

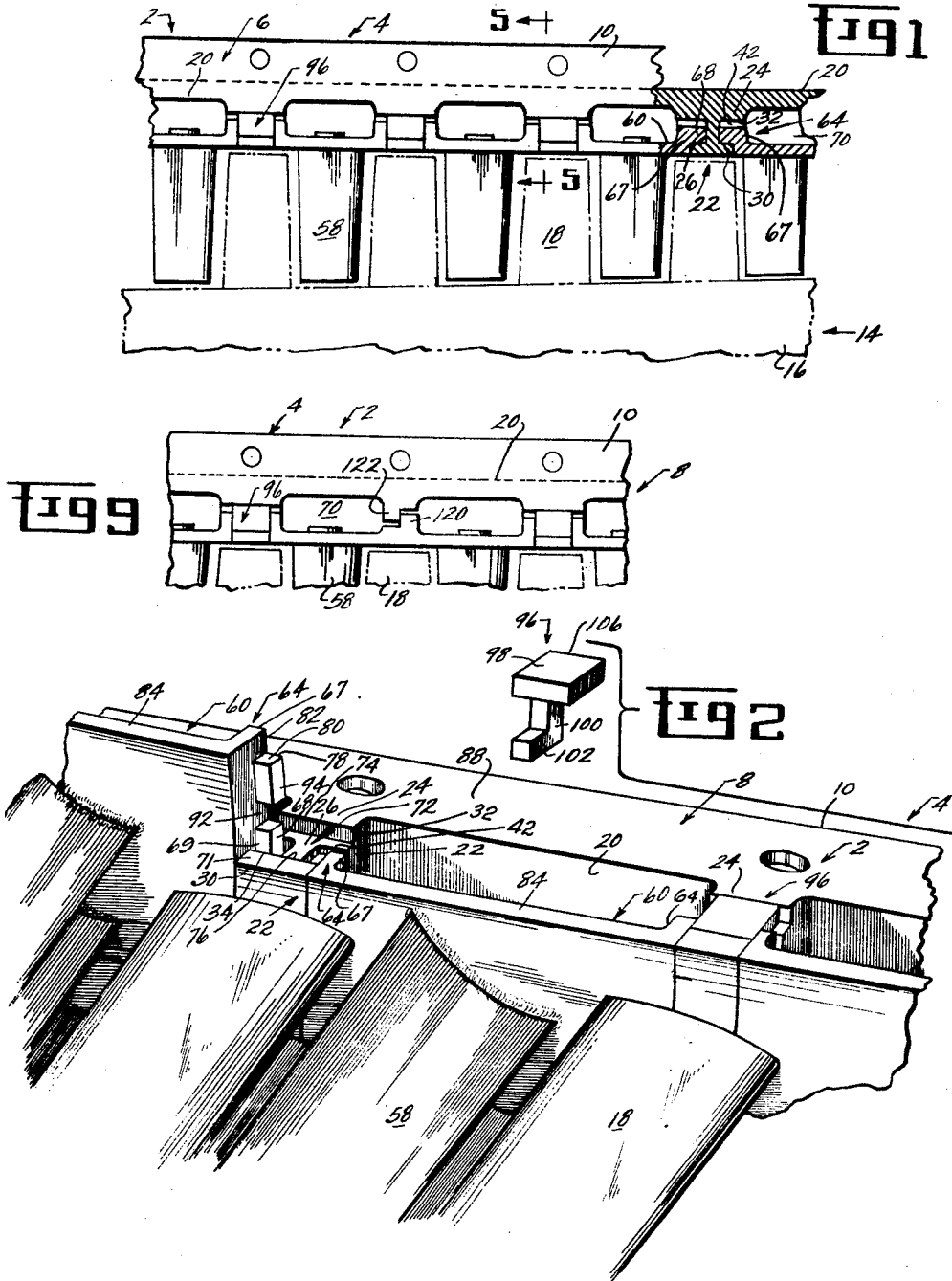
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STATOR VANE LOCKING KEY

