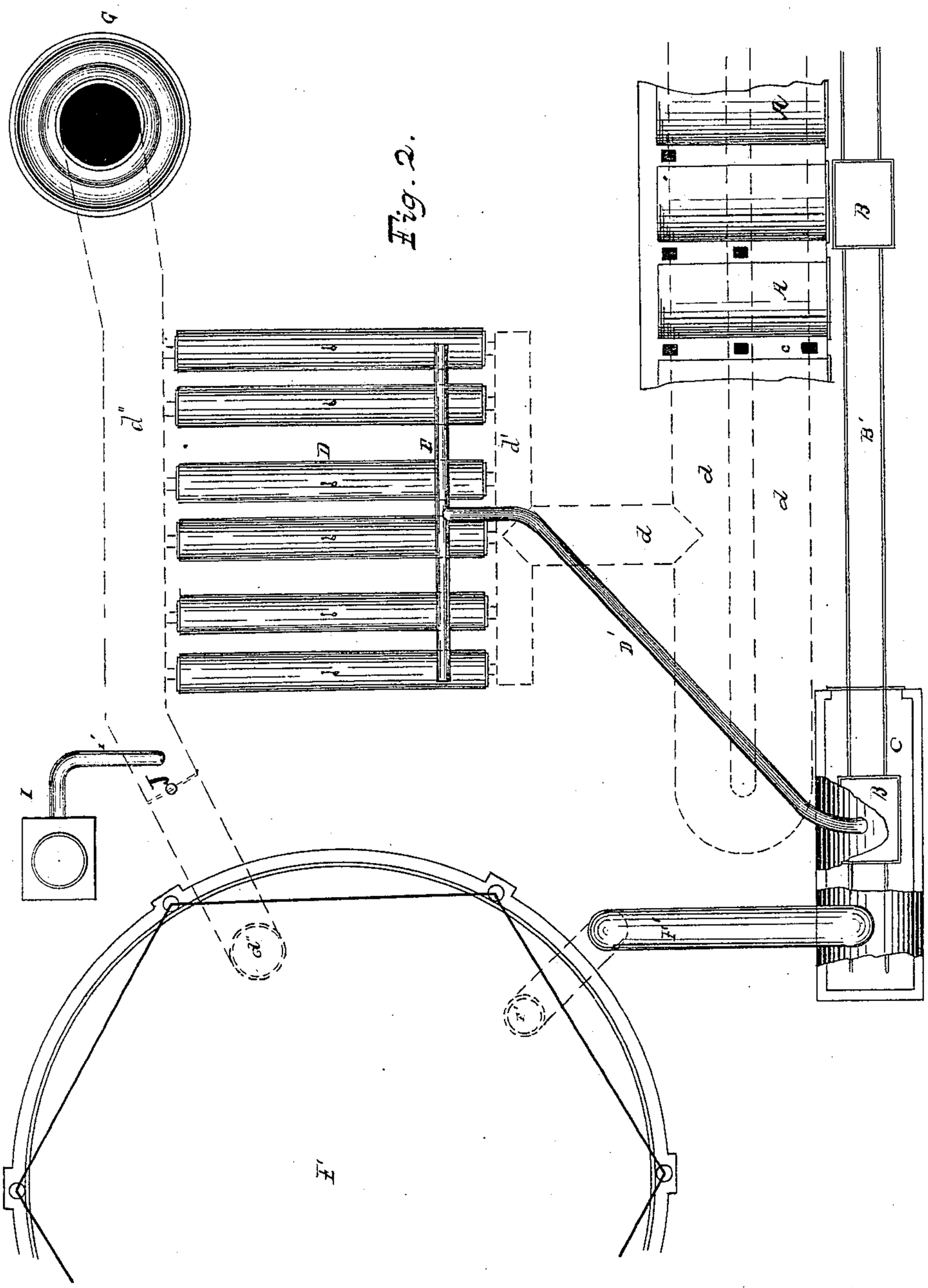

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(No Model.) 3 Sheets—Sheet 3.

