July 2, 1963 L. J. PRATT ETAL 3,096,074

BLADED ROTORS OF MACHINES SUCH AS GAS TURBINES

Filed Nov. 27, 1961 2 Sheets-Sheet 1

Fig.1.

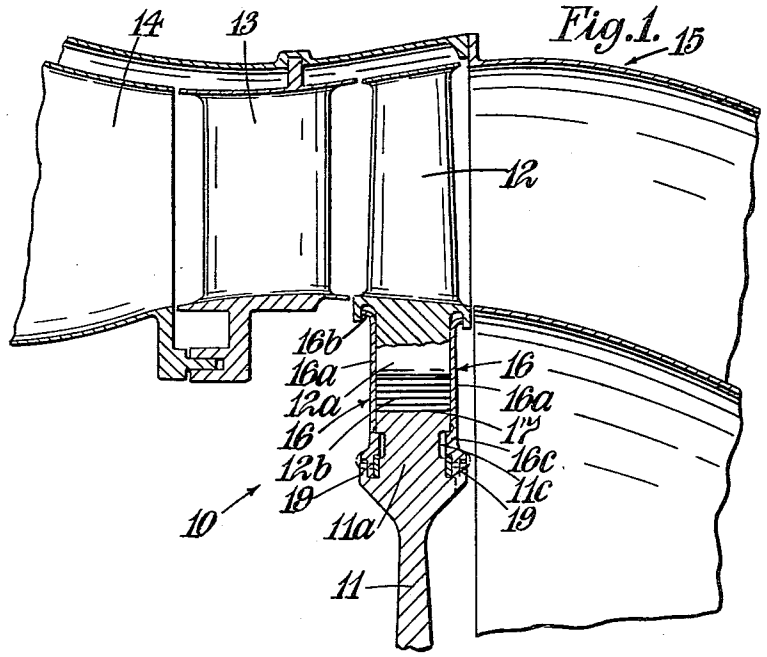


Fig.2.

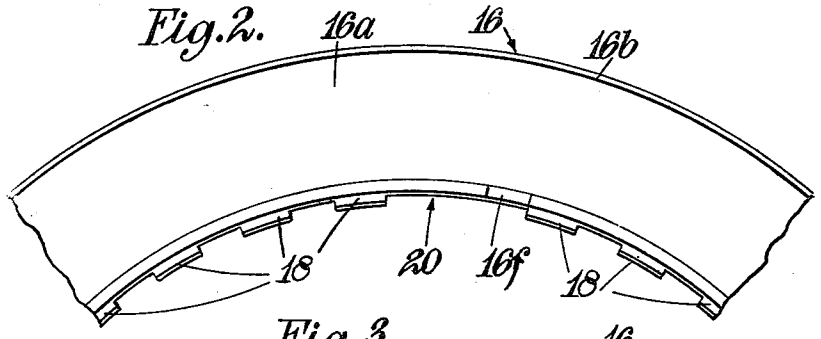
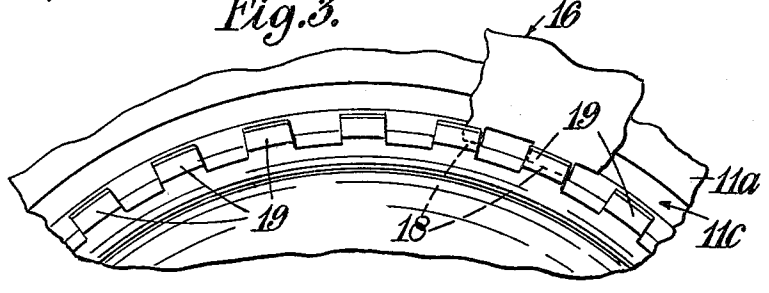


Fig.3.



July 2, 1963 L. J. PRATT ETAL 3,096,074

BLADED ROTORS OF MACHINES SUCH AS GAS TURBINES

Filed Nov. 27, 1961 2 Sheets-Sheet 2

Fig.5.

