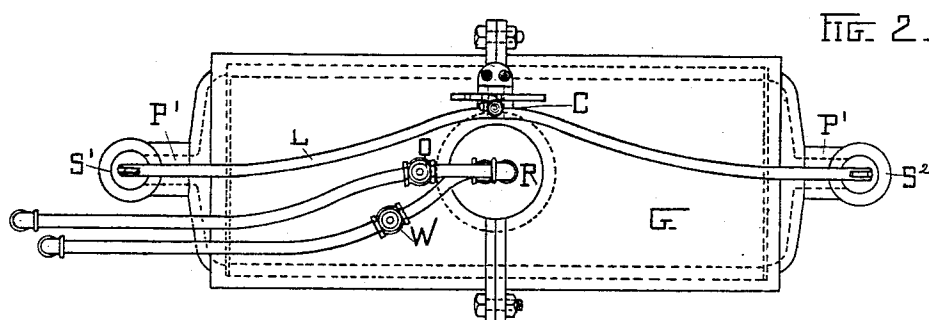
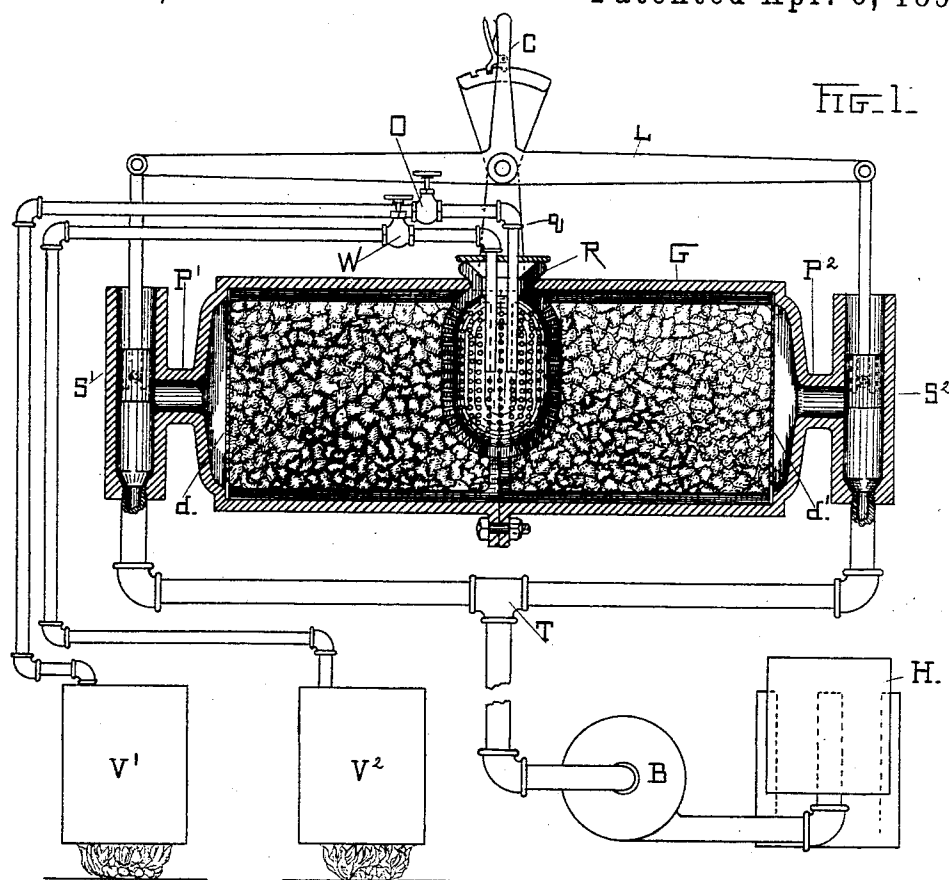


(No Model.)

E. THOMSON.
PROCESS OF PRODUCING GAS.

No. 580,020.

Patented Apr. 6, 1897.



WITNESSES.
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PROCESS OF PRODUCING GAS.

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Application filed December 11, 1896. Serial No. 615,318. (No specimens.)

To all whom it may concern:

Be it known that I, ELIHU THOMSON, a citizen of the United States, residing at Swampscott, in the county of Essex and Commonwealth of Massachusetts, have invented certain Improvements in Processes of Producing Gas, as fully set forth in the annexed specification.

