



1 IMPROVED BUSHING FOR A JET ENGINE VANE

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1. Field of the Invention

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2. Discussion of the Related Art

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The present invention relates generally to a bushing for a jet engine and more specifically to an improved bushing which is less expensive to manufacture and which facilitates shipping and installation of the bushing.

Jet engines generally include an axial air compressor which supplies compressed air into a combustor. The front section of a jet engine includes the axial air compressor. The axial air compressor generally includes several consecutive stages, each having a number of stator (stationary) vanes in a shroud and an equal number of rotor (rotating) vanes. Rotor vanes are designed and arranged such that, as the rotor vanes pass by the stator vanes in a particular stage, they take in a volume of air, compress the air and pass this compressed air into the next stage for further compression of the air. Some jet engines, such as the CFM56-2 turbofan engine manufactured by General Electric for example, have thirteen stages of compression. Stages 1 through 5 of this engine have stator vanes in which the pitch of the vanes is variable. The pitch of the variable stator vanes can be adjusted to vary the volume of air intake and thereby control the volume and pressure of the air that is subsequently injected into the combustor to be combined with fuel and ignited. The thrust of the engines can thereby be varied and the amount of air can be metered accurately for maximum fuel consumption. This is desirable because it provides the

1 pilot with greater control over the amount of thrust
2 produced within the engine at given engine speeds. For
3 example, when the pilot is bringing the jet in for a
4 landing, he or she can keep the engine running at very
5 high RPMs and vary the pitch of the vanes to generate
6 less thrust within the engine. If there is a problem and
7 the pilot has to quickly generate thrust to pull up, he
8 or she simply rotates the vanes of the stator to a pitch
9 which increases the amount of air directed into the
10 stator, thus increasing the thrust produced by the
11 engine. The adjustable vanes allow the pilot to quickly
12 produce thrust without having to adjust the RPMs at which
13 the rotor is rotating.

14 As shown in Fig. 7, each vane 10 of the engine
15 described above includes a blade 12 which is rotatably
16 mounted between an inner shroud 14 and an outer
17 shroud 15. It will be understood that each stator of a
18 jet engine may include several stages, each having many
19 adjustable vanes. However, for simplicity, only one vane
20 is shown in Fig. 7. Vane 10 includes a spindle,
21 partially shown at 16 in Fig. 7 and fully shown at 16 in
22 Fig. 1, which is held in place between portions 20a
23 and 20b of inner shroud 14 within aperture 18. Vane 10
24 also includes a drive portion 22 mounted within outer
25 shroud 15. A steering mechanism (not shown) is coupled
26 to the drive portion 22 to rotate the vane 10 within the
27 inner shroud 14 and the outer shroud 15.

28 In order to facilitate the rotation of the vane 10,
29 a bushing is mounted on spindle 16 before it is
30 mounted between portions 20a and 20b of inner shroud 14.
31 A prior art bushing 24 is shown in Figs. 1 and 2. Since
32 the operating temperature of the jet engine can reach 550°
33 F, bushing 24 must be made from a material that can
34 withstand the extremely high temperatures to which it

1 will be subjected. Therefore, bushing 24 is typically
2 formed from a plastic which is capable of withstanding
3 these temperatures. One prior art bushing 24 is formed
4 from a plastic material sold by DuPont under the
5 trademark VESPEL. However, this material is not capable
6 of being melt processed, meaning that it cannot be used
7 in an injection molding process to form the bushing 24.
8 Bushing 24 is typically formed from a billet of the
9 VESPEL material and is machined to the shape shown in
10 Fig. 1, including a circumferential groove 28 (Fig. 2).
11 The bushing 24 is then cut in half to form parts 26a
12 and 26b. An elastic band 30, made from a high
13 temperature-resistant material, is placed within groove
14 28 to hold parts 26a and 26b together on spindle 16 until
15 the spindle is mounted to inner shroud 14, as described
16 above.

