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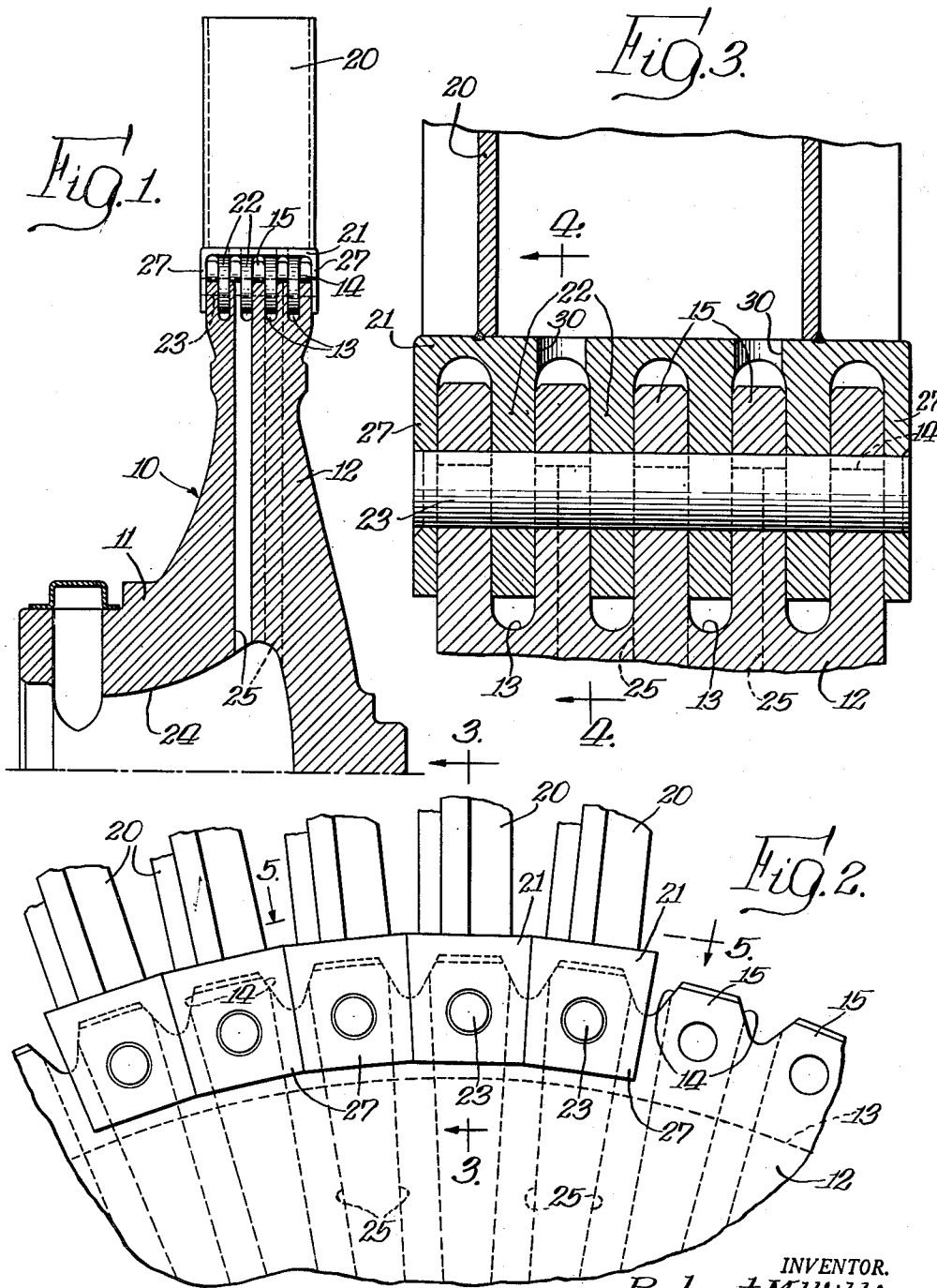
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2,625,366

