Jan. 9, 1968 P. CHAULIN 3,362,431

APPARATUS FOR THE RAPID MIXTURE OF FLUIDS, ESPECIALLY ON A TURBO-RAM-JET UNIT

Filed Oct. 8, 1964 4 Sheets-Sheet 1

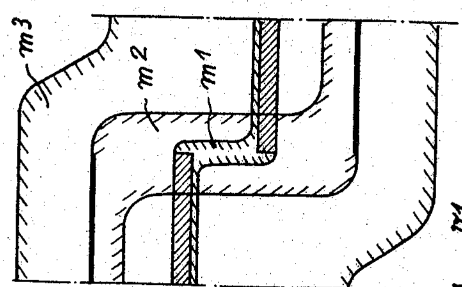

Fig.2.

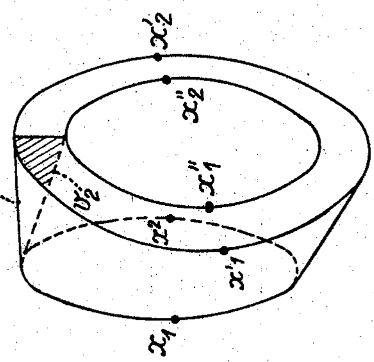

Fig.7a.

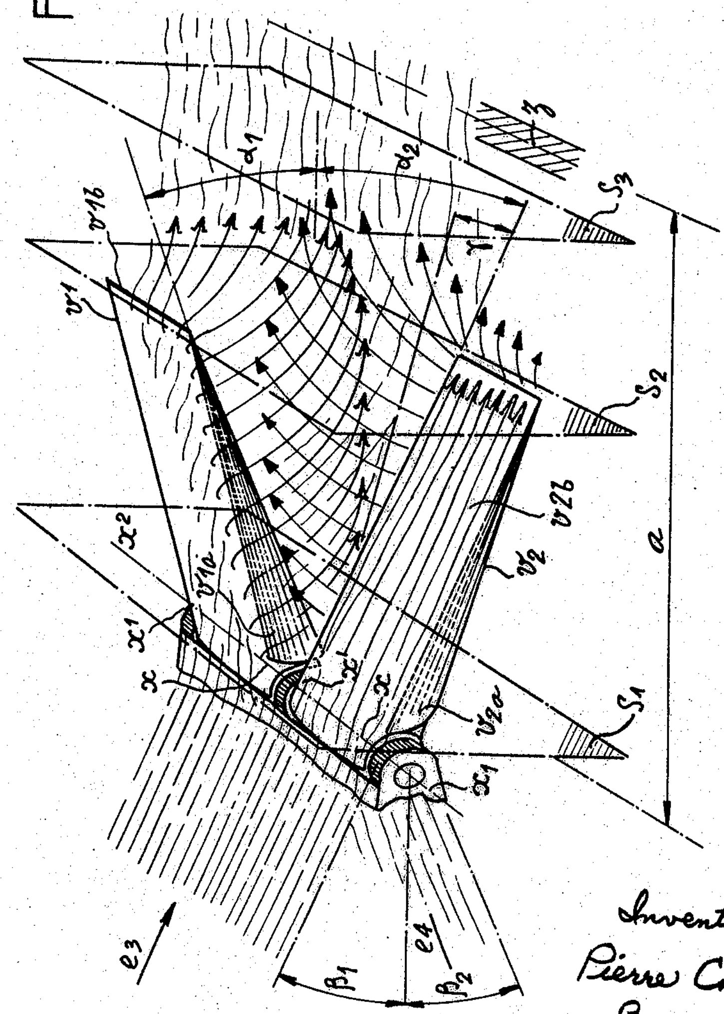

Fig.1.

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Fig.3.

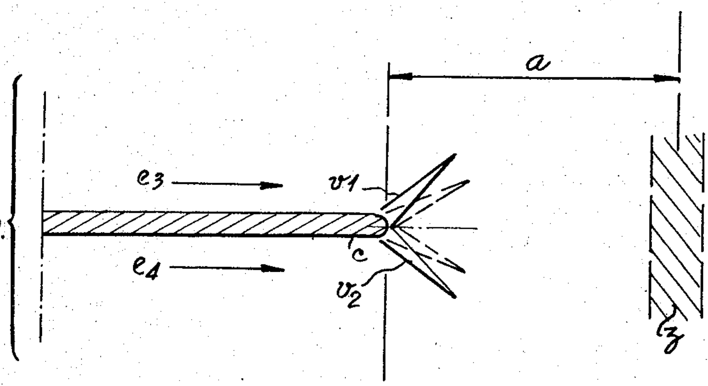


Fig.4.

