

April 14, 1931.

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1,801,007

PRODUCTION OF GAS JETS FOR POWER PURPOSES

Filed Sept. 13, 1927

Fig. 1.

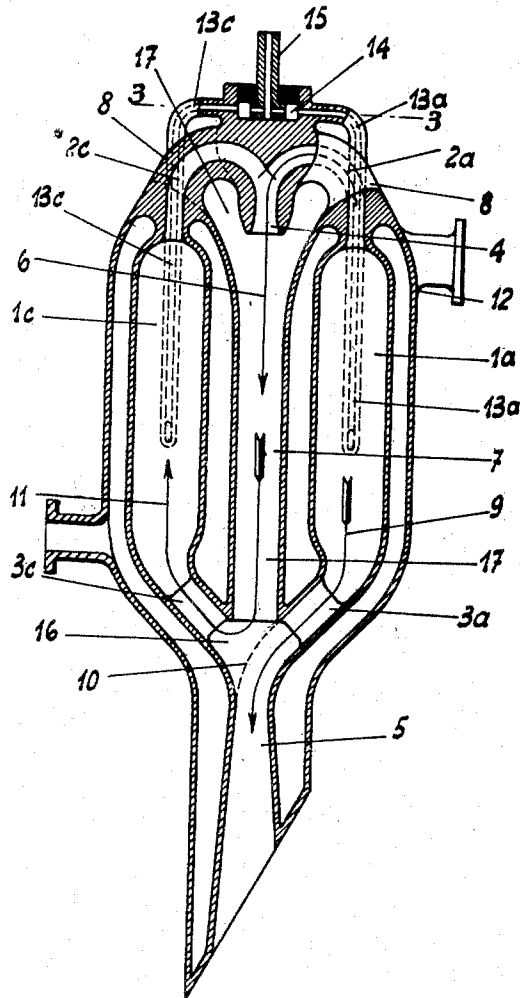
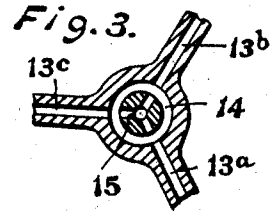
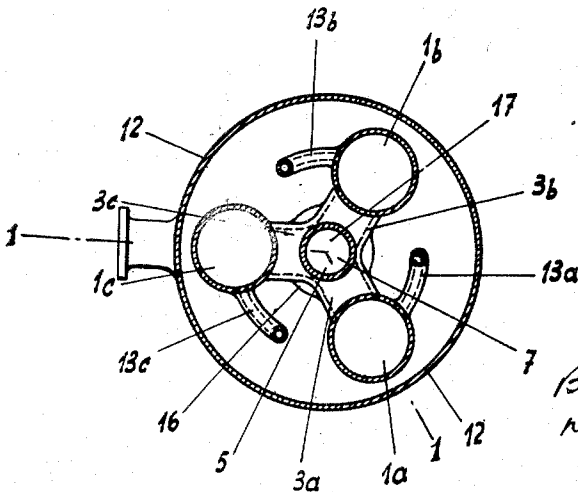


Fig. 2.



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UNITED STATES PATENT OFFICE

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PRODUCTION OF GAS JETS FOR POWER PURPOSES

Application filed September 13, 1927, Serial No. 219,233, and in Switzerland September 23, 1926.

The invention relates to a new and improved apparatus for the production of gas jets for the performance of mechanical work.

The invention consists in the process to produce gas jets by a succession of more or less explosive combustions in a plurality of combustion chambers, without any motive parts whatever such as the usual valves, slides and so on. The high pressure gas jets issuing from the combustion chambers not only perform the work attributed to the other parts of the motors known up to now, but they moreover introduce fresh air and gaseous fuel into the chambers, compress the mixture and ignite the compressed fuel. In this manner I am able to produce, by means of simple, reliable and safe apparatus either a continuous or an intermittent gas jet of high power.

The apparatus, hereinafter to be called the multiple combustion chamber, consists of a plurality of combustion chambers with means such as nozzles, ducts or the like for suction, acceleration of the gaseous fuel and for charging the chambers with fresh air; also an ignition device, and tubular and nozzle systems for the production and conduction of the working gas jet.

In the accompanying drawings two examples of the multiple combustion chamber are shown diagrammatically.

Fig. 1 being a longitudinal section of a construction embodying my invention, said section being taken on the line 1—1 of Fig. 2,

Fig. 2 being a cross section, and Fig. 3 is a transverse section on the line 3—3 of Fig. 1.

