United States Patent [19]

Pollert et al.

[11] **3,898,799**

[45] **Aug. 12, 1975**

[54] **DEVICE FOR BLEEDING-OFF COMPRESSOR AIR IN TURBINE JET ENGINE**

[75] Inventors: **Wolfgang Pollert**, Hebertshausen; **Eckhard Kraft**, Munich; **Gregor Pennig**, Dachau, all of Germany

[73] Assignee: **Motoren- und Turbinen-Union Munchen GmbH**, Germany

[22] Filed: **Sept. 27, 1973**

[21] Appl. No.: **401,544**

[30] **Foreign Application Priority Data**

Sept. 27, 1972 Germany 2247400

[52] **U.S. Cl.** ..... **60/226 R**; 60/39.07; 415/145

[51] **Int. Cl.** **F02c 3/06**

[58] **Field of Search** ..... 60/39.07, 39.29, 39.23, 60/226 R, 226 A; 415/144, 145, 28, 157–159, 166; 137/625.31, 625.33; 74/159, 166

[56] **References Cited**

UNITED STATES PATENTS

3,030,006	4/1962	Shoup	415/145
3,057,541	10/1962	Hasbrouck et al.	415/145
3,094,270	6/1963	Kent et al.	415/145
3,095,010	6/1963	McLean et al.	60/39.29 X
3,688,504	9/1972	Hutchinson et al.	60/39.29 X
3,747,341	7/1973	Davis	415/145 X
3,777,489	12/1973	Johnson et al.	60/226 R

FOREIGN PATENTS OR APPLICATIONS

27,272	10/1954	Finland	415/157

Primary Examiner—William L. Freeh
Assistant Examiner—Robert E. Garrett
Attorney, Agent, or Firm—Craig & Antonelli

[57] **ABSTRACT**

Apparatus for bleeding off compressor air in a turbine engine of the type having a plurality of serially arranged compressors. The apparatus includes a first annular chamber communicated directly with compressor air from one of the compressors and a second annular chamber communicated directly with atmosphere or with a bypass duct of the engine. Arranged in between the first and second chambers are internal and external rings slideable with respect to one another with the external ring having openings which are controlled by the position of the internal ring. Actuating means, including a radially extending actuating shaft and a pair of pivotally connected levers interconnecting the internal ring and the actuating shaft are provided for moving the internal ring with respect to the external ring. The internal ring is provided with guide slots and the external ring is provided with guide rollers for guiding relative movement of the internal and external rings such that the internal ring simultaneously moves both circumferentially and axially during adjustments thereof.

46 Claims, 4 Drawing Figures

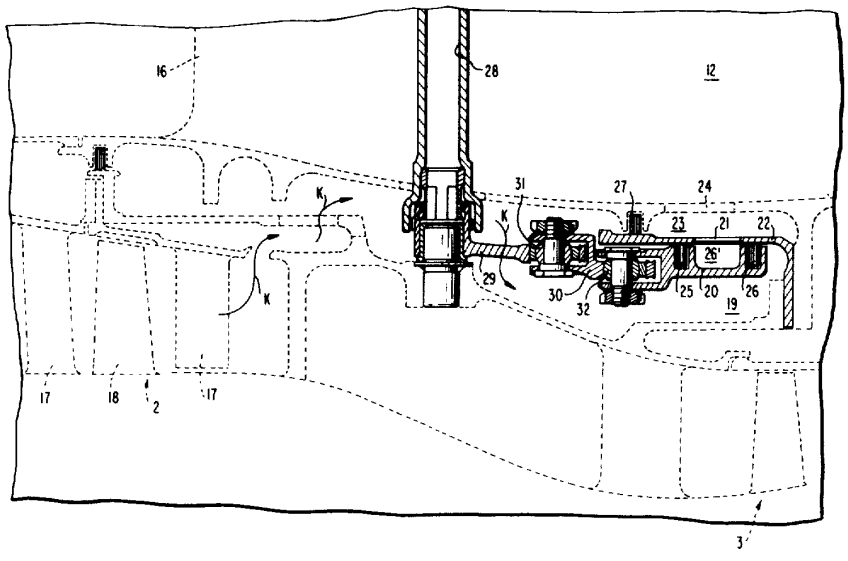
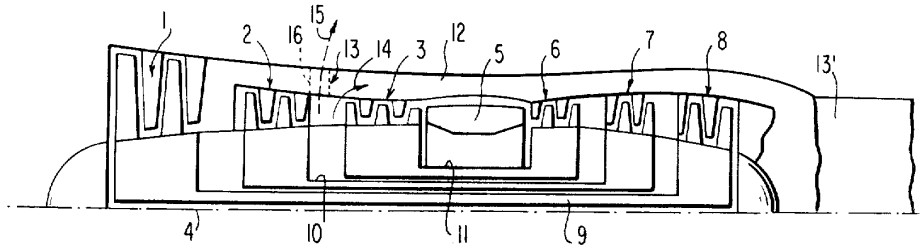


