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DEVICE FOR CONTROLLING THE FLOW DIRECTION OF A REACTION JET ISSUING FROM A NOZZLE

Original Filed June 4, 1951

Fig. 1

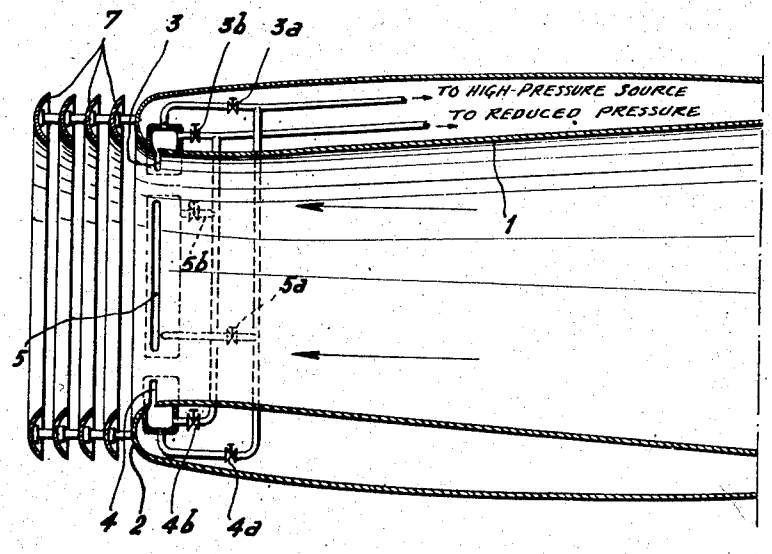
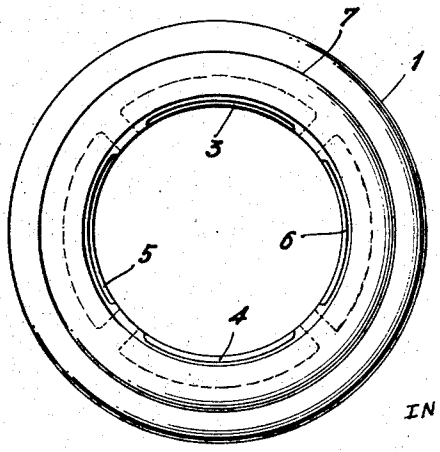


Fig. 2



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DEVICE FOR CONTROLLING THE FLOW DIRECTION OF A REACTION JET ISSUING FROM A NOZZLE

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Claims priority, application France June 16, 1950

2 Claims. (Cl. 60—35.54)

This application is a divisional application of our co-pending U. S. patent application Serial No. 229,772, filed June 4, 1951, now Patent No. 2,793,494 issued May 28, 1957.

The present invention has for its object to provide means for deflecting a reaction jet issuing from a nozzle in an axial direction, away from said axial direction, thus altering the axial component of the thrust and/or producing a steering or a braking action on the jet propelled aircraft.

A further object of this invention is to provide means for deflecting a reaction jet issuing from a nozzle, in any one of several directions at an angle with the axis of said nozzle.

According to the invention, the nozzle is provided with opposed slots extending on the periphery of said nozzle and connected to a source of pressure substantially different from that obtaining in said nozzle, individual valve means being provided for controlling the connection of said source to each slot.

Other objects and advantages of the invention will be apparent during the course of the following description.

In the accompanying drawing in which like reference characters are employed to designate like parts throughout the same,

Fig. 1 is a diagrammatic axial section through a nozzle according to the invention.

Fig. 2 is an end view of this nozzle.

The nozzle **1** is formed, at its outlet, with an outwardly curved, convex extension **2** which is provided with opposed slots **3**—**4**, **5**—**6** forming minor nozzles opening into the main nozzle **1** in a direction substantially perpendicular to the axis of the latter and preferably slightly inclined upstream. These slots extend, along the periphery of the nozzle **1**, over arcs of a circle smaller than 90° (in the present example including 4 successive slots located in the same diametrical plane).