TURBINE ROTOR CONSTRUCTION

Filed Nov. 18, 1948

2 SHEETS—SHEET 1



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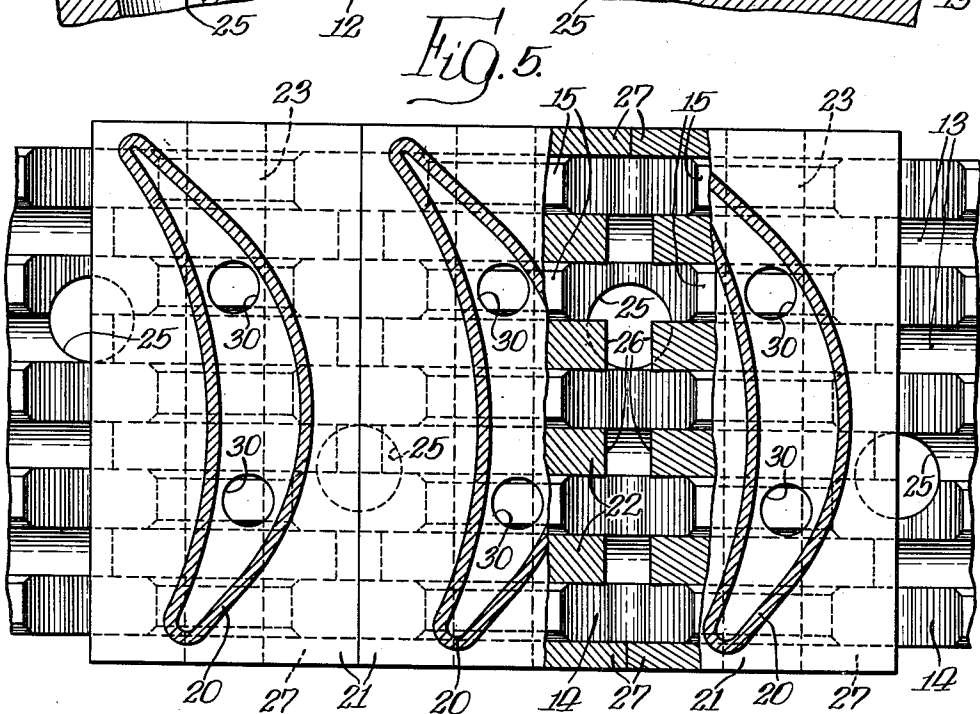
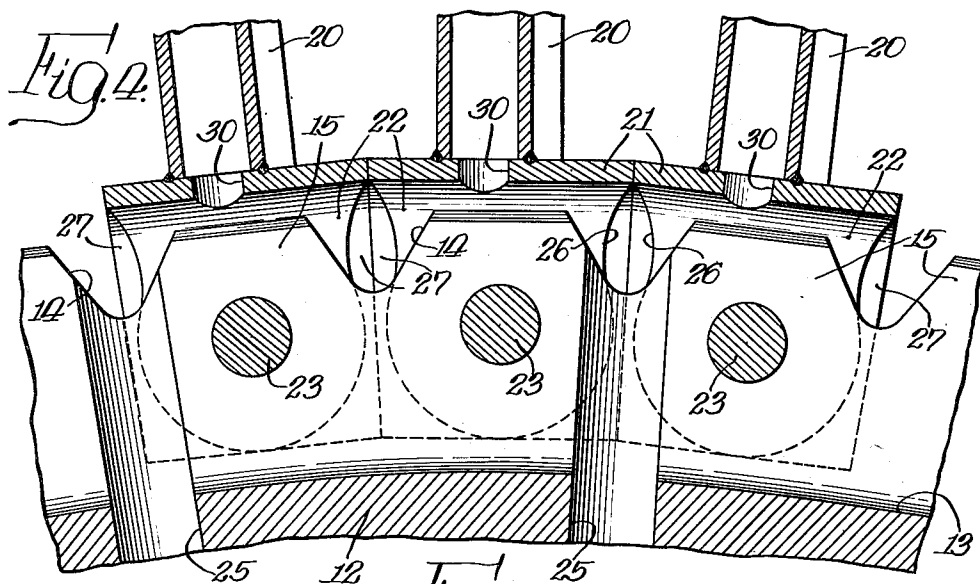
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2 SHEETS—SHEET 2



