AMENDED SPECIFICATION

Reprinted as amended in accordance with the Decision of the Superintending Examiner, acting for the Comptroller-General, dated the twenty-fifth day of October, 1948, under Section 11 of the Patents and Designs Acts, 1907 to 1946.

PATENT SPECIFICATION

561,338

Application Date: Aug. 11, 1942. No. 11243/42.

Complete Specification Left: May 26, 1943.

Complete Specification Accepted: May 16, 1944.

3631

PROVISIONAL SPECIFICATION

A Process for the Manufacture of Water Gas and like Gases

I, MICHAEL STEINSCHLAEGER, of 50, Portsea Hall, Connaught Square, London, W.2, of no nationality, formerly of Russian nationality, do hereby declare the nature of this invention to be as follows:—

This invention relates to the manufacture of blue water gas and like gases such as synthesis gases containing carbon monoxide and hydrogen for example in ratios varying from 1:2 to 1:1 all of which are hereinafter referred to collectively as "blue water gas or like gases."

It is well known that by producing blue water gas or like gases it is advantageous to use pre-heated steam and air.

It is an object of the present invention to provide a simple and efficient process for the production of blue water gas and like gases with the advantages of using pre-heated air and steam.

According to the present invention in the manufacture of blue water gas a unit consisting of a generator and regenerator is used, in manufacturing carburetted water gas a unit consisting of a generator, carburettor and superheater is used and in manufacturing synthesis gas a unit consisting of a generator and two regenerators is used.

The process can be applied to generator constructions in which the ash leaves the generator in solid condition or fluid condition and to generators with hand or mechanically operated ash discharge. The points at which the hot gas, steam or air leave or enter the generator will depend upon the generator system used. For instance in a generator with mechanically operated ash discharge the hot gases, steam or air may be introduced and removed above the grate. In this case it is also possible to dispense with a jacket boiler.

By using the process of the present invention the depth of the reaction zone can be considerably increased because the blow gases can be allowed to leave the reaction zone at a higher temperature and resulting therefrom the capacity of the generator is considerably increased.

The velocity of the blow gases and the temperature of the blow gases leaving the reaction zone in the generator is chosen according to the temperature required in the reaction zone and the pre-determined depth of the reaction zone. The amount of the blow gases is low and for this reason in most cases the pressure will be lower than in generators operating without pre-heated air despite the high velocity of the latter. As the blow gases are rich in carbon dioxide and part of the heat necessary for the reaction is brought in with the pre-heated steam the coke consumption per cubic metre of gas produced is lower than in the best of the hitherto known processes.

The following description shows in greater detail the operation of the process as applied to the production of different gases and using different fuels.

1. Production of carburetted water gas from coal.

By using coal it is possible to produce a gas which has a higher calorific value than ordinary blue water gas produced from coke. The operation is then as follows:

Gas making period: The gas is made in the up direction. Steam is sent through the superheater to the generator the gases produced and undecomposed steam leaving the reaction zone are used for the

[Price 2/-]

carbonisation of the coal which has been preheated to a temperature at which carbonisation begins by the blow gases leaving the reaction zone. If the temperature of the blow gases is too high and so the coal is pre-heated to a higher temperature than is required, the coal can be introduced at a time most suitable to achieve the pre-determined temperature or a part or the whole of the blow gases can be brought out at the side and not at the bottom of the generator.

The sensible heat and the temperature of the mixture of water gas, coal gas, cracked tar and undecomposed steam is used and is sufficient to evaporate and crack the injected oil without using a carburettor or superheater (if necessary the oil can be pre-heated, or the amount of undecomposed steam increased or the temperature of the reaction zone increased). The sensible heat of the carburetted water gas produced is used for heating the carburettor (this heat is used for pre-heating the air required for blowing and secondary combustion).

As the calorific value of the gas produced before injecting the oil is higher than is the case when blue water gas is produced in the hitherto usual manner (the absolute calorific value depends on the composition of the coal used) the amount of the oil used is considerably decreased although the same calorific value is obtained in the carburetted water gas as when using other processes.

Blow period: The air is brought through the carburettor to the generator and the superheater is heated with the blow gases.

2. Production of carburetted water gas from coke.

Gas making period: Steam is sent through the superheater for pre-heating and then to the generator. The gas is made in the up direction. The necessary amount of cold or pre-heated oil is injected into the mixture of gas produced and undecomposed steam. The sensible heat of the mixture is sufficient to evaporate and crack the oil and no carburettor and superheater are required. The coke is charged at a time to be sufficiently pre-heated with the blow gases leaving the reaction zone, so as not to cool down to any considerable extent the gases made in the up gas making. The sensible heat of the carburetted water gas produced is used for heating the carburettor and for air pre-heating in the blow period.