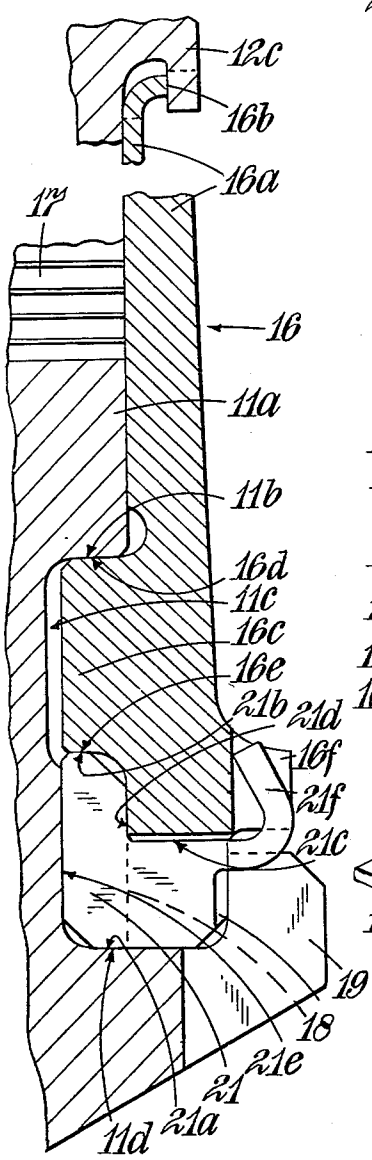


Fig.4

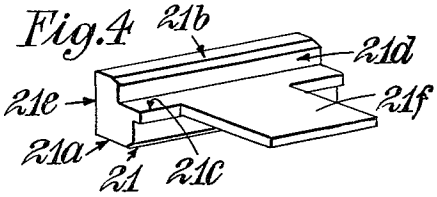
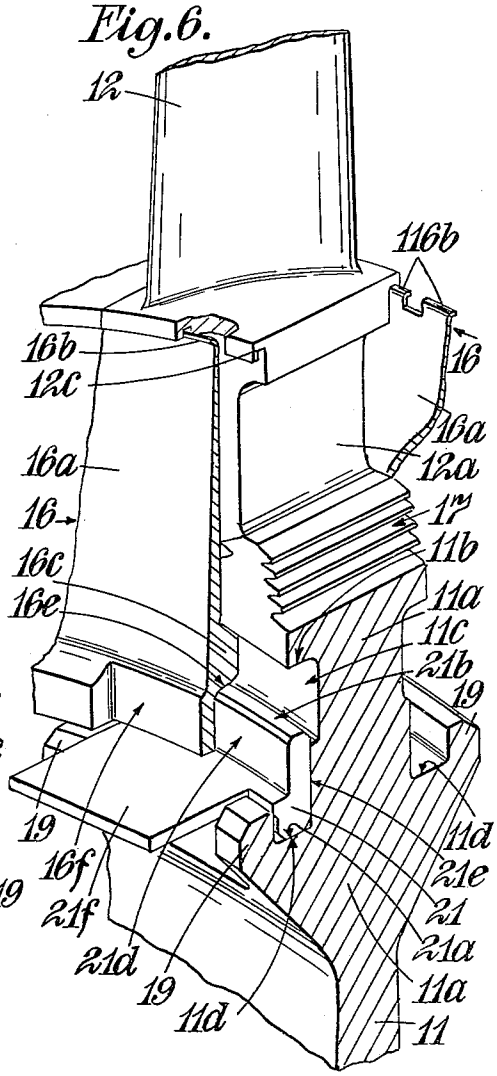


Fig.6.



United States Patent Office

3,096,074

Patented July 2, 1963

3,096,074

BLADED ROTORS OF MACHINES SUCH AS GAS TURBINES

Leslie James Pratt, Allenton, and Ronald Brien, Allestree, England, assignors to Rolls-Royce Limited, Derby, England, a British company

Filed Nov. 27, 1961, Ser. No. 155,117
Claims priority, application Great Britain Dec. 6, 1960
6 Claims. (Cl. 253—77)

This invention comprises improvements in or relating to bladed rotors of machines such as gas turbines, the rotors being of the class comprising a ring of blades mounted at the periphery of a rotor disc or drum and an annular plate which lies against axially facing surfaces of the periphery of the disc or drum and of the root portions of the blades.

According to this invention, in a rotor of the class referred to, the annular plate is retained axially against said surfaces by having a ring of angularly-spaced dogs which are engaged behind corresponding dogs on the disc or drum by presenting the plate to the disc or drum with the dogs on the plate angularly between those on the disc or drum and then rotating the plate relative to the disc or drum, and there is at least one key which is trapped between a pair of the dogs on the disc or drum to hold it against circumferential displacement, and is located radially and axially relative to the disc or drum, the key having a tab which is bent to engage between circumferentially-facing shoulders on the plate to locate the plate circumferentially relative to the disc or drum.

In one preferred arrangement, the tab engages said pair of the dogs on the disc or drum to locate the key circumferentially and engages in a radial notch in the plate to locate the plate circumferentially.