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TURBINE ROTOR CONSTRUCTION

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6 Claims. (Cl. 253—39.15)

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The invention relates generally to turbine rotors and more particularly to a rotor construction for a gas turbine.

The general object of the invention is to provide a novel turbine rotor of the foregoing character, having individually mounted blade members, and in which cooling by air is provided not only for the blade sections of the members but also for the base or attaching sections of the members.

Another object is to provide a novel turbine rotor for a gas turbine, which comprises a rotor body and a plurality of hollow blade members individually mounted thereon, and in which air for cooling the blade sections of the members may first be circulated in and around the base or attaching sections of the members to prevent excessive heating thereof by heat conducted from the blade sections.

Other objects and advantages will become apparent from the following description taken in connection with the accompanying drawings, in which:

Figure 1 is a sectional view, on a reduced scale, taken along the axis, of a turbine rotor construction embodying the features of the invention, and showing one of the blades in side elevation.

Fig. 2 is a fragmentary face view of the upstream face of the rotor shown in Fig. 1.

Fig. 3 is a fragmentary sectional view taken on the line 3—3 of Fig. 2.

Fig. 4 is a fragmentary sectional view taken on the line 4—4 of Fig. 3.

Fig. 5 is a fragmentary sectional view taken on the line 5—5 of Fig. 2, with certain portions of the structure broken away.

The present turbine rotor construction contemplates the use of a rotor body having mounted on its periphery a plurality of individually attached blade members. The problem of attaching such blade members to the rotor body requires careful consideration of the stresses involved because of the high speed at which a rotor of this character operates and because of the high temperatures to which the blades are subjected during such operation. The high-speed operation, of course, results in high centrifugal stresses on each blade and its attaching means, as well as other stresses due to the force of the gas of the power stream acting against the faces of the blades. The high temperature of the gases of the power stream results in heating of the blade members so that the safe working stress of the metal thereof is substantially reduced.

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A construction which has been frequently used for securing the blade members to the rotor body is to provide interfitted portions on the base of each blade and on the periphery of the rotor body, which are secured together by a pin extending generally parallel to the axis of the rotor. Such pin and the interfitted portions, of course, transmit the stresses on the blade member to the rotor body, so that the strength of the pin and interfitted portions is rather critical. It is also common practice to provide hollow blades so that a stream of cooling air may be forced there-through to maintain them at a temperature substantially below the temperature of the gases of the power stream so that the metal of the blades will operate at a sufficiently high tensile strength to meet the requirements.

The present invention contemplates a construction whereby the stream of cooling air that passes through the blade portions is first circulated around the interfitted portions of the blade members and rotor body so that such portions are prevented from becoming excessively heated by heat conducted from the blade section. The pin type of attachment for blades at best approaches the margin of safety and can only be tolerated when the safe working stress of the metal in the attaching portions is at an optimum. Consequently, it is highly desirable to cool the metal of the attaching portions so as to provide a safe working stress for the metal thereof. In the present instance, the rotor body and the base section of each blade member are provided with interfitted tangs pinned to each other and so proportioned that a stream of cooling air, which is eventually discharged through the blade members, is first circulated around the tangs to remove heat therefrom and maintain them at a relatively low operating temperature.

The rotor construction disclosed in the drawings, and constituting one embodiment of the invention, includes a rotor body, indicated generally at 10 (see Fig. 1). The rotor body 10 is shown as comprising a hub portion 11 and a flange portion 12. The flange portion 12 is provided with a plurality of circumferentially extending grooves 13 and a plurality of intercepting axially extending grooves 14 which together provide circumferentially spaced sets of axially spaced tangs 15.