Blow period: Air is sent through the carburettor to the generator the blow gases are used to heat the superheater to the pre-determined temperature for steam pre-heating. The rest of the heat in the blow gasses is used for steam raising.

Instead of steam water can be injected into the superheater so producing the steam with the required temperature and pressure for the reaction and saving the expenditure for a boiler or a part of the expenditure for a boiler. This form of operation is preferable in producing gases of higher calorific value under pressure.

3. Blue water gas production from coke.

Gas making period: The gas is made in the down direction. By introducing the steam at the upper part of the generator the steam is pre-heated with the heat stored in the coke to near the reaction temperature before reching the reaction zone. The heat stored in the coke is obtained from the blow gases leaving the reaction zone and going to the outlet of the generator. Besides this heat the heat necessary for the coke going to the reaction zone is also provided by the blow gases. The sensible heat of the produced gases and undecomposed steam is used for heating the regenerator.

Blow period: Air is sent through the regenerator for pre-heating and then this air is brought into the generator in which the air is further pre-heated with heat stored in the ash blowing the reaction zone to the pre-determined temperature. The amount of air used and consequently the temperature of the blow gases leaving the reaction zone is determined by the heat necessary to store in the coke for pre-heating the steam and the coke for the reaction.

4. Production of synthesis gases from coke and gases.

The plant consists of a generator and two regenerators (I and II) and is operated in the following way: Regenerator I is used for pre-heating the air and the Regenerator II is used for decomposing coke oven gas, carbonisation gases, residual gases, mixtures of these gases or any other gaseous or fluid hydrocarbons or fuels. If necessary the gases before used are freed from carbon dioxide, sulphur compounds, and the like. According to the synthesis process used and the composition of the gases required the above mentioned fuels are mixed with the steam or carbon dioxide necessary for the decompostion reaction.

Blow period: Air or pre-heated air is sent through the regenerator I and from there to the generator. The blow gases leave the reaction zone with a high temtemperature and a part of the heat is stored in the coke and used to heat the coke bed to the required temperature. The blow gases leaving the generator

after addition of secondary air or pre-heated secondary air are mixed with residual gases or other fuels and used for heating the regenerator II.

Gas making period: The whole or a greater part of the gases is made in the down direction, introducing the steam or carbon dioxide or pre-heated steam or carbon dioxide or other gases necessary for the reaction through the hot coke bed to the reaction zone, or pre-heating the steam to near the reaction zone temperature. The gases and the undecomposed steam or carbon dioxide leaving the generator or the gases leaving the regenerator II are used for pre-heating the regenerator I. Regenerator II is used for decomposing residual gases (if necessary the residual gas can be freed from carbon dioxide before further treatment), coke oven gases or any other gaseous or liquid hydrocarbons used in the process or any mixture of them. The above mentioned gases with the exception of the residual gases of the hydrocarbon synthesis are preferably freed from sulphur compounds before the decomposition reaction.

In producing primary products rich in olefines using gases rich in carbon monoxide the gases leaving the generator are freed from their sulphur contents and then mixed with a greater part of the decomposed residual gas leaving the regenerator II. The gas thus obtained is used as a synthesis gas if necessary after adjusting the ratio of $CO:H_2$.

If residual gas is used alone or in admixture a part of the undecomposed or decomposed gas is taken out of the circulation and used for heating the regenerator or for producing primary products and in the latter case the residual gas II is used for heating purposes The amount of the residual gases so taken out is dependent on the inert content, which is allowable or desirable in the synthesis gases. By producing synthesis gases with an approximate ratio of $CO:H_2=1:2$ the following method is used. Before mixing the sulphur-free water gas (coming from the generator through the sulphur purification plant) with the decomposed gas the water gas or a part of it is sent through a conversion plant and preferably a carbon dioxide washing-out plant or the gas can be mixed with a hydrogen rich gas so as to adjust the ratio of $CO:H_2$ to the required proportion. Instead of converting the water gas the decomposed gas can be converted and freed from carbon dioxide.

If desirable in this case as in other cases catalysts can be used for the decomposition reaction.

5. Production of synthesis gases from coal.

By using coal for synthesis gas production a generator and three regenerators are preferably used.

