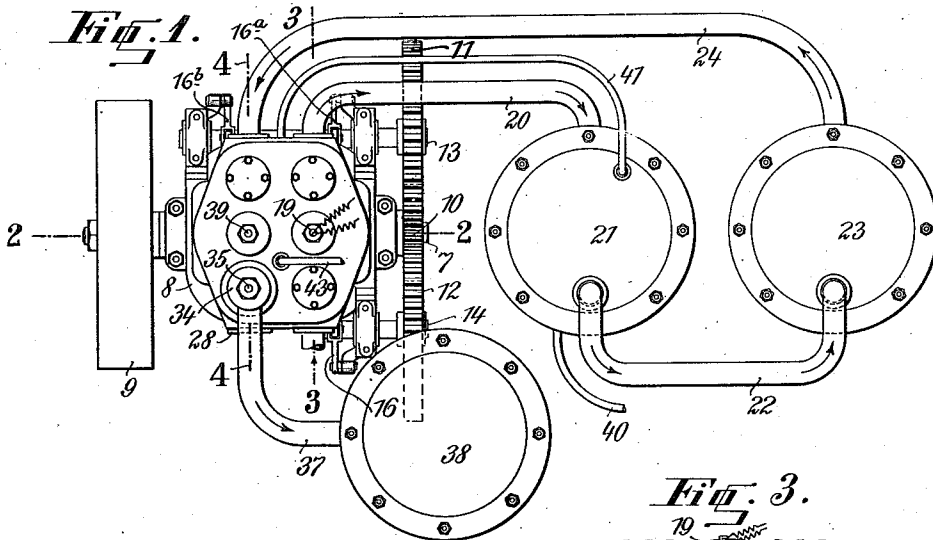
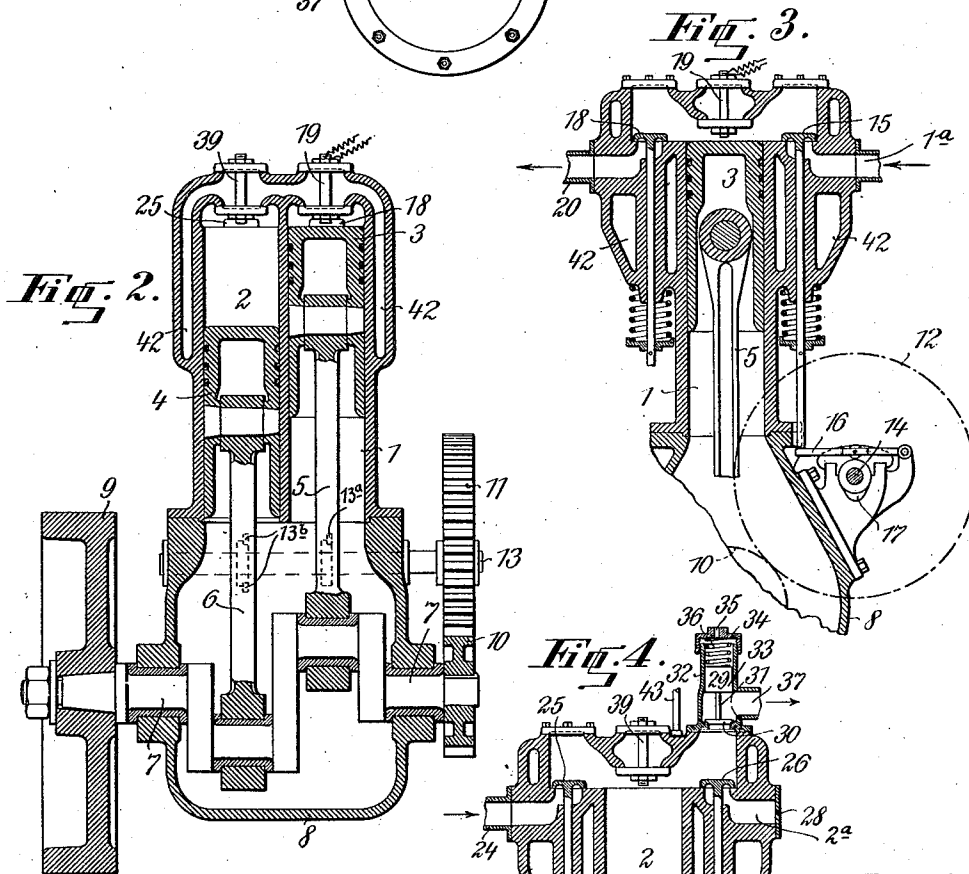


H. VON EICKEN.
 PRODUCER OF INERT GASES.
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1,066,391.

Patented July 1, 1913.



