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BLADED ROTOR OF AXIAL-FLOW FLUID MACHINE WITH MEANS TO RETAIN BLADES IN POSITION ON ROTOR

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Fig.1.

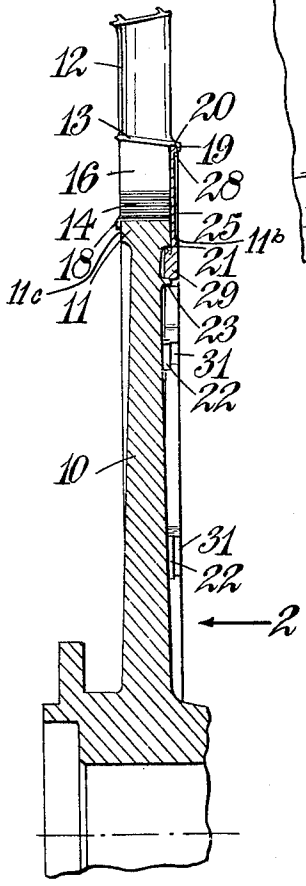

Fig.3.

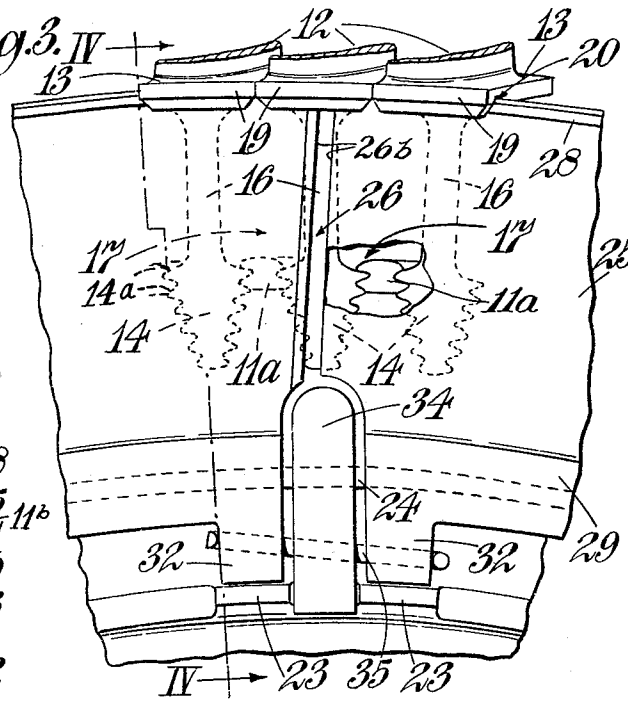

Fig.4.

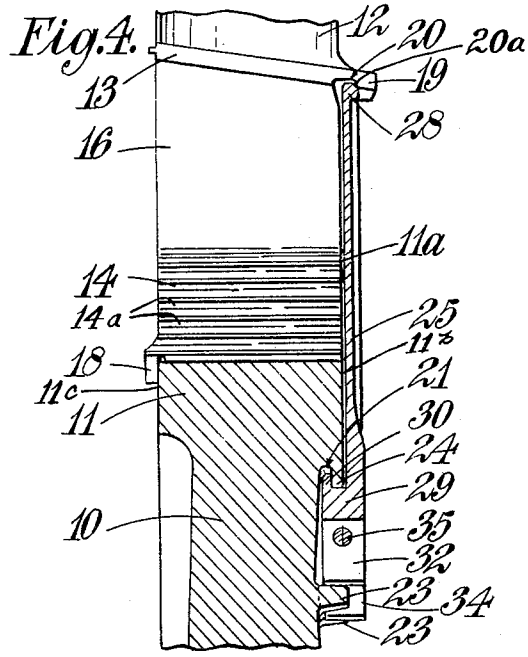

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Fig.2.