Gas making period: Steam or carbon dioxide or pre-heated steam or carbon dioxide (heated for instance in a heat exchanger with the sensible heat of the decomposed gases leaving the regenerators I, II or III or pre-heated in the regenerators I and III) is brought into the generator. The gas is made in the up direction. The gases leaving the reaction zone are used to pre-heat further the coal and to carbonise the same. The gases leaving the generator are brought with the necessary amount of steam or carbon dioxide or other gases used in or for the reaction into the regenerator II for decomposing. The amount of steam, or carbon dioxide brought into the generator is preferably chosen so high as to be sufficient for the water gas reaction and the decomposing reaction. The sensible heat of the gases leaving the regenerator II can be used for preheating the steam and carbon dioxide and for heating the regenerators I and III (alternately) in the gas making period. The regenerators I and III are used for the decomposing of the residual gases, coke oven gas and the like.

Blow period: Air pre-heated in the regenerators I or III is brought into the generator. The blow gases leaving the reaction zone are used for pre-heating the coal to a temperature where carbonisation just begins. The blow gases leaving the generator are, after addition of secondary air or pre-heated secondary air and residual gases or pre-heated residual gases or other fuels, used for heating the regenerators II and I or III (one of the regenerators I or III is used in the blow cycle for air pre-heating).

In a plant consisting of more generator units more suitable conditions of operation can be applied and less regenerators are required per generator unit. This applies to the production of other gases and in using fuels other than coal.

Dated this 11th day of August, 1942.

ELKINGTON & FIFE,
Consulting Chemists and
Chartered Patent Agents,
Bank Chambers,
329, High Holborn, London, W.C.1,
Agents for the Applicant.

COMPLETE SPECIFICATION

A Process for the Manufacture of Water Gas and like Gases

I, MICHAEL STEINSCHLAEGER, of 50, Portsea Hall, Connaught Square, London, W.2, of no nationality, formerly of Russian nationality, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to the manufacture of water gas and like gases such as synthesis gases containing carbon monoxide and hydrogen for example in ratios varying from 1:3 to 2:1 all of which are hereinafter referred to collectively as "water gas or like gases," but this term as used herein does not include carburetted gases and is concerned with the provision of an intermittent process for the manufacture of water gas and like gases of the type in which a bed of solid fuel in a generator provided with a grate is subjected to alternate blow periods by blowing with air, oxygen or oxygen rich gases and gas making periods (hereinafter referred to as "an intermittent process for the manufacture of water gas and like gases of the type described)."

The process of this invention comprises the combination of a number of features each known *per se*. Furthermore it is known to use in combination the pre-heating of gases used in a gas making period by the heat of gases produced in a blowing period and the pre-heating of gases used in a blowing period by the heat of gases produced in a gas making period.

It is an object of the present invention to provide a simple and efficient intermittent process for the production of water gas and like gases with the advantages of using pre-heated air and superheated steam.

According to the present invention, an intermittent process for the manufacture of water gas and like gases of the type described is provided in which:

(1) the velocity of the gases used in the blow period is chosen according to the temperature and depth of the reaction zone required;

(2) the blow gases and the gases introduced into and produced in the generator during up and/or down gas making, are respectively introduced into and removed from the generator at a point or points at which they will not adversely affect the parts of the generator with which they come into contact and at which a part of the heat in the introduced gases can be stored in the solid fuel or ash in the generator, and at least a part of each of such gases is introduced or removed, as the case may be, above the grate and below the reaction zone;

(3) the gases produced are removed from the generator at a point or points at which they possess the heat required for the purpose for which they are to be utilised;

(4) the heat necessary for the reaction in the generator and to compensate for heat losses being provided partly by pre-heating the gases used during the blow period by the use of the heat of the gases produced in a gas making period, with or without admixture with other gases, and by pre-heating the gases introduced into the generator during the gas making period by the use of the heat of the gases leaving the generator in a blow period, with or without admixture with other gases, part of the heat of the gases leaving the reaction zone being stored in the ash bed and/or in the fuel bed.

In the process of the invention as applied to the production of a synthesis gas, preferably gas produced in a gas making period in the generator is mixed with a gas containing carbon monoxide and hydrogen produced in a regenerator which has been wholly or partly heated by the gases leaving the generator in a blowing period.

The process can be applied to generator constructions with hand or mechanically operated ash discharge. In a generator with mechanically operated ash discharge it is possible to dispense with a jacket boiler.

By using the process of the present invention the depth of the reaction zone can be considerably increased because the blow gases can be allowed to leave the reaction zone at a higher temperature and resulting therefrom the capacity of the generator is considerably increased.

