L. A. HAYOT.

EJECTOR FOR APPARATUS FOR SUSTAINING AND PROPELLING AEROPLANES AND FOR OTHER USES.

APPLICATION FILED FEB. 18, 1913.

1,069,694.

Patented Aug. 12, 1913.

2 SHEETS—SHEET 1.

Fig.1.

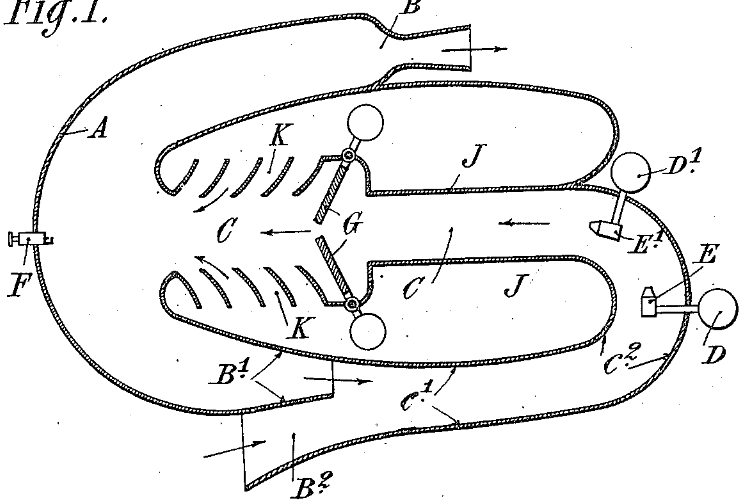


Fig.2.

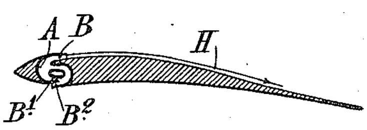


Fig.2a.

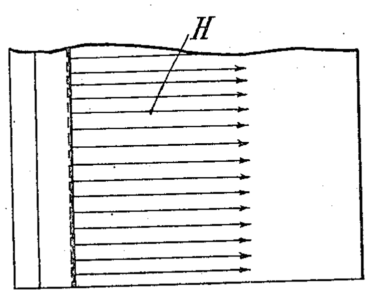
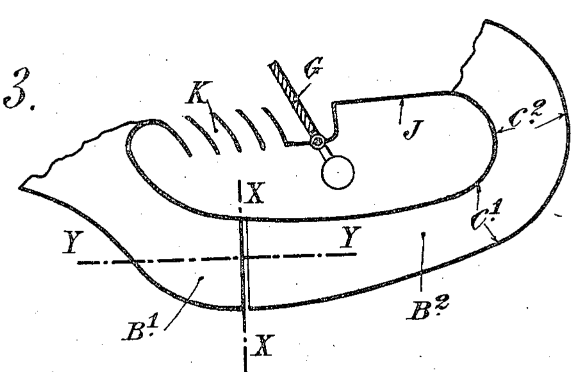


Fig.3.



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2 SHEETS—SHEET 2.

Fig. 4.

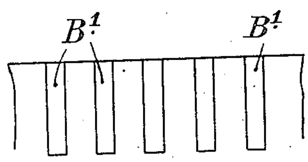


Fig. 5.

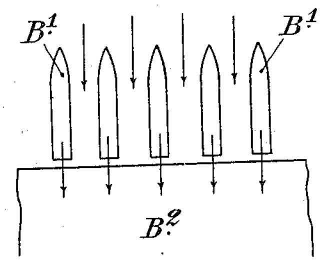


Fig. 6.

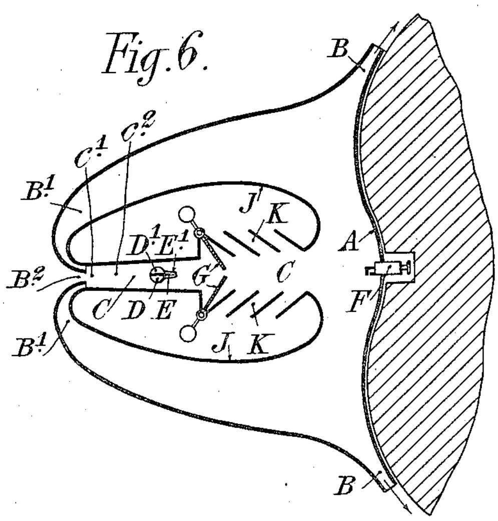


Fig. 7.