17 Due to the properties of the material used in the
18 manufacture of bushing 24, the requirement that each
19 bushing be separately machined and the requirement for
20 the elastic band 30, bushing 24 is very time consuming
21 and expensive to manufacture. Shipping the bushings from
22 the manufacturer to the end user is problematic because
23 the three-piece bushings are prone to disassembling
24 during shipping, thus requiring extra time for
25 reassembling the bushing before it is installed on the
26 vane 10. Furthermore, since each part 26a and 26b must
27 be held in place on spindle 16 while the elastic band 30
28 is installed, the installation of bushing 24 on the
29 vane 10 is very time consuming. Since, every time a jet
30 engine is rebuilt, every vane bushing is replaced, the
31 replacement of the bushings adds considerably to the
32 expense and time required to rebuild an engine.

1 What is needed is a vane bushing for a jet engine
2 which is simple and inexpensive to manufacture, and which
3 is easy to ship and install on a jet engine vane.

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Summary of the Invention

6 The present invention is directed to a bushing for
7 a jet engine vane which is injection moldable and
8 therefore is simple and inexpensive to manufacture, and
9 is formed into such a design which enables the bushing to
10 be easily shipped and installed on a jet engine vane.

11 According to one embodiment of the invention, a vane
12 assembly for an engine is disclosed, the vane assembly
13 comprising a vane comprising a blade having a spindle
14 disposed at one end thereof and a bushing mounted on the
15 spindle. The bushing comprises first and second half
16 portions, each half portion having a generally
17 semicircular body having a first finger disposed at a
18 first end of a first side of the body, a second finger
19 disposed at a second end of the first side of the body
20 and a third finger disposed on a second side of the body,
21 between the first and second ends of the body. The first
22 and second fingers have a distance between them which is
23 not less than a width of the third finger.

24 The first and second half portions are snap fit onto
25 the spindle of the vane such that the third finger of the
26 second half portion is located between the first and
27 second fingers of the first half portion, and the third
28 finger of the first half portion is located between the
29 first and second fingers of the second half portion.

30 Each of the first and second half portions further
31 comprise a semi-annular flange disposed at the first end
32 of the body portion, the semi-annular flange lying in a
33 plane which is substantially perpendicular to a
34 longitudinal axis of the body.

1 According to another embodiment of the invention, a
2 vane assembly for an engine is disclosed, the vane
3 assembly comprising a vane comprising a blade having a
4 spindle disposed at one end thereof and a cylindrical
5 bushing having first and second portions hingedly
6 attached to each other. The first portion has a first
7 finger disposed at a first end of the bushing and a
8 second finger disposed at a second end of the bushing,
9 the second portion having a finger disposed at a point
10 between the first and second ends of the bushing.

11 The bushing is secured on the spindle by placing one
12 of the first and second portions on the spindle and
13 closing the bushing around the spindle such that the
14 finger of the second portion is located between the first
15 and second fingers of the first portion.

16 According to yet another embodiment of the
17 invention, a vane assembly for an engine is disclosed,
18 the vane assembly including a blade having a spindle
19 disposed at one end thereof and a bushing having a
20 cylindrical body. The body has a slot which extends from
21 an upper edge of the body to a lower edge of the body and
22 a number of slits which extend from the upper edge of the
23 body to a point between the upper and lower edges of the
24 body, the slot and the number of slits being constructed
25 and arranged to permit the bushing to be temporarily
26 pried open.

27 The bushing is mounted on the spindle by prying the
28 bushing open at the slot, placing the bushing around the
29 spindle and releasing the bushing, thereby allowing the
30 bushing to encircle the spindle.

31 According to yet another embodiment, a bushing is
32 disclosed, the bushing including first and second half
33 portions, each half portion having a substantially
34 semicircular body, an upper end, a lower end, a first

1 side and a second side. The first side of the body of
2 each of the first and second half portions have an
3 intermediate finger disposed intermediate the upper and
4 lower ends of the body and the second side of the body of
5 each of the first and second half portions has an upper
6 finger disposed at the upper end of the body and a lower
7 finger disposed at the lower end of the body. The upper
8 and lower fingers having a distance therebetween which is
9 no less than the width of the intermediate finger.

