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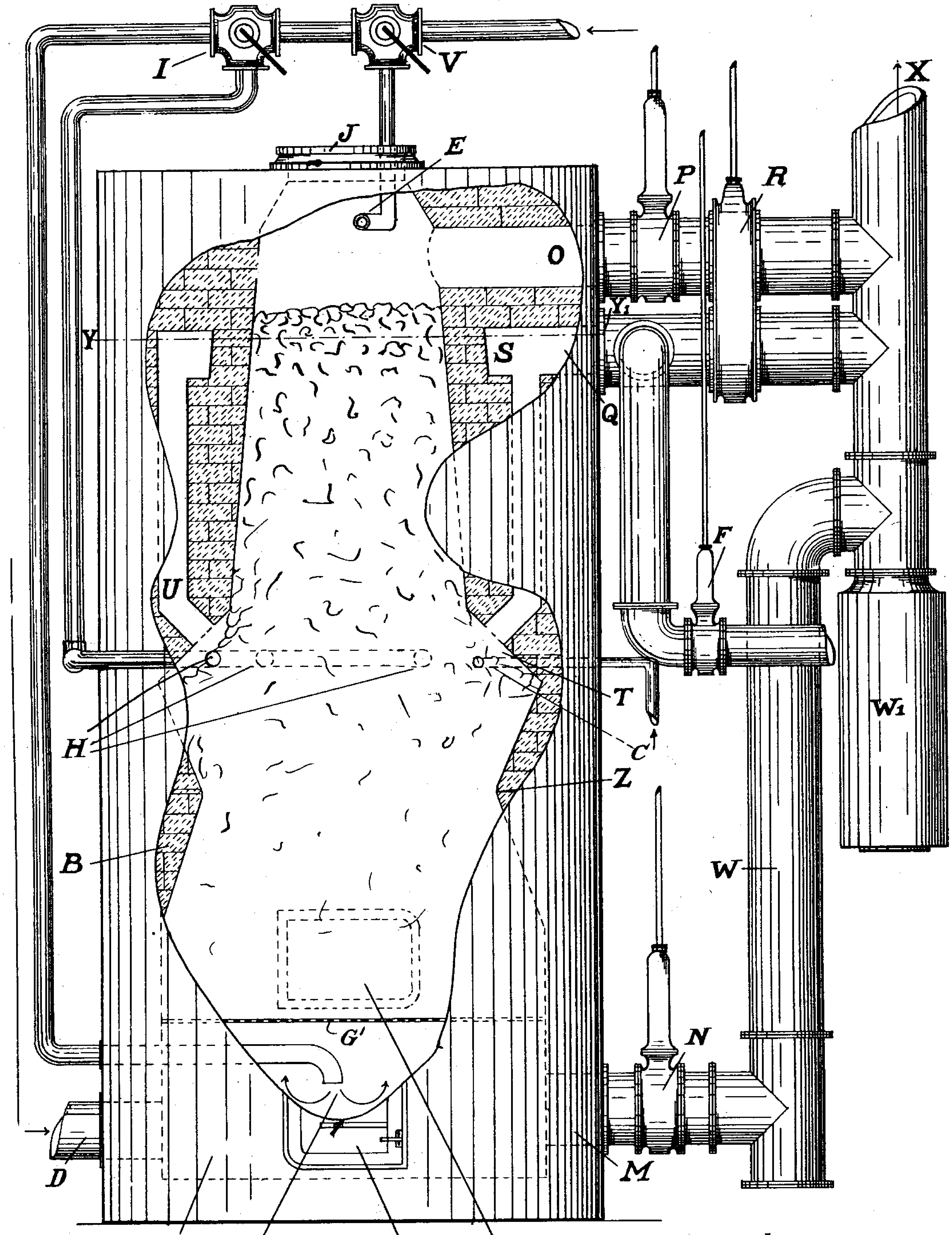
C. W. BOTSFORD

GAS GENERATOR

Filed Dec. 26, 1919 2 Sheets-Sheet 1



Witnesses

Benj. J. J. Odell

Wm. W. Odell.

