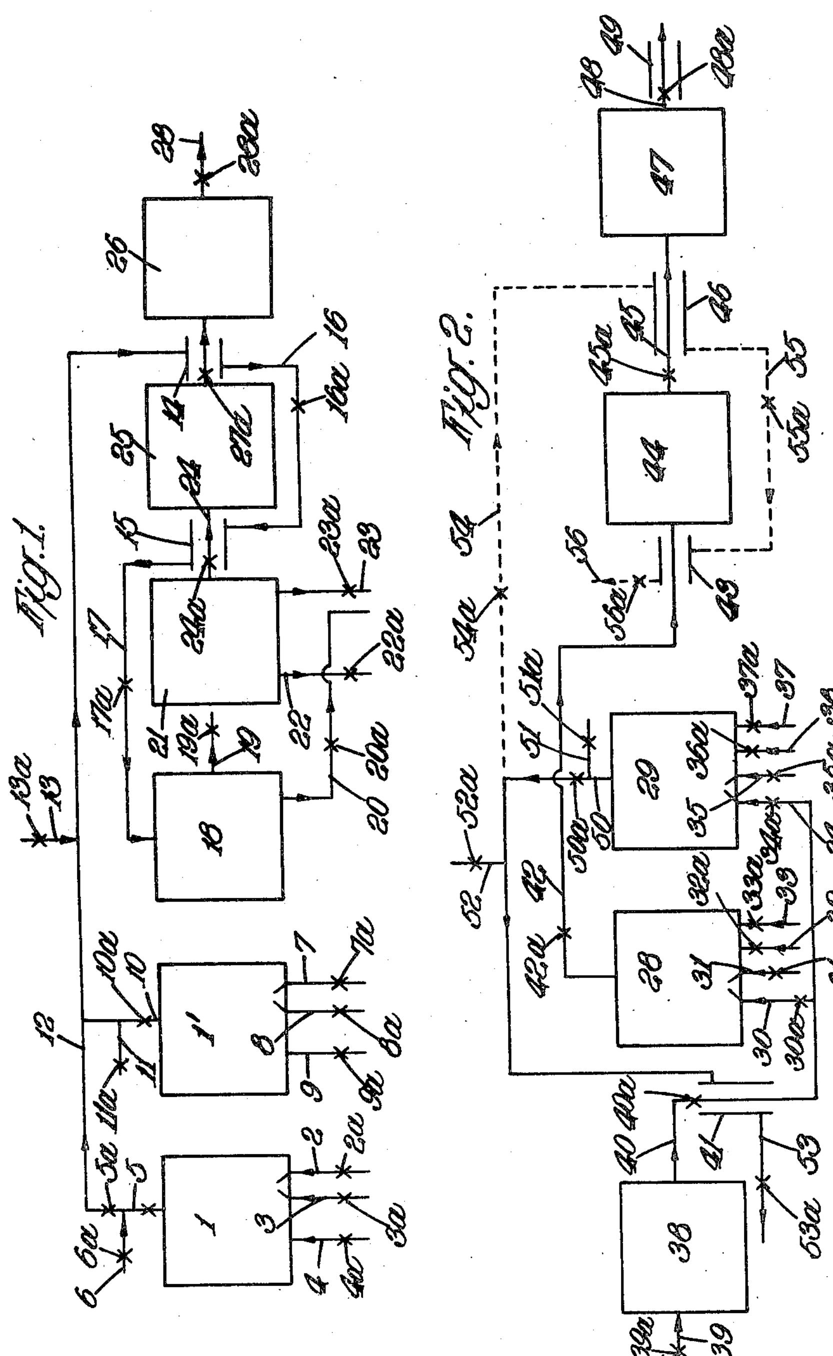
March 6, 1951 M. STEINSCHLAEGER 2,544,188

PROCESS FOR THE MANUFACTURE OF CARBURETED WATER GAS AND LIKE GASES

Filed April 3, 1944 4 Sheets-Sheet 1

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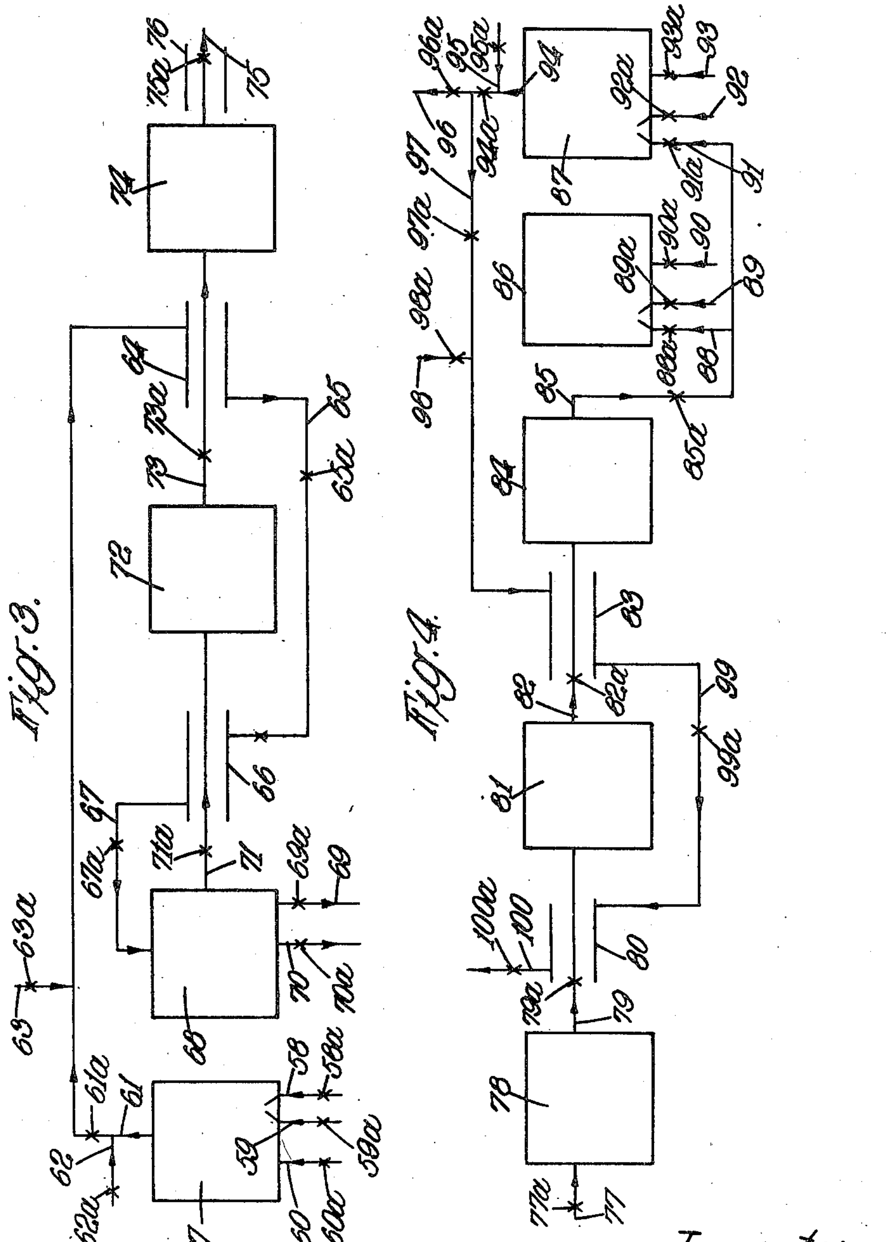
PROCESS FOR THE MANUFACTURE OF CARBURETED WATER GAS AND LIKE GASES

Filed April 3, 1944 4 Sheets-Sheet 2

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Filed April 3, 1944 4 Sheets-Sheet 3