10 The first and second half portions are constructed
11 and arranged to be snap fit onto a spindle such that the
12 intermediate finger of the first half portion is
13 positioned between the upper and lower fingers of the
14 second half portion and the intermediate finger of the
15 second half portion is positioned between the upper and
16 lower fingers of the first half portion.

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19 Brief Description of the Drawings

20 The invention will now be described in greater
21 detail with reference to the accompanying drawings, in
22 which:

23 Fig. 1 is a perspective view of a prior art vane
24 bushing, shown removed from a vane;

25 Fig. 2 is an exploded view of the prior art vane
26 bushing shown in Fig. 1;

27 Fig. 3 is a perspective view of a vane bushing
28 according to a first embodiment of the present invention,
29 shown removed from a vane;

30 Fig. 4 is an exploded view of the vane bushing
31 according to the first embodiment of the invention;

32 Fig. 5 is a perspective view of the vane bushing
33 according to the first embodiment of the invention, shown
34 partially installed on a vane;

1 Fig. 6 is a perspective view of the vane bushing
2 according to the first embodiment of the invention, shown
3 fully installed on a vane;

4 Fig. 7 is a perspective view of a vane mounted
5 within a shroud of a jet engine;

6 Fig. 8 is a cross-sectional view of the bushing of
7 the first embodiment of the present invention mounted on
8 a vane, taken along line 8-8 in Fig. 7;

9 Fig. 8A is a close-up view of the bushing of the
10 first embodiment of the present invention mounted on a
11 vane, as shown in Fig. 8;

12 Fig. 9 is a perspective view of a vane bushing
13 according to a second embodiment of the present
14 invention, shown removed from a vane;

15 Fig. 10 is a perspective view of a vane bushing
16 according to a second embodiment of the present
17 invention, shown in a closed position;

18 Fig. 11 is a perspective view of a vane bushing
19 according to the second embodiment of the present
20 invention, shown in an open position;

21 Fig. 12 is a perspective view of a vane bushing
22 according to a third embodiment of the present invention,
23 shown removed from a vane; and

24 Fig. 13 is a perspective view of a vane bushing
25 according to the third embodiment of the present
26 invention.

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28 Detailed Description

29 Referring now to the drawings, and more particularly
30 to Figs. 3-13, the vane bushing of the present invention
31 will be described. Shown in Figs. 3-6 is a first
32 embodiment of a vane bushing 40 of the present invention.
33 Bushing 40 includes two identical parts 42 which are
34 mated together on spindle 16 to form the bushing 40.

1 Each part 42 is injection molded in one piece from a
2 material which, while being capable of being melted and
3 injection molded, is also capable of withstanding the
4 very high temperatures experienced in a jet engine once
5 the part is formed. The material must also be
6 machinable, since, in some cases, in order to finish the
7 part, each part may be machined to bring it within
8 specific tolerances. The material presently contemplated
9 as the preferred material for this application is a
10 combination of approximately 80% of a material sold under
11 the trademark PEEK by Victrex USA, Inc. of West Chester,
12 Pennsylvania, and approximately 20%
13 polytetrafluoroethylene (PTFE). This combination of
14 materials allows complex shapes to be formed fairly
15 easily and inexpensively, compared to the prior art
16 process of machining a billet into the desired shape.
17 However, any material which possesses the characteristics
18 described above may be used to form the present
19 invention.