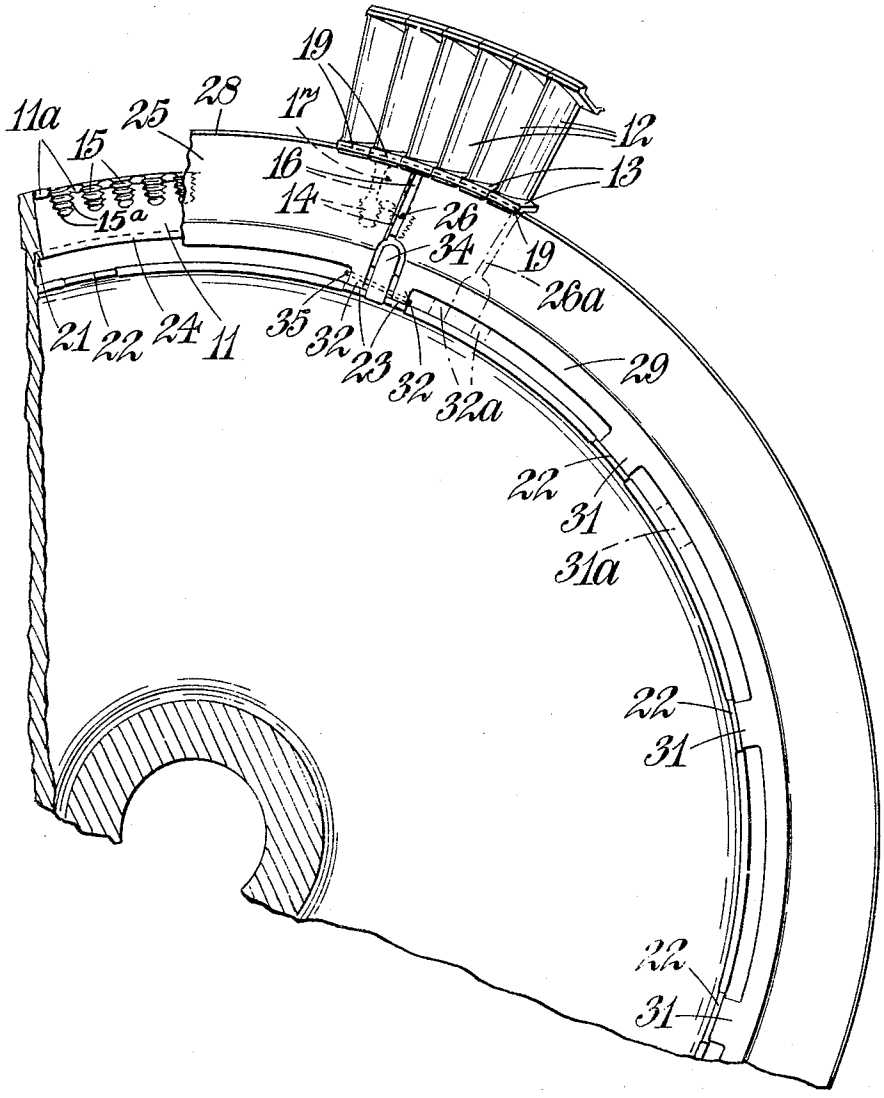

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Fig.5.

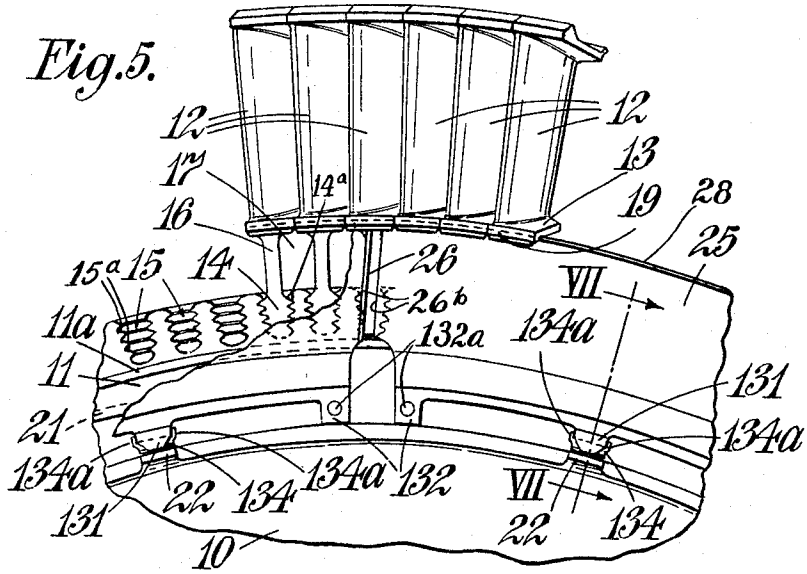


Fig.7.

