

[54] VANE EJECTOR TOOL

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[58] Field of Search ..... 29/254, 275, 283, 427, 202,  
29/23.5, 156.8 R, 156.8 B

[56] References Cited  
UNITED STATES PATENTS

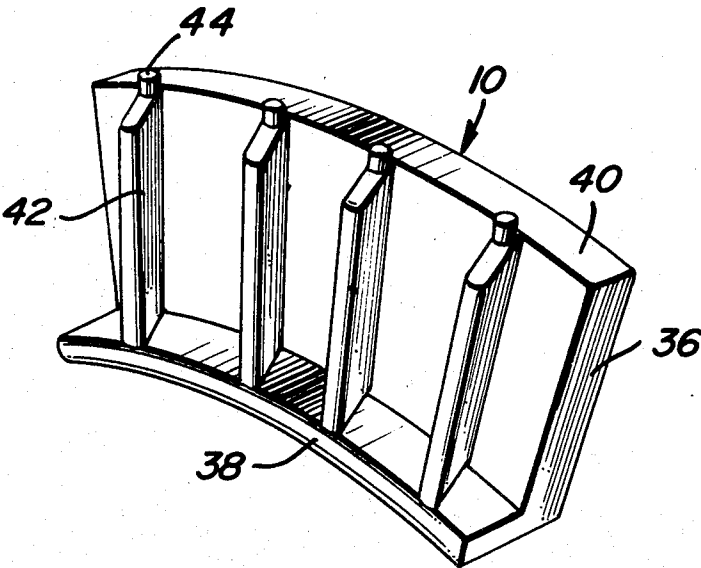
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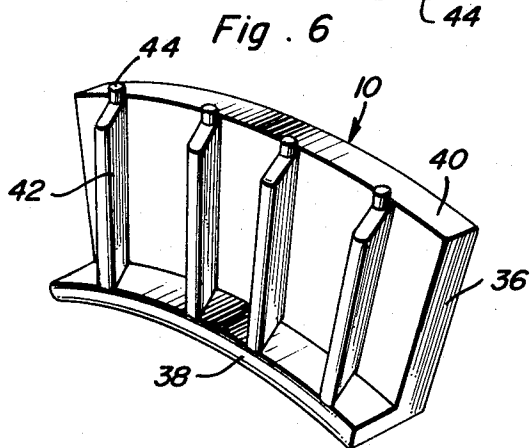
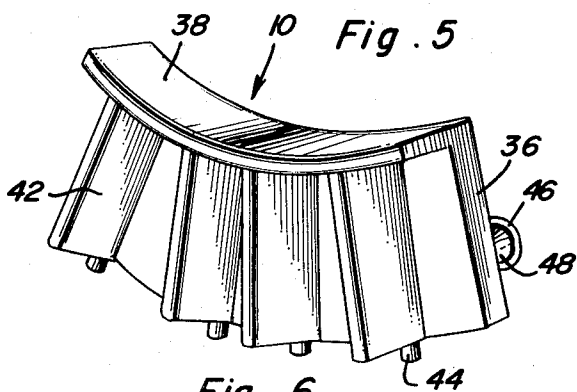
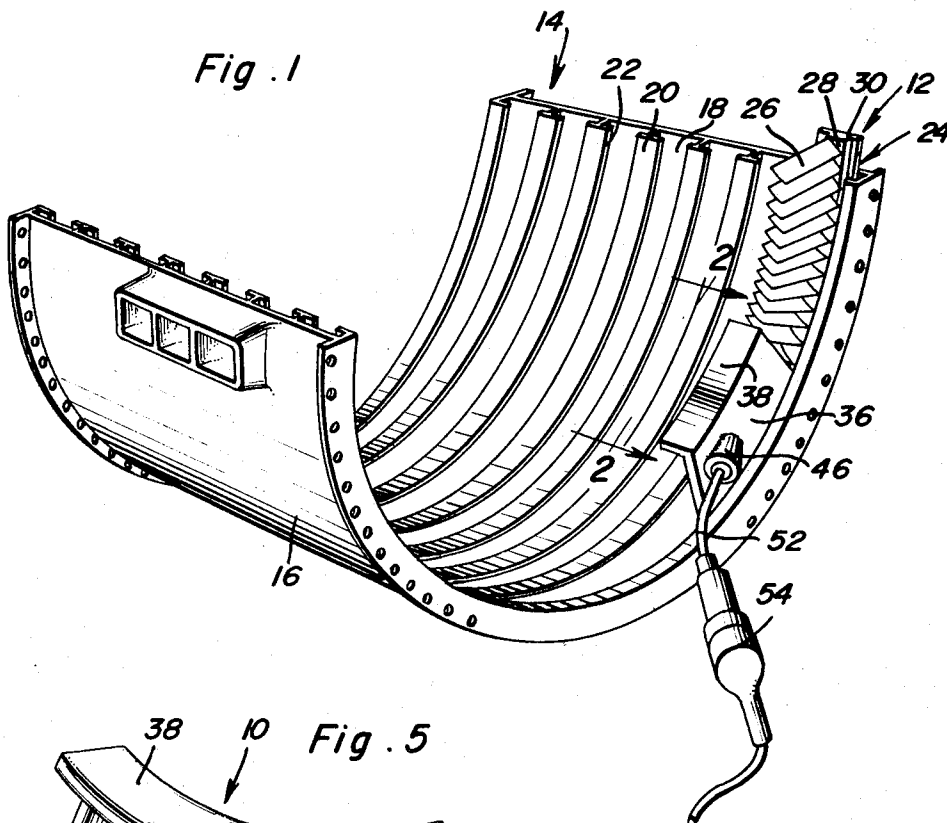
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[57] ABSTRACT