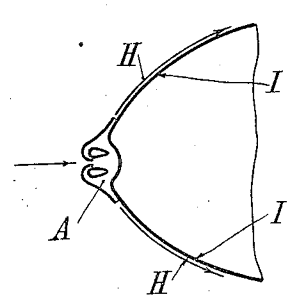


Fig. 8.

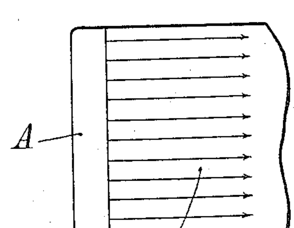


Fig. 6a

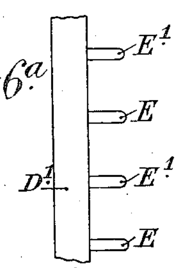


Fig. 9.

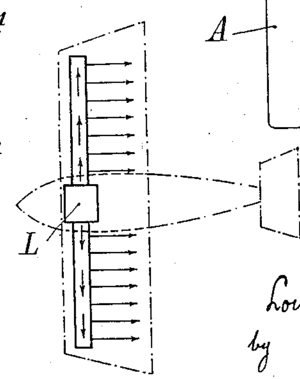
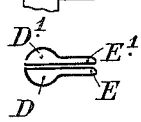


Fig. 6b



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UNITED STATES PATENT OFFICE.

LOUIS ADOLPHE HAYOT, OF BEAUVAIS, FRANCE.

EJECTOR FOR APPARATUS FOR SUSTAINING AND PROPELLING AEROPLANES AND FOR OTHER USES.

1,069,694. Specification of Letters Patent. Patented Aug. 12, 1913.

Application filed February 18, 1913. Serial No. 749,069.

To all whom it may concern:

Be it known that I, LOUIS ADOLPHE HAYOT, citizen of the Republic of France, residing at Beauvais, France, have invented certain new and useful Improvements in Ejectors for Apparatus for Sustaining and Propelling Aeroplanes and for other Uses, of which the following is a specification.

With the object of enabling aeroplanes to soar, and also to rise from and come to the ground without speed of translation, various means have been proposed consisting in the projection of jets or sheets or thin streams of gas either underneath the supporting surfaces so as to produce compression there, or above the said surfaces for the purpose of producing a depression at that spot. Similar means have also already been proposed for propelling aeroplanes without the aid of screw propellers. In such cases the surface acted upon by the gas jets was distinct from the wing surfaces, and was so arranged that the pressure or the depression to which it was subjected, constituted a horizontal propelling force opposing the resistance offered to progression, instead of being a vertical lifting force opposing the action of the weight of the aeroplane. It has also been proposed to propel aeroplanes by simply utilizing the reaction of gas jets directed to the rear. In order to carry out those various methods of sustaining or propelling, it is generally necessary to employ one or more ejectors, an air-compressor and a motor for driving the latter, as well as piping for distributing the compressed air to the ejectors.

Now the present invention has for its object to provide an improved ejector which shall dispense with the distributing piping, the air compressor and the motor for driving the latter while insuring its own feed.

This self-feeding ejector may be constructed in various forms suited to its employment in an aeroplane and to the device to which it is applied; for instance a wing, body or framing of the aeroplane.

Two embodiments of this invention are illustrated by way of example in the accompanying drawings. In both cases the same essential elements are present, namely:—1. A metal body or casing A having a lining of refractory material, into which an explosive gaseous mixture, for instance carbureted air is introduced, and which constitutes the explosion or combustion chamber for the said mixture. 2. An injector consisting of one or more nozzles B (Figs. 1 and 6) of suitable shape for projecting the gases that are to sustain or propel the aeroplanes. 3. An automatic feed apparatus constituting an air trumpet or blower and comprising one or more converging nozzles B′ (Figs. 1 and 6) through which the gases escape and suck in fresh air from the outside which they force into the combustion chamber A through a duct C having a longitudinal section such that it forms in succession a converging suction nozzle B^2, a mixer C′ and a diverging diffuser C^2. 4. A fuel feed device consisting of a duct D to which are connected sprayers E that deliver the liquid fuel in the axis of the delivery duct C whence it is drawn and mixed with the burning gases (Figs. 1 and 6). 5. An igniting device consisting of sparking plugs F, platinum spirals or other known igniters, suitably located in the combustion chamber, and serving to ignite the gaseous mixture on starting, and so long as the refractory lining has not attained a temperature sufficient for itself to produce ignition (Figs. 1 and 6). 6. A device for retaining and regulating consisting of a valve G having the function of preventing the gases from passing back into the duct and the feed ejector, and of a chamber J J having for its object to moderate the variations of pressure in the combustion chamber and to aid in the introduction of the combustible mixture into the said chamber. For this purpose the chamber J J adjacent to the delivery duct C is in communication with the latter through ducts K having partitions which divide the gases issuing therefrom, into jets directed toward the combustion chamber. Any sudden rise in the pressure tending to produce a return flow in the feed duct, will close the non-return valve and compress the gases in the regulating chamber. The fall in pressure following that increase, will then produce a flow of gas from the chamber J

