July 30, 1957 B. J. TERRELL ET AL 2,801,076

TURBINE NOZZLES

Filed Sept. 8, 1953 2 Sheets-Sheet 1

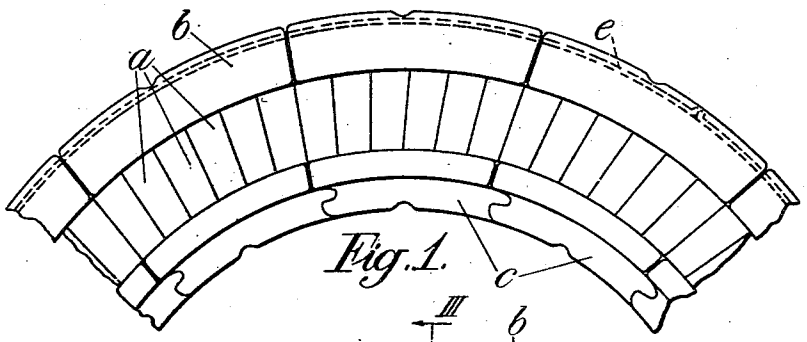

Fig. 1.

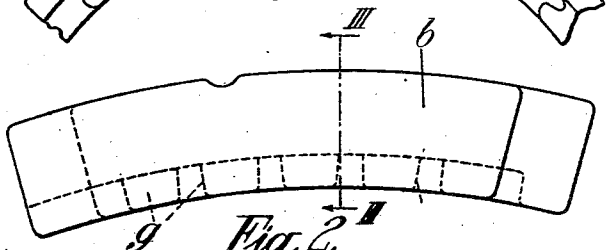

Fig. 2.

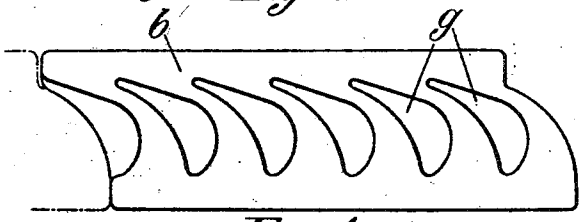

Fig. 4.

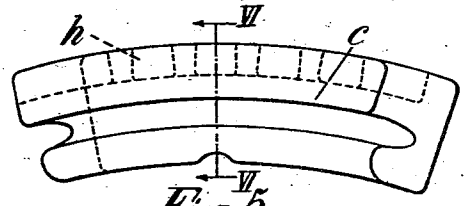

Fig. 5.

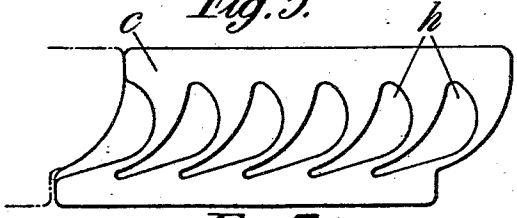

Fig. 7.

July 30, 1957 B. J. TERRELL ET AL 2,801,076

TURBINE NOZZLES

Filed Sept. 8, 1953 2 Sheets-Sheet 2

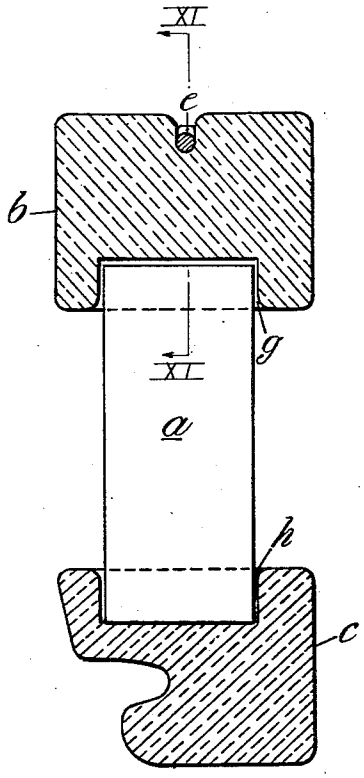

Fig. 8.

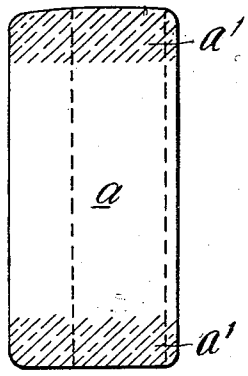

Fig. 9.

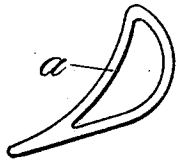

Fig. 10.

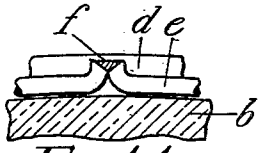

Fig. 11.