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PRODUCER OF INERT GASES.

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To all whom it may concern:

Be it known that I, HERMANN VON EICKEN, a subject of the German Emperor, and resident of Friedenau, near Berlin, Germany, have invented certain new and useful Improvements in Producers of Inert Gases, of which the following is a specification.

For the purpose of preventing the accidental ignition of gasolene and other highly inflammable liquids, they have been stored in suitable tanks, and then conveyed to the place of use, in the presence and with the aid of inert or non-oxidizable gases. While pure carbonic acid and pure nitrogen are suitable for this purpose, the exhaust gases of ordinary internal combustion engines offer the advantage of much greater cheapness, and have been preferred for this reason. Certain difficulties, however, occur in connection with the use of such exhaust gases, particularly in view of the fact that in the event of a misfire the gases expelled by the piston contain a relatively high percentage of oxygen, and if several misfires follow each other, the percentage of oxygen in the mixture of exhaust gases stored in a suitable tank may become so high as to render the mixture explosive.

My present invention has for its object to overcome this difficulty and to provide an efficient apparatus for producing an inert gas that will never contain a dangerous percentage of oxygen. This I secure by a novel valve arrangement fully set forth herein-after.

In the accompanying drawings I have shown how a two-cylinder explosive engine may be converted into a single-cylinder engine provided with my improvements, but I desire it to be understood that this is an example only and that the improvements may be applied in various other ways without departing from the nature of my invention as set forth in the appended claims. Reference is to be had to the accompanying drawings, in which—

Figure 1 is a top view of the engine and associated apparatus; Figs. 2, 3 and 4 are vertical sections taken respectively on lines 2—2, 3—3, and 4—4, of Fig. 1.

The cylinders 1, 2 of equal size and arranged side by side, contain the reciprocating pistons 3, 4 respectively provided with connecting rods 5, 6 respectively leading to corresponding opposed cranks on the engine shaft 7, so that the two pistons 3, 4 move in

opposite directions. On one end of the shaft 7 which is arranged in a chamber 8 connected to the cylinders 1, 2, is secured a fly-wheel 9, preferably of a mass sufficient to continue the rotation in the case of a single misfire, but not sufficient to keep the apparatus in motion if there should be two successive misfires. On the other end of the shaft is mounted a pinion 10 in mesh with wheels 11 and 12 mounted to turn with shafts 13 and 14 respectively, the wheels 11 and 12 being twice the size of the pinion 10 and therefore performing one revolution for every two revolutions of said pinion.

The working cylinder 1 receives the explosive mixture from a pipe 1^a, the connection being controlled by a spring-pressed inlet valve 15, opened periodically by the action of a lever 16 operated by a cam 17 on the shaft 14. The piston 3 is operated according to the customary four-cycle system. The exhaust valve 18 of the engine cylinder 1 is operated in a manner similar to the valve 15 by a lever 16^a governed by a cam 13^a on the cam shaft 13. The explosive mixture is ignited by the spark plug 19. The exhaust gases pass into a conduit 20 leading to a cooler 21 of any well known or approved character, and then the gases, contracted in volume by the cooling action, travel through a pipe 22 to a purifier 23 and then through a conduit 24 to the compressor cylinder 2, the connection being controlled by the valve 25 governed by the lever 16^b actuated by the cam shaft 13. In the original use of this engine, the valve 25 controlled the exhaust from the cylinder 2, opening at every fourth stroke of the piston 4, but as modified or converted for the purposes of my invention, the cylinder 2 is no longer an engine cylinder, but a compressor cylinder, and the shaft 13 has two diametrically opposite cams 13^b for actuating the lever 16^b, so that the valve 25 will be opened at every down-stroke of the piston 4. The valve 26, which originally served as an inlet valve for the explosive mixture (when the engine was operated as a two-cylinder engine) is rendered inactive by means of a nut 27, and the corresponding inlet connection 2^a is closed by a cover 28.

In the head of the cylinder 2 is located a compressor outlet controlled by a valve 29 having a valve plate 30 and a stem 31 connected with a piston 33 arranged to slide in a guide or housing 32. A cap 34 provided with

a through opening 35 leading to the outer air, is screwed upon the upper end of the housing 32, and a coiled spring 36 is interposed between this cap and the upper surface of the piston 33, thus pressing the valve plate 30 against its seat with a force which can be regulated by screwing the cap 34 up or down. The upper surface of the valve plate 30 has the same area as the lower surface of the piston 33, thus producing a balanced action with resulting advantages set forth hereinafter. The gases entering the compressor cylinder 2 through the connection 24 and valve 25 are expelled through the valve 30 into the conduit 37 and into a collector or storage receptacle 38; at each upstroke of the piston 4, provided they have been brought to a pressure exceeding that exerted by the spring 36. The receptacle 38 may be the one in which the gasoline or other inflammable fluid is stored, or it may be suitably connected with such gasoline storage tank.