FIG. 1



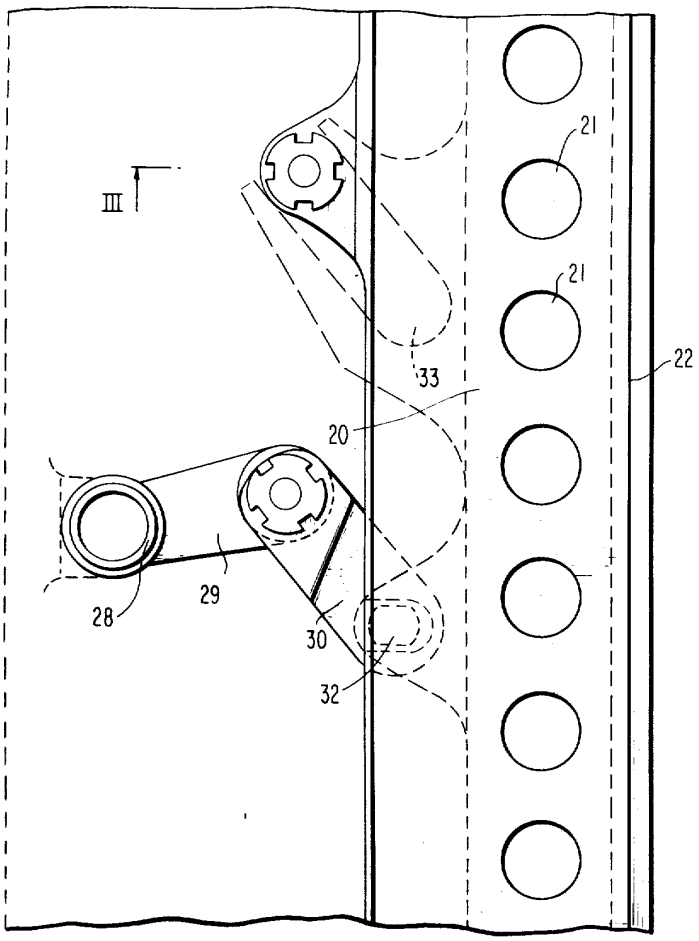


FIG. 3

FIG. 4

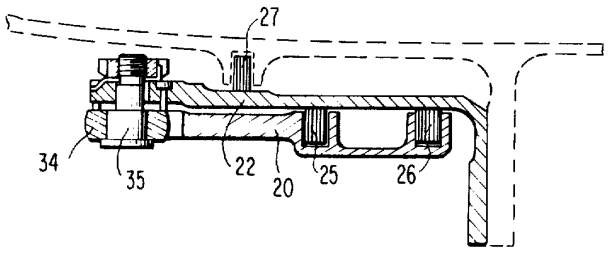
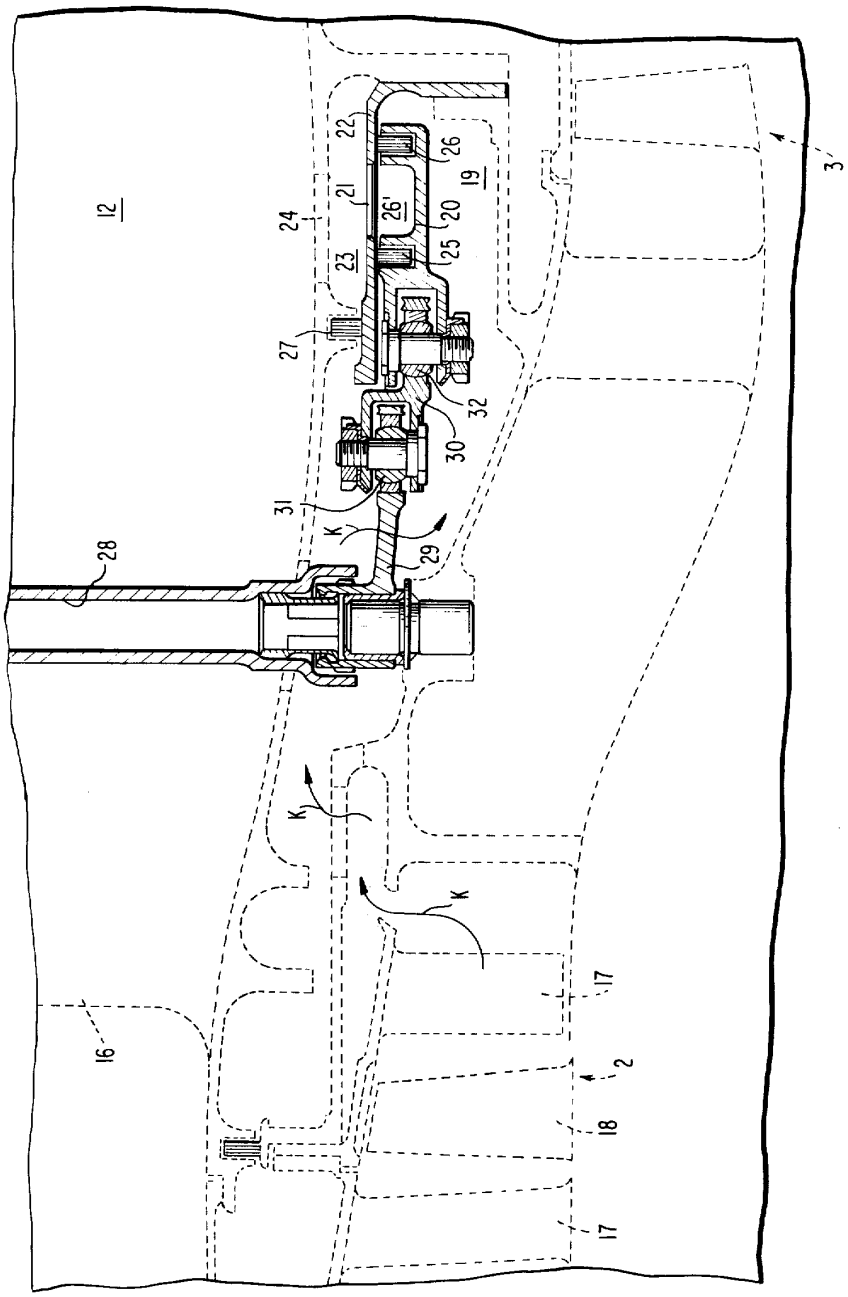


FIG. 2



DEVICE FOR BLEEDING-OFF COMPRESSOR AIR IN TURBINE JET ENGINE

BACKGROUND AND SUMMARY OF THE INVENTION

This invention relates to a device for bleeding-off compressor air in turbine jet engines provided with a plurality of mechanically independent compressors (compressors with compressor wheels freely rotatable with respect to the compressor wheels of the other compressors).

In turbine jet engines with a plurality of mechanically independent compressors, arranged one behind the other, in certain operating ranges a condition may occur where, e.g., the speed and consequently also the flow supplied by a first compressor is excessive relative to the speed of a subsequent second compressor. In order to avoid compressor surge it has been suggested to bleed off compressor air within the range of the pressure gradient, i.e. in this case between the first and the second compressor, until the most constant possible compressor pressure ratio within the scope of the optimum engine design point is restored.

The present invention contemplates providing a relatively simple, robust and reliable device for compressor air bleed-off. In addition, this device is easy to actuate, permits the bleed-off of a relatively large amount of compressor air and provides a tight seal at the compressor bleed point(s) when no bleed-off is desired.

Further, according to the present invention control of the bleed air flow is provided for adaptation to the prevailing operating conditions.

The present invention further contemplates providing an internal ring adjustable both axially and tangentially within a first annular chamber supplied with compressor air actuation of this internal ring uncovers a plurality of openings of an associated external ring and thus allows compressor air to flow into a second annular chamber located above or radially outwardly of the external ring and communicating with the bypass duct of the engine or with atmosphere.

Furthermore, the present invention avoids the disadvantages of contemplated arrangements with only one and consequently relatively large compressor bleed air opening to be opened or closed so that the bleed sectional area on the one hand is relatively limited and on the other hand an uneven load distribution occurs over the circumference of the compressor casing section concerned. In addition, the existence of only one and thus relatively large compressor bleed air opening results in a relatively large differential pressure between the chambers to be sealed and consequently in a relatively large actuating force for opening or closing the compressor bleed air opening.

