April 5, 1960 J. A. C. HYDE 2,931,623

GAS TURBINE ROTOR ASSEMBLY

Filed May 2, 1957

FIG. 1

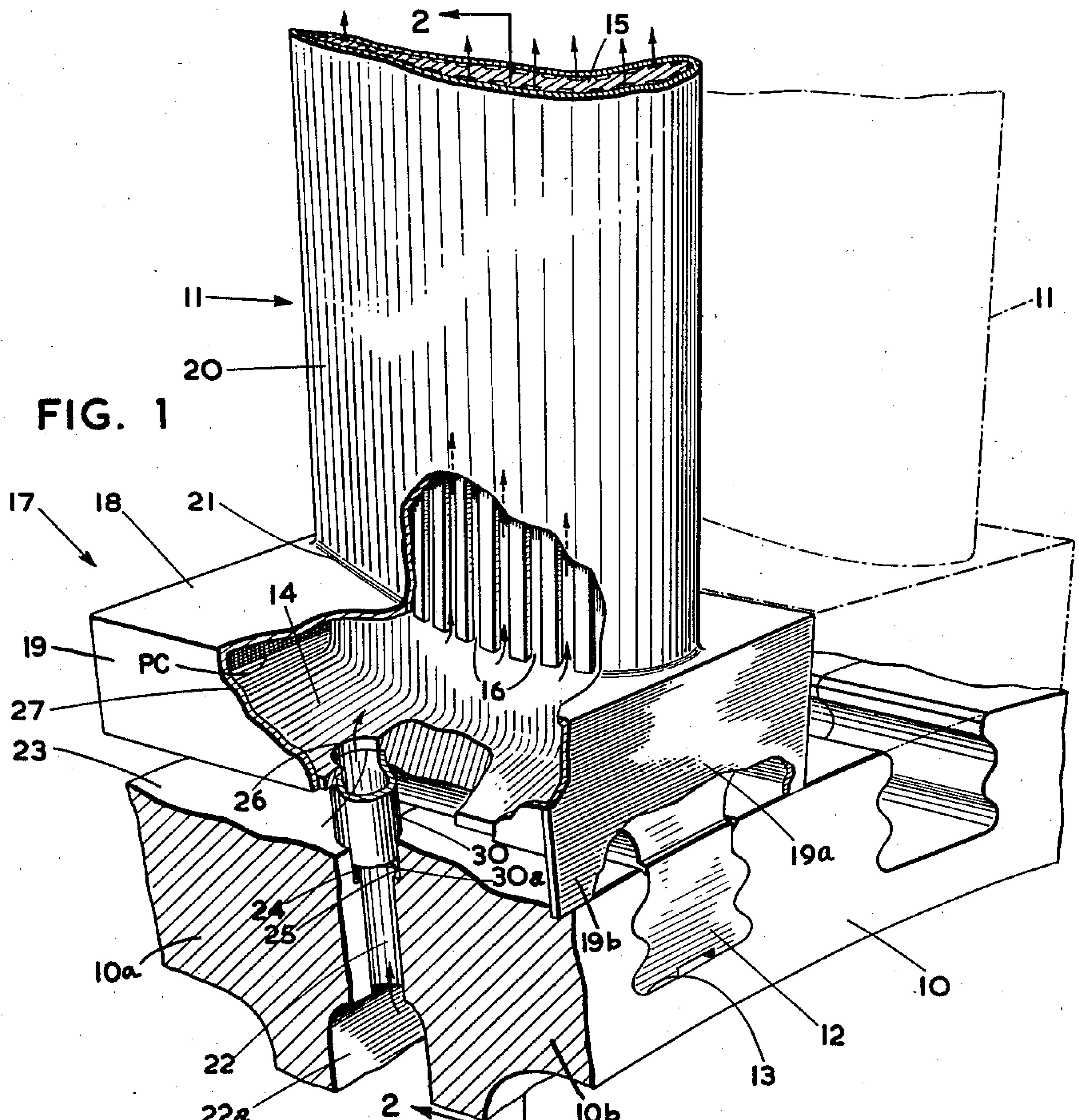
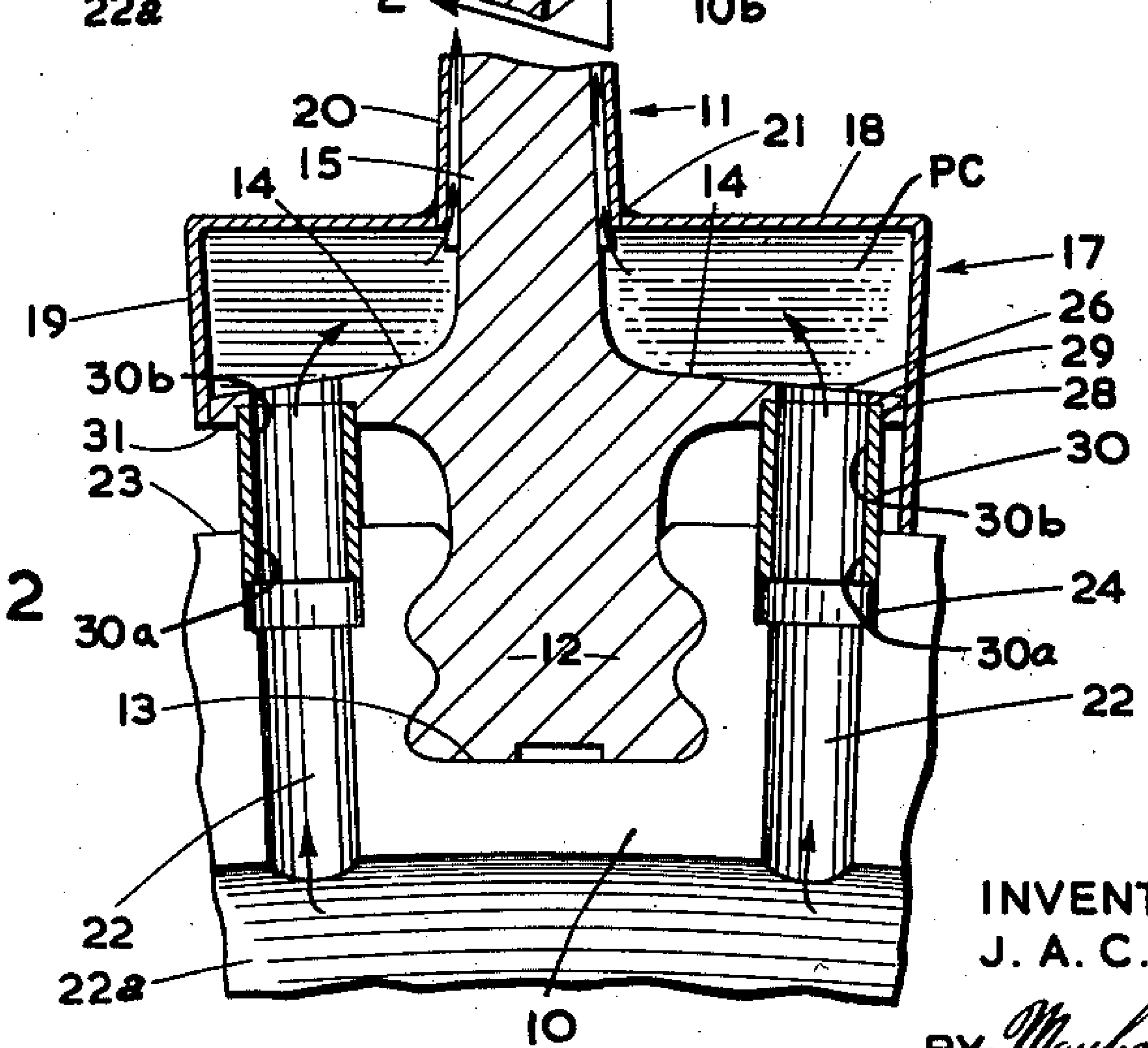


FIG. 2



INVENTOR
J. A. C. HYDE

BY Maybee & Legris
ATTORNEYS

United States Patent Office

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GAS TURBINE ROTOR ASSEMBLY

John Alan Courtney Hyde, Georgetown, Ontario, Canada, assignor to Orenda Engines Limited, Malton, Ontario, Canada, a corporation

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This invention relates to gas turbine rotor assemblies anć, in particular, to a gas turbine rotor assembly in which novel means are provided for conveying cooling air to the interior of a turbine blade provided with passages for cooling purposes.