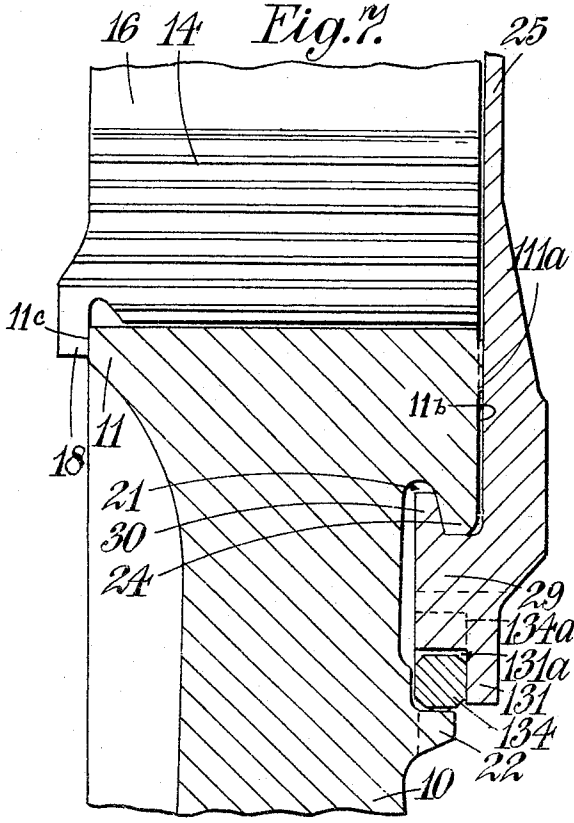
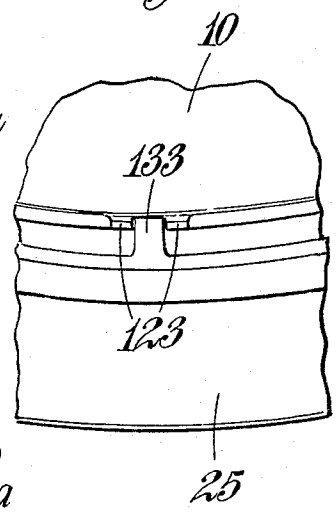


Fig.6.



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BLADED ROTOR OF AXIAL-FLOW FLUID MACHINE WITH MEANS TO RETAIN BLADES IN POSITION ON ROTOR

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7 Claims. (Cl. 253—77)

This invention relates to rotors of axial-flow fluid machines, such, for instance, as axial-flow compressors and turbines, especially those of gas-turbine engines.

Such a rotor often comprises a disc carrying a ring of rotor blades at its periphery, the blades having shouldered root attachment portions which engage in correspondingly-shaped generally-axial slots in the rim of the disc to retain the blades radially in position. Such a rotor will be referred to as "a rotor of the type described."

This invention has for an object to provide a simple construction of means to prevent inadvertent disengagement of the blades from the disc of a rotor of the type described.

According to this invention, in a rotor of the type described, the disc is provided on an axially-facing surface of its rim with annular radially-inwardly-facing channel means coaxially with the rotor, the blade root attachment portions have radially-inwardly-facing channels which together form a substantially continuous annular channel coaxial with the rotor and of greater radius than the annular channel means on the rim, and there is provided means to retain the blades in position on the rim comprising an annular plate adapted to be resiliently contractable in diameter by provision of a gap at one side, said annular plate overlying axially-facing surfaces of the rim and attachment portions and engaging in the uncontracted condition by an edge in the channels in the attachment portions and by an annular flange thereon radially inwards of said edge in the annular channel means on the rim, thereby to be positioned relative to the disc and blade root attachment portions and to retain the blade root attachment portions against displacement in their slots.

Preferably, there is also provided means to prevent undesired disengagement of the annular plate from the channels in the rim and in the blades. In one preferred construction, this means comprises circumferentially-spaced radially-inwardly-extending lugs on the annular plate and correspondingly-spaced axial projections on the rim providing radial abutments for the lugs to prevent contraction of the annular plate, and a block extending circumferentially between a pair of the lugs and their associated projections and secured to the annular plate thereby to prevent circumferential displacement of the annular plate; the block is conveniently positioned between lugs on the annular plate at each side of the gap therein and is secured to the annular plate by a locking pin passing through bores in the block and adjacent lugs. In another preferred construction, the means comprises circumferentially-spaced axial projections on the disc and correspondingly-spaced radially-inwardly-projecting lugs on the plate which are cut back opposite the projections to leave recesses which are occupied by filler pieces, the latter having tabs which are bent up on each side of the lugs to retain them in the recesses, and diametrically opposite the gap in the plate a lug on the plate engaging between a pair of circumferentially-spaced projections on the disc.

