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Soligny et al.

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[54] **GAS TURBINE DUCTED FAN ENGINES**

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[73] Assignee: **Societe Nationale D'Etude Et De Construction De Moteurs D'Aviation,** Paris, France

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[52] **U.S. Cl.** ..... **60/226 A,** 60/230, 415/145, 239/265.27, 239/265.37

[51] **Int. Cl.** **F02k 3/02**

[58] **Field of Search** ..... 60/226 A, 229, 230, 228; 239/265.29, 265.31, 265.37; 137/15.1, 15.2; 415/145

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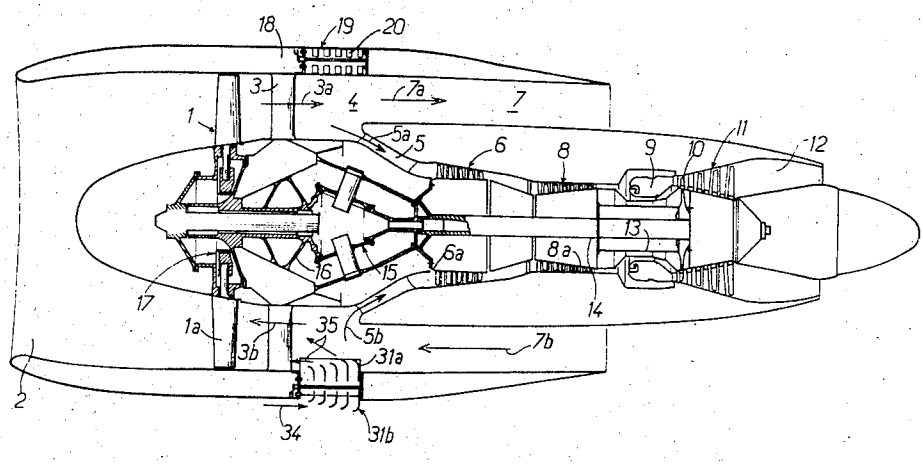
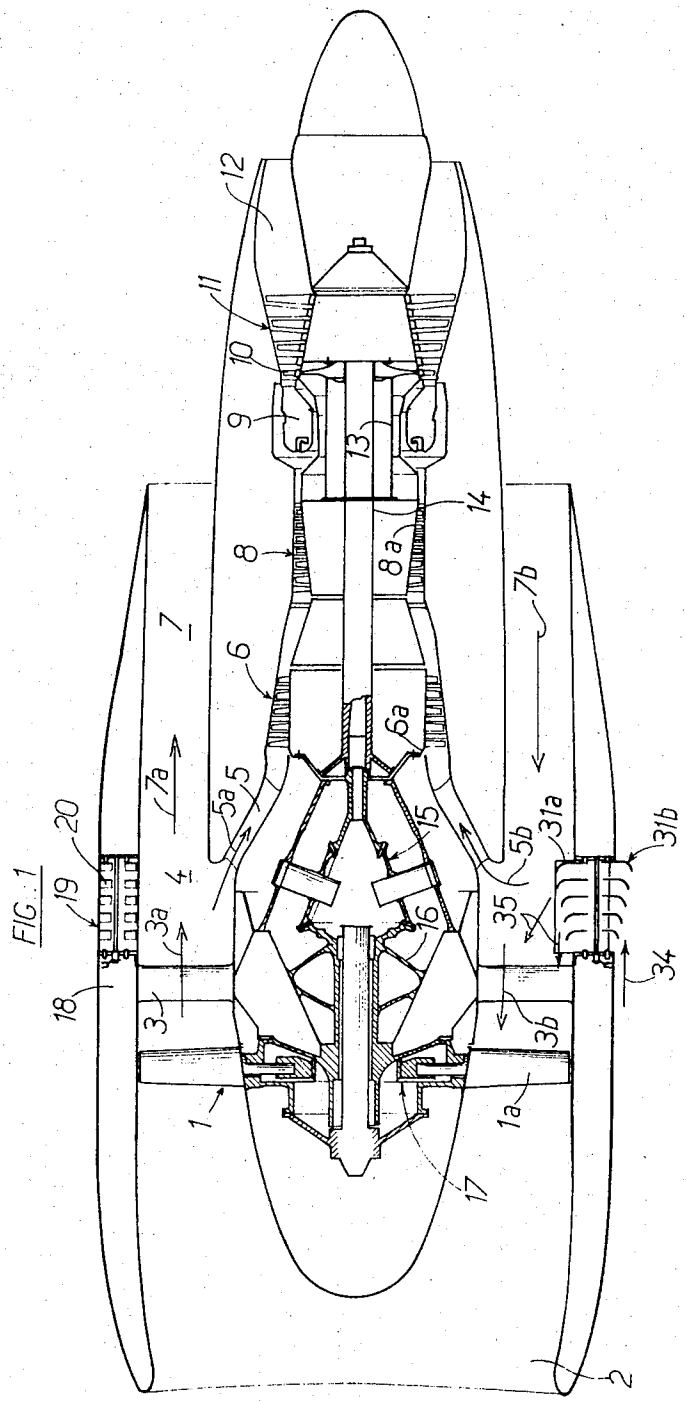
Primary Examiner—William L. Freeh
Assistant Examiner—Robert E. Garrett

