No. 676,245. Patented June 11, 1901.

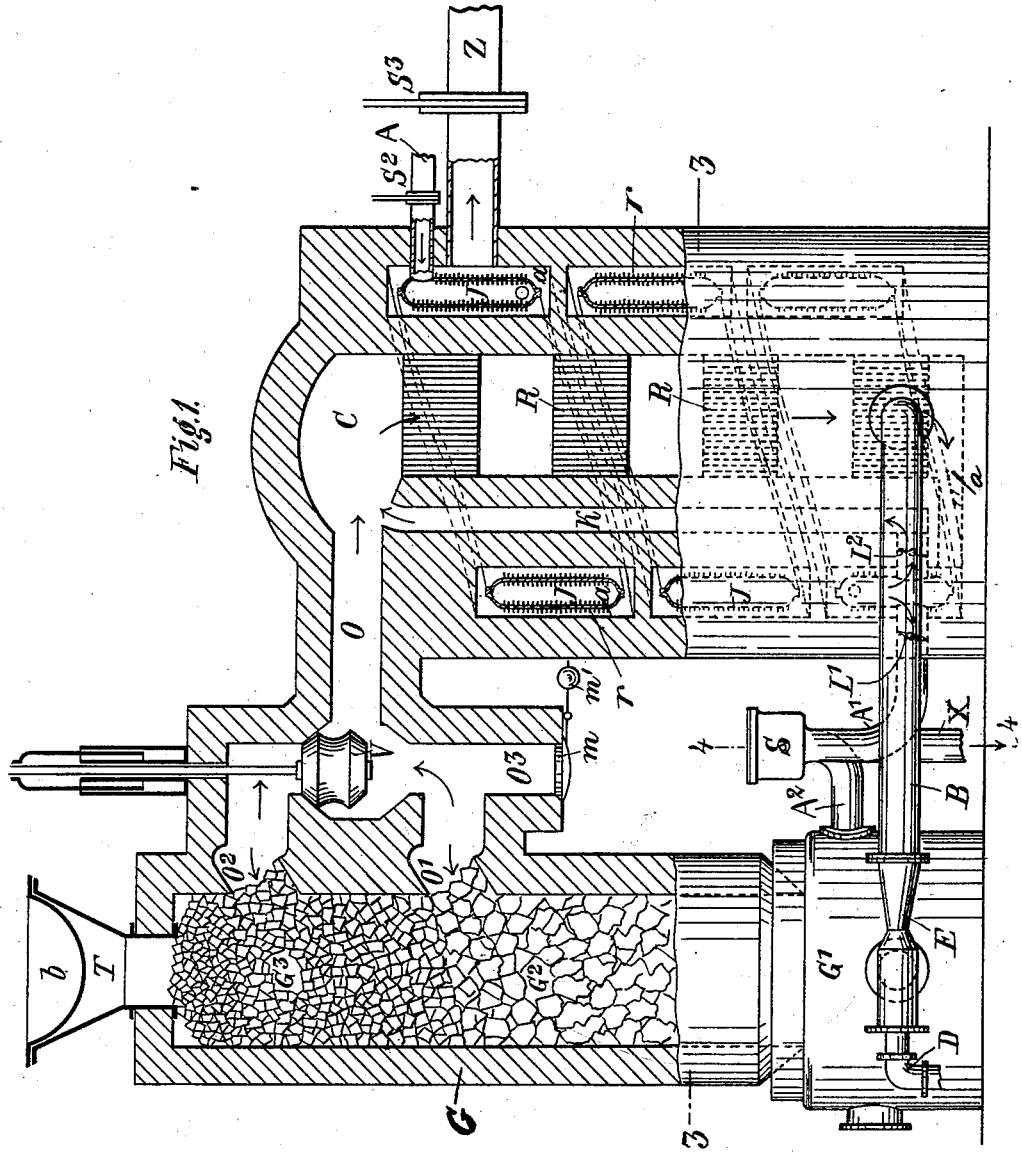
H. STRACHE.

APPARATUS FOR MAKING WATER GAS.

(Application filed Feb. 19, 1896.)

(No Model.) 3 Sheets—Sheet 1.

Fig. 1.