One construction of rotor of the class referred to embodying the above and other features of invention will now be described with reference to the accompanying drawings in which:

FIGURE 1 is an axial section through part of a gas turbine,

FIGURE 2 is an axial view of part of the annular plate,

FIGURE 3 is an axial view of part of the rotor,

FIGURE 4 is a perspective view of one form of key,

FIGURE 5 is a view of part of FIGURE 1 to a larger scale, and

FIGURE 6 is a perspective view showing the locking key in position.

In FIGURE 1, the rotor 10 is the turbine rotor of a gas turbine engine and comprises a rotor disc 11 having an axially thickened peripheral rim 11*a* whereon a ring of rotor blades 12 are mounted to extend radially between nozzle guide vanes 13, which lead hot combustion gases from combustion equipment 14 to the blades 12, and an exhaust assembly 15.

Each blade has a root 12*a*, including a shoulder portion 12*b* which engages a correspondingly shouldered channel 17 extending across the disc rim 11*a* in a generally axial direction.

The rotor also includes a pair of unsplit annular plates 16 which are mounted one on each side of the disc 11 to lie in contact with the axially facing surfaces of the disc rim 11*a* and blade root portions 12*a*, 12*b*.

A part of one form of the plates 16 is shown in FIGURES 2, 5, 6 and it comprises a main portion 16*a*, which tapers radially outwards in thickness (see FIGURE 5), and which extends radially inwards from a turned over circumferential lip 16*b* at its outer edge to just beyond a circumferentially-continuous land 16*c* near its inner edge, the land 16*c* projecting axially from the surface of

the plate which lies against the disc rim 11*a* and blade roots to provide a pair of oppositely and radially facing surfaces 16*d*, 16*e*. The surface 16*d* engages a radially inwardly facing surface 11*b* formed by an annular groove 11*c* on the disc rim 11*a*, thereby to centre the plate 16 relative to the rotor disc 11.

The inner edges of the plates 16 are provided with groups of angularly-spaced radially-inwardly-projecting dogs 18 which when the plate is in position engage behind radially-outwardly-projecting dogs 19 projecting from the disc rim 11*a* at the inner limit of the groove 11*c*. The dogs 19 have a spacing equal to that of the dogs 18 but there are a greater number of the dogs 19 than there are dogs 18, there being between each group of the dogs 18 a space sufficient to be occupied by one further dog as indicated at 20 in FIGURE 2. One or more of such spaces 20 may be provided around the plate 16 and for instance in one arrangement six such spaces are provided so that when the plate 16 is in position on the disc rim there will be six dogs 19 which do not have dogs 18 engaged behind them. The dogs 18 are engaged behind the dogs 19 by first presenting the plate 16 to the disc rim 11*a* with the dogs 18 entering the spaces between the dogs 19 and then rotating the plate 16 relative to the disc 11 to bring the dogs 18 behind the dogs 19. In this way the plate 16 is held axially in position relative to the disc 11.

In order to locate the plate 16 angularly with respect to the disc 11, a series of keys 21 such as are shown in FIGURE 4 are provided, the number of such keys being the same as the number of the spaces 20 above referred to.

As will best be seen from FIGURES 4, 5 and 6, each key 21 comprises a short bar of metal having a flat lower radially-inwardly-facing surface 21*a* which bears on the lower side surface 11*d* of the groove 11*c*, and a stepped upper surface to provide a first radially-outwardly-facing surface portion 21*b* which bears against the surface 16*e* of the circumferential land 16*c* on the plate 16 and a surface portion 21*c* which is spaced slightly away from the inner edge of the plate 16. Since the surface 16*d* of the land 16*c* engages the surface 11*b*, the surface 21*b* engages the surface 16*e* and the surface 21*a* engages the surface 11*d*, the key is located against radial movement. The stepped formation also provides a pair of axially-facing radially-extending surfaces 21*d* and 21*e* which contact respectively the plate 16 and the disc rim 11*a* so that thereby the key is trapped axially in position.

The axially wider portion of the key 21 has a length somewhat greater than the space between a pair of the dogs 19 so that when the key is in position its end portions lie between a pair of the dogs 19 and the adjacent surface of the disc rim 11*a* (FIGURE 6).

Each key also has a tab 21*f* which prior to assembly projects axially as seen in FIGURES 4 and 6, and this tab is positioned centrally between the ends of the key at such a height above the surface 21*a* that its circumferentially-facing surfaces can abut the adjacent circumferentially-facing surfaces of the two dogs 19 behind which the ends of the key are engaged. As will be seen from FIGURE 5, after the plate 16 has been properly positioned with its dogs 18 behind the dogs 19, the tab 21*f* is bent upwardly so that the tab end engages in a radial notch 16*f* formed in the inner edge of the plate 16, the notch 16*f* by its side surfaces providing circumferentially-facing shoulders which co-operate in abutment with the circumferentially-facing surfaces of the tabs 21*f* to locate the plate circumferentially. In this way the tab 21*f* of the key 21 serves both to locate the key circumferentially with respect to the disc 11 and to locate the plate 16 relative to the disc 11.