The use of cooled gas turbine blades in gas turbine engines of the type commonly used to power jet propelled aircraft is now a well established practice due to the high temperatures which are encountered in the engine during operation.

The use of such cooled turbine blades, however, creates a number of problems in the design of the turbine rotor assembly. One of these problems is the provision of means to convey the cooling fluid, which is usually air, to the interior of the turbine blade where it may flow through the cooling passages provided within the blade. One method of solution which has been adopted by a number of manufacturers is to provide the blade root itself with a passage for the transmission of cooling air. Such a passage is difficult to machine and usually requires that the blade root be made somewhat larger than would otherwise be necessary since the passage in the blade root weakens it considerably and more material must be used to compensate for this factor. The use of more material may increase the over-all weight of the blade which, in itself, is an undesirable feature. Other methods which have been employed in an attempt to overcome the problems attendant upon the use of a passage within the blade root include the use of a root platform which is spaced from the periphery of the rotor disc upon which the blades are mounted to provide a plenum chamber between the rotor disc and the blade itself into which cooling fluid may be conducted and from which it may be led into the cooling passages within the blade without the necessity of weakening the blade root itself.

This method involves the disadvantage that it is necessary to seal the edges of the annular ring of root platforms to enclose the plenum chamber. As a result, additional weight is added to the rotor assembly which, again, is a disadvantage which it would be desirable to eliminate.

It is an object of the present invention to employ a construction in which the cooling air may be conducted from a gallery within the rotor disc to the interior of a hollow gas turbine blade without either a passage through the root of the blade or a fully enclosed, heavy plenum chamber beneath the root platform.

According to the invention, the gas turbine rotor assembly comprises a rotor disc having turbine blades mounted on and extending radially therefrom, each blade having a root platform spaced from the rotor disc, the root platform being hollow and constituting a plenum chamber in communication with cooling passages within the blade, a gallery for cooling fluid in the rotor disc having an opening beneath the root platform of each blade, an aligned opening in the radially inner surface of the root platform and means operable under the influence of centrifugal force to join the two openings with a substantially air-tight conduit.

Other advantages and objects of the invention will appear as the following detailed description proceeds. A preferred embodiment of the invention is illustrated in the accompanying drawings in which like reference numerals denote like parts in the various views and in which:

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Figure 1 is a partially cut away perspective view of a portion of a gas turbine rotor disc supporting a gas turbine blade, and

Figure 2 is a section taken along line 2—2 of Figure 1.

In Figure 1 a fragment of a gas turbine rotor assembly is shown. The rim **10** of the rotor disc supports gas turbine blades shown generally at **11**. The rim **10** of the rotor disc is, of course, supported by a structure which enables the rim **10** to rotate about an axis. Since this part of the structure forms no part of the present invention and is common knowledge, it is not described in detail. It may be noted, however, that the rotor is of the "split disc" construction, comprising two mating discs **10***a* and **10***b* in abutment near their periphery but separated by a space adjacent their centres.

Each gas turbine blade **11** is provided with a root portion **12** which is a snug sliding fit within a root slot **13** in the rim **10**, means being provided to lock the root portion **12** in the slot **13** when it is in the position shown in Figure 1. These means are also common knowledge in the art and, accordingly, are not shown in the drawing.

The gas turbine blade illustrated in the drawings accompanying this application is shown as having, in addition to the root portion **12**, a root platform **14** which extends laterally of the root on either side thereof and a central forged blade core **15** which is provided with grooves **16** cut in its external surface in a direction parallel to the longitudinal axis of the blade core.