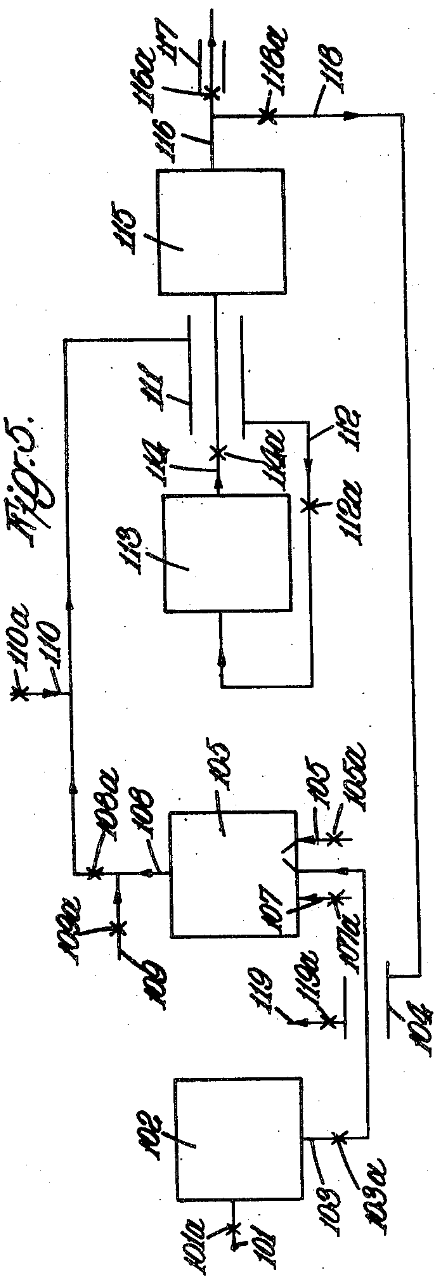


Fig. 5.

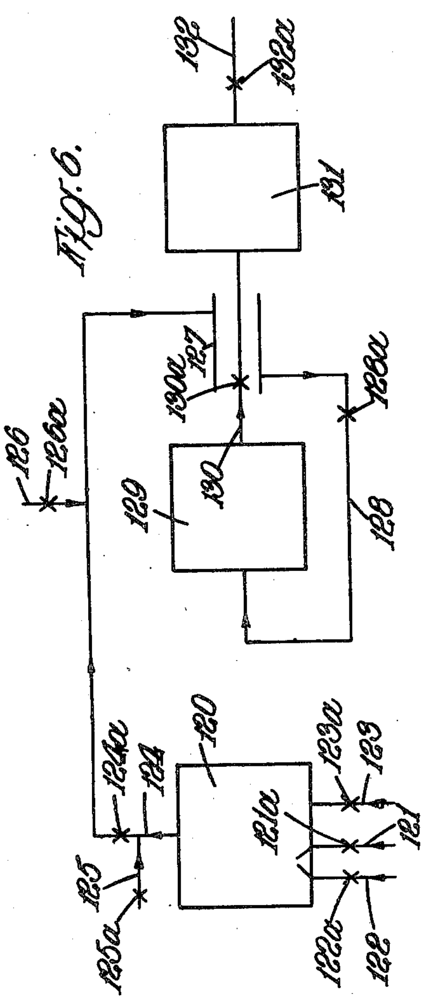


Fig. 6.

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PROCESS FOR THE MANUFACTURE OF CARBURETED WATER GAS AND LIKE GASES

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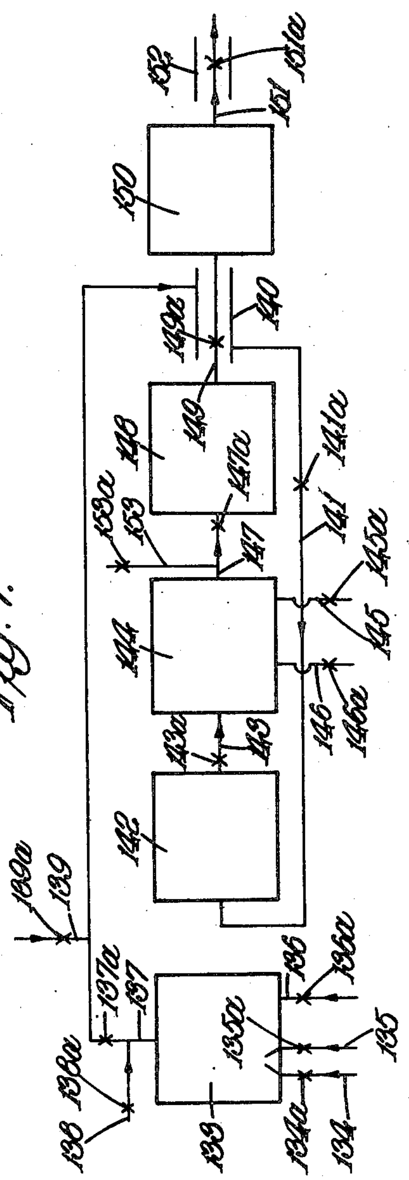
Fig. 7.

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Patented Mar. 6, 1951

2,544,188

# UNITED STATES PATENT OFFICE

2,544,188

## PROCESS FOR THE MANUFACTURE OF CARBURETED WATER GAS AND LIKE GASES

Michael Steinschlaeger, London, England

Application April 3, 1944, Serial No. 529,387
In Great Britain April 29, 1943

3 Claims. (Cl. 48—196)

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This invention relates to a process for the manufacture of carburetted water gas and like gases and it is an object of the present invention to provide an improved process for the manufacture of such gases.

With this object in view the present invention provides a process for the manufacture of carburetted water gas, oil gases, blau gas or similar gases, all of which are hereinafter referred to as carburetted water gas, wherein a regenerator is heated by means of a hot gas to a predetermined temperature, tar and/or oil and/or hydrocarbon gases and steam and/or carbon dioxide are introduced into the heated regenerator to produce water gas and oil and/or tar and/or hydrocarbon gases is introduced into the gases leaving the regenerator which gases are at a temperature and have a sensible heat at least sufficient to crack the oil and/or tar and/or hydrocarbon gases and thus produce carburetted water gas.

It should be understood that the expression "oil" as used hereinafter includes "hydrocarbon gases."

Preferably the heating of the regenerator is effected by burning tar or gas therein but if desired other liquid, solid or gaseous fuels may be used for this purpose. If steam is used in the manufacture of the water gas in the regenerator preferably excess steam is employed. The amount of excess steam used will depend upon the calorific value required in the gas to be produced. The tar and/or oil which is introduced into the regenerator may be pre-heated if desired and various kinds of oils or tars may be used such as crude oils, fuel oils, boiler oils, low or high temperature tars, pitch and water gas tar which can be obtained in the process. Furthermore the steam and/or carbon dioxide employed may be pre-heated.

Preferably two regenerators are employed in conjunction with each other, one regenerator being heated whilst the other regenerator is being used for gas making.

In addition to the production of carburetted water gas, the process also produces as a byproduct a certain amount of tar and this tar is precipitated from the gas produced, for example electrostatically. Preferably the sensible heat, and if desired at least a part of the potential heat, of the gases produced is used for steam generation or power generation, in gas turbines.

As indicated above the temperature of the gases leaving the regenerator must be sufficiently

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high to crack the oil and/or tar injected for carburetting the gas and this cracking can be accomplished in more than one stage at different temperatures, for example a part of the oil and/or tar may be introduced into the gases which are at a temperature of for example 1100° to 1200° C. whereby cracking is effected at a temperature of about 1000° C., and thereafter further oil and/or tar may be introduced into the gas which is now at a temperature of 1000° C. so that cracking takes place at about 750° C.

It will be understood that a different grade of oil and/or tar or different kind of oil and/or tar may be used in the two stages of the cracking referred to above, and the gases leaving the regenerator may be divided into a plurality of streams, each being treated separately and afterwards, if desired, again mixed.

The tar obtained in the cracking process may be partly or wholly re-cycled and in this way it is possible to produce valuable products such as toluene, benzene and other liquid and gaseous hydrocarbons which may be extracted from the gas before it is used. The manufactured gases may be freed from undesirable compounds.

Preferably the tar or oil for burning will be sprayed into the regenerator and for this purpose a part of the energy in the gases produced can be used, or steam, carbon dioxide, or air or other gas or vapour may be used for this purpose.

The calorific value of the gas produced can be regulated by the temperature employed for water gas production in the regenerator; by the proportion of steam, carbon dioxide and the like used; by the cracking temperature chosen; and by the nature and amount of the oil or tar employed for the water gas production.

According to a modification of the invention, a process is provided for the manufacture of carburetted water gas, oil gases, blau gas or similar gases, wherein tar and/or oil and/or powdered coal, oxygen or an oxygen-containing gas and steam and/or carbon dioxide are introduced into a vessel in which a part of the tar or oil or powdered coal is burnt, thus providing the heat necessary to produce water gas and oil and/or tar is introduced into the gases leaving the vessel, which gases are at a temperature and have a sensible heat at least sufficient to crack the oil and thus produce carburetted water gas.

The oxygen or oxygen-containing gases may be pre-heated if desired. The vessel employed in this modification may or may not contain checker bricks.

The process may be operated under pressure and catalysts may be employed in one or more stages of the process.

Some embodiments of the invention will now be described by way of example, with reference to the accompanying drawings, in which Figs. 1 to 7 show diagrammatically seven embodiments of apparatus for carrying into effect the processes of the invention.

Referring to Fig. 1 of the drawings, a pair of regenerators 1 and 1' is provided, each being used alternately. The regenerator 1 is provided with a burner 2 controlled by a valve 2*a*, a conduit 3 controlled by a valve 3*a* for the admission of oil and/or tar and a conduit 4 controlled by valve 4*a* for the admission of steam and/or carbon dioxide. The regenerator 1 is also provided with an outlet conduit 5 controlled by a valve 5*a* with an inlet conduit 6 having an atomiser or spray nozzle controlled by the valve 6*a* for the admission of oil and/or tar for carburetting the gas formed. The regenerator 1' is provided with similar conduits and valves 7, 8, 9, 10 and 11 and 7*a*, 8*a*, 9*a*, 10*a* and 11*a*. The apparatus also comprises a manifold 12, additional conduit 13 with spray nozzle or atomiser controlled by valve 13*a* for admitting further oil and/or tar, heat exchanges 14 and 15, conduits 16 and 17 controlled by valves 16*a* and 17*a* respectively, cooler and precipitator 18, conduits 19 and 20 controlled respectively by valves 19*a* and 20*a*, compressor 21, conduits 22, 23, and 24 controlled respectively by valves 22*a*, 23*a* and 24*a*, turbines 25 and 26, and conduits 27 and 28 controlled respectively by valves 27*a* and 28*a*.

In operation, regenerator 1 is heated by air and fuel admitted through the burner 2, and the regenerator 1' which has been heated in a similar manner in a previous operation is used for gas making. Oil and/or tar is admitted through line 8 and steam and/or carbon dioxide through line 9, the water gas formed leaving through the line 10. Oil and/or tar for carburetting the water gas is admitted through the spray producer or atomiser of the conduit 11, the carburetted gas passing along the manifold 12. Further oil and/or tar is admitted through the spray producer or atomiser of the conduit 13 and the product passes through the heat exchanger 14, giving up part of its heat, and thence proceeds via the conduit 16 and heat exchanger 15, where it gives up more heat, and conduit 17 to the cooler and precipitator 18, where tar is precipitated and removed via the conduit 20. The gas is passed via the conduit 19 to the compressor 21 from whence normally liquid hydrocarbons and normally gaseous hydrocarbons and other gases which are liquefied under the pressure prevailing are removed via the conduit 23. The compressed gas leaving the compressor 21 through the conduit 24 absorbs heat from the heat exchanger 15 and is used to drive the turbine 25. The exhaust gases leaving the turbine 25 via the conduit 27 absorb heat from the heat exchanger 14 and are used to drive the turbine 26. The exhaust gases leaving this turbine can be sent to the consumer at the required pressure, and/or used for heating a boiler and/or heat exchanger, and/or used in the plant.

Referring now to Fig. 2 of the drawings, a pair of regenerators 28 and 29 is provided, each being used alternately. The regenerator 28 is provided with a conduit 30 for compressed air, a fuel conduit 31, a conduit 32 for the admission of oil and/or tar and a conduit 33 for the admission of steam and/or carbon dioxide, controlled respectively by valves 30*a*, 31*a*, 32*a* and 33*a*. The regenerator 29 is provided with similar conduits 34, 35, 36 and 37 controlled respectively by valves 34*a*, 35*a*, 36*a* and 37*a*. The conduits 30 and 34 are fed from the compressor 38 which is supplied with air via conduit 39 controlled by valve 39*a*. The compressed air is conveyed to the conduits 30 and 34 by conduit 40 controlled by valve 40*a*, the conduit passing through a heat exchanger 41. The conduits 30 and 31 and also the conduits 34 and 35 have outlets adjacent each other and constitute burners. In the description which follows it will be assumed that the regenerator 28 is being heated and the regenerator 29, which has been heated in the preceding cycle, is being used for gas making. Certain conduits and valves have been omitted from the drawing for the sake of clarity, as will be explained hereinafter. The apparatus is operated as follows:

The regenerator 28 is heated by burning fuel admitted through conduit 31 by means of air admitted through conduit 30 which is supplied from the compressor 38 by conduit 40. The hot products of combustion under pressure leave the regenerator 28 through conduit 42 controlled by valve 42*a*, and after passing through heat exchanger 43, pass through turbine 44, via conduit 45 controlled by valve 45*a*, through heat exchanger 46 to turbine 47 and thence via conduit 48, controlled by valve 48*a*, through heat exchanger 49. At the same time there is introduced into regenerator 29, which has been heated in a previous operation, oil and/or tar through conduit 36 and steam and/or carbon dioxide through conduit 37 to produce a fuel gas which leaves the regenerator 29 via conduit 50 controlled by valve 50*a*. The gas is carburetted by the injection of oil and/or tar through conduit 51 controlled by valve 51*a* and provided with an atomiser or spray producer, further oil and/or tar being injected in a similar manner via conduit 52 controlled by valve 52*a*. The hot gas is then cooled by passage through the heat exchanger 41 and leaves via conduit 53 controlled by valve 53*a*, whence it can be delivered to the consumer with or without passing through a cooler or condensation plant for the removal of liquids or easily liquefied gases. Alternatively the whole or a part of the gases leaving the regenerator 29 may take the path shown in broken lines, namely, via the conduit 54 controlled by valve 54*a* through the heat exchanger 46, conduit 55 controlled by valve 55*a*, through heat exchanger 43 and thence by conduit 56 controlled by valve 56*a* to the consumer. It will be understood that in the succeeding cycle the functions of the regenerators 28 and 29 will be reversed and each regenerator will be provided with the necessary conduits and valves to enable it to be connected to the appropriate turbines, heat exchangers and the like, these additional connections being omitted from the drawings for the sake of clarity.

Referring to Fig. 3 of the drawings, this illustrates an apparatus in which only one regenerator is employed.

According to this embodiment, a regenerator 57 is provided having a conduit 58 controlled by valve 58*a* for the admission of oxygen or an oxygen-containing gas under pressure, a conduit 59 controlled by valve 59*a* for the admission of oil and/or tar, the conduits 58 and 59 having outlets adjacent each other to constitute a burner. The regenerator 57 is also provided with a conduit 60 controlled by valve 60*a* for the admission of steam and/or carbon dioxide. Oil and/or tar is burnt in the regenerator simultaneously with the admission of the steam and/or carbon dioxide and the gases produced leave the regenerator by the conduit 61 controlled by the valve 61*a*. Oil and/or tar for carburetting the gas is admitted through conduits 62 and 63 controlled respectively by valves 62*a* and 63*a*. The carburetted gases are then cooled in the heat exchanger 64 and proceed via the conduit 65, controlled by valve 65*a*, to the heat exchanger 66 and thence via conduit 67 controlled by valve 67*a* to the cooler and precipitator 68, where liquid hydrocarbons or easily liquefied gases are precipitated and drawn off through conduit 69 controlled by valve 69*a*. A part of the gas is also removed through conduit 70 controlled by valve 70*a*, from whence it is sent to the consumer at the desired pressure. Another part of the gas proceeds via the conduit 71 controlled by valve 71*a* through the heat exchanger 66 to the turbine 72 and thence via conduit 73 controlled by valve 73*a* through the heat exchanger 64 to the turbine 74, from whence the gases are sent to the consumer through the conduit 75 controlled by valve 75*a*, passing through the heat exchanger or cooler 76.