Where a plate **16** has a continuous lip **16***b*, the ring of blades **12** is provided at the outer ends of their roots with undercut flanges **12***c* to receive the lip **16***b* and in assembly the blades are first hooked on the lip **16***b* and the plate and blades are then offered up to the rotor disc **11** so that the shouldered root portions **12***b* engage their respective channels **17** and so that the dogs **18** pass between the dogs **19** as the blade root portions **12***b* are forced home. The keys **21** are already positioned with their end portions behind the dogs **19** and it is arranged in offering up the plate **16** to the disc rim **11***a* that the spaces **20** are angularly level with the keys. When the blades are fully home, the dogs **18** have reached an axial position as shown in FIGURE 5 and the plate **16** may now be rotated to bring the dogs **18** behind the dogs **19** and to bring the notches **16***f* into radial alignment with the tabs **21***f* of the keys **21**. The tabs **21***f* are now bent upwardly to the position shown in FIGURE 5 so locking the assembly.

When one of the plates **16** has a continuous lip **16***b* as above described, the other of the plates **16** will have at its outer edge a series of radially-outwardly-extending dogs **116***b* (FIGURE 6) to engage behind corresponding dogs on alternate blade roots **12***a*, or will have a radial extent insufficient to reach the outer limit of the blade roots **12***a*.

In another construction both plates **16** have at their outer edges a dog formation such as is provided by the dogs **116***b* to engage behind corresponding dogs formed on the blade roots.

If desired the plates **16** may be provided with holes to admit cooling air to, or to allow escape of cooling air from channels between the blade roots or cooling fluid ducts in the blades.

Alternatively, when the blades are uncooled, the plate or plates **16** act to prevent a flow of fluid, say sealing air, from one side of the rotor disc to the other through the gaps between the blade roots.

We claim:

1. A bladed rotor comprising

(*a*) a rotor disc having a peripheral portion with axially-facing surfaces,

(*b*) a ring of blades carried by the peripheral portion of the disc, each blade having,

(*c*) a root interengaging with the peripheral portion of the disc to retain the blade radially in position, the root having axially facing surfaces corresponding to the axially-facing surfaces of the peripheral portion of the disc,

(*d*) a circumferential groove in one of said axially-facing surfaces of the peripheral portion, said groove affording by its sides a radially outwardly facing surface and a radially inwardly facing surface spaced outwards from the outwardly facing surface,

(*e*) a series of angularly-spaced first dogs on said peripheral portion, said first dogs projecting radially outwards from the outwardly facing surface of said groove in axially spaced relation to said peripheral portion,

(*f*) at least one key having a surface engaging said outwardly facing surface of said groove, said key further having circumferentially-spaced end portions each extending between one of an adjacent pair of said first dogs and the peripheral portion of the disc, said key further having a radially outwardly facing surface spaced inwardly from the radially inwardly facing surface of said groove,

(*g*) a tab on said key projecting axially between and abutting circumferentially against the said pair of first dogs, and

(*h*) an annular unsplit plate extending in contact with the axially-facing surface of said peripheral portion and said blade roots, said annular plate having a circumferential land projecting axially therefrom into said circumferential groove, said land having a radially outwardly facing surface in contact with the radially inwardly-facing surface of said groove and a radially inwardly-facing surface in contact with the radially outwardly-facing surface of said key, said annular plate further having circumferentially spaced second dogs engaging axially in the spaces between the said first dogs and the peripheral portion of the disc, and said annular plate further having a radial notch therein defining a pair of opposed circumferentially-facing shoulders, said tab having a portion engaging in said notch and abutting said opposed circumferentially-facing shoulders.

2. A bladed rotor as claimed in claim 1, there being a plurality of such keys and a corresponding plurality of such notches, said second dogs on the annular plate being less in number than said first dogs on the peripheral portion, said second dogs being arranged in groups, the dogs in each group having an angular spacing corresponding to the spacing of said first dogs, and said notches being angularly between the said groups of said second dogs.

