Nov. 4, 1947. A. J. PHELAN ET AL 2,430,140

TURBINE BLADE AND MOUNTING

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Fig. 1.

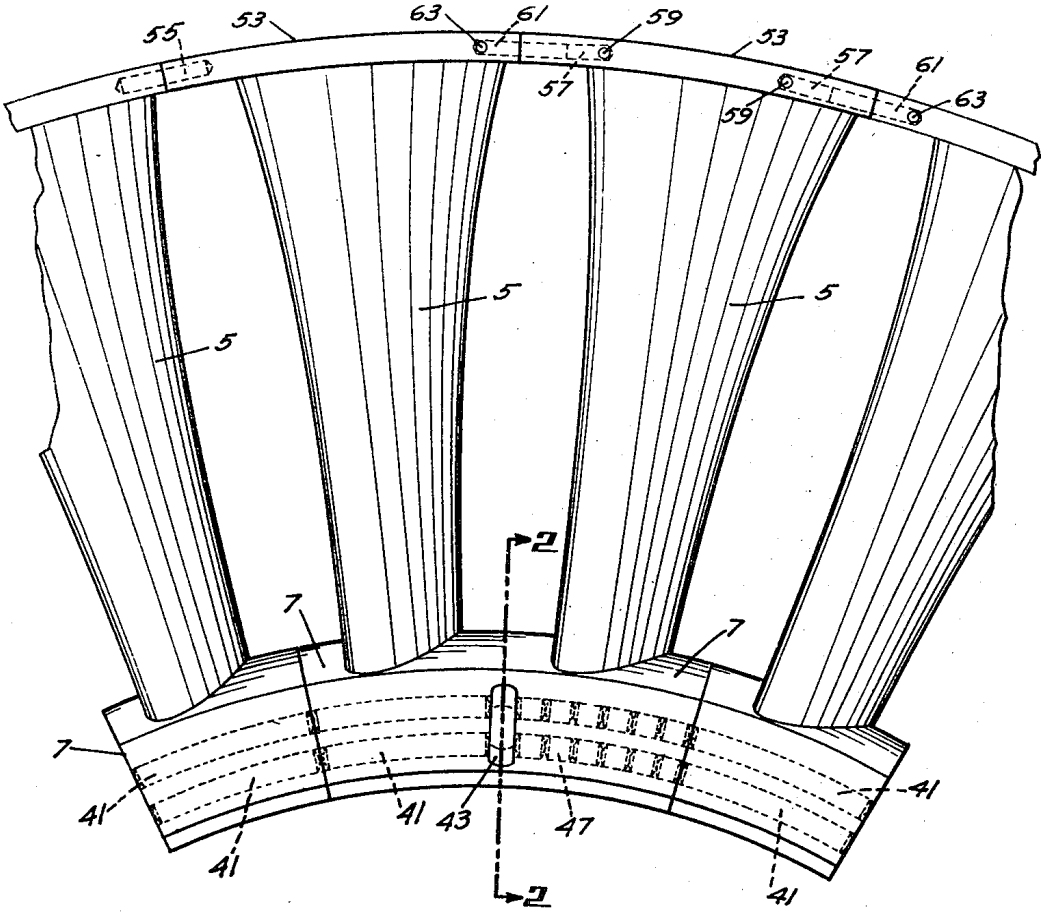

Fig. 4.

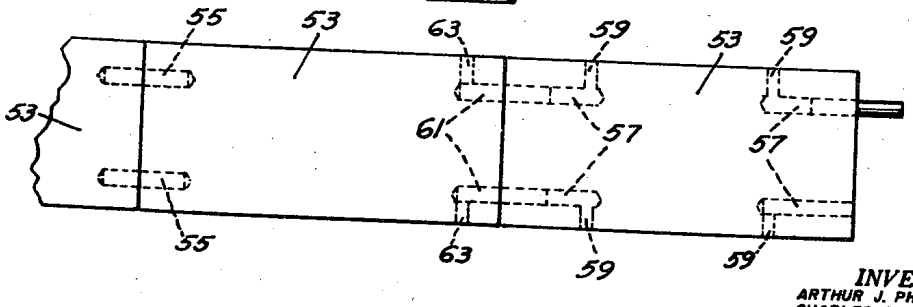

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Fig. 2.