Where the spark plug of the cylinder 2 was placed originally, a suitable plug or screw-bolt with covers may be substituted, as shown at 39, or the spark plug may be left in place and simply disconnected from the electric circuit.

The cooler 21 shown in Fig. 1 is supposed to be a water-circulation cooler, water being admitted at 40, passing out through 41 to the jacket 42 which is common to the engine cylinder 1 and the compressor cylinder 2, and leaving the jacket through the pipe 43 (Figs. 1 and 4).

The operation of the device is as follows: At every fourth stroke of the power piston 3, the valve 18 opens and allows the exhaust gases to pass into the conduit 20, cooler 21, pipe 22, purifier 23 and conduit 24 to the valve 25, which is open at the same time. Inasmuch as the exhaust stroke of the piston 3 is simultaneous with a suction stroke of the compressor piston 4, the gases are drawn into the cylinder 2. Then follows the suction stroke of the power piston 3, at the same time with a compression stroke of the piston 4. The valve 25 is closed, and the valve 29 opens to let the compressed gases pass through the conduit 37 to the receptacle 38, provided the pressure of the gases is sufficient to overcome the resistance of the spring 36. Then follows the compression stroke of the power piston 3, simultaneous with another suction stroke of the compressor piston 4, during which, the valve 18 being closed and the valve 25 open, the piston 4 draws a further supply of exhaust gases from the amount left in the conduit 20, cooler 21, pipe 22, purifier 23 and conduit 24. Then follows the explosion or working stroke of the power piston 3, simultaneous with another delivery stroke of the compressor piston 4, the valve 29

opening as described above. Since the opposing surfaces of the valve plate 30 and of the piston 33, which surfaces are exposed to the pressure existing in the delivery pipe 37, are of equal area, it follows that the valve is balanced, that is to say, the pressure in pipe 37 and receptacle 38 has no tendency either to seat or to unseat the valve plate 30. The only force (aside from gravity) tending to seat the valve plate 30 is the pressure of the spring 36, and this is constant as long as the tension of the spring is unaltered, or in other words, as long as the cap 34 remains in the same position. From this arrangement it results that the compressor piston 4 has to perform the same amount of work at each compression stroke, that is, it will compress the exhaust gases to a pressure just sufficient to overcome the action of the spring 36. In view of this constant or even work, the operation of the entire machine becomes exceedingly efficient. In case of a misfire in the cylinder 1, the unconsumed exhaust gases would contain a relatively high percentage of oxygen, and if two misfires occurred in succession, the gases delivered to the conduit 37 and receptacle 38 might contain such a percentage of oxygen as to be liable to form an explosive mixture with the vapors of the inflammable liquid (such as gasoline), which said gases are intended to protect. To avoid this danger, the flywheel 9 is made only large enough to keep the machine in motion in the event of a single misfire, but not large enough to keep it going if two misfires should occur in succession. The resistance caused by the compression strokes of the power piston 3 and of the compressor piston 4 would in this latter case cause the engine to stop, and thus prevent the delivery, to the receptacle 38, of gases containing a dangerous percentage of oxygen. If, as it will occur in practice, the pressure in the collector or receptacle 38 is not constant, but fluctuates say from atmospheric pressure to a pressure of several atmospheres, then, of course, the work to be performed by the compressor piston 4 will also vary, since it depends on this pressure. It may thus happen that the pressure within the receptacle 38 will for a relatively considerable time be lower than the pressure which has been assumed as a basis for calculating the flywheel 9. In such a case of an abnormally low pressure in the receptacle 38, the energy stored in the flywheel may be sufficient to keep the machine in motion even in the event of two successive misfires, so that there would arise the danger of delivering to the receptacle 38 a greater amount of unconsumed gases and therefore a greater amount of oxygen than intended. This danger, however, is overcome by the automatic action of the bal-

anced delivery valve 29, which allows gases to pass out of the compressor cylinder 2 only when they exceed slightly the pressure corresponding to the tension of the spring

36. Therefore, if this definite and constant pressure be used as the basis for calculating the flywheel 9, the intended operation will be obtained with certainty, that is to say, the work performed by the pistons 3 and 4 during their compression strokes will stop the engine in the event of two successive misfires, while in the case of a single misfire the energy stored in the flywheel will be sufficient to carry the machine to the next explosion or power stroke.

