

An Alignment Tool

Technical Field

The present invention generally relates to an
5 alignment tool for aligning connecting pins for connecting
a shaft and a radial bearing.

Background

It is sometimes desirable to mount a radial bearing
10 to a shaft. In one such application, it is necessary to
install a radial bumper bearing onto a shaft of an
aircraft engine. During installation and refitting of
aircraft engines, the radial bumper bearing needs to be
connected to the shaft to allow the bumper bearing to
15 rotate with the shaft. Shoulder pins are initially
installed in holes provided on the shaft. The
installation requires the radial bumper bearing to be
preheated to a required elevated temperature before being
installed in precise alignment to the pins mounted to the
20 shaft. The installation process cannot be visually
inspected by the installation operator.

The installation of the radial bumper bearing to the
shaft has previously been conducted with a bumper bearing
pin restraining ring. The bumper bearing pin restraining
25 ring comprises an annular ring that is capable of being
mounted to the shaft. The bumper bearing pin restraining
ring is provided with three knurled screwing nuts
extending through the annular ring. The knurled nuts are
capable of rotational movement and are turned in a
30 clockwise direction to thereby exert a compression force
against the pins inserted in the shaft. The compression
force exerted by the knurled nuts is provided in an
attempt to ensure that the pins are kept in alignment for
mating with engagement holes of the radial bumper bearing.

A problem with the known restraining tool is that application of the compression force by the knurled nuts against the pins is that it does not always maintain the precise alignment of the pins for mating with the
5 corresponding holes of the radial bumper bearing. In fact, the torsional compression force exerted by the knurled nuts may in fact lead to the pins being subject to some rotation and hence misalignment. This misalignment may result in damage to the bumper bearing during repeated
10 installation and refitting of the aircraft engine. If damage occurs to the radial bumper bearing, during installation and re-fitting of the aircraft engine, the life cycle and performance of the radial bumper bearing and the shouldered pins of the aircraft engine can be
15 affected.

In the event that the radial bumper bearing is unable to mate with the shoulder pins due to misalignment, the radial bumper bearing has to be removed and the entire installation procedure repeated. This may result in lost
20 man hours, particularly as the bumper bearing and the LPT shaft must be preheated prior to installation.

There is a need to provide an alignment tool that overcomes, or at least ameliorates, one or more of the disadvantages described above.

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Summary

According to a first aspect of the invention, there is provided an alignment tool for aligning connecting pins for connecting a shaft and a radial bearing, the shaft and
30 the radial bearing respectively having at least two holes for receiving the connecting pins, the alignment tool comprising:

an annular ring capable of being located between and about the shaft and the radial bearing; and

at least two engagement members extending through and disposed around the annular ring and being capable of moving toward and away from the bearing surface , each engagement member having an engagement arm on a distal end thereof for retaining the connecting pins in alignment to enable the connecting pins to engage with the respective holes provided on the shaft and the radial bearing.

According to a second aspect of the invention, there is provided an alignment system comprising:

10 a shaft having at least two holes for receiving respectively, at least two connecting pins therein;

a radial bearing having at least two holes for receiving the at least two connecting pins therein; and

an alignment tool for aligning the at least two connecting pins for engaging the respective holes of the shaft and the radial bearing, the alignment tool comprising: an annular ring capable of being located between and about the shaft and the radial bearing; and at least two engagement members extending through and disposed around the annular ring and being capable of moving toward and away from the bearing surface, each engagement member having an engagement arm provided on a distal end thereof for retaining the connecting pins in alignment to enable the connecting pins to engage with the respective holes provided on the shaft and the radial bearing.

According to a third aspect of the invention, there is provided a method of aligning connecting pins for connecting a shaft and a radial bearing, the shaft and the radial bearing respectively having at least two holes for receiving the connecting pins, the method comprising the steps of:

locating an annular ring between and about the shaft and radial bearing;

moving at least two engagement members, extending through and disposed around the annular ring, toward the radial bearing surface, each of the engagement members having an engagement arm on a distal end thereof; and

5 retaining the connecting pins in alignment using the engaging arms to enable the connecting pins to engage with the respective holes provided on the shaft and the radial bearing.

10 **Detailed Disclosure of Embodiments**

Exemplary, non-limiting embodiments of an alignment tool will now be disclosed.

In one embodiment, the shaft may be the shaft of an engine. The engine may be an aircraft engine. In one
15 embodiment, the shaft may be a low pressure turbine (LPT) shaft.

The movement of the at least two engagement members may be a sliding movement through the annular ring.

In one embodiment, the alignment tool further
20 comprises a biasing member to bias the at least two engagement members in a radial direction toward the longitudinal axis of the shaft. In one embodiment, the biasing member may be a spring mounted to bias the engagement members in a radial direction toward the
25 longitudinal axis of the shaft. In another embodiment, the biasing member may be an elastic annular member mounted around the circumference of the annular ring and the engagement members to bias the engagement members in a radial direction toward the longitudinal axis of the
30 shaft.