Fig 1

Inventor

Claude Winfield Botsford.

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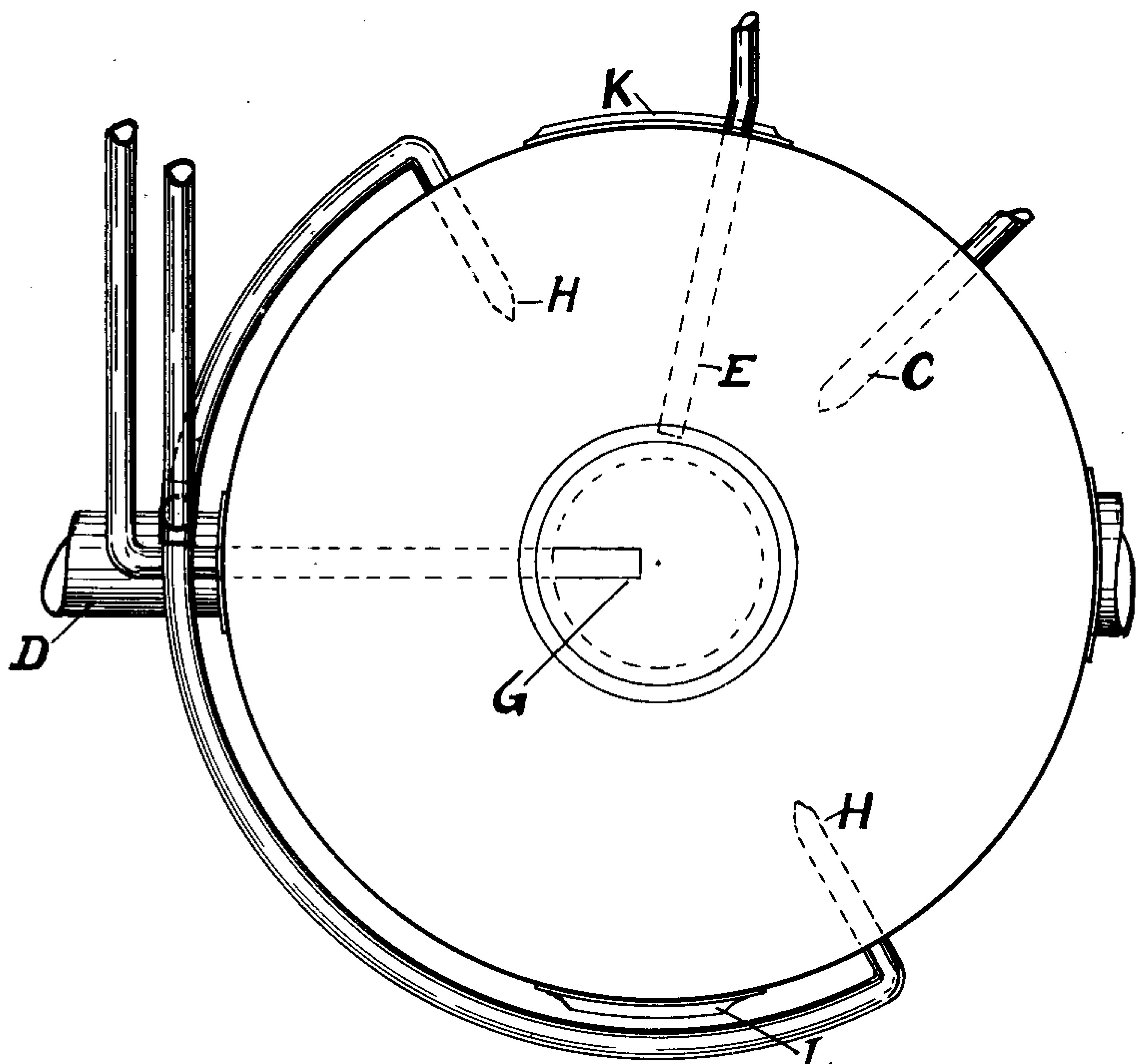

