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# PATENT SPECIFICATION



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## PROVISIONAL SPECIFICATION

### Improvements in Aircraft

We, THE BRISTOL AEROPLANE COMPANY LIMITED, a British Company, ALFRED HUBERT ROY FEDDEN, a British Subject, and FRANK MORGAN OWNER, a British Subject, all of Filton House, Bristol, in the County of Gloucester, do hereby declare the nature of this invention to be as follows:—

This invention is for improvements in aircraft and has for its object to reduce the power lost in overcoming skin-friction.

It is already known that the drag on an aircraft wing or other part is caused principally by turbulence in the "boundary layer" which is the layer of air immediately surrounding the surface of the wing. According to one feature of the invention an aircraft body comprises the combination with an internal-combustion engine of means actuated by the exhaust gases of the engine for drawing the external air into the interior of the body through suitable perforations in the surface of the said body. The term "body" is used herein to denote any part of which the surface is exposed to an external stream of air.

The said exhaust-driven means is preferably an ejector-nozzle which draws air from the boundary layer and discharges it rearwardly at a suitable point.

In a specific embodiment of the invention an aeroplane wing is formed with perforations in its upper surface along a strip lying at about the middle of the chord. The perforations are connected by suitable conduits to a mixing chamber of an ejector within the wing and a dis-

charge conduit leads from the mixing chamber to a discharge orifice in the lower surface of the wing near the trailing edge.

An exhaust pipe from an engine mounted on the leading edge of the wing extends through the interior of the wing to a nozzle contained within the mixing chamber. The nozzle is so arranged that the exhaust gases issuing from it draw air from the boundary layer of the wing whereby the turbulence is suppressed and the drag greatly reduced. The air drawn into the wing is discharged together with the exhaust gases through the discharge conduit above described.

An advantage of using the energy of the exhaust gases for sucking in the air from the boundary layer is that such energy would otherwise be wasted and thus no additional demand is made on the power of the engine.

The invention also contemplates so designing the ejector nozzle and mixing chamber as to give an easy path of flow between the perforations and the discharge orifice, and possibly also a forward thrust to assist in propelling the aircraft by a form of jet propulsion. The principles of such design are described in "Aircraft Engineering" for August, 1936, pages 218 to 220.

Dated this 2nd day of November, 1936.

BOULT, WADE & TENNANT,  
Chartered Patent Agents,  
111 & 112, Hatton Garden,  
London, E.C.1.

## COMPLETE SPECIFICATION

### Improvements in Aircraft

We, THE BRISTOL AEROPLANE COMPANY LIMITED, a British Company, ALFRED HUBERT ROY FEDDEN, a British Subject, and FRANK MORGAN OWNER, a British Subject, all of Filton House, Bristol, in the County of Gloucester, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

[Price 1/-]

This invention is for improvements in aircraft and has for its object to provide improved means for reducing the power lost in overcoming skin-friction.

It is already known that the drag on an aircraft wing or other aircraft body is caused principally by turbulence in the boundary layer which is the layer of air immediately surrounding the surface of the wing, and it has been proposed to draw air from the boundary layer into the

interior of an aircraft body by means of a fan driven by the exhaust gases of the internal-combustion engine by which the aircraft is propelled.

5 According to the present invention, an aircraft comprises an internal-combustion engine for propelling the aircraft, a chamber within an aircraft body forming part of the aircraft, an inlet conduit leading to the said chamber from perforations in the surface of the body, an ejector-nozzle within said chamber, an exhaust-pipe leading to said nozzle from the engine whereby the discharge of exhaust gases from the said nozzle draws air from the boundary layer along said inlet conduit into the chamber, and an outlet conduit leading from said chamber to discharge said air and said exhaust gases from said body in a rearward direction. The term "body" is used herein to denote any part of the aircraft of which the surface is exposed to an external stream of air.

A specific embodiment of the invention will be described by way of example with reference to the accompanying diagrammatic drawing which is a sectional elevation through an aeroplane wing. The wing 10, the leading edge 11 of which is shown as a dotted line, is formed with a forwardly-protruding enlargement 12 which carries a radial-cylinder internal-combustion engine 13 driving the airscrew 14. The exhaust gases from the engine cylinders are collected in an exhaust-ring 15 situated at the leading edge of a streamlined cowl 16 surrounding the engine.

The upper surface of the wing is formed along a strip lying at about the middle of the chord and running lengthwise of the wing with a series of perforations which in the accompanying drawing are shown as an orifice 17. The perforations are preferably fine holes, closely spaced; for example, the holes may be each one sixty-fourth of an inch in diameter with their centres spaced one-quarter of an inch apart. An inlet-conduit 18 leads from the perforations to a mixing-chamber 19 from which an outlet-conduit 20 leads to an outlet orifice in the lower surface of the wing near the trailing edge.

Leading from the exhaust-ring 15 of the engine to the chamber 19 is an exhaust tail-pipe 21 from which the exhaust gases are discharged through ejector-nozzles 22.