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Fig 3.

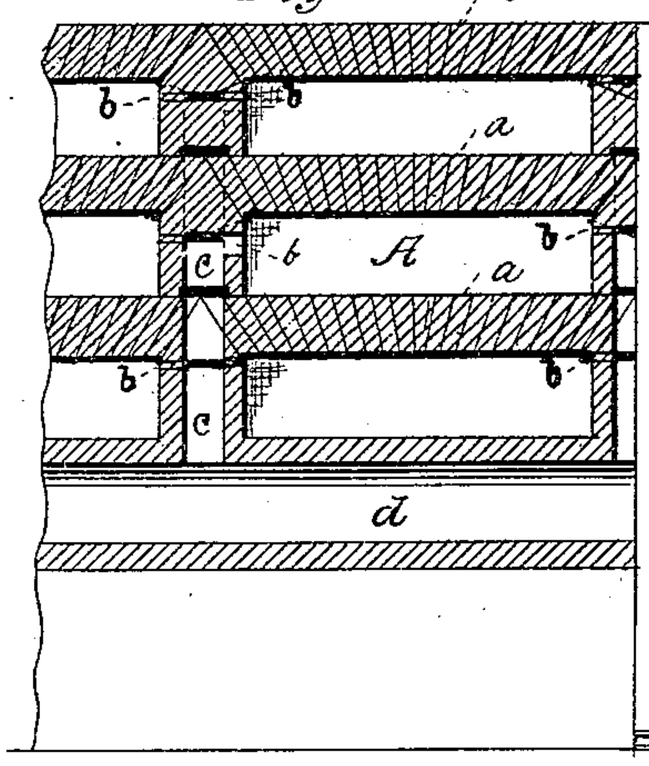


Fig 4.

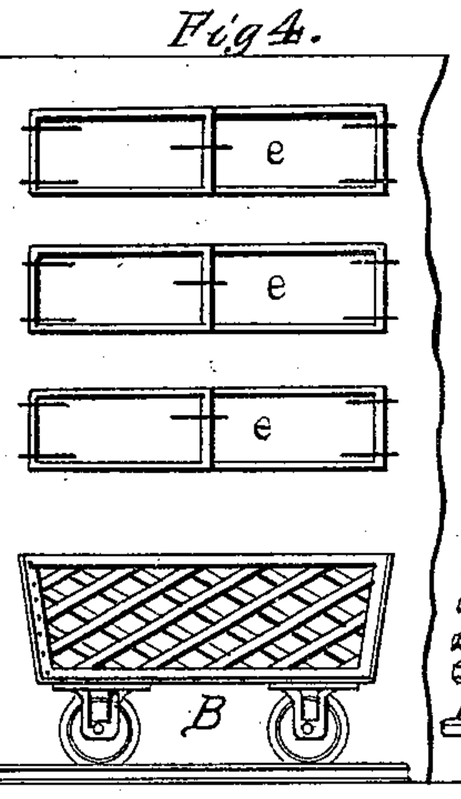


Fig 5.