Referring to Fig. 4 of the drawings, this shows a modified form of the apparatus employed in Fig. 3, in which two regenerators are used alternally. According to this embodiment, air is supplied through conduit 77 controlled by valve 77*a* and compressed in the compressor 78 from whence it proceeds via conduit 79 controlled by valve 79*a* and is heated in the heat exchanger 80. It then proceeds through the turbine 81 and thence by the conduit 82 controlled by valve 82*a* to the heat exchanger 83 where it is again heated, and thence through turbine 84 and conduit 85 controlled by valve 85*a* to one or other of the regenerators 86 and 87. The regenerator 86 is provided with a conduit 88 controlled by valve 88*a* for the admission of the compressed air and conduit 89 controlled by the valve 89*a* for the admission of oil and/or tar, the outlets of the conduits 88 and 89 being adjacent each other to constitute a burner. The regenerator 86 is also provided with a conduit 90 controlled by valve 90*a* for the introduction of steam and/or carbon dioxide. The regenerator 87 is provided with similar conduits 91, 92 and 93 controlled respectively by valves 91*a*, 92*a* and 93*a*.

In the followng description it will be assumed that the regenerator 86 is being heated by the admission of air and oil and/or tar, whilst the regenerator 87 which has been heated in a previous cycle has admitted thereto oil and/or tar and steam and/or carbon dioxide. The gases produced leave the regenerator 87 by the conduit 94, controlled by valve 94*a*, oil and/or tar for carburetting the gas being admitted through conduit 95 controlled by valve 95*a*, which is provided with an atomiser or spray producer. Part of the gas is sent to the consumer via conduit 96 controlled by valve 96*a*, the remainder proceeding via conduit 97 controlled by valve 97*a* into which further oil and/or tar is injected by conduit 98 controlled by valve 98*a*, which is also provided with an atomiser or spray producer. After the gas has thus been further carburetted it is cooled in the heat exchanger 83 and proceeds via conduit 99 controlled by valve 99*a* through the heat exchanger 80, in which it is further cooler, and is then sent to the consumer via the conduit 100 controlled by valve 100*a*, with or without passing through the cooler or condenser. It will be understood that the regenerator 86 will likewise be provided with conduits and valves connecting it with conduit 97, and also with a conduit for the introduction of oil and/or tar into the gas produced, but these have been omitted from the drawings for the sake of clarity.

Referring to Fig. 5 of the drawings, air is admitted through conduit 101 controlled by valve 101*a*, into the compressor 102, in which it is compressed. The air leaves the compressor through conduit 103 controlled by valve 103*a*, passing through the heat exchanger 104 to the regenerator 105 into which tar and/or oil is admitted through conduit 106 controlled by valve 106*a*, the outlets of the conduits 103 and 106 being adjacent each other to form a burner. At the same time steam and/or carbon dioxide is admitted through conduit 107 controlled by valve 107*a* and the gas formed in the regenerator 105 leaves via conduit 108 controlled by valve 108*a*, oil and/or tar for carburetting the gas being admitted through conduits 109 and 110 controlled respectively by valves 109*a* and 110*a*. The carburetted gas then passes through the heat exchanger and precipitator 111 in which it is cooled and thence via conduit 112 controlled by valve 112*a* to the turbine 113, from which it passes via the conduit 114 controlled by valve 114*a* again through the heat exchanger 111, in which it is heated, to the turbine 115. Part of the gas leaving the turbine 115 proceeds via conduit 116 controlled by valve 116*a* through the heat exchanger 117 to the consumer. The remainder of the gas proceeds through the conduit 188 controlled by valve 118*a* through the heat exchanger 104, through conduit 119 controlled by valve 119*a* to the consumer.

Referring now to Fig. 6 of the drawings, oxygen is admitted to the regenerator 120 through conduit 121 controlled by valve 121*a*, and oil is admitted through conduit 122 controlled by valve 122*a*, the outlets of the conduits 121 and 122 being adjacent each other to form a burner. At the same time steam and/or carbon dioxide is admitted through conduit 123 controlled by valve 123*a* and the gas produced leaves the regenerator through conduit 124 controlled by valve 124*a*, oil and/or tar for carburetting the gas being admitted through conduit 125 controlled by valve 125*a*, which conduit is provided with an atomiser or spray producer. Oil and/or tar is also admitted in a similar manner through conduit 126 controlled by valve 126*a* and the carburetted gas is then cooled in the heat exchanger 127 and proceeds via conduit 128 controlled by valve 128*a* to the turbine 129, from whence it passes via conduit 130 controlled by valve 130*a* through the heat exchanger 127 to the turbine 131. The gases leave the turbine 131 through conduit 132 controlled by valve 132*a* and are sent to the consumer at the required pressure and temperature with or without passing through a cooler or condenser.