[57] **ABSTRACT**

A gas turbine ducted fan engine, comprising, at the front, a fan having reversible blades which normally discharge air into a discharge duct which is divided into an internal duct through which there passes a primary air flow which feeds the compressor of the engine and an external duct through which a secondary air flow passes from front to rear, and in order to ensure that the compressor is fed when the pitch of the vanes is reversed in order to obtain a braking effect, openings which are normally closed but which open into the region of the duct from which there diverge the two ducts and which are provided with guide-blade cascades which can be adjusted between an inoperative position, in which they are retracted into the external wall of the duct, and an operative position in which they project, on the one hand, on the outside of and, on the other hand, into the duct, in such a way as to scoop up air on the outside in order to discharge it into the said region of the duct.

5 Claims, 4 Drawing Figures

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31b
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5b
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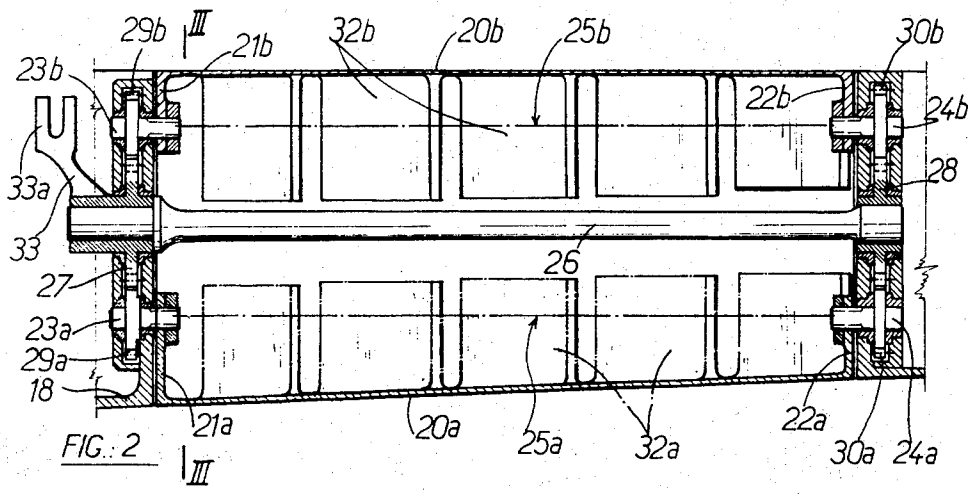
16
3a
34
18
3
3b
1
1a
17
2

