May 15, 1956 DE WITT L. KING ET AL 2,745,171

METHOD OF PRODUCING A BLADED STRUCTURE

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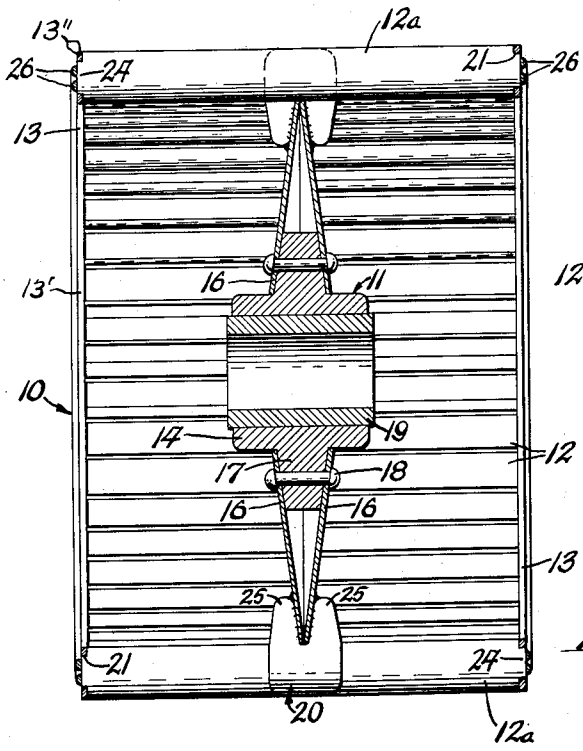


Fig. 1.

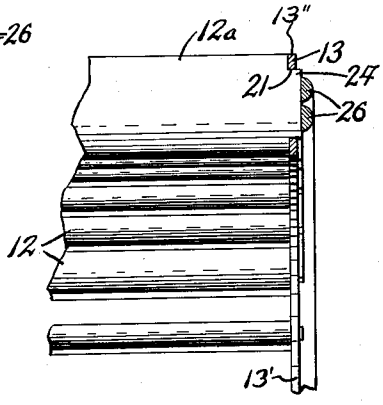


Fig. 3.

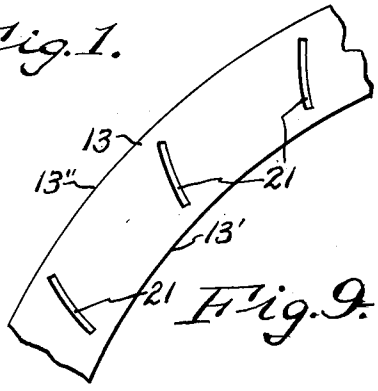


Fig. 9.

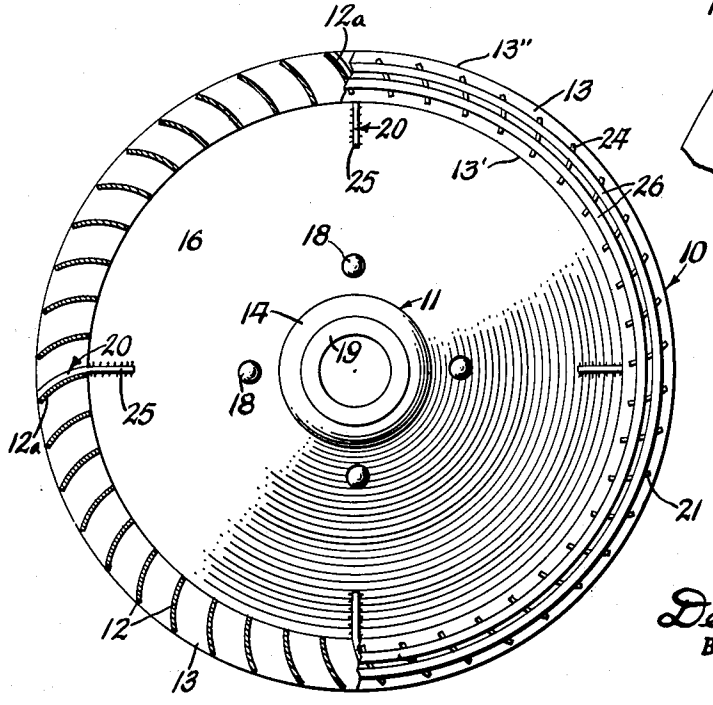


Fig. 2.

