

No. 676,245.

Patented June 11, 1901.

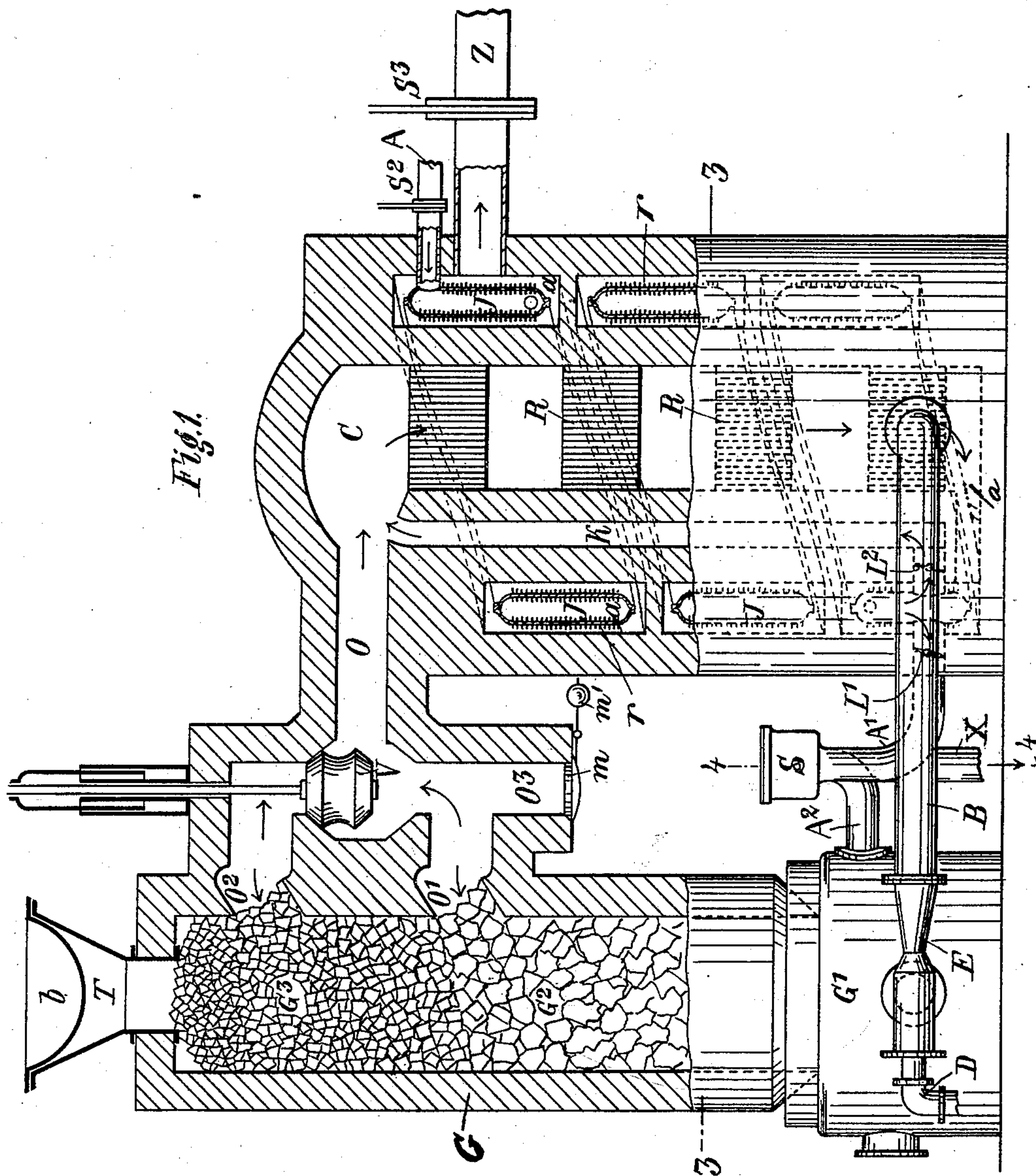
H. STRACHE.

APPARATUS FOR MAKING WATER GAS.

(Application filed Feb. 19, 1896.)

(No Model.)