FIG. 1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III
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24b
33a
28
33
26
27
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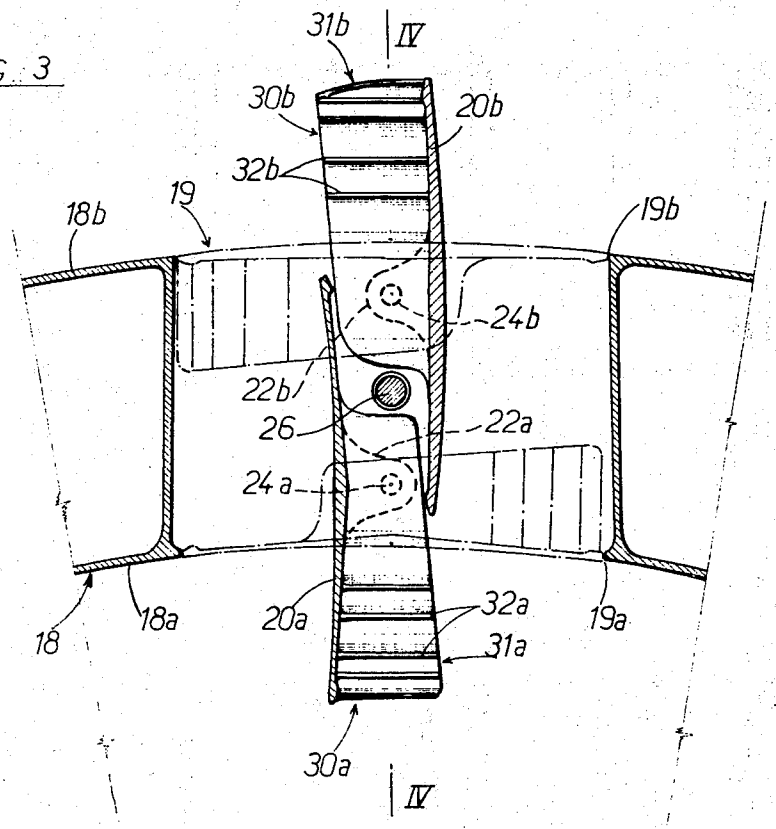
29a
18
21a
20a
25a
32a
22a
30a
24a
III

FIG. 2

FIG. 3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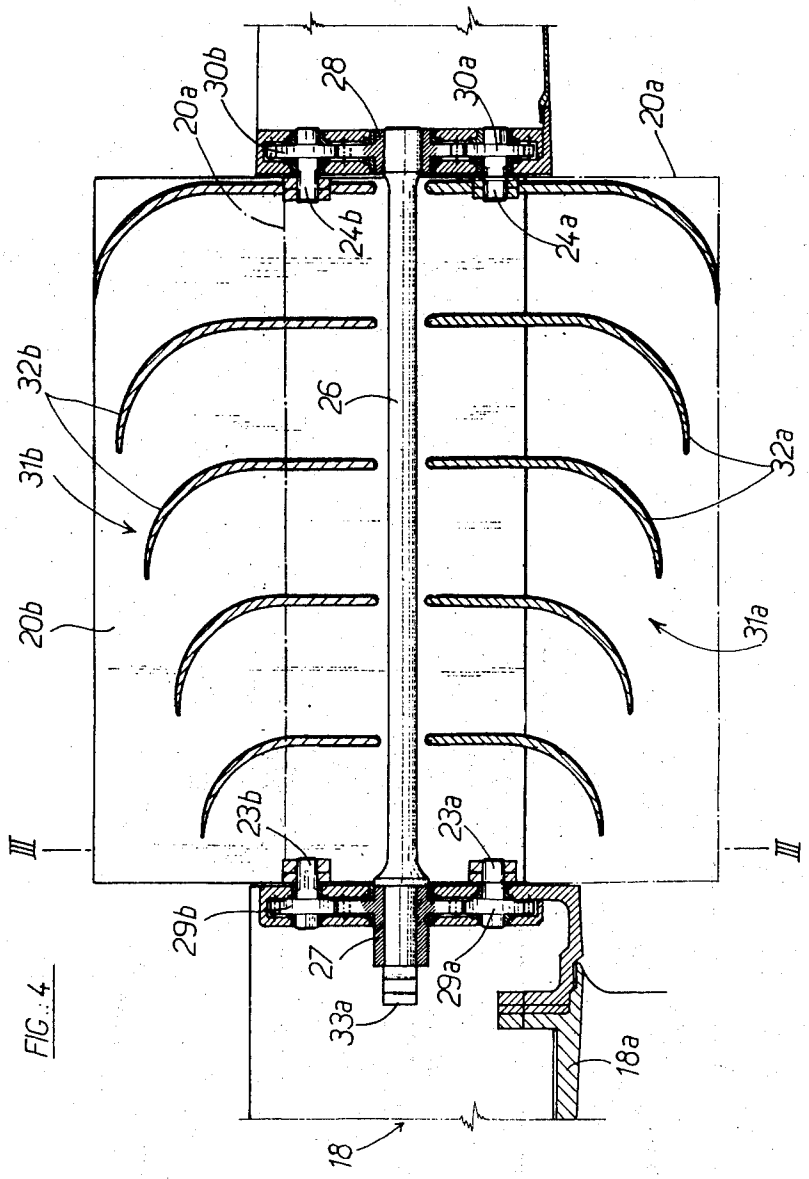
IV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26
31b
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20b
31a
III
23b
23a
III
29b
27
29a
33a
18a
18

