

March 2, 1971

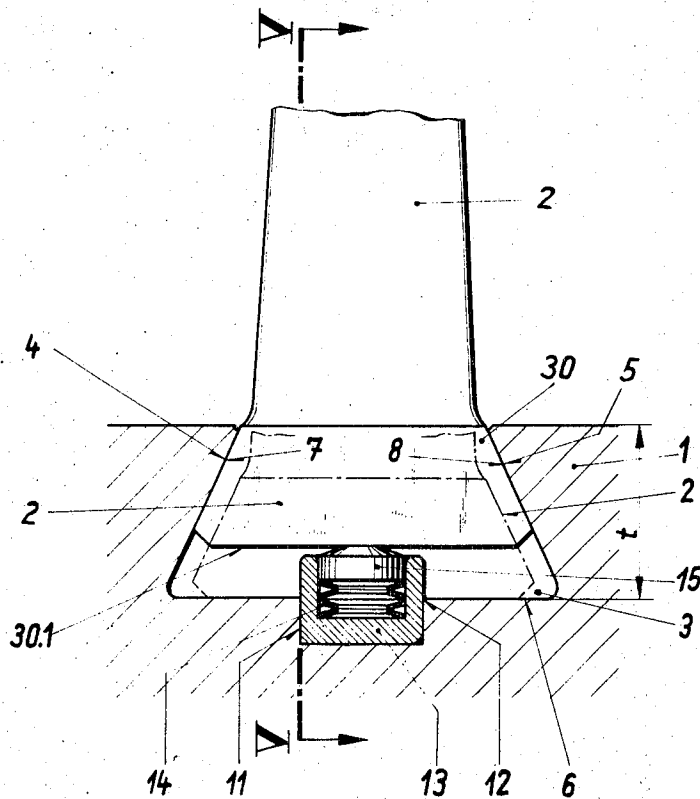
F. ZERLAUTH ET AL
ROTOR FOR TURBOENGINES

3,567,337

Filed Nov. 27, 1968

5 Sheets-Sheet 1

Fig. 1



Inventors:
FERDINAND ZERLAUTH
HERBERT FLEGEL
BY *Henry H. Henry*
ATTORNEYS

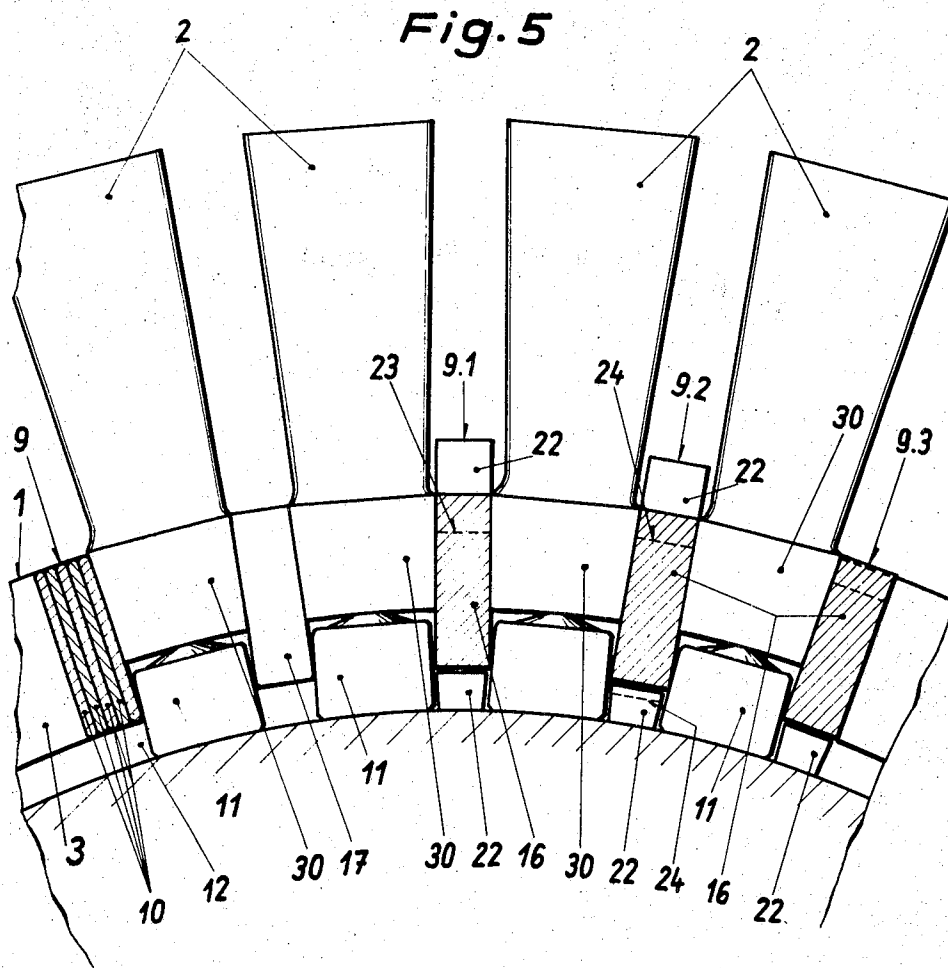
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Inventors:
FERDINAND ZERLAUTH
HERBERT FLEGEL
BY *Terryon Terryon*
ATTORNEYS

