

July 9, 1957 **H. S. RAINBOW ET AL** **2,798,362**
MEANS FOR SLOWING DOWN AN AIRCRAFT PARTICULARLY

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MEANS FOR SLOWING DOWN AN AIRCRAFT, PARTICULARLY
DURING LANDING, WHEN POWERED BY A TURBO-JET

Filed Feb. 28, 1955

4 Sheets-Sheet 1

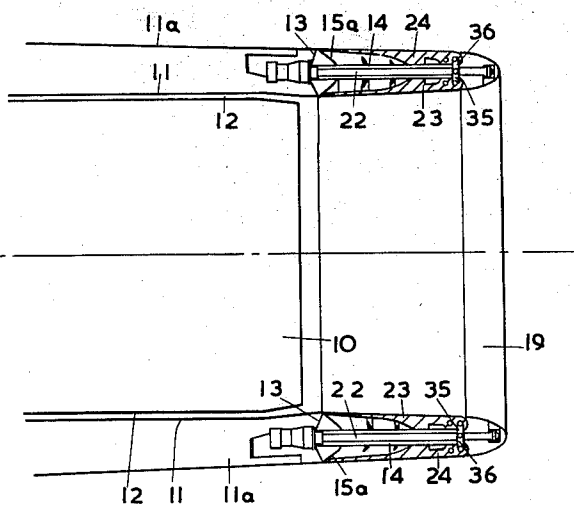


FIG.1.

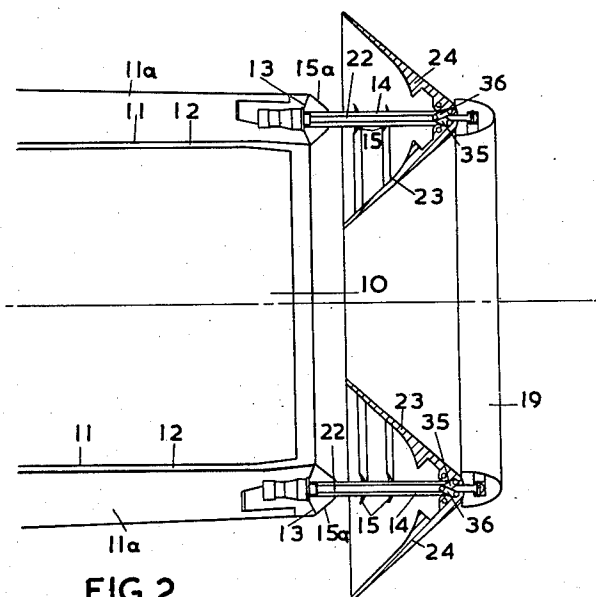


FIG. 2.

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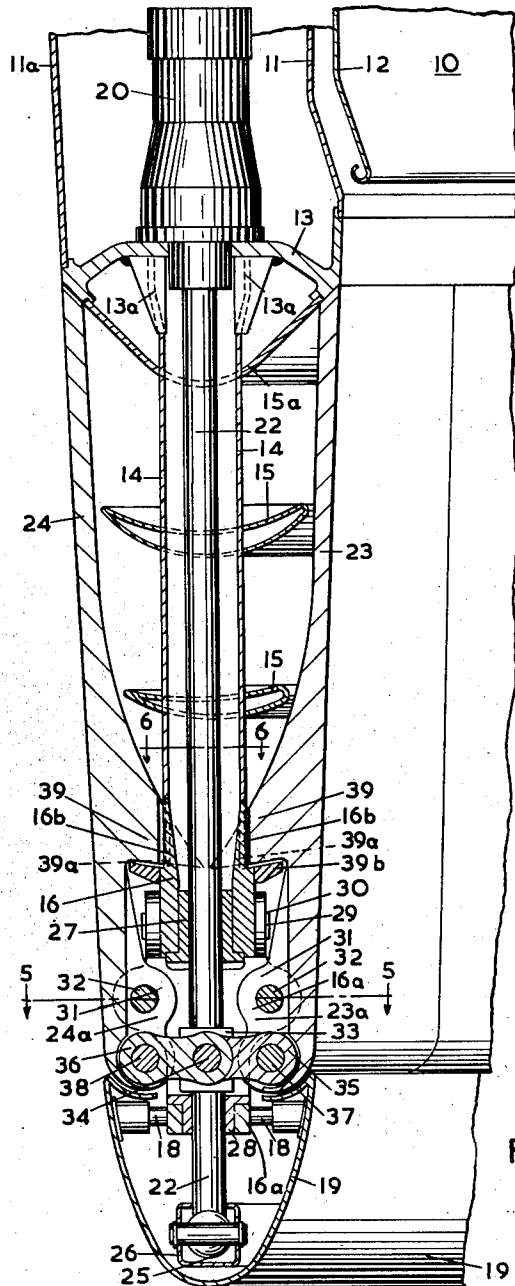