FIG. 4

GAS TURBINE DUCTED FAN ENGINES

This invention relates to a gas turbine ducted fan engine of the by-pass type having a front fan and is particularly useful for the propulsion of aircraft. The invention more specifically concerns an engine of this type comprising a fan having adjustable pitch which can be reversed in order to produce a braking effect. The term front fan is used to denote a fan which is disposed upstream in the flow of gases passing through the compressor, combustion chamber and turbine of the engine. The engine is described as being of the by-pass type, if the fan effects delivery into a discharge duct which is divided, further downstream, into a primary duct in which the primary flow discharges to feed the compressor, and a secondary duct in which there flows a secondary flow.

In the gas turbine ducted fan engine with which the invention is more specifically concerned, a device for varying the pitch of the fan blades makes it possible to adjust their setting, for example after the fashion of reversible-pitch propellors, and thus to obtain an important braking effect which may, if applicable, supplement that of a conventional system for reversing the propulsive jet. It may be feared, however, that the flow reversal in the discharge duct of the fan may give rise to disturbances in the feeding of the compressor, thereby entailing, for the latter, a risk of surge or even of stall.

According to the present invention, these drawbacks are voided by forming in the outer wall of the duct, in the zone in which the secondary flow is separated from the primary flow, openings provided with guide-blade cascades which are retracted into the said wall during normal flight and which can be displaced, when the pitch of the fan blades is reversed, in order to bring them into an operative position in which they project on the outside and also into the duct in such a way as to scoop up air on the outside in order to discharge it into the said zone of the duct.

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

FIG. 1 is a view, in diagrammatic axial section, of a gas turbine ducted fan engine of the by-pass type having a front fan with reversible blades and provided with openings and with guide-blade cascades according to the invention, which are shown in the inoperative position in the upper part of the figure, and in the operative position in the lower part;

FIG. 2 is a partial view which is analogous to FIG. 1 and shows a guide-blade cascades on a larger scale;

FIG. 3 is a view, in section along the line III—III in FIGS. 2 and 4, showing the guide-blade cascades in the open position (in solid lines) and in the closed position (in chain-dotted lines); and

FIG. 4 is a view in section along the line IV—IV IN FIG. 3, showing the guide-blade cascades in the open position.

FIG. 1 shows diagrammatically a gas turbine ducted fan engine comprising a fan 1 which is fed with air through an intake duct 2 and discharges the said air at 3*a*, by means of guide vanes 3, into an annular duct 4 where the air is divided into a primary flow 5*a*, which flows into a primary duct 5 for the purpose of feeding the low-pressure compressor 6 of the engine, and a secondary flow 7*a* which flows into a secondary duct 7.