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2 Sheets-Sheet 1



INVENTORS,
EDWARD J. WALSH
OSCAR E. RIDLEY
BY
Maurice H. Kitzman
ATTORNEY-

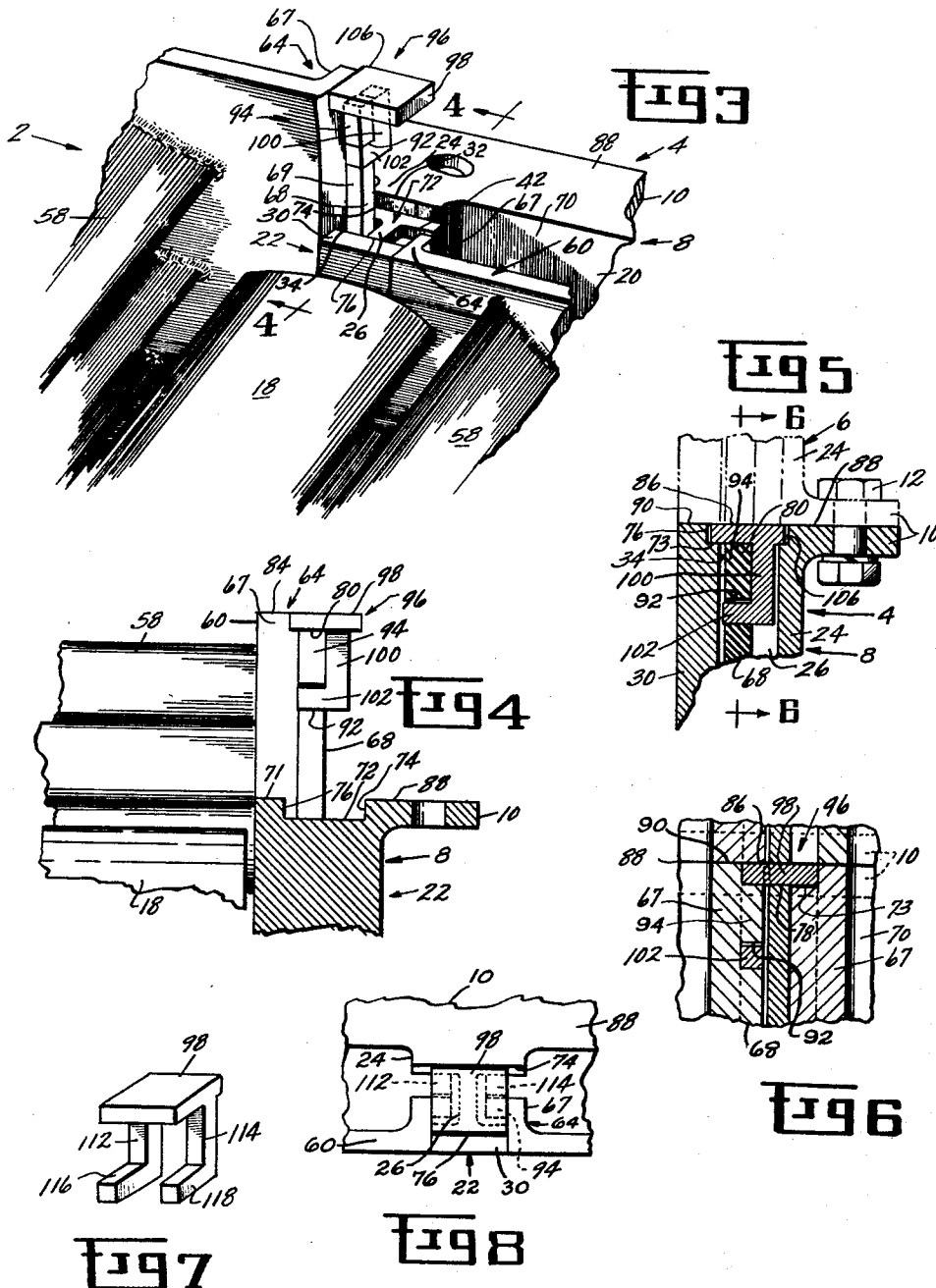
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ATTORNEY-

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STATOR VANE LOCKING KEY

Oscar, Earl Ridley, North Wilmington, and Edward Joseph Walsh, Beverly, Mass., assignors to General Electric Company, a corporation of New York

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6 Claims. (Cl. 253—78)

The present invention relates to a stator vane assembly construction for use in gas compressors or turbines of the type used in gas turbo engines.