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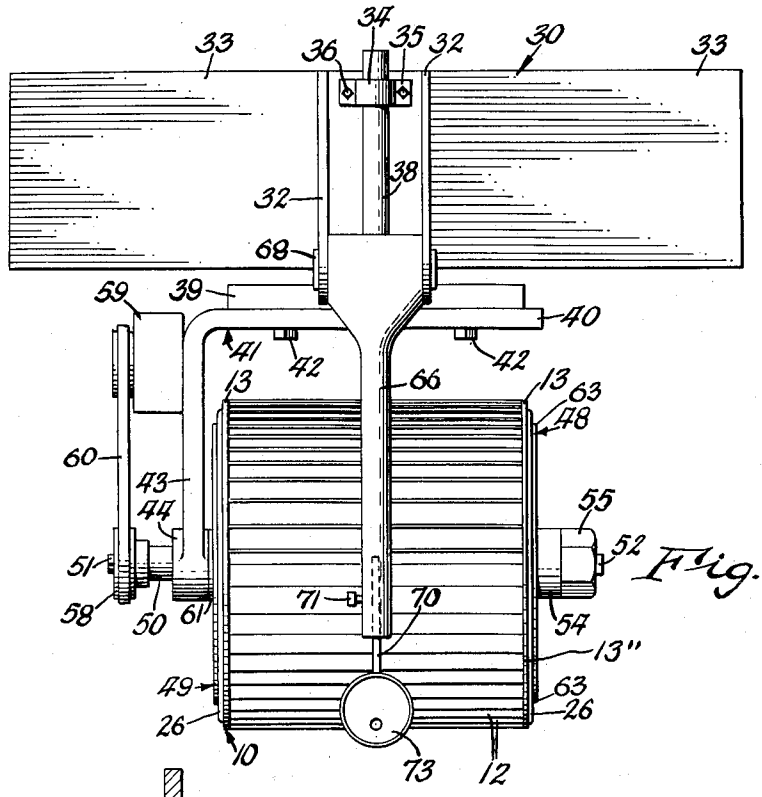


Fig. 4.

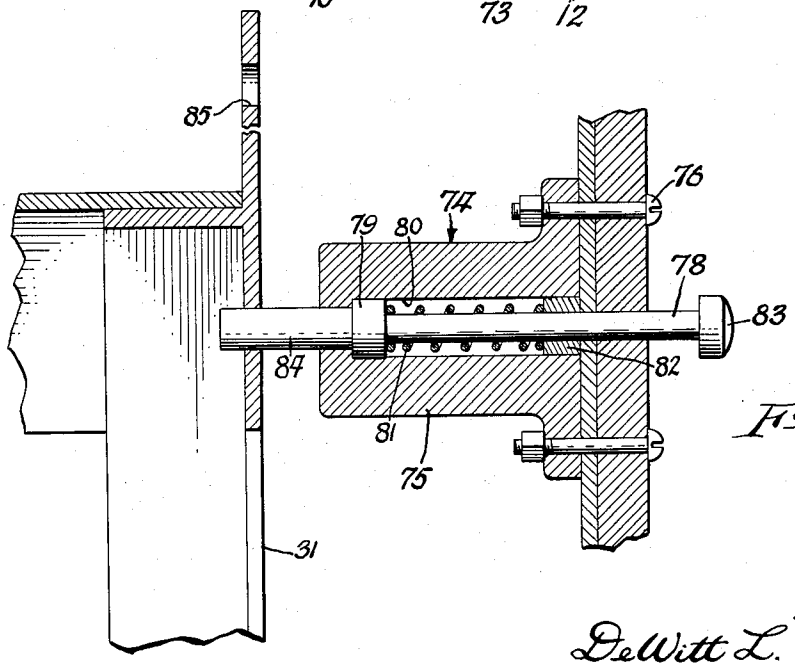


Fig. 5.