My present invention relates to a process for manufacturing combustible gas by a continuous method from mineral oils, tars, and such like liquid products, which, when subjected to high temperatures, yield carbonaceous residues and fixed hydrocarbon gases. I sometimes use with the oil, tar, or other material used as the source of the gas water-vapor for increasing the volume and taking up the free carbon which would otherwise be deposited.

My process is intended particularly to yield a gas suitable for the working of gas-engines, and is free from condensable products, at the same time that it is delivered from the generator practically cold.

My process consists in passing through a generator of suitable construction a stream of air which, before it reaches the combustion-chamber or combustion area of the generator, is intensely heated by the heat which had been previously stored in heat-resisting material, such as pieces of fire-brick. This highly-heated or superheated air passes then to the combustion area, meeting the oil-stream, or oil and vapor of water, together. It there immediately burns a portion of the oil, and, the oil being in excess, the resulting products of combustion consist of hydrocarbons, carbonic oxid, a small amount of carbonic acid, the nitrogen of the introduced air, and hydrogen. When water-vapor is introduced, the amount of carbonic oxid is increased, as is also the free hydrogen. The gases so formed by the superheated air coming into contact with the oil fuel introduced into the combustion area or fire-space are extremely hot and are carried at once through heat-resisting material with interstices, during which passage the gases part with their heat while heating the material. By reversing the direction of the flow of the incoming air and the produced gas-stream at intervals the heat stored up for a certain time by the

gas produced is employed to heat the subsequent stream of air, and so on. In this way but little if any of the heat of combustion is wasted or carried off, and the resulting effect is to produce a richer and less costly gas.

In carrying my invention into practice I prefer an apparatus somewhat similar to that shown in Figures 1 and 2 in the accompanying sheet of drawings, although of course it will be readily understood that many modifications might be made giving the same result. For example, the heat-storing material, instead of being, as in the figures, contained in a single apartment or receptacle, could be separated and contained in contiguous receptacles or in receptacles connected by a fire-brick-lined pipe or conduit, and the fire-space, instead of being in the center of a single receptacle, could be located between two separate receptacles and connected thereto by tubes or pipes properly lined with fire-resisting material. The object of the figures is simply to show a way in which my invention may be carried into practice.

In Fig. 1 an elevation, partly in section, of the essential parts of an apparatus suitable for generating gas according to my invention is shown. Fig. 2 is a plan of the gas-generator proper.

In Fig. 1, G is an elongated receptacle, which may be cylindrical in outline, constructed of thin metal, having a lining of fire-resisting material, such as fire-clay or fire-brick, immediately within its outer walls, except at the ends. This receptacle is divided in the center by a fire-pot, which is shown of fire-resisting material, somewhat in the form of a flask or bottle, the sides of which are full of perforations. This construction, however, is by no means essential, and all that is required is to have the space near the center for the entrance of the materials, such as oil and water-vapor, where they are commingled with air and partly burned. At each side of this receptacle, supported in place by any suitable means, as by perforated disks at the ends *d*, is a mass composed of pieces of broken fire-brick or any other heat-resisting material or refractory substance which is inert. In large generators these portions could be constructed, as is the case with the regular checker-work in regenerators for furnaces, of special

fire-brick piled up with open spaces. The receptacle or generator *d*, then, is practically composed of three portions—a furnace or fire-pot communicating on each side with heat-resisting and heat-storing material inert in character. At the ends or at any suitable point are pipes or passages *P' P²* leading from the generator, and the opening of which is controlled by a suitable valve, the function of which valve or valves is to reverse the flow of air or gas through the generator, taken as a whole.

The oil or fuel may be vaporized before it enters the fire-chamber at the center, or it may be allowed to drip therein, according to its nature. A petroleum-oil, for example, may be vaporized in a separate vaporizer, heated in any suitable way, and the vapor carried through a pipe, as *g*, leading into the fire-pot and controlled by a valve *O*. In like manner, when water-vapor is introduced, a boiler or vaporizer *V²* may be employed and the supply controlled by suitable valves or equivalent mechanism *W*, the oil being led into the fire-space and commingled with the contents thereof. These vapors of water and oil may be driven into the chamber under pressure, if desired, through suitable jets, which thoroughly commingle them and the air which reaches the chamber.