In U.S. application No. 629,075 filed by Robert M. Oppenheimer on Dec. 18, 1956 and assigned to the same assignee as the present application there is described a stator vane assembly in which the stator vanes of each stage are carried by a stator ring made up of two halves. The casing is also made up of two halves and each half of the ring is supported in its half of the casing by means of cooperating ring and casing rabbets. The splits between the halves of each stator vane ring and the casing lie substantially in the same plane. A number of long thin locking strips are used to lock the half rings against rotation in the casing.

The particular stator vane assembly design described in the above mentioned application is particularly suitable for use in very small turbo engines of the type described in application Serial No. 548,987 filed by G. W. Lawson on November 25, 1955 and assigned to the same assignee as this application. It has been found, however, that this small engine design does not lend itself to the use of the thin locking strips because with such engines the strips are so thin and small and fragile they are difficult to handle and manufacture and are very easily assembled improperly resulting in damage to the rotor blades and possible failure of the engine.

These locking strips can be eliminated by designing the rings so that the edges of the halves thereof abut against each other with an individual locking key being provided for each casing rabbet and its associated ring rabbet or rabbets. The key is anchored or locked between the abutting edges of the halves of the casing rabbet and is located in a recess in one of such edges. It extends between the abutting edges of the halves of the ring rabbet or rabbets supported by such casing rabbet into a recess in one of such edges to thereby lock the ring halves against rotation in the casing. However, the use of such keys in small engines of the type described in the Lawson application presents a problem because the keys are so tiny that it is difficult to assemble them without dropping them into the casing and they are very easily assembled improperly in their recesses. After the keys have been placed in their recesses and before the other half of the casing is moved into place there is nothing to hold them there and they are apt to fall out into the casing, especially when they have not been seated properly in the first place. Furthermore, the handling of the required large number of such small, hard to handle pieces makes assembly and disassembly, and consequently manufacture and maintenance, time consuming and expensive.

To fasten each key firmly in its recess by a screw or bolt or some other separate part to keep it in place and to make sure that it is located in its proper position is not practical because of the size of the parts and because

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it requires a great deal of time thereby making manufacture and maintenance expensive.

In accordance with the present invention, a locking mechanism for locking stator vane rings against rotation in their casing is provided which employs keys of the above mentioned type, in which each key has an interlocking portion movable into interlocking relationship with other interlocking parts of the mechanism to lock it in its proper position at the time it is assembled in that position so that it cannot fall out into the casing during subsequent assembly and disassembly of the other parts of the unit, in which the keys in spite of their small size can be easily assembled in the unit without dropping them into the casing unit, in which improper assembly of the keys is avoided, which simplifies and reduces the time required for assembly and disassembly of the unit and which thereby reduces the cost of manufacture and maintenance. This is accomplished without additional separate parts such as screws or bolts or the like.

Briefly stated and in accordance with one aspect of the invention, the interlocking part of the key is movable into and out of interlocked relationship with a cooperating interlocking part of the ring while such part of the ring is removed from its casing segment, the key having a portion which can be grasped firmly in the fingers to move the interlocking part thereof into and out of such interlocked relationship. Sliding movement into assembled position in its casing segment of such part of the ring with the key interlocked therewith moves the key into its proper locking position with respect to the ring and casing segment. A portion of the casing segment overlying the key when it is moved to this position locks the interlocking parts of the key and ring against moving out of interlocked relationship. Movement of the interlocking part of the ring out of its casing segment carries the key with it to a position in which the casing segment no longer locks together the interlocking parts and the key can be grasped by the fingers and moved out of interlocked relationship with the ring.