Witnesses:
John A. Paulson
Clifford E. Dunn.

Hugo Strache, Inventor

By Henry Schreiter his Attorney

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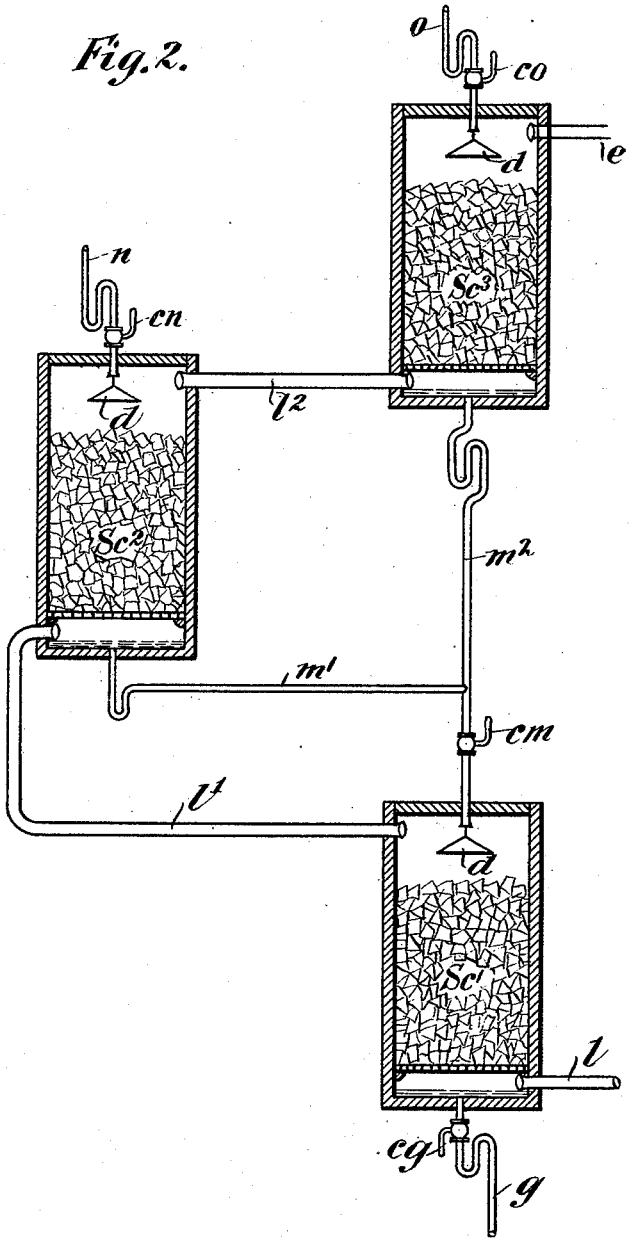
(No Model.) 3 Sheets—Sheet 2.

Fig. 2.



Witnesses
John P. Noidstrom
Richard A. Elliott.

Hugo Strache, Inventor
By his Attorney Henry Schreiter

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3 Sheets—Sheet 3.

Fig. 3.

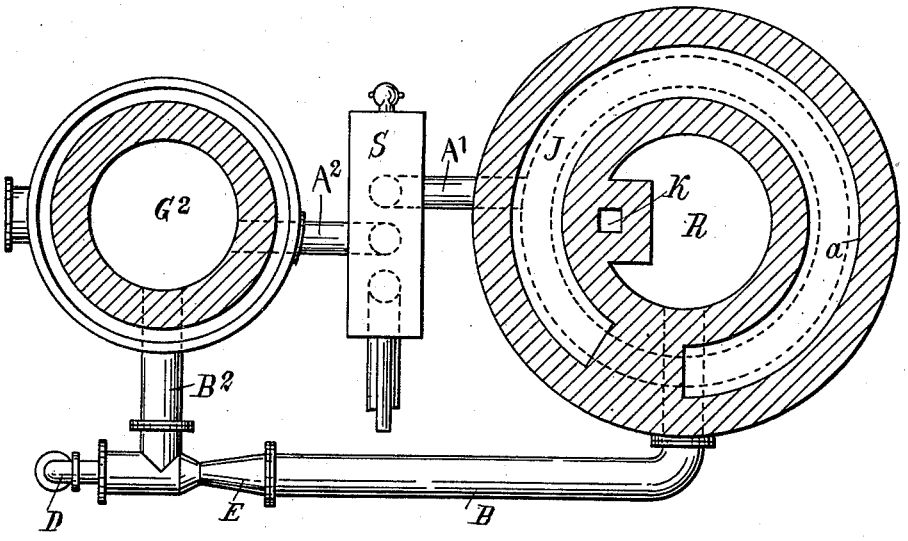


Fig. 4.

