Aug. 18, 1942. J. E. JOHANSSON 2,293,548

PRESSURE GAS GENERATOR

Filed March 25, 1940

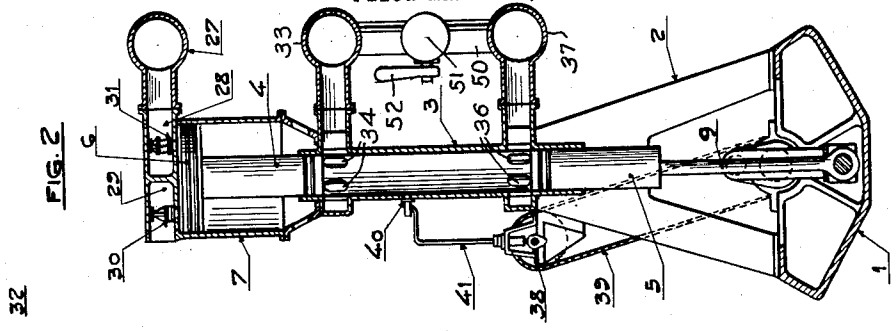


FIG. 2

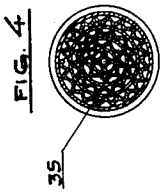


FIG. 4

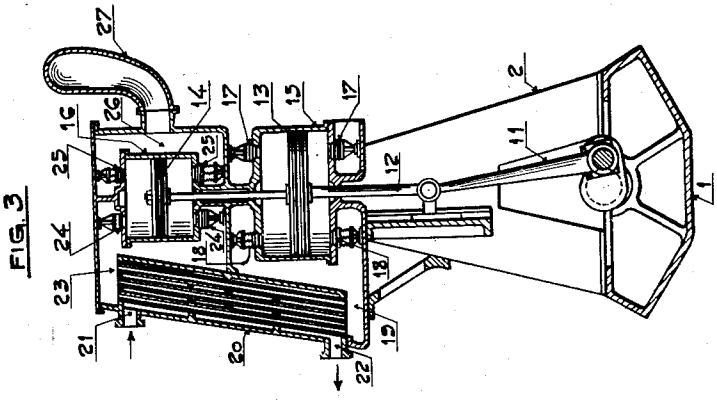


FIG. 3

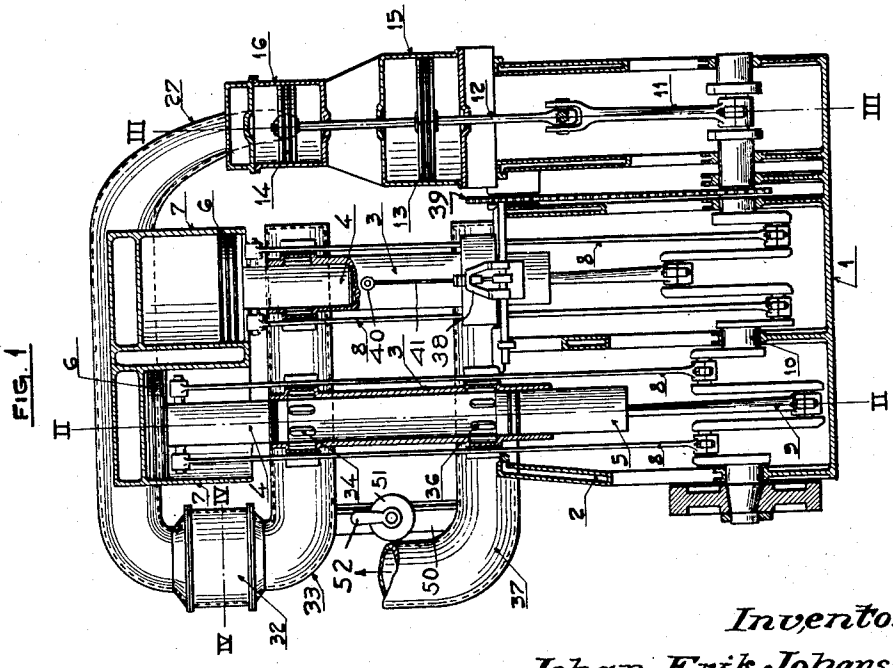


FIG. 1

*Inventor:*
*Johan Erik Johansson,*
*By* Cushman Darby & Cushman
*Attys.*

Patented Aug. 18, 1942

2,293,548

# UNITED STATES PATENT OFFICE

2,293,548

## PRESSURE GAS GENERATOR

Johan Erik Johansson, Goteborg, Sweden, assignor to Aktiebolaget Götaverken, Goteborg, Sweden, a corporation of Sweden

Application March 25, 1940, Serial No. 325,898
In Sweden March 31, 1939

6 Claims. (Cl. 60—44)

The present invention relates to improvements in pressure gas generators comprising internal combustion engines and air compressors driven thereby. In such pressure gas generators the compressed air produced by said compressors and the partly expanded exhaust gases of the internal combustion engines form the pressure gas. Now, as a result of the air compression in known generators of this type it sometimes happens, that the compressed air produced by the compressors reaches a temperature, which is so high that oil, which may gather at the air inlet openings of the cylinders of the internal combustion engines or at other points, is ignited, when it comes into contact with the hot compressed air. In order to avoid the danger and disadvantages connected with this circumstance it has been proposed to cool down the entire air quantity produced by the compressors before said air is admitted to the cylinders of the internal combustion engines, which, however, results in a considerable reduction of the thermodynamic efficiency of the air production.

One object of the invention is to increase this efficiency.

Another object of the invention is to combine the compressors and internal combustion engines of a pressure gas generator of the abovementioned type so as to form a more concentrated and convenient construction.

A further object of the invention is to provide means for equalizing the temperature of the compressed air admitted to the internal combustion cylinders.

With these and other objects in view I provide means for intermediate cooling of a stepwise compressed portion of the air produced by the compressors. Further features of the invention are set forth in the following specification and claims.

In the accompanying drawing one embodiment of the invention is illustrated by way of example.

Fig. 1 is a side sectional view of a pressure gas generator according to the invention.

Fig. 2 is a cross section on line II—II in Fig. 1.

Fig. 3 is a cross section on line III—III in Fig. 1, and

Fig. 4 is a section on line IV—IV in Fig. 1.

In the drawing 1 designates the lower half and 2 the upper half of a crank case of a pressure gas generator comprising an internal combustion engine and air compressors driven thereby. The internal combustion engine may naturally be of any type operating on the two or multiple stroke principle and having any number of cylinders, and in the present embodiment of the invention a two stroke Diesel engine is illustrated comprising two Diesel cylinders 3, in which opposed motion pistons 4 and 5 are provided. The air compressors driven by the internal combustion engines may also be of any suitable type such as reciprocating compressors, rotating compressors or the like, at least one of which is working with stepwise compression. The drawing shows two one step and one two step reciprocating compressors. The pistons 4 of the Diesel engine are connected or preferably integral with compressor pistons 6 operating in compressor cylinders 7 of single acting one step compressors arranged on top of the internal combustion cylinders 3. The pistons 4 and 5 are connected by means of connecting rods 8 and 9, respectively, to a crank shaft 10 mounted in the crank case 1. A further connecting rod 11 is connected to the crank shaft 10 and by means of a piston rod 12 with two pistons 13 and 14 of a two step double acting reciprocating compressor. In the present case said two step compressor produces approximately one third of the total air quantity delivered by the air compressors comprised in the pressure gas generator. The two step compressor consists in a large cylinder 15 and a small cylinder 16, in which the pistons 13 and 14, respectively, operate. The cylinder 15 is provided with automatic inlet valves 17 and automatic outlet valves 18 and an outlet chamber 19 common for both ends of the low pressure compression cylinder and serving to conduct the air compressed in the cylinder 15 to an intermediate cooler 20, which may be of any suitable type and in the illustrated embodiment is a tubular cooler, to which cooling medium is supplied through a connection 21 and from which the cooling medium is led away through an outlet 22. From the cooler 20 the air flows to an inlet chamber 23 common for both ends of the high pressure cylinder 16. The high pressure cylinder 16 is provided with automatic inlet valves 24 and automatic outlet valves 25 and an outlet chamber 26 common for both ends of the high pressure cylinder 16. The air, which has been cooled down to a considerable extent in the intermediate cooler 20, is compressed in the cylinder 16 to about the same pressure as the air compressed by the compressor pistons 6 in the cylinders 7, for instance, 4 to 5 kg./cm.$^2$ above atmospheric pressure. The compressed air from the two step compressor flows from the outlet chamber 26 through a conduit 27, which is also connected with outlet chambers 28 of the

one step compressor cylinders 7. 29 designates the inlet chambers of the compressor cylinders 7 and 30 and 31 automatic inlet valves and automatic outlet valves, respectively, of the compressor cylinders 7. The air produced by the one step compressors 7 is mixed in the conduit 27 with the air produced by the two step compressor 15, 16, which has previously been cooled down in the intermediate cooler 20 and consequently has a lower temperature than the air produced in the one step compressor cylinders 7.

In order that the mixture of the different air quantities shall obtain a uniform temperature before the air reaches the internal combustion cylinders 3 a device 32 for equalizing the temperature of the compressed air is connected between the conduit 27 and a conduit 33, which is connected to the inlet openings 34 of the internal combustion cylinders 3. The temperature equalizing device 32 consists in a sheet metal drum enclosing a pack of corrugated sheet metal 35 or other suitable heat exchange bodies with large heat exchange surfaces and preferably good heat conductivity. The air, which has the highest temperature, gives off heat to the heat exchange bodies upon passage of the temperature equalizing device and said bodies give off heat to the cooler portions of the air passing the device so that the air, which leaves the temperature equalizing device, is of substantially a medium temperature corresponding to the temperatures and quantities of compressed air produced by the compressors 7 and 15, 16.