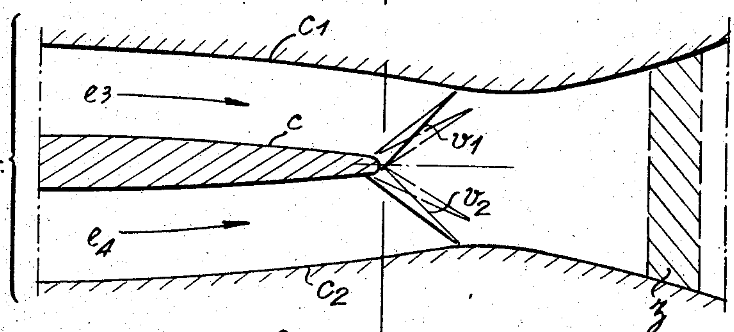
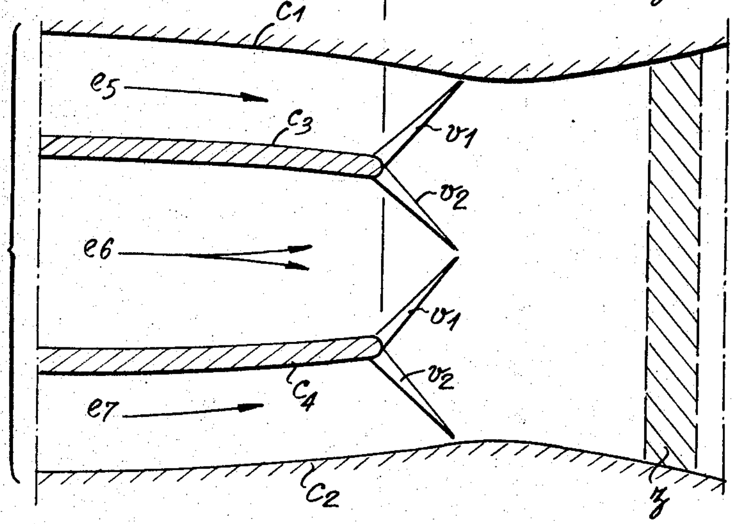


Fig.5.



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APPARATUS FOR THE RAPID MIXTURE OF FLUIDS, ESPECIALLY ON A TURBO-RAM-JET UNIT