Fig-2

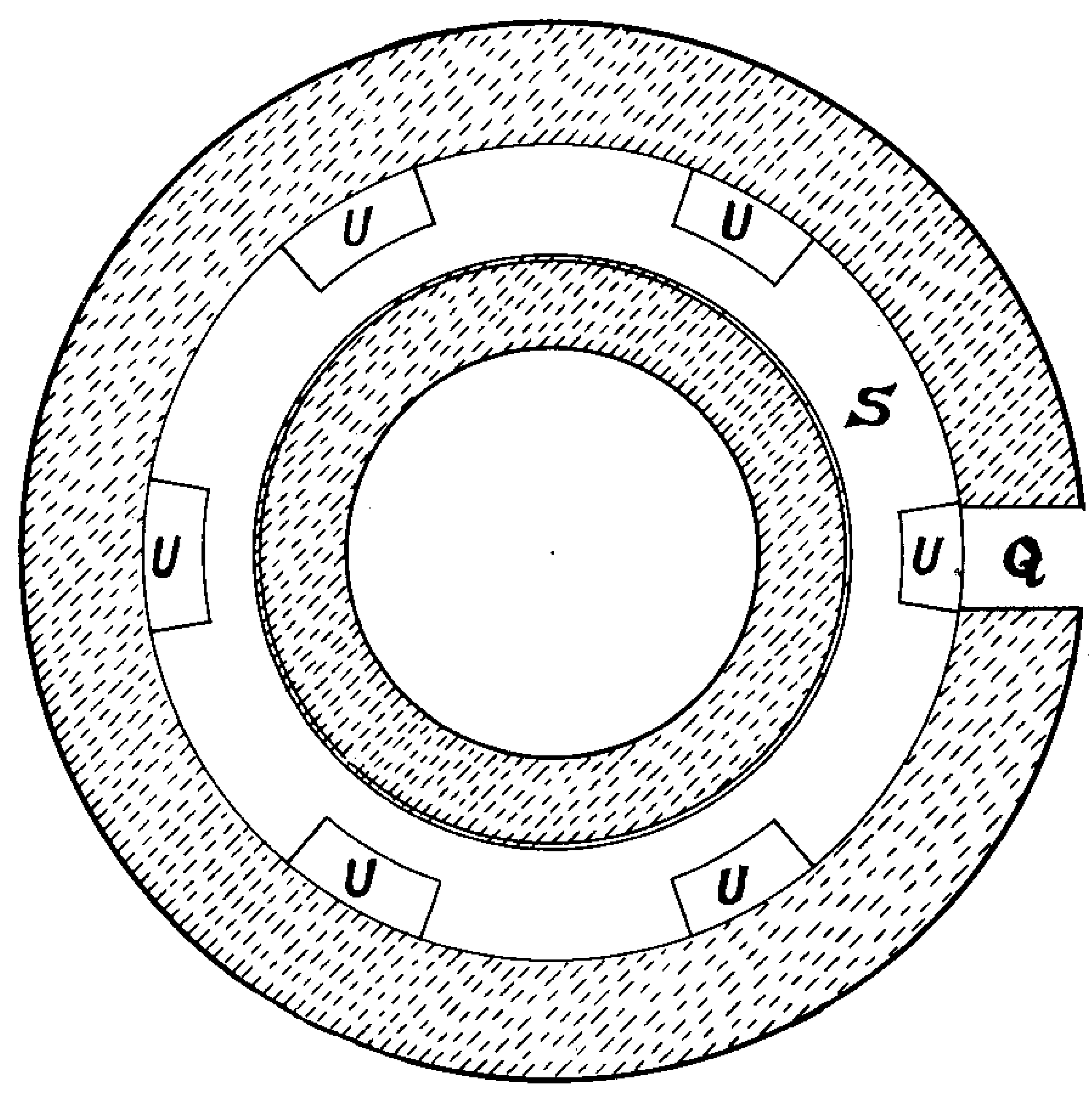

Fig-3.

Witnesses

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UNITED STATES PATENT OFFICE.