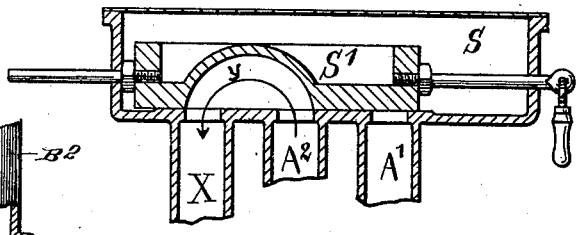
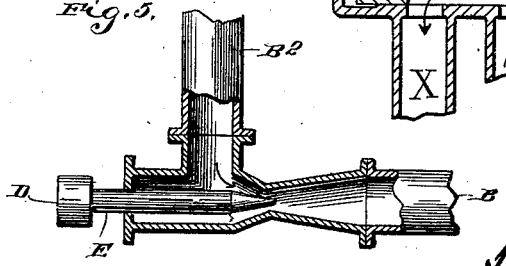


Fig. 5.



Witnesses:
John A. Paulson
Clifford E. Dunn

Hugo Strache Inventor

By Henry Schreiter his Attorney

UNITED STATES PATENT OFFICE.

HUGO STRACHE, OF VIENNA, AUSTRIA-HUNGARY, ASSIGNOR TO THE SOCIÉTÉ INTERNATIONALE DU GAZ D'EAU BREVETS STRACHE SOCIÉTÉ ANONYME, OF SAME PLACE.

APPARATUS FOR MAKING WATER-GAS.

SPECIFICATION forming part of Letters Patent No. 676,245, dated June 11, 1901.

Application filed February 19, 1896. Serial No. 579,954. (No model.)

To all whom it may concern:

Be it known that I, HUGO STRACHE, Ph. D., of Vienna, Province of Lower Austria, in the Empire of Austria-Hungary, have invented certain new and useful Improvements in Apparatus for the Manufacture of Water-Gas, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, wherein—

Figure 1 is a vertical section, partly in elevation, of the apparatus for generating water-gas. Fig. 2 is a diagram of the arrangement and connection of scrubbers used in connection with the gas-generating apparatus. Fig. 3 is a horizontal view on line 3 3 indicated in Fig. 1, and Fig. 4 is a vertical sectional view on line 4 4 indicated in the same figure. Fig. 5 is a sectional partly plan view showing steam-injector in position in the inlet-tube.

Similar letters of reference indicate corresponding parts in all views of the drawings.

My invention relates to the manufacture of illuminating and fuel gas; and it consists of the herein-described apparatus for the manufacture of water-gas of fresh anthracite or bituminous coal, coke, or other carbonaceous substances.

The apparatus for generating water-gas is illustrated in sectional view in Fig. 1.

There are two complete circuits provided through the entire generating apparatus, one from the inlet of the air-blast pipe A through inner flue J, pipes A′, switch-slide S′, pipe A^2, oven G, flues O′ and O, combustion-chamber C, regenerator R, and from there through flue *a* into main flue Z, leading into chimney, and the other from the steam-inlet of pipe B through generator R, combustion-chamber C, flues O and O^2, oven G, pipe A^2, switch-slide S′, and discharge-pipe X into the purifying apparatus. Channel K is a branch of the first circuit conveying during the period of hot-blowing heated blast-air into the combustion-chamber C, whereas pipe B^2 is a branch of the second circuit connecting with pipe B, conveying the gases generated in the oven into the regenerator R during the period of gas-making. Flues J are provided with projecting ribs *r* to increase their contact (heating) surfaces. These ribs absorb and accumulate the heat of the gases passing through the flue *a* and give up this heat to the draft-air blown through them. Besides heating the air the heat accumulated in the walls of flue J helps also to maintain the required high temperature in the regenerator R during the period of producing gas.