Filed Oct. 8, 1964 4 Sheets-Sheet 3

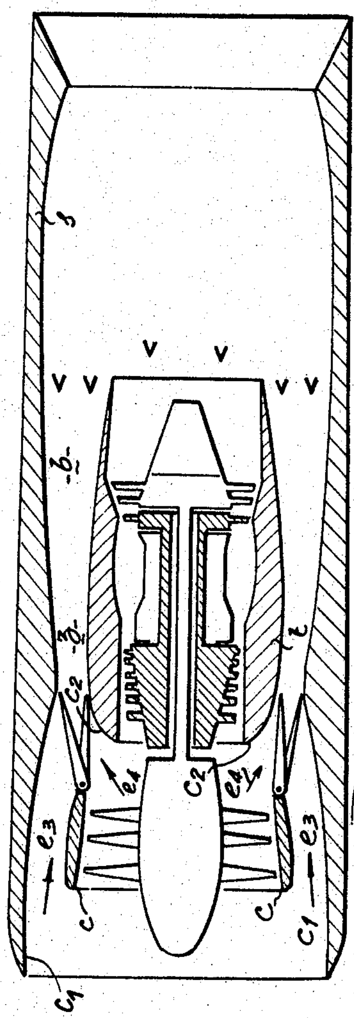

Fig.6

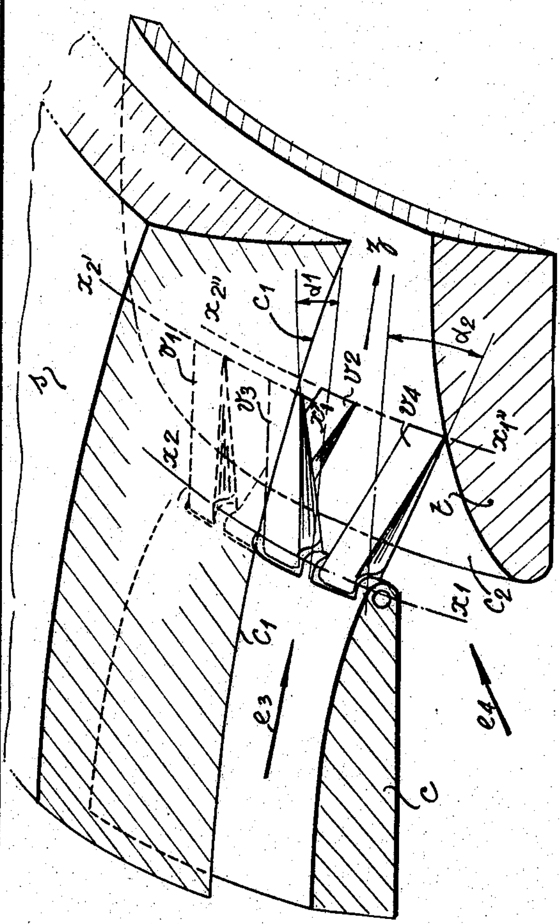

Fig.7

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FIG. 9.

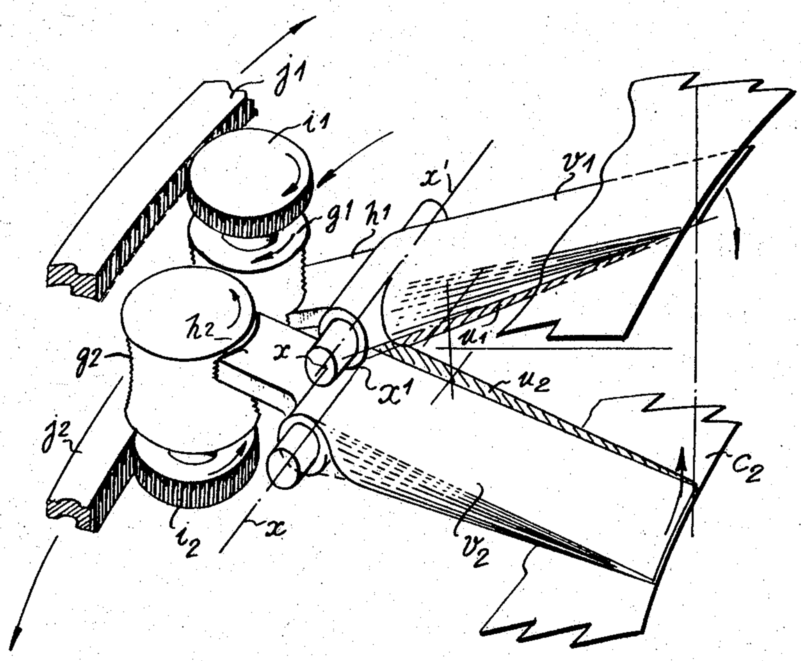
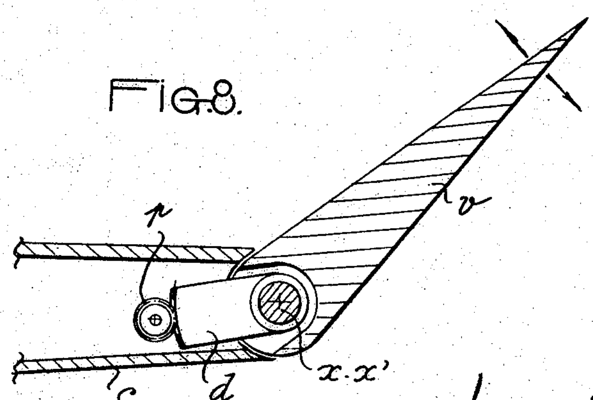


FIG. 8.



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APPARATUS FOR THE RAPID MIXTURE OF FLUIDS, ESPECIALLY ON A TURBO-RAM-JET UNIT

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9 Claims. (Cl. 137—604)

ABSTRACT OF THE DISCLOSURE

A device for mixing fluxes using at least two adjacent, oppositely pivotally mounted flaps.

The present invention relates to a method for the rapid mixing of fluids; it is also concerned with a device for carrying the said method into effect, especially on a combined turbo-ram-jet unit.

Devices for mixing fluids of different natures are already well-known, but they all effect only an adaptation of the fluid streams before they come together, and the mixture only develops very slowly thereafter. The zone in which the mixture becomes sufficiently homogeneous is frequently very far downstream of the mixing device.

Now, in the majority of cases, it is desirable to obtain a suitable mixture as close as possible to the mixer, and it is furthermore this distance of the mixture which often governs the dimensional size of injectors, ejectors and other devices producing and/or utilizing fluids of different natures.