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GAS GENERATOR.

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My invention relates to improvements in gas generators in which I have developed a generator that can be used for manufacturing either water gas, producer gas, carburetted water gas, carburetted producer gas or combinations of any of these using either coke, anthracite coal, bituminous coal or other carbonaceous fuel.

Heretofore there has been considerable difficulty in using bituminous or coking coal as generator fuel in the manufacture of water gas. Where attempts have been made to use it, the results were; (1) reduced capacity; (2) increased consumption of steam per M cubic feet; (3) a decrease in the volume of incandescent fuel in the generator due to the greater difficulty of heating coal, the temperature of which tends to remain below 250 degrees F. till the moisture is driven off; (4) the production of large volumes of smoke during blasting; and (5) the production of an excess amount of combustible constituents in the blast gas (more than is required for heating carburetting checker chambers) due to the volatile matter from the coal and the superficial heating of the coking coal.

The objects of my invention in detail are:

(1) To produce a combination generator in which water gas can be manufactured successfully from bituminous fuels without the difficulties met with in common practice with the present forms of apparatus.

(2) In which anthracite coal or coke can be used equally as well as bituminous fuel.

(3) In which a greater volume of incandescent fuel is produced from a given amount of air blast than in the present practice.

(4) In which the capacity of a given sized set is increased with either of the fuels mentioned.

(5) In which less CO_2 (carbon dioxide) is produced during a steam run.

(6) In which clinker difficulties are mitigated or eliminated.

(7) In which less steam is required per 1,000 cu. ft. of water gas made.

(8) In which the loss of fuel in the ash is particularly decreased when using bituminous fuel, and is reduced to a minimum with any solid fuel.

(9) In which producer gas can be made by a continuous or intermittent process.

(10) In which carburetted water gas or carburetted producer gas can be made.

(11) In which a hot air blast can be safely and advantageously used.

(12) In which the blast air is automatically heated in a chamber within the generator.

Fig. 1 is a vertical elevation partially broken away to show in section the interior of the generator;

Fig. 2 is a top view of the generator with the pipe connections thereto; and

Fig. 3 is a section taken substantially on the line Y—Y[1] of Fig. 1.

In the drawings there is shown a generator and connections, in which part of shell A is eliminated to show the interior in section. B is the brick lining within which the fuel is retained. The air blast connections are shown at D and Q, the valve F controlling the air through Q. G, H and E are the steam ports and I and V are the steam control valves. The charging door is at J, the cleaning door at K and the ash pit door at L, while G′ is the grate. M is the down run off-take with shut-off valve N. O is the up run off-take with shut-off valve at P. Q is one off-take for blast gases as well as the inlet for air blast. R is a double valve controlling the course of the gas through either off-take O or Q. This valve R may be provided with a common valve stem with parts so arranged that it will close passage through one off-take while permitting passage through the other, and vice versa, and in the present construction the passage through S is open when the stem is in its "up" position and is closed when the stem is in its lowest or "down" position. S is an annular collecting chamber for the gases passing through flues U and out at Q. S is also the heating chamber for air blasted through valve F and inlet Q. T is an annular recess formed by a sharp deflection in the generator wall. The inlet for tar or oil is shown at C. More than one tar inlet is employed, but for simplicity and clearness only one tar inlet is shown. W is the connecting pipe for gas from a down run, or down blast, with the main outlet X. W_1 is a dust chamber and Z is a contraction in the lower portion of the generator wall.

It will be noted that the generator comprises generally a vertical shaft having superposed frusto-conical sections, separated by the annular recess T which is open to the fuel bed. A plurality of parallel air inlet passages or flues U are formed in the wall of the shaft, these passages being substantially upright and communicating with the annular recess T for the admission of air to the fuel bed. Likewise steam and carburetting material are admitted adjacent the air admission ports.