The velocity of the blow gases and the temperature of the blow gases leaving the reaction zone in the generator is chosen according to the temperature required in the reaction zone and the pre-determined depth of the reaction zone. The amount of the blow gases is low and for this reason in most cases the pressure will be lower than in generators operating without pre-heated air despite the high velocity of the latter.

The following description shows in

greater detail the operation of the process as applied to the production of different gases and using different fuels.

1. Blue water gas production from coke.

The operation is illustrated in Figs. 1 to 3 of the accompanying diagrammatic drawings, in which:

Fig. 1 is a flow sheet showing a blowing period,

Fig. 2 is a similar flow sheet showing a down gas making period, and

Fig. 3 is a similar flow sheet showing an up gas making period.

Down gas make period: Referring to Fig. 2 of the drawings, by introducing the steam at the upper part of the generator 23 through line 24 (the steam having been admitted through line 25 to the regenerator 26) the steam is superheated with the heat stored in the coke 23*b* to near the reaction temperature before reaching the reaction zone 23*a*. The heat stored in the coke is obtained from the blow gases leaving the reaction zone and going to the outlet of the generator. Besides this heat the heat necessary for heating the coke going to the reaction zone is also provided by the blow gases. The sensible heat of the gases produced and undecomposed steam leaving the generator through lines 27 is used for heating a regenerator (not shown).

Blow period: Referring to Fig. 1 of the drawings, air is sent through a regenerator (not shown) for pre-heating and then this air is brought through line 28 into the generator 23 in which the air is further pre-heated with heat-stored in the ash blowing the reaction zone 23*a* to the pre-determined temperature. The amount of air used and consequently the temperature of the blow gases leaving the reaction zone and passing through line 24 to regenerator 26 is determined by the heat necessary to store in the coke for superheating the steam in the subsequent gas making period and the pre-heating of the coke for the reaction. The air can also be wholly pre-heated in the ash using one regenerator only for superheating the steam.

Up gas makeing period: Referring to Fig. 3 of the drawings, steam is sent through the regenerator 26 heated in the blow period described above and thereby superheated and then introduced at the bottom of the generator 23 via lines 21 and 27, additional steam being admitted through line 28. The sensible heat of the gases produced and undecomposed steam leaving the generator through line 24 is used for heating a regenerator (not shown).

2. Production of synthesis from coke and gases.

The operation is illustrated in Figs. 4 and 5 of the accompanying drawings, in which:

Fig. 4 is a flow sheet showing a blowing period, and

Fig. 5 is a similar flow sheet showing a gas making period.

Referring to Figs. 4 and 5 of the drawings the plant consists of a generator 29 and two regenerators 30 and 31 and is operated in the following way: Regenerator 30 is used for pre-heating the air and the regenerator 31 is used for decomposing coke oven gas, carbonisation gases, residual gases, mixtures of these gases or any other gaseous or fluid hydrocarbons or fuels. If necessary the gases before use are freed from carbon dioxide, sulphur compounds, and the like. According to the synthesis process used and the composition of the gases required the above mentioned fuels are mixed with the steam or carbon dioxide necessary for the decomposition reaction.

Blow period: Referring to Fig. 4 of the drawings, air or pre-heated air admitted through line 32 is sent through the regenerator 30 and from their via lines 33 and 34 to the generator 29. The blow gases leave the reaction zone 29*a* with a high temperature and a part of the heat is stored in the coke 29*b* and used to heat the coke bed to the required temperature. Additional air is admitted through line 40 to the generator 29. The blow gases leaving the generator through line 35 before or after addition of secondary air or pre-heated secondary air admitted through line 36 may be mixed with residual gases or other fuels admitted through line 37 and used for heating the regenerator 31.

Gas making period: The whole or a greater part of the gases is made in the down direction and this is the process illustrated in Fig. 5 of the drawings.

Referring to Fig. 5 of the drawings, steam or carbon dioxide, or superheated steam or carbon dioxide or other gases necessary for the reaction is introduced by lines 38 and 39 through the hot coke bed 29*b* to the reaction zone 29*a*, thus superheating the steam to near the reaction zone temperature. The gases and the undecomposed steam or carbon dioxide leaving the generator 29 via lines 34 and 34*a* or the gases leaving the regenerator 31 are used for heating the regenerator 30. Regenerator 31 is used for decomposing residual gases (if necessary the residual gas can be freed from carbon dioxide before further treatment), coke oven gases or any other gaseous or liquid hydrocarbons used in the process or any

mixture of them. The said gases are admitted through lines 31*c*, 31*a* and steam and/or carbon dioxide through line 31*d*. The abovementioned gases with the exception of the residual gases of the hydrocarbon synthesis are preferably freed from sulphur compounds before the decomposition reaction.