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ROTOR FOR TURBOENGINES

Ferdinand Zerlauth and Herbert Flegel, Winterthur, Switzerland, assignors to Sulzer Brothers, Ltd., Winterthur, Switzerland

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10 Claims

ABSTRACT OF THE DISCLOSURE

The rotor body is provided with a continuous uninterrupted slot which receives the blades in complementary locking manner. Spacers formed of individual plates space the blades and intermediary locking layers fill in the last spaces to lock the blades in place. The blades are also spring biased against the lateral surfaces of the slot.

This invention relates to a rotor for turboengines.

The rotors of turboengines require significant strength properties, that is, as far as mechanical and thermal properties are concerned. For example, in addition to the purely mechanical stresses which occur, mainly as a result of centrifugal forces, additional stresses are superimposed on the rotors due to an expansion differential resulting from temperature differences particularly upon starting and stopping of the rotors. Such superimposed stresses can, however, reach the admissible limit at unfavorable points and occasionally exceed the admissible limit. Further, the alternating thermal stress and vibration stress which are likely to be added thereon can rapidly result in fatigue phenomena as has been repeatedly confirmed by blade ruptures.

Additionally, the rotors and especially the blades require a high degree of precision during manufacture. For example, not only must the profiles be complied with exactly but also must be set in proper position in order to assure a flow with minimum losses. Accordingly, the connection of the blades with the rotor is subjected to maximum stress.

Heretofore, in order to overcome these above problems, the blades have had feet which have been form-locked upon insertion in slots of a rotor. In many instances, the foot of such blades has been shaped substantially like a hammer head or, as in other instances, with tuber heads, pine cones or other configurations with wave-shaped slots. In order to obtain a tight positive fit of these various foot configurations, considerable demands have been made on the precision of the blade profiles as well as the slot profiles. Also, the insertion of the blades through one fitting site extending over a part of the slot circumference has caused considerable work. In addition, the recesses required for the formation of the fitting site has weakened the rotor body.

More recent solutions attempt to remedy the above problems in that all blades of the vane ring as well as the rotor body have been manufactured in a single casting process. On the whole, however, practically useful solutions have been obtained only by means of precision casting in the centrifugal process in view of the fact that such permits the blades to be made of a material capable of withstanding mainly thermal stresses, whereas the rotor body can be made of a different material capable of

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withstanding in particular mechanical stresses. However, while having many advantages, this solution has been attended by the disadvantage of being limited only to the manufacture of smaller vane wheels with few stages or only to a single stage. In addition, there has been practically no possibility for the repairing or replacing of the blades. Thus, in the case of slight blade damage, the entire rotor has required replacement.

Accordingly, it is an object of the invention to reduce the demands on strength properties and machining precision in the manufacture of a rotor.

It is another object of the invention to produce a reliable and efficient rotor.

It is another object of the invention to avoid weakening of the rotor body in adapting the same to receive rotor blades.

Briefly, the invention provides a rotor which is manufactured with a continuous slot having surfaces disposed coaxially of the rotor axis to receive a plurality of blades.

The surfaces of the slot include at least one lateral surface which is sloped so as to engage the blades in opposition to the centrifugal force exerted on the blades. The blades are further provided with feet which are dimensioned relative to the slot so as to permit insertion of a blade foot into the slot when positioned in one direction and to allow locking of the blade foot in the slot when rotated 90°. In order to maintain the blades in place, a spring foot is placed in the slot below each blade to bias the blade outwardly of the slot against the sloped surface of the slot. Further, the blades are spaced apart within the slot by the use of individual spacers.