J, and the impulse of this flow will be added to that of the feed injector for the purpose of feeding the combustible mixture into the combustion chamber. 7. A water-injecting device consisting, like the fuel-feed device of a duct D′ to which are connected sprayers E′ which deliver the water in the axis of the delivery duct C where it is sucked in and vaporized by the gaseous mixture whose temperature it lowers during its compression.

Figs. 1, 2 and 2^a are respectively a section, elevation and plan of a self-feeding ejector of the type hereinbefore described, employed for sustaining an aeroplane, and producing in the known manner a depression upon the rear face of the supporting surfaces by projecting a sheet of gas H tangentially to said face. These figures give at the same time an example of a self-feeding-ejector for producing a horizontal propelling force by the direct reaction of the gases issuing from it. The ejector A located in the thickness of the wing parallel to the advancing edge of the latter, may serve as a longitudinal stiffening member (Figs. 2 and 2^a). B is the expansion nozzle constituting the ejector proper which projects to the outside, the gases whose action—in the present example—is utilized for both sustaining and propelling the aeroplane (Fig. 1). B′ is the driving nozzle of the feed blower. B^2, C′, C^2 (Fig. 1) are the successive sections of the delivery duct C which constitute the suction nozzle, the mixer and the diverging diffuser. D is the liquid fuel feed pipe, and E is one of the sprayers mounted on said pipe. D′ is the water feed pipe; E′ is one of the sprayers mounted thereon. F is one of the sparking plugs mounted on the combustion chamber and connected to any suitable supply of electricity. G is the non-return valve, consisting for instance of two flaps balanced on their axes in such a manner that they can yield readily to any pressure of the gases while remaining unaffected by any forces of inertia to which they may be subjected. J J is the regulating chamber with its ducts K.

Figs. 3, 4 and 5 are respectively a longitudinal section, a vertical cross section on the line X—X of Fig. 3, and a horizontal section on the line Y—Y of Fig. 3, of a special form of the driving nozzle B′, having for its object to divide the driving current into parallel streams so as to facilitate its drawing action upon the outer air, and promote the intimate mixing of the driving fluid with the drawn-in fluid.

Figs. 6, 7 and 8 illustrate a self-feeding ejector slightly modified as to construction, employed for propelling an aeroplane, not solely by the reaction of the gases, but mainly by producing a depression upon the forward part of the aeroplane body by projecting a sheet of gas H upon each face of the prow or fore part. The ejector A is arranged along the forward edge of an aeroplane body of fish-like shape, shown in Figs. 7 and 8 in elevation and in plan, or vice-versa in plan and in elevation, according to the type of body. B, B are the expansion nozzles (Fig. 6); and B′, B′, the driving nozzles of the feed blower B^2 C′ C^2. D is the pipe and E are the sprayers for delivering the fuel at the center of the delivery duct. D′ is the pipe and E′ are the sprayers for delivering the cooling water (shown separately in Figs. 6^a and 6^b). F is a sparking plug. G is the non-return valve consisting of two balanced flaps. J, J is the regulating chamber with its ducts K. These two examples of a self-feeding ejector are characterized more particularly (as shown in Figs. 1, 2 and 2^a, and Figs. 6, 7 and 8) by the feature that for their special adaptation to the supporting surfaces and the body of the aeroplane, the introduction into and the movement of the gases in the ejector body or combustion chamber which is very long, are effected transversely to the axis of the said chamber like the delivery of the gases. In other words, referring to Figs. 1 and 6 which show a section of the ejector at right angles to its axis, the admission, the circulation, and the delivery of the gases take place in the plane of these figures whereas in all the gaseous jet apparatus proposed hitherto which have been fed by a compressor L (Fig. 9), the introduction and movement of the gases passing to the expansion nozzles take place longitudinally like the movement of a gas in a pipe.