20 As shown in Fig. 4, each part 42 includes a body
21 portion 44 and a flange portion 46. Each body portion 44
22 includes an upper finger 48 formed at the upper end 60 of
23 one side of body portion 44 proximate flange portion 46
24 and a lower finger 50 formed at the lower end 62 of the
25 same side of body portion 44 on which upper finger 48 is
26 formed. On the other side of body portion 44, an
27 intermediate finger 52 is formed at a point between the
28 upper end 60 and lower end 62 of body portion 44. Upper
29 finger 48 and lower finger 50 have a distance between
30 them which is substantially the same as the width of
31 intermediate finger 52 as defined by the distance between
32 upper edge 54 and lower edge 56 of intermediate finger
33 52. However, the distance between upper finger 48 and
34 lower finger 50 may be greater than the width of

1 intermediate finger 52 to allow for expansion of the
2 parts when the bushing 40 is installed on a spindle and
3 for the accumulation of debris from the normal wear
4 associated with the bushing 40. Upper finger 48 has a
5 width, defined by the distance between upper end 60 of
6 body portion 44 and lower edge 66 of upper finger 48,
7 which is substantially the same as the distance between
8 the upper edge 54 of intermediate finger 52 and the upper
9 end 60 of body portion 44. Lower finger 50 has a width,
10 defined by the distance between lower end 62 of body
11 portion 44 and upper edge 68 of lower finger 50, which is
12 substantially the same as the distance between the lower
13 edge 56 of intermediate finger 52 and the lower end 62 of
14 body portion 44. These dimensions of the fingers 48, 50
15 and 52 allow each part 42 of the bushing 40 to interlock
16 with the other part 42 of the bushing 40 when it is
17 installed on the spindle 16 of the vane 10.

18 In Fig. 5, one part 42 of bushing 40 is shown
19 mounted on a spindle 16 of a vane 10. As shown in
20 Fig. 5, the distance between upper and lower fingers 48
21 and 50 and intermediate finger 52 is less than the
22 diameter of spindle 16. Therefore, in order to install
23 part 42 onto spindle 16, part 42 is lined up with
24 spindle 16 such that fingers 48, 50 and 52 are in contact
25 with spindle 16, and part 42 is pressed onto spindle 16,
26 causing upper and lower fingers 48 and 50 to be flexed
27 away from intermediate finger 52 in order to allow
28 spindle 16 to pass between upper and lower fingers 48
29 and 50 and intermediate finger 52. Once upper and lower
30 fingers 48 and 50 and intermediate finger 52 pass beyond
31 the widest part of spindle 16, upper and lower
32 fingers 48 and 50 and intermediate finger 52 snap back
33 into their normal positions, thereby engaging spindle 16
34 within part 42. Once mounted on spindle 16, upper and

1 lower fingers 48 and 50 and intermediate finger 52 span
2 spindle 16 approximately 270° . However, a span of
3 approximately 250° to 280° may be used. The same process
4 is carried out to install the other part 42 on
5 spindle 16.

6 As shown in Fig. 6, due to the configuration and
7 size of upper and lower fingers 48 and 50 and
8 intermediate finger 52, when both parts 42 are installed
9 on the spindle 16, intermediate finger 52 of each part 42
10 fits into the gap between the upper and lower fingers 48
11 and 50 of the other part 42. The resulting bushing 40
12 completely covers the spindle 16.

13 Figs. 8 and 8A show cross-sectional views, taken
14 along line 8-8 of Fig. 7, of the bushing 40 installed on
15 a spindle 16 of a vane 10 which is mounted to inner
16 shroud 14. Once bushing 42 is installed on spindle 16,
17 bushing 40 and spindle 16 are sandwiched between portion
18 20a and 20b of inner shroud 14. Portions 20a and 20b are
19 secured together via nut and bolt assemblies 70. This
20 assembly holds vane 10 in place, while allowing it to be
21 rotated about spindle 16.

22 Since both parts 42 of this embodiment are
23 identical, there is no need for preassembling the
24 bushings before they are shipped, and therefore, the
25 prior art problem of having to reassemble bushings that
26 become disassembled during shipping has been eliminated.
27 Furthermore, since each part 42 of bushing 40 can be
28 separately attached to the spindle 16, the need for the
29 elastic band to hold the prior art bushing in place on
30 the spindle 16 has also been eliminated.