Preferably the key is provided with a locking hook which comprises its interlocking part and the ring segment has a hook engaging portion which comprises its interlocking part, so that the key can be hooked onto the ring segment while its hook engaging portion is removed from its casing segment. The ring segment is then slid into its casing segment and the key which is hooked to it is moved with it into the proper locking position with respect to the edges of the ring and casing segments. A portion of the casing segment overlying the key when it is moved to this position locks it in its hooked position on the ring segment so that the key cannot be removed from, or fall out of, its locking position until the hook engaging portion of the ring segment is slid out of its casing segment thereby moving the key to a position in which the casing segment no longer overlies it whereupon it can be unhooked from the ring segment.

The above and other advantages of the present invention will be apparent from the following description and claims and the accompanying drawings all of which describe by way of illustration only and without limitation what now is considered to be a preferred embodiment of the present invention.

Fig. 1 is a view in elevation and partly in section of a part of the lower half of a compressor which is similar in construction to the compressor described in the above mentioned Oppenheimer application and which embodies an embodiment of the locking mechanism of the present invention.

Fig. 2 is a view in perspective similar to that shown

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in Fig. 1 with a lower half ring partially removed from its casing half to expose its hook engaging portion and with the key associated with such half ring removed therefrom.

Fig. 3 is a view similar to Fig. 2 showing the key hooked to the half ring but with the half ring still partially out of its casing half.

Fig. 4 is a view taken along the line 4—4 of Fig. 3.

Fig. 5 is a section taken along the line 5—5 of Fig. 1, showing the key in its assembled position and showing in broken lines a portion of the edge of the top half of the casing and the top half of the ring.

Fig. 6 is a view taken along the line 6—6 of Fig. 5.

Fig. 7 shows another embodiment of the locking key of the present invention.

Fig. 8 is a view similar to Fig. 1 but showing a smaller portion and in which the key of Fig. 7 is installed.

Fig. 9 is a view similar to Fig. 1 showing another embodiment of the present invention.

Referring to the figures, 2 is a compressor comprising a stator vane casing 4, having an upper half 6 and a lower half 8 joined by means of flanges 10 and bolts 12 as shown in Fig. 5, and a rotor 14 comprising a rotor drum 16 and rotor blades 18.

Each of the halves of the casing 4 is made up of a relatively thin semi-cylindrical casing wall 20 having a plurality of spaced T-shaped rabbets 22 extending radially inwardly thereof and circumferentially therearound. Each T-shaped rabbet comprises a base portion 24 which extends radially inwardly into the narrow stem 26 of the T, which in turn extends into the flange or tongue portions 30 forming the web of the T and extending at right angles from the stem 26 in opposite axial direction. Each tongue has a radially outwardly facing supporting surface 34 and forms with the stem 26 and the shoulder 32 between 24 and 26, a recess 42 so that each rabbet 22 has a pair of recesses 42 on opposite sides thereof.

A plurality of stages or rows of stator vanes 58 are mounted on a plurality of flexible half rings 60 made of a thin flexible and resilient steel and the ring halves are in turn mounted on the casing halves in spaced relationship with casing wall 20 by means of a pair of offset, semi-annular rabbet portions 64 which are located along opposite sides of each ring 60, each of which comprises a portion 67 extending radially outwardly and a portion 68 extending in an axial direction from portion 67, and which are received in oppositely facing recesses or spaces 42 of adjacent rabbets 22, as shown, with the radially inwardly facing surfaces 69 of the portion 68 thereof engaging and rigidly supported by the radially outwardly facing surfaces 34 of the adjacent rabbets 22. The casing rabbet recesses 42 are radially wider than the thickness of portion 68 (Fig. 1). Rotor blades 18 extend between adjacent rows of vanes and a chamber 70 is defined by adjacent casing rabbets, the ring located between the adjacent casing rabbets and the inner surface of shell 20 located between the adjacent casing rabbets.

All of the above is described in detail in the above mentioned Oppenheimer application.

