No. 753,296. PATENTED MAR. 1, 1904.

P. NAEF.

# APPARATUS FOR MAKING GAS.

APPLICATION FILED MAY 14, 1900.

NO MODEL.

FIG. 1.

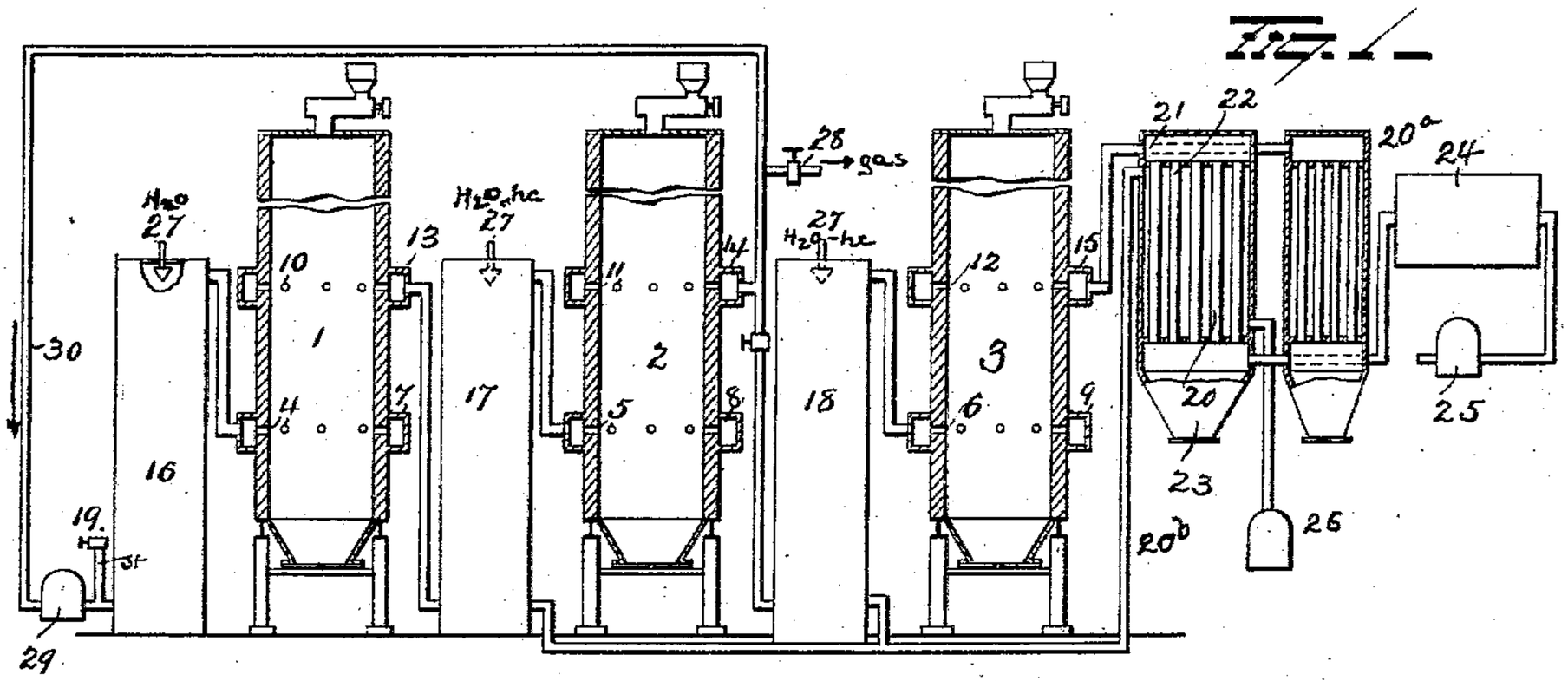



FIG. 2.