This combination generator may be operated in several different ways, as follows:

(1) When using bituminous coal and generating water gas by an intermittent process, I prefer to operate as follows; the ignited fuel is heated to incandescence by air blasting through inlet D. The valves N and F are closed and R is raised so that the blast gases pass out through flues U and off-take Q and out at X. After the fuel in the lower zone is incandescent and before reaction $CO_2+C=2CO$ can take place to any appreciable extent, the blast at D is shut off and valve F is raised and valve R lowered. The air blast through F is started and air which is preheated by the time it strikes the fuel passes through Q, S and U to the fuel. The fuel in a higher zone of the generator is thus heated and the blast gases pass up through the upper zone of the fuel bed, out through off-take O, through P, and out at X. When the fuel is sufficiently hot, air blast is turned off at F, and steam is admitted through G by opening valve I. The steam passes up through the full depth of the fuel bed and out through O, P and X to the holder. After a short interval when the fuel is no longer hot enough to generate good blue water gas, the cycle is repeated—only steam is admitted at H and a down run made. In this case valve N is open and P closed and R is lowered, permitting the gas to pass out through M, N, W and X. It is to be noted that the time of contact of the steam and incandescent fuel is considerably greater than the time of contact of the blast gas and the fuel. Thus during blasting more complete combustion of carbon takes place and reaction (I)—$C+O_2=CO_2$ predominates over reaction (II)—$CO_2+C=2CO$—and more heat is liberated in the generator. During the steam run, the time of contact is so long that the reaction—$H_2O+C=CO+H_2$ takes place more completely and there is less of reaction—$C+2H_2O=CO_2+2H_2$.

(2) When using bituminous coal and making carburetted water gas, I proceed similarly as in the method described above only during the steam run I admit tar or oil through tar inlet C entering in the recess T of the generator. On down runs I prefer to admit the tar during the latter part of the run only, thus preventing the complete cracking of the hydrocarbons into hydrogen. During up runs, I prefer to admit the tar or oil during the first part of the run or during the entire run.

(3) When making producer gas by a continuous process, I blow air into the fuel through D and simultaneously blow steam into the fuel at H, meanwhile having valves N and F closed, P open and R down so that the gases generated pass out through O and X. After a given interval I shut off the air entering at D, open valve F and blow air in through Q, S and U, and simultaneously I shut off steam entering at H and force it through G by operating valve I. This alternate changing keeps the fire in more uniform condition and eliminates blow holes and the tendency for them to form. I attain, in this manner, a more uniform temperature throughout the fuel bed and can therefore operate between smaller maximum and minimum temperature limits and can thus avoid the clinker difficulties which commonly prevail when using coals with a low ash fusing point.

(4) When making carburetted producer gas I operate similarly as in (3), only I blow tar or oil into the fuel bed through the tar ports C during a part of, or the complete, time of operation. I prefer to make some down blasts, also, which help to give a more perfect control over the temperature, clinker, and the cracking of the tar or oil. When the down blasts are made the air at D is turned off and air is forced in through F, Q, S and the flues U. Steam is admitted through H and valve N is open, P is closed and R is down. Obviously any desired carburetting material may be used. For example, powdered coal or other pulverized carbonaceous material may be blown into the fuel bed through the ports C.

(5) When making water gas using coke or anthracite coal as fuel, I frequently blast up from D through the entire bed of fuel taking the blast gases out at O, through P and X. This is sometimes necessary when an increased amount of CO or combustible is desired in the blast gas (as when checker chambers are to be heated). This is accomplished by closing valve N and F, opening P, lowering valve R and starting blast through D. Using this kind of fuel it is sometimes necessary to blow steam in from the top of the fuel bed in order to keep the top of generator from becoming too hot. This can be done and to good advantage by opening valve V permitting steam to enter generator at E. The gas produced may be taken off through M and N, at bottom of generator, or through U, S, Q and X by merely operating the valves. When operating the latter way, air or steam may be blown in (beneath the grate) through D and G respectively, while the steam is entering at E.