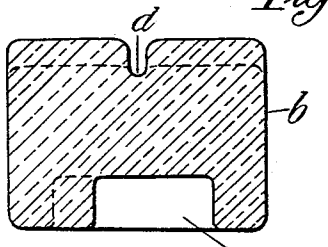

Fig. 3.

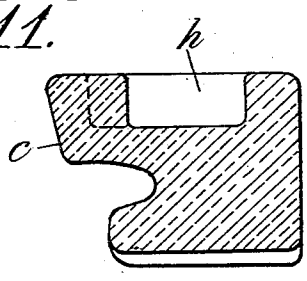

Fig. 6.

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TURBINE NOZZLES

Basil Joseph Terrell and Robert Francis Darling, Monkseaton, England, assignors to The Parsons and Marine Engineering Turbine Research and Development Association, Wallsend, England

Application September 8, 1953, Serial No. 378,927

Claims priority, application Great Britain November 18, 1952

4 Claims. (Cl. 253—78)

This invention relates to nozzles, i. e. fixed blades for turbines where the inlet temperature is too high to permit the use of uncooled steels or metallic alloys.

The invention consists in a turbine nozzle assembly having features as set forth in the claims appended hereto.

Referring to the accompanying diagrammatic drawings:

Figure 1 is an end elevation view of part of a ring of fixed nozzle blades with mounting assembly.

Figure 2 is an enlarged end elevation view of one of the outer annulus elements thereof.

Figure 3 is a cross-section view on the line III—III of Figure 2.

Figure 4 is a developed plan view of the element of Figure 2.

Figure 5 is an enlarged end elevation view of one of the inner annulus elements.

Figure 6 is a cross-section view on the line VI—VI of Figure 5.

Figure 7 is a developed plan view of the element of Figure 5.

Figure 8 is a sectional elevational view through the nozzle ring.

Figure 9 is an elevational view of an individual blade of a modification.

Figure 10 is an end view of the individual blade of Figure 9, viewed from one of the open ends of the blade and showing the hollow interior thereof, and

Figure 11 is an enlarged fragmentary section on the line XI—XI of Fig. 8.

In carrying the invention into effect according to one convenient example illustrated in Figures 1 to 11, a nozzle assembly comprises 72 separate hollow blades *a* of ceramic material, each blade being open at both its inner and outer ends and being supported in radial positions between an outer annulus and an inner concentric annulus. The outer annulus comprises 12 segmental members *b* also of ceramic material, and the inner annulus comprises 12 segmental members *c*. Both sets of annuli are furnished with interlocking ends and the outer set is furnished with external grooves *d* to form a circumferential groove into which a bonding wire *e* is fitted and the ends welded together at *f* (Figure 11).

The opposing faces of the segments *b*, *c* comprising the outer and inner concentric annuli are furnished with recesses *g*, *h* respectively into which the respective ends of each blade *a* are fitted in such a way as to be free to expand both lengthwise and chordwise. This is effected

by shaping the recesses *g* and *h* to afford clearance in a circumferential direction between the blade end and at least one of the side walls of the recess in which said blade end is received, and also by arranging the recesses in the segments *b* and *c* to afford end clearance for the blade as shown in Fig. 8.

The purpose of using hollow blades is that under conditions of rapidly-changing temperature the various portions of the blade are at substantially the same temperature at any given instant, thus avoiding thermal stresses that would be involved in the case of solid blades where the central portions would warm up or cool down much more slowly than the surface layers. The fact of the blades being open at both ends avoids the stresses which would be set up if the ends were closed.

If desired, the blade ends for occupying the recesses may be sprayed with metal to enhance uniformity of distribution of the supporting stresses. The sprayed area is indicated at *a'* in Fig. 9.

We claim:

1. A turbine nozzle assembly comprising hollow blades of ceramic material open at both ends, and supporting pieces of non-metallic material having recesses therein receiving the ends of the blades and supporting the latter, said recesses having walls following the contours of the said ends for holding the said ends in position and being spaced circumferentially from the said ends to afford clearance in a circumferential direction between the ends of the blades and the recesses receiving such ends, and means holding the said supporting pieces together to form two annuli, the recesses thereof facing respectively outwardly and inwardly and being spaced from the respective axes of the annuli by distances differing by more than the length of the blades, and thus providing end clearance between the ends of the blades and the bottoms of the said recesses, whereby the blades are free to expand both lengthwise and chordwise.

2. A turbine nozzle assembly as claimed in claim 1 wherein said supporting pieces are also of ceramic material.

3. A turbine nozzle assembly as claimed in claim 1 wherein the end portions of the blades have a metallic covering so as to enhance uniform distribution of the supporting stresses.

4. A turbine nozzle assembly as claimed in claim 1, wherein said supporting pieces comprises concentric rings of segments, the segments of each ring being shaped to interlock with one another at their ends.

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