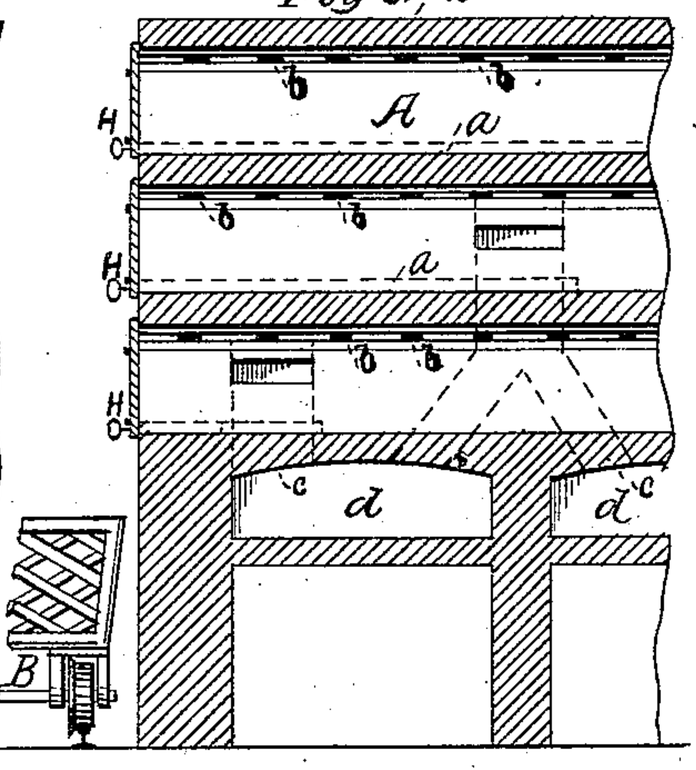
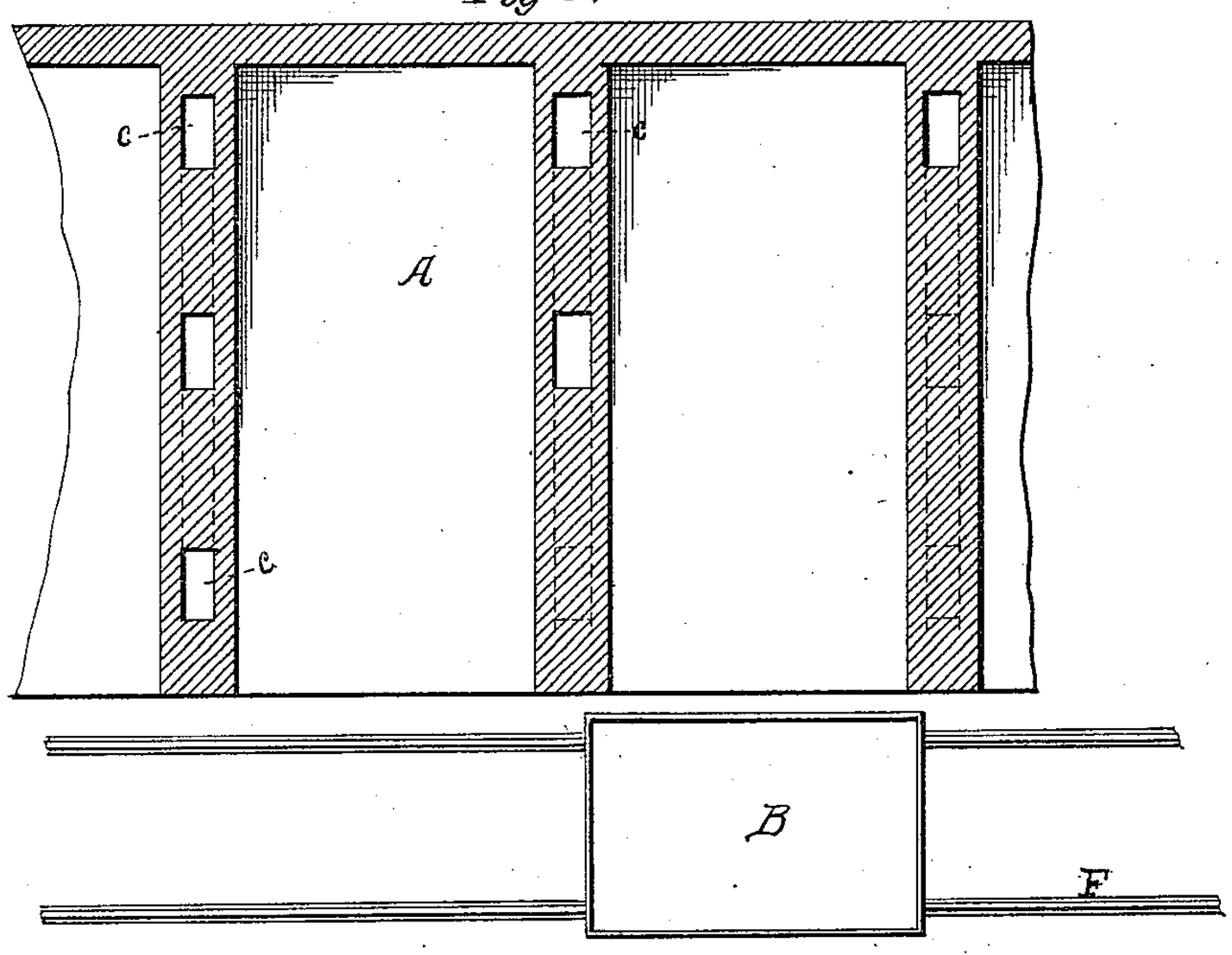