3 Sheets—Sheet 1.



Witnesses:
John A. Paulson
Clifford E. Dunn.

Hugo Strache, Inventor
By Henry Schreier, his Attorney

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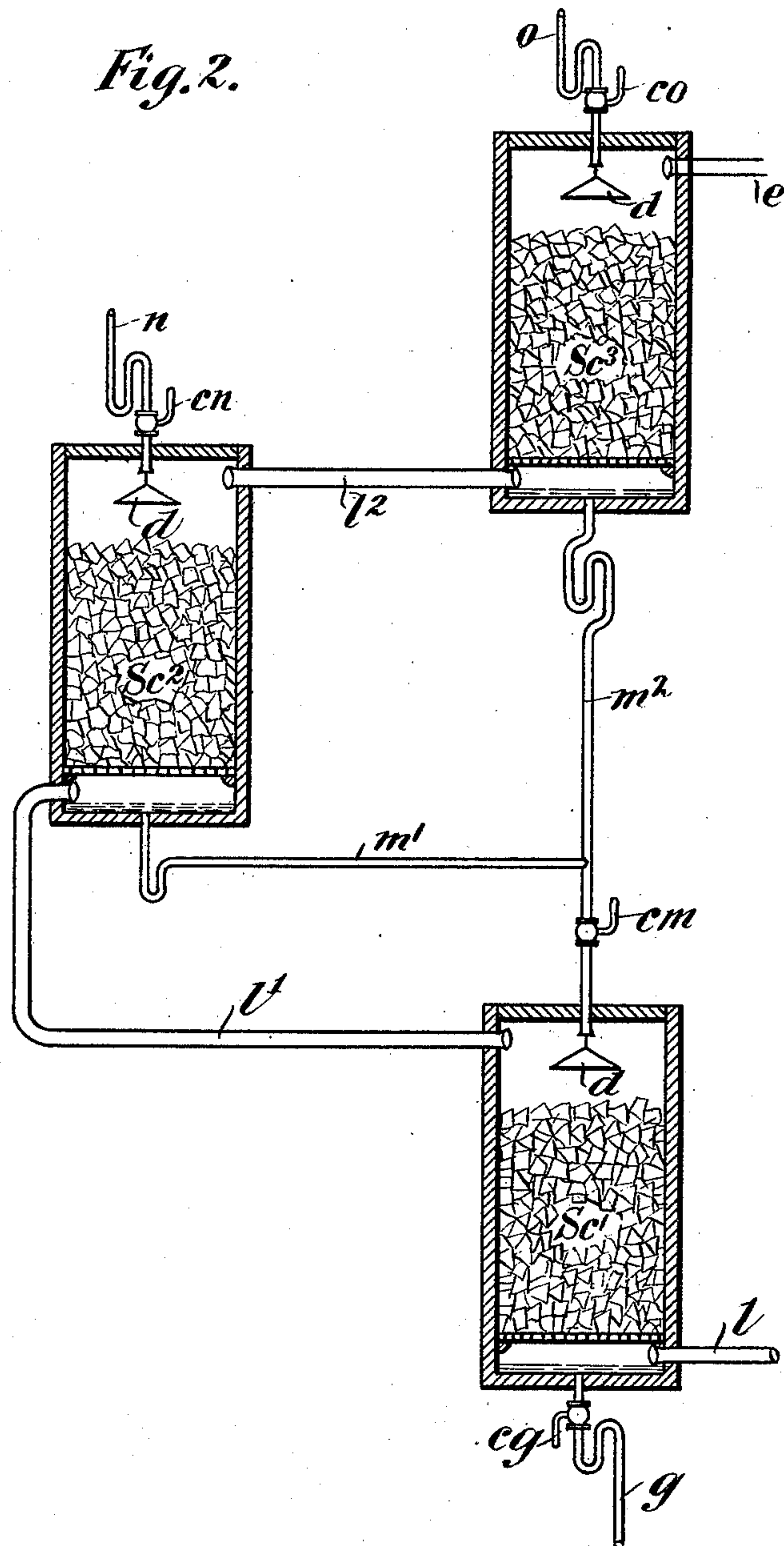
H. STRACHE.

APPARATUS FOR MAKING WATER GAS.