A tool for removing vanes from a jet engine compressor casing in the form of an arcuate plate having a plurality of projecting blades on one side thereof spaced apart and angulated to fit between the vanes in a jet engine together with projections on the outer end of each blade for engaging corresponding openings in the vane assembly in the jet engine compressor casing. The opposite surface of the arcuate plate is provided with an angulated socket having a rounded inner end for receiving the output member of an impact tool such as an air hammer to apply a driving force to the tool.

10 Claims, 6 Drawing Figures





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Fig. 2

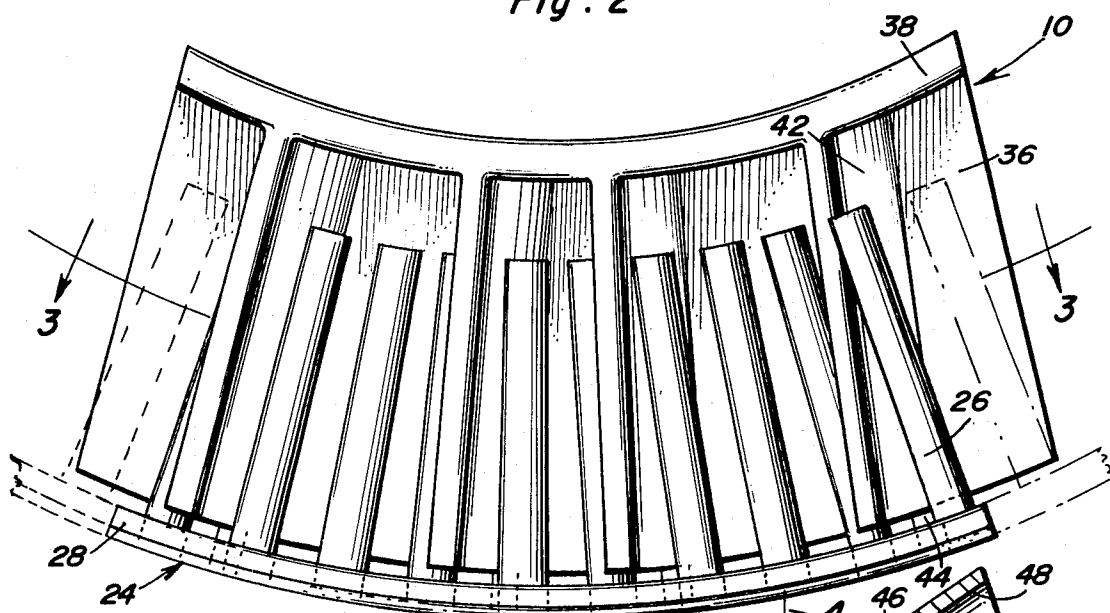


Fig. 3

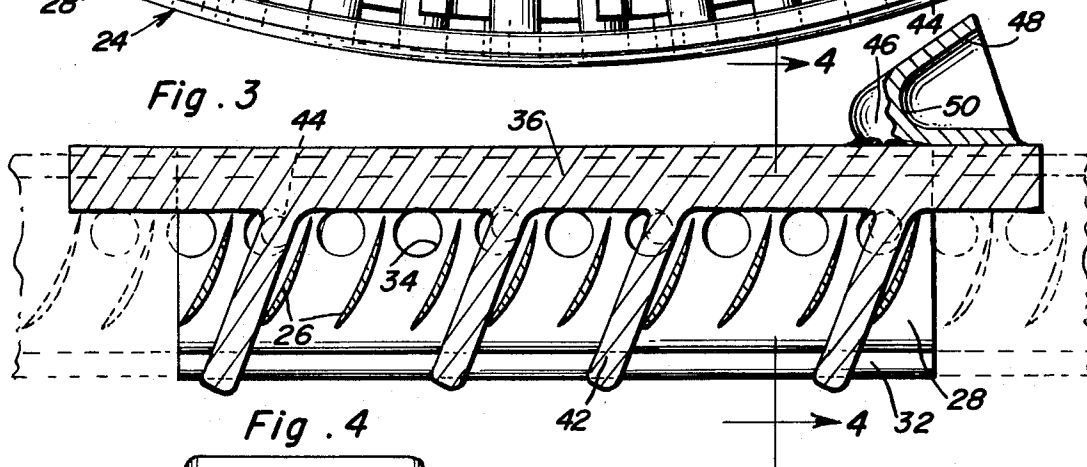
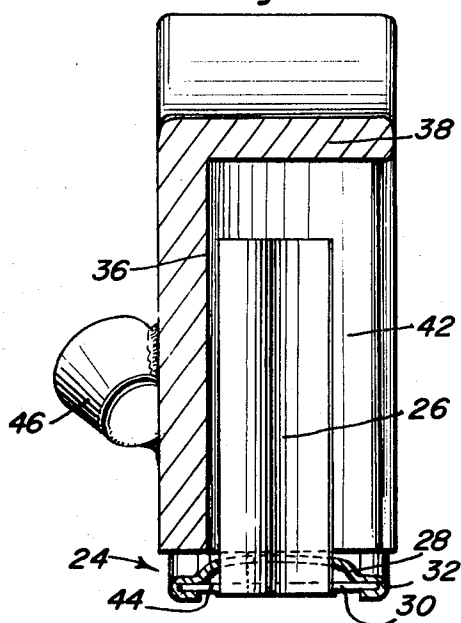


Fig. 4



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## VANE EJECTOR TOOL

## BACKGROUND OF THE INVENTION

## 1. Field of the Invention

The present invention generally relates to a tool especially adapted for use in conjunction with an air hammer or other suitable impact device and is constructed in a manner to remove or eject vanes employed in a jet engine compressor casing to facilitate removal of the vanes for replacement thereof without damage to the compressor casing.

## 2. Description of the Prior Art

In present day jet engine constructions, the vanes or blades in the compressor casing are mounted on an arcuate backing strip secured in a groove or recess in the compressor casing. When the jet engine is overhauled, the vanes frequently become "frozen" in the casing and cannot be removed thus requiring replacement of the casing which results in expensive waste of compressor casings as well as groups