In another contemplated arrangement the motions of a ring, movable both tangentially and radially are superimposed to one another for opening an annular slot in the compressor casing section for compressor air bleed-off. When moved as described this ring is highly susceptible to tilting within the compressor casing, unless this ring is moved in an absolutely synchronous motion over its complete circumference. The radial motion occurring when the sliding ring is actuated generally excludes the employment of this arrangement for compressor casings of relatively small diameter. In addition, this makes the requirement of an absolutely tight seal at the bleed opening questionable. The present invention also eliminates the disadvantages of this type of arrangement.

These and further objects, features, and advantages of the present invention will become more apparent from the following description when taken in connection with the accompanying drawings which show, for purposes of illustration only, several embodiments in accordance with the present invention, and wherein:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic and fragmentary sectional view of the top half of a turbine jet engine taken along the longitudinal center axis which illustrates the association of the device according to the invention relative to said engine;

FIG. **2** is a longitudinal section of the device according to the invention arranged between a first and a second compressor, shown partially and within the bypass duct area only;

FIG. **3** is a view of a section of the device in direction A of FIG. **2**, and

FIG. **4** is a sectional view along line III-III of FIG. **3**.

DETAILED DESCRIPTION OF THE DRAWINGS

The turbine jet engine shown schematically in FIG. **1** comprises low pressure compressor **1**, intermediate pressure compressor **2**, high pressure compressor **3**, annular combustion chamber **5** coaxial in this case, for example, with the longitudinal center axis **4**, followed by high pressure turbine **6**, intermediate pressure turbine **7** and low pressure turbine **8** arranged one behind the other. Low pressure compressor **1** and low pressure turbine **8** are connected by a common shaft **9**. Intermediate pressure compressor **2** and intermediate pressure turbine **7** are connected to each other by means of a hollow shaft **10** coaxially enclosing shaft **9**. Another hollow shaft **11** enclosing hollow shaft **10** connects high pressure compressor **3** with high pressure turbine **6**. A portion of the bypass air flow supplied by low pressure compressor **1** enters bypass duct **12** arranged coaxially with the longitudinal center axis **4** of the engine and after joining the engine exhaust gases it flows into afterburner jet pipe **13'**. Between intermediate pressure compressor **2** and high pressure compressor **3**, for example, the device for compressor air bleed-off explained in more detail in conjunction with FIGS. **2** and **3** is located on compressor section **13**, arranged coaxially with the center longitudinal axis **4**.

As required, a portion of the air supplied by intermediate pressure compressor **2** can be bled off by the apparatus of the present invention either into bypass duct **12** of the engine (arrow **14**) or via hollow struts **16**, passing through bypass duct **12**, to atmosphere as indicated by dotted arrow **15**.

In a turbine jet engine according to FIG. **1**, intermediate pressure compressor **2**, generally indicated by guide vanes and rotor blades **17** and **18**, respectively, in FIG. **2**, supplies compressed air in the direction of arrows K into a first annular chamber **19**. Within this annular chamber **19** an internal ring **20**, adjustable axially and tangentially is provided, which when actuated uncovers openings **21** of associated external ring **22** and thus allows compressor air to flow into a second annular chamber **23**, arranged above or radially outward of external ring **22** and communicating via additional openings **24** with bypass duct **12** of the jet en-

gine. This chamber 23 can alternatively be communicated with atmosphere by an arrangement such as 15, 16 of FIG. 1.

Internal ring 20 in combination with two seal rings 25, 26, cooperating with the inner side of external ring 22, forms a third annular chamber 26' which is separated from the first annular chamber 19 when the internal ring 20 is in an inoperative or closed position as illustrated in FIG. 2. Ring 20 and the seal rings 25, 26, are slidable in circumferential (tangential) and axial (parallel to center line 4) to open positions where openings 21 of external ring 22 are in communication with chamber 19 (open position would be with ring 20 and seal ring 25 and 26 moved leftward of position in FIG. 2).

External ring 22 is supported elastically in radial direction at its free end (left end in FIG. 2) and is provided with a seal relative to the first annular chamber 19 through seal ring 27. The right end of ring 22 is threadedly connected with a radially inwardly projecting rib of the housing.

Inner ring 20 is actuated by means of actuating shaft 28, passing through bypass duct 12. The torque or rotational movement of the shaft 28 is transmitted to inner ring 20 by at least one actuating lever 29 and intermediate lever 30 pivotably connected to lever 29. Between actuating lever 29 and intermediate lever 30 and between the latter and internal ring 20 spherical bearings 31, 32 are provided.