The very important advantage resulting from the improved construction, is that since the kinetic and thermo-dynamic occurrences are the same in any section of the ejector, the velocity, pressure and temperature of the gases and consequently also the velocity of their delivery are the same throughout the length of the ejector; these being conditions which are indispensable for high efficiency, and are also necessary in order that the sustaining or propelling effects due to the discharge of the gases which are a function of the velocity of the latter, shall be the same throughout the entire area of the sustaining or other surface subjected to the said effects. Now these conditions cannot be satisfied by the apparatus proposed hitherto. In those apparatus it is to be noted, since the gases travel longitudinally as in a pipe (Fig. 9), the pressures and consequently the velocities of discharge, will vary throughout the length of the ejector, owing to the losses of gas due to the delivery of the expansion nozzles and the friction of the gases with the walls, and also owing to the differences of temperature due to the fact that the combustion has not the same intensity throughout the length of the chamber, because the combustion being propagated, like the gases themselves, along the axis of the combustion chamber, is more or less intensified by the mingling together of the gases and their contact with the hot walls of the said chamber. Another characteristic of these two examples of self-feeding ejector, consists in the arrangement of the admission and ejection nozzles for the purpose of being adapted to an aeroplane.

As shown in Fig. 2, the outlet orifice of the gas discharging nozzle B is located in a part of the wing where a depression exists during the flight of the aeroplane, and the inlet orifice of the admission nozzle B^2 is located in a compression zone. This arrangement is to be found also in Fig. 7 where the translation of the aeroplane produces a compression on the stem of the aeroplane body and consequently also at the inlet of the admission nozzle B^2, and a depression in the zone H swept by the air molecules that escape along the surfaces of the prow. The result of these arrangements is that the velocity of translation of the aeroplane promotes the operation of the self-feeding ejector, by producing across the latter a continuous current of air having the same direction as that which is due to the actual operation of the ejector and which enables the latter to start again at any time if it has ceased working. Finally these two examples of the improved self-feeding ejector are characterized by their non-return valves which are balanced on their axles as hereinbefore stated.

Referring to Figs. 1 and 6 it will be seen that owing to the position of the ejector in the aeroplane, the flaps of the said non-return valves, if not balanced, would turn on their axles and thus, be more or less opened or closed by the forces of inertia due in agitated air to the sudden variations in the speed of the aeroplane. The consequence of this would be that the admission of gases into the combustion chamber becoming changed, the sustaining or propelling force produced by said gases would be varied, and fresh disturbances would result therefrom.

In order to start the ejector when the aeroplane is at rest, a small quantity of combustible liquid is introduced into the combustion chamber by means of a vaporizer through the orifice of the expansion nozzle B or the admission nozzle B^2, and the explosive mixture is ignited for instance by electric sparks where this means of igniting has been provided as shown in Figs. 1 and 6. The resulting sudden rise in pressure closes the valve G, compresses the gases contained in the chamber J J and produces a rapid discharge of the combustion gases through the nozzles B and B′, while the fresh air drawn in by the nozzle B^2 and the gases passing out through the driving nozzle B′ are compressed in the delivery duct C. The discharge of the gases through the nozzles B and B′ produces also immediately a pressure drop in the casing A, and consequently the expansion of the gases in the regulating chamber. The impulse of these gases coming in aid of that of the driving current of the nozzle B′, then introduces into the combustion chamber the mixture of fresh air and burned gases which has been temporarily arrested in the delivery duct C and has become carbureted by passing over the sprayers E. This mixture may be ignited by a fresh spark and the same succession of phenomena will be repeated until the walls of the combustion chamber have reached a temperature sufficient to ignite automatically the gaseous mixture and the mean working pressure has become established in the ejector; whereupon a practically continuous combustion and discharge succeed the intermittent explosions and pulsations at the start.

It is to be understood that the use of the self-feeding ejector is not limited to aeroplanes. Among other uses it may be employed in air ships for propelling purposes, or for producing vertical displacements, for instance, by being applied to the elevating and depressing rudders which are thereby converted into aeroplanes. The improved ejector may also be used in connection with certain aerial screws which often have been proposed for aeroplanes and helicopters, and are known as reaction screws, because they are actuated by the reaction of compressed gases issuing from their arms or blades.

What I claim is:—

1. In an ejector for the continuous production of a gaseous jet for propelling or sustaining aeroplanes or for other purposes, the combination of a combustion chamber, a driving ejector nozzle receiving burned gases from said combustion chamber, a delivery duct delivering into said combustion chamber, a non-return valve in said delivery duct, a liquid fuel sprayer in said delivery duct, an air injector worked by burned gases from said combustion chamber delivering air into said delivery duct, and an igniting device projecting into said combustion chamber, whereby the air delivered by said air injector into said delivering duct in passing over said sprayer draws and mixes with liquid fuel spray therefrom to form an explosive mixture which passing said non-return valve into said combustion chamber is exploded therein by said igniting device, the burned gases exhausting

through said driving ejector nozzle with a velocity capable of being utilized for useful purposes.