A sheet metal casing **17** is provided with an upper wall **18** having an aperture through which the blade core **15** protrudes and having side walls **19** which depend from the free edges of the upper wall **18** and which are secured to the edges of the root platform **14** by brazing or other suitable means. A blade skin **20** is provided around the forged blade core **15** to enclose the grooves **16** to define passages for cooling fluid, the lower end of the skin **20** being brazed, welded or similarly secured to the upper wall **18** of the casing at **21**. Brazing, welding or similar means of securing are employed to fix the side walls **19** of the casing **17** to the edges of the root platform **14**. Accordingly, it will be seen that the casing **17** defines, in conjunction with the root platform **14**, a plenum chamber PC which is in communication with the grooves **16** in the blade core **15** so that cooling air in the chamber PC has free access to the cooling passages **16** within the blade skin **20**.

A plurality of first passages are provided in the rim **10** of the rotor disc, one on either side of each root slot **13** as may be seen in Figure 2, the passages being cylindrical and each having its axis lying along a radius of the rim **10**. Since each passage **22** is similar to each other such passage and since all the structure associated with each passage is similar to the structure associated with each other passage, the description will proceed with reference to only one such passage and associated structure. The end of the passage **22** adjacent the periphery **23** of the rim **10** is enlarged at **24** to provide an enlarged diameter, the shoulder **25** separating the portion **24** from the passage **22** constituting a stop for a purpose which will be later described. The other end of passage **22** is in communication with a gallery **22***a* which lies within the rotor rim **10** and which is constituted by the space separating the two sections of the "split disc" rotor. This gallery or space is in communication with a source of cooling air.

Coaxial with the first passages **22** are a plurality of second passages **26** in the radially inner surface **31** of the root platform **14**, the end of the passage **26** adjacent the passage 22 being similarly enlarged at 28 to provide a larger diameter portion, the shoulder 29 separating the passage 26 from the enlarged portion 28 constituting a second stop for a purpose which will subsequently be described.

A tube 30 which is freely slidable in the enlarged portion 24 of passage 22 is positioned therein, the tube 30 being of a length which is greater than the separation between the radially inner surface 31 of the root platform 14 and the periphery 23 of the rotor rim 10. The tube 30 has an external dimension which, as mentioned above, is a sliding fit within the enlarged portions 24 and 28 of passages 22 and 26 which are of equal diameter and has an internal dimension equal to the diameter of the passages 22 and 26 which are also of equal diameter. Hence, when the tube 30 is in the position shown in Figures 1 and 2 it constitutes a substantially air-tight conduit between the plenum chamber 27 and the passage 22 which is in communication with a gallery 22*a* within the rim 10 of the rotor disc.

The distance between the periphery 23 of the rim 10 and the shoulder 29 separating the portions 26 and 28 of the passage 26 in the root platform 14 is less than the length of the tube 30 but the distance between the radially inner surface 31 of the root platform 14 and the shoulder 25 separating portions 24 and 22 of the passage 22 in the rotor rim 10 is greater than the length of the tube 30.

Having now set forth the structure which embodies the present invention, the mode of operation will be described.

Assuming the rotor rim 10 and the associated structure to be stationary and not revolving, and the axis of the rotor to be horizontal, the tubes 30 near the top of the rotor will occupy a position in which the end 30*a* of the tube will be in abutment with the shoulder 25 due to gravitational forces. Since the distance between the shoulder 25 and the radially inner surface 31 of the root platform 14 is greater than the length of the tube, the end 30*b* of the tube will be completely free and clear of the root platform and, hence, the blades 11 can be readily removed from the rotor rim by sliding it in a direction axially relative to the rotor rim 10 and in the sense of the leading edge of the blade to remove the root 12 from the slot 13. As the rotor is moved to position successive blades above the axis of rotation, the tubes 30 associated with such blades will drop into the drillings 24 and thereby free these blades for removal. The presence of portion 19*b* of side wall 19*a* of the casing prevents the removal of the blade in a direction axially of the rotor and in the sense of the trailing edge. This portion 19*b* is necessary to form a barrier for the motive fluid in the turbine which could otherwise bypass the blades by flowing between the rim 10 and the root platform 14 of the blades.