A plurality of blade members are mounted on the periphery of the flange portion 12 of the rotor body, with each blade member comprising a blade section 20 and a base section 21. The base section 21 has formed on its inner surface a plurality of axially spaced tangs 22 which interfit

with the tangs 15 on the periphery of the rotor body. To secure the two sets of tangs together, a pin 23 is inserted axially therethrough. The pins 23 as well as the tangs 15 and 22 thus sustain the stresses which are exerted on the blade members by the centrifugal force and the forces exerted by the power stream.

Because of the fact that a pin and tang type of connection between a blade member and a rotor body at best approaches the margins of safety, the blade sections 20 are hollow so as to reduce the weight thereof, and this characteristic of the blade sections permits a stream of cooling air to be discharged therethrough so that the metal of the blade sections may operate at a lower temperature. The air discharged through the blade sections 20 may be supplied from an air supply chamber or cavity 24 (see Fig. 1) formed in the hub 11 of the rotor body. Extending from the air supply chamber 24 is a plurality of radially extending air passages 25 provided in the flange portion 12 of the rotor body. In the present instance, the radial passages 25 are in a staggered relation, as is clearly apparent in Figs. 1, 3 and 5, so that they will not be too close together at their inner ends and thus weaken the rotor body.

The base section of each blade member and the forming of the periphery of the rotor body are such as to provide for the flow of air from the radial passages 25 to the interior of the blade sections 20. In the present instance, the cooling air in passing from the radial passages 25 to the blade sections is circulated around the tangs 15 and 22 so as to carry away heat therefrom and permit them to operate at a safe working stress. To this end, the spacing of the blades is such in relation to the peripheral width of the tangs 22 that the air supplied by the radial passages 25 may circulate freely in the grooves 14 across the entire peripheral face of the rotor body. Thus, as will be noted in Figs. 4 and 5, the tangs 22 on one blade member are spaced from the tangs on the adjacent blade member, as indicated at 26, so that the air discharged from the outer ends of the radial passages 25 freely circulates in the grooves 14 throughout the length thereof. To provide for further circulation of the cooling air about the tangs, it will be noted in Figs. 3 and 4 that the tangs 22 are of lesser depth than the grooves 13 while the tangs 15 are of lesser length than the depth of the spaces in the base section 21 between the tangs 22. Thus, the air circulating in the grooves 14 may pass circumferentially over and around the edges of all of the tangs (including both the tangs 15 and the tangs 22) so that the tangs will all be cooled by the air stream.

To control the flow of the air and prevent it from passing out at the base of the blade members, the base sections of the blades are so dimensioned as to contact one another edgewise and thus jointly cover the periphery of the rotor body. The ends of the grooves 14 in the rotor body are closed by segmental flanges 27 extending radially inwardly from the base sections 21 and contacting one another so as to provide a complete closure at the two faces of the rotor body. To discharge the air through the blade sections 20 after it has circulated around the edges of the tangs, a pair of apertures 30 is provided in each base section 21 to open into the interior of the blade section 20. The apertures 30 are substantially centered over two of the tangs 15 on the rotor body so that the air, in passing from the grooves 14 to the interior of the blade section is forced through the space over the

outer edges of the tangs 15 in passing to the apertures 30.

With the foregoing construction, the stream of cooling air which is utilized to cool the blade sections 20 of the blade members is thus first circulated around the edges of the attaching tangs of the blade members and rotor body. The inter-fitting tangs and connecting pins for the blade members are thus prevented from becoming overheated and will operate at a safe working stress.

