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PROCESS AND APPARATUS FOR PRODUCING INERT GASES.

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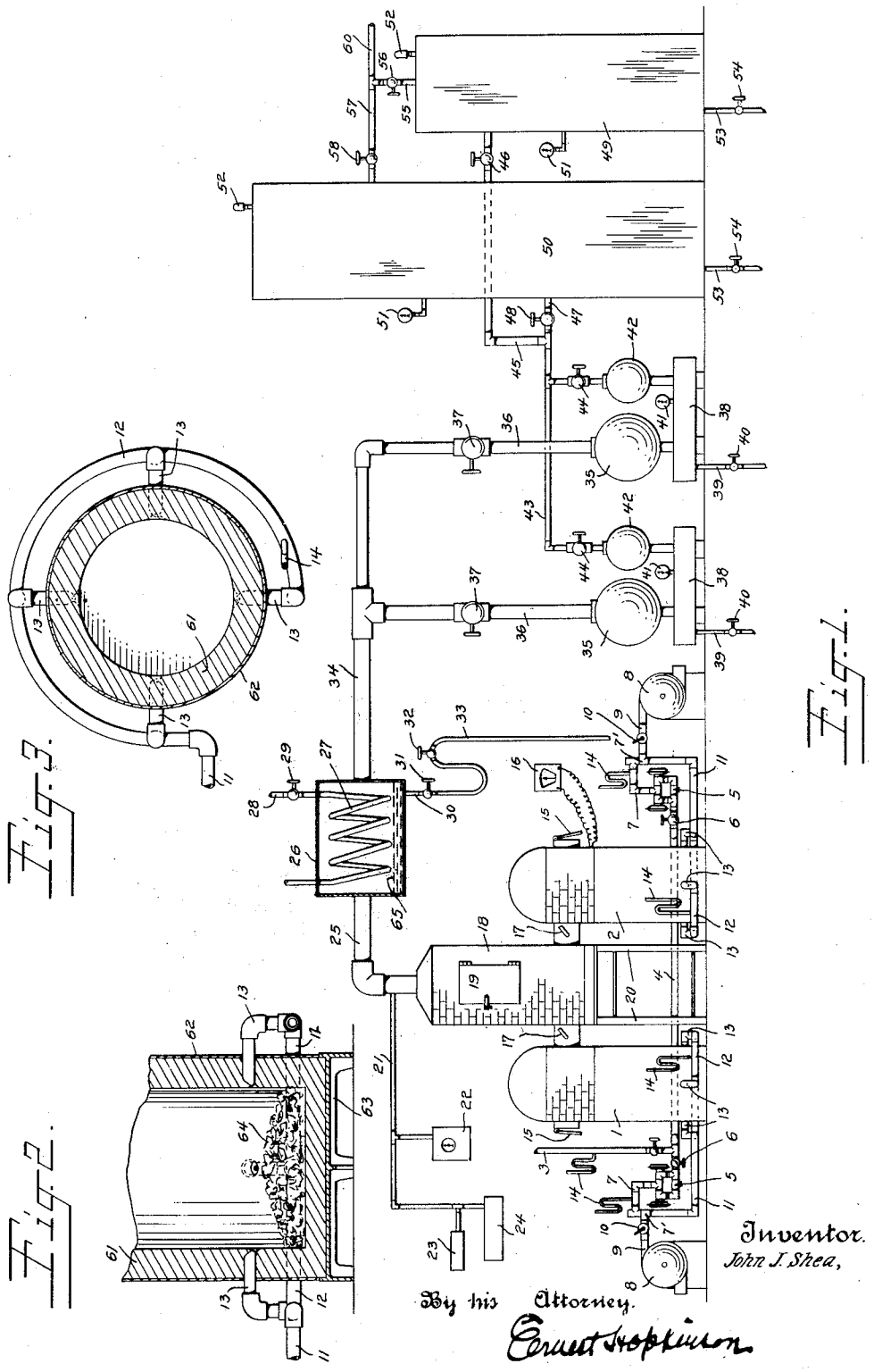


Fig. 1.

Fig. 2.

Fig. 3.

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PROCESS AND APPARATUS FOR PRODUCING INERT GASES.

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To all whom it may concern:

Be it known that I, JOHN J. SHEA, a citizen of the United States, residing at Hartford, county of Hartford, State of Connecticut, have invented certain new and useful Improvements in Processes and Apparatus for Producing Inert Gases, of which the following is a full, clear, and exact description.

This invention relates to a process and apparatus for producing inert gases, and more particularly to a process and apparatus for producing inert gases from a city gas supply.