In accordance with the present invention the edge 71 of each semi-annular T-shaped casing rabbet 22 in the lower half of the casing has a recess 72 extending axially thereacross, such recess having a bottom surface, a radially inwardly facing wall 74 and a radially outwardly facing wall 76. The corresponding edge of the axially extending portion 68 of each ring rabbet also has a cooperating recess 78 therein, having a bottom surface 80 and a side wall 82. The depth of the ring rabbet recess 78 is the same as the depth of the casing rabbet recess 72 and when the half rings are in assembled position in the casing half, the recess 72 in the edge of the T-shaped casing rabbet 22 and the recesses 78 in the corresponding edges of the two ring rabbets being supported by such casing rabbet form a single recess defined by a bottom made up of bottom surface of the casing rabbet recess and the

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two bottom surfaces 80 of the recesses in the two ring rabbets, a wall 74, a wall 76, a wall 82 of the recess in one ring rabbet and a wall 82 of the recess in the other ring rabbet. The non-recessed portion 84 of the edge of the lower half 60 of each ring including the edge of portion 67 is flush with the corresponding non-recessed portion 88 of the edge of the lower casing half, the portion 88 also including the non-recessed portion of edge 71 of the casing rabbet.

One of the rabbet portions 68 of the two ring rabbets 64 supported by each casing rabbet 22 has a notch or slot 92 therein spaced from the recess 78 as shown, the portion of 68 between the recess and notch being designated as 94.

Associated with the edge 71 of each T-shaped casing rabbet is a locking key 96 having a locking portion 98 which is received in the recess formed by recess 72 in the edge of the casing rabbet and the two recesses 78 in the edges of the two ring rabbets supported by such casing rabbet, as shown, and which has a leg 100 extending from the lower surface thereof. The leg 100 in turn extends into a hook or foot 102 which is received in the notch 92 as shown in Figs. 3 to 5. The thickness of portion 98 is the same as the depth of the recesses 72 and 78 so that the top surface of 98 is flush with the non-recessed edges 84 and 88 of the lower half rings and lower casing half respectively when the lower half rings are in assembled position in their casing half as shown in Figs. 1, 5 and 6.

When the two halves of the casing are bolted together the edges 84 of the lower halves of the rings and edge 88 of the lower casing half abut snugly against the non-recessed edges 86 of the upper halves of the rings and the non-recessed edge 90 of the upper casing half respectively (see Figs. 5 and 6). The locking portion 98 is held firmly between the bottom surface of the recess 72 in the edge of the lower casing rabbet half and the adjacent edge 90 of the other half of the rabbet in the upper casing half, as shown in Figs. 5 and 6. Since the bottom surface of the recess 78 in the edge of the portion 68 of the lower half of each of the two ring rabbets supported by the casing rabbet abut against the lower surface of portion 98 and the edge 86 of the portion 68 of the upper half of each of such ring rabbets in the upper casing half abut against the upper surface of the portion 98, the half rings are locked against rotation in the casing.

When the two casing halves containing the ring halves assembled therein are removed from each other the locking key 96 cannot fall out of position because of the hook 102 in the notch 92. The engagement of the edge 106 of portion 98 with the wall 74 of recess 72 and the leg 100 with the shoulder 32 of the casing rabbet prevents the key from being moved radially outwardly and consequently prevents the hook 102 from being removed from the notch 92 when the lower half ring is assembled in the lower casing half as shown.

The key can be removed simply by sliding the lower half ring containing the recess and notch partially out of the casing half to the position shown in Figs. 2, 3 and 4 whereupon the key can be easily removed by merely moving it in a radially outward direction.

The assembly of the unit is simple, requiring only that one end of each half ring with the vanes attached thereto be inserted into one end of a space 70 with the rabbets 64 of the ring being inserted into the oppositely facing recesses 42 of adjacent rabbets 22 whereafter the half ring is slid circumferentially around the recess into the positions shown in Fig. 2. Then the key can be easily grasped by the fingers and slipped into place on the half ring partially removed from the casing and having the notch by moving it radially inwardly thereby moving the hook 102 into the notch 92 and at the same time the locking portion 98 into the recess 78, thereby hooking the key on the ring rabbet and interlocking them together, as shown in Figs. 3 and 4. Thereafter the half