FIG. 3.

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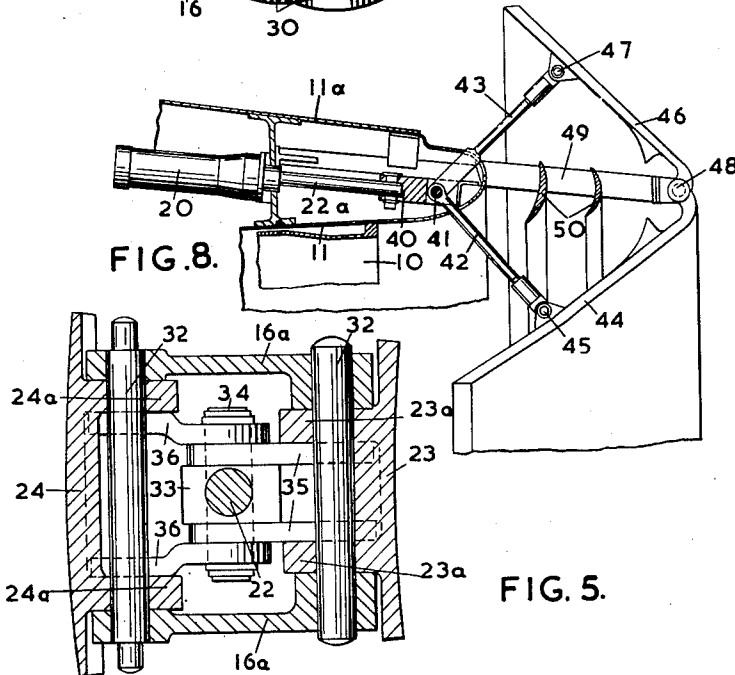
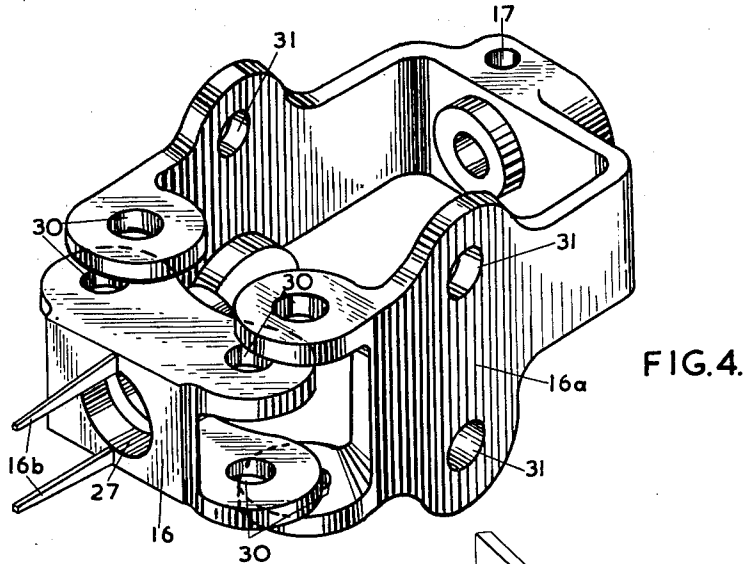
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4 Sheets-Sheet 4

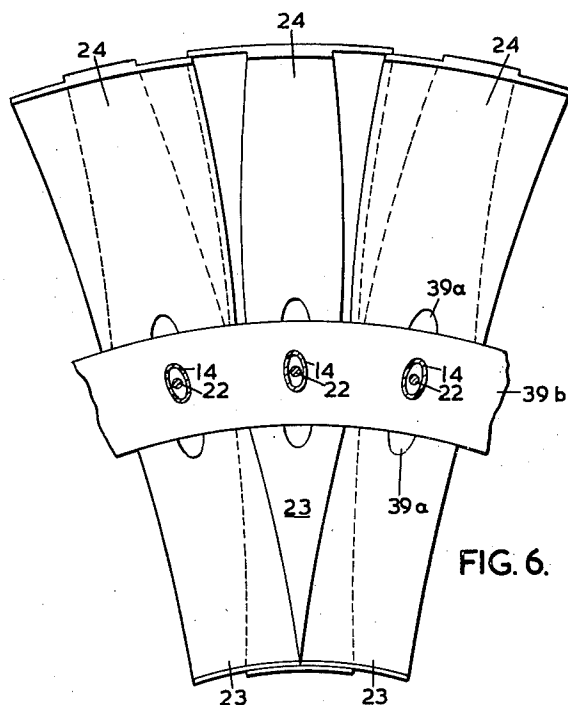


FIG. 6.

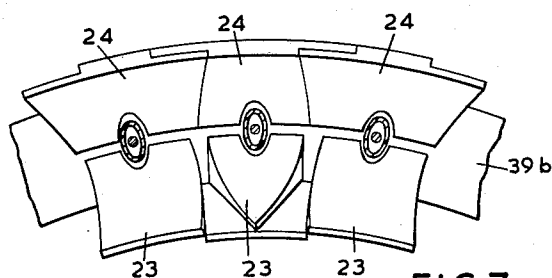


FIG. 7.

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**MEANS FOR SLOWING DOWN AN AIRCRAFT,
PARTICULARLY DURING LANDING, WHEN
POWERED BY A TURBO-JET**

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9 Claims. (Cl. 60—35.54)

This invention relates to means for slowing down an aircraft, particularly during landing, when powered by a gas turbine jet engine.

The main object of the invention is to provide means for producing a reverse thrust by diverting the direction of flow of a substantial portion of the jet gases in a very simple and satisfactory manner.

According to the invention, the means comprises, downstream of and around the jet nozzle, oppositely opening flaps which are pivotally mounted at or adjacent their downstream ends, adjacent flaps overlapping to provide, when opened, a complete annulus of V-shaped cross-section having one curved flange extending well into the path of the jet gases and the other extending to outside the jet nozzle so as to change the direction of flow of a material part of the jet gases.

According to a further feature of the invention, the upstream ends of the internal flaps (adapted when opened to extend well into the path of the jet gases) abut a casing adjacent the downstream end of the jet nozzle when in the closed position, the casing being separated from the jet nozzle by an annular space, and the internal flaps, when closed, forming a slightly divergent nozzle portion.

The invention further consists in the provision of a number of stationary curved annuli downstream of the end of the jet nozzle, between the internal and external flaps, serving to guide the diverted portion of the jet gases in an appropriate manner.

In the drawings:

Figures 1 and 2 are diagrammatic sections through a jet pipe of a gas turbine engine embodying the invention, the flaps being in closed and open positions respectively;

Figure 3 is a fragmentary sectional plan through one wall of the downstream end of the jet pipe of a gas turbine jet engine embodying the invention;

Figure 4 is a perspective view of a two-part pivot bracket shown in Figure 3;

Figure 5 is a section on line 5—5 of Figure 3;

Figure 6 is a fragmentary elevation on the line 6—6 of Figure 3, showing the positions occupied by flaps when open;

Figure 7 is a similar fragmentary elevation showing the positions occupied by the flaps when closed; and

Figure 8 is a somewhat diagrammatic fragmentary elevation, partly in section, of an alternative embodiment of the invention.

In Figures 1 and 2 is shown the downstream end of a jet nozzle 10 separated from an outer casing 11 by an annular space 12. The casing 11 and a casing 11a support, downstream of the jet nozzle 10, oppositely-opening flaps 23, 24, shown closed in Figure 1 and open in Figure 2. As can be seen from Figure 2 the flaps, when opened, form a complete annulus of V-shaped cross-section having one curved flange extending well into the path of the jet gases and the other extending to outside the jet nozzle

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so as to change the direction of flow of a material part of the jet gases.

Figure 3 shows, in more detail, the downstream end of the jet nozzle 10 separated from the outer casing 11 by the annular space 12 through which cooling air flows. The casing 11 and a casing 11a support a stationary annulus 13 which is sited externally of the nozzle 10, and which, in turn, supports longitudinally-extending struts 14 of elliptical cross-section.

The struts 14 carry stationary members in the form of curved annuli 15, 15a for guiding a diverted portion of the jet gases, one of them, 15a, being additionally supported by the annulus 13 and serving to enclose the downstream ends of actuators, later described, and at the downstream ends of each strut is supported one part 16 of a two-part pivot bracket 16, 16a, shown in more detail in Figure 4. The part 16, and the annulus 13 are provided with fingers 16b, 13a respectively, which are received in slots in the strut 14 and welded thereto. At the downstream ends of at least three of the bracket parts 16a are apertures 17 in which are fitted pins 18 in turn supporting a streamlined end casing 19.

The stationary annulus 13 supports a cylinder 20 in which is reciprocable a piston (not shown) connected to an actuator rod 22, this mechanism forming a hydraulic ram for actuating inner and outer flaps 23 and 24 respectively. Each actuator rod 22 (only one of which is shown, although of course there is a hydraulic ram and actuator rod for each pair of flaps) extends through a strut and is connected by a joint 25 to a box-section ring 26 contained in the end casing 19, the ring 26 ensuring that the movements of all of the rods 22 will be synchronized.

The two-part bracket 16, 16a (Figures 3 and 4) has coaxial bores 27, 28 each of which contains a bush in which is slidable the actuator rod 22. The two parts 16, 16a are connected together by pins 29 which pass through appropriate apertures 30.

The part 16a has coaxial pairs of apertures 31 in which are received pivot pins 32 on which the flaps 23 and 24 are journaled through integral lugs 23a and 24a.

Integral with the actuator rod 22 is a block 33 (Figures 3 and 5) through which passes a pin 34 pivotally supporting one end of each of links 35 and 36, respectively. The other ends of the links 35 and 36 are pivoted to the downstream ends of the flaps 23 and 24 respectively by pins 37 and 38 respectively.

In the position shown in Figure 3 the flaps 23 and 24 are closed and the links 35 and 36 are at their dead-centre position. The links 35 and 36 are moved slightly further by the actuator rod 22 until they are over-centre (i. e., their common pivot pin 34 is downstream of the pins 37 and 38), the movement of links 35 and 36 being limited by the block 33 engaging the adjacent end of the bush in the bore 28. Thus, should the actuators fail, the danger of the flaps being forced open by the gaseous stream is reduced, since the links cannot be moved back over-centre by a force acting on the pins 37, 38. The internal surfaces of the flaps 23 and 24 are formed with internally projecting portions 39 which are recessed at 39a to embrace the strut 14 when the flaps are in their closed position, the portions 39 being curved inwardly, so that in the open position of the flaps 23 and 24 they assist in providing a smooth change of direction of the flow of the gases. All the parts 16 are mounted in a curved annulus 39b for a similar purpose, the annulus additionally serving to shroud the brackets and pivots of the flaps 23 and 24.

To open the flaps 23 and 24 the hydraulic ram is actuated thereby causing the actuator rod 22 to move upstream, together with the box-section ring 26, carrying with it the block 33. This movement of the block

33 causes the links 35 and 36 to pass over their dead-centre position and to exert a force on the downstream ends of the flaps 23 and 24 causing them to pivot inwardly and outwardly respectively about their pivot pins 32.

The flaps 23 and 24 are arranged to overlap in their open positions as shown in Figure 6 and in their closed positions as shown in Figure 7.

To close the flaps 23 and 24 the hydraulic ram is actuated in the reverse direction, the final movement of the rod 22 causing the links 35 and 36 to pass over their dead centre.

In the alternative embodiment shown in Figure 8 a rod 22a actuable by fluid pressure from a cylinder 20, is connected, through a ring 40 and pivot pin 41, to links 42 and 43 respectively. The link 42 is connected to an inner flap 44 between its ends by means of a pivot pin 45 and the link 43 is connected to an outer flap 46 between its ends by means of a pivot pin 47.

The downstream ends of the flaps 44 and 46 have a common pivot pin 48 which is carried by fixed struts 49 supported from the casings 11, 11a.

The struts 49 carry curved annuli 50 between the flaps for guiding the diverted portion of the jet. In this embodiment there is no annular space between the nozzle and the casing.

As will be obvious, movement of the rod 22a from its position shown, in an upstream direction, will collapse the links 42, 43, causing the flaps 44, 46 to move to their closed position.

What we claim as our invention and desire to secure by Letters Patent of the United States is:

1. A means for slowing down an aircraft, particularly during landing, when powered by a jet engine, including a jet nozzle, and a plurality of pairs of oppositely opening flaps, each pair of flaps being pivotally mounted near their downstream ends downstream of and around the jet nozzle, adjacent ones of said flaps overlapping one another to provide, when opened, a complete annulus of generally V-section, one flange of said annulus extending well into the path of the jet gases and the other extending to outside the jet nozzle so as to change the direction of flow of a material part of the jet gases.

2. A means for slowing down an aircraft, particularly during landing, when powered by a jet engine, including a jet nozzle, a plurality of pairs of oppositely opening flaps which are pivotally mounted near their downstream ends downstream of and around the jet nozzle, adjacent flaps overlapping to provide when open a complete an-

nulus of generally V-shaped cross-section, said annulus having one flange extending well into the path of the jet gases and the other flange extending to outside the jet nozzle so as to change the direction of flow of a material part of the jet gases, and a number of fixed curved annuli downstream of the jet nozzle and disposed between the oppositely opening flaps, the internal and external flaps being provided with curved surfaces in order to coact with said curved annuli in guiding the diverted portion of the jet gases.

3. A means for slowing down an aircraft, according to claim 1, including a casing around and outside the jet nozzle, the upstream ends of the flaps being adapted when closed to abut the casing adjacent the trailing end of the jet nozzle.

4. Means for slowing down an aircraft, according to claim 1, including a casing outside the jet nozzle and separated therefrom by an annular space.

5. Means for slowing down an aircraft, according to claim 2, one of said curved annuli forming a wall at the downstream end of a cavity, actuators being provided for said flaps the actuators being disposed in said cavity.

6. Means for slowing down an aircraft, according to claim 1, including actuators for the flaps, one actuator being provided for each pair of flaps, and a single stationary annulus, outside the jet nozzle, which supports the actuators.

7. Means for slowing down an aircraft, according to claim 6 and comprising for each actuator a hydraulic ram supported by said stationary annulus, and for each hydraulic ram a rod which is movable in a direction substantially parallel to the longitudinal axis of the jet nozzle, a pair of links for each rod, each rod being connected near its downstream end to said pair of links, said links being connected to a pair of said flaps.

8. Means for slowing down an aircraft, according to claim 7, and including pins on which the pair of flaps are respectively pivoted, said pins being just upstream of where the links are connected to the flaps.

9. Means for slowing down an aircraft, according to claim 8, characterized in that the links are arranged to be over-centre in the closed position of the flaps so as to lock the flaps in the closed position.

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