(Application filed Feb. 19, 1896.)

(No Model.)

3 Sheets—Sheet 2.



Witnesses
John P. Nordstrom
Richard J. Elliott.

Augo Strache, Inventor
By his Attorneys Henry Schreiter

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3 Sheets—Sheet 3.

Fig. 3.

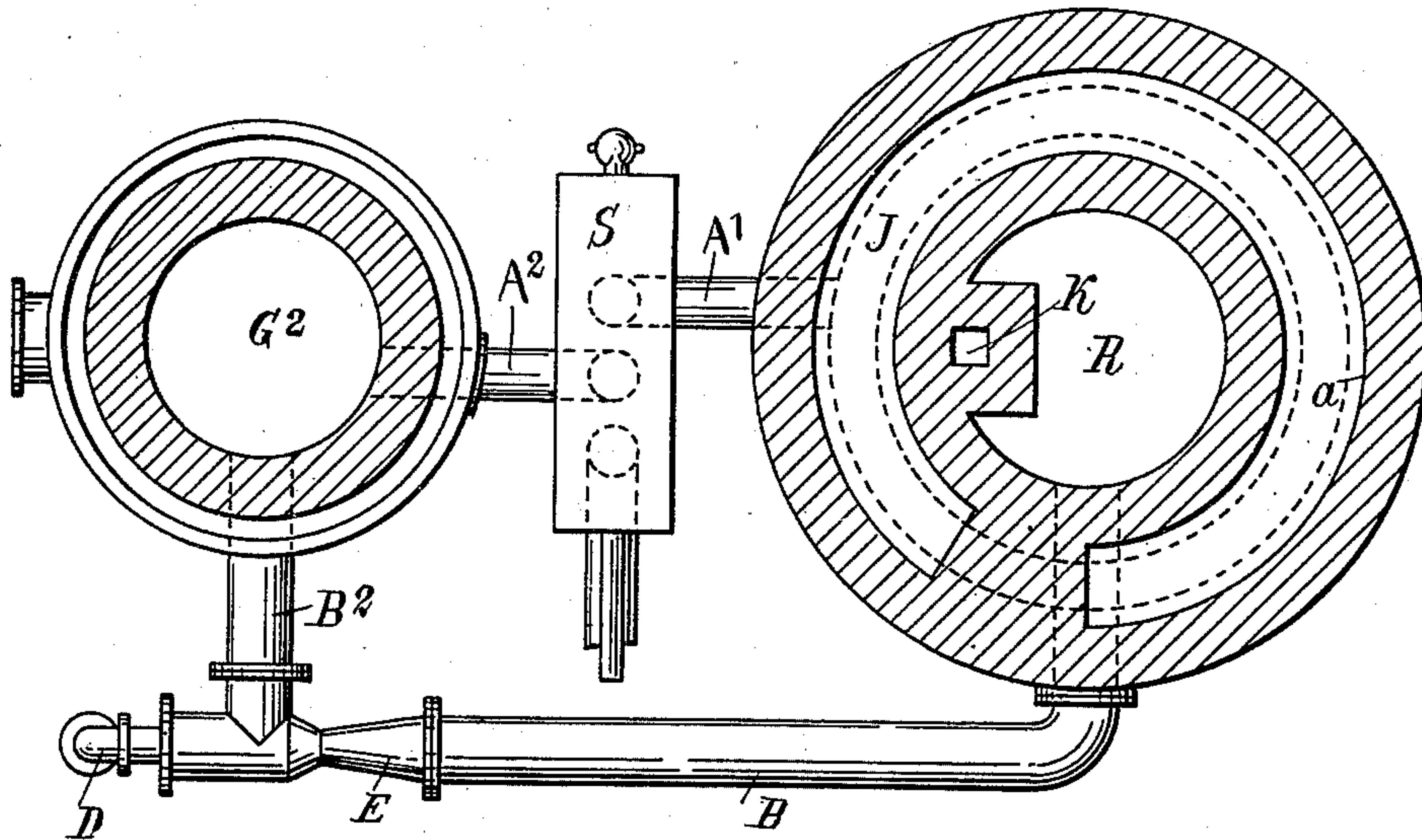


Fig. 4.