It has been the practice wherever inert gases were needed for various commercial processes to produce them by burning solid fuel with just sufficient air to effect complete combustion to carbon dioxid or to burn limestone rock and collect the carbon dioxid gases expelled in suitable receivers. In both of these methods of production one disadvantage has been that the cost of transporting the fuel and limestone needed for the respective processes has been considerable and thereby increased the cost of production. Another disadvantage has been that it was a difficult matter to exclude oxygen entirely from the gases produced by either process. A third method has been to purchase cylinders of carbon dioxid on the market and employ these wherever inert gases were needed. This also involved the cost of transportation and made it necessary to operate with small units and had the disadvantage that a special structure had to be provided for uniform gas pressures.

This invention has as an object the provision of a process and apparatus for manufacturing an inert gas containing a very small proportion of oxygen, and to provide means for controlling the amout of oxygen in said gases. It has also as an object to provide a process and apparatus for producing inert gases in large quantities and at uniform gas pressures. It has also as an object to manufacture such gases very cheaply without the troublesome handling and transportation of raw materials. Another object is to provide a process and apparatus which is efficient in operation, easy to operate and control, and inexpensive.

The invention accordingly includes a process which comprises mixing combustible gas with air in sufficient quantity to effect complete combustion on ignition without excess of air, burning the mixture, and removing water vapor from the gases of combustion. The invention also includes an apparatus comprising the combination of a gas combustion furnace, a source of gas and air supply connected thereto, and a combustion chamber connected by a flue to the furnace.

The apparatus in its preferred form is illustrated in the accompanying drawings which form part of this specification.

In the drawings:

Figure 1 represents an elevation of the entire apparatus or system for producing inert gases.

Fig. 2 shows a vertical section of the lower portion of the gas combustion furnace.

Fig. 3 shows a horizontal sectional view of the furnace taken through a plane above the nozzles.

The complete system will be first described. Two gas combustion furnaces substantially identical in construction, are shown connected to a system of piping for the admission of gas. The furnaces are designated by numerals 1 and 2 and are supplied with gas from a source of gas supply through pipe 3 which delivers to a pipe 4 serving to supply the gas to either or both furnaces. Pipe 3 is provided with a valve for turning on the gas supply and valves 6, 6 are provided in pipe 4 for admitting gas to furnaces 1 and 2 respectively. Gas regulating devices 5 designed to function automatically, are placed in the circuit from pipe 4 there being one such regulator for each furnace, and these automatic regulators serve to keep the gas pressure constant with respect to the air supply in order to secure proper combustion. Any type of gas regulator may be used, the drawing illustrating a diaphragm valve diagrammatically. Such valves operate to adjust the gas admission orifices by the movement of the diaphragm under gas pressure fluctuations.

From the regulators 5, pipes or conduits 7 lead to mixing chambers or mixing valves 7′ into which air is forced by air blowers 8 through pipes 9 provided with valves 10. The mixing valves 7′ may be of the internal atomizer type wherein the two gas streams are blown against or into each other thereby effecting a mixture. The pipes 11

lead from the mixing chambers 7′ and are connected to manifolds 12 encircling the furnaces. Projecting up from the manifolds at suitable intervals are gas nozzles 13 entering the furnaces which serve to admit gas into the combustion chambers. The U-tubes 14 are provided on the manifolds, on pipe 3, and on the pipes 7 for the purpose of measuring gas pressures in inches of water.

The furnaces are provided with relief valves 15 and may be provided with pyrometers 16 (only one being shown on the drawing, connected to furnace 2). From the furnaces flues provided with dampers 17 lead to a combustion chamber 18. The structure of this combustion chamber is simple in that it is built up of refractory material such as fire brick with an empty space inside for the passage of gases. It may be provided with shelves holding perforated trays containing cast iron chips for the purpose of absorbing or combining with residual oxygen in the gases of combustion. A door 19 is provided for entrance to the combustion chamber. The latter is suitably supported by any system of supports such as 20.

A pipe 21 is connected to the gas main above the combustion chamber and to it are connected a carbon dioxid gas recorder 22, a tube 23 for Orsatt apparatus, and pressure gage 24. A gas main or pipe 25 connects the combustion chamber with the condenser 26 which is cooled by a coil 27 to which a cooling medium such as water is admitted by a pipe 28 provided with valve 29. The condenser has a blow-off pipe 30 provided with valve 31 which may be in the form illustrated or may be made in the form of a drip device cut off at point 33 and provided with a valve 32 for regulating the flow of liquid. The blow-off or drip device can be made to remove the condensed liquids in the condenser at any desired rate.