The primary air is compressed by the low-pressure compressor 6, then compressed again by the high-pressure compressor 8 which discharges it into a combustion chamber 9 where a fuel is injected which burns while producing hot gases. These hot gases work in a high-pressure turbine 10 and then in a low-pressure turbine 11 and escape through a nozzle 12, thereby producing a hot, propulsive jet. The high-pressure turbine 10 drives the rotor 8*a* of the high-pressure compressor by means of a hollow shaft 13. The low-pressure turbine 11 drives a shaft 14 which itself directly drives the rotor 6*a* of the low-pressure compressor and, by means of reduction gearing 15 and a hollow shaft 16, the fan 1. In the form of construction shown, the secondary flow runs out of the secondary annular duct 7 while forming, around the hot jet, a jet of air which contributes to propulsion.

A known mechanism, which is shown diagrammatically at 17, makes it possible to vary the pitch of the vanes 1*a* of the fan 1 and to reverse their setting, after the fashion of reversible-pitch propellors, in order to obtain a braking effect. When the pitch of the fan 1 is reversed in this way, some air is, in fact, sucked from the back to the front by the fan, flows through the secondary duct 7 and the duct 4 in the direction of the arrows 7*b* and 3*b*, and exits out through the front of the intake duct 2, thus forming a jet which produces the braking effect. This obviously results in a reduction of the primary flow 5*a*, and this may entail a risk of causing surge or stall of the compressor. It is in order to eliminate this danger that, according to the invention, a stream of air is artificially induced into the disharge duct 4, that is to say into the zone in which the secondary flow 7*a* is normally separated from the primary flow 5*a*.

For this purpose, the external wall 18 of the discharge duct 4 incorporated openings 19 which are spaced out over the circumference of this wall and are provided with guide-blade cascades 20, which are illustrated in detail in FIGS. 2 to 4.

As can be seen, in particular, in FIG. 3, the wall 18 of the duct 4 is constituted by a sheet-metal fairing having an internal face 18*a* and an external face 18*b*. Each opening is made up of two holes 19*a*, 19*b*, which are formed in the internal face 18*a* and external face 18*b*, respectively, of the fairing. Each of the openings 19*a*, 19*b* accomodate a door 20*a*, 20*b* each of which being provided, at the front and rear respectively, with two lugs 21*a*, 22*a*, and 21*b*, 22*b* (FIG. 2) which are integral with respective coaxial pivots 23*a*, 24*a* and 23*b*, 24*b* which swivel in the fairing 18. The common axis 25*b* of the pivots 23*b* and 24*b* is parallel to the common axis 25*a* of the pivots 23*a* and 24*a*.

A control shaft 26, which is parallel to the axes 25*a* and 25*b* and situated between them, also swivels in the fairing 18 and is provided, at the front and rear respectively, with two pinions 27 and 28 which each mesh with two pinions 29*a*, 29*b* or 30*a*, 30*b* which are integral with the two adjacent pivots 23*a*, 23*b* or 24*a*, 24*b*. By causing the shaft 26 to rotate, the two doors 20*a*, 20*b* are driven in rotation about their respective pivoting axes 25*a*, 25*b*, between the inoperative position (FIG. 2 and the upper part of FIG. 1), in which they blank off the openings 19*a* and 19*b*, and the operative position illustrated in FIG. 4 and in the lower part of FIG. 1 and, in solid lines, in FIG. 3.

Each of the doors **20***a*, **20***b* carries, on one of its faces (the one which is turned towards the other door when in the inoperative position), a guide-blade cascade **31***a*, **31***b* which is disposed in such a way that, when the doors are in the operative position, the guide-blade cascade scoop up some air on the outside of the fairing **18**, and discharge it into the duct **4**. For this purpose, the guide-blade cascade **31***b* comprises a plurality of guide blades **32***b* which are of increasing width from the front to the rear and are each constituted by an airfoil which is roughly perpendicular to the door **20***b*, the outer end of said airfoil (that is to say the end which projects outside the fairing **18** when in the operative position) is curved in the forward direction. In this way, the guide blades **32***b* are able to scoop up some external air without masking one another when in the operative position. The guide-blade cascade **31***a*, which comprises a plurality of guide blades **32***a*, has a disposition which is symmetrical to that of the guide-blade cascade **31***b*, in relation to the axis of the shaft **26**.