For insuring a combined motion of internal ring 20 in axial and circumferential direction, ring 20 is provided with guide slots 33 (FIG. 3), inclined in accordance with the desired direction of rotation. A plurality of said guide slots, e.g. three or six are preferably spaced uniformly over the circumference of ring 20.

These guide slots 33 permit positive guidance of internal ring 20 along rollers 34 (FIG. 4) which are mounted on external ring 22. By means of the guide slots 33 (FIG. 3) and the barrel-shaped rollers 34 rotating therein an axial motion is positively imposed upon the rotary motion effected by actuating shaft 28 (FIG. 2) corresponding to the actuating motion of the valve or internal ring 20, respectively. The position of rollers 34 can be adjusted with respect to the external ring by means of eccentric pins 35. In this connection, the advantage is achieved of an essentially clearance-free support or alternative bearing of the sliding ring 20, in that the rollers 34 can be adjusted by means of the eccentric pins 35, per guide slot 33 alternatingly against righthand flank face of a guide slot and against a lefthand flank face of a guide slot. FIG. 3 includes a dashline showing the internal ring 20 in blocking relationship to the openings 21 in external ring 22. As can be seen in FIG. 3, a large number of openings 21 are provided on external ring 22.

Since the chamber 19 is sealed off from the chamber 23 when the internal ring 20 is in a position closing the openings 21, the compressor air from compressor 2 will then all be transmitted to downstream compressor 3. When internal ring 20 is ir a position opening the openings 21, a portion of the compressed air from compressor will be bled off via chamber 23 to atmosphere or to the duct A.

The actuating shaft 28 is forcefully rotated by means not shown in the desired positions corresponding to the desired compressed air bleed-off flow. The control of this actuating shaft 28 could be responsive to sensed pressures within the engine so as to assure that undesirable compressor surge is avoided.

A further preferred embodiment of the present invention includes thread-type spiral shaped guide slots in place of slots 33. (see FIG. 3)

While we have shown and described several embodiments in accordance with the present invention, it is understood that the same is not limited thereto but is susceptible of numerous changes and modifications as known to those skilled in the art, and we therefore do not wish to be limited to the details shown and described herein but intend to cover all such changes and modifications as are encompassed by the scope of the appended claims.

What we claim is:

1. Apparatus for bleeding off compressor air in a turbine engine of the type having a longitudinal center line and a plurality of mechanically independent compressors; and apparatus comprising:

a first chamber communicated directly with compressor air from one of said compressors,

an internal ring positioned in said first chamber,

an external ring positioned downstream of said internal ring with respect to air flow through said turbine engine, positioned adjacent and externally of said internal ring with respect to said center line, and including a plurality of openings,

a second chamber communicated with bypass means of the engine which bypass means accommodates air flow therein in bypassing relationship to an engine combustion chamber arranged downstream of said compressors,

and internal ring actuating means for moving said internal ring between closed positions with said internal ring blocking said openings in said external ring to prevent flow from said first chamber to said second chamber and open positions with said internal ring out of blocking relationship with respect to said openings such that air can flow from said first to said second chamber through said openings.

2. Apparatus according to claim 1, wherein each of said chambers are annular chambers which extend around said longitudinal centerline of the engine which center line forms the axes of rotation for compressor wheels, and wherein each of said rings are annular rings which extend about said centerline.

3. Apparatus according to claim 2, wherein said actuating means includes means for moving said internal ring in both axial and circumferential directions with respect to said centerline.

4. Apparatus according to claim 3, further comprising two annular seal rings on said internal ring which sealingly engage said external ring to form a third annular chamber between said internal and external rings which is sealed relative to said first chamber when said internal ring is in said closed positions.

5. Apparatus according to claim 4, wherein said external ring is supported elastically at one axial end thereof and is sealed relative to the first chamber by seal means separate from said seal rings adjacent the other axial end thereof.

6. Apparatus according to claim 3, wherein said external ring is supported elastically at one axial end thereof and is sealed relative to the first chamber by seal means adjacent the other axial end thereof.

7. Apparatus according to claim 1, wherein said actuating means includes: a rotatable actuating shaft ex-

DOCKET ALARM

Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

Real-Time Litigation Alerts

Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

Advanced Docket Research

With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

Analytics At Your Fingertips

Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

LAW FIRMS
Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

FINANCIAL INSTITUTIONS
Litigation and bankruptcy checks for companies and debtors.

E-DISCOVERY AND LEGAL VENDORS
Sync your system to PACER to automate legal marketing.