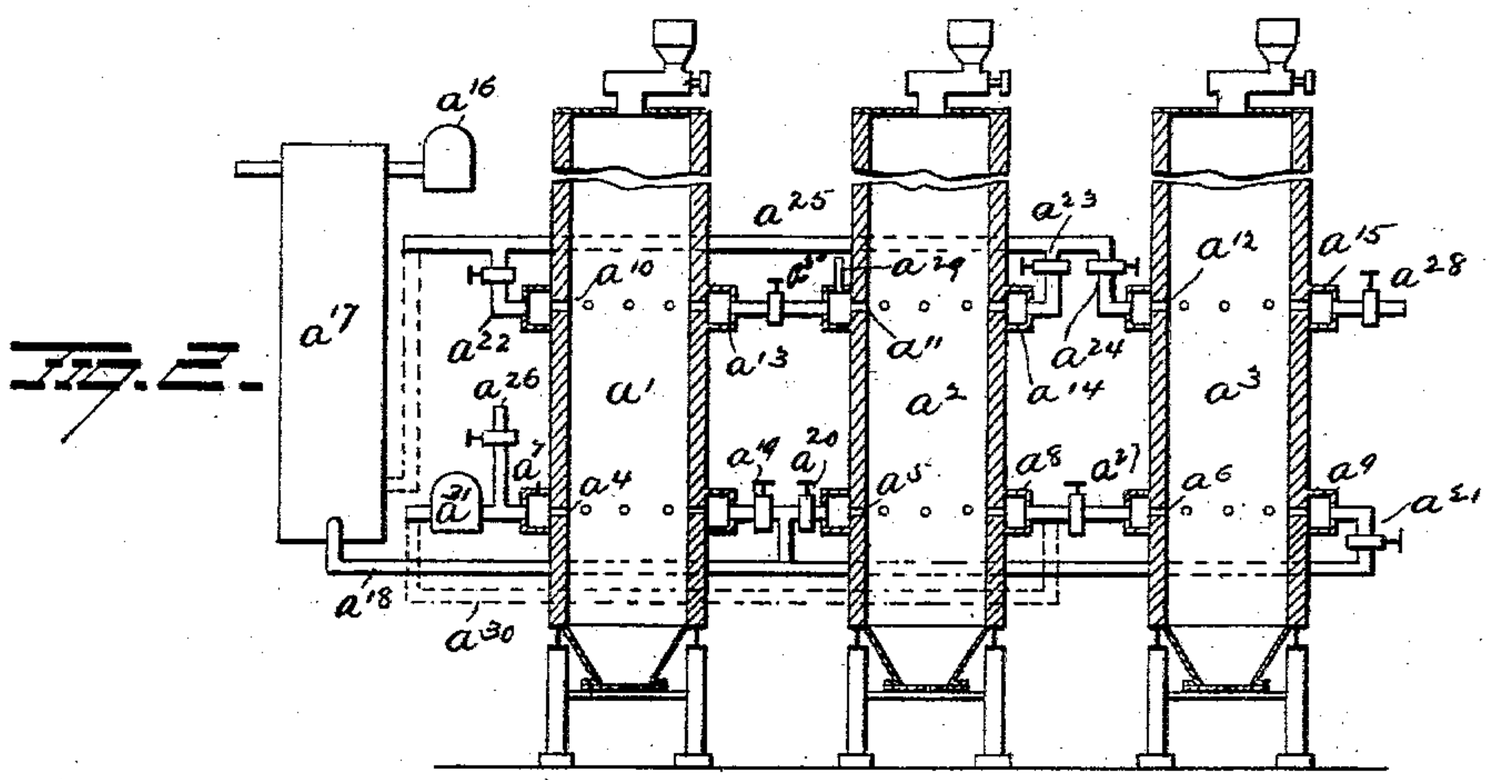
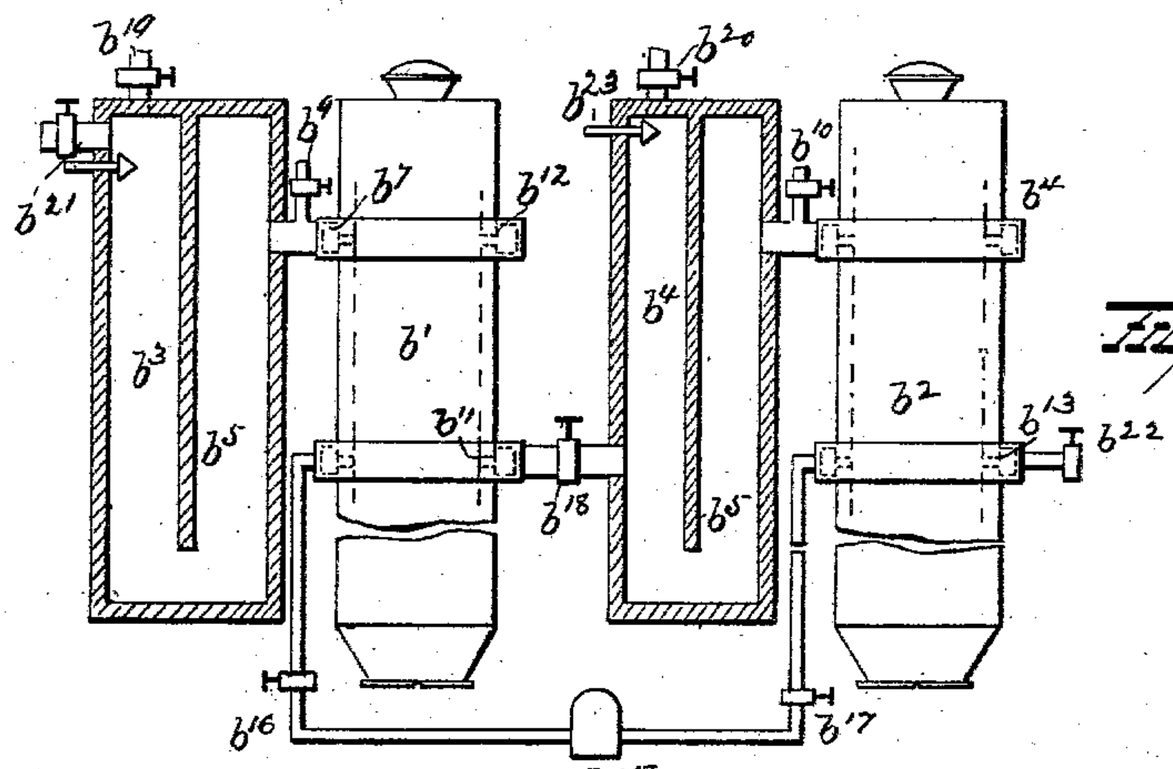



FIG. 3.




WITNESSES

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# UNITED STATES PATENT OFFICE.

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## APPARATUS FOR MAKING GAS.

SPECIFICATION forming part of Letters Patent No. 753,296, dated March 1, 1904.

Application filed May 14, 1900. Serial No. 16,668. (No model.)

*To all whom it may concern:*

Be it known that I, PAUL NAEF, of New York, in the county of New York and State of New York, have invented certain new and useful Improvements in Apparatus for Making Gas; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

The invention refers to apparatus for treating materials with gas, especially applicable in the manufacture of gas. Objects of the invention are to increase the capacity of such apparatus, to reduce the cost of operation and repair.

Figure 1 shows an apparatus consisting of three shafts 1 2 3, having suitable means for charging material on the top and withdrawing material at the bottom. Some distance from the bottom each shaft has ducts 4 5 6, communicating with an annular channel 7 8 9. A considerable distance from the top each shaft has ducts 10 11 12, communicating with an annular channel 13 14 15. Heaters 16 17 18 communicate with the annular channels of the generators, which are so constructed that gaseous fluid passing through them is heated to very high temperature. They may be continuous or discontinuous, as the well-known Cowper stoves. In the latter case two heaters are used alternately to get a continuous flow of hot gas. As the operation of such heaters is well known, they are only shown in outline. They are disconnected during the heating period by means of suitable valves in well-known manner and heated by the combustion of gas. When the heaters have been raised to a sufficiently high temperature, the supply of combustion-gas is discontinued and the heater is connected to the gas-making plant. If gas is to be produced, the shafts are filled with fuel. The fuel may be heated by introducing air forced through the heater 16 by means of a fan 29, which burns a small amount of fuel. The gas evolved during this starting period may pass from generator 1 through generators 2 and 3 and the corresponding heaters and escape where later on the water-gas leaves the apparatus. Afterward steam is conducted through pipe 19 into heater 16 and is there raised to a temperature above that necessary to carry out the reaction $C+H_2O=H_2+CO$. It enters generator 1 through ducts 4 and acts on the fuel, which, as before stated, has been heated by hot air. A hot mixture of steam and water-gas leaves through the ducts 10, is reheated in heater 17, and acts afterward again on the fuel in the generator 2, which it enters through the ducts 5. A mixture of gas containing less steam leaves generator 2 through the ducts 11. It is heated by passing through heater 18, and the rest of the steam is here decomposed, and dry gas leaves this last generator. In each of the heaters 16 17 18 the gaseous fluid is heated to a higher temperature than is required for the reaction. In each of the generators 1 2 3 steam is therefore decomposed and converted into water-gas. The result is that the fuel is consumed in the generators and dry water-gas leaves continuously the generator 3. It passes from it through a cooler 20, which consists of a system of pipes incased in a cylinder. The gas from generator 3 passes into the space 21 above the pipe system and passes through the pipes 22 into the lower conical space 23, from which it is conducted to a washer 24 and exhaust 25. The conical port 23 of the cooler has means for withdrawing dust. Through the chamber surrounding the pipes 22 air from the blower 26 is conducted, which is conducted to the heaters by a pipe $20^b$ and afterward used for heating the heaters 16 17 18 by combustion of gas. A second cooler $20^a$ may be provided between the cooler 20 and the washer 24. Usually I employ two coolers 20. Through the second of these coolers I conduct the gas used for heating the heaters 16 17 18, if the latter is supplied at ordinary temperature. The gas enters washer 24 at low temperature, and ammonia and tar are recovered from the same. The fuel can be fed continuously through the generators 1, 2, and 3, or the charging can take place intermittingly.

To avoid the use of steam, sprays 27 are arranged for the purpose of spraying liquid water into the heaters 16 17 18. If illuminating-gas is to be produced, water is sprayed into the first heater to produce the steam nec-

essary for the process and oil is sprayed into heater 18 or both into heaters 17 and 18. During the passage through heater and generator the oil is converted into permanent gas. Instead of spraying oil into the heaters it can be sprayed into the generators.

The apparatus offers great facility for the use of bituminous fuel, which can be used in several ways to produce the best effect under given conditions.

All the bituminous fuel can be charged into generator 1 or generator 2 or both 1 and 2. If, for instance, all the fresh fuel is charged in generator 1 and the heating fluid passed through it, distillation will take place in that generator. The coke withdrawn from the bottom of the same generator is then charged into generators 2 and 3 by a suitable conveyer. The hydrocarbon vapors developed from generator 1 are converted into permanent gas in generators 2 and 3 and the heaters 17 and 18. Sufficient oil is then added in the last set of heaters and generators to produce sufficient illuminating power.

If by-products are of great value, the distillation of all the fuel is effected in generator 3, and the material, consisting mostly of coked fuel, leaving the same is charged into generators 1 and 2. It is then preferred to pass only so much gas into heater 18 as is required to distil the volatile matter and to produce ammonia from the nitrogenous constituents of the coal. A large amount of tar oils are obtained, and only a small volume of gas has to be subjected to the recovery of ammonia. No oil is then used in heater 18. If illuminating-gas is required, oil is introduced into heater 17, and the gas from generators 1 and 2 is conducted off for use from generator 2 through pipe 28.

For the purpose of increasing the capacity of the plant it is of great advantage to have in part of the same a heated mixture of water-gas and steam circulating at considerable velocity. The amount of heat transferred from heater to generator is thus increased. To effect this, I conduct some of the gas leaving the second generator 2 back to a blower 29 by means of a pipe 30 and conduct it into heater 16 after adding steam through pipe 19. There is thus a circuit of a mixture of gas and steam maintained in the first generators, and a rapid circulation takes place, with a large production of water-gas. The excess leaving the second generator is conducted through the last generator 3, where the gas is completely freed from steam and from which it passes on to the cooler and washer. In this case no gas is withdrawn through pipe 28.

The apparatus shown in Fig. 2 consists of several shafts $a'$ $a^2$ $a^3$, with ducts $a^4$ $a^5$ $a^6$ and annular channels $a^7$ $a^8$ $a^9$ communicating with the same. Above these channels are ducts $a^{10}$, $a^{11}$, and $a^{12}$ and channels $a^{13}$ $a^{14}$ $a^{15}$. The shafts have means to charge fuel and to withdraw material at the bottom. Each shaft is further fitted with means for alternately injecting air into it and afterward conducting steam or a mixture of the same with gas through it. A blower $a^{16}$ conducts air through the heater $a^{17}$ to a general main $a^{18}$. From the latter hot air can be conducted into $a'$ through pipe and valve $a^{19}$, into $a^2$ through pipe and valve $a^{20}$, and through $a^3$ through $a^{21}$. The gas produced by the injection of air passes from $a'$ through $a^{22}$ $a^{23}$ $a^{24}$ into a general main $a^{25}$, which conducts to the heater $a^{17}$, where most of the gas is burned. Another part of this gas passes into a heater and is burned for the purpose of heating the air with which the producer-gas is burned in heater $a^{17}$. The latter can be of any suitable construction and is usually operated on the principle of the hot-air stoves or blast-furnaces. After the shafts are filled with fuel air is injected, by means of blower $a^{16}$, through heater $a^{17}$ into each generator. As the air is heated to high temperature, the fuel is heated to very high temperature by combustion. The gas passes off through the main $a^{25}$ and is burned in heaters, which are alternately used with $a^{17}$. After a sufficient temperature is reached all the valves communicating with mains $a^{18}$ and $a^{25}$ are shut off. Steam is injected through $a^{26}$, passes through $a'$. A mixture of steam and gas leaves said shaft through $a^{10}$ and $a^{13}$, passes through $a^{30}$ into generator $a^2$, where renewed action takes place. From the latter it passes into $a^3$ through $a^{27}$, where the last remainder of the steam is decomposed. Dry gas leaves at $a^{28}$. It is cooled and ammonia recovered from the same as described in Fig. 1. After the gas leaving at $a^{28}$ contains too much steam, the latter is shut off, the air-valves are opened, and the generators are heated up again.

If illuminating-gas is to be produced, oil is sprayed into the annular channels through sprays $a^{29}$, generator $a^2$, and is fixed during the passage through the coal in the shaft.

For the purpose of increasing the capacity the method of rapidly circulating a mixture of steam and gas is with advantage employed.

Gas is returned from the second generator $a^2$ to $a'$ through pipe $a^{30}$ by fan $a^{31}$, steam being added through $a^{26}$. The gas produced by the circulation passes through $a^{27}$ into generator $a^3$, where it is deprived of its moisture.

The apparatus offers great facility for the use of bituminous fuel. Such fuel can be fed into each of the generators. Most of the volatile matter is thus converted into permanent gas. A perfect decomposition of all liquid hydrocarbons is obtained by feeding all the fuel consumed into $a'$ and charging the coke from the same into $a^2$ and $a^3$ in a similar way as described with Fig. 1.

For the purpose of avoiding the decomposition of ammonia and hydrocarbons the following mode of operation is of advantage. All the coal is charged into $a^2$ and the coke with-

drawn from the same into $a'$ and $a^3$. The latter $a'$ and $a^3$ are heated up by air, as described, but no air is conducted into $a^2$. During the gas-making period the hot gas from $a'$ distils the fuel in $a^2$ and a permanent gas is produced in $a^3$, where also some oil may be introduced. In cases where only water-gas is required and oils are valuable all the fuel is charged into $a^3$. The process is then so conducted that the gas leaving $a'$ does not contain very much excess of steam, and consequently a reheating of the gas takes place in $a^2$ sufficient to effect the distillation in $a^3$.

The apparatus Fig. 3 consists of several generators $b'$ and $b^2$. In direct communication with each generator is a gas-heater $b^3$ $b^6$. The heaters consist of properly-lined chambers and have a division-wall $b^5$, forcing the gas to go downward in one part and upward in the other. The heaters communicate with the annular channels $b^7$ $b^8$ and have near that point valved inlets $b^9$ $b^{10}$ for air, which may be in communication with a blower. (Not shown.) Each shaft $b'$ and $b^2$ has two rows of ducts and corresponding annular channels $b^{11}$ $b^{12}$ and $b^{13}$ $b^{14}$. Both lower channels are in connection with a blower $b^{15}$ by pipes $b^{16}$ and $b^{17}$. Generator $b'$ has, further, a valved connection $b^{18}$ with heater $b^4$. The operation is as follows: Air is blown into the shafts $b'$ and $b^2$ by means of fan $b^{15}$ and pipes $b^{16}$ and $b^{17}$. The gases produced and leaving are burned by introducing air at $b^9$ and $b^{10}$. The gas of combustion from $b'$ goes downward and afterward upward in heater $b^3$ and leaves through valved pipe $b^{19}$. The combustion-gas from $b^2$ passes through heater $b^4$ and leaves through the valved pipe $b^{20}$. Valve $b^{18}$ is closed during the heating period. After $b'$ and $b^2$ are sufficiently heated the air-valves $b^{16}$ $b^{17}$ $b^{18}$, also valve $b^{19}$ and $b^{20}$ $b^9$ $b^{10}$, are closed. Steam or a mixture of steam and gas is introduced through $b^{21}$, passes through heater $b^3$ through generator $b'$, where part of the steam is decomposed. The mixture so produced leaves $b'$ through $b^{18}$, which is now opened, is superheated in $b^4$, and the rest of the steam is decomposed, the gas leaving through the valved pipes $b^{22}$. As a large amount of heat is stored in $b^3$ and $b^4$, long gas runs can be made. The water-gas leaving at $b^{22}$ is conducted through suitable apparatus for the recovery of ammonia. For the production of illuminating-gas oil is sprayed into $b^4$ through $b^{23}$.

Having described the nature of my invention, what I claim is—

1. The combination of several generators, means to pass fuel into and through each generator, means for heating a gaseous fluid and means to pass the heated gaseous fluid at suitable temperature through each of the generators successively.

2. The combination of several generators, means to pass gaseous fluid successively through the generators, means to pass bituminous fuel into the generators, through which the gaseous fluid passes first and means for heating the gaseous fluid before it enters each generator.

3. The combination with three generators, of means to pass gaseous fluid through them, means to charge coke into the generators at each end of the series and means to charge bituminous fuel into the intermediary generator and means for heating the gaseous fluid before it enters each generator.

4. The combination of several generators, means to produce a circulation of gaseous fluid through some of them in such a manner that the same fluid circulates repeatedly and means to pass gas through the last generator of the series once.

5. The combination of several generators, means for alternately injecting air into each generator and means for passing at intermediate periods steam into one generator and the gases thus produced successively through the other generators.

6. The combination of several generators, means for alternately conducting air into one generator and the gases produced successively through the other generators, means for adding air at the entrance into each generator and means for afterward conducting at intermediate periods gaseous fluid through the generators preferably from the other end of the series.

7. The combination of several generators, two systems of ducts and annular channels on each, both of said systems of ducts and annular channels being located a considerable distance from both ends of the generators, an air connection to each of the lower channels, a gas-outlet from each of the upper channels, means for successively passing gaseous fluid through the generators after shutting off the air connections.

8. The combination of several generators, means for heating the same, means for introducing at intermediate periods aqueous fluid into some of the generators and means for passing the gases produced successively through the other generators.

9. The combination of several generators, means for heating the same, means for afterward introducing aqueous fluid and oil into some of the generators and simultaneously conducting gaseous fluid through all the generators successively.

10. The combination of several generators, means for heating the first generators of the series, means for afterward conducting gaseous fluid successively through the whole series, means for passing bituminous fuel through the last generator and means for withdrawing coke from the same.

11. The combination of several generators, means for heating them, means for circulat-

ing afterward a mixture of gas and steam through part of the series in such a way that the same gas passes several times, means for conducting the gas through the last generator of the series.

12. The combination of several generators, means for heating them, means for successively passing gaseous fluid through part of the series, a pipe and a fan to return gas to the first generator of the series and means to conduct gas through the last generator.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

PAUL NAEF.

Witnesses:
A. W. BRIGHT,
GEO. F. DOWNING.