Each slot is connected both to a source of fluid under pressure (which may be a stage of the air compressor if the nozzle belongs to a jet turbine engine) and to a source of depression (which may be suction slots provided on the wings or elsewhere). Of course the overpressure of the former source and the depression of the latter one are relative to the normal pressure obtaining at the outlet of the nozzle **1**. Each slot is associated with two individual valves *3a*—*3b*, *4a*—*4b*, . . . controlling respectively the connections to the source of pressure and to the source of depression.

Downstream of the outlet of nozzle **1** is mounted a series of spaced successive vanes **7** coaxial with nozzle **1** and forming lateral, annular, curved passages.

The arrangement described operates as follows:

If it is desired to deflect the jet vertically downwards,

the valves *3a* and *4b* are opened, all the other valves remaining closed. An auxiliary screen-like jet will issue from slot **3** forming a kind of fluid obstacle which urges the main jet issuing from **1** towards the opposite side of the nozzle, i. e. towards the wall portion adjacent the slot **4**. This deflection is furthered by the sucking action produced by the slot **4**. Thus the jet issuing from nozzle **1** is bent downwards and "sticks" to the curved walls **2** and **7** which, owing to their very curved shape, increase the deflection, so that the jet eventually issues at an angle with the axis of the nozzle.

Obviously, deflection can be obtained by operating only one of the opposed slots **3**—**4**, i. e. by opening only one of the valves *3a*—*4b*.

Now, an opposite deflection (upwards) will be had if valves *3b*—*4a* are opened, the others remaining closed. Similarly lateral deflection is produced by operating slots **5**—**6** in either of the two ways described.

Therefore, the jet issuing from the nozzle **1** can be bent in any one of 4 directions perpendicular to each other. It can also be bent in the 4 directions bisecting the angles formed by the formed 4 directions in the following way:

Two adjacent slots, say **3**—**5** are connected to the pressure source, whereas the opposite adjacent slots **4**—**6** are connected to the depression source.

Lastly any intermediate deflection can be obtained by adequately proportioning the blowing and/or sucking actions of the corresponding slots.

The device described affords a very efficient and simple steering action. The valves are of course operated by the pilot through any adequate transmission which can be conveniently under the control of the "joy-stick." With this device, the conventional control surfaces of aircraft can be done without, thus allowing considerable reduction in losses through air friction and turbulence, which is particularly important in high-speed flight.

It will be appreciated that the axial component of the thrust produced by the deflected jet is considerably decreased as compared with that of the non-deflected jet. If the deflection obtained is of about 90°, the axial thrust is practically negligible; if this deflection is greater than 90°, a braking effect will be produced, and the greater the angle of deflection beyond 90°, the more powerful the braking effect.

Such a reduction in the axial thrust or even braking action are highly desirable in certain cases, e. g., when landing. However in this case, a steering effect may be undesirable.

The device of the invention can be operated so as to produce such a braking action without any steering effect. For that purpose, the opposed slots will be similarly operated: for instance, slots **3**—**4** are both connected to the pressure source, whereas slots **5**—**6** are both connected to the depression source.

The screen-like jets issuing from the opposed slots **3**—**4** form a kind of diametrical fluid obstacle which divides the main jet into two equal fractions which are laterally deflected, this lateral deflection being furthered by suction of the slots **5**—**6**. The two deflected fractions of the jet being symmetrical, there will be no resultant lateral thrust, while the axial thrust will be considerably decreased and even cancelled or inverted (braking action).

This operation is carried out without affecting the output of the engine which may operate at normal rate, so that, in case of emergency, full axial thrust can be had at once by closing all the valves.

What we claim is:

1. A device for steering a jet propelled aircraft having a propulsive nozzle opening towards the rear of said aircraft through a circular outlet, said device comprising

two pairs of opposite slot-like passages, at 90° with each other, extending along the periphery of said outlet, in a plane perpendicular to the axis of said nozzle, each passage being in the form of an arc of a circle concentric with said circular outlet and facing substantially towards the center thereof, a source at a pressure substantially higher than the pressure existing at said outlet, another source at a pressure substantially lower than the pressure existing at said outlet, and controllable means for selectively connecting the opposite passages of either pair respectively to said sources.

2. Device as claimed in claim 1, wherein the slot-like passages of the two pairs are respectively vertically and horizontally directed.

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