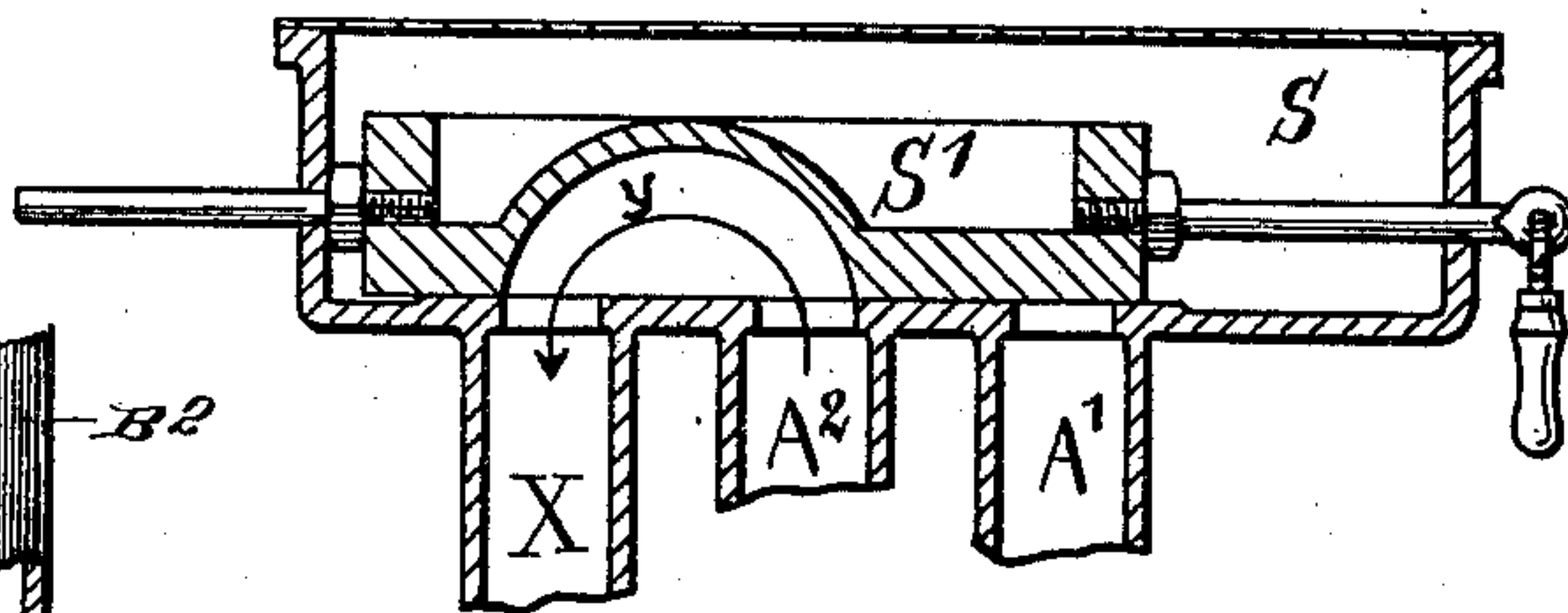
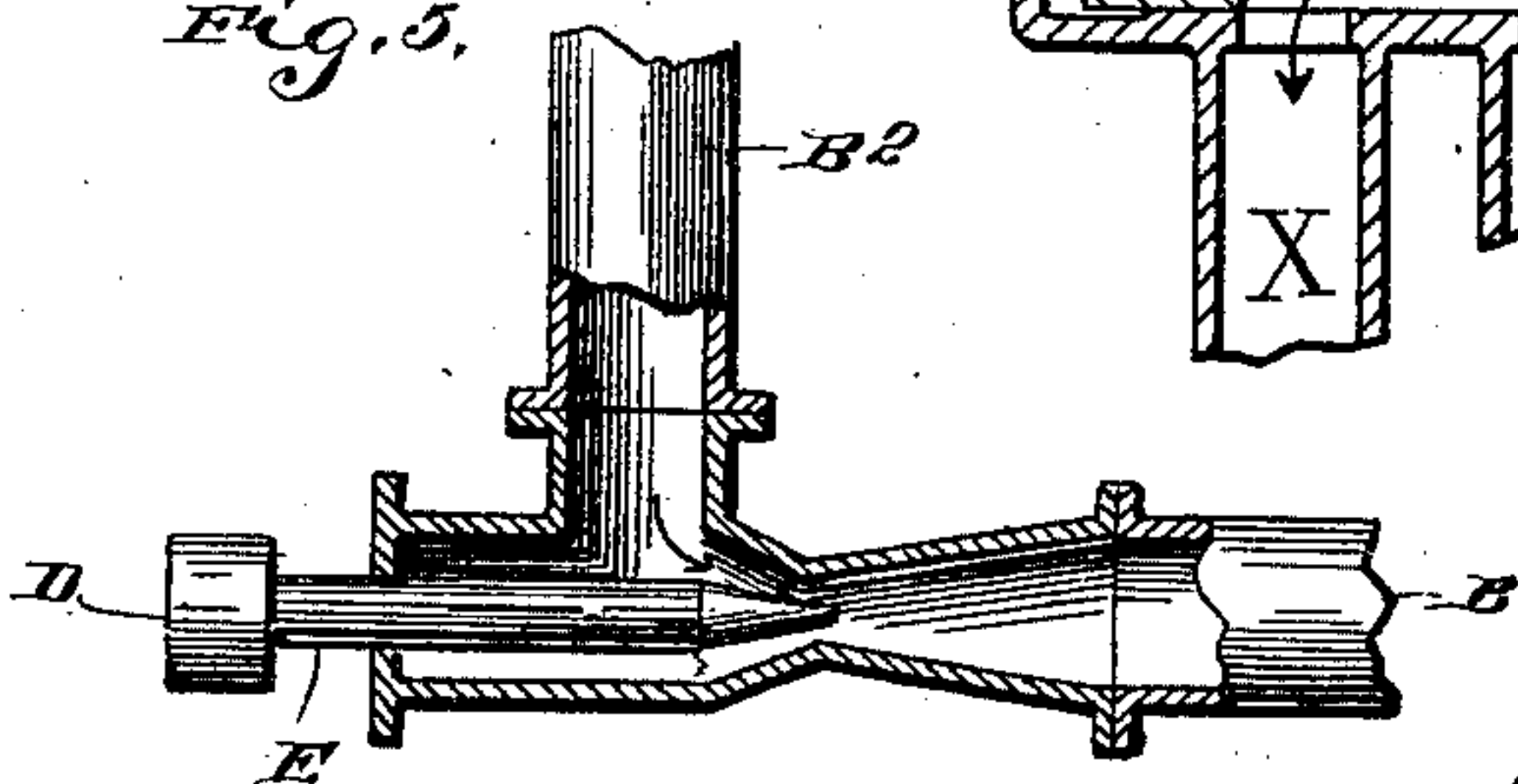