At its front end, the shaft **26** carries a lever **33** housed in the fairing **18** the end of which forms a yoke **33***a*. The levers **33** of the various openings **19** are connected together by rods (not illustrated) which are pivotally mounted in the yokes **33***a*; a jack (not illustrated), which is also housed in the fairing makes it possible to pivot all the levers **33** simultaneously. It is thus possible to cause all the guide-blade cascades to pass simultaneously from the inoperative position into the operative pisition, and vice versa.

When the pitch of the fan **1** is reversed in order to produce a braking effect in the manner explained above, the jack, which is not shown, is actuated in order to bring the guide-blade cascades into the operative position. In this position, the guide-blade cascades **31***b* scoops up some external air (the relative flow of which, referred to the jet, is represented diagrammatically by the arrow **34** in FIG. **1**) and discharges it, in the direction of the arrows **35**, into the annular duct **4** in such a way that the latter is fed with air at a rate of flow and a pressure which are sufficient to supply some air both to the primary duct **5** (arrow **5***b*) and to the intake of the fan (arrow **3***b*). It is thus possible to supply enough air to the compressor to eliminate the risk of stall or surge.

When the jack (not illustrated) is actuated for the purpose of bringing the guide-blades cascades back into the inoperative position, the doors **20***a* and **20***b* blank off openings **19** by re-establishing the continuity of the profiles of the internal face **18***a* and external face **18***b*, respectively, of the fairing **18**.

It is self-evident that the form of embodiment described is only an example and could be modified, particularly by the substitution of technical equivalents, without thererby departing from the scope of the invention. In particular, the guide-blade cascades **20** might be replaced by retractable guide-blade cascades of another type, and particularly of the type described in published French Patent application No. 70 14 491 (publication No. 2,096,650).

What is claimed is:

1. A gas turbine ducted fan engine of the by-pass type having an external wall; a fan at the front of the turbo-jet, having blades which can be adjusted between a running position, for the purpose of drawing in air in front of the turbo-jet and discharging it toward the rear, and a braking position; a compressor for supplying compressed air to a combustion chamber in order to produce hot gas which serves to actuate a turbine driving the compressor, and to form a propulsive jet; a discharge duct for the fan in the running position, said discharge duct having an internal branch for conducting a primary air flow to the compressor and an external branch for conducting a secondary air flow which flows from front to rear in the turbo-jet, the said internal branch and the said external branch diverging from a flow-dividing region of the said discharge duct which is limited by the said external wall; openings in the external wall which are normally closed and which lead into the said flow-dividing region; guide-blade cascades which are located in said openings and can be adjusted between an inoperative position, in which the blades are retracted into the external wall, and an operative position, in which the blades project, on the one hand, outside the external wall and, on the other hand, inside the flow-dividing region; guide-blade cascades which are located in said openings and can be adjusted between an inoperative position, in which the blades are retracted into the external wall, and an operative position, in which the blades project, on the one hand, outside the external wall and, on the other hand, inside the flow-dividing region; means for bringing the said blades of the fan into the braking position for the purpose of drawing air into the said duct and discharging it toward the front of the turbo-jet; and means for uncovering the said openings and bringing the said guide blades into the operative position so that the said blades scoop up air flowing from front to rear on the outside of the said external wall, and discharge the air scooped up into the said flow-dividing region.

2. An engine as claimed in claim **1**, in which each guide-blade cascade comprises a plurality of guide blades which, in the operative position, project outside said external wall at heights which increase from front to rear.

3. An engine as claimed in claim **1**, in which said external wall comprises an internal surface and an external surface which incorporate the openings, each said opening being provided with two guide-blade cascades which are respectively carried by two doors which are pivotable between the inoperative position and the operative position, the said doors being respectively situated in the said internal surface and in the said external surface, when in the inoperative position, in order to blank off said openings.

4. An engine as claimed in claim **3**, in which the two doors are respectively pivotable about two axes directed from front to rear, and each said door carries a guide-blade cascade on its face which is turned toward the other said door when in the inoperative position.

5. An engine as claimed in claim **4**, comprising a control pinion which meshes with two pinions respectively carried by the two doors, for the purpose of controlling the pivoting of said doors.

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