Any suitable means, either by pressure or exhaust, may cause a flow of the gas-stream through the apparatus. I have indicated an exhaust-blower *B* taking the gases by a branch pipe at *T* from either end of the generator and delivering it to any suitable holder, (indicated by *H*.) A lever *L* permits, by a suitable handle *C*, that the valves located at *S' S²* may be operated simultaneously, but in opposite directions, so as to reverse the flow of the gases through the chamber.

The valves shown are simply pistons sliding in a cylindrical space in front of the openings *P' P²* of the generator. When the valve at *S'* is raised to its highest point and *S²* lowered, the gas is taken to the suction-blower *B* from opening *P'* and air enters the opening *P²* from above. A reversal of position raises the valve *S²* to its highest point and depresses *S'* simultaneously and causes air to be taken through opening *P'* and gas to be drawn out of the opening *P²*. The valves are shown in an intermediate position, and it will be noticed that both openings *P' P²* are connected to the exhaust-blower or suction-pump *B*. In this case the tendency is to take gas away from both ends, and it is preferable that the reversal of direction of flow of the gas-stream by the movement of the valves be made gradually, so that the valve shall rest for a short time in the position shown, in which case whatever slight leak of air into the apparatus occurs at the lid of the fire-pot, and a slight leak may at all times be permitted at *R*, causes the gradual displacement and dilution with gas of whatever air is contained in the apparatus

at either end instead of its being suddenly displaced by gas on a quick reversal. This is a minor point, however, and is not of any consequence to the actual operation of the process.

The operation is as follows: Assuming that by prior combustion the heated gas is passed, say, from the fire-pot or fire-space through the material to the left and toward the opening *P'*, such material is highly heated. This can be accomplished by leaving the opening *P'* connected to the blower *B* while the lid at *R* is raised and oil supplied to valve *O* in suitable amount. This operation is preliminary to the actual use of the generator and serves the purpose of getting the heat-storing material, at least on one side of the apparatus, in a condition ready for use. No gas is produced during this operation, but simply waste products, and they are thrown away. When the heat-storing material reaches a high temperature, the gas production itself can be begun. Assuming the material situated toward *P'* so heated through a considerable portion of its mass nearest the fire-space, the valve *S'* is depressed and the opening *P'* communicates with the external air, while the valve *S²* is raised and the opening *P²* communicates with the gas-suction apparatus for discharging the gas into the reservoir or delivering it to any point where it may be desired for consumption. The flow of oil or oil-vapor at *O* is now regulated and, if desired, mixed with a regulated quantity of water-vapor, which oil, entering the fire-pot, meets the stream of highly-superheated air which has passed the heat-storing material in coming from the opening *P'* to the fire-space. This highly-superheated air containing oxygen causes partial combustion of the oil, thus keeping up the temperature of the fire-pot. The temperature also disassociates the water, when it is present, and a portion of the carbon of the oil unites with the oxygen of the air to form carbon monoxid, while the hydrogen is set free. The lid *R* of course has been closed nearly air-tight or with only a moderate leakage before this action. The products so reacting pass to the right through the heat-storing material on the side of the opening *P²* and gradually give up their heat and pass the opening *P²* practically cold. This process goes on so long as may be desired, or until the gases passing the opening *P²* are beginning to be sensibly warm, or until the air which has entered the opening *P'* has abstracted the larger part of the heat stored in the heat-storing material on that side. When this condition is approached, and before the temperature of the incoming air to the fire-pot is materially or greatly decreased, the lever *L* reverses the valves and they are set for a few moments in the middle position, as in the figures, and then valve *S'* is carried up so as to connect the opening *P'* with the gas-delivery piping and opening *P²* with the external air. Now the heat which was stored

in the material by the gas is returned in the direction of the fire-pot, being taken up by the incoming air, while the combustion is going on in the fire-pot, and the heat accumulated is carried forward and taken up by the material to the left, or toward the opening P², previously cooled by the incoming air. This process goes on indefinitely by periodical reversals given to the valves. It is desirable, of course, that the capacity of the generator be not too great and that the reversals, therefore, be made at fairly frequent intervals, as by that means there is less impoverishment of the gases at each reversal, as a small amount of air necessarily exists in the apparatus which does not pass the fire-pot under these conditions. This does no particular harm to the gas as a fuel-gas, and air is never present in quantity sufficient to give rise to danger of explosion.