In producing primary products rich in olefines using gases rich in carbon monoxide the gases leaving the generator 29 are freed from their sulphur contents and then mixed with a greater part of the decomposed residual gas leaving the regenerator 31 via line 31*a*, the mixing taking place in line 41. The remainder of the gas leaves regenerator 31 via line 31*b*. The gas thus obtained is used as a synthesis gas if necessary after adjusting the ratio of $CO:H_2$.

If residual gas is used alone or in admixture a part of the undecomposed or decomposed gas is taken out of the circulation and used for heating the regenerator or for producing primary products and in the latter case the residual gas is used for heating purposes. The amount of the residual gases so taken out is dependent on the inert content, which is allowable or desirable in the synthesis gases. In producing synthesis gases with an approximate ratio of $CO:H_2=1:2$ the following method is used. Before mixing the sulphur-free water gas (coming from the generator through the sulphur purification plant) with the decomposed gas the water gas or a part of it is sent through a conversion plant and preferably a carbon dioxide washing-out plant or the gas can be mixed with a hydrogen rich gas so as to adjust the ratio of $CO:H_2$ to the required proportion. Instead of converting the water gas the decomposed gas can be converted and freed from carbon dioxide.

If desirable in this case as in other cases catalysts can be used for the decomposition reaction.

3. Production of synthesis gases from coal.

When using coal for synthesis gas production a generator and three regenerators are preferably used.

The operation is illustrated in Figs. 6 to 9 of the accompanying drawings, in which:

Fig. 6 is a flow sheet which shows a blowing period,

Fig. 7 is a similar flow sheet showing a gas making period.

Fig. 8 is a similar flow sheet showing a second blowing period, and

Fig. 9 is a similar flow sheet showing a second gas making period.

First gas making period: Referring to Fig. 7 of the drawings, steam or carbon dioxide or superheated steam or preheated carbon dioxide (heated for instance in a heat exchanger with the sensible heat of the decomposed gases leaving the regenerators 43, 44 or 45 or pre-heated in the regenerators 43 and 45) is brought into the generator 42 through lines 46, 47 and 48. The gas is made in the up direction. The gases leaving the reaction zone 42*a* are used to preheat further the coal and to carbonise the same. The gases leaving the generator 42 through line 49 are brought with the necessary amount of steam or carbon dioxide or other gases used in or for the reaction into the regenerator 44 for decomposing. The amount of steam, or carbon dioxide brought into the generator is preferably chosen so high as to be sufficient for the water gas reaction and the decomposing reaction. The sensible heat of the gases leaving the regenerator 44 can be used for superheating the steam and pre-heating carbon dioxide and for heating the regenerators 43 and 45 (alternately) in the gas making period. The regenerators 43 and 45 are used for the decomposing the residual gases, coke oven gas and the like.

Thus, in regenerator 43 steam and residual gas are admitted through lines 50 and 51 respectively, the gases produced leaving through line 52. In the regenerator 45 air and fuel are admitted through lines 53 and 54 respectively for heating the regenerator.

Second blow period: Referring to Fig. 8 of the drawings, air admitted through line 55 pre-heated in the regenerator 43 is brought into the generator 42 through line 56. The blow gases leaving the reaction zone 42*a* are used for pre-heating the coal 42*b* to a temperature where carbonisation just begins. The blow gases leaving the generator through line 57 are, after addition of secondary air or preheated secondary air through line 58 and residual gases or pre-heated residual gases or other fuels through line 59, used for heating the regenerator 44. The regenerator 45 is used for decomposing residual gas admitted through line 62 by steam admitted through line 63.

Referring to Fig. 9 of the drawings, which illustrates the second gas making period, steam or carbon dioxide is admitted through line 46 into the generator 42 and the products leave through line 49 and pass to regenerator 44. Regenerator 43 is heated by the admission of fuel through line 60 and air through line 61. Steam admitted through line 62 reacts with residual gas admitted through line 63 in the regenerator 45, the gases pro-

duced leaving through line 64.

Referring to Fig. 6 of the drawings, air is introduced through line 65 into the regenerator 45 and passes through line 66 to the generator 42. The blow gases leave the generator by line 67 and pass after the addition of further fuel through line 68 and air through line 69 to the regenerator 44 to heat the same. Steam is admitted through line 50 and residual gas through line 51 to the regenerator 43. The gas produced leaves through line 52.