Thus, for example, the design of a by-pass turbo-reactor and ram-jet-unit combination (in which the by-pass turbo-reactor is installed in the interior and on the axis of the ram-jet unit, and in which a part of the flow of secondary air of the by-pass turbo-reactor is discharged through an appropriate channel into the annular conduit of the flux of the ram-jet unit, the mixture of the turbo-reactor secondary flux and the ram-jet flux being effected in a region comprised between the outlet of the low-pressure compressor and the inlet of the combustion device in front of the outlet plane of the primary flux of the turbo-reactor) is only possible if the said mixture can actually be effected in the said region. Now, up to the present time, with the mixture devices available and for the reasons already stated, the combined turbo-ram-jet unit could only be designed with a by-pass turbo-reactor having a great length or considerably extended downstream of the turbine.

The present invention contemplates a method and a device for the rapid mixing of fluxes, which make it possible to obtain relatively short apparatus, and in particular a combined turbo-blower-ram-jet unit resulting from the adaptation of a ram-jet on a modern by-pass turbo-reactor having a large section and a proportionately short length.

In accordance with the method of the invention, the fluxes to be mixed are inclined differently in order to intersperse them deeply and to obtain in the first place a pre-mixture which is still coarse but which develops rapidly over a short length to form a perfectly homogeneous mixture.

The fluxes may be divided into numerous elementary streams, each of which is subjected to a different inclination with respect to the two elementary streams flowing immediately on each side of it.

The device for carrying the above method into effect is characterized by:

At least two streamlined flaps, the volume of which approximates to that of a straight isosceles triangular prism having very finely tapered bases, and in which the straight line pivotal axis is perpendicular to these bases;

A fairing for each flap which is defined according to each case by the conditions of the mixture and the nature of the fluids in presence;

A successive arrangement of these flaps, such that the pivotal axes are located substantially in the extension, one of the other, and in a direction perpendicular to the direction of flow of the fluid or fluids;

A position of the said flaps in the stream of fluid and at the point of convergence of at least two different fluids, the said position being such that the pivotal axes of the flaps are on the upstream side of the fluids to be mixed;

A successively opposite inclination of each flap, which is determined as a function of the condition of the incident fluids.

Other characteristic features and advantages of the invention will be brought out in more detail during the course of the description which follows below with reference to the accompanying drawings, of non-limitative forms of construction obtained by the application of the above method, and especially of one form of construction in accordance with a preferred embodiment of the invention.

In the drawings:

FIG. 1 is a diagram showing in perspective the flow of the streams of two different fluids over two alternate streamlined flaps;

FIG. 2 is a diagram showing the proportion of mixture obtained in transverse planes formed in FIG. 1 and at various spacing distances from the point of meeting of the fluids;

FIGS. 3, 4 and 5 are diagrams showing by way of example certain arrangements of alternate flaps at the intersection of at least two fluids, this being effected in a closed or open chamber;

FIG. 6 represents a longitudinal section passing through the axis of a combined turbo-ram-jet unit, equipped with a mixing device according to the invention;

FIG. 7 is a perspective view in partial section showing to a larger scale the positioning of the device in the interior of the said turbo-ram jet unit;

FIG. 7*a* shows diagrammatically the mixing zone in the case of the arrangement shown in FIG. 7;

FIG. 8 represents a possible mechanism for inclining the flaps, and FIG. 9 shows a further inclination device for a particular case.

In FIG. 1, two shutters *v*1–*v*2, forming an elementary part of the mixing device, are located at the point of convergence of two fluids *e*3, *e*4, having angles of incidence $\beta 1$, $\beta 2$. (The fluids have been shown without thickness for the sake of clearness of the drawings.)

These flaps, which are intended to mix streams of gas having a very high speed, have been given a profile such that the faces which create the obstacle in the fluxes have surfaces *v*1*a* and *v*2*a* similar to the profiles of the leading edges of aircraft wings. These profiles separate the flow without appreciable loss and produce a mixing interaction with the layers of flux passing over the faces *v*1*b*, *v*2*b*, which are substantially flat and opposite to the profiled faces *v*1*a*, *v*2*a*.

The mixture which is initially effected at the point of meeting of the fluxes will be proportionately increased as the distance from this point increases. FIG. 2 shows, seen from the upstream side and given by way of example, the increase diagram of mixing of three transverse sections S1, S2 and S3, of which the first two are in the flaps

$v1$ and $v2$, and the third is slightly downstream of the flaps.