The shape of the blade feet is such as to allow insertion of all the blades and respective spring mounted feet as well as most of the spacers into the rotor slot without the need of recesses in the slot while also permitting displacement of the blade feet with sufficient clearance at their respective sites in the rotor circumference. Since only a few open spaces exist between some of the blades which are uniformly distributed about the rotor, an intermediary locking layer is used to fill up these remaining spaces after all the blades have been positioned. As these intermediary locking layers are subjected to loading to a much less extent than the circumference of the rotor body or blade feet, where formed multi-sectionally in order to form a closure, there is no danger such as that frequently arising at the closing points of the rotor.

These and other objects and advantages of the invention will become more apparent from the following detailed description taken in conjunction with the accompanying drawings in which:

FIG. 1 illustrates a view taken on line I—I of FIG. 4 of a blade abutted against the slot of a rotor according to the invention;

FIG. 2 illustrates a view taken on line II—II of FIG. 4 of a spacer within the rotor slot according to the invention;

FIG. 3 illustrates a view taken on line III—III of FIG. 4 of an intermediary locking layer according to the invention;

FIG. 4 illustrates a fragmentary plan view of a rotor according to the invention; and

FIG. 5 illustrates a view taken on line V—V of FIG. 4.

Referring to FIG. 1, the rotor has a rotor body 1 which receives a plurality of blades 2 in a circumferential slot 3 having two symmetrically disposed tapered lateral surfaces 4, 5 and a flat base surface 6; the surfaces 4, 5, 6 of the

slot 3 being disposed on axes coincident to the rotor axis. The slot surfaces 4, 5, 6 are uninterrupted by recesses throughout their circumference so as to prevent the tension stresses in the rotor from reaching peak values at any point. Thus, a uniform tension stress pattern is obtained along the slot surfaces which is readily controlled by appropriate shaping of the rotor body and blade feet. The blades 2 are dimensioned to seat against contact strips on the tapered surfaces 4, 5 of the slot 3 by means of counterfitting surfaces 7, 8. Thus, the centrifugal force of each blade 2 is transmitted to the rotor body 1 at these contact strips while the blades 2 are held in equilibrium by the rotor body 1.

Referring to FIGS. 1 and 2, the mouth of the slot 3 and the length 1 of the blade foot with respect to the periphery of the rotor are so dimensioned as to allow insertion of the blade foot into the slot 3 when turned 90° with respect to the final blade position in the slot 3. Further, the depth *t* of the slot 3 and the slope of the surfaces 7, 8 of the blade foot are such that the maximum diagonal *d* of the blade foot remains smaller than the width of the slot base surface 6.

Referring to FIGS. 1 and 2, in order to insert a blade 2 in the slot 3, the blade 2 is inserted into the slot 3 in a position as shown in dotted line in FIG. 2 approximately perpendicular to the final position in the slot 3. Next, the blade 2 is rotated 90° about its axis into the position shown in FIG. 1. Thereafter, the blade 2 is lifted to engage the lateral surfaces 4, 5 of the slot 3.

Referring to FIGS. 2 and 5, in order to space the blades 2 within the slot 3 in a manner to form a vane ring, spacer layers 9 are disposed between each pair of adjacent blades 2. The spacers 9 which are disposed in a major part of the rotor circumference consist of individual plates 10 which are inserted in identical manner to the blades longitudinally into the blade slot down to the base surface 6 and then turned against the side faces of the blade feet. Depending on the slight sheet-metal thickness, the shape of these plates 10 completely fills out the space of the complete profile of the slot 3 so that the plates 10 are held captive in position, practically without any clearance, by the lateral surfaces 4, 5 and the slot base surface 6.

Referring to FIG. 1, in order to prevent displacement of the blades upon stoppage when centrifugal forces no longer exist a spring foot 11 is arranged beneath each blade 2 within a spring groove 12. Each spring foot 11 consists of a prismatic foot element 13, for example, of rectangular or square cross section, which has a bore in which a cup spring 14 carrying a pressure plate 15 is mounted. Following insertion of a blade 2 into operative position, a spring foot 11 is pushed as an assembly into the spring groove 12 beneath the blade foot so that, even at stoppage and without the effect of centrifugal forces, the blade 2 is urged into operative position against the lateral surfaces 4, 5 of the slot 3. The length of the spring foot 11 is selected in such a manner as to be held with a slight clearance by the spacer layers 9 at either side of the blade supported by the spring foot 11 (FIG. 5).

