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INERT GAS PRODUCING APPARATUS

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INERT GAS PRODUCING APPARATUS

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This invention relates particularly to an improved method and apparatus for the production of inert gas, although it may be used for other purposes where applicable.

The exhaust gases from an internal combustion engine are used as a source of the inert gas. After the exhaust gases are treated for removing impurities and compressed they are delivered under pressure of several hundred pounds to a storage tank and used in various ways for protective purposes. The inert gas consists mainly of nitrogen and a lesser percentage of carbon dioxide.

The main object of the invention is to provide an apparatus and method of control which will operate at high efficiency in producing a maximum of inert gas from the available capacity of the apparatus. Another object is to accomplish this by apparatus of a simple character which may be easily controlled and adjusted for obtaining the best results. Another object is to avoid the cost and use of regulating valves which require special care and maintenance. A further object is to provide controlling means which will occupy a small amount of space and be dependable and durable under long continued use. Other objects and advantages will be understood from the following description and accompanying drawing.

The drawing is a diagram of the various parts and their interrelationship showing one embodiment of the invention.

In general the invention is based upon the use of a multi-stage compressor driven by the internal combustion engine and the introduction between stages of an adjustable control of a simple character, such as by a needle valve, for the purpose of imposing a proper load and back pressure upon the driving engine and for properly proportioning the compression of the gases in the different compression stages.

The production and storage of inert gases requires the use of a compressor together with coolers, scrubbers, filters and the like for proper treatment of the exhaust gases from the engine. By causing the gas engine to drive the compressor, a load is imposed on the engine for the production of the exhaust gases. However, this is not sufficient, when using a standard compressor, to cause the engine to use up enough fuel to produce the desired quantity and in some cases quality of exhaust gases. Prior to this invention this difficulty was overcome by recirculating part of the compressed gases to the intake of the compressor. This, of course, increased the load on the engine and increased the amount of exhaust

gases. But such recirculation has the disadvantage of requiring the recompressing, scrubbing and filtering of gases which had been previously so treated.

By the present invention, this recirculating is avoided which permits the size of the scrubbers and filters to be much smaller than heretofore required for the same output of inert gas. This is accomplished by raising the inter-stage pressure of a multi-stage compressor. This increases the load on the compressor which in turn increases the load on the engine and increases the production of the exhaust gases. Although the efficiency and capacity of the compressor is reduced by the increase of the inter-stage pressure, the over-all production of the inert gas product by the apparatus is greatly increased by this improvement.

Referring to the drawing, the internal combustion engine 1, usually of the gasoline type, is shown directly driving a two-stage compressor having the first stage 2 and a second stage 3. The outlet 4 from the engine exhaust is connected to a scrubber 6 which is provided with a pressure gauge 5. The exhaust gases are washed and cooled in the scrubber. The outlet 7 for the gases is connected to a suitable filter 8 from which connection is made by the pipe 9 to the intake of the first stage of the compressor. The connection 9 is provided with a relief valve 13a.

The outlet of the first compression stage is connected by the pipe 10 to an inter-cooler 11, the pipe 10 being provided with a pressure gauge 12 and a safety valve 13. The outlet from the inter-cooler is passed through an adjustable valve 14 which is capable of refined adjustment, such as a needle valve, as shown. The outlet from this valve is connected by the pipe 15 to the inlet of the second stage 3 of the compressor. The connection between the needle valve and the second compression stage is provided with a pressure gauge 16 and a pulsating chamber 17. The needle valve 14 in itself may be insufficient to pass the full volume of the gases and a by-pass 18 is connected around it for passing the larger volume of the gases. This by-pass is shown provided with a union 19 for forming a restricted orifice for controlling the volume of the gases passed through it. This restricted orifice is shown in the form of a perforated disk or washer 20 positioned between the meeting faces of the union. In order to properly relate the volume of gases passed through this restricted orifice with reference to that controlled by the adjustable valve 14, the disk 20 may readily be replaced by one having a larger or smaller perforation; and after the proper sized

orifice is once determined, it may remain fixed, the refinement of control being accomplished by the needle valve 14.

The outlet from the second stage of the compressor is connected by a pipe 21 to another scrubber 22, the outlet from which is connected to another filter 23 and thence through the load valve 24 to a storage tank or other devices where the inert gas is to be used for protective purposes.

The refinement of control is accomplished by the adjustable needle valve 14 and may be set to impose any desired outlet pressure upon the first stage of the compressor within required limits and this pressure is made sufficient to impose a greater load on the engine, thereby forcing it to do more work, to burn more fuel, and thus create more inert gases and a consequent greater amount for the compressor to take away, thereby imposing a back pressure upon the exhaust of the combustion engine which pressure should be maintained at least above atmospheric pressure. Thus the adjustment of the needle valve not only determines the pressure under which the different stages are caused to work and thereby determines the engine and compressor loads but also imposes a desirable pressure above atmosphere on the engine exhaust. The load may be made the full horse power which the engine is capable of delivering and thereby a maximum amount of inert gases are obtained from the engine exhaust.

An adjustable clearance pocket may also be provided for either or both of the compression stages of the compressor for additional control of the compressor output. In the drawing a clearance pocket 25 is shown in section in the head of the second stage of the compressor. An axially adjustable rod 26 projects within the pocket and extends outwardly through a stuffing box 27. The rod has a threaded engagement with the interior of the stuffing box for adjusting the distance the rod extends within the pocket. The rod is held in any fixed position by lock nuts on opposite sides of a fixed support 28 which loosely embraces the rod. The more the rod is adjusted inwardly to reduce the size of the clearance pocket, the greater will be the efficiency of the compressor and the more the rod is adjusted outwardly, the less the efficiency of the compressor. In this manner the compressor efficiency can be adjusted so that the gas handled by the compressor is in balance or partially in balance with the output of the gas from the engine. An adjustable clearance pocket device is indicated in the drawing on the first compression stage as well as on the second stage. These devices may be used instead of the adjustable needle valve already described or in addition thereto for obtaining additional control.

It will be appreciated that the required control apparatus for obtaining the maximum output of inert gas within the capacity of the engine and compressor is of a simple character and occupies small space. It is capable of being readily adjusted and of being maintained adjusted for the best results with a proper load on the engine and proper proportioning of the work on the two stages of the compressor. It avoids the cost, complication and repair of regulating valves. It likewise avoids the necessity for any by-passing of the inert gas from a high pressure source to the inlet of the compressor for obtaining a desirable positive pressure thereon; and by eliminating this recirculation of a portion of the inert gas, the efficiency and output of the apparatus is correspondingly increased.

Although a particular embodiment of the invention has been described, it will be understood that it is capable of various modifications for particular requirements; and more than two compression stages may be utilized when desirable.

I claim:

1. Gas producing apparatus comprising an internal combustion engine, a multi-stage compressor driven thereby, connections from the exhaust of the engine to the intake of the first stage of the compressor, connections between successive stages of the compressor and to the inert gas load, and an adjustable valve in a connection between stages for adjusting the back pressure of a prior stage.

2. Gas producing apparatus comprising an internal combustion engine, a multi-stage compressor driven thereby, connections from the exhaust of the engine to the intake of the first stage of the compressor, connections between successive stages of the compressor and to the inert gas load, an adjustable valve in a connection between stages for adjusting the back pressure of a prior stage, and a restricted by-pass around said valve.

3. Gas producing apparatus comprising an internal combustion engine, a multi-stage compressor driven thereby, connections from the exhaust of the engine to the intake of the first stage of the compressor, connections between successive stages of the compressor and to the inert gas load, and an adjustable needle valve in a connection between stages for adjusting the back pressure of a prior stage.

4. Gas producing apparatus comprising an internal combustion engine, a multi-stage compressor driven thereby, connections from the exhaust of the engine to the intake of the first stage of the compressor, connections between successive stages of the compressor and to the inert gas load, an adjustable needle valve in a connection between stages for adjusting the back pressure of a prior stage, and a restricted by-pass around said valve.

5. Gas producing apparatus comprising an internal combustion engine, a multi-stage compressor driven thereby, connections from the exhaust of the engine to the first stage of the compressor, connections between the outlet of the first stage of the compressor to the inlet of the second stage and from the outlet of the second stage to the inert gas load, and an adjustable valve in the connection between the first stage and the second stage for adjusting the back pressure of the first stage.

6. Gas producing apparatus comprising an internal combustion engine, a multi-stage compressor driven thereby, connections from the exhaust of the engine to the first stage of the compressor, connections between the outlet of the first stage of the compressor to the inlet of the second stage and from the outlet of the second stage to the inert gas load, an adjustable valve in the connection between the first stage and the second stage for adjusting the back pressure of the first stage, and a restricted by-pass around said valve.

7. Gas producing apparatus comprising an internal combustion engine, a multi-stage compressor driven thereby, connections from the exhaust of the engine to the intake of the first stage of the compressor, connections between successive stages of the compressor and to the inert

gas load, and a variable clearance pocket device on at least one of the stages of the compressor.

8. Gas producing apparatus comprising an internal combustion engine, a multi-stage compressor driven thereby, connections from the exhaust of the engine to the intake of the first stage of the compressor, connections between suc-

cessive stages of the compressor and to the inert gas load, an adjustable valve in a connection between stages for adjusting the back pressure of a prior stage, and a variable clearance pocket device on at least one of the stages of the compressor.

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