3. A rotor comprising a rotor disc having an axially facing surface at its periphery, a ring of blades having root portions which are mounted in said rotor disc at the periphery thereof and which have axially facing surfaces, an annular plate which lies against the said axially facing surfaces of the rotor disc and of the root portions of the blades, spaced circumferentially facing shoulders on said annular plate, rings of angularly-spaced dogs on said annular plate and on said rotor disc respectively, the dogs on said annular plate being mounted behind the dogs on said rotor disc, at least one key which is trapped against circumferential displacement between a pair of rotor disc dogs, said key and said rotor disc having cooperating surfaces which locate the key radially and axially with respect to the rotor disc, and a bent tab on said key which engages between the said spaced circumferentially facing shoulders on the annular plate and which thus locates the annular plate circumferentially with respect to the rotor disc.

4. A rotor comprising a rotor having an axially facing surface at its periphery, a ring of blades having root portions which are mounted in said rotor disc at the periphery thereof and which have axially facing surfaces, an annular plate which lies against the said axially facing surfaces of the rotor disc and of the root portions of the blades, spaced circumferentially facing shoulders on said annular plate, an axially projecting circumferential land which is provided on the annular plate and which has radially outwardly and radially inwardly facing surfaces, the rotor disc having a radially inwardly facing surface which engages the said radially outwardly facing surface on the said land to center the annular plate, rings of angularly-spaced dogs on said annular plate and on said rotor disc respectively, the dogs on said annular plate being mounted behind the dogs on said rotor disc, at least one key which is trapped against circumferential displacement between a pair of rotor disc dogs, the rotor disc having a radially outwardly facing surface and the said key being trapped radially between the radially inwardly facing surface of said land and the radially outwardly facing surface of said rotor disc, and a bent tab on said key which engages between the said spaced circumferentially facing shoulders on the annular plate and which thus locates the annular plate circumferentially with respect to the rotor disc.

5. A rotor comprising a rotor disc having an axially facing surface at its periphery, a ring of blades having root portions which are mounted in said rotor disc at the periphery thereof and which have axially facing surfaces, an annular plate which lies against the said axially facing surfaces of the rotor disc and of the root portions of the blades, spaced circumferentially facing shoulders on said annular plate, an axially projecting circumferential land which is provided on the annular plate and which has radially outwardly and radially inwardly facing surfaces,

the rotor disc having a radially inwardly facing surface which engages the said radially outwardly facing surface on the said land to center the annular plate, rings of angularly-spaced dogs on said annular plate and on said rotor disc respectively, the dogs on said annular plate being mounted behind the dogs on said rotor disc, at least one key which has oppositely facing radially extending surfaces and which is trapped against circumferential displacement between a pair of rotor disc dogs, the rotor disc having a radially outwardly facing surface and the said key being trapped radially between the radially inwardly facing surface of said land and the radially outwardly facing surface of said rotor disc, and a bent tab on said key which engages between the said spaced circumferentially facing shoulders on the annular plate and which thus locates the annular plate circumferentially with respect to the rotor disc, said annular plate and said rotor disc respectively having opposed radially extending surfaces which bear against the oppositely facing radially extending surfaces on the key to trap the latter axially.

6. A rotor comprising a rotor disc having an axially facing surface at its periphery, a ring of blades having root portions which are mounted in said rotor disc at the periphery thereof and which have axially facing surfaces, an annular plate which lies against the said axially facing surfaces of the rotor disc and of the root portions of the blades, spaced circumferentially facing shoulders on said annular plate, an axially projecting circumferential land which is provided on the annular plate and which has radially outwardly and radially inwardly facing surfaces, the rotor dics having a radially inwardly facing surface which

engages the said radially outwardly facing surface on the said land to center the annular plate, rings of angularly-spaced dogs on said annular plate and on said rotor disc respectively, the dogs on said annular plate being mounted behind the dogs on said rotor disc, at least one key which has oppositely facing radially extending surfaces and which is trapped against circumferential displacement between a pair of rotor disc dogs, the rotor disc having a radially outwardly facing surface and the said key being trapped radially between the radially inwardly facing surface of said land and the radially outwardly facing surface of said rotor disc, a bent tab on said key which engages between the said spaced circumferentially facing shoulders on the annular plate and which thus locates the annular plate circumferentially with respect to the rotor disc, said annular plate and said rotor disc respectively having opposed radially extending surfaces which bear against the oppositely facing radially extending surfaces on the key to trap the latter axially, and end portions on said key which extend circumferentially on each side of said tab and which engage behind an adjacent pair of the rotor disc dogs.

References Cited in the file of this patent

UNITED STATES PATENTS

2,985,426	Hunter et al.	May 23, 1961
2,998,959	Haworth et al.	Sept. 5, 1961

FOREIGN PATENTS

699,582	Great Britain	Nov. 11, 1953
1,134,832	France	Dec. 10, 1956