Referring to FIG. 3, as a few spaces remain after all the blades 2 are inserted into the slot 3 which cannot accommodate insertion of the spacer layers 9, for example, three to six spaces, intermediary layers are radially inserted individually into the spaces between the already inserted blades so as to act as a closure or lock. These intermediary layers substantially comprise two shaped plates 16, 17 of substantially identical configuration of which each one bears with one shaped edge 18 on a respective contact strip 4, 5 of the slot and with one shaped edge 19 on the slot base surface 6. The intermediary layers also have a compartment between the inner edges 20 of two adjoining shaped plates 16, 17, defined by parallel walls. This compartment 21 is filled by two hook-shaped locking elements 22, 23 and a filler 24 between the locking elements. Each of the locking elements

22, 23 has the lower hooked end disposed in the groove 12 under a respective plate 16, 17 so that owing to the inserting of the filler 24, the two locking elements 22, 23 are held against the shaped elements 16, 17 with a sufficient force to prevent removal. In addition, the longer locking element 2 is bent over the filler 24 so that the intermediary layer is secured against falling out.

It is noted that only one contact strip each is provided for in the exemplified embodiment at either side of the slot. Alternatively, it would be possible to use for instance two or even a greater number of subdivided pairs of contact strips wherein the blade foot would then assume the shape of a pine cone. Further, the spacing between each pair of such contact strips can radially increase toward the outside of the rotor slot from the base of the slot. However, in normal cases, a single stage blade foot, as illustrated in FIGS. 1 to 5, is sufficient.

It is further noted that as the rotor slot is defined by precise rotary surfaces, there is no weakening of the rotor as has been the case in the past.

What is claimed is:

1. A rotor for a turboengine comprising:

a rotor body having a peripheral circumferential slot of smooth uninterrupted surfaces therein, said slot having a pair of lateral surfaces sloped toward the interior of said slot and a base surface;

a plurality of blades mounted in said slot, each blade having a blade foot engaging said lateral surfaces of said slot to transfer the centrifugal force exerted on said blade to said lateral surface and being spaced from said base surface, each blade foot being dimensioned to pass radially into and out of said slot in a position transverse to the mounted position of said blade foot in said slot and to be rotated within said slot into said mounted position;

spacing means in said slot between each pair of adjacent blades; and

spring means in said slot biasing each said blade from said base surface against said lateral surfaces of said slot.

2. A rotor as set forth in claim 1 wherein each said blade foot has an outer dimension less than the mouth of said slot and a diagonal length less than the width of the base of said slot.

3. A rotor as set forth in claim 1 wherein said lateral surfaces are disposed symmetrically of said blades engaging each blade foot.

4. A rotor as set forth in claim 3 wherein each said lateral surface includes at least one contact strip thereon abutting said blades.

5. A rotor as set forth in claim 1 wherein said spring means is disposed in a peripheral groove in said base surface of said slot to urge each said blade radially outwardly of said slot, said groove being of less width than said base surface.

6. A rotor as set forth in claim 5 wherein said spring means includes a prismatic foot element having a bore mounted in said groove, a pressure plate slideably mounted in said bore, and a spring in said bore biasing said pressure plate against a respective blade.

7. A rotor as set forth in claim 6 wherein said spring includes at least one cup spring.

8. A rotor as set forth in claim 1 wherein said spacing means includes a plurality of flat plates having profiled edges fitting against the surfaces of said slot.

9. A rotor as set forth in claim 8 wherein said spacing means includes at least one intermediary locking layer of multisectional components of a width less than the width of said slot.

10. A rotor for a turboengine comprising:

a rotor body having a circumferential slot of smooth uninterrupted surfaces therein, said slot having at least one lateral surface sloped toward the interior of said slot;

a plurality of blades mounted in said slot, each blade

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having a blade foot engaging said lateral surface of said slot to transfer the centrifugal force exerted on said blade to said lateral surface, each blade foot being dimensioned to pass into and out of said slot in a position transverse to the mounting position of said blade foot in said slot;
 5 spring means in said slot biasing each said blade against said lateral surface of said slot; and
 spacing means in said slot between each pair of adjacent blades, said spacing means including at least one
 10 intermediary locking layer of multi-sectional components of a width less than the width of said slot, said intermediary locking layer including a pair of spaced profiled plates defining a compartment therebetween,
 15 a pair of hook shaped locking elements in said compartment engaging under opposite profiled plates, and a filler engaged between said locking elements, one of

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said locking elements having an end bent over said filler to lock said filler in said compartment.

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EVERETTE A. POWELL, JR., Primary Examiner

U.S. Cl. X.R.

416-215

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,567,337 Dated March 2, 1971

Inventor(s) Ferdinand Zerlauth and Herbert Flegel

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 4, line 6, "2" should be --22--

Signed and sealed this 1st day of June 1971.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents