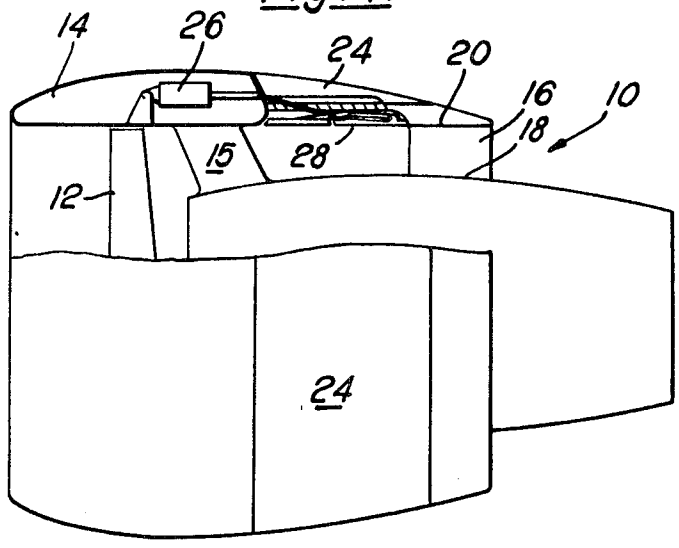
Sept. 28, 1971 R. H. COLLEY 3,608,314

THRUST REVERSER

Filed Aug. 25, 1969 2 Sheets-Sheet 1

Fig. 1.



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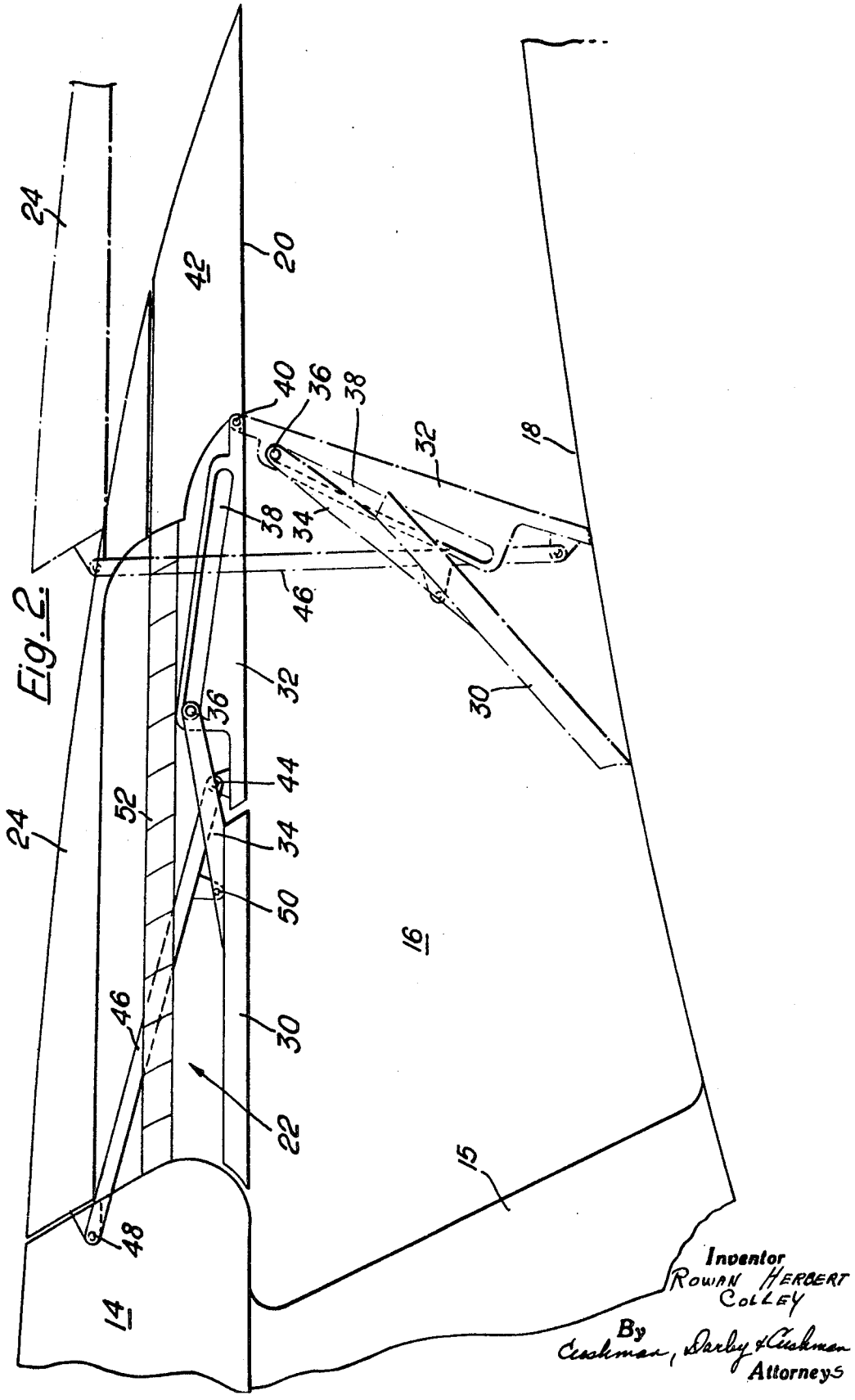