The condenser 26 is connected with a pumping means 35 by pipe 34 and pipes 36 provided with valves 37. The pumping means consists of two two stage, compound steam driven, gas compressors and they are provided with cooling chambers 38 between the compressors 35 and 42. These cooling chambers may be cooled in any desired way, and serve to cool the gases as they pass from the low pressure pump 35 to the high pressure pump 42, the gas thus being compressed from low to high pressure in two stages and any water or other liquid which is condensed after the first compression is removed in the condenser or cooler 38 through blow-offs 39 provided with valves 40. Pressure gages 41 are attached to the coolers 38. From the compressors 42, pipe 43, provided with valves 44, leads by a branch pipe 45 provided with valve 46 to storage tank 49. Another pipe 47 provided with valve 48 leads from pipe 43 to storage tank 50. Tank 50 and tank 49 are provided with pressure gages 51, safety valves 52 and blow-offs 53 containing valves 54. From tank 49 to pipe containing valve 56 connects to pipe 57 containing valve 58 which leads into tank 50, thus providing means for interchange of gases between the two tanks. A pipe 60 leads from pipes 55 and 57 to the point of use or consumption of the gases, and it will be seen that the gases in either tank or both tanks may be passed through pipe 60 to the point of use or consumption. These tanks are constructed to withstand a high gas pressure in case it is desired to employ a gas at high pressure.

The furnaces are constructed of refractory material 61 such as fire brick, and the bricks are surrounded by a steel casing 62 and supported by a suitable base 63. Inside of the furnace are placed loose heaps of refractory material such as refractory aluminum oxid or alundum. These refractory pieces may be united by a refractory cement. The nozzles are so constructed that the gas is deflected downwardly upon the loosely piled refractory material in a manner to cause combustion to take place upon the surfaces thereof. The furnaces are provided with suitable doors lined with fire brick and lighting or ignition holes at convenient places in the sides thereof (not shown).

While the drawing shows only two storage tanks, it is to be understood that a larger number may be provided for the purpose of having on hand a large supply of gas. The number of furnaces is not necessarily limited to two only, but a number of them may be provided leading to one retort or several retorts in order to provide for continuous production of gas or to keep the system running in case one or more furnaces are in need of repair. Similarly several two stage gas compressors may be employed in the system although it is only necessary in the plant herein shown to keep one running, the other compressor being held in reserve in case of accidents to the other.

The preferred method of carrying out the process of this invention is as follows: A gas such as illuminating gas, city gas, or other combustible gas is passed through pipe 3 from a suitable source of supply such as the ordinary city gas pipes, into the gas regulators 5 which serve to automatically regulate the gas pressure so that when the gas is mixed with the air blown in by blower 8, a constant ratio of gas to air will be maintained. The gas and air are mixed at the juncture of the gas and air pipes by a suitable mixing device or valve shown at 7′ and pass through the manifold 12 and nozzles 13 into the furnaces. As previously mentioned the gases are deflected down-

wardly by the nozzles onto the refractory material 64 and the gases are burned on the surfaces of the refractory particles with the result that complete combustion of the gases is obtained. The gases of combustion pass from the furnaces upwardly into the combustion chamber where combustion is completed and the gases are partially cooled before passing to the condenser 26. In the latter the water vapor formed during combustion is condensed and precipitated to the bottom of the condenser as a layer of water 65 which may be drawn off through pipe 30 as previously described. The gases pass from the condenser to the compressor 35 which compresses them to a certain degree and during this compression any remaining water vapor is condensed while passing through the cooler 38, and the water therein precipitated is removed by pipe 39. The gases are then compressed to a higher pressure by the compressor 42 and forced under this high pressure into tanks 49 or 50 as desired, from which the gases are drawn off through pipe 60 to the point of consumption.

It is necessary to carefully proportion the mixture of air and gas passing to the furnaces so that just sufficient oxygen will be present for the complete combustion of the gases without having any appreciable excess of oxygen. It has been found practicable in this process to so regulate the gas pressure that a mixture of air and gas is constantly obtained which will when burned result in gases of combustion containing a large amount of nitrogen and a smaller amount of carbon dioxid with only about one-half or at the most 1% of oxygen. In case it is desired to remove the last traces of oxygen from the gases of combustion, cast iron chips may be placed in the combustion chamber 18 as previously described and these chips will absorb excess oxygen from the gases at the temperature prevailing within the combustion chamber. It has been found, however, that these chips are not necessary and that they require considerable attention because they have to be moved about frequently to expose fresh surfaces, and that it is easier to regulate the proportions of incoming gases in order to eliminate oxygen.