When the rotor rim 10 is rotating, however, centrifugal forces will be set up within the rotating mass and, as a result, tube 30 will move in a direction radially outwardly of the rotor rim 10 and the end 30*b* of the tube 30 will enter the bore 28 in the root platform until the end 30*b* of the tube 30 is in abutment with the shoulder 29 separating portions 26 and 28 of passage 26. In view of the fact that the length of the tube 30 is greater than the distance between shoulder 29 and the periphery 23 of the rim 10, the end 30*a* of the tube 30 will remain within the enlarged portion 24 of the passage 22 even though the end 30*b* is in abutment with shoulder 29. Thus, when the rotor rim 10 is revolving as is the case when the engine is in operation the tube 30 will constitute a substantially air-tight conduit between the gallery 22*a* in the rim 10 and the plenum chamber 27 defined by the root platform 14 and the sheet metal casing 17 surrounding it. As a result, cooling air may follow the flow paths indicated by the arrows in Figures 1 and 2 to provide cooling means for the blade.

The structure which has been disclosed in the specification and illustrated in the drawings provides means for supplying cooling air to the interior of a gas turbine blade without the necessity of providing a passage through the root of the blade and without the provision of enclosing members to enable the space between the lower surface 31 of the root platform and the periphery of the rim 23 to define a plenum chamber in this location. As a preferred construction the plenum chamber is integral with and carried by the blade in a manner which can be done with a considerable saving in weight.

In addition, a positive sealing arrangement has been provided to conduct the cooling air from the gallery 22*a* within the rim 10 to the passages in the turbine blade which means will still permit individual blade removal without disassembling any of the cooling conduits.

While the invention has been disclosed and described in detail in the form of a single preferred embodiment it is to be understood that this embodiment is considered to be illustrative of the invention rather than limiting and minor modifications may be made in the construction and arrangement of parts without departing from the spirit of the invention or the scope of the appended claims.

What I claim as my invention is:

1. A gas turbine rotor assembly comprising a rotor disc in which there is provided an annular cavity in communication with a source of cooling fluid, a rim on the rotor disc, the rim having a plurality of circumferentially spaced, axially aligned slots cut therein, a blade mounted in each slot by means of a root portion adapted to be inserted in the slots in an axial direction, cooperating abutments on the sides of the slots and the roots to maintain the blades and the rim against relative radial movement, a root platform on each blade extending laterally from each side thereof and spaced from the rotor disc rim in a radial direction, a sheet metal casing surrounding the root platform on the side thereof remote from the rim of the rotor disc and having a radially outer wall spaced from the root platform and having side walls, the radially outer wall and the side walls, in conjunction with the root platform, defining a plenum chamber, cooling passages within the blade and in fluid communication with the plenum chamber, first passages in the root platform radially aligned of the rotor disc, one on each side of the blade, each first passage communicating between the plenum chamber and the space between a root platform and the rim of the rotor disc, second passages in the rim of the rotor disc radially aligned of the rotor disc and aligned with the first passages, each second passage communicating between the space between the rim of the rotor and a root platform at one end and, at the other end, with the annular cavity in the rotor disc, one second passage on each side of each slot and conduit means slidably associated with each pair of first and second passages, the conduit means being movable under the influence of gravity when the rotor is stationary to a first position within the second passages and out of engagement with the first passages to permit withdrawal of the blades from their slots and movable to a second position under the influence of centrifugal force when the rotor is rotating to extend from the second passages into and in engagement with the first passages to join the two passages with a substantially air-tight conduit thereby establishing fluid communication between the annular cavity in the rotor disc, the plenum chamber and the cooling passages within the blade.

2. A gas turbine rotor assembly as claimed in claim 1 in which the conduit means includes a tube of a length greater than the distance from the rim of the rotor disc to the adjacent, radially inner surface of the root platform and in which stop means are provided in the first and second passages to limit the movement of the tube under the influence of gravity and centrifugal force.

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