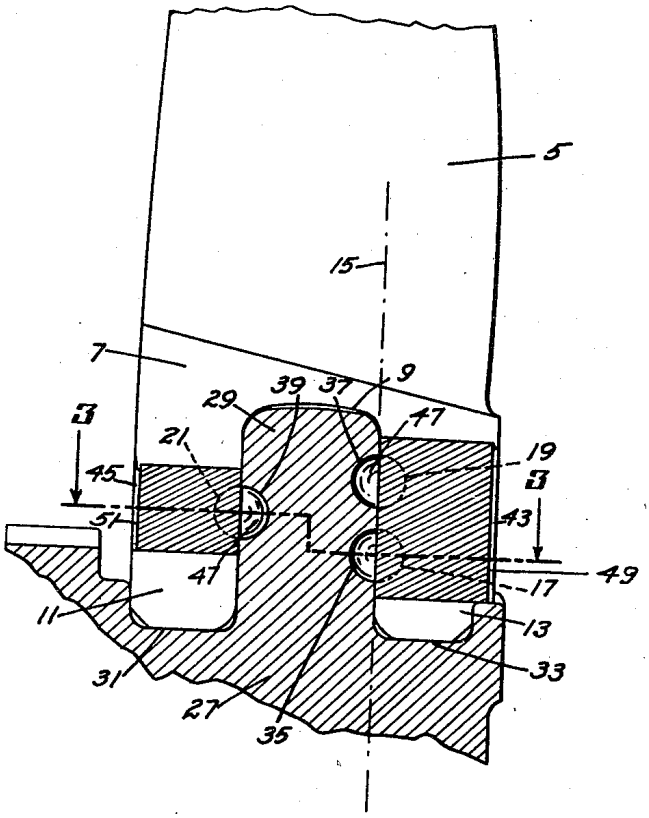
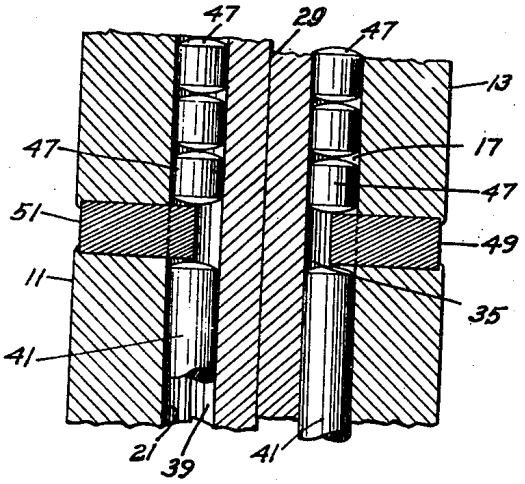


Fig. 3.



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TURBINE BLADE AND MOUNTING

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2 Claims. (Cl. 253—77)

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Our invention relates to turbines and more particularly to the blades and the manner of mounting the same to the rotor or stator frame of a turbine.

Turbines, and gas turbines in particular, are constructed with a minimum of clearance between the rows of blades on the rotor frame and those on the stator frame. The individual blades are customarily mounted in undercut grooves formed in the turbine components, such as the rotor and stator frames. The assembling of such blades presents a rather tedious operation, in that they must be assembled individually by inserting each blade at an open point in the undercut groove and then urging it along the groove until the blade reaches its final position in the assembly in contact with the previously assembled baldes. Added to the problem of assembling the blades, the prior art construction referred to, has led to other difficulties. At the speed at which gas turbines operate, many factors come into existence tending to stress the blades, to the end that such blades in time are loosened at their base sections where anchored to the rotor or stator frame, and a certain amount of rocking of the blades results. The point at which rocking occurs, varies from blade to blade, thus imparting to such blades differing resonant frequencies. The normal minimum clearance between rows of blades in a turbine of this type, however, will not permit excessive rocking of the blades in their mountings, and after a period of time it becomes inevitable that the blades when set in vibration at their resonant frequencies will not only become highly stressed, particularly at the base sections, but such blades will ultimately clash with the blades of adjacent rows and cause a breakdown, which will necessitate rebuilding of the entire machine.