Fig. 5.



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 A², oven G, flues O' and O, combustion-chamber C, regenerator R, and from there through flue α 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 O², oven G, pipe A², 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 B² 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 (heat-

ing) surfaces. These ribs absorb and accumulate the heat of the gases passing through the flue α 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 L² divide the blast-air and regulate its flow within the apparatus. Damper L' governs its flow into the oven, and damper L² 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', A², and X open. The apertures of these pipes are in line and equidistantly from each other, and in slide S' is provided a chamber γ , which is dimensioned to encompass two of the apertures in any position of the slide. Thus pipe A² 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 S² and S³ (S² closing air-blast A and S³ 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 O². During the period of "hot-blowing" it closes flue O² and during the period of gas-making it closes flue O'. By manipulating slides S', S², and S³ and double-acting valve V correspondingly the operation in the apparatus is changed. Valve m closes passage O³. 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 Scrud-
 der and so named by them. It is developed
 from the pyrites or other compounds of iron
 5 contained in the material from which the gas
 is produced. Connecting with the outlet-
 pipe of this scrubber and some distance there-
 from is arranged the apparatus shown dia-
 grammatically in Fig. 2 of the drawings.
 10 This apparatus comprises three closed ves-
 sels Sc^1 , Sc^2 , and Sc^3 , arranged successively
 one above the other. These vessels are made
 of acid-proof material and are provided with
 double bottoms, the inner raised bottom be-
 15 ing perforated. Vessel Sc^2 is connected by
 pipe n to a tank containing concentrated nitric
 acid, and vessel Sc^3 is connected by pipe o to
 a water-tank. Vessels Sc^1 and Sc^2 are con-
 nected by gas-conduits l^1 and vessels Sc^2 and
 20 Sc^3 by gas-conduits l^2 in such manner that
 always the upper end of the preceding con-
 nects with the lower end of the next follow-
 ing vessel. Vessels Sc^2 and Sc^3 are connected
 by conduit-pipes m^1 and m^2 to the top of ves-
 25 sel Sc^1 , in whose bottom is set the outlet-pipe
 g . Pipes m^1 and m^2 convey the liquids ac-
 cumulating on the bottoms of vessels Sc^2 and
 Sc^3 into vessel Sc^1 , where they are utilized, as
 will be explained hereinafter.