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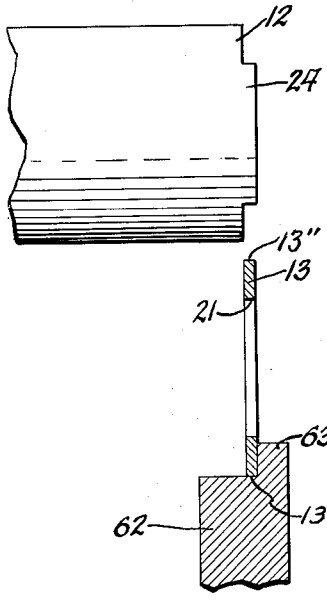
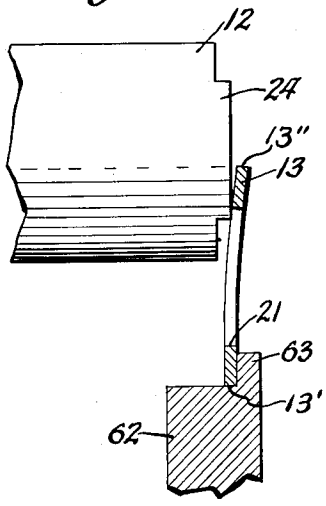


Fig. 6.

Fig. 7.



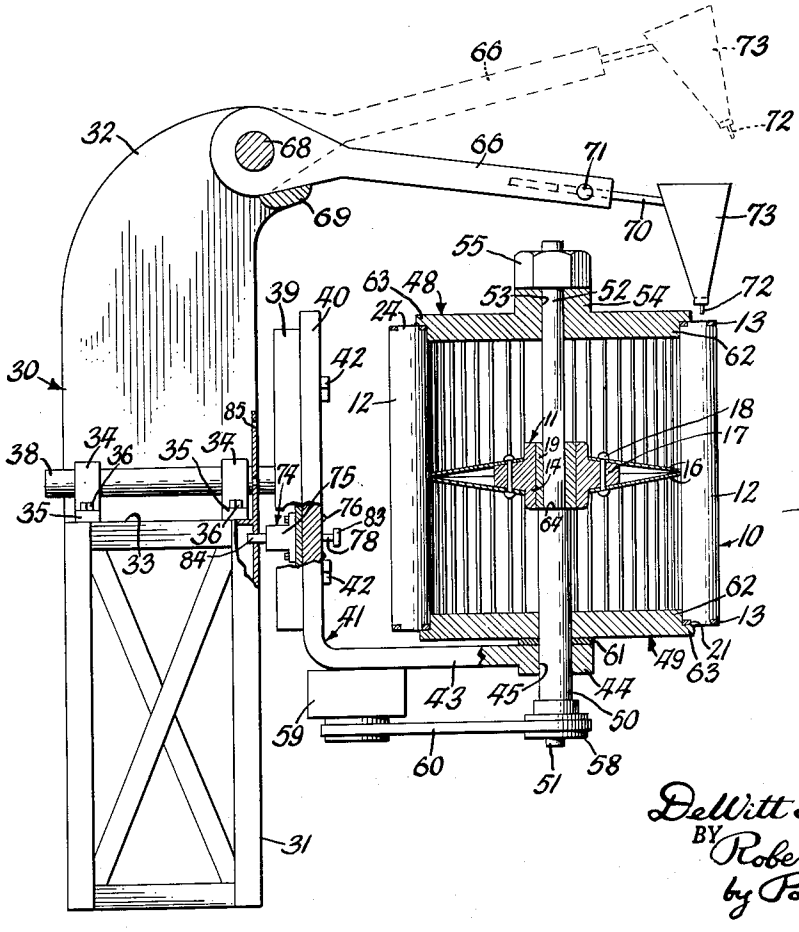


Fig. 8.

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METHOD OF PRODUCING A BLADED STRUCTURE

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Application September 8, 1949, Serial No. 114,652

1 Claim. (Cl. 29—156.8)

This invention relates generally to a method of producing a bladed structure and more particularly to producing an improved bladed structure such as a fan or blower rotor.

In the manufacture of bladed structures such as fan or blower rotors it is a common practice to utilize a series of elongated, substantially parallel blades, arranged in an annulus about a hub or central support. Each of the blades in the series is attached at its ends to a pair of end plates or rings and the assemblage is driven from the hub by driver plates having a connection with certain of the blades.

It is an object of the present invention to provide a fan or rotor structure which is simple in construction, is easy to assemble, and is stronger than those heretofore produced.

Another object of the invention is to provide a fan or rotor structure which utilizes blades which are of simple design and a pair of identical thin, flat end rings.

Further objects of the invention are to provide a fan or rotor structure in which the blades are securely and rigidly attached to the end rings and in which the rigidity and strength of the end rings are increased by such attaching means.