31 A second embodiment of the bushing of the present
32 invention is shown at 80 in Figs. 9-11. Bushing 80 may
33 be injection molded in one piece using the same material
34 as that used in the embodiment of Figs. 3-6. Bushing 80

1 includes a first part 82a and a second part 82b which are
2 attached to each other along a hinge 84. Preferably,
3 hinge 84 is molded as a living hinge, which permits
4 bushing 80 to be formed in one piece, while also
5 providing the hinge function. As shown in Figs. 9-11,
6 part 82a of bushing 80 includes a body portion 86 having
7 an upper finger 88, a lower finger 90 and a flange
8 portion 100a, disposed along an upper end 102a of body 84
9 of part 82a. Part 82b of bushing 80 includes a body
10 portion 92 having an intermediate finger 94 and a flange
11 portion 100b, disposed along an upper end 102b of body 92
12 of part 82b.

13 Bushing 80 is formed such that the distance between
14 hinge 84 and the ends of upper and lower fingers 88 and
15 90, as well as the distance between hinge 84 and the end
16 of intermediate finger 94 is less than the diameter of
17 spindle 16. This permits either of parts 82a and 82b to
18 be mounted onto the spindle 16 by snap fitting the part
19 onto the spindle.

20 Bushing 80 is installed on a spindle 16 by hingedly
21 opening parts 82a and 82b as shown by arrows 110 in Fig.
22 11, snap fitting either of parts 82a and 82b onto the
23 spindle 16, hingedly closing bushing 80 around the
24 spindle 16 to snap fit the other of parts 82a and 82b
25 onto the spindle 16. Upper and lower fingers 88 and 90
26 of part 82a and intermediate finger 94 of part 82b are
27 sized and positioned such that when bushing 80 is in the
28 closed position shown in Fig. 10, intermediate finger 94
29 fits between upper and lower fingers 88 and 90, thereby
30 covering the spindle 16.

31 A third embodiment of the bushing of the present
32 invention is shown at 120 in Figs. 12 and 13. Bushing 120
33 may be injection molded in one piece using the same
34 material as that used in the embodiment of Figs. 3-6 and

1 9-11. Bushing 120 includes a body portion 122 and a
2 flange portion 124 disposed at an upper end 126 of body
3 portion 122. Bushing 120 includes a slit 128 which
4 extends completely through flange portion 124 and from
5 upper end 126 to lower end 130 of body portion 122.
6 Bushing 120 also includes a number of slots 132 which
7 extend completely through flange portion 124 and from
8 upper end 126 to a point between upper end 126 and lower
9 end 130 of body portion 122. Slit 128 and slots 132
10 permit bushing 120 to be flexed open to allow the bushing
11 120 to be pressed onto and thereby installed on a spindle
12 16. Slit 128 and slots 132 also provide space for
13 thermal expansion of the bushing 120 and for the
14 accumulation of debris from the normal wear associated
15 with the bushing 120.

16 While there is shown and described herein certain
17 specific structures embodying the invention, it will be
18 manifest to those skilled in the art that various
19 modifications and rearrangements of the parts may be made
20 without departing from the spirit and scope of the
21 underlying inventive concept. For example, the
22 intermediate finger of the first and second embodiments
23 may have upper and lower edges which are tapered, rather
24 than parallel, as shown in the figures. In such a case,
25 the space between the upper and lower fingers would be
26 formed to positively accept the tapered intermediate
27 finger when the bushing is installed on a spindle. Also,
28 while the hinge 84 of the second embodiment is disclosed
29 as being a living hinge, it will be understood that the
30 parts 82a and 82b may be formed separately and hingedly
31 attached using any type of hinge structure. Furthermore,
32 while the bushings of the present invention are described
33 for use in connection with jet engines, the bushings may
34 be used for any application in which a bushing having the

1 above-described properties is desirable. Accordingly,
2 the inventive concept is not limited to the particular
3 forms herein shown and described except insofar as
4 indicated by the scope of the appended claims.