The multiple combustion chamber according to Fig. 1 consists of three chambers, two of which, marked 1a and 1c, are visible, the chambers being disposed symmetrically, about the central axis, and parallel to the same. The combustion chambers communicate at their upper ends with ducts 2a, and 2c and at their lower ends with ducts 3a and 3c. The upper and lower ducts respectively merge obliquely into axial downwardly directed nozzles 4 and 5. The upper nozzle 4 forms part of an injector and projects into the flared upper end of a central pipe 7. The injector 4, 7 serves for the suction and acceleration of fresh air drawn in through

openings 8, a jet 6 with high velocity passing downwards through the injector pipe 7.

The nozzle 5 is the main nozzle, giving a definite direction to the jets which enter it at 16 from the ducts 3a, 3c.

In the example shown in Fig. 1 the main nozzle 5 is cut away obliquely at its lower end, like the nozzle of a De Laval turbine, and may be used for directing the jet on to the blades of a turbine rotor, so as to drive the same.

For starting the apparatus in operation the ignition may be effected by the use of ordinary spark plugs, such as are commonly used in connection with explosion chambers. After a short run the parts become heated so that self-ignition takes place by the very hot walls of the chambers, and owing to the high pressure to which the charge is subjected.

When an explosion takes place in the chamber 1a the high pressure combustion gases flow at a high speed in part through the curved duct 2a, jet nozzle 4 and injector downwards, and in part through the duct 3a and main nozzle 5. The combustion gases which issue from the nozzle 4 have a high speed and high temperature. In the injector pipe 7 there is produced a mixture of burnt gas and a surplus of fresh air, at a temperature above the ignition temperature of the fuel employed. The gas jet flowing through the duct 3a in the direction of the arrow 9 is subjected at its junction with the injector stream to constriction and to deflection towards the main nozzle 5, somewhat as is shown by the line 10. If the arrangement is so made that, for example, two chambers side by side fire together, then the narrowest cross-section of the main nozzle 5 is completely filled by the gas jets flowing from these chambers through the ducts 3a, and the mixture of burnt gas and air coming from the injector pipe 7 cannot flow through the main nozzle 5, but is deflected as indicated by the arrow 11 and passes from the chamber 1c into the chamber 1c.

The arrangement may, however, be such that only one chamber fires at a time, and then the cross-section of the ducts 3a and 3c

are approximately equal to the narrowest part of the main nozzle 5, so that by one jet a complete closure is obtained and the air and burnt gas mixture jet is deflected in the direction of arrow 11. To prevent eddies in the jet directing element 16 the ducts 3a and 3c are made cylindrical or at least tapering but slightly. In this case the velocities of the two jets do not greatly differ; the jets from the chambers 1a, 2a, etc. then remain compact and have little or no tendency to mix with the mixture of burnt gas and air.

The air and burnt gas mixture entering the combustion chamber 1c drives out the combustion gases from this chamber, through the ducts 2c and towards the nozzle 4. The quantity of combustion gas to be driven out is not large, since the momentum of the gases emerging rapidly during the explosion tends to create a vacuum in the chamber.

It is of special importance that the mixture from the injector is forced with great velocity into the relatively small chambers, so that these are rapidly charged, the flow of the gas being then suddenly stopped, and subjected to an abrupt reversal of movement on impact with the top of the chamber. The effect of this is comparable with an effect observed in connection with hydraulic rams; there is a definite increase in pressure accompanied by considerable eddying. The injector stream itself receives a continuous succession of violent impulses through the explosions, increasing its kinetic energy more or less in proportion with the rate of the impulses. In this manner it is possible to produce for a short time a very high compression. During this short period the ignition of the injected fuel takes place, and the thermal efficiency is consequently high. As soon as combustion in the chamber 1c takes place, with resulting increase in pressure, a reversal of the movement takes place in the ducts 3a and 3c. In these such reversals occur constantly, in accordance with the successive charging and combustion, whereas in the ducts 2a and 2c the direction of flow is always the same.

The multiple combustion chamber may comprise numerous chambers, but as previously noted the form illustrated has three chambers. In a three chambered unit only one chamber fires at a time. According to the rate of succession of the explosions the gas jet flowing from the main nozzle 5 is constant or intermittent. In the latter case the intervals may be so large that on account of the momentum of the injector stream fresh air is drawn in, and this air likewise flows through the main nozzle, and has a cooling effect upon the blades of a turbine.

The supply of fuel is effected by means of a pipe system, which connects the chambers with each other and with a central injector. Highly heated combustion gases flow through these pipes from the chambers after explo-

sion, and liquid fuel is sucked in and atomized, and reduced to the form of vapour for mixing with highly heated air for combustion, so that the combustion is sudden and explosive.

The chambers 1a, 1b and 1c are in communication with small tubes 13a, 13b and 13c, which join them at the lower parts. The tubes are joined at their other ends to the central injector 14, (see Fig. 1) to which the fuel is supplied by way of a pipe 15.