I claim as my invention:

1. The combination, with an internal combustion engine, of a compressor, a connection for leading the exhaust gases of the engine to said compressor, a delivery conduit, a valve controlling the passage of the compressed gases from the compressor to said conduit, a piston held to move in unison with said valve and having a face exposed to the gases contained in the delivery conduit to counteract the pressure exerted by said gases on the valve, and means for pressing the valve toward its seat.

2. The combination, with an internal combustion engine, of a compressor, a connection for leading the exhaust gases of the engine to said compressor, a delivery conduit, a valve controlling the passage of the compressed gases from the compressor to said conduit, means connected with said valve to move therewith and exposed to the pressure of the gases contained in the delivery conduit to counteract the pressure exerted by said gases on the valve, and means for pressing the valve toward its seat.

3. The combination, with an internal combustion engine, of a compressor, a connection for leading the exhaust gases of the engine to said compressor, a delivery conduit, a valve controlling the passage of the compressed gases from the compressor to said conduit, means connected with said valve to move therewith and exposed to the pressure of the gases contained in the delivery conduit to counteract the pressure exerted by said gases on the valve, means for pressing the valve toward its seat, and a device for adjusting the power of the last-named means.

4. The combination, with an internal combustion engine, of a compressor, a connection for leading the exhaust gases of the engine to said compressor, a delivery conduit, a valve controlling the passage of the compressed gases from the compressor to said conduit, a piston held to move in unison with said valve and having a face exposed to the gases contained in the delivery conduit to counteract the pressure exerted by said gases on the valve, the other face of

the piston being exposed to atmospheric pressure, and means for pressing the valve toward its seat.

5. The combination, with an internal combustion engine, of a compressor, a connection for leading the exhaust gases of the engine to said compressor, a delivery conduit, a valve controlling the passage of the compressed gases from the compressor to said conduit, a piston held to move in unison with said valve and having a face exposed to the gases contained in the delivery conduit to counteract the pressure exerted by said gases on the valve, and a spring engaging the other face of the piston to press the valve toward its seat.

6. The combination, with an internal combustion engine, of a compressor, a connection for leading the exhaust gases of the engine to said compressor, a delivery conduit, a valve controlling the passage of the compressed gases from the compressor to said conduit, a piston held to move in unison with said valve and having a face exposed to the gases contained in the delivery conduit to counteract the pressure exerted by said gases on the valve, a spring engaging the other face of the piston to press the valve toward its seat, and an adjustable cap engaging the said spring and adapted to vary its tension.

7. The combination, with an internal combustion engine, of a compressor, a connection for leading the exhaust gases of the engine to said compressor, a delivery conduit, a valve controlling the passage of the compressed gases from the compressor to said conduit, a piston held to move in unison with said valve and having a face exposed to the gases contained in the delivery conduit to counteract the pressure exerted by said gases on the valve, a spring engaging the other face of the piston to press the valve toward its seat, and an adjustable cap engaging the said spring and adapted to vary its tension, said cap being apertured to expose the outer face of the piston to atmospheric pressure.

8. The combination, with an internal combustion engine having a piston operated according to the four-cycle system, and a valve controlling the escape of the exhaust gases, of a compressor having alternate compression and suction strokes, a connection for leading the exhaust gases of the engine to said compressor, a valve controlling said connection, and means for opening said valve at each alternate stroke, while the exhaust valve of the engine is opened only at every fourth stroke.

9. The combination, with an internal combustion engine having a piston operated according to the four-cycle system, and a valve controlling the escape of the exhaust gases, of a compressor having alternate com-

pression and suction strokes, a connection for leading the exhaust gases of the engine to said compressor, a valve controlling said connection, and a shaft provided with cams
5 for operating the exhaust valve of the engine and the inlet valve of the compressor respectively, there being twice as many cams to govern said inlet valve as to govern said exhaust valve.
10 10. The combination, with an internal combustion engine, of a compressor, a connection for leading the exhaust gases of the engine to said compressor, a delivery conduit, a spring-pressed valve controlling the

passage of the compressed gases from the 15
compressor to said conduit, and means, connected with said valve, for neutralizing the effect of the pressure prevailing in said conduit, on the said valve, so that the operation of the valve will not be affected by fluctua- 20
tions of the pressure in said conduit.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

HERMANN VON EICKEN.

Witnesses:

WOLDEMAR HAUPT,
HENRY HASPER.