The removal of the blades, like the assembling thereof, is a rather difficult job inasmuch as the blades must be removed in the reverse order in which they have been assembled and this means that the blades must be urged individually along the undercut groove to the point of removal. Such dismantling operation is further complicated by the fact that the individual blades after they have been urged to their final positions, are usually wedged into tight engagement with the walls of the undercut groove by wedge elements between the base section of each blade and the component of the turbine to which the blade is mounted.

Among the objects of our invention are:

(a) To provide novel and improved means of assembling rotor and stator blades in a turbine.

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(b) To provide novel and improved turbine blades which will facilitate and improve the assembling of the same to a rotor or stator frame of a turbine.

(c) To provide a novel and improved turbine blade assembly in which the blades are solidly anchored against the effects of forces developed during normal operation of a turbine.

(d) To provide a novel and improved turbine blade and anchoring means for simplifying the assembling and disassembling of the blades.

Additional objects of our invention will be brought out in the following description of the same, taken in conjunction with the accompanying drawings wherein:

Fig. 1 is a fragmentary view in elevation depicting certain features of our invention relating to the anchoring of the last blade to be assembled to the rotor frame of a turbine;

Fig. 2 is a view in section along the line 2—2 of Fig. 1 and illustrating the manner of assembling the last blade in position;

Fig. 3 is a view in section along the line 3—3 of Fig. 2;

Fig. 4 is a plan view of the shroud portion of Fig. 1.

In the drawings, we have illustrated a preferred form of our invention as applied to the assembling of the blades to a turbine rotor frame, it being understood, of course, that the underlying principles of our invention are equally as well applicable to the mounting of the blades to the stator component of a turbine.

Each blade comprises a working section 5 and a base section 7. The base section is provided with a deep groove 9 in the bottom end thereof to form a pair of spaced depending legs 11 and 13. The side walls of the groove 9 in the end of the base section are provided with locking pin receiving grooves of substantially semi-circular cross-section and where the particular blade is of airfoil cross-section, the groove 9 in the end of the base section is so dimensioned that one of the side walls coincides with or lies near a longitudinal line 15 through the center of gravity of the blade, and that particular side wall of the groove will have more locking pin grooves than the opposite side wall. In the specific embodiment of our invention as disclosed in Fig. 1, a pair of locking grooves 17 and 19 are formed in one side wall of the base section groove 9 whereas only a single locking pin groove 21 is provided in the opposing side wall.

The rotor frame 27 is provided with a peripheral mounting rib 29 for the blades, this rib being

bounded on either side by a channel 31 and 33. The dimensions of the rib 29 and mounting channels 31 and 33 are such as to enable the blades to snugly fit over and straddle the rib with the legs 11 and 13 entering and closely fitting into the mounting channels 31 and 33 respectively. The rib is provided in its side walls with locking pin grooves, 35, 37 and 39, complementary to the locking pin grooves, 17, 19 and 21 in the base section of the blade.

In assembling a blade, it is applied radially into straddling engagement with the rib at the position it is to occupy on the rotor frame. The complementary locking pin grooves then form cylindrical passages for the reception of locking pins 41 which when driven into these passages, serve to lock the blade to the rib and prevent its removal therefrom. The pins 41 are preferably of a length equal to the length of the base section 7, with their ends tapered or rounded to facilitate insertion into position, and are arcuate in form to conform to the curvature of the passages provided by the locking pin grooves.

The above discussed procedure for assembling a blade to the rotor frame will be repeated in connection with each blade except the last blade to be mounted on that particular rib. In assembling this last blade in the row, to the rotor frame, a departure from the above described method of assembling blades must be resorted to.

In this connection, a side opening 43 is provided at the junction of the base section of the last blade and base section of the preceding blade, such opening being of a depth sufficient to expose the grooves 35 and 37 in the mounting rib 29. A corresponding opening 45 is also provided on the opposite side of the base sections of the last blade and preceding blade. Through these openings, short anchor pins 47 preferably having beveled or rounded edges, are inserted one at a time and then driven laterally into the locking pin passages of the last blade by means of a sharp wedge-shaped tool, until such passages are filled, at which time snugly fitting plugs 49 and 51, respectively, are driven into the openings 43 and 45 and retained therein by peening over the adjacent metal of the base sections of both the last blade and the preceding blade.