of vanes. In one type of jet engine currently used by the U.S. Air Force, the compressor casing is constructed in separable halves with each half of the compressor casing having a plurality of rows of compressor vanes or blades mounted therein and each row of blades has a plurality of groups of vanes or blades mounted on an arcuate backing strip or plate which is slidably received in grooves in the compressor casing. When the groups of vanes cannot be extracted from the casings after usage, or the casing is damaged during the extraction, the whole casing half is wasted as well as the damaged vanes which results in a substantial loss especially when considering the average loss of casings and vanes is relatively high and when a substantial number of engines are being overhauled, the total loss is substantial. When the vanes only are damaged, the casing can still be used by removing the damaged vanes. In some instances, if the vanes are "frozen" too tight, they will be damaged during removal which still permits reuse of the casing.

## SUMMARY OF THE INVENTION

An object of the present invention is to provide a tool which will effectively remove vanes from a jet engine compressor casing with no damage to the compressor casing and little or no damage to the vanes being removed in a manner to conserve time and labor.

It is another object of the invention to provide a tool in accordance with the preceding object which is safe in use inasmuch as the tool will not slip off of the vanes as they are being extracted which occurs frequently with a hammer and chisel or other type tools which can slip off of the vanes thus resulting in injury to the person using such tools or damage to the compressor casing or vanes or both.