Instead of sucking out the gas the apparatus might of course be made to work with pressure-blowers in obvious ways. The generator and its heat-storing material could be divided into one or more sections. Separate openings could be used for the entrance of air and removal of gas. These are obvious changes which it is not necessary to dwell upon. It will also be understood that the oil or water may be fed to the fire-space either in the form of vapor or in the liquid state by being pumped in definite quantity by a suitable pump. Further, a portion of the waste heat around the generator fire-space, in case the walls of the generator are not very thick, could of course, in obvious ways, be used to vaporize the oil or water supplied. The generator, also, for ease of examination and repair, is constructed in two or more parts, which can be separated or unbolted one from the other.

It will be obvious that the parts in Fig. 2 are the same as those in Fig. 1, but seen in a different direction, and there is no need of going into a description thereof, inasmuch as the details of construction may be varied almost indefinitely.

Having above described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. The process of producing and delivering cooled gas from hydrocarbon liquid fuels, consisting in first passing air through a mass of incombustible, inert material in which heat has been stored; then passing the air, so heated, through a fire-space into which is continuously fed, from a suitable supply source, oil, or hydrocarbon in a liquid or vaporous state, in excess; mixing the gases in the fire-space, and, finally, robbing the gaseous products of their heat by passing the same through heat-absorbing and heat-storing, inert, incombustible, material: and altering, or changing at intervals, the inflow of air and outflow of gas, so that the hot gases leaving the fire-space shall give up their heat to the heat-storing material, which heat shall

afterward be taken up by the entering air, to heat said air, while the heat-storing material which has been cooled by the entering air is then heated by the passage through it of the gaseous products leaving the fire-space; whereby the produced gases are delivered in a comparatively cooled state and the heat of combustion is preserved for effecting the necessary chemical reactions, substantially as described.

2. The process of producing and delivering cold gas from hydrocarbon liquid fuels, consisting in first passing air through a mass of incombustible, inert, material in which heat has been stored; then passing the air, so heated, through a fire-space into which is fed continuously oil or hydrocarbon in a liquid or vaporous state, in excess; mixing with said gases watery vapor in regulated amount; and, finally, robbing the gaseous products of their heat by passing the same through heat-absorbing and heat-storing, inert, incombustible material; and altering or changing at intervals the inflow of air and outflow of gas, so that the hot gases leaving the fire-space shall give up their heat to the heat-storing material, which heat shall afterward be taken up by the entering air, to heat said air, while the heat-storing material which has been cooled by the entering air is then heated by the passage through it of the gaseous products leaving the fire-space: whereby the produced gases are delivered in a comparatively cooled state, and the heat of combustion is preserved for effecting the necessary chemical reactions, substantially as hereinbefore set forth.

3. The process of producing gas in a comparatively cool state from liquid hydrocarbons, consisting in feeding a regulated amount of air, water-vapor, and hydrocarbon into a fire-space, kept hot by the combustion of a portion of the hydrocarbon introduced, said air having been previously heated by passing through a regenerator, and said gas being cooled just after its formation by passing through a regenerator containing heat-storing, inert, material; the passage of air and gas being changed at intervals, so that the air and gas will traverse the regenerating portions of the apparatus provided alternately in reaching and leaving the fire-space.

4. The process of producing combustible gas from hydrocarbons, consisting in feeding into a hot space said hydrocarbon in excess as compared with air; simultaneously feeding into said hot space, after having been superheated by passage through a body of inert material at high temperature; and cooling the gas produced by the reactions of the gases of hydrocarbon on the superheated air by causing it to traverse heat-storing, inert, material, the heat stored in which can afterward be utilized to heat the incoming air by reversing the course of the air and gas relatively.

5. The process of producing a combustible

gas from a hydrocarbon liquid or vapor, consisting in feeding into a fire-space said hydrocarbon in excess as compared with air, said air simultaneously fed into said fire-space
5 after having first been superheated by passing through a body of inert, incombustible, heat-storing material; feeding, also, into said fire-space a regulated supply of water or water-vapor for reacting on the free carbon
10 so as to form carbonic oxid and hydrogen; the gases formed by the resulting reactions of said gases being cooled by their passage

through a body of inert, heat-storing material, incombustible in character, the heat stored in which material can afterward be utilized to heat the incoming air by simply reversing the course of the hot gases and the incoming air, relatively.

Lynn, Massachusetts, December 8, 1896.

ELIHU THOMSON.

Witnesses:

JOHN W. GIBBONEY,
ROBERT SHAND.