Dec. 3, 1963 B. M. MILLER, JR., ETAL 3,112,916

FLUID FLOW MACHINE ASSEMBLY

Filed April 30, 1962

Fig 1

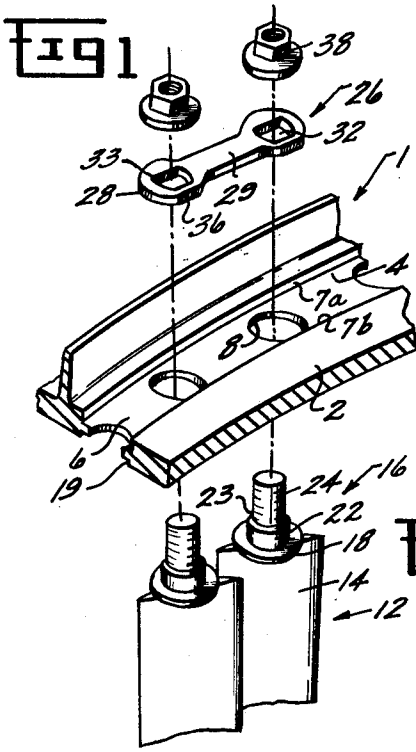


Fig 3a

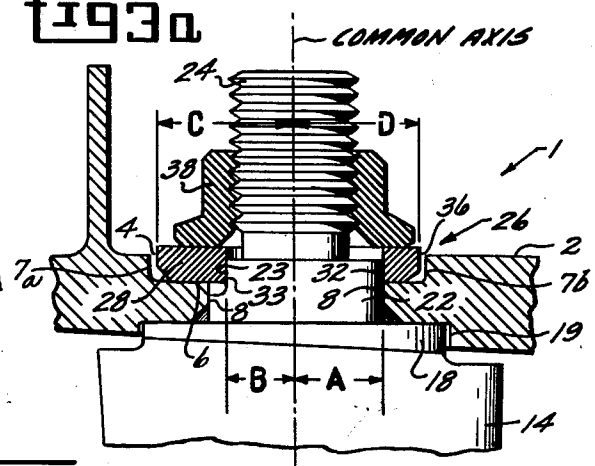


Fig 3b

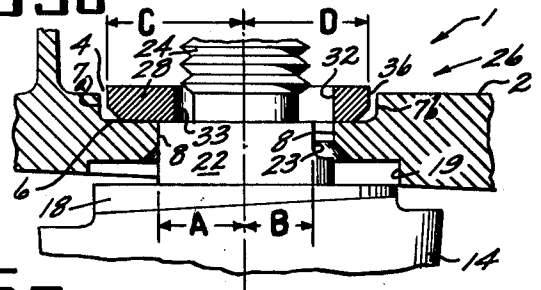


Fig 3c

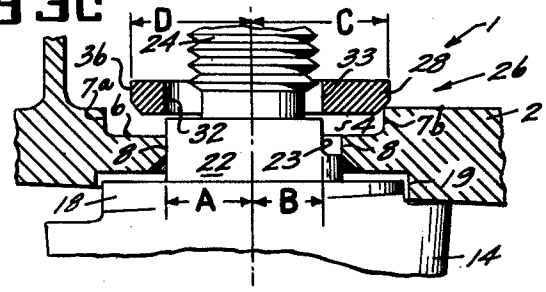


Fig 2

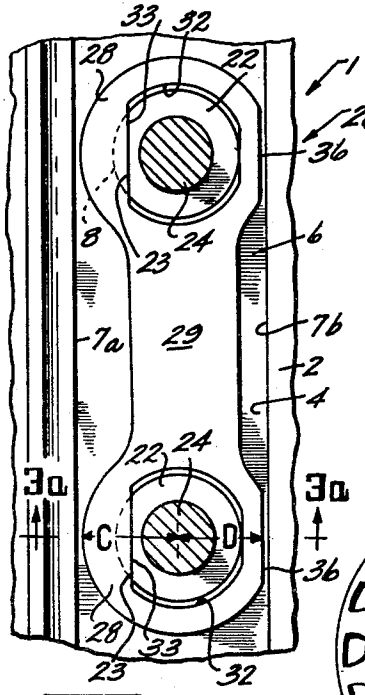


Fig 5

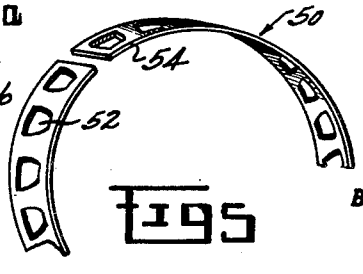
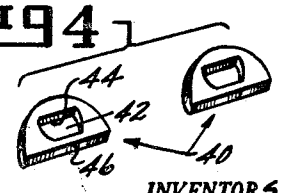