Claims

WHAT IS CLAIMED IS:

- 1 1. A vane assembly for an engine, the vane
2 assembly comprising:
3 a vane comprising a blade having a spindle disposed
4 at one end thereof; and
5 a bushing mounted on said spindle, said bushing
6 comprising first and second half portions, each half
7 portion having a generally semicircular body having a
8 first finger disposed at a first end of a first side of
9 said body, a second finger disposed at a second end of
10 said first side of said body and a third finger disposed
11 on a second side of said body, between said first and
12 second ends of said body, said first and second fingers
13 having a distance between them which is not less than a
14 width of said third finger;
15 wherein said first and second half portions are snap
16 fit onto said spindle of said vane such that said third
17 finger of said second half portion is located between
18 said first and second fingers of said first half portion,
19 and said third finger of said first half portion is
20 located between said first and second fingers of said
21 second half portion.
- 1 2. The vane assembly of claim 1, wherein each of
2 said first and second half portions further comprise a
3 semi-annular flange disposed at said first end of said
4 body portion, said semi-annular flange lying in a plane
5 which is substantially perpendicular to a longitudinal
6 axis of said body.

1 3. The vane assembly of claim 1, wherein said
2 bushing is formed from a plastic material.

1 4. The vane assembly of claim 2, wherein said
2 bushing is formed from a plastic material.

1 5. The vane assembly of claim 3, wherein said
2 bushing is formed using an injection molding process.

1 6. A vane assembly for an engine, the vane
2 assembly comprising:

3 a vane comprising a blade having a spindle disposed
4 at one end thereof; and

5 a cylindrical bushing having first and second
6 portions hingedly attached to each other, said first
7 portion having a first finger disposed at a first end of
8 said bushing and a second finger disposed at a second end
9 of said bushing, said second portion having a finger
10 disposed at a point between said first and second ends of
11 said bushing;

12 wherein said bushing is secured on said spindle by
13 placing one of said first and second portions on said
14 spindle and closing said bushing around said spindle such
15 that said finger of said second portion is located
16 between said first and second fingers of said first
17 portion.

1 7. The vane assembly of claim 6, wherein each of
2 said first and second portions further comprise a semi-
3 annular flange disposed at said first end thereof, said
4 semi-annular flange lying in a plane which is
5 substantially perpendicular to a longitudinal axis of
6 said body.

1 8. The vane assembly of claim 6, wherein said
2 bushing is formed from a plastic material.

1 9. The vane assembly of claim 7, wherein said
2 bushing is formed from a plastic material.

1 10. The vane assembly of claim 9, wherein said
2 bushing is formed using an injection molding process.

1 11. A vane assembly for an engine, the vane
2 assembly comprising:

3 a vane comprising a blade having a spindle disposed
4 at one end thereof; and

5 a bushing having a cylindrical body, said body
6 having a slit which extends from an upper edge of said
7 body to a lower edge of said body and a number of slots
8 which extend from said upper edge of said body to a point
9 between said upper and lower edges of said body, said
10 slit and said number of slots being constructed and
11 arranged to permit the bushing to be temporarily pried
12 open;

13 wherein said bushing is mounted on said spindle by
14 prying the bushing open at said slit, placing the bushing
15 around the spindle and releasing the bushing, thereby
16 allowing the bushing to encircle the spindle.

1 12. The vane assembly of claim 11, wherein said
2 bushing is formed from a plastic material.

1 13. The vane assembly of claim 12, wherein said
2 plastic material is a mixture of PEEK™ and PTFE.

1 14. The vane assembly of claim 13, wherein said
2 bushing is formed using an injection molding process.

1 15. A bushing for a spindle, the bushing
2 comprising:

3 first and second half portions, each half portion
4 having a generally semicircular body having a first
5 finger disposed at a first end of a first side of said
6 body, a second finger disposed at a second end of said
7 first side of said body and a third finger disposed on a
8 second side of said body, between said first and second
9 ends of said body, said first and second fingers having
10 a distance between them which is substantially a width of
11 said third finger;

12 wherein said first and second half portions are snap
13 fit onto said spindle such that said third finger of said
14 second half portion is located between said first and
15 second fingers of said first half portion, and said third
16 finger of said first half portion is located between said
17 first and second fingers of said second half portion.