30 All liquid-conduits are provided with drips
 d , traps and cocks cn , co , cm , and cg , respec-
 tively, for regulating the flow of the liquids
 into and out of the vessels. About two-thirds
 35 of the space of each vessel above the perfo-
 rated 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-flow-
 ing gas and the dripping liquids through the
 40 scrubbers.

The raw gas enters vessel Sc^1 through pipe
 l^1 and passes successively through this ves-
 sel, conduit l^1 , vessel Sc^2 , and conduit l^2 into
 vessel Sc^3 and from there (purified) through
 45 pipe e into the odorizing apparatus.

The odorizing apparatus comprises a cham-
 ber filled with some porous material, prefer-
 ably animal charcoal, pumice-stone, wood
 fiber, and the like, and a closed vessel con-
 50 nected with the chamber by an outlet-pipe
 provided with a stop-cock or a reduction-
 valve. The gas in passing through this ap-
 paratus is scented with a penetrating odor
 and then conducted to a reservoir, from which
 55 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 G^2 with coke and in the up-
 60 per part with the material (coal, coke, peat,
 &c.) of which the gas is to be produced, where-
 as its lowest part is filled with some readily-
 burning material, like wood, &c. Then the
 fire is started from underneath, valve V set in
 65 the position shown in the drawings, slides S^2
 and S^3 open, and slide S^1 set to connect pipe
 A^1 with pipe A^2 . Then draft-air is driven in

through pipe A , flue J , and pipes A^1 and A^2
 into the oven, part of it being diverted through
 channel K into combustion-chamber C . The
 70 air is forced through the burning coke filled
 in the middle part G^2 of the oven. The com-
 bustion-gases are driven through flue O^1 into
 the combustion-chamber C , where they are
 met by a current of fresh heated air driven
 75 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
 80 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
 85 of the coke filled in the oven is burned up.
 Then the air-blast is shut off by slide S^2 , slide
 S^3 is closed, valve V is pushed down to close
 communication between flues O^1 and O , and
 90 overheated steam is driven through the in-
 jector 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 G^3
 95 of the oven through pipe B into the regenera-
 tor R and drives them through the combus-
 tion-chamber C and flues O and O^2 into the
 top of the oven. The raw material filled into
 the top of the oven is coked. The products
 100 of the distillation are drawn through the glow-
 ing 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
 105 the generator through pipes A^2 and X into
 the purifying apparatus. The period of gen-
 erating gas is stopped when the charge of
 fresh material is fully coked. The steam is
 then turned off, valve V moved upward to
 110 close flue O^2 , slide S^1 shifted, a fresh material
 is filled in the oven, slides S^2 and S^3 with-
 drawn, and the fire, inflamed afresh by air,
 driven through pipe A , as described above.

When first charging the oven, a charge of
 115 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
 120 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
 125 of gas-making and before the fresh material
 is charged.

The generated water-gas is not pure, it
 containing various impurities. The most de-
 tractive of these is iron carbonyl, which is
 130 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 of 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 successively 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 con-
necting the air-blast pipe with the combus-
5 tion-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 con-
10 necting 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 connect-
ing 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.