When the blade root attachment portions are of the kind providing between them passages through which a fluid could travel axially of the rotor, the annular plate may also be employed to seal off the ends of the passages by lying flat against the end surfaces of the root attachment portions and the adjacent surface of the rim.

Two rotor constructions incorporating the invention will now be described, the description referring to the accompanying drawings in which:

FIGURE 1 is an axial section through one construction of rotor,

FIGURE 2 is an enlarged view in the direction of arrow 2 in FIGURE 1,

FIGURE 3 is a view to a larger scale of part of FIGURE 2,

FIGURE 4 is a section on the line IV—IV of FIGURE 3,

FIGURES 5 and 6 are axial views of two portions of the second construction of rotor, the portion shown in FIGURE 6 being located 180° from the portion shown in FIGURE 5, and

FIGURE 7 is a section on the line VII—VII of FIGURE 5 but drawn to a larger scale.

Referring to FIGURES 1 to 4, the rotor comprises a rotor disc **10** having rim portion **11** whereon a ring of blades **12** are mounted.

Each blade **12** has a root attachment portion comprising a platform **13** adjacent the operative part of the blade, a shouldered part **14**, commonly known as a fir-tree root, to engage a correspondingly-shaped generally-axial slot **15** in the disc rim **11**, and a stem portion **16** which is circumferentially narrower than the platform **13** and the shouldered part **14** so that axial passages **17** are left between the stem portions **16**. The part **14** of the root attachment portion has radially outwardly facing shoulders **14***a* and the slot **15** has cooperating radially inwardly facing shoulders **15***a*, these shoulders interengaging in abutment radially against one another to retain the blade radially in position.

The blades are provided with parts **18** in the form of tangs which abut the upstream axially-facing surface **11***c* of the rim **11** of the disc to prevent disengagement of the blades in one sense (to the right as seen in FIGURE 1).

In order to retain the blades **12** against disengagement in the opposite sense and to seal off the passages **17**, the following arrangement is provided.

Each platform **13** is formed along one edge with an axial extension **19** which is undercut with a radially-inwardly-facing groove **20**. The grooves **20** together afford a substantially continuous groove coaxial with the rotor.

The rim **11** is formed on its axially-facing surface **11***b* on the same side of the rim as the grooves **20** and at a radius less than that of the slots **15**, with a continuous radially-inwardly-projecting flange **24** which forms with the rim **11** a radially-inwardly-facing channel **21**, and radially inwards from the channel **21** the disc **10** is provided with a series of circumferentially spaced axial projections **22** of which two of said projections are closely adjacent projections **23**. The parts of the rim **11** which separate the blade slots **15** are provided, on the same side of the rim as the groove **20**, axial projections **11***a* having in this instance an axial depth of .005" to .010".

A flat annular plate **25** is mounted on the rotor to co-operate with the grooves **20**, channel **21** and projections **22**, **23**. The plate **25** is split radially to provide a gap **26** bounded or defined by a pair of spaced radially-extending edges **26***b*, and is resilient so that it can be contracted in diameter, and to facilitate this operation the lugs **32** can be gripped by an appropriate tool.

The outer edge or the first edge of the plate **25** is formed as a bead **28** and, when the plate is uncontracted, the bead is of such diameter as to occupy the substantially continuous groove formed by grooves **20** in the blade platforms **13**.

The radially-inner part **29** of the plate **25** is axially-

thickened and is formed with a radially-outwardly-directed flange **30** which is of such diameter that, when the plate is uncontracted, the flange **30** occupies the channel **21**.

The plate **25** is also provided with radially-inwardly-projecting lugs **31**, **32** corresponding in position and number to the projections **22**, **23**, and the lugs and projections when radially aligned co-operate in abutment to prevent contraction of the plate **25**. It is therefore apparent that the projections **22**, **23** on the disc and the lugs **31**, **32** on the plate **25** constitute radial abutment means to prevent undesirable contraction and disengagement of the plate from the disc.