I claim:

1. A rotor for a gas turbine, comprising a rotor body having a plurality of circumferentially extending grooves in its periphery and a plurality of intercepting axially extending grooves providing a plurality of sets of axially spaced tangs, a plurality of blade members individually mounted on the periphery of the rotor body, each blade member comprising a hollow blade section and a base section having a plurality of grooves and tangs interfitted with the tangs and circumferentially extending grooves on the rotor body, and a pin for each blade member extending axially through the interfitted tangs to secure the blade member to the rotor body, said rotor body having a plurality of radially extending air supply passages opening into said axially extending grooves to circulate cooling air in and around the tangs, and said base section being apertured to discharge the cooling air through the blade section.

2. A rotor for a gas turbine, comprising a rotor body having a plurality of circumferentially extending grooves in its periphery intercepted by a plurality of axially extending grooves thereby providing a plurality of sets of tangs, said rotor body having passages for supplying air to said grooves, and a plurality of blade members each comprising a hollow blade section and a base section having grooves providing axially spaced tangs fitting within said circumferentially extending grooves and pinned to one of said sets of tangs and said one set of tangs fitting within the grooves of the base section, the circumferentially extending grooves in the rotor body and the grooves in the base sections being deeper than the tangs whereby said air may circulate around the edges of all of the tangs to cool them, the base sections having apertures for discharging the air through the blade sections.

3. A rotor for a gas turbine comprising a rotor body having a plurality of circumferentially spaced sets of tangs and having passages for supplying air to the spaces between said sets, a plurality of blade members each comprising a hollow blade section and a base section having a set of tangs in face-to-face engagement with the tangs of one of said sets on the rotor body, and a pin for each blade member extending through the tangs thereof and the tangs on the rotor body and holding the tangs of both sets out of edgewise engagement whereby the air supplied to said spaces may freely circulate around the edges of all of the tangs, each base section being apertured to discharge the air through the blade section.

4. A rotor for a gas turbine comprising a rotor body, and a plurality of blade members each comprising a hollow blade section and a base section, the rotor body and each base section both having interfitted tangs and grooves pinned together, the grooves in both the rotor body and base section being deeper than the interfitted tangs, and the rotor body having grooves intercepting the first-mentioned grooves and having passages for supplying air to the intercepting grooves, whereby air is circulated around the

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edges of the tangs of both the rotor body and the base section, each base section being apertured to discharge the air through the blade section.

5. A rotor for a gas turbine comprising a rotor body having a plurality of circumferentially spaced sets of tangs, and a plurality of blade members each comprising a hollow blade section and a base section having a plurality of tangs interfitting with and secured in face-to-face relation to one of said sets of tangs on the rotor body and holding the base section outwardly spaced from the edges of the tangs on the rotor body, the rotor body having passages for supplying air to the spaces between the sets of tangs, and each base section being radially apertured to provide communication from the spaces between the base section and the tangs on the rotor body to the interior of the blade section whereby air from said passages will flow over the edges of the tangs on the rotor body and thence outwardly through the blade section.

6. A rotor for a gas turbine comprising a rotor body having a plurality of circumferentially spaced sets of tangs, and a plurality of blade members each comprising a hollow blade section and a base section having a plurality of tangs interfitting with and secured to one of said sets of tangs on the rotor body and holding the base

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section outwardly spaced from the edges of the tangs on the rotor body, the rotor body having passages for supplying air to the spaces between the sets of tangs, and each base section having a pair of axially spaced radial apertures for conducting air from two of the spaces between the base section and the edges of the tangs on the rotor body outwardly to the interior of the blade section.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,362,074	Baumann	Dec. 14, 1920
2,141,401	Martinka	Dec. 27, 1938
2,220,420	Meyer	Nov. 5, 1940
2,241,782	Jendrassik	May 13, 1941
2,326,145	Kroon	Aug. 10, 1943
2,364,189	Buchi	Dec. 5, 1944
2,401,826	Halford	June 11, 1946

FOREIGN PATENTS

Number	Country	Date
345,984	France	Nov. 8, 1904
611,650	Great Britain	Nov. 2, 1948