In a plant consisting of more generator units more suitable conditions of operation can be applied and less regenerators are required per generator unit. This applies to the production of other gases and in using fuels other than coal.

A further modification of the process wherein tar or low temperature tar and synthesis gas can be obtained is described below.

A plant consisting of a generator and one or two regenerators is used.

The plant is operated in the following way.

Blow period: Air or oxygen-containing gases or pre-heated air or oxygen-containing gases are brought into the generator for blowing and the blow gases leave the generator at the side at a point or points level with the end of the reaction zone. From there the blow gases are brought before or after the addition of secondary air into a regenerator to heat the same. The heated regenerator is used for heating the steam, carbon dioxide or the like in the following gas-making period. The air can be pre-heated in a regenerator and/or with the heat stored in the ash.

Gas making period: Steam, carbon dioxide or the like is superheated or pre-heated in the regenerator and is brought into the generator above the grate into the reaction zone. The gases produced and undecomposed steam, carbon dioxide or the like leaving the reaction zone go through the coal bed thus carbonizing the coal and the mixture of the gases produced, steam, carbon dioxide, tar and carbonisation gases is brought out at the top of the generator to the regenerator or direct to the cooling or removal plant for tar and other desirable components or impurities. The gas thus obtained is used as synthesis gas either alone or in admixture with decomposed residual gases or other gases. If required the composition of the synthesis gas may be adjusted by the addition of other gases.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. An intermittent process for the manufacture of water gas and like gases of the type described in which

(1) the velocity of the gases used in the blow period is chosen according to the temperature and depth of the reaction zone required;

(2) the blow gases and the gases introduced into and produced in the generator during up and/or down gas making, are respectively introduced into and removed from the generator at a point or points at which they will not adversely affect the parts of the generator with which they come into contact and at which a part of the heat in the introduced gases can be stored in the solid fuel or ash in the generator, and at least a part of each of such gases is introduced or removed, as the case may be, above the grate and below the reaction zone;

(3) the gases produced are removed from the generator at a point or points at which they possess the heat required for the purpose for which they are to be utilised;

(4) the heat necessary for the reaction in the generator and to compensate for heat losses being provided partly by pre-heating the gases used during the blow period by the use of the heat of the gases produced in a gas making period, with or without admixture with other gases, and by pre-heating the gases introduced into the generator during the gas making period by the use of the heat of the gases leaving the generator in a blow period, with or without admixture with other gases, part of the heat of the gases leaving the reaction zone being stored in the ash bed and/or in the fuel bed.

2. A process as claimed in claim 1 applied to the production of a synthesis gas wherein gas produced in a gas making period in the generator is mixed with a gas containing carbon monoxide and hydrogen produced from hydrocarbons and steam in a regenerator which has been wholly or partly heated by the gases leaving the generator in a blowing period.

3. An intermittent process for the manufacture of water gas and like gases substantially as described.

4. Water gas and like gases when manufactured by the process claimed in any one of the preceding claims.

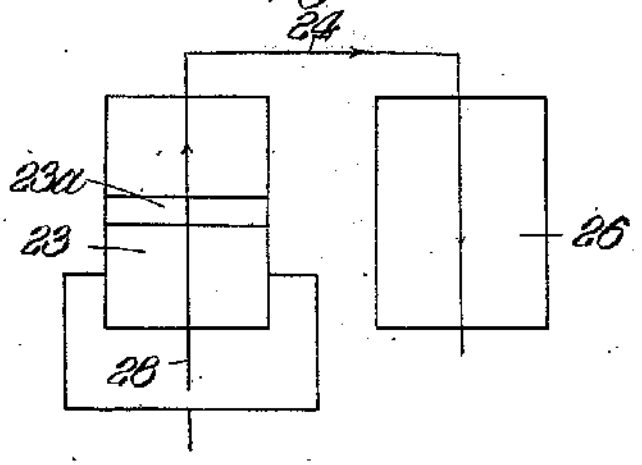
Dated the 26th day of May, 1943.

ELKINGTON & FIFE,
Consulting Chemists and
Chartered Patent Agents,
Bank Chambers,
329, High Holborn, London, W.C.1,
Agents for the Applicant.

Leamington Spa: Printed for His Majesty's Stationery Office, by the Courier Press.—1949.
Published at The Patent Office, 25, Southampton Buildings, London, W.C.2, from which copies, price 2s. 0d. each (inland) 2s. 1d. (abroad) may be obtained.

[This Drawing is a reproduction of the Original on a reduced scale.]

Fig. 1.