The following is an analysis of an inert gas produced by the process above described but of course the gases produced by such a process and apparatus may vary in composition from time to time, according to circumstances: carbon dioxid 13½%, nitrogen 71%, steam 15%, oxygen ½%.

Illuminating gas or city gas fluctuates in composition at times, and in case CO is not objectionable in the inert gases, the supply of air to the furnaces can be so restricted that CO will always be present in the gases of combustion, thereby avoiding any oxygen content. Otherwise cast iron chips can be placed in the combustion chamber, or the gas supply can be regulated from time to time.

In case SO_2 or sulfur compounds are not desired in the inert gases, they may be removed by passing the gas on its way to the furnaces, through a suitable SO_2 absorbent material, or the purification may take place at any point in the system after the gases are burned.

It will accordingly be evident that this system and process is capable of producing inert gases by the combustion of combustible gases such as city gas, in sufficient quantities and in an efficient and economical manner requiring but ordinary attention during the operation, and that the gases produced are very low in oxygen content, generally below ½%, and are free of condensible vapors such as water vapor.

As many apparently widely different embodiments of this invention may be made without departing from the spirit thereof, it is to be understood that I do not intend to limit myself to the specific embodiment herein set forth, except as indicated in the appended claims.

Having thus described my invention, what I claim and desire to protect by Letters Patent is:

1. A process for producing inert gases substantially free of oxygen gas comprising mixing a combustible gas with air in sufficient quantity to effect complete combustion on ignition without excess of air, burning the mixture on refractory surfaces, and removing water vapor from the gases of combustion.

2. A process for producing inert gases substantially free of oxygen gas comprising mixing combustible gas with air in sufficient quantity to effect complete combustion on ignition without excess of air, burning the mixture on refractory surfaces, removing water vapor from the gases of combustion, and compressing the substantially water-free gases.

3. A process for producing inert gases substantially free of oxygen gas comprising mixing combustible gas with air in sufficient quantity to effect complete combustion on ignition without excess of air, and burning the mixture while impinging it against pieces of refractory material in a spacious furnace.

4. A process for producing inert gases substantially free of oxygen gas comprising mixing the combustible gas with air in sufficient quantity to effect complete combustion on ignition without excess of air, burning the mixture while impinging it on refractory surfaces in a spacious furnace and passing the resulting gases through a combustion chamber.

5. A process for producing inert gases substantially free of oxygen gas comprising mixing combustible gas with air in sufficient quantity to effect complete combustion on ignition without excess of air, burning the mixture and passing the resulting gases through a combustion chamber to complete the combustion and cool the gases, and removing water from the gases.

6. A process for producing inert gases substantially free of oxygen gas comprising mixing combustible gas with air in sufficient quantity to effect complete combustion on ignition without excess of air, burning the mixture while impinging it against refractory surfaces in a spacious furnace, passing the gases through a combustion chamber to complete the combustion and cool the gases, and removing water from the gases.

7. A process for producing inert gases substantially free of oxygen gas comprising mixing a combustible gas with air in sufficient quantity to effect complete combustion on ignition without excess of air, burning the mixture while impinging it on refractory surfaces in a spacious chamber, and removing water vapor from the gases of combustion.

8. A process for producing inert gases substantially free of oxygen gas comprising mixing combustible gas with air in sufficient quantity to effect complete combustion on ignition without excess of air, burning the gases, passing them through a substantially empty combustion chamber, removing water vapor from the gases of combustion, and compressing the gases.

9. A process for producing inert gases substantially free of oxygen gas comprising burning a mixture of combustible gas and air and passing the gases through a combustion chamber containing particles of cast iron.

10. A process for producing inert gases substantially free of oxygen gas comprising continuously mixing a combustible gas with air in sufficient quantity to effect complete combustion on ignition without excess of air, continuously regulating the gas pressure to maintain said proportion of gas and air, burning the mixture, passing the gases through a combustion chamber to complete the combustion and partly cool them, cooling the gases and removing the water condensed, compressing the gases in two stages, removing condensed water, and passing them under pressure into storage tanks.

11. A process for producing inert gases substantially free of oxygen gas comprising continuously mixing combustible gas with air in sufficient quantity to effect complete combustion on ignition without excess of air, continuously regulating the gas pressure to maintain said proportion of gas and air, burning the mixture, passing the gases through a combustion chamber to complete the combustion and partly cool them, cooling the gases and removing the water condensed, compressing the gases in two stages, cooling the gases after the first stage and removing the water condensed thereby, and passing them under pressure into storage tanks.