A further object of the invention is to provide a vane ejecting tool in accordance with the preceding objects in which the tool is constructed to engage the vane group and move in an arcuate manner with an air impact tool engaged with the vane ejecting tool to enable variation in the angular relation between the tool and the impact hammer or the like to facilitate manipulation of the tool during its arcuate movement in extracting the vane groups.

Yet another important object of the present invention is to provide a vane ejecting tool which is quite simple in construction, easy and effective to use and relatively inexpensive to manufacture while effecting substantial savings in the replacement cost of compressor casings and vane groups.

## DESCRIPTION OF THE INVENTION

FIG. 1 is a perspective view of a jet engine compressor casing half illustrating the tool being employed to eject vane groupings from the compressor casing.

FIG. 2 is a side elevational view of the tool illustrating its relationship to the compressor casing and vane group which is engaged by the tool taken generally along reference line 2—2 of FIG. 1.

FIG. 3 is a sectional view taken along section line 3—3 of FIG. 2 illustrating the relationship of the vane ejector tool of

the present invention and the vane group in the compressor casing.

FIG. 4 is a transverse, sectional view taken substantially upon a plane passing along section line 4—4 of FIG. 3 illustrating further structural details of the tool and the relationship of the tool to the vane group.

FIG. 5 is a perspective view of the tool illustrating the inner arcuate plate and the blades on one surface of the side arcuate plate.

FIG. 6 is a perspective view taken from the outer end of the tool illustrating the blades and the projections thereon.

## DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now specifically to the drawings, the numeral 10 generally designates the vane ejector tool of the present invention for removing vane groups or assemblies generally designated by the numeral 12 from a jet engine compressor casing generally designated by the numeral 14.

The compressor casing 14 is constructed of two matching semi-cylindrical members and in FIG. 1, one of the semi-cylindrical members 16 is illustrated and constitutes half of the compressor casing. The compressor casing itself forms no part of the present invention inasmuch as these are conventional and are presently employed in various jet engine structures. The compressor casing includes a plurality of arcuate grooves or recesses 18 defined by inwardly projecting arcuate ribs 20 having projecting side flanges 22 defining overhanging flanges or ribs for the grooves 18 so that the vane groups or assemblies 12 are secured in place by an arcuate sliding assembly. Each vane group 12 includes an arcuate base plate assembly 24 having a plurality of inwardly extending vanes or blades 26 thereon which are arcuate in cross-sectional configuration and angulated as illustrated in FIGS. 2 and 3 and which are conventionally employed in various types of jet engine structures and form no particular part of the present invention except in their association with the tool.

As illustrated in FIG. 4, the arcuate base 24 of the vane group 12 includes an upper plate 28 spaced slightly from a lower plate 30 with the edge of the upper plate wrapped around and secured to the lower plate as at 32. The blades or vanes 26 extend through the upper plate 28 and between adjacent blades and disposed along one side of the upper plate 28, apertures 34 are provided through both the upper plate 28 and the lower plate 30. An aperture is provided between each adjacent blade and occupies a substantial portion of the area between one edge of the blades 26 with the apertures 34 being disposed in alignment as illustrated in FIG. 3. All of the structure of the vane group or assembly 12 is conventional and is currently employed in jet engine compressor casing constructions.

The vane ejector tool 10 of the present invention includes an arcuate side plate 36 having an arcuate inner edge plate 38 integral with the inner edge thereof with the outer edge of the side plate 36 being arcuate as at 40 in substantially the same arc as the inner surface of the base 24. Rigidly affixed to the side surface of the arcuate side plate 36 and to the outer surface of the inner edge plate 38 is a plurality of projecting vanes or blades 42 which are spaced apart in a manner to be received between certain of the blades or vanes 26 as illustrated in FIG. 3. Also, the vanes or plates 42 are angulated and radially disposed for conforming with and reception between the vanes 26 on the vane group 12 without bending or distortion thereof. Also, as illustrated in FIG. 3, the blades 42 are substantially thicker than, more rugged than and provided with parallel surfaces as compared with the compressor vanes or blades 26. The free side edge of the plates or blades 42 coincide with the arcuate side edge of the inner plate 38 and the over-all thickness of the tool is substantially the same as the over-all width of the vane groups 12. Projecting from the outer end of each blade or vane 42 on the tool 10 is a projecting lug 44 which extends radially outwardly beyond the arcuate edge surface 40 of the side plate 36 and axially beyond the

end of the blade or vane 42 with the projection 44 being disposed adjacent the edge of the blade or vane 42 adjacent the arcuate side plate 36 with the projections 44 being spaced and aligned in a manner to be received within the holes or apertures 34 in the base 24 of the vane group 12 so that an impact force can be exerted on the vane 12 by the use of an impact tool engaged with the vane ejector tool 10.