Slides or dampers L′ and L^2 divide the blast-air and regulate its flow within the apparatus. Damper L′ governs its flow into the oven, and damper L^2 governs its flow into the combustion-chamber C through channel K. Switch-slide S′ (shown in Fig. 4 in sectional view) is housed in box S, into which pipes A′, A^2, and X open. The apertures of these pipes are in line and equidistantly from each other, and in slide S′ is provided a chamber *y*, which is dimensioned to encompass two of the apertures in any position of the slide. Thus pipe A^2 is always open and by shifting slide S′ is brought in communication either with pipe A′ or with pipe X, the other pipe being at the same time closed.

Slides S^2 and S^3 (S^2 closing air-blast A and S^3 closing the main flue Z, leading to the chimney) shut off the circulation of air through the apparatus during the period of distillation. Double-acting valve V governs the flow of the gases through flues O, O′, and O^2. During the period of "hot-blowing" it closes flue O^2 and during the period of gas-making it closes flue O′. By manipulating slides S′, S^2, and S^3 and double-acting valve V correspondingly the operation in the apparatus is changed. Valve *m* closes passage O^3. It is hinged to the outlet and held in closed position by the weight *m*′, which is sufficient to press the valve tightly in the outlet, but does not prevent the opening of the valve and the escaping of the gases from the oven when exceeding a predetermined limit of pressure.

The purifying apparatus consists of a battery of closed vessels. The first of these is similar to those commonly used for washing coal-gas and known under the name "scrubber." It is, however, filled with sulfuric acid in place of water. When the generated water-gas is passed through this vessel, all iron

carbonyl is eliminated therefrom. Iron carbonyl is a gas discovered by Mond and Scrudder and so named by them. It is developed from the pyrites or other compounds of iron contained in the material from which the gas is produced. Connecting with the outlet-pipe of this scrubber and some distance therefrom is arranged the apparatus shown diagrammatically in Fig. 2 of the drawings. This apparatus comprises three closed vessels Sc′, Sc², and Sc³, arranged successively one above the other. These vessels are made of acid-proof material and are provided with double bottoms, the inner raised bottom being perforated. Vessel Sc² is connected by pipe *n* to a tank containing concentrated nitric acid, and vessel Sc³ is connected by pipe *o* to a water-tank. Vessels Sc′ and Sc² are connected by gas-conduits *l′* and vessels Sc² and Sc³ by gas-conduits *l²* in such manner that always the upper end of the preceding connects with the lower end of the next following vessel. Vessels Sc² and Sc³ are connected by conduit-pipes *m′* and *m²* to the top of vessel Sc′, in whose bottom is set the outlet-pipe *g*. Pipes *m′* and *m²* convey the liquids accumulating on the bottoms of vessels Sc² and Sc³ into vessel Sc′, where they are utilized, as will be explained hereinafter.

All liquid-conduits are provided with drips *d*, traps and cocks *cn*, *co*, *cm*, and *cg*, respectively, for regulating the flow of the liquids into and out of the vessels. About two-thirds of the space of each vessel above the perforated bottoms is filled with broken pieces of glass, burnt clay, pumice-stone, or some other acid-proof material to produce a very large contact-surface between the upwardly-flowing gas and the dripping liquids through the scrubbers.

The raw gas enters vessel Sc′ through pipe *l′* and passes successively through this vessel, conduit *l′*, vessel Sc², and conduit *l²* into vessel Sc³ and from there (purified) through pipe *e* into the odorizing apparatus.

The odorizing apparatus comprises a chamber filled with some porous material, preferably animal charcoal, pumice-stone, wood fiber, and the like, and a closed vessel connected with the chamber by an outlet-pipe provided with a stop-cock or a reduction-valve. The gas in passing through this apparatus is scented with a penetrating odor and then conducted to a reservoir, from which it is distributed for use.

The manufacture of water-gas is carried on in this improved apparatus as follows: At the beginning of the operation the oven is charged in its middle part G² with coke and in the upper part with the material (coal, coke, peat, &c.) of which the gas is to be produced, whereas its lowest part is filled with some readily-burning material, like wood, &c. Then the fire is started from underneath, valve V set in the position shown in the drawings, slides S² and S³ open, and slide S′ set to connect pipe A′ with pipe A². Then draft-air is driven in through pipe A, flue J, and pipes A′ and A² into the oven, part of it being diverted through channel K into combustion-chamber C. The air is forced through the burning coke filled in the middle part G² of the oven. The combustion-gases are driven through flue O′ into the combustion-chamber C, where they are met by a current of fresh heated air driven into the chamber through channel K. There all combustible substances contained in the combustion-gases are entirely consumed. During this period the raw material filled in the upper part of the oven, the regenerator R, and also the air-flue J are heated to a very high degree and the gases escape finally (through flue *a* and main flue Z) into the chimney. This (the period of operation called "hot-blowing") is continued until nearly all of the coke filled in the oven is burned up. Then the air-blast is shut off by slide S², slide S³ is closed, valve V is pushed down to close communication between flues O′ and O, and overheated steam is driven through the injector E into the pipe B. The suction created by the forcible injection of steam into the pipe B draws first the gases from the oven G and then the products of the distillation of the raw material filled into the upper part G³ of the oven through pipe B into the regenerator R and drives them through the combustion-chamber C and flues O and O² into the top of the oven. The raw material filled into the top of the oven is coked. The products of the distillation are drawn through the glowing coke in the middle part of the oven, are thereby chemically separated, and, absorbing the hydrogen of the injected steam, are thus transformed into water-gas, which passes from the generator through pipes A² and X into the purifying apparatus. The period of generating gas is stopped when the charge of fresh material is fully coked. The steam is then turned off, valve V moved upward to close flue O², slide S′ shifted, a fresh material is filled in the oven, slides S² and S³ withdrawn, and the fire, inflamed afresh by air, driven through pipe A, as described above.

When first charging the oven, a charge of coke is required; but every subsequent charge consists only of fresh carbonaceous material, because this material is coked during the period of generating gas, and when the coke is consumed this fresh charge drops into the middle part of the oven and serves in the next turn the same purpose as the first charge of coke. The slag, ash, and other residue of the combustion process are withdrawn from the bottom part of the oven after each period of gas-making and before the fresh material is charged.

The generated water-gas is not pure, it containing various impurities. The most detractive of these is iron carbonyl, which is combustible and would render the gas unfit for illuminating purposes, because its residue (almost pure oxid of iron) would settle on the incandescent material used in the burner and

quickly render it useless. Iron carbonyl may be eliminated by conducting the raw gas through iron pipes heated to red heat, whereby the iron carbonyl is separated into its components and the iron thus liberated is deposited on the pipes. It may also be eliminated by driving the gas through a chamber wherein it is brought into contact with some acid, preferably sulfuric acid. This latter method is preferable.

The raw water-gas contains also carbonic oxid and carbonic dioxid, their relative quantity varying, according to the material used in distillation, from thirty to forty per cent. of carbonic oxid and from two to five per cent. of carbonic dioxid. These gases are not eliminated because the carbonic oxid increases the heating capacity of the gas, and the quantity of the carbonic dioxid (from two to five per cent.) is so insignificant that its effect is not noticeable in the use of the gas.

Hydric sulfid is another impurity contained in the raw water-gas generated in my apparatus. This is eliminated in my improved apparatus illustrated diagrammatically in Fig. 2 by nitric acid in such manner that the nitric acid is more fully utilized and the necessity of using such large quantities of it as required in the processes heretofore known obviated. In my improved apparatus one quantity of nitric acid is used continuously until consumed, though the hydric sulfid is not as completely eliminated as it would be if the nitric acid were not used over again. The result, however, is fully adequate for practical use. The construction of the apparatus is based on the discovery that tetroxid of nitrogen (N_2O_4) dissolves in water, forming nitric acid (HNO_3) and nitrous acid (HNO_2,) and further upon the fact that the nitrous acid when in an aqueous solution separates easily into nitric acid and nitric oxid, and finally that nitric acid when in diluted solution precipitates sulfur from hydric sulfid, forming nitrous acid.

The raw gas containing hydric sulfid passes through pipe *l* into vessel Sc′, wherein it meets an aqueous solution composed of sulfuric, nitrous, and nitric acids, the sulfuric acid resulting from the oxidation of hydric sulfid contained in the gas and the nitrous acid from the reduction of nitric acid. The nitrous acid separates here into nitric acid and nitric oxid, the latter passing, with the gas, into vessels Sc^2 and Sc^3. Thus the main component of what is retained in vessel Sc′ is nitric acid and besides this sulfuric acid, and there may remain, also, a small percentage of nitrous acid.

The nitric acid eliminates from the gas the greatest part af the hydric sulfid, separating it by precipitating the sulfur. The gas passing through pipe *m′* into vessel Sc^2 is subjected therein to the action of concentrated nitric acid flowing constantly into this scrubber through the pipe *n* and dripping over the material filled therein. This gas contains only a very little hydric sulfid, which is split by the action of the nitric acid, and thereby a small quantity of sulfuric acid is produced. From vessel Sc^2 the gas passes through pipe l^2 into vessel Sc^3, where it comes into contact with water. This eliminates from it all tetroxid of nitrogen by transforming it into nitric and nitrous acids and discharges in aqueous solution through pipe m^2 into vessel Sc′, together with the nitrous acid flowing from vessel Sc^2 through pipe *m′*. When this aqueous solution reaches vessel Sc′, the nitrous acid splits instantly into nitrous acid and nitric oxid, the latter escaping again into vessel Sc^2 (and Sc^3) with the inflowing water-gas. The reactions are repeated until the nitric acid is consumed, being successsively and almost fully transformed into nitric oxid (gas.) Only a very small quantity of nitric and sulfuric acids escape through pipe *g* from the first vessel Sc′ of the apparatus.

The purified gas contains some nitric oxid. This can be eliminated (absorbed) by water if a sufficient quantity of air or oxygen is added to the gas. The air or oxygen may be added to the gas before the same enters scrubber Sc′ and it is preferable to do so, because then also the nitrous acid produced there will constantly be re-formed into nitric acid. The sulfur precipitated in vessel Sc′ accumulates on the material, filling the scrubber, and can be recovered by drying the sediment and melting it. That part of the sulfur that escapes through pipe *g* accumulates as a porous sediment on the bottom of a tank and can be gathered directly.

The purified gas is absolutely odorless, and carbylamins—such as, for instance, methyl, æthyl, tolyl, and carbylamin itself—are the best substances for scenting. They possess an odor which cannot be confounded with others, are cheaply produced, and easily assimilated by the gas.

The odorizing solution is absorbed in porous material filled in a chamber connected by a pipe to the reservoir, and the gas passing through it absorbs the odor of the carbylamin solution, retaining it permanently. The absorbed odorizer is replaced continuously by connecting the odorizing-chamber with a hermetically-sealed can containing the odorizer and provided with a reduction-valve or a stop-cock.

Water-gas produced, purified, and odorized in the apparatus herein described can be used for all purposes for illuminating or heating.

I claim as my invention—

An apparatus for the manufacture of water-gas from coal, coke, and other carbonaceous material consisting of an oven, a combustion-chamber, a regenerator, a two-way flue connecting the upper and middle parts of the oven with the combustion-chamber, a double-acting valve set in the two-way flue, a pipe connecting the lower part of the oven with the regenerator, a damper set in the pipe, a flue

surrounding the regenerator and connecting it from its lower end with the chimney, an air-blast pipe set in the flue, a channel connecting the air-blast pipe with the combustion-chamber, a damper set in the channel a box set between the oven and the regenerator, a pipe connecting the air-blast pipe with the box, a pipe connecting the box with the lower part of the oven, and a discharge-pipe connecting the box, a switch-slide set in the box, slides set in the air-blast pipe and in the flue connecting the apparatus with the chimney, and a steam-injector set in the pipe connecting the regenerator with the lower part of the oven.

In witness that I claim the improvements described in the foregoing specification I have signed my name in the presence of two subscribing witnesses.

HUGO STRACHE.

Witnesses:
DEAN MASON,
HARRY BELMONT.