(6) When operating with a strong coking coal I prefer to operate in another different manner. I make the usual up blast through D and the subsequent blast through F, Q, S and U up through the fuel bed and then make the up run as in (1) by admitting steam at G, taking off the gas through O, P and X, but with this difference I admit a small quantity

of air through F, Q, S and U during the up runs. Not enough air is admitted to cause combustion to continue but enough to cause oxidation or incipient combustion in the coking coal. The oxidation I find decreases the tendency for the coal to cake and mat together by partially destroying its strong coking tendencies. I find this to be particularly advantageous when making carburetted gas. The tar or oil along with the blue gas reaction cool the fuel to such an extent that the oxygen in the air thus admitted reaches the fuel at a higher level than otherwise. Further, I prefer to admit this air during the latter part of the run.

My generator is so designed and equipped that when desired the fuel can be blasted with hot air from the flues U, either up or down or both ways at once by merely operating the valves. The amount of such blast going either up or down can be controlled by the valves N and P of Fig. 1. When blasting both up and down at the same time I operate as follows: I open air blast valve F, and take-off valves N and P and lower valve R. The steam run can now be made either up or down from the middle, both up and down from the middle through ports H, or up from G and out at U (performed when the upper zone is too cool or when fresh wet fuel is charged) or up from G and out at O.

My invention is characteristically different from any other, so far as I am aware of, in that:

(1) It has an upper vertical coking chamber as shown between charging door J and the V-shaped annular recess T in Fig. 1.

(2) The coking chamber walls taper as shown so as to prevent the coal from caking and sticking on coking, and causing it to pass down through the generator due to its own weight, as fast as the fuel is consumed.

(3) Only a very small amount of free space exists above the fuel bed in the generator.

(4) Down run steam ports are below the coking zone. Thus coking is not retarded by down run steam as it is in common practice when bituminous fuel is used.

(5) An off-take for the blast gas is provided below the coking line, Fig. 1—U and S, whereby a greater proportion of the volatile matter of the coal is utilized in the blue gas.

(6) A means of blasting the fuel with preheated air is provided through S and U—Fig. 1, whereby the fuel can be blasted with air at points considerably above what is usually known as the hot zone. By avoiding the necessity of passing this air through the lower hot zone, I am enabled to produce complete combustion in the middle of the fuel bed. In common practice during the latter part of the blast there is very little complete combustion, or rather the CO_2 formed combines with carbon ($C+CO_2=2CO$) and absorbs heat, simultaneously producing considerable CO in the blast gas.

(7) A means is provided for carburetting the gas by injecting tar or oil into the fuel bed at especially devised entry ports. Under the portion of the wall sloping away from the fuel in which is formed the recess T.

(8) A portion of the generator wall, where air, steam and tar is admitted, is sloped at such an angle that the fuel will not be in permanent contact with it, thus creating an annular space T that will allow the steam, tar and air an opportunity to pass through the fuel bed evenly. Clinker can not form and stay on this wall for obvious reasons.

(9) There is a constriction in the size of the generator at and slightly above the clinker zone. This causes an increased velocity of the gases, and, during blasting, the ash has a better opportunity to fuse and run free from the wall. This prevents the arching of clinker in umbrella formation a foot or two above the grates, which is a common source of trouble in present practice.

(10) A means is provided for making producer gas with less poking of the fire, more uniformity of temperature in the fuel bed, and less trouble from blow holes. This is provided by the triple steam connections E, H and G, and the double air connections D and Q.

(11) A combination method of blasting is afforded in that the generator can be blasted either way from the middle, or both ways, up and down, from the middle, with hot air.

(12) A combination method of making steam runs is afforded in that steam can not be only blown in from top or bottom, but it can be blown in from the middle of the fuel bed either up or down, or both up and down simultaneously. Further, when steam is admitted at either top or bottom of fuel bed the gas produced can be taken off either at the opposite end of generator or at about the middle as through flues U in Fig. 1.

When blasting through D and taking the blast gas off through U it is evident that there can not be any smoke produced for the fuel is entirely carbonized between the grates and U. When blasting through F, Q and U the air being preheated permits the blast gas which now passes through O, P and X to leave at a temperature above the ignition point of the combustible constituents which can be burned to complete combustion by the addition of secondary air as in an auxiliary carburettor or when coming in contact with air at the stack.