It will be obvious from the above described means and method of assembling blades, that such means and method can be employed in the assembling of blades having free peripheral ends. In many cases, however, it is desirable that the peripheral ends of the blades be tied together, as for example, to form a shroud. One such method involves the termination of each blade in a shroud segment 53 which is adapted to abut the shroud segment of the adjacent blade on either side thereof during assembling, and tying the shroud segments together by anchoring pins 55 therein which bridge the abutting ends of the segments.

Adapting this general procedure to the assembling of the last blade in accordance with the present invention, we provide anchoring pin holes 57 in the ends of the shroud segment to a depth slightly greater than the length of the anchoring pins to be employed, and lateral connecting openings 59 at the inner ends of such anchoring pin holes.

In the opposing ends of the shroud segments of the adjacent blades, we provide correspondingly located anchoring pin holes 61 to a depth approximately equal to half the length of the anchororing pins to be utilized.

Prior to assembling the last blade to the mounting rib, anchoring pins are inserted into the shroud segment thereof to a depth which will leave the pins flush with the ends of the shroud segment. After the last blade has been assembled to the mounting rib as previously described, fluid under high pressure is forced into the lateral connecting openings 59 to drive the shroud anchoring pins into the shroud segments of the adjacent blades.

To provide relief for trapped air in the anchoring pin holes of the segments of the adjacent blades, as well as for such fluid as may escape past the pins during the application of the high pressure fluid thereto, we provide leak openings 63 through the side edges of the adjacent shroud segments and connecting with the inner ends of the shroud anchoring pin holes in such segments.

Following the driving of the shroud anchoring pins to their final positions, a ball pointed tool is applied to collapse or constrict the hole behind each pin just sufficiently to prevent the pin from working out. This leaves slight impressions in the outer face of the shroud segment of the last blade, but this is removed in the final machining operation on the shroud.

While we have shown only one mounting rib in the drawing, it is understood that there will be as many mounting ribs as there are rows of blades on the rotor, and that these rows will be interspersed with rows of blades of the associated stator of the machine.

In the event that the blades are of the type wherein the center of gravity lies on the longitudinal axis of the blade, the number of locking pins on either side of the mounting ribs will preferably be the same, and in most cases need not exceed one.

Our invention results in very solidly anchored blades. The construction is such as to discourage rocking of the blades, thereby prolonging the life of a machine beyond what might be expected for prior constructions, wherein the blades are mounted in undercut grooves. As also previously pointed out, the assembling of the blades has been considerably simplified by the fact that they are applied radially, and therefore can be assembled directly to their positions on the frame. Thus, it is apparent that our invention fulfills the objects thereof as outlined previously, and while we have disclosed a preferred embodiment of our invention, it is apparent that the same may be subject to change or alteration without departing from the principles thereof, and we accordingly do not desire to be limited in our protection to the specific details disclosed, except as may be necessitated by the appended claims.

We claim:

1. In combination, a circular blade carrying component of a turbine or the like, a peripheral rib encircling said component and having parallel flat side walls with semicylindrical locking pin grooves in the side walls thereof, a plurality of blades each including a base section having a rib engageable groove in the bottom end thereof and complementary semi-cylindrical locking pin grooves in the side walls of said rib engageable groove, said blades being mounted in straddling engagement with said rib, and a plurality of cylindrical locking pins in the passages formed by said complementary locking pin grooves.

2. In combination, a circular blade carrying component of a turbine or the like, having a peripheral rim section, a turbine blade having a base section, one of said sections having a ra-

dially projecting rib with parallel flat side walls and circumferentially extending locking pin grooves formed therein, the other of said sections having a rib engageable groove with complementary locking pin grooves formed in the side walls thereof, said blade being mounted on said blade carrying component with said rib in said rib engageable groove, and locking pins in the passages formed by said complementary grooves.

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