Still another object of the invention is to provide a novel and improved method of assembly of fan or rotor structures of this character which reduces the expense of manufacture.

Additional objects of the invention will be apparent from the following description taken in conjunction with the drawings.

In the drawings:

Fig. 1 is a longitudinal sectional view of a fan or blower rotor constructed in accordance with the present invention.

Fig. 2 is an end view of a rotor like that shown in Fig. 1 with part of one of the end rings cut away to show the rotor blade arrangement.

Fig. 3 is an enlarged, fragmentary view of a portion of Fig. 1 showing details of the attachment of the end of a rotor blade to an end ring.

Fig. 4 is a plan view of a machine embodying a rotatable jig which may be used in the assembly of rotors constructed in accordance with the present invention, an assembled rotor being shown in position thereon.

Fig. 5 is an enlarged detail view in section of a detent or lock for positioning the jig.

Figs. 6 and 7 are enlarged detail views illustrating the method by which the rotor blades are positioned between the end plates; and

Fig. 8 is a vertical sectional view of the machine and jig illustrated in Fig. 4 with the jig turned into position for weldng the end rings on the rotor, and with the rotor assembly shown in section.

Fig. 9 is an enlarged, fragmentary side elevational view of one of the identical flat sheet metal end rings of the bladed structure.

Referring to the drawings, the numeral **10** is applied

generally to the fan or blower rotor of the present invention. The rotor **10**, as shown in Fig. 1, comprises a central support **11** and an annular series of blades **12** and **12***a* surrounding the support and having their ends attached to end rings **13**.

The central support **11** comprises a hub **14** and a pair of dished, sheet metal discs **16** which are attached, with their concave sides facing, to a peripheral medial flange **17** of the hub **14**. The discs **16** are secured to the flange **17** on opposite sides thereof by suitable means such, for example, as rivets **18**. A machined bearing bushing **19** may, if desired, be inserted in the tubular hub **14**.

The rotor blades **12** are elongated and transversely curved and are preferably formed of thin metal strips of uniform cross-section. They are interchangeably similar or, preferably, identical. The driver blades **12***a* are substantially similar to and are preferably identical with the blades **12** except that each driver blade **12***a* has a driver plate **20** attached to its rear face by welding or other suitable means. The blades **12** are arranged around the support **11** in parallel spaced relation with a plurality of the driver blades **12***a* placed at equi-distant intervals in the annular series. All of the blades are maintained in proper alignment by the end rings **13**.

The flat end rings **13** are identical and are conveniently formed by stamping from thin sheet metal. The flat end rings **13**, as best shown in Figs. 1 through 3 and 6 through 9, have inner margins **13′** spaced from their outer margins **13″**. The rings **13** are provided with a series of regularly spaced, transverse, curved slots **21** extending between their flat faces. The opposite ends of each slot **21** terminate close to the inner and outer margins **13′** and **13″** of its ring **13**. Each of the blades **12** and **12***a* has its corners notched to provide a longitudinally extending tongue **24** at each end thereof, the tongues **24** being adapted to pass through and fit snugly within the slots **21** in the end rings **13**, as shown in Figs. 3, 6 and 7. The tongues **24** are accordingly of smaller size than the blades **12**, **12***a*.

The driver plates **20** have an outer portion curved similarly to the rotor blades **12** and an inner bifurcated portion forming wings **25** which are adapted to extend toward the hub **14** on opposite sides of the driver discs **16**. The number of driver plates **20** employed will vary in accordance with the size and number of blades of the rotor, but they are preferably spaced equi-distantly around the hub **14**. The wings **25** of the plates **20** are attached by welding or other suitable means to the discs **16**.

As shown most clearly in Figs. 2 and 3, the tongues **24** of the blades **12** and **12***a* project slightly beyond the slots **21** in the end rings **13** to form a series of small transverse ridges. The blades **12** and **12***a* are preferably secured in place in slots **21** by forming one or more continuous annular weld beads **26** on the outer faces of the rings **13** over the projecting ends of the tongues **24**. Not only do the weld beads **26** thus securely fasten the rotor blades **12** and **12***a* in place, but they also serve materially to stiffen and strengthen the flat end rings **13** and to make the fan or rotor structure more rigid.

The improved fan or rotor construction above described can, of course, be assembled in a number of different ways. It has been found, however, that the rotor of the present invention can be most convenient and economically assembled by the novel method hereinafter described.

As previously mentioned, and as particularly shown in Figs. 6 and 7, the tongues **24** on the ends of the blades **12** and **12***a* project only slightly beyond the outside faces of the end rings **13**. As shown in Fig. 7, the end rings **13**, being of thin sheet metal, may be sprung sufficiently at their outer edges to permit the insertion of the blades **12** and **12***a* between the rings with the tongues **24** of the blades passing through the slots **21**. The assembly of the fan in this way is most conveniently carried out with

the aid of a rotatable jig. The jig and its mounting are shown in Figs. 4–8, in which the numeral 30 indicates generally the machine or apparatus for supporting the jig.

The support 30 comprises a reinforced base 31 having thereon, preferably on each side of the middle thereof, a pair of spaced, upwardly extending plates 32. Arranged on the base 31 outside each of the plates 32 are horizontal surfaces 33 which may be used as work surfaces for tools and the like. A pair of bearings 34 having side flanges 35 are secured by bolts or screws 36 to the base 31 intermediate the vertical, spaced plates 32. The bearings 34 are aligned in a plane parallel to the vertical plates 32 and transversely of the base 31 and are adapted to receive a shaft 38 therein for rotation about a horizontal axis. At its forward end the shaft 38 is secured by suitable means to a circular plate 39 which is strengthened and made rigid by a rearwardly extending flange around its periphery.

One leg 40 of an L-shaped bar 41 is attached to the forward face of the plate 39 by bolts 42 or other suitable means. The other leg 43 of the bar 41 extends forwardly at an angle of 90 degrees to the leg 40 and supports the jig. At its forward end the leg 43 is provided with an enlarged portion 44 having a hole 45 therein, the axis of the hole 45 being in a plane parallel to the arm 40 of the bar 41.

The rotatable jig preferably employed in assembling the fan or rotor of the present invention comprises a pair of jig plates 48 and 49 and a shaft 50. The jig plate 49 is attached to the shaft 50 adjacent the end 51 thereof. The shaft 50 at approximately its midpoint is reduced in diameter, the reduced portion 52 being slidably received within the central bore 53 of the other jig plate 48. The jig plate 48 is also provided with a central, outwardly extending boss 54 surrounding the shaft 50. A nut 55 is provided on the threaded outer end of the reduced portion 52 of the shaft 50 to prevent outward movement or removal of the jig plate 48.

When positioned as shown in Fig. 8, with the leg 40 of the L-shaped jig supporting bar 41 in vertical position, the jig plate 49 is horizontally disposed and the shaft 50 extends vertically. The lower end 51 of the shaft 50 passes through the hole 45 in the leg 43 and extends below the enlarged portion 44. A pulley 58 is mounted on the end 51 of the shaft 50 and the jig is adapted to be rotated, when required, by a motor 59 mounted on the leg 43 and operatively connected by a belt 60 to the pulley 58. A washer 61 adapted to absorb wear and impact is inserted between the enlarged portion 44 of the leg 43 and the lower jig plate 49.

Each of the jig plates 48 and 49 is provided, as shown in Fig. 8, with a central, axially extending portion 62 which is the same diameter as the inside diameter of the end rings 13. A circumferential, outwardly extending flange 63 is provided on each of jig plates 48 and 49 adjacent said central portions 62, the flanges being materially narrower than the end rings 13.

In assembling the blades 12 and 12*a*, the rings 13, and the support 11 into a rotor the rotatable jig is positioned as shown in Fig. 4 with the shaft 50 horizontal. The end rings 13 are placed, in parallel relation and with the slots 21 therein aligned, on the jig plates 48 and 49 around the facing central portions 62. The jig plates are spaced apart on the shaft 50 with the nut 55 preventing the further separation of the plates. The central support 11 is mounted on the shaft 50 between the jig plates 48 and 49 and rests against the shoulder 64 formed on the shaft 50 at the inner end of its reduced portion 52.

The blades 12 and the driver blades 12*a* are then successively placed in position around the discs 16 between the parallel end rings 13, and the tongues 24 of each of the blades are inserted in the corresponding aligned slots 21 of the end rings. To do this, it is necessary, as shown in Fig. 7, to slightly spring or flex the outer

edge of one of the end rings 13 outwardly and away from the blade so as to permit entry of the tongue 24 into the slot 21. However, since the end rings 13 are of thin, resilient sheet metal and since the amount of springing required is small, this operation poses no difficulty.

In placing the blades 12 and 12*a* in position, it will be necessary, of course, to take care that the driver blades 12*a* are symmetrically spaced around the central support 11 with the wings 25 of the driver plates 20 which are attached to the blades 12*a* located on opposite sides of the discs 16. It will be found convenient in inserting the blades in the manner above described to rotate the jig through a partial revolution at intervals so as to permit easy access to all sides of the rotor which is being assembled. For this purpose the jig may be rotated by hand or the motor 59 may be intermittently operated to produce by its connection through the pulley 58 and the belt 60, rotation of the shaft 50 of the jig.

When all of the blades 12 and 12*a* have been placed in position in the manner described above, the plate 39 and the jig supporting bar 41 are turned to place the jig in the vertical position shown in Fig. 8, in which position it is preferred to weld the blades in place between the end rings 13. In the welding, use is made of an arm 66 one end of which is supported for pivotal movement in a vertical plane by a pin 68 carried by and extending between the upper ends of the two vertical, spaced plates 32.

The arm 66 normally extends outwardly over the jig in a substantially horizontal position in the same vertical plane as the shaft 50. A stop arm or lug 69 is provided on one of the vertical plates 32 to thus support the arm 66. When the arm 66 is not in use it may be raised as shown in dotted lines in Fig. 8 to position it out of the way. An extension 70 is telescopically mounted in the outer end of the arm 66 and a set screw 71 is provided on the arm 66 to retain the extension 70 fixed in adjusted position.

A welding electrode conventionally shown at 72 is carried on the outer end of the extension 70. In conjunction with the electrodes 72 there is provided a suitable electrical connection and an automatic electrode feeding device (not shown) for maintaining the distance between the electrode 72 and the end rings 13 constant during welding. The electrode feeding device may be of any of the well known types or designs. The extension 70 also carries a hopper 73 which is adapted to be filled with a granular reducible material used in producing the weld.

The weld method employed is a well known method, identified as submerged arc welding, and is characterized by the formation of the weld bead under a blanket of reductible granular material which is fed onto the face of the end plates 13 from the hopper 73 just ahead of the electrode 72. The resultant annular bead 26 of weld metal is continuous and is very clean and solid. In depositing the welding metal, the arc is drawn between the electrode 72 and the end ring 13 under the layer of granular reducible material, the end ring being connected to ground through the jig and the jig support 30. The jig is rotated at a constant speed by the motor 59 through the belt 60 and the pulley 58 during the deposition of metal, thus making the metal deposition automatic.

Additional similar annular weld beads are placed on the end ring 13 by adjusting the extension 70 to properly locate the electrode 72.

When the desired number of rings of weld metal have been placed on the top end ring 13 of the assembly, as shown in Fig. 8, the L-shaped jig supporting bar 41 is turned through 180 degrees so that the jig plate 49 is uppermost and the welding process is repeated on the other end plate 13. Before disassembling the jig after both end plates have been welded to the protruding ends of the tongues 24 of the blades 12 and 12*a*, the driver plates 20 carried by the driver blades 12*a* are temporarily secured, preferably by tack welding, to the discs 16 ex-

tending from the hub **14**. After the assembled rotor is removed from the jig, the welding of the driver plates **20** to the discs **16** is completed.

In order to conveniently hold the jig-supporting bar **41** and the plate **39** in the desired angular position during use of the jig, a detent or locking device **74** has been provided. The locking device **74**, shown most clearly in Fig. 5, comprises a casing **75**, secured to the back of the plate **39** by suitable means such as the bolts **76**, and a plunger **78** having an enlarged piston-like portion **79** slidable in a bore **80** in the casing **75**. A helical spring **81** is situated in the bore **80** around the plunger **78** and is retained in position to bear against the enlarged portion **79** or the plunger **78** by a tubular bushing **82** through which the plunger extends. A head **83** for convenient manual manipulation is provided at the outer end of the plunger **78**, which extends through the plate **39** and the bar **41**.