Fig 4



INVENTORS.
DEAN D. SCHEER
BLAINE M. MILLER, JR.
BY
Harry C. Burgess
ATTORNEY—

United States Patent Office 3,112,916 Patented Dec. 3, 1963

3,112,916

FLUID FLOW MACHINE ASSEMBLY

Blaine M. Miller, Jr., Malvern, Pa., and Dean D. Scheer, Cincinnati, Ohio, assignors to General Electric Company, a corporation of New York

Filed Apr. 30, 1962, Ser. No. 190,931
2 Claims. (Cl. 253—78)

This invention relates to fluid flow machines and, more particularly, to means for locating and securing stator vanes in a compressor or turbine of such a machine, and wherein accidental misalignment of the vanes or locating means is prohibited.

A typical axial-flow compressor or turbine for a fluid flow machine, such as an aircraft gas turbine engine, may utilize a plurality of rows of rotor blades, each rotor blade row being followed by a row of fixed, i.e., stationary, stator blades or vanes. The stator vanes are usually suspended from an outer casing or shell and are directed radially inward of the machine into the path of the working fluid. In the design of the stator vanes and mountings therefor both aerodynamic and mechanical requirements must be taken into account. Aerodynamic conditions require that the angular positioning or angle at which the vane airfoils face the oncoming fluid, be very accurately controlled. On the other hand, mechanical considerations dictate that the stator vane and mounting configuration provide adequate strength to withstand existent static and vibratory conditions. Particularly, are these mechanical considerations important in the design of advanced, lightweight aircraft gas turbine engines.

It has been the practice to fabricate fixed stator vanes and mounting assemblies individually, or in segments of two or more vanes, wherein the airfoil is prepositioned and then welded or brazed to a sheet metal type base plate. The base plate and vane assemblies may then be mounted in the casing by means of permanent fastenings, or removably, for ease of replacement, as shown in the patent of Wilkes, Jr., 2,912,222, assigned to the assignee herein. However, in the case of very advanced lightweight engines for high Mach applications the fabricated stator vane assembly may not always be desirable from a strength standpoint. Hence, a proposed configuration for such applications may consist of a rigid bolted assembly wherein individual fixed, i.e., non-variable, stator vanes are fastened directly to the casing. Proposals for positioning stator vanes in this manner have included internally grooved casings wherein a ring is placed in a groove, the ring having holes aligned with holes in the casing through which threaded vane tangs or stems are adapted to be inserted. The ring may then be keyed to the vanes to prevent angular rotation of the vanes under the force of the working fluid from an initial design position. With such an arrangement, however, certain difficulties are inherent. First, with use of internal rings it is impossible to detect flaws or cracks in the ring likely to cause eventual loss of one or more vanes. Secondly, it is obviously a difficult and time-consuming job to replace any structure located within the casing, especially where in the case of the internal ring all the stator blades would have to be removed to replace a worn or damaged ring. Thirdly, since an internal ring is necessarily smaller than the casing, some means must be provided to support it, or at least hold it in place during assembly of the rows of vanes within the compressor or turbine. Lastly, but more importantly, it is difficult, if not impossible, to be absolutely certain that each of the stator vanes is not reversed from its design position when a simple keyed hole, such as a D-shaped slot, is used to locate the vane within the casing if the keyed device, i.e., the ring, is inside the casing.

Accordingly, an object of the present invention is to provide a fixed stator vane locating and securing means of improved strength for use in a fluid flow machine wherein the possibility of the vane or vane securing means being reversed from the design position is eliminated.

A further object of the invention is to provide a fixed stator vane locating and securing means having increased strength and improved ease of maintenance and replacement for use in a fluid flow machine compressor or turbine.