To assemble the plate to the disc, the plate is contracted to reduce the diameters of the bead **28** and flange **30** sufficiently to pass axially inside the extensions **19** and also the flange **24** bounding channels **20** and **21** respectively, and the plate is offered up to the disc with the gap **26**, which is closed by the contraction, in the position indicated at **26***a* in FIGURE 2 and thus with the lugs **31**, **32** in the positions shown at **31***a*, **32***a* and offset from the projections **22**, **23**. The plate is now released from contraction so permitting the bead **28** to enter the groove formed by grooves **20** and the flange **30** to enter channel **21**. The projections **11***a* on the rim **11** serve to spring the beaded edge **28** into good sealing contact with the axial wall **20***a* of the groove **20** on each blade. The plate **25** is now rotated to the full line position with the lugs **31**, **32** and projections **22**, **23** radially aligned.

To prevent rotation of the plate **25**, a block **34** is provided to extend axially and radially between the lugs **32** and projections **23**, and the block **34** is secured to the plate **25** by having a flange, similar to flange **30**, which engages in the channel **21** in the disc and by means of a wire pin **35** which passes through holes in the lugs **32** and the block **34**, and has its ends bent over to prevent its detachment.

It will be noticed that for the purpose of maintaining the sealing of the passages **17** between the stems **16**, the gap **26** in the plate **25** is arranged to extend along the end surface of one of the stems **16**.

Referring now to FIGURES 5 to 7, in which the same reference numerals are employed as in FIGURES 1 to 4, to denote corresponding parts, there is illustrated a construction in which the plate **25** can be presented to the disc in the angular position it is to occupy. In this construction, the plate is provided adjacent the gap **26** with a pair of lugs **132** which are perforated at **132***a* to receive the contracting tool, and also around its inner edge with a series of circumferentially-spaced radially-inwardly-extending lugs **131** the spacing of which is the same as that of the projections **22** on the disc. The lugs **131** are cut back axially to form recesses **131***a* in FIGURE 7 above the projections **22** to permit the lugs **131** on the plate to be passed over the projections when the plate is contracted in diameter for assembly. Also at a position diametrically opposite the gap **26**, the plate **25** is provided a further radial lug **133** and the disc has at this position a pair of circumferentially-spaced projections **123** spaced by the width of the lug **133**. The lug **133** and projections **123** prevent rotation of the plate in operation, and facilitate positioning of the plate in assembly.

To assemble the plate to the disc, the plate **25** is contracted in diameter and is presented axially to the disc in the appropriate angular position to engage the lug **133** between the projections **123** and with the lugs **131** angularly in line with the projections **22**. The plate is now allowed to expand so that its outer edge **28**, which is preferably beaded as in the construction of FIGURES 1 to 4, engages in the grooves in the extensions **19** of the platforms **13**, its flange **30** being sprung into good sealing engagement with the walls of the channel **21** by the annular land **111***a*. In order to prevent accidental removal of the plate by contraction, filler pieces **134** are inserted in the recesses between the projections **22** and the cut-back parts **131***a* of the lugs **131**, and thin tabs **134***a* on the filler pieces are bent up to lie on each side of the lugs **131** to retain the filler pieces in position.

It will be appreciated that the combined locking and sealing plate of these constructions is simple in form and readily assembled and removed.

We claim:

1. A rotor of an axial-flow fluid machine, the rotor comprising a disc having a rim with axially-facing surfaces, a plurality of blades, each blade having a root attachment portion provided with radially-facing shoulders, a plurality of slots extending in said rim between said axially-facing surfaces, each slot having radially facing shoulders complementary to the shoulders on the root attachment portions, said shouldered root attachment portions of said blades being engaged in said slots with radially-facing shoulders of the blades and slots interengaging to retain the blades radially in position, said rim having adjacent one of said axially-facing surfaces an annular radially-inwardly-facing channel coaxial with the rotor, said shouldered root attachment portions having adjacent said one of the axially-facing surfaces radially-inwardly-facing grooves which having a circumferential extent together to form a substantially continuous annular groove coaxial with the rotor and of greater radius than said annular radially-inwardly-facing channel, means to retain the blades in position on the rim comprising an annular plate of resilient material overlying said one of the axially-facing surfaces of the rim and the root attachment portions of the blades, said plate having a first edge engaging the grooves in the root attachment portions and also having thereon at a substantially smaller radius than said edge an annular flange engaging the annular radially-inwardly-facing channel on the rim, thereby to be positioned relative to the disc and root attachment portions and to retain the root attachment portions against axial displacement in their slots, said plate being split radially at a single angular position to form a pair of spaced radially-extending edges of the plate between which is a gap permitting contraction in diameter of the plate by closing the gap for engaging and disengaging the said first edge in the grooves and the flange in the channel, and radial abutment means provided between said annular plate and the rim and operative to prevent undesirable contraction and disengagement of the annular plate.