Fig 6.



Witnesses.

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UNITED STATES PATENT OFFICE.

JOHN F. BENNETT, OF PITTSBURG, PENNSYLVANIA.

APPARATUS FOR THE MANUFACTURE OF BITUMINOUS-COAL COKE.

SPECIFICATION forming part of Letters Patent No. 282,604, dated August 7, 1883.

Application filed January 15, 1883. (No model.)

To all whom it may concern:

Be it known that I, JOHN FRANCIS BENNETT, a citizen of the United States, residing at Pittsburg, in the county of Allegheny and State of Pennsylvania, have invented certain new and useful improvements in apparatus for the manufacture of bituminous-coal coke, and for rapidly cooling said coke without causing it to lose strength or increase weight; and I do hereby declare that the following is a full, clear, and exact description of the invention, which will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to apparatus for the manufacture of bituminous-coal coke, in which furnaces are provided for eliminating and flues for conducting off those gases of the coal whose absence is necessary to the formation of coke; and the objects of my improvements are, first, to utilize the fuel to approximate its entire heating capacity; second, to obtain a coke of porous structure, and yet of sufficient strength to withstand the pressure it is subjected to in blast-furnaces; third, to expel the largest proportion of sulphur without affecting deleteriously the strength of the coke due to the presence of other gases; fourth, to obtain a maximum yield of coke from a given quantity of coal, and hence a minimum of ash therein; and, fifth, to cool the newly-made coke rapidly without adding to its weight materially or decreasing the temperature of the ovens. I attain these objects by the means illustrated in the accompanying drawings, in which—

Figure 1 represents an elevation, partly in section, of the plant used in the operation of my invention. Fig. 2 is a plan view of the same, showing the hood partially broken and in section. Fig. 3 is a cross-section of the oven illustrated in Fig. 5. Fig. 4 is an elevation of the oven shown in Fig. 5. Fig. 5 is a longitudinal section of the coking-ovens I employ; and Fig. 6 is a plan view of the furnace, illustrating the construction of the flues.

Similar letters refer to corresponding parts throughout the several views.

A represents the furnace, having ovens *a a a*, whose sides have flues *b b b*, which transmit the products of combustion by means of flues *c c c* to the main flues *d d d*, which conduct them through flue *d'* under the boilers D, and thence either directly to the shaft G through flue *d''*, or to the gas-holder F by opening a valve, J, and operating a fan, I, whereby a suction toward the rear end is produced greater than the natural suction toward the forward end caused by the chimney G. When the gases have deposited in the gas-holder any valuable substances suspended in them and been relieved of excess of temperature, they are conducted over the hot coke in the hood by pipe F' to cool the coke, and thence discharged to the atmosphere.

B represents wagons running on rails B', which convey the newly-made coke from the furnace A to the hood C, where it is cooled.

C is the house or hood, capable of hermetic closure. It is connected with the boilers D by pipes E D' and with the gas-holder F by pipe F'.

G represents the chimney discharging the products of combustion received from flue *d''*.

H H H are dampers regulating the egress of gases from the ovens *a a a* to the flues *c c c*.

I represents a suitable fan-blower to induce a current of the waste gases into the gas-holder F.

J is a valve in the flue *d''*, controlling passage of the gases to the gas-holder F.

