June 19, 1951 R. J. IMBERT 2,557,435

REGULATING DEVICE FOR THE OUTLET SECTION
OF REACTION PROPELLER TUBES OR NOZZLES
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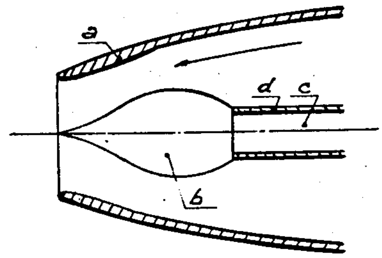

Fig. 1

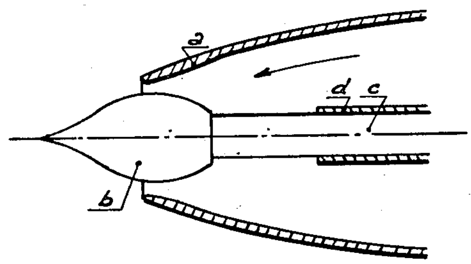

Fig. 2

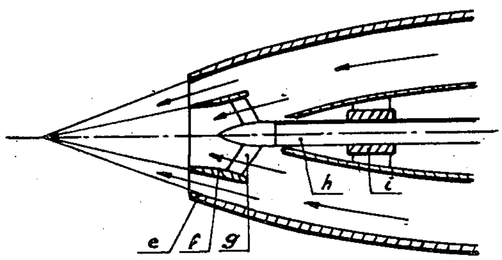

Fig. 3

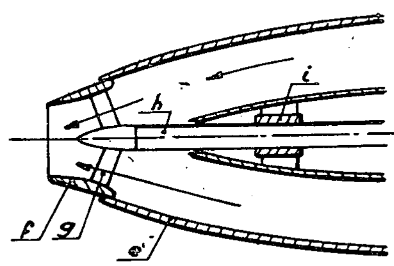

Fig. 4

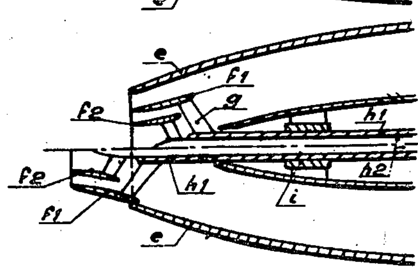

Fig. 5

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REGULATING DEVICE FOR THE OUTLET SECTION OF A REACTION PROPELLER TUBE OR NOZZLE

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3 Claims. (Cl. 60—35.5)

1

This invention relates to a regulating device for the outlet section of a reaction propeller tube or nozzle.

It is known that in vehicles, projectiles or other movable objects propelled at great speed by a reaction device, the motive gases escape rearwards at great velocity in an expansion tube or nozzle. The motive fluid may be air taking part in a thermal cycle, or it may comprise combustion gases.

In order to ensure expansion of the motive gases in the most favourable conditions under different operating conditions, taking into account for example the mechanical characteristics of the compressor for the combustive air, the velocities of the movable object and the variations in specific weight of the ambient air, it is indispensable to provide means for varying the outlet section of the expansion tube or nozzle.

It has already been proposed, in the case of circular tubes for example, to use a throttle comprising a body of revolution which can be displaced longitudinally along the axis of the tube, but this device requires a throttle of relatively substantial diameter when the partial throttling takes a relatively high value, as well as a big axial displacement of the throttle. It involves an increase in the parasitic frictions of the gases by increasing the friction surfaces.

The present invention permits of very substantially reducing these disadvantages; it consists essentially in providing a throttle comprising one or more telescopic nozzles which can be displaced along the axis of the tube.

The following description relating to the accompanying drawing, given by way of non-limiting examples, will permit of understanding the manner of carrying the invention into effect, it being understood that the details of the drawing and of the description form part of the said invention.

Figs. 1 and 2 illustrate in section a throttle for a nozzle of known type, Fig. 1 showing the position of the throttle for maximum opening and Fig. 2 the same throttle in the position of minimum opening.

Figs. 3 and 4 illustrate a throttle made according to the invention in the two positions corresponding respectively to Figs. 1 and 2.

Fig. 5 illustrates a modification of the throttle shown in Figs. 3 and 4 comprising two concentric telescopic nozzles. In this figure, the upper half section and the lower half section illustrate, respectively, the throttle in two different operating positions.

2

The operating conditions provided for a reaction device, taking into account the various obstructions above described by way of example, permit of determining the maximum and minimum flow sections of the gases on leaving the expansion tube.

In the throttle of known type, illustrated in section in Figs. 1 and 2, *a* is the external envelope of the tube or nozzle, *b* the throttle proper mounted on its control rod, *c*, which is displaceable axially in a guide *d*. Assuming, for example that it is desired to obtain the value 4 for the ratio of the maximum outlet section to the minimum outlet section, it will be necessary for the ratio of the diameter of the throttle at the right of the outlet orifice of the tube to the diameter of the orifice of the tube to be $\sqrt{3/4}=0.866$. Thus, when the ratio of the outlet sections to be effected is high the maximum diameter of the throttle will be very close to that of the tube; this will result in an increase in the frictions in the interior of the tube and, consequently, a decrease in the output of the latter.