Fig. 2.

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THRUST REVERSER

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ABSTRACT OF THE DISCLOSURE

A thrust reverser for a gas turbine engine comprises an annular duct adapted to have gases from the engine pass therethrough and defined by radially inner and radially outer walls, the radially outer wall having a circumferentially extending opening, a plurality of angularly spaced apart flaps movable between a first position in which they close the said opening and a second position in which they extend across and at least partially close the annular duct to the rear of the opening, each flap comprising front and rear flap portions, the front flap portion being folded in front of the rear flap portion in the annular duct when the flaps are in the second position.

This invention relates to thrust reversers for gas-turbine jet propulsion engines, and particularly to thrust reversers for gas turbine jet propulsion engines having ducted fans.

The invention provides a thrust reverser for a gas turbine engine comprising an axially extending duct adapted to have gases from the engine pass therethrough; wall structure of the duct having a circumferentially extending opening; a plurality of flaps angularly spaced apart around the duct and having respective front and rear flap portions movable between respective first positions in which they close the opening, and respective second positions in which they extend across and at least partially close the duct to the rear of the opening, the front flap portions being disposed in front of the rear flap portions when in the said second positions; and first means pivotally connecting the front flap portions to their respective rear flap portions, the connecting means being slidable along the rear flap portions.

The front flap portions may be interconnected with the rear flap portions for relative pivoting and sliding movement.

The rear flap portion may be pivotally connected to a fixed portion of the radially outer wall to the rear of said opening.

Preferably, when each flap is moved from its first to its second position, the point of interconnection of the front flap portion and the rear flap portion slides towards the point of pivotal connection of the rear flap portion to the fixed wall portion.

The rear flap portion may be pivotally connected to a link which is itself pivotally connected to a rearwardly displaceable member carried by the radially outer wall, rearward displacement of said member moving the flap into its second position.

The rearwardly displaceable member may comprise a fairing which covers the radially outer end of said opening, rearward displacement thereof uncovering said opening.

The said link may be also pivotally connected at a point intermediate the length thereof to the front flap portion.

The link may be connected to the front flap portion at a point forwardly of the point of interconnection of the front flap portion and the rear flap portion.

The link may be pivotally connected to the front of the fairing.

The opening may contain guide vanes adapted to direct

the said gas forwardly when the flaps are in the said second position.

The invention also provides a gas-turbine engine having a thrust reverser as set forth above.

The gas-turbine engine may have a ducted fan, the thrust reverser being adapted to reverse the thrust produced by the ducted fan.