The ovens *a a a* of the furnace A, whose roofs are flat-arched to utilize the entire heating capacity of the fuel, are filled by spreading small coal, or, preferably, pulverized, washed, and dried coal therein, to a depth about ten inches, in such a manner that it shall lay evenly on the floor except next to the wall, where its depth is slightly less than the average, by which binding due to swelling is obviated. I deem this method of spreading essential to the successful coking operation.

Having charged the ovens, I begin the operation by igniting wood and coal placed therein, allowing free draft of air. The flat roof materially assists at this juncture the elimination and distillation of the volatile gases by radiating the intense heat generated over the entire bed of coal, which diffusion of heat causes a material acceleration of the operation, which I deem necessary to obtain a coke of the desired structure and quality. When the coke

reaches the maximum temperature it should be subjected to, the air access is cut off, and the heat already present allowed to continue the elimination of the gases. When this has been accomplished, I close the dampers H H H, open the doors *e e e*, and draw the coke immediately into the wagon B, and, rapidly rolling it on the track B′ into the hood C, I roll in front of the emptied oven a wagon having an adjustable horizontal platform thereon, from which the coal may be fed thereto. As rapidity of execution is essential both to prevent the ovens from cooling and the newly-made coke from burning by exposure to the atmosphere, as many men as can advantageously work together should be employed. When the oven is refilled, I repeat the operation by closing the doors *e* and opening air-apertures and the damper H. After some practice the workmen will be able accurately to judge the critical moment of withdrawal, which occurs when all the gases have been eliminated consistently with the necessity for retaining inherent strength in order to withstand pressure in the blast-furnace. So long as the requisite of strength is attained, it is not so material that all the volatile substances shall have been expelled, inasmuch as the entire elimination of these is at the expense of a considerable consumption of carbon, which causes a larger amount of ash (silica) and sulphur in the coke—two substances difficult to get rid of in the blast-furnace—while unconsumed volatile matter simply means loss of heat to the descending stock in the furnace, being absorbed by the distilling volatile matter in the upper part of the furnace. This loss, however, is partially or wholly compensated for by the richer quality of the gases evolved, which serve for heating the boilers and the ovens, and the air blown into the blast-furnace is consequently of higher temperature.

It is found that a very porous fuel is preferable for smelting ores in a blast-furnace, which I believe to be in consequence of the increased surface presented to the air with which it combines. For example, it has been found that in a compound of seventy-two grains of saltpeter, with twelve grains of carbon from hemp-stalks, combustion is attained in ten seconds; with twelve grains of carbon from pine wood in seventeen seconds; with twelve grains of carbon from coke in fifty seconds. It is desirable, then, that coke should be made as porous as possible for use in blast-furnaces. The coke now made from bituminous coals of Pennsylvania in open pits is of the greatest porosity and most free from sulphur; but these advantages are neutralized by a smaller yield of coke from a given quantity of coal and a larger proportion of ash therein. A greater yield of coke with a smaller proportion of ash is obtained by means of the Belgian ovens; but these advantages are offset by the greater density thereof and the retention therein of more sulphur, and the excess of moisture which inevitably follows the mode of cooling the newly-made coke employed. The coke obtained from the beehive ovens is the best now obtainable for use in blast-furnaces, and its desirability is gaged by its porosity, that having been in the oven about twenty-four hours being preferred, and its desirability lessened in proportion as the length of stay in the oven is prolonged. In the beehive oven the average loss of carbon is about thirteen per cent. and the increase of silica or ash proportional. The amount of sulphur eliminated in either the Belgian or the beehive oven rarely exceeds five per cent., whereas in open-pit coking as much as fifty per cent. is expelled. It is desirable, then, that the coke should have such a composition and be so manipulated that it shall, consistently with the requisites of porosity and strength, have a minimum quantity of sulphur and silica (ash) from a given amount of coal.

I now proceed to describe the final operation in the coking process, which consists in so cooling the newly-made hot coke that there will neither be a decrease in the temperature of the coking-oven nor an increase in the weight of the coke.