2. In an ejector for the continuous production of a gaseous jet for propelling or sustaining aeroplanes or for other purposes, the combination of a combustion chamber having a refractory lining, a driving ejector nozzle receiving burned gases from said combustion chamber, a delivery duct delivering into said combustion chamber, a non-return valve in said delivery duct, a liquid fuel sprayer in said delivery duct, an air injector worked by burned gases from said combustion chamber delivering air into said delivery duct, and an igniting device projecting into said combustion chamber, whereby the air delivered by said air injector into said delivering duct in passing over said sprayer draws and mixes with liquid fuel spray therefrom to form an explosive mixture which passing said non-return valve into said combustion chamber is exploded therein by the hot refractory lining, and the burned gases exhausting under pressure through said driving ejector, the said igniting device being used only for starting the apparatus until the said refractory lining has acquired an igniting temperature.

3. In an ejector for the continuous production of a gaseous jet for propelling or sustaining aeroplanes or for other purposes, the combination of a combustion chamber, a driving ejector nozzle receiving burned gases from said combustion chamber, a delivery duct delivering into said combustion chamber, a non-return valve in said delivery duct, an equalizing chamber surrounding the forward portion of said delivery duct, and a plurality of passages located between said non-return valve and said combustion chamber establishing communication between the latter and said equalizing chamber, whereby the variations of pressure in said combustion chamber are equalized, a liquid fuel sprayer in said delivery duct, an air injector worked by burned gases from said combustion chamber delivering air into said delivery duct, and an igniting device projecting into said combustion chamber, whereby the air delivered by said air injector into said delivering duct in passing over said sprayer draws and mixes with liquid fuel spray therefrom to form an explosive mixture which passing said non-return valve into said combustion chamber is exploded therein by said igniting device, the burned gases exhausting through said driving ejector nozzle with a velocity capable of being utilized for useful purposes.

4. In an ejector for the continuous production of a gaseous jet for propelling or sustaining aeroplanes or for other purposes, the combination of a combustion chamber having a refractory lining, a driving ejector nozzle receiving burned gases from said combustion chamber, a delivery duct delivering into said combustion chamber, a non-return valve in said delivery duct, an equalizing chamber surrounding the forward portion of said delivery duct, and a plurality of passages located between said non-return valve and said combustion chamber establishing communication between the latter and said equalizing chamber whereby the variations of pressure in said combustion chamber are equalized, a liquid fuel sprayer in said delivery duct, an air injector worked by burned gases from said combustion chamber delivering air into said delivery duct, and an igniting device projecting into said combustion chamber, whereby the air delivered by said air injector into said delivering duct in passing over said sprayer draws and mixes with liquid fuel spray therefrom to form an explosive mixture which passing said non-return valve into said combustion chamber is exploded therein by the hot refractory lining, and the burned gases exhausting under pressure through said driving ejector, the said igniting device being used only for starting the apparatus until the said refractory lining has acquired an igniting temperature.

5. In a burned gas ejector for sustaining and propelling an aeroplane and the like the combination with the aeroplane of a combustion chamber having an air injector and a driving ejector nozzle, means for causing the gases to travel from the inlet orifice of the injector nozzle to the outlet orifice of the driving ejector nozzle, at right angles to the longitudinal axis of the ejector, the driving ejector nozzle and the air injector being oppositely disposed whereby the wind due to the translation of the aeroplane produces across the ejector a continuous air current having the same direction as the normal travel of the gases in the ejector, and a non-return valve for preventing the reflux of the gases into said air injector.

6. A burned gas ejector for the purpose specified, embodying therein a casing having a combustion chamber and oppositely disposed ports for the discharge of burned gases, means adjacent one of said ports through which air suction is induced by the escape of gases through said port, and means for supplying fuel to the air entering through said means.

7. A burned gas ejector for the purpose specified, embodying therein a substantially U-shaped casing having an intermediate combustion chamber and a discharge port for burned gases at each side of said com-

bustion chamber, a second substantially U-shaped casing having one of its ends arranged adjacent one of said discharge ports for the intake of air and its other end discharging into said combustion chamber, and means for supplying fuel to the air entering said combustion chamber.

In testimony whereof I have affixed my signature in presence of two witnesses.

LOUIS ADOLPHE HAYOT.

Witnesses:
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