In one embodiment of the invention there is provided, in combination, an axial-flow compressor casing having rows of holes therein, a plurality of stator vanes having threaded stems, and stator vane locating and securing means including, at least one outer member having holes therein keyed to a flat on the vane stems, the member being adapted to fit in a channel in the outer surface of the casing with the holes in the casing and member in registry, and a plurality of fastening means adapted to securely fasten the stator vanes and outer member to the casing, wherein mis-assembly of either the outer member and the vanes, or a combination of both is prevented by means of unsymmetrical dimensioning of the parts forward and aft of a common axis through each of the vane stem, the outer member and the casing holes.

While the specification concludes with claims particularly pointing out and distinctly claiming the subject matter of the present invention, it is believed that the invention will be better understood, and other advantages and objects thereof become more apparent, from the following detailed description read in conjunction with the accompanying drawings in which:

FIGURE 1 is a fragmentary perspective view, partially in section, of one embodiment of the combination of the stator vanes, the vane locating and securing means, and the casing, all in a disassembled relationship;

FIGURE 2 is a fragmentary plan view of a portion of the casing illustrating the placement of the outer member and vanes in the combination of the subject invention illustrated in FIGURE 1;

FIGURE 3(*a*) is a side view, partially in section, taken along line 3*a*—3*a* of FIGURE 2;

FIGURES 3(*b*) and 3(*c*) are side views of the structure of FIGURE 3(*a*) illustrating the manner whereby misassembly of the vanes and/or outer member is prohibited;

FIGURES 4 and 5 illustrate alternate embodiments of the outer member or members of the vane locating and securing means of the subject invention.

Referring to FIGURE 1, therein is depicted a fragmentary section of a compressor or turbine casing, indicated generally by numeral **1**. The outer surface **2** of the casing contains a circumferential channel **4** having a bottom wall **6** and side walls **7***a* and **7***b*. The bottom wall of the channel contains a plurality of evenly spaced circular holes **8**, the centers of which are arranged in a single plane offset towards side wall **7***b*, as perhaps best seen in FIGURE 2. As will be seen in the drawing, a plurality of stator vanes, two of which are indicated at **12**, are provided which together with like vanes arranged in a row form a compressor stage when combined with a row of rotor blades (not shown). Each stator vane includes an airfoil section **14** and a tang or stem section, indicated generally at **16**. The stem includes an enlarged collar portion **18** adapted to fit in a recess **19** inside the casing, a smooth, generally circular neck portion **22**, having a notch or flat **23** cut therein, and a threaded portion

24. As perhaps shown more clearly in FIGURE 3(*a*), the smooth neck portion and threaded portion of the vane stem are adapted to project through the circular casing hole **8**, the clearance being such as to provide a slip fit between the stem and hole. Also illustrated in FIGURE 1 is an outer member, in this case a strap, indicated at **26**, which comprises an important part of the subject invention. The outer member in the illustrated embodiment includes a pair of enlarged end portions **28—28** joined by a middle portion **29** of reduced size. Each end portion **28** has a hole **32** therethrough having a flattened side **33**, so that the holes conform generally to a D-shape. The outer circumference of each end portion **28—28** is foreshortened or flattened at **36**, the flattened portion being adapted to be located opposite wall **7***b* of the channel **4** in the outer surface of the casing.

In an assembled relationship, as depicted in FIGURES 2 and 3(*a*), with the vane stem inserted in the casing hole, the stem will be able to project through the D-shaped strap holes **32** if—and only if—the notch or flat **23** in the stem is aligned with the flat **33** in the strap hole. The vanes and strap are then ready to be securely held together with the casing by fasteners in the form of flanged nuts **38**. Thus, it is clear that with the described arrangement it is possible to correctly assemble the stator vanes and outer ring or strap member in a single manner only, i.e., with the stem and hole flats in registry.

In addition, when the flats **36** on the outer circumference of the end portions **28—28**, are opposite the correct wall of the channel **4**, in this case, wall **7***b*, it is impossible to misassemble, i.e., reverse the stator vanes 180° from their design position. Thus, to insure against the eventuality that an assembler might incorrectly position the strap, the invention includes further means for preventing accidental reversal of the outer strap or the vanes, either alone or in combination. By referring to FIGURES 3(*b*) and 3(*c*), therein illustrated are two attempts at incorrect assembly of the structure of FIGURE 3(*a*). As indicated above, in the first case the attempt at assembly results in an area of interference between the vane neck portion **22** and the strap end portion **28** which prevents the vane stem flat **23** from registering correctly with the strap hole flat **33**. Thus, in FIGURE 3(*b*) the outer member or strap **26** is correctly positioned but the stator vane is reversed, i.e., 180° out of the design position. This causes an area of interference due to dimension "A" being greater than dimension "B." On the other hand, FIGURE 3(*c*) illustrates an attempt to assemble the structure with both vanes and outer member reversed. In this case, an area of interference exists between the strap end portions **28** and the casing surface since dimension "C" is greater than dimension "D," i.e., the plane of the axis of the holes **8** is offset towards wall **7***b* although the vane itself is correctly positioned with respect to the outer member only.