At the other side of the enlarged portion **79** and extending through the end of the casing **75** there is provided an extension **84** which is adapted to engage in a plurality of spaced, circularly arranged holes **85** in a plate **86** which is attached integrally or otherwise to the front of the base **31** of the jig support **30**. The holes **85** are located so that the jig may, during assembly of the rotor, be secured in a horizontal positon as in Fig. 4, in a vertical position as in Fig. 8, or in a vertical position rotated 180 degrees from the position shown in Fig. 8, as required. Shifting of the jig from one position to another is accomplished manually, the nob **83** being first pulled outwardly to disengage the extension **84** from the hole **85** and the jig support being then turned to the desired position. The knob **84** should then be released to permit the extension **84** of the detent **74** to engage in the proper hole **85** to prevent undesired movement of the jig.

It will be seen that the manipulative steps of the present invention essentially comprise spacing the pair of rings **13, 13** axially from each other a distance slightly less than the overall length of the blades **12, 12*a***, including their tongues **24** and with the slots **21** of these rings **13** in register with one another; holding the inner margins **13'** of these rings, completely around these rings, against further separation; springing successive portions around these rings of the outer margin **13''** of at least one of the rings beyond said distance (less than the overall length of the bleds **12, 12*a***) to permit the successive insertion of the tongues **24** of the blades into the corresponding pair of slots **21** of the rings, such insertion being lengthwise of the slots **21** of the rings, such insertion being lengthwise of the slots **21** from the ends of the slots adjacent the outer margins **13''**; successively releasing the sprung portions of said outer margin to trap the blades in the slots **21**; and thereafter welding the tongues **24** to the rings **13**.

From the foregoing description it will be apparent that the present invention provides a bladed structure which is very simple in construction and is easily assembled. The end rings **13** being identical may be inexpensively produced and no distinction is required between the rings used on opposite ends of the fan or rotor. The provision of continuous annular weld beads on the outside faces of the end rings to securely fasten the blades in place adds greatly to the rigidity and strength of the end rings and results in a lighter, stronger rotor.

The design of the rotor or fan of the present invention is such that a novel and improved method of assembly may be employed. In this method, as pointed out above, the end rings are spaced apart and the blades are inserted between the end rings around the central support, the tongues on the blades being engaged in the slots in the end rings while the outside edge of one of the end rings is sprung slightly away from the blade. The speed with which the assembly operation can be carried out as a result of the interchangeability of the blades **12** or **12*a*** and the identical structure of the end rings **13**, together with the fact that the continuous welded beads on the outside faces of the end rings which hold the blades and end rings in rigid assembled relation can be applied automatically, makes the assembly process of the present invention inexpensive and thus reduces the cost of fans or rotors produced in accordance therewith.

The assembly of blades, support, and end rings is well balanced since the end rings are identical, all of the blades are preferably identical, and the blades and driver plates attaching certain of the blades to the support for rotation therewith are symmetrically arranged around the support. The weld beads on the outside faces of the end rings are continuous and automatically applied. Consequently, being uniform, they do not affect the balance of the rotor.

We claim:

The method of producing a bladed structure from a pair of substantially identical and substantially flat end rings having inner and outer margins and said rings also having an annular series of registering, regularly spaced, transverse slots therethrough, the opposite ends of each of said slots terminating close to the inner and outer margin of the corresponding end ring, and a series of identical, longitudinally straight blades each continued at its opposite ends to form tongues of smaller size than said blades transversely of said blades, which comprises spacing said rings axially from each other a distance slightly less than the overall length of said blades including said tongues and with the slots of one ring in register with the slots of the other ring, holding said inner margins of said rings, completely around said rings, against further separation, springing successive adjacent segments of the outer margin of at least one of said rings progressively beyond said distance to permit the successive insertion of the tongues of said blades into the corresponding pairs of slots of said pair of rings, said insertion of said blades at the progressively sprung segments of said rings being lengthwise of said slots from the ends of said slots adjacent said outer margins of said rings, progressively releasing said sprung adjacent segments of said rings to trap said tongues of said blades in said slots, and thereafter welding said tongues to said rings.

References Cited in the file of this patent

UNITED STATES PATENTS

741,860	Wheeler	Oct. 20, 1903
1,366,667	Junggren	Jan. 25, 1921
1,484,579	Still	Feb. 19, 1924
1,637,652	Ness	Aug. 2, 1927
1,876,518	Mathis	Sept. 6, 1932
1,890,226	Mathis	Dec. 6, 1932
2,157,441	Sullivan	May 9, 1939
2,258,050	Evans	Oct. 7, 1941
2,480,804	Yeager	Aug. 30, 1949

FOREIGN PATENTS

267,405	Great Britain	Mar. 17, 1927