The outer surface of the arcuate plate 36 is provided with a socket forming projection 46 rigidly mounted thereon either by being of one piece construction or otherwise secured thereto with the member 46 having a socket 48 formed therein provided with a rounded or curved surface 50 in the bottom thereof. The socket forming member 46 is disposed toward the arcuate free edge 40 of the side plate 36 and adjacent one end thereof as illustrated in FIGS. 1, 3 and 4 for receiving the impact member 52 of an impact tool 54 such as a pneumatic hammer or other fluid operated impact tool or any suitable mechanically actuated impact tool so that impact forces can be exerted to the tool 10 through the member 46 and arcuate plate 36 and subsequently to the vane group 12 through the projections 44 on the blade 42.

In using the tool, the compressor casing after separation into its two halves is supported in any suitable manner so that it will be retained relatively stationary and the vane groups or assemblies 12 are removed by movement in an arcuate manner. To facilitate removal of the vane groups, the compressor casing is soaked in a solvent for a predetermined period of time to release the vane groups. A single solvent may be employed or the casing may be soaked in one solvent for a predetermined period of time and subsequently soaked in a subsequent solvent of another type. In any event, the vane groups which are difficult to remove or frozen or otherwise locked in place can be effectively removed by engaging the tool with the vane group by moving the blades 42 between the blades 26 and registering the projections 44 with the apertures 34 after which an impact tool such as an air hammer or the like may be engaged with the member 46 thus effectively removing the vane groups.

The foregoing is considered as illustrative only of the principles of the invention. Further, since numerous modifications and changes will readily occur to those skilled in the art, it is not desired to limit the invention to the exact construction and operation shown and described, and accordingly all suitable modifications and equivalents may be resorted to, falling within the scope of the invention.

What is claimed as new is as follows:

1. A tool for removing vanes from a jet engine compressor casing comprising an arcuate member having a plurality of radially extending blades mounted on the convex side thereof,

said blades on the arcuate member adapted to extend between the vanes in the compressor casing, and means on said member for receiving an external force, whereby said force causes said vanes to move arcuately along the inner surface of the compressor casing.

2. The structure as defined in claim 1 wherein said blades on the arcuate member have axial projections thereon for reception in correspondingly spaced apertures in the base of a group of vanes in the compressor casing.

3. The structure as defined in claim 2 wherein said means on said member includes an impact receiving socket thereon, said impact receiving socket having a rounded bottom surface for engaging a correspondingly shaped impact imparting member to enable forces to be exerted on the tool at various angular relations between the tool and the impact imparting member.

4. The structure as defined in claim 3 wherein said arcuate member includes a side plate having an arcuate outer edge curved to conform generally with the inner surface of the compressor casing, said blades being rigid with and coextensive with the arcuate side plate, and an inner plate connected with the inner edges of the blades with the width of the blades being substantially equal to the width of the inner arcuate plate and the total width of the tool being substantially equal to the width of a group of vanes in the compressor casing.

5. The structure as defined in claim 4 wherein said axial projections on said blades are oriented adjacent the juncture between the blades and side plate.

6. The structure as defined in claim 5 wherein said impact receiving socket is oriented adjacent one end of the side plate and adjacent the arcuate outer edge thereof.

7. The structure as defined in claim 6 wherein said blades are angularly disposed in relation to the side plate and radiate from a common point generally conforming with the center of curvature of the compressor casing.

8. A tool comprising an arcuate member, a plurality of radially extending members on the convex side of said arcuate member, means on each radially extending member to engage a workpiece, and means on said arcuate member to receive an external force applied to said tool.

9. The tool as defined in claim 8 wherein said radially extending members are substantially the same length and disposed in alignment for engaging an arcuate workpiece, said means on said arcuate member including a curved surface to receive forces as the tool moves in an arcuate path along the workpiece.

10. The tool as defined in claim 8 wherein said means on each radially extending member includes a radial projection for reception in recesses in a workpiece.

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