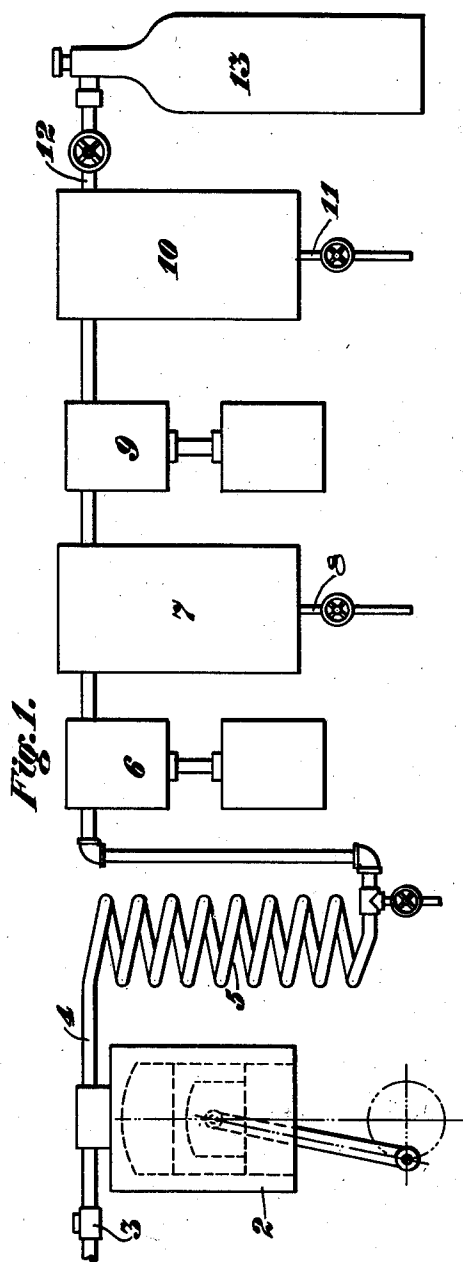


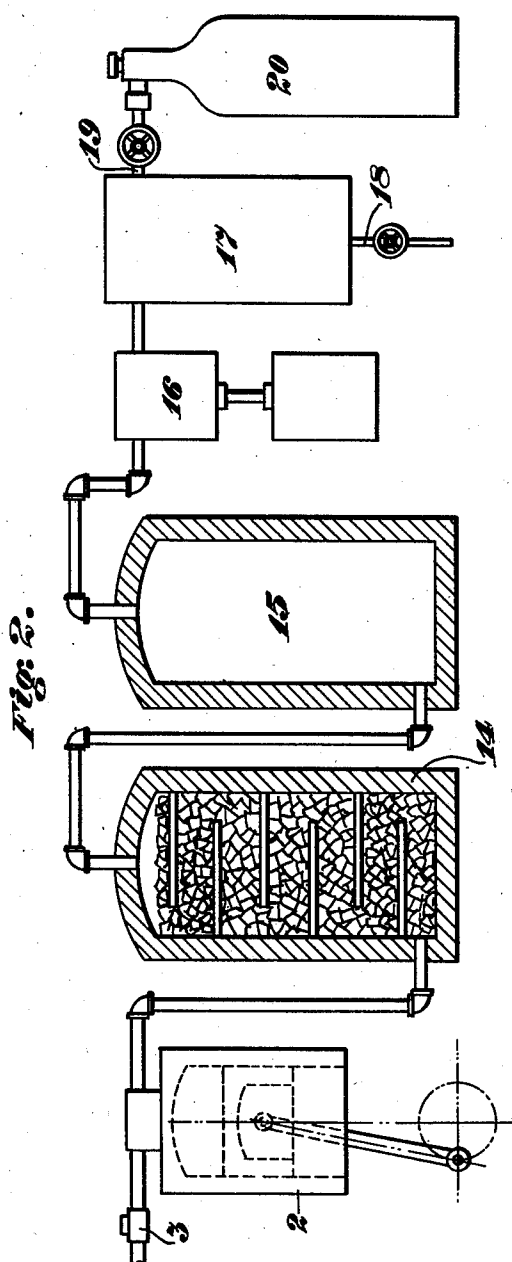
R. H. BROWNLEE & R. H. UHLINGER.
 PROCESS OF MAKING CARBON MONOXID, HYDROGEN, AND NITROGEN.
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1,107,581.

Patented Aug. 18, 1914.



Witnesses:
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UNITED STATES PATENT OFFICE.

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PROCESS OF MAKING CARBON MONOXID, HYDROGEN, AND NITROGEN.

1,107,581.

Specification of Letters Patent.

Patented Aug. 18, 1914.

Application filed April 12, 1913. Serial No. 760,673.

To all whom it may concern:

Be it known that we, ROY H. BROWNLEE and ROY H. UHLINGER, citizens of the United States, residing at Pittsburgh, in the county of Allegheny and State of Pennsylvania, have invented certain new and useful Improvements in Processes of Making Carbon Monoxid, Hydrogen, and Nitrogen, of which the following is a specification.