Referring to Fig. 7 of the drawings, air or oxygen is admitted to the regenerator 133 through conduit 134 controlled by valve 134*a*, and oil and/or tar is admitted through conduit 135 controlled by valve 135*a*, the outlets of conduits 134 and 135 being adjacent each other to form a burner. At the same time steam and/or carbon dioxide is admitted through conduit 136 controlled by valve 136*a* and the gas produced leaves the regenerator through conduit 137 controlled by valve 137*a*, oil and/or tar for carburetting the gas being admitted through conduits 138 and 139, controlled respectively by valves 138a and 139a, each conduit being provided with an atomiser or spray producer. The carburetted gas is then cooled in the heat exchanger 140 and passes via conduit 141 controlled by valve 141a to the cooler 142, where it is further cooled and thence proceeds by conduit 143 controlled by valve 143a to the compressor 144, in which it is compressed. The liquid hydrocarbons and easily liquefied gases which condense in the compressor 144 are removed through conduit 145 controlled by valve 145a, and part of the gas under pressure leaves the compressor by conduit 146 controlled by valve 146a, and is sent to the consumer. The remainder of the gases leave the compressor 144 by conduit 147 controlled by valve 147a and proceeds to the turbine 148 from whence it passes via conduit 149 controlled by valve 149a through the heat exchanger 140 to the turbine 150, the gas leaving the turbine then being sent to the consumer via conduit 151 controlled by valve 151a after passing through the heat exchanger 152 with or without passing through a further condenser. If desired the temperature of the gases in the conduit 147 may be increased by admitting air through the conduit 153 controlled by valve 153a so that a part of the gas is burnt. It will be understood that the proportion of air must not be such as will make an explosive mixture.

It will be understood that the oil, tar, steam, carbon dioxide, air or oxygen used may be so admitted to the various vessels that they atomise the oil and/or tar used for heating the regenerators, or some of the gas manufactured in the process may be used for this purpose.

Furthermore, the precipitator used may be an electrostatic precipitator.

The term "oil" as used in the appended claims refers to hydrocarbon oils, tars, and hydrocarbon gases or mixtures thereof.

I claim:

1. A process of making carburetted water gas with simultaneous cracking of heavier hydrocarbons to produce a fixed gas for the carburettion and a liquefiable fraction, which comprises introducing oil and at least one substance selected from the group consisting of steam and carbon dioxide into a regenerator heated to a temperature sufficient to promote reaction of the oil hydrocarbons with the selected substance to form water gas and sufficient to insure that the resulting water gas product discharges therefrom at a temperature of at least 1100° C., leading the water gas from said regenerator and thereafter, while the gas is still heated to a temperature of at least 1100° C. and in the absence of checker brick contact material, introducing oil into said gas and causing cracking thereof solely by the sensible heat contained in said gas, and thereafter separating and recovering the liquefiable hydrocarbons resulting from the cracking treatment.



2. A process according to claim 1 in which the sensible heat remaining in the water gas at the conclusion of the carburetting and cracking stage is in large part recovered and returned to a succeeding stage of the gas-making process.

3. A process of making carburetted water gas with simultaneous cracking of hydrocarbons to produce a fixed gas for the carburettion, which comprises introducing hydrocarbons and at least one substance selected from the group consisting of steam and carbon dioxide into a regenerator heated to a temperature sufficient to promote reaction of the hydrocarbons with the selected substance to form water gas and sufficient to ensure that the resulting water gas product discharges therefrom at a temperature of at least 1100° C., leading the water gas from said regenerator and thereafter, while the gas is still heated to a temperature of at least 1100° C., and in the absence of checker brick contact material, introducing hydrocarbons into said gas and causing cracking thereof solely by the sensible heat contained in said gas.

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