The throttle in conformity with the invention comprises a different arrangement, and is illustrated, in Fig. 3 in the position of maximum opening, and, in Fig. 4, in the position of minimum opening. In these figures *e* is the external envelope of the tube, *f* the body of the throttle constituted by a nozzle or tube *f*. This nozzle is connected by profiled arms *g* to the control rod *h* slidably mounted in a guide *i*. Referring again to the example of the maximum ratio of the outlet sections, fixed at 4 in the preceding example, the ratio of the outlet diameter of the tube to the outlet diameter of the throttle will be no more than $\sqrt{1/4}=0.5$. The frictional surface inside the tube, and more particularly in the region where the gases have the greatest velocities will be much more reduced and the output of the tube will be correspondingly increased.

Further, if desired, the throttle may comprise several concentric nozzles in order to fractionate the throttling and thus reduce the longitudinal dimension of the device for regulating the outlet section of the tube. In this way a multistage telescopic device is obtained. Fig. 5 shows in two half sections, corresponding respectively to two different operating positions a form of construction of this kind. The throttle comprises two concentric nozzles f_1 and f_2 carried respectively by the control rods h_1 h_2 mounted one inside the other. For maximum opening of the tube outlet, the nozzles occupy the position illustrated in the upper half of the figure; the mean opening corresponds to the position of the nozzles illustrated in the lower half of the figure; the smallest opening would be obtained by displacement to the left of the nozzle f_2 up to the point where it extends the nozzle f_1. It is obvious that a greater number of nozzles could be provided. Arrangements analogous to those described may be adapted for tubes having a cross-sectional shape which is not a circle, as, for example, an elliptical shape or, more generally, any desired shape.

The control rod or rods of the throttle or throttles of the telescopic device could be driven by any appropriate device, or servo-motor, in order to provide a given law of opening to the reaction tube.

It is obvious that the particular forms of construction described have been given only by way of examples, and they might be modified, in particular by the substitution of technical equivalents, without thereby departing from the scope of the invention.

What I claim is:

1. In an exhaust nozzle for jet reaction propellers, the combination of a tubular shell for conveying gas, having a rear exit aperture and a rear, frusto-conical section with an inner surface that tapers rearwardly to said aperture, at least one axially movable, frusto-conical throttling ring in said shell, having an outer surface which tapers throughout from its front end to its rear end at the same inclination as said inner surface of said shell rear section and has substantially the same diameter at its front end as has said inner surface of said shell rear section in the neighborhood of said exit aperture, so that the ring moved to maximum throttling position has the extreme forward portion of its outer surface fitting snugly against, and the remainder of its outer surface in prolongation of, said inner surface of said shell rear section, means axially disposed in said shell, comprising an axially slidable rod, for moving said ring, and an openwork rigid structure between said rod and said ring connecting the same together.

2. In an exhaust nozzle for jet reaction propellers, the combination of a tubular shell for conveying gas, having a rear exit aperture and a rear, frusto-conical section with an inner surface that tapers rearwardly to said aperture, at least one axially movable, frusto-conical throttling ring in said shell, having an aerofoil axial section and an outer surface which tapers throughout from its front end to its rear end at the same inclination as said inner surface of said shell rear section and has substantially the same diameter in is front portion as has said inner surface of said shell rear section in the neighborhood of said exit aperture, so that the ring moved to maximum throttling position has the extreme forward portion of its outer surface fitting snugly against, and the remainder of its outer surface in prolongation of, said inner surface of said shell rear section, a rearwardly tapering casing within said shell arranged in coaxial relationship therewith said casing having a rear aperture, a ring control rod slidably held in said casing, having a tapering rear end protruding through said rear aperture of the casing to a controllable extent, and rigid means in spider formation extending from said rod rear end to said ring, for supporting the same.

3. In an exhaust nozzle for jet reaction propellers, the combination of a tubular shell for conveying gas, having a rear exit aperture and a rear, frusto-conical section with an inner surface that tapers rearwardly to said aperture, at least one axially movable, frusto-conical throttling ring in said shell, having an outer surface which tapers throughout from its front end to its rear end at the same inclination as said inner surface of said shell rear section and has substantially the same diameter in its front portion as has said inner surface of said shell rear section in the neighborhood of said exit aperture, so that the ring moved to maximum throttling position has the extreme forward portion of its outer surface fitting snugly against, and the remainder of its outer surface in prolongation of, said inner surface of said shell rear section, ring supporting members fast with said ring, arranged in spaced-apart radial planes with respect to said ring, and an axially slidable member, fast with said ring supporting members to connect the same together, for controlling bodily axial movement of said ring.

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