The nozzles 22 and the chamber 19 constitute a fluid-ejector which, when the aircraft is in flight, draws air through the perforations 17 along the conduit 18 into the chamber 19 and expels it rearwardly

together with the exhaust gas through the conduit 20. In this way the air is continuously drawn away from the boundary layer on the upper surface of the wing whereby the turbulence is suppressed and the drag greatly reduced.

The ejector-nozzles 22 and chamber 19 may be so designed as to give an easy path of flow between the perforations 17 and the discharge orifice at the end of the conduit 20. With this object in view, the conduit 18 is designed so as to expand gradually, without a sudden change in section, to form the chamber 19 so that a part of the kinetic energy of the air in the inlet-conduit 18 is converted into pressure energy in the chamber 19. In passing through the chamber 19, the air is entrained by the exhaust gases issuing from the nozzles 22. The chamber 19 at its rearward end converges to the outlet-conduit 20, again without sudden change in section, so that the pressure energy of the gases in the chamber 19 is reconverted into kinetic energy. By designing the parts in this way it is possible, in some cases, to obtain a forward thrust to assist in the propulsion of the aircraft.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. An aircraft comprising an internal-combustion engine for propelling the aircraft, a chamber within an aircraft body forming part of the aircraft, an inlet conduit leading to the said chamber from perforations in the surface of the body, an ejector-nozzle within said chamber, an exhaust-pipe leading to said nozzle from the engine, whereby the discharge of exhaust gases from the said nozzle draws air from the boundary layer, along said inlet conduit into the chamber, and an outlet conduit leading from said chamber to discharge said air and said exhaust gases from said body in a rearward direction.

2. An aircraft according to Claim 1, wherein the said perforations are fine holes, closely spaced, in the upper surface of an aircraft wing.

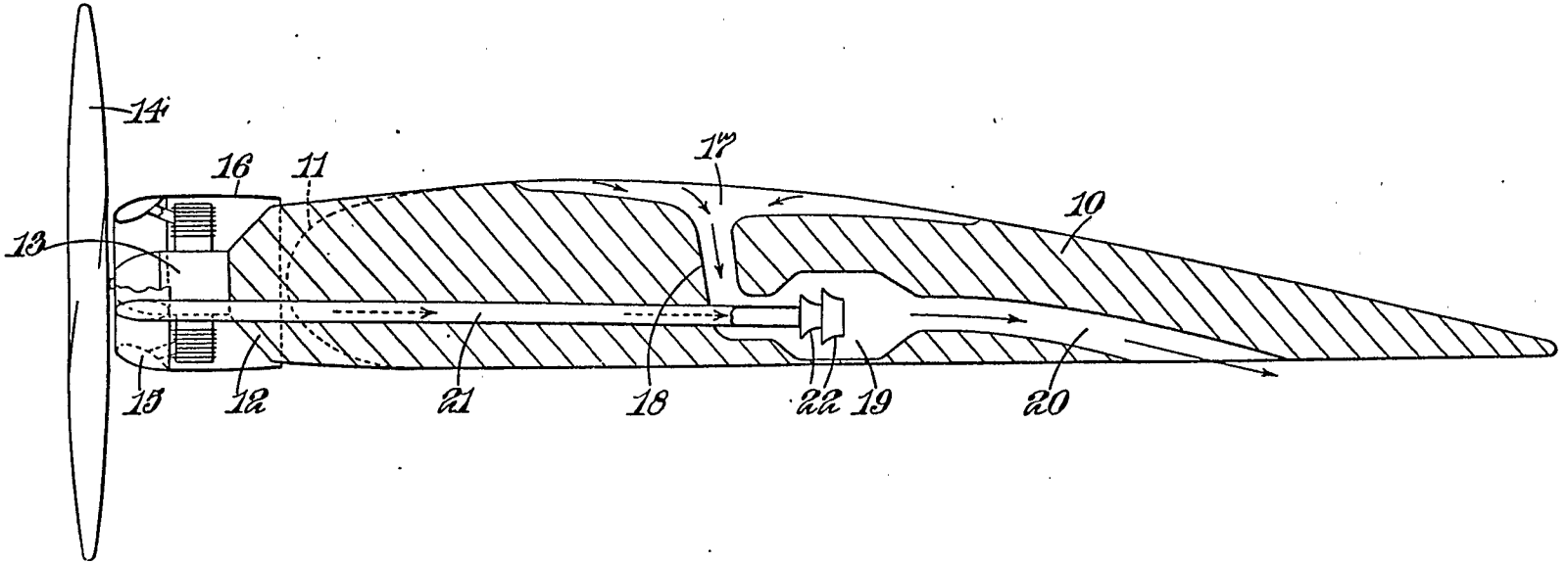
3. In an aircraft, means for drawing air from the boundary layer into the interior of the aircraft, substantially as herein described with reference to the accompanying diagrammatic drawing.

Dated this 1st day of November, 1937.

BOULT, WADE, & TENNANT,

Chartered Patent Agents,  
111 & 112, Hatton Garden,  
London, E.C.1.

[This Drawing is a full-size reproduction of the Original.]



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