The same system of unsymmetrical dimensioning about a common reference line through each of the vane stem, the casing holes and the openings **32** in the outer member to prevent misassembly of the parts will be equally effective in the case of the alternate embodiments of the outer member shown in FIGURES 4 and 5. In FIGURE 4 the "outer member" consists of a plurality of positioning and locating key members, two of which are indicated at **40**. Each member **40** consists of a generally triangular body portion having a hole **42** therethrough, the hole including a flat **44**. One side **46** of the body portion is flat so as to be capable of abutting a wall **7** of the channel **4** to locate the center line of the hole **42** axially of the compressor and to prevent rotation of the key member during assembly. When assembled, the vane stem flat **23** and the dimensioning along a common axis through each of the vane stems, the key member holes, and the casing holes is such that the possibility of the vanes or keys, either alone or in combination, being assembled incorrectly, i.e., reversed, is eliminated. FIGURE 5 illustrates still another embodiment wherein a resilient, split outer member or ring **50** is provided. The ring is adapted to be spread apart at the ends to enable it to slip over the casing **1** and into position in the channel **4**. The ring includes D-shaped holes **52** for receiving vane stems and a flat (side) **54**, the ring providing fail-safe assembly similar to that provided by the strap **26** of the embodiment of FIGURE 3 and the key members of FIGURE 4. The outer member **50** could also comprise two half-rings for further ease of assembly.

While several specific embodiments of the subject invention have been shown and described, it will be obvious to those skilled in the art that various changes and modifications may be made without departing from the spirit or scope of the present invention as particularly pointed out in the following claims.

What is claimed is:

1. A turbomachine assembly comprising:
a cylindrical casing having an outer and an inner surface,
a circumferentially-extending channel in said outer surface having side and bottom walls,
a plurality of holes in said bottom wall opening into said casing, said hole centers being arranged in a plane offset towards one of said side walls;
a plurality of vanes positioned within said casing, said vanes including stems projecting through said holes and into said channel,
at least one outer member received in said channel, said member overlying said bottom wall and including locating means opposing said one of said side walls, said outer member having openings therethrough adapted to receive said vane stems;
fastening means engaging said vane stems and said outer member, said fastening means securing the vanes and outer member to said casing;
and means preventing assembly of said vanes in other but a predetermined aerodynamic position including unsymmetric dimensioning of said vane stems and said outer member openings relative to a common axis through each and unsymmetric dimensioning of said outer member openings and said casing channel relative to a common axis through said openings and said casing holes.

2. A turbomachine assembly comprising:
a cylindrical casing having an outer and an inner surface,
a circumferentially-extending channel in said outer surface having side and bottom walls,
a plurality of holes in said bottom wall opening into said casing, said hole centers being arranged to a plane offset towards one of said side walls;
an outer member received in said channel, said outer member extending circumferentially of the casing and overlying said bottom wall, said outer member including circumferentially-spaced, openings adapted to be radially aligned with said casing holes and means opposing said one of said side walls for locating the outer member axially of the casing;
a plurality of stator vanes positioned within the casing, said vanes including stems adapted to project radially outwardly through said holes and said openings;
fastening means engaging said vane stems and said outer member, said fastening means securing the vanes and outer member to said casing;
and means preventing assembly of said vanes in other but a predetermined aerodynamic position including unsymmetric dimensioning of said vane stems and said outer member openings relative to a common axis through each and unsymmetric dimensioning of said outer member openings and said casing channel relative to a common axis through said openings and said casing holes,

such that a first area of interference exists between each vane stem and the outer member when a vane is attempted to be inserted in said outer member openings in other but said predetermined position, and a second area of interference exists between the outer member and said one of said side walls when said outer member and a plurality of said vanes are attempted to be assembled together with said casing in other but said predetermined position.

References Cited in the file of this patent

UNITED STATES PATENTS

2,755,064	Simonsen	July 17, 1956
2,801,822	Speed	Aug. 6, 1957