ring with the locking key hooked thereto is slid all the way into assembled position in the casing, as shown in Fig. 5, the locking portion 98 moving into locking position in the recess 72 in the edge of the casing rabbet and the recess 78 in the edge of the portion 68 of the other half ring. The key associated with the other edge of the lower half of the casing rabbet 22, shown in Fig. 3, and the other corresponding edges of the lower halves of the ring rabbets supported by such casing rabbet is hooked in the same way to the ring rabbet of the lower half ring shown in assembled position in the casing half in Fig. 3 while it is partially removed from the other edge of the casing half since the half ring shown in Fig. 3 partially removed from the casing half cannot be slid out of the other edge of the casing half once the key is hooked thereto. Another alternate construction of these other edges is to make them non-recessed, the recesses and notch being provided in the edge of the upper half of the casing rabbet and the corresponding edges of the upper halves of the ring rabbets abutting such other edges. However, only one key is needed for each complete ring so that it is not essential to provide another key for these other edges. After all the half rings and keys are assembled in their casing halves, the two halves are bolted together.

If merely the thin disc 98 is used as a key without the leg 100 and hook 102 there is nothing to hold it in its shallow recess when the upper half of the compressor is removed from the lower half. Since there are a number of such tiny discs being held in place only by gravity it will be realized that it is very easy for some of them to fall out of their recesses into the casing during assembly, in many cases without the assembler even knowing that it has happened. These loose keys which have fallen into the casing are apt to cause damage during operation of the compressor and furthermore the particular rings with which they were intended to be associated are not locked against rotation around the casing. Even if the assembler is aware that the keys have fallen into the casing it is time consuming to remove them. Furthermore, it is difficult to handle such small parts since there is very little to hold onto and consequently while they are being assembled in their recesses they are prone to slip out of the fingers into the casing. They have to be dropped into the recesses and consequently they are prone to assume improper positions. This also increases the tendency of the small keys to fall into the casing interior.

In accordance with the present invention each key is like a clip or hook and is in effect very easily clipped or hooked on the ring segment in the position shown in Fig. 3. It can be firmly held in the fingers while it is being so hooked or clipped so that the danger of its slipping out of the fingers is reduced. Once it is hooked or clipped on the ring segment there is very little danger of it falling out during the time it takes to move the ring segment with the key hooked thereto into place in its casing segment. It can be kept in its hooked position on the ring segment very easily merely by the pressure of the finger while the ring segment is being slid into place. Furthermore, the key is always assembled in the proper position in its recess since once it is pushed into the notch and recess it cannot help but be moved into proper position when the ring segment is slid into place. Although it cannot be removed when the ring segment is assembled in its casing half because of the casing recess wall 74 and the shoulder 32 of the casing rabbet it is easily removed by merely sliding part of the ring segment from the casing half. It is locked in place by an interlocking of the parts of the key, the ring segment and the casing segment and without any additional separate part such as a screw or bolt.

As described in the above mentioned Oppenheimer application the half rings are supported rigidly by the supporting surfaces 34 of the casing rabbets 22 but are

spaced from the shell 20 of the casing and the shoulders 32 so that they are not rigidly supported against movement in a radially outward direction, the ring rabbets being yieldably held against the radially outwardly facing supporting surfaces of the casing rabbet by air pressure in chambers 70. The keys are so designed that the radially inwardly facing surface of the leg 100 is spaced a sufficient distance from the radially outwardly facing surface 34 of the tongue 30 so that the key does not interfere with this feature. That is, the sum of the radial thicknesses of the leg 100 and portion 68 of the ring rabbet is less than the radial width of space 42. Furthermore, the key has some radial play with respect to the casing rabbet.