The manner of operation is as follows: When for example the chamber 1a has fired, combustion gas under high pressure flows from it through the tube 13a to the injector 14, where fuel is sucked in through the pipe 15, and atomized. This fuel passes through the tube 13c in the form of vapour to the chamber 1c, at a high speed. By virtue of the whirling motion imparted to the heated air, (above ignition temperature) explosive combustion then takes place in the chamber 1c.

By the admission of fuel at short intervals of time explosions are caused to take place in one chamber after the other, in rapid succession the issuing combustion gases always passing in a jet through the nozzle 5 as shown at 10 in Fig. 1, so that the air and burnt gas mixture is deflected into the chamber 1a, 1b, 1c in succession, according to the changing position of the obstructing stream of gas.

So long as the combustion gases mixed with the air do not exceed the ratio 2:3 there is no interference with combustion. In fact the combustion gases later accelerate the combustion and take the place of the usual excess of air, as no lubricating oil vapours are present to retard combustion. It is well recognized that the presence of chemically inert bodies, such as combustion gases, do not reduce the thermal efficiency; if they are not dissociated by the heat.

Experiments have shown that a compressor operating according to the above said injector principle, with the gas stream broken up and reversed at short intervals by impact, with part of the heat of the driving jet used for performing work at a later stage, works very economically. Furthermore it is to be observed that the compression takes place in the primary stage of the cycle, and the efficiency coefficient of the compressor is not compounded with a bad coefficient of efficiency, e. g., of a Curtis turbine, as would be the case if the air were compressed by a compressor coupled to the turbine.

All the members of the multiple combustion chamber are preferably enclosed in a casing 12 (Fig. 2) with cooling fluid in the cavities.

For the purpose of improving the thermal efficiency the temperature of the walls of the combustion chambers are maintained at the ignition temperature of the fuel. The

amount of heat carried away by the cooling medium is thus reduced, and the combustion is rendered complete, since the temperature of the burning mixture is in the region of the walls not below the ignition temperature of the fuel.

An improvement of thermal efficiency occurs, when using mineral oils, at a wall temperature of about 450 to 500° C., since the ignition temperature of the oils is of this order.

High wall temperatures can also be attained by using the cooling water under pressure, or by cooling with steam. I may also use melted salts as a cooling medium. Particularly suitable for this purpose are mixtures of fluorides, bisulphates and chlorides, whose fusing temperature is about 300° C.; at 400° C., these salts are sufficiently fluid to circulate under the action of differences of temperature, and they are not decomposed by temperatures up to 1000° C., and do not attack iron.

Thin-walled parts, as for instance the nozzles, blades, etc., may be brought into contact with such fused salts to prevent them from burning or melting.

As already mentioned the kinetic energy of the gas jet issuing from the main nozzle may be utilized in any desired manner.

It will be obvious that the multiple combustion chamber may have forms other than those herein described.

The method hereinbefore described and which may be carried out by the apparatus herein claimed is claimed in my copending application Serial No. 510,964, filed January 24, 1931.

What I wish to secure by the U. S. Letters Patent is:—

1. An apparatus for the purpose described including a series of explosion chambers, an exhaust gas tube, an outlet passage from each chamber to said tube, said passages being arranged around the tube adjacent to the inlet end of the latter, an air tube in alignment with the exhaust tube and terminating at said inlet end, and an injector at inlet end of said air tube and having ducts leading thereto from said chambers, the proportioning of the parts being such that the escape of exhaust gas from any of said chambers through its passage to the exhaust gas tube diverts air from said air tube to another of said chambers through the said passage of the latter.

2. An apparatus for the purpose specified including a series of explosion chambers, an air tube, means for forcing a current of air therethrough, a common exhaust gas tube in alignment with said air tube, a separate passage from each chamber and communicating with both of said tubes at the inlet end of the exhaust gas tube and the outlet of the air tube, each of said passages

serving for delivery of air from said air tube to the corresponding chamber and exhaust gas from said chamber to said exhaust tube alternately.

3. An apparatus for the purpose specified including a series of explosion chambers, an air tube, an injector for forcing air through said tube and having supply ducts connected to said explosion chambers, a common exhaust gas tube in alignment with said air tube, a separate passage from each chamber and communicating with both of said tubes at the inlet end of the exhaust gas tube and the outlet of the air tube, each of said passages serving for delivery of air from said air tube to the corresponding chamber and exhaust gas from said chamber to said exhaust tube alternately, said last mentioned passages and said tubes being so proportioned and positioned that the outflow of exhaust gas through one passage causes the deflecting of air from said air tube through another of said passages.

In testimony whereof I affix my signature.

HUBERT JEZLER, Dr. Eng.