The compressed air produced by the compressor serves as charging and scavenging air for the internal combustion cylinders and is mixed with the partly expanded exhaust gases, which are expelled from the motor cylinders at substantially the same pressure as the pressure of the compressed air through outlet openings 36 and a conduit 37, which is the delivery conduit of the pressure gas generator. Fuel is supplied to the internal combustion cylinders by fuel pumps 38 driven from the crank shaft 10 by means of a chain drive 39 and connected with conventional fuel injection valves 40 through pipes 41. The output of the internal combustion engine comprised in the illustrated pressure gas generator may be completely utilized for driving the compressors comprised in the generator or a portion of the output of the internal combustion engine may be utilized for other purposes.

It is understood that my invention is by no means limited to the embodiment above described and illustrated in the drawing, which should only be considered as an example, and the invention may naturally be modified in several different ways within the scope of the following claims. The pressure gas generator may naturally be of a type, in which a portion of the compressed air does not pass the motor cylinders but is admixed to the exhaust gases of the motor when said gases are already expelled from the motor. In such a generator a direct communication may be provided between the delivery conduit of one or all compressors and the delivery conduit of the generator and suitable valves may be provided in said conduits to ensure the desired operation. Thus, as shown in Figures 1 and 2, a passage or conduit 50 is arranged to communicate the conduit 33 with the conduit 37. A casing 51 on the pipe or passage 50 houses a valve (not shown), and a handle 52 is connected to the valve for controlling the flow of the air through the passage 50.

What I claim is:

1. In a pressure gas generator, an internal combustion engine, an air compressor without inter-stage cooling driven by said internal combustion engine, a multi-stage air compressor driven by the internal combustion engine, a common delivery conduit for said compressors communicating with the combustion cylinders of the internal combustion engine, and an inter-stage cooler between two steps in said multi-stage compressor, the compressed air from said compressors and the partly expanded exhaust gases of the internal combustion engine forming together the pressure gas produced by said pressure gas generator.

2. In a pressure gas generator, a reciprocating internal combustion engine, a reciprocating air compressor without inter-stage cooling driven by said reciprocating internal combustion engine, a multi-stage air compressor driven by the reciprocating internal combustion engine, a communication between two successive compression steps in said multi-stage compressor, cooling means in said communication for intermediate cooling of the air passing said multi-stage compressor, and a common delivery conduit for said compressors communicating with the combustion cylinder of the internal combustion engine, compressed air from said compressors and the exhaust gases of said internal combustion engine forming together the pressure gas produced by said generator.

3. In a pressure gas generator, a reciprocating internal combustion engine, opposed motion pistons in said internal combustion engine, a crank shaft, connecting rods connecting said crank shaft and said opposed pistons, a two step reciprocating air compressor operated by means of a connecting rod connected to said crank shaft, a communication between the steps of said two step compressor, a cooler in said communication, one step compressor pistons connected with one of each pair of opposed internal combustion pistons, and a common delivery conduit for said two and one step air compressors communicating with the internal combustion cylinders, the compressed air of said compressors and the exhaust gases of the internal combustion engine forming together the pressure gas produced by the generator.

4. In a pressure gas generator, an internal combustion engine, air compressors driven by said internal combustion engine, at least one of said air compressors having means for stepwise compression of the air passing through said compressor, a communication between two steps of said stepwise compressor, a cooling means provided in said communication and adapted for intermediate cooling of the air passing said stepwise compressor, said stepwise compressor being arranged to produce about one third of the compressed air produced by all compressors of said generator, and a common delivery conduit for said compressors communicating with the combustion cylinders of the internal combustion engine, the compressed air of said compressors and the exhaust gases of the internal combustion engine forming together the pressure gas produced by the generator.

5. In a pressure gas generator, an internal combustion engine, air compressors driven by said internal combustion engine, at least one of said compressors having means for stepwise

compression of the air passing through said compressor, a communication between two steps of said stepwise compressor, a cooling means in said communication adapted for intermediate cooling of the air passing through said communication, a delivery conduit communicating with said compressors and the internal combustion cylinders, and a temperature equalizing device in said conduit between said compressors and said internal combustion cylinders, the compressed air of said compressors and the exhaust gases of said internal combustion engine forming together the pressure gas produced by the generator.

6. In a pressure gas generator, an internal combustion engine, air compressors driven by said internal combustion engine, at least one of said air compressors having beans for stepwise compression of the air passing through said compressor, a communication between two steps of said stepwise compressor, a cooling means in said communication adapted for intermediate cooling of the air passing through said communication, a conduit communicating with the air compressors and the internal combustion cylinders, a temperature equalizing device in said conduit between the compressors and the internal combustion cylinders, and heat exchange bodies in said device, the compressed air of said compressors and the exhaust gases of the internal combustion engine forming together the pressure gas produced by said generator.

JOHAN ERIK JOHANSSON.