The recesses and notches can be located in the top halves of the casing and rings, in which case the keys are clipped or hooked on the top halves of the rings and the top half of the casing holds the keys in clipped position. Furthermore, the notch can be in the lower half of the ring and the cooperating ring and casing recesses in the top halves of the rings and casing, or the casing recess can be in the lower half of the casing and the ring recesses and notch in the upper half or vice versa or the casing recess can be in the top casing half, the notch in the top ring half and the ring recesses in the lower ring half. Furthermore, both the adjacent edges of the top and bottom halves of the rings and casing can be recessed so that the portion 98 is located partly in the recesses in the edges of the top halves and partly in the recesses in the edges of the bottom halves. The terms "bottom" and "top" and "upper" and "lower" are used herein only for the purpose of simplifying the description, and they are not intended to limit the invention in any way because what is "bottom" and "lower" becomes "top" and "upper" and vice versa when the unit is turned upside down. Although a compressor has been described having two halves, the present invention is useful with compressors or turbines having casings and rings split into any number of segments and even in units in which the rings are in one piece and the casing is split into segments.

Furthermore, although the locking mechanism of the present invention is particularly suitable for use in small compressors and turbines used in small engines it can be used in larger units.

Figs. 7 and 8 show another embodiment of the present invention in which the locking portion of the key has a pair of legs 112 and 114 each of which has a locking hook 116 and 118 respectively and the portion 68 of the ring rabbets of both of the ring halves associated with each casing rabbet have notches similar to notch 92. In such case, in clipping the key in place, both of these ring halves must be partially removed from the casing half to positions similar to the position occupied by the single partially removed half ring in Fig. 3 whereupon the key is slipped in place by sliding each foot into its notch and the locking portion 98 into the recesses 78 in the edges of the rabbets of both half rings whereafter both rings are pushed into place at the same time and occupy the positions shown in Fig. 8. The locking portion 98 is moved into locking position in recess 72 when the half rings are pushed into place. In such case the key associated with the other adjacent edges of the half rings and casing halves must be clipped to the edges of the top halves of the ring rabbets and the recesses are located in the top halves of the casing and ring rabbets.

Fig. 9 shows a ring and casing construction exactly like that shown in the above mentioned Oppenheimer application in that each ring has two stages of vanes and has a radially outwardly extending steadying rim or rabbet 120 intermediate thereof between the two stages of vanes. This rim cooperates with a steadying rim or rabbet 122 extending radially inwardly from the casing shell between adjacent T-shaped rabbets, all as described in the

above mentioned application. In the construction of Fig. 1 these steadying rims or rabbets are omitted. However, this does not affect the operation of the compressor or the locking mechanism of the present invention.

We claim:

1. A stator vane assembly comprising an annular casing made up of at least two casing segments, an annular stator vane ring mounted in said casing, said ring being made up of at least two ring segments, said ring having an annular segmented rabbet, said casing having an annular segmented casing rabbet cooperating in circumferential engagement with the ring rabbet to support said ring in said casing, a locking key having a locking portion located between the adjacent edges of adjacent ring segments and the corresponding adjacent edges of the casing segments containing said ring segments for locking said ring segments against rotation around said casing, said locking key and one of said ring segments having a hook and the other a hook engaging portion for engaging said hook and securing said key on said one of said ring segments and against falling out of locking position with respect to the edge of said ring segment when said ring segment is disassembled from said casing segment, a portion of the casing segment in which said one of said ring segments is located overlying said key when said ring segment is in assembled position in said casing segment to lock said hook against moving out of engaged relationship with said hook engaging portion.

2. An assembly according to claim 1, said one of said ring segments having said hook engaging portion which comprises a notch therein spaced circumferentially from the edge thereof and said key having said hook which is receivable in said notch to hold said key on said ring segment with said locking portion in locking position with respect to the edge of said ring segment, said hook and locking portion of said key being slidable into and out of said notch and said locking position respectively to hook and unhook said key to and from said ring segment respectively when the portion of said ring segment having said notch is removed from its casing segment.

3. An assembly according to claim 2 wherein each of said casing segments together with its ring segment assembled therein comprises a casing and ring segment assembly, said adjacent edges of said adjacent ring segments and adjacent casing segments abutting against each other when the casing and ring segment assemblies are assembled, a recess in at least one of the abutting edges of the rabbets of adjacent casing segments, a recess in at least one of the corresponding abutting edges of the rabbets of the adjacent ring segments contained in said adjacent casing segments, said locking portion of said key lying in said recesses.