Our invention consists of an improved method or process of making carbon monoxid, hydrogen and nitrogen by utilizing the products of combustion of internal combustion or explosion engines, or other combustion chamber, whereby to produce the carbon monoxid and hydrogen from the original combustible substance, and in so doing extract the oxygen from the air used to support the combustion or explosion, and so also obtain nitrogen, in the manner more fully hereinafter described.

The process may be carried out in connection with suitable installation of mechanism and will be readily understood by reference to the accompanying diagrammatic drawings, showing the principal elements employed.

In practising the invention, natural gas, coal gas, or other suitable gaseous, liquid or solid carbonaceous substance, is mixed in any suitable manner, with an insufficient amount of air for complete combustion, and the mixture is exploded in the cylinder of an internal combustion engine, or is exploded or burned in any suitable chamber. The terms "exploded" and "burned" may be understood as synonymous in so far as they indicate combustion generally, differing merely in rate or speed. It is intended that the mixture shall be so regulated as to be supplied with only sufficient air for incomplete combustion of the carbonaceous material, *i. e.*, in suitable amount for producing the largest practicable yield of carbon monoxid and hydrogen, and under these conditions practically all of the oxygen is removed from the air, leaving the nitrogen. For example, if natural gas is used, a mixture of approximately 1 volume of gas to 6½ volumes of air is preferably employed with a compression before explosion of seventy to eighty pounds, although a mixture differing from the above may be employed and exploded or burned under any pressure desired.

Under the above conditions considerable power is produced and at the same time good yields of carbon monoxid and hydrogen are obtained. The mixture of water vapor, carbon dioxid, carbon monoxid, hydrogen and nitrogen resulting after the combustion or explosion is then cooled to remove the moisture, then compressed, and the carbon dioxid and carbon monoxid and nitrogen liquefied in turn, thus leaving very pure hydrogen in the gaseous state, but highly compressed. The carbon monoxid and nitrogen will be liquefied together and are separated by absorbing the carbon monoxid in a suitable absorbent, thus leaving nitrogen for further use, or by maintaining the mixed liquefied gases under proper conditions of temperature and pressure, the two substances may be separated by fractional distillation, using the same apparatus, with intermittent steps of operation.

It will be further understood that instead of compressing and liquefying the carbon dioxid, etc., after the removal of moisture by cooling, we may absorb the carbon dioxid with suitable absorbents, as calcium oxid or hydroxid (lime) and likewise the carbon monoxid with suitable absorbents, as ammoniacal cuprous chlorid, leaving the nitrogen and hydrogen to be separated by compression and liquefaction of the nitrogen.

The process may be carried out by the use of apparatus similar to that shown in our copending application, Serial No. 760674, for process of making carbon monoxid and hydrogen.

Referring to the diagrammatic drawings, Figure 1, 2 is an internal combustion engine or other suitable chamber, to which the mixture of carbonaceous material and air is supplied in the normal manner from the mixer 3 and compressed and exploded in the engine chamber. The resulting products of combustion, water vapor, carbon dioxid, carbon monoxid, hydrogen and nitrogen pass by exhaust pipe 4 to a suitable chamber or refrigerating coil 5, or through several such, where the gases are chilled and the moisture separates as water, thence to compressor 6 where the gases are compressed and the carbon dioxid is liquefied and collected in a holder 7 provided with a suitable draining pipe 8. The carbon monoxid and nitrogen pass thence to a compressor 9 where the

gases are further compressed and the carbon monoxid and nitrogen are liquefied and collected in a holder 10. The remaining hydrogen passes through outlet 12 to a receiver or holder 13.

In Fig. 2, the exhaust gases from the engine 2, or other combustion chamber, are carried to an absorption tower or chamber 14 where the carbon dioxid is absorbed by lime, the remaining gases passing by a suitable conduit to a similar tower or chamber 15 where the carbon monoxid is absorbed, the gases passing thence finally to a compressor 16. Being compressed, the resulting liquefied nitrogen collects in a receiver 17 having a drain pipe 18, and the remaining hydrogen in gaseous state passes off through conduit 19 to a receiver 20 and may be therein stored and compressed for further use.

What we claim is:

1. The process of making carbon monoxid, hydrogen and nitrogen consisting in mixing a carbonaceous substance with an amount of air sufficient to support incomplete combustion of the mixture to produce a maximum amount of carbon monoxid and hydrogen but insufficient to support combustion sufficiently complete to produce the normal

amount of carbon dioxid and water, exploding the mixture in a suitable chamber, and then separately separating the carbon monoxid, hydrogen, and nitrogen from the other products of combustion, substantially as set forth.

2. The process of making carbon dioxid, carbon monoxid, hydrogen and nitrogen consisting in mixing a carbonaceous substance with an amount of air sufficient to support incomplete combustion of the mixture to produce a maximum amount of carbon monoxid and hydrogen but insufficient to support combustion sufficiently complete to produce the normal amount of carbon dioxid and water, exploding the mixture in a suitable chamber, and then separately separating the carbon dioxid, carbon monoxid and nitrogen, and hydrogen, substantially as set forth.

In testimony whereof we hereunto affix our signatures in the presence of two witnesses.

ROY H. BROWNLEE.
ROY H. UHLINGER.

Witnesses:

C. M. CLARKE,
FREDK. STAUB.