2. A rotor as claimed in claim 1, wherein said radial abutment means comprises circumferentially-spaced radially-inwardly-extending lugs on the annular plate, which lugs are cut back axially on their radially-inner ends to define recesses with the rim of the disc, correspondingly-spaced axial projections on the rim of the disc at a radius less than said lugs and radially aligned with the recesses, and filler pieces in said recesses extending radially between the cut back ends of said lugs and said axial projections, said filler pieces having tabs at their ends which are bent up on each side of the lugs to retain them in the recesses; and comprising also means holding the annular plate against circumferential displacement comprising a lug on the plate at a position diametrically opposite the gap in the plate and a pair of circumferentially-spaced projections on the disc, said lug on the plate engaging between said circumferentially-spaced projections.

3. A rotor as claimed in claim 1, wherein each of the blade root attachment portions has a part engaging the rim and limiting movement of the blades relative to the rim in an axial direction towards said one of the axially-facing surfaces, and wherein an annular land is formed coaxially with the rotor on said one of the axially-facing surfaces, and engages said annular plate to urge the plate into sealing engagement with the sides of said grooves on the blade root attachment portions.

4. A rotor of an axial-flow fluid machine, the rotor comprising a disc having a rim with axially-facing surfaces, a plurality of blades, each blade having a root

attachment portion provided with radially-facing shoulders, a plurality of slots extending in said rim between said axially-facing surfaces, each slot having radially facing shoulders complementary to the shoulders on the root attachment portions, said shouldered root attachment portions of said blades being engaged in said slots to retain the blades radially in position, said rim having adjacent one of said axially-facing surfaces an annular radially-inwardly-facing channel coaxial with the rotor, said shouldered root attachment portions having adjacent said one of the axially-facing surfaces radially-inwardly-facing grooves which together form a substantially continuous annular groove coaxial with the rotor and of greater radius than said annular radially-inwardly-facing channel, means to retain the blades in position on the rim comprising an annular plate of resilient material overlying said one of the axially-facing surfaces of the rim and the root attachment portions of the blades, said plate having a first edge engaging the grooves in the root attachment portions and also having thereon at a substantially smaller radius than said edge an annular flange engaging the annular radially-inwardly-facing channel on the rim, thereby to be positioned relative to the disc and root attachment portions and to retain the root attachment portions against displacement in their slots, said plate being split radially to form a pair of spaced radially-extending edges of the plate between which is a gap permitting contraction in diameter of the plate by closing the gap for engaging and disengaging the edge in the grooves and the flange in the channel, and disengagement-preventing means comprising circumferentially-spaced radially-inwardly-extending lugs on the annular plate and correspondingly-spaced axial projections on the rim providing

radial abutments co-operating with the lugs to prevent undesirable contraction and disengagement of the annular plate.

5. A rotor as claimed in claim 4 wherein disengagement-preventing means also comprise a block extending circumferentially between a pair of the lugs and their associated axial projections on the rim and secured to the annular plate thereby to prevent circumferential displacement of the annular plate.

6. A rotor as claimed in claim 5, wherein the said pair of the lugs are provided on the annular plate one at each side of the gap therein and there is provided a locking pin passing through bores in the block and said pair of lugs and securing them together.

7. A rotor as claimed in claim 4, wherein each of the blade root attachment portions has a part engaging the rim and limiting movement of the blades relative to the rim in an axial direction towards said one of the axially-facing surfaces, and wherein a substantially continuous annular land is formed coaxially with the rotor on said one of the axially-facing surfaces, and engages said annular plate to urge the plate into sealing engagement with the side walls of said groove on the blade root attachment portions.

References Cited in the file of this patent

UNITED STATES PATENTS

2,755,062	Hill	July 17, 1956
2,755,063	Wilkinson	July 17, 1956

FOREIGN PATENTS

161,997	Australia	Mar. 17, 1955
699,582	Great Britain	Nov. 11, 1953