The invention will be described, merely by way of example, with reference to the accompanying drawings, in which:

FIG. 1 shows a gas-turbine engine provided with a thrust reverser according to the present invention, and

FIG. 2 shows part of the structure of FIG. 1.

Referring to FIG. 1, a gas-turbine engine **10** has a front fan **12** disposed in a cylindrical fan cowl **14**. The fan cowl encloses the upstream portion of the engine casing, to form an annular fan duct **16**. The cylindrical fan cowl **14** supports the engine by means of angularly spaced apart struts **15**. The duct **16** is defined by a radially inner wall **18** constituted by the engine casing, and a radially outer wall **20** constituted by the internal wall of the fan cowl. In operation of the engine, the air compressed by the fan **12** passes through the annular duct **16**.

The duct fan is provided with a thrust reverser, best seen in FIG. 2. The fan cowl **14** has a circumferentially extending opening **22** in the portion thereof forming the wall **20** of the annular duct **16**. The opening **22** extends around the whole circumference of the fan cowl **14**, and opens to the radially outer surface thereof. When the thrust reverser is not in operation, the opening is covered at its radially outer end by a rearwardly displaceable fairing **24**. The fairing is displaceable by means of hydraulic rams **26**, one of which is shown in FIG. 1.

The opening **22** is closed from the annular duct **16** by means of a plurality of angularly spaced apart flaps **28**, which form part of the radially outer wall **20** of the duct. Each flap **28** comprises a front flap portion **30** and a rear flap portion **32**. The terms "front" and "rear" are to be understood as referring to the engine, the front of the engine being on the left in FIG. 1. The front flap portion **30** has an extension arm **34** which carries at its end a roller **36**. This roller is received in a slot **38** provided on the rear flap portion **32**. The front flap portion is thus interconnected with the rear flap portion for relative pivoting and sliding movement.

The rear end of rear flap portion **32** is pivotally connected at a point **40** to a fixed portion **42** of the fan cowl **14** forming part of the radially outer wall **20** to the rear of the opening **22**. It will be appreciated that the portion **42** of the fan cowl **14** is supported from the front portion thereof by means of struts extending across the opening **22**. These struts may conveniently be disposed between neighboring flaps **28**, and may assist in closing off the opening **22**.

The rear flap portion **32** is pivotally connected at its front end **44** to a link **46**. The other end of the link **46** is pivotally connected at **48** to the front of the rearwardly displaceable fairing **24**. The link **46** is also pivotally connected at a point **50** intermediate its length to the front flap portion **30** at a point on the flap portion forwardly of the point of interconnection **36** of the front flap portion **30** and the rear flap portion **32**.

Within the opening **22** are cascades of guide vanes **52**, to aid in directing the air passing through the annular duct **16** forwardly through the opening **22**, when the thrust reverser is in operation as hereinafter described.

When the thrust reverser is inoperative, the flap portions **30** and **32** of each flap are in the positions shown in full lines in FIG. 2 (hereinafter called the first position), in which they close off the opening **22**, allowing the air compressed by the fan **12** to pass rearwardly along the annular

duct **16**, providing forward thrust for an aircraft to which the gas-turbine engine is fitted.

When reverse thrust is required, the fairing **24** is displaced rearwardly by means of the hydraulic rams **26**, into the position shown in dotted lines in FIG. 2, thereby uncovering the opening **22**. The rearward movement of the fairing **24** causes the link **46** to pivot the rear flap portion **32** about point **40** into a second position shown in dotted lines. The link **46** also causes the front flap portion **30** to be folded in front of the rear flap portion **32**, as shown by the dotted lines. As the flap is moved from its first to its second position, the point of interconnection of the front flap portion **30** and the rear flap portion **32**, constituted by the roller **36**, slides towards the point **40** of pivotal connection of the rear flap portion **32** to the fixed wall portion **42**.

It will be appreciated of course that the construction and operation of each of the flaps **28** is identical.

When the flaps **28** are in their second or folded position, as shown by the dotted lines, the flaps at least partially close the annular duct **16** to the rear of the opening **22**, deflecting the air compressed by the fan **12** forwardly through the opening **22**, thereby producing thrust reversal. The guide vanes **52** assist in directing the air forwardly.

It will be appreciated that the gas-turbine engine **10** is also provided with a thrust reverser for forwardly directing the gases issuing from the jet pipe thereof. This thrust reverser may be of any convenient conventional type, or it could alternatively be similar to the thrust reverser hereinbefore described. In that case, a tail bullet may be provided, in order to form the radially inner wall of an annular duct, the outer wall being formed by the engine casing.

The present invention may bring the advantage that the minimum cross-sectional area of the duct **16** when the thrust reverser is in operation is greater than if a set of single large flaps were provided and will thus avoid choking of the reverser outlet. Also, when the thrust reverser is not in operation, the annular duct **16** is not obstructed by operating mechanism of the thrust reverser such as struts or linkages extending across the duct.

I claim:

1. A thrust reverser for a gas turbine engine, comprising:

an axially extending duct adapted to have gases from the engine pass therethrough; wall structure defining said duct and having a circumferentially extending opening therein; a plurality of flaps angularly spaced apart around said wall structure and having respective front and rear flap portions movable between first positions in which they close said opening, and second positions in which they extend across and at least partially close said duct to the rear of said opening, said front flap portions being disposed in front of said rear flap portions when in said second positions; and a first connection means pivotally connecting said front flap portions to their respective rear flap portions, said first connecting means having pivot points slidable along the respective rear flap portions.

2. A thrust reverser as claimed in claim **1** comprising guide vanes disposed in said opening in said wall structure and arranged to direct the gas forwardly when said flaps are in the second position.

3. A thrust reverser as claimed in claim **1** in which said wall structure has a fixed wall portion situated to the rear

of said opening, and including a second connecting means pivotally connecting said rear flap portions to said fixed wall portion.

4. A thrust reverser as claimed in claim **3** wherein the pivot points of said first connecting means which are slidable along the rear flap portions are arranged to slide towards the points of pivotal connection of said rear flap portions and the fixed wall portion, when the flaps are moved from their first position to their second position.

5. A thrust reverser as claimed in claim **3** comprising a link for each rear flap portion, means pivotally connecting a respective rear flap portion to each link, a rearwardly displaceable member carried by said wall structure for closing the opening therein when said flaps are in said first position, and means pivotally connecting said links to said member so that rearward displacement of said member moves said flaps into their second position.

6. A thrust reverser as claimed in claim **5** wherein said rearwardlly displaceable member comprises a fairing which covers the radially outer end of said opening in said wall structure.

7. A thrust reverser as claimed in claim **5** comprising means also pivotally connecting each of said links at a point intermediate the length thereof to a respective front flap portion.

8. A thrust reverser as claimed in claim **7** in which each link is connected to its respective front flap portion at a point forwardly of the point of interconnection of the front flap portion and the rear flap portion.

9. A thrust reverser as claimed in claim **6** wherein said links are pivotally connected to the ront of said fairing.

10. A gas turbine engine having a thrust reverser comprising: an axially extending duct adapted to have gases from the engine pass therethrough; wall structure defining said duct and having a circumferentially extending opening therein; a plurality of flaps angularly spaced apart around said wall structure and having respective front and rear flap portions movable between first positions in which they close said opening, and second positions in which they extend across and at least partially close said duct to the rear of said opening, said front flap portions being disposed in front of said rear flap portions when in said second positions; and means pivotally connecting said front flap portions to their respective rear flap portions, said connecting means having pivot points slidable along the respective rear flap portions.

11. A gas turbine engine as claimed in claim **10** having a ducted fan disposed in a fan duct, said thrust reverser being disposed in said fan duct, downstream of the fan.

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