[This Drawing is a reproduction of the Original on a reduced scale.]

Fig. 2.

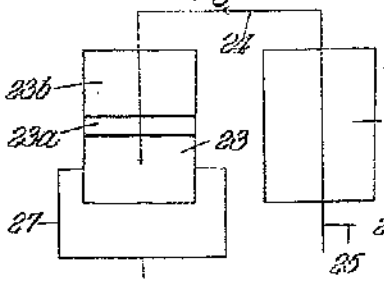


Fig. 3.

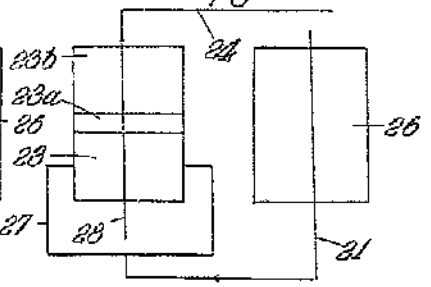


Fig. 4.

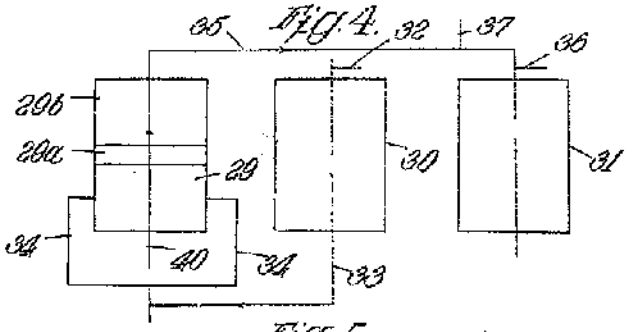


Fig. 5.

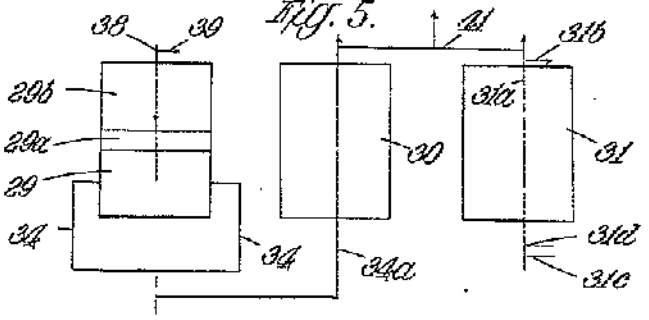
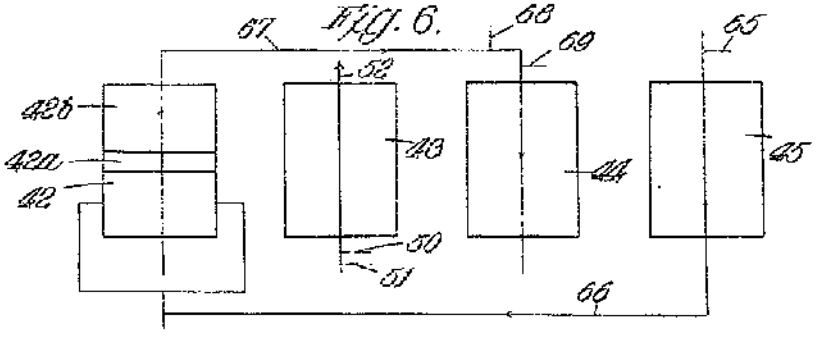


Fig. 6.



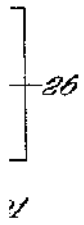


Fig. 7.

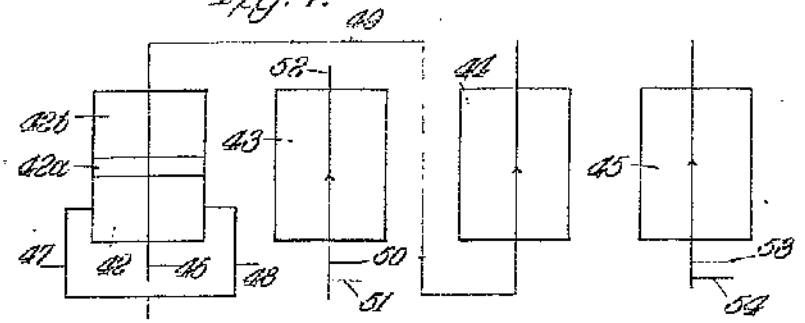


Fig. 8.