The section S1 which is the nearest to the point of meeting, indicates a very small mixing surface $m1$. The section S2, farther away, shows a definite increase in the mixing surface $m2$ and the section S3, which is located very close to the zone of complete mixture z, indicates a very large mixing surface $m3$. It is clear that the mixture will be 100% completed in a zone z located at the distance a from the intake of the mixing device, this distance being always made optimum by the adaptation of the elements of the mixer. There can also be seen from FIG. 1 the possibility of pivoting the flaps $v1$ and $v2$ along the axes x, x' which may furthermore be arranged in line along a single axis $x1$, $x2$. This pivotal mounting permits the variation γ of the angles $\alpha 1$, $\alpha 2$, in order to be able to vary the sections of the two fluxes at the level of the mixer for the adaptation of the rates of flow of the fluxes to be mixed. A fixed value of the angles $\alpha 1$ and $\alpha 2$, for which the adaptation is suitable, may also be determined as a function of the range of operation.

FIG. 3 represents the simplest arrangement of the mixing device according to the invention. The fluids $e3$ and $e4$ are simply separated by the separation c. The flaps $v1$ and $v2$ are mounted at the intersection of these two fluids. The zone z of homogeneous mixture, located at a distance a from the mixer, will have a surface which is a function of the incidence and of the speed of the fluids and of the occultation surface of the flaps.

FIG. 4 represents the arrangement shown in FIG. 3, the fluids $e3$ and $e4$ being contained in this case in a chamber, the internal profiles of which are the contours $c1$ and $c2$.

FIG. 5 shows an arrangement in which three fluids $e5$, $e6$ and $e7$ are to be mixed with each other. They are delimited by the contours $c1$ and $c2$, and the separations $c3$ and $c4$. The contour $c1$ and the separation $c3$ delimit the fluid $e5$, the separation $c3$ and the separation $c4$ define the fluid $e6$, and the separation $c4$ and the contour $c2$ the fluid $e7$. It is easy to show that the fluids $e5$, $e6$ and $e6$, $e7$ are mixed with each other, as shown in FIG. 3, and that there may be any desired number of fluids, the mixing principle being in all cases that shown in FIG. 3. It is obvious that the surface of the stream delimited by the occultation of the flaps and/or the contours c may have any shape whatever, rectangular, cylindrical, ring-shape, elliptical, etc.

FIG. 6 shows a preferred form of embodiment of the invention, in which the method is applied to a combined turbo-blower-ram jet. In this figure, the ram-jet unit s is mounted concentrically with a by-pass turbo-reactor t. This propulsion unit ensures, over a fairly wide range of Mach numbers in flight, the mixture at z of the secondary flux $e4$ of the turbo-reactor and the flux $e3$ of the ram-jet unit, in variable proportions, depending on the conditions of flight.

This mixture, followed by a diffusion stage, is intended to feed the annular combustion chamber b under good conditions. In addition, due to reasons of length and weight of the combination unit, the downstream part of the combustion device of the annular chamber b is located approximately in the outlet plane of the primary flux of the turbine, equipped with a short discharge nozzle. In the case of combinations which provide advantageous characteristics, especially if they are based on short, modern turbo-blowers, it becomes necessary to provide a very high mean divergence between the mixer and the end of the annular chamber. The conventional methods of mixing necessitate a sufficient cylindrical portion downstream of the flaps to permit the mixture to be correctly obtained, followed by a diffuser of conventional divergence angle which is in turn followed by the combustion device, and results in a total length of the order of twice that available between the outlet of the secondary flux and the outlet of the primary flux of the turbine.

The arrangement which has been adopted on the turbo-ram jet unit of FIG. 6, and which is shown in perspective and to a larger scale in FIG. 7, has been directly inspired by the arrangement shown in FIG. 4.

In the case of an application of this kind, the mixing zone is annular (see FIG. 7a). The flaps can produce a partial occultation of the streams of fluid in consequence of the interstice which is formed between the flaps and which is due to the defect of juxtaposition of the occultation surfaces of each flap projected on the lateral surfaces of the ring of straight triangular section, the apex of which is on the line $x1$–$x2$, and the base of which is comprised between the lines $x1'$–$x2'$ and $x1''$–$x2''$ joining together in pairs the free extremities of the flaps. This lack of total occultation, without importance in the majority of cases, can be eliminated in others, by means of a particular arrangement of the flaps which will be described later. Thus, consideration of all the cases of operation of the combined unit leads to the idea of supplying the annular combustion zone b (FIG. 6), either by the ram-jet flux $e3$ alone, or by the secondary turbo-reactor flux $e4$ alone.