Heretofore coke has been cooled by sprinkling water on it, either while in the oven or just subsequent to withdrawal therefrom, or both. The objection to this method is that a greater quantity of water than necessary is applied, the efficiency of the coke being lessened by the excess remaining therein. The loss is of a twofold nature, in that, first, the water, materially increasing the weight of the coke, causes corresponding augmentation in freight-charges; second, the water, absorbing heat in vaporizing, lessens the heat of the descending stock in the furnace and diminishes the value of the escaping gases as heating factors to the ovens; and, finally, because that portion of the water which is hygroscopically suspended in the coke does not vaporize until it enters the zone of fusion, where any reduction in temperature causes a serious deficiency in the quantity of metal smelted. Coke has been known to attract as much as thirty per cent. of its own weight of water from the air in damp weather, and retains water hygroscopically with such tenacity that combustion only will release it. Coke drawn at a white heat from the bottom of a blast-furnace has been found to contain five per cent. of water. It has hitherto been the practice to allow the coke to remain in the oven for a short period after coking to cool before withdrawal; but this is objectionable as involving, first, a decrease in the temperature of the oven, and, second, an unnecessary loss of time.

In my invention, as before explained, a wagon, B, is provided to convey the newly-made coke at the precise juncture from the oven *a* to the hood C, which is then closed, with the exception of the apertures at the top and bottom, respectively, for the inlet and exit of the steam and the waste gases received through pipe F′ from the gas-holder F. Steam

from the boilers D, through pipes E D′, is admitted to impart a cooling saturation to the coke, yet not to such extent as to become open to the same objection, which is tenable against the use of water. The steam and cold gases may enter at the bottom and discharge at the top, or vice versa, until the coke is so cooled that it will not burn upon exposure to the air, after which I withdraw the wagon from the hood and the coke is ready for use. I prefer cooling the hot coke by steam alone (inasmuch as the passage of steam through it removes a little of any sulphur contained therein) in the early part of the cooling operation, and later the charging of incombustible gases alone, the purpose being to prevent any absorption of moisture by the coke. It will be sufficiently cooled when reduced to a temperature of 700° Fahrenheit.

I now point out more specifically the desirable portions of the ovens *a a a*.

The ovens may be two or more stories high, generally three, as shown on the drawings, and of any suitable length and width; but I find it preferable to construct it twelve feet long, six feet wide, and eighteen inches high. Each oven is level at top and bottom, the top forming what may be termed a "flat" arch. Each oven or chamber has openings *b b b* along its sides, near the roof, to allow the products of combustion access to the flues *c c c*, which are between the walls of the ovens, and which lead to the main flues *d d d* underneath the ovens, extending perpendicularly to the length of the ovens under the entire series. Thence they are conducted under the boiler D by flue *d′*, whence, after having given up their heat to the boilers, they are drawn through the flue *d″*, either into the shaft by its natural draft, or into the gas-holder F by fan I, the valve J having previously been opened. Each oven or chamber has a damper, H, in the side flue, *c*, to cut the main flue *d* off from the chamber while it is being discharged and refilled.

Having thus fully described my invention, what I claim as new, and desire to secure by Letters Patent of the United States, is—

1. A furnace, A, having flat-arched-roof ovens *a a a*, passages *b b b*, flues *c c c d d d d′*, the flues *d d d* running crosswise the entire length of all the ovens employed, in combination with boilers D, pipes E D′, and hood C, substantially as described.

2. A furnace, A, having flat-arched-roof ovens *a a a*, passages *b b b*, flues *c c c d d d d′*, the flues *d d d* running crosswise the entire length of all the ovens employed, in combination with boilers D, pipes E D′, hood C, flue d^2, fan I, valve J, gas-holder F, and pipe F′, substantially as specified.

3. A furnace, A, having flat-arched-roof ovens *a a a*, passages *b b b*, flues *c c c d d d d′*, in combination with boilers D, flue d^2, shaft G, fan I, valve J, gas-holder F, pipe F′, pipes E D′, hood C, cars B, and track B′, for the purpose herein fully set forth.

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Witnesses:
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