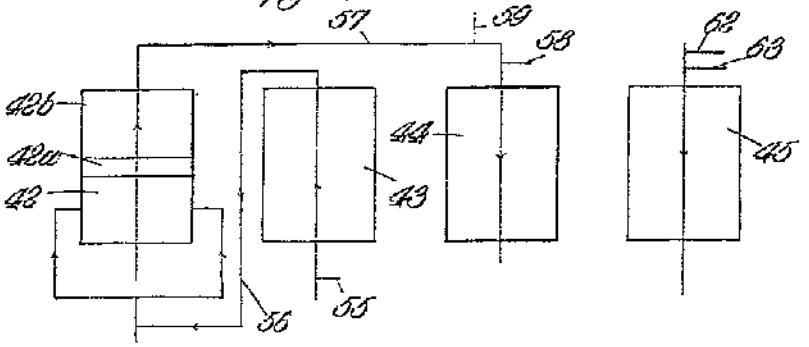
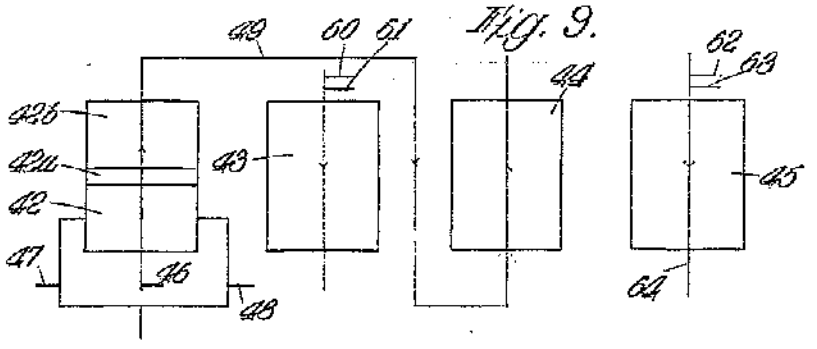
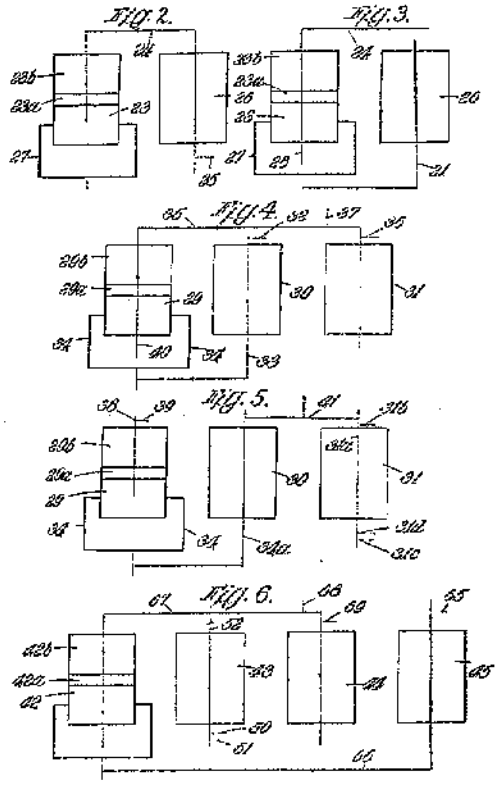


Fig. 9.



551,338 AMENDED SPECIFICATION

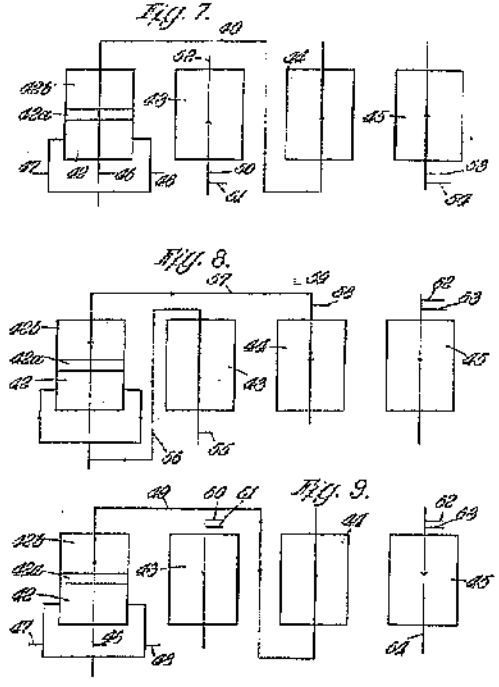
SHEET 2



[This Drawing is a reproduction of the Original on a reduced scale.]

5 SHEETS

SHEET 3



H.M.S.O. (75 R)