1 16. A bushing for mounting a variable-pitch stator
2 vane within a shroud of a jet engine having a number of
3 the variable-pitch stator vanes, each variable-pitch
4 stator vane including a blade having a spindle disposed
5 at one end thereof, the bushing comprising:

6 first and second half portions, each half portion
7 having a substantially semicircular body, an upper end,
8 a lower end, a first side and a second side;

9 the first side of the body of each of the first and
10 second half portions having an intermediate finger
11 disposed intermediate said upper and lower ends of the
12 body, said intermediate finger having a width;

13 the second side of the body of each of the first and
14 second half portions having an upper finger disposed at
15 said upper end of said body and a lower finger disposed

16 at said lower end of said body, said upper and lower
17 fingers having a distance therebetween which is no less
18 than the width of said intermediate finger;

19 wherein said first and second half portions are
20 constructed and arranged to be snap fit onto the spindle
21 of the vane such that said intermediate finger of said
22 first half portion is positioned between said upper and
23 lower fingers of said second half portion and said
24 intermediate finger of said second half portion is
25 positioned between said upper and lower fingers of said
26 first half portion.

1 17. The bushing of claim 16, wherein each of said
2 first and second half portions further comprise an flange
3 disposed at said upper end of said body, said flange
4 lying in a plane which is substantially perpendicular to
5 a longitudinal axis of said body.

1 18. The bushing of claim 16, wherein said first and
2 second half portions are formed from a plastic material.

1 19. The bushing of claim 18, wherein said plastic
2 material comprises a mixture of PEEKTM and PTFE.

1 20. The bushing of claim 19, wherein said mixture
2 comprises approximately 80% PEEKTM and approximately 20%
3 PTFE.

1 21. The bushing of claim 17, wherein said first and
2 second half portions are formed from a plastic material.

1 22. The bushing of claim 18, wherein said first and
2 second half portions are formed by injection molding.

1 23. The bushing of claim 16, wherein, when said
2 bushing is snap fit on the spindle, each of said first
3 and second half portions spans the spindle approximately
4 270°.

1 24. A bushing comprising:
2 first and second half portions, each half portion
3 having a substantially semicircular body, an upper end,
4 a lower end, a first side and a second side;
5 the first side of the body of each of the first and
6 second half portions having an intermediate finger
7 disposed intermediate said upper and lower ends of the
8 body, said intermediate finger having a width;
9 the second side of the body of each of the first and
10 second half portions having an upper finger disposed at
11 said upper end of said body and a lower finger disposed
12 at said lower end of said body, said upper and lower
13 fingers having a distance therebetween which is no less
14 than the width of said intermediate finger;
15 wherein said first and second half portions are
16 constructed and arranged to be snap fit onto a spindle
17 such that said intermediate finger of said first half
18 portion is positioned between said upper and lower
19 fingers of said second half portion and said intermediate
20 finger of said second half portion is positioned between
21 said upper and lower fingers of said first half portion.

1 25. The bushing of claim 24, wherein each of said
2 first and second half portions further comprise an flange
3 disposed at said upper end of said body, said flange
4 lying in a plane which is substantially perpendicular to
5 a longitudinal axis of said body.

1 26. The bushing of claim 24, wherein said first and
2 second half portions are formed from a plastic material.

1 27. The bushing of claim 26, wherein said plastic
2 material comprises a mixture of PEEKTM and PTFE.

1 28. The bushing of claim 27, wherein said mixture
2 comprises approximately 80% PEEKTM and approximately 20%
3 PTFE.

1 29. The bushing of claim 25, wherein said first and
2 second half portions are formed from a plastic material.

1 30. The bushing of claim 27, wherein said first and
2 second half portions are formed by injection molding.

1 31. The bushing of claim 24, wherein, when said
2 bushing is snap fit on the spindle, each of said first
3 and second half portions spans the spindle approximately
4 270°.