In the first case, all the flaps $v1$, $v3$, $v5$ . . . , must be capable of folding back so that they touch the wall $c2$; the flaps $v2$, $v4$, $v6$ . . . also come into contact with this wall. The assembly formed by all these flaps constitutes a wall which is as tightly closed as possible to the flux $e4$.

In the second case, all the flaps are applied under the same conditions against the wall $c1$ and form a wall which is hermetically closed to the flux $e3$.

The control of the inclination of the flux in accordance with FIG. 7 can be obtained by the mechanism illustrated in FIG. 8. In this latter figure, a toothed segment d is keyed on the shaft which forms the axis $x1$–$x2$ rigidly fixed to the flaps v. The toothed segment v engages with a pinion p mounted on a mechanical device fixed to the frame c. It is easy to see that, depending on the direction of rotation of the pinion p, the flap v is inclined in a direction and to an amount which is a function of the rotation of the pinion p.

FIG. 9 shows a device which permits the total covering of the occultation surface of the flaps. In this figure, the axes x, x' are displaced, which enables overlapping zones $u1$, $u2$ to be obtained, irrespective of the relative position of the flaps $v1$, $v2$. The mechanism shown permits an identical inclination of the lines of flaps $v1$ and $v2$. This mechanism comprises worm screws $g1$, $g2$, actuating the toothed segments $h1$, $h2$, rigidly fixed to the flaps $v1$, $v2$. These screws are driven by means of pinions $i1$, $i2$ from toothed rings $j1$, $j2$. The movement of the rings, depending on the direction of the threads of the worm screw, produces an inclination of the flap proportional to the said rotation. It will be obvious that all these mechanisms are enclosed in adequate fairings. Similarly, any other different mechanism may be employed in order to obtain the same results.

The present invention is not limited to the forms of embodiment described and shown. It may be modified and in particular there may be placed in fluxes of fluids of any nature, volume, speed, pressure, temperature, etc., and of any number, an adequate quantity of devices according to the method forming the object of the invention, these devices having a sufficient number of flaps of suitable shape, positions and inclinations, all these means being directed to obtaining a mixing distance which is always a minimum, whatever may be the variations of the characteristics of these fluxes of fluids.

Similarly, it is possible to employ any known devices to incline the flaps, and these devices may be actuated manually or automatically by any desired means.

In particular, a servo-control or regulation may be associated with these actuation means.

Generally, all modifications of detail may be made to the arrangements described which are comprised within the scope of the invention.

I claim:

1. A device for mixing fluxes of fluids comprising at least two contoured, articulated flaps mounted in a passage means at the juncture of at least two separate streams supplying fluids of different fluxes to said juncture, said flaps having leading and trailing edges and side edges, said flaps being mounted in juxtaposition in side to side relationship on axes parallel to a common line, control means connected to each of said flaps so as to rotate them about their respective axes in opposite directions to each other to promote rapid mixture of said at least two different fluxes controlled thereby, the oppositely rotated condition and the contoured shape of said flaps causing the fluxes to become inclined and overflowing and rapidly interlaced and interspersed in the variable angle opening between said two flaps.

2. A device for mixing fluxes of fluids as claimed in claim 1, in which the pivotal axes of said flaps are located in a direction perpendicular to the direction of flow of said fluxes.

3. A device for mixing fluxes as claimed in claim 2, in which the pivotal axes of said flaps are located on the upstream side in the flow of said fluxes.

4. A device for mixing fluxes as claimed in claim 2, in which the pivotal axes of said flaps are located in the line of extension of each other.

5. A device for mixing fluxes as claimed in claim 2, in which the pivotal axes of said flaps are staggered, one with respect to the other.

6. A device for mixing fluxes as claimed in claim 5, in which said flaps can overlap.

7. A device for mixing fluxes as claimed in claim 1, and further comprising a succession of flaps, the pivotal axes of said flaps being disposed in annular form on the same circle.

8. A device for mixing fluxes as claimed in claim 1, and further comprising a series of flaps, the pivotal axes of said flaps being disposed alternately on two concentric circles.

9. A device for mixing fluxes as claimed in claim 1, in which the fairing of said flaps approximates to the shape of a straight isosceles prism of very finely tapered form, and in which all the said flaps have the same true edge and a same edge on the leading side of the aerofoil, so that, considering at least two flaps, a true edge of one flap is next to a leading edge of the other flap.

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