The steam is more completely decomposed with the formation of less CO_2 when using my generator due to the maintenance of a hot zone higher up in the generator than in common practice. I am able to increase the capacity of a given size set for the same reason which is due to the fact that for a given amount of air blast I get more heat liberated in the generator since I have less CO formed and more CO_2. The fuel in the ash is minimized due to better temperature control, to the fact that no uncarbonized fuel ever reaches the grate, and chiefly on account of the employment of the upper air blast through F, Q, S and U.

I recognize that the composition of fuels in different parts of the country varies, that the ash fusibility is not the same, and therefore I do not specify a given slope from the narrow zone Z to the grates nor the distance of this zone above the grates.

I claim:

1. A combined water gas generator and gas producer comprising a substantially upright, lined shell for retaining a bed of ignited solid fuel, said shell having an annular recess in said lining intermediate the ends of said shell and contacting said fuel, said shell being provided with separate and independent passages for admitting steam and an air blast directly to the fuel bed at said annular recess, outlets adjacent the top and bottom of said shell for the discharge of gas and valves for controlling said discharge outlets.

2. In a generator for the manufacture of water gas, a container for solid fuel comprising a single upright shell provided with a V-shaped annular recess in its inner wall between the ends of the fuel bed, means for admitting steam and a preheated air blast to the fuel bed at said annular recess, and for discharging finished gas therefrom.

3. In a generator for the manufacture of carburetted water gas, a container for solid fuel comprising a single upright shell having an inner lining, said generator being constructed to provide an annular recess formed in said inner lining between the ends of the fuel bed, and provided with separate and independent means for admitting steam, carburetting material and an air blast respectively to the fuel bed at said annular recess and having ports for the discharge of the finished gas, said air blast passing through one of said ports in a direction reverse to that of the gas discharged therethrough, and means for controlling the discharge of said gas through said ports.

4. A carburetted water gas generator comprising a vertical lined shell for retaining a bed of ignited solid fuel, and having a recess in said lining contacting said fuel and located midway of the ends of the fuel bed, said shell being provided with a passage opening into said recess for the admission of steam, means independent of said steam passage for admitting an air blast to the fuel bed at said annular recess and for preheating said air blast within the shell lining before its discharge into said annular recess, passages, separate and independent of said air and steam passages, for admitting carburetting material to the fuel bed at said annular recess, said shell having outlets at top and bottom for the discharge of gas, and valves for controlling each of said gas outlets.

5. In a generator for the manufacture of combustible gas, a container for solid fuel comprising a single upright shell constructed with an intake port for the admission of a blast adjacent the bottom, and with an inner wall intermediate the ends flared downwardly for a distance and arranged to cooperate with the contained fuel and to provide an annular recess, said shell having ports at said recess for the admission of air blasts or discharge of gas and provided with means for discharging steam in said recess, means for admitting steam at the bottom and top of said shell, said shell provided with ports for discharging the finished gas at the top and bottom, and means for controlling the admission of blast and steam in a predetermined manner, and means for controlling the discharge of the finished gas from either end or from the ports at said annular recess, whereby the gas may be discharged and the contained fuel may be blasted in either direction, or a plurality of directions as desired.

6. In a combustible gas generator, a container for solid fuel comprising a single upright shell constructed with an intake port for the admission of a blast adjacent the bottom and with an inner wall intermediate the ends flared downwardly for a distance and arranged to cooperate with the contained fuel, and to provide an annular recess, said shell having ports at said space for the admission of air blasts or discharge of gas, and provided with means for discharging steam in said space and with means for discharging a carburetting material in said recess, means for admitting steam at the bottom and top of the shell, said shell being provided with ports for discharging the finished gas at the top and bottom, and means for controlling the admission of gas and steam in a predetermined manner, and means for controlling the discharge of the finished gas from either end or the ports at said annular recess, whereby the gas may be discharged and the contained fuel may be blasted in either direction or a plurality of directions as desired.

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