4. A stator vane assembly comprising a casing made up of at least two segments, a stator vane ring in said casing made up of at least two corresponding segments, said ring having an annular ring rabbet, said casing having an annular casing rabbet for cooperating with said ring rabbet to support said ring in said casing, each of said casing segments together with its ring segment assembled therein comprising a casing and ring segment assembly, the adjacent edges of adjacent ring and casing segments abutting against each other when the casing is assembled, a recess in the edge of the casing rabbet of a casing segment and in the corresponding edge of the ring rabbet of a ring segment mounted in said casing segment, a locking key having at least a portion thereof receivable in said recess and fitting snugly between the bottom of the recess and the adjacent edges of the ring and casing rabbets of the adjacent ring and casing segments, a notch in the rabbet of the ring segment having said recess, said notch being spaced circumferentially from said recess in said ring segment, said key having a locking hook extending into said notch to prevent said locking portion of said key from accidentally falling out of said recess in said ring segment during assembly and

disassembly and while the casing and ring segment assemblies are removed from each other, said key being movable in a radial direction to slide said locking portion and hook into and out of said recess and said notch in said ring segment when the portion of the ring segment in which said recess and notch are located is moved out of its casing segment, said locking portion of said key being movable with said ring segment while it is hooked thereto, into and out of said recess in said casing rabbet when said portion of said ring segment is moved into and out of said casing segment respectively, a portion of said casing segment which contains said ring segment overlying said key and thereby locking said key against movement of said hook in a radial direction out of said notch when said ring segment is in assembled position in said casing segment, said movement of said locking portion of said key into and out of said casing recess moving said key into and out of overlying relationship with said portion of said casing segment respectively.

5. A stator vane assembly comprising an annular casing made up of at least two casing segments, an annular stator vane ring mounted in said casing, said ring being made up of at least two ring segments, said ring having an annular segmented ring rabbet, said casing having an annular segmented casing rabbet for cooperating in circumferential engagement with said ring rabbet to support said ring in said casing, each of said casing segments together with a ring segment assembled therein comprising a casing and ring segment assembly, a locking key formed with a locking portion located in a recess in one of the abutting edges of at least one of the casing rabbet segments and in a recess in a corresponding abutting edge of at least one of the ring rabbet segments, said locking portion cooperating with an abutting edge of an adjacent ring rabbet segment and with an abutting edge of an adjacent casing rabbet segment for locking said ring segments against rotation around said casing, said locking key formed with a hook, a notch spaced circumferentially from said abutting edge formed in one of said ring rabbet segments, such that said locking key is movable into and out of interlocking relationship with said one of said ring rabbet segments when the ring segment associated therewith is disassembled from the corresponding one of said casing segments, said one of said casing segments securing said locking key against movement relative to said one of said ring rabbet segments when said ring segment associated therewith is assembled with said one of said casing segments.

6. A stator vane assembly comprising an annular casing made up of at least two casing segments, at least two annular stator vane rings mounted in said casing, each of said rings being made up of at least two ring segments, each of said rings having an annular segmented ring rabbet, said casing having annular segmented casing rabbets for cooperating in circumferential engagement with said ring rabbets to support said rings in said casing, each of said casing segments together with the ring segments assembled therein comprising a casing and ring segment assembly, a locking key formed with a locking portion located in a recess in an edge of at least one of the casing rabbet segments and in a recess in a corresponding edge of at least one of the ring rabbet segments of each of said rings, said locking portion cooperating with an edge of an adjacent ring rabbet segment of each of said rings and with an edge of an adjacent casing rabbet segment for locking said ring segments against rotation around said casing, said locking key formed with at least two hooks, a notch formed in said one of said ring rabbet segments of each of said rings and spaced circumferentially from said edge thereof, such that said locking key is movable into and out of interlocking relationship with said one of said ring rabbet segments of each of said rings when said ring segments are disassembled from a corresponding one of said casing segments, said one of said casing

segments securing said locking key against movement relative to said one of said ring segments of each of said rings when said ones of said ring and casing segments are assembled.

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