12. A process for producing inert gases substantially free of oxygen gas comprising continuously mixing a combustible gas with air in sufficient quantity to effect complete combustion on ignition without excess of air, continuously regulating the gas pressure to maintain said proportion of gas and air, burning the mixture on refractory surfaces, passing the gases through a combustion chamber to complete the combustion and partly cool them, cooling the gases and continuously removing the water condensed, compressing the gases in two stages removing condensed water, and passing them under pressure into storage tanks.

13. An apparatus for producing inert gases comprising the combination of a gas combustion furnace, a source of gas and air supply connected thereto, and a substantially empty combustion chamber connected to the exhaust of the furnace.

14. An apparatus for producing inert gases comprising the combination of a gas combustion furnace, a source of gas and air supply connected thereto, a substantially empty combustion chamber connected to the exhaust of the furnace, and a cooler provided with means for withdrawing condensed gases.

15. An apparatus for producing inert gases comprising the combination of a gas combustion furnace, a source of gas and air supply connected thereto, means for regulating the admission of gas, and a substantially empty combustion chamber connected to the exhaust of the furnace.

16. An apparatus for producing inert gases comprising the combination of a gas combustion furnace, a source of gas and air supply connected thereto, means for regulating the admission of gas, a substantially empty combustion chamber connected to the exhaust of the furnace, and means for removing condensable vapors.

17. An apparatus for producing inert gases comprising the combination of a gas combustion furnace, a source of gas and air supply connected thereto, a combustion chamber connected to the exhaust of the furnace, a cooler provided with means for withdrawing condensed gases, and a two stage gas compressor provided with intermediate means for cooling the gases and removing the condensed gases.

18. An apparatus for producing inert gases comprising the combination of a gas

combustion furnace, a source of gas and air supply connected thereto, a combustion chamber connected to the exhaust of the furnace, a cooler provided with means for withdrawing condensed gases, a two stage gas compressor provided with intermediate means for cooling the gases and removing the condensed gases, and gas storage tanks.

19. An apparatus for producing inert gases comprising the combination of gas combustion furnaces provided with refractory combustion surfaces and gas admission nozzles, a source of gas supply provided with a gas pressure regulator, an air supply, a mixing chamber for gas and air connected to said supplies and furnace nozzles, a substantially empty combustion chamber connected to the exhaust of the furnace, a gas cooler connected to the combustion chamber and provided with means for removing condensed gases, a two stage gas compressor provided with means for removing condensed water, and gas storage tanks.

20. An apparatus for producing inert gases comprising the combination of furnaces provided with refractory combustion surfaces and gas admission nozzles, a source of gas supply provided with a gas pressure regulator, an air supply, a mixing chamber for gas and air connected to said supplies and furnace nozzles, a substantially empty combustion chamber provided at its base with flues leading to the furnaces, a gas cooler connected to the combustion chamber and provided with means for removing condensed gases, a gas compressor, a gas cooler provided with means for removing condensed water, a second gas compressor, and storage tanks for receiving the compressed gases.

21. An apparatus for producing inert gases comprising the combination of a gas combustion furnace provided with refractory combustion surfaces, a source of gas and air supply connected thereto, and a combustion chamber connected to the exhaust of the furnace.

22. An apparatus for producing inert gases comprising the combination of furnaces provided with refractory combustion surfaces and gas admission nozzles, a source of gas supply provided with gas pressure regulators, an air supply, a mixing chamber for gas and air connected to said supplies and furnace nozzles, and a combustion chamber connected to the exhausts of said furnaces.

23. An apparatus for producing inert gases comprising the combination of a gas combustion furnace containing refractory material providing combustion surfaces, an air and a gas supply connected thereto provided with means for regulating the admission of gas, and a combustion chamber connected to the exhaust of the furnace.

24. An apparatus for producing inert gases comprising the combination of a gas combustion furnace containing refractory material providing combustion surfaces, an air and a gas supply connected thereto provided with means for regulating the admission of gas, and a substantially empty combustion chamber connected to the exhaust of the furnace.

25. An apparatus for producing inert gases comprising the combination of a gas combustion furnace containing refractory material providing combustion surfaces, an air and a gas supply connected thereto provided with means for regulating the admission of gas, a mixing chamber for air and gas, and a combustion chamber connected to the exhaust of the furnace.

26. An apparatus for producing inert gases comprising the combination of a gas combustion furnace containing refractory material providing combustion surfaces, an air and a gas supply connected thereto provided with means for regulating the admission of gas, a mixing chamber for air and gas, a combustion chamber connected to the exhaust of the furnace, and a gas cooler connected to the chamber and provided with means for removing condensed gases.

Signed at Hartford, Connecticut, this 30th day of March, 1920.

JOHN J. SHEA.