The radial bearing may be a spacer to be connected to a shaft. The radial bearing may be a bumper bearing. In one embodiment, radial bearing may be a main engine bearing. In one embodiment, the bumper bearing may be

connected adjacent to a number five main engine bearing to provide support. The connecting pins may be shouldered pins. The connecting pins may be dowel pins. The dowel pins may have a first connecting part shape to enable
5 mating with a corresponding mating shape of the holes provided on the shaft. The first connecting part shape may be provided on a distal end of the dowel pins to enable mating with the holes provided in the shaft. The dowel pins may have a second connecting part shape to enable
10 mating with the holes provided on the bearing. In one embodiment, the second connecting part shape may be provided between the distal end and proximal end of the dowel pin.

In one embodiment, the connecting pins are
15 substantially square shaped or substantially rectangular shaped in cross section to the longitudinal axis of the pins.

The engaging arms may be shaped to engage the proximal end of the connecting pins. In one embodiment,
20 the engaging arms may comprise two fork arms. The fork arms may be disposed from each other sufficiently to allow engagement of the connecting pins.

The engagement arms may be of sufficient size to prevent further transverse movement of the engagement
25 member away from the longitudinal axis of the shaft.

The engagement members may be non-circular in cross-section. In one embodiment, the engagement members may have a substantially square shape or a substantially rectangular shape in cross-section to the longitudinal
30 axis of the engagement members. In one embodiment, a handle is provided on the proximal end of each engagement member. The handle may be of sufficient size to prevent further transverse movement of the engagement member toward the longitudinal axis of the shaft when the handle

contacts the annular ring. The handle may be in the form of a cap. The cap may be secured to the engagement member by a cap screw capable of screwing engagement with the engagement member to allow the handle to be released from the engagement member.

In one embodiment, three engagement members are disposed around and extend through the circumference of the annular ring. The three engagement members may be spaced at a substantially equal distance from each other around the circumference of the annular ring.

In one embodiment, the annular ring may have a first radial dimension on a first side to enable it to be seated onto an end of the shaft. The annular ring may have a second radial dimension on a second side, opposite to the first side, to enable it to be seated onto the corresponding facets of the shaft.

The annular ring may be made from any material of suitable strength. In one embodiment, the annular ring is made from steel such as steel.

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Brief Description of Drawings

The accompanying drawings illustrate a disclosed embodiment and serves to explain the principles of the disclosed embodiment. It is to be understood, however, that the drawings are designed for purposes of illustration only, and not as a definition of the limits of the invention.

Fig. 1 discloses a top view of an annular ring of an alignment tool of a disclosed embodiment;

Fig. 1A is a cross-sectional view of the annular ring through the plane shown by line A-A of Fig. 1;

Fig. 2 shows a cross-sectional view of the annular ring of Fig. 1;

Fig. 3 shows a side view of an engagement member having an engagement arm on its distal end that is used in the alignment tool embodiment disclosed herein;

Fig. 3A shows a cross-sectional side view of the
5 engagement member of Fig. 3;

Fig. 4 shows a side view of a handle that is connectable to the engagement member of Fig. 3;

Fig. 5 shows a cross-sectional partial assembly view of an engagement member assembled to the annular ring of
10 Fig. 1;

Fig. 6 shows a close-up assembly view of the alignment tool being used to align a connecting pin to a shaft of the disclosed embodiment;

Fig. 7 shows an assembled top view of the alignment
15 tool; and

Fig. 8 shows a cross-sectional view of the alignment tool being used to align connecting pints on an LPT shaft during installation of a radial bumper bearing.

20 Mode of performing disclosed embodiment

Referring to Figs. 1, 1A and 2, there is shown an annular ring in the form of support ring 10 that is used in an alignment tool 8. The support ring 10 has three holes 12 extending around the support ring 10. The three
25 holes 12 are spaced at an angle of 120° relative to each other so that they are equally spaced around the circumference of the support ring 10.

The support ring 10 has a first side 16 having a annular inner radius that is dimensioned to be mounted to
30 the end of a shaft in the form of low pressure turbine (LPT) shaft 20 of an aircraft as shown in Fig. 8 and as will be described further bellow.

The support ring 10 has an opposite second side 14, opposite to first side 16, having an annular inner radius that is dimensioned to engage a radial bumper bearing as shown in Fig 8.

5 Referring to Fig. 3, Fig 3A and Fig 4, there is shown a engagement member in the form of a longitudinal pin guide 18. The pin guide 18 has an engagement arm in the form of engagement fork arms 24 on a distal end and a threaded hole 26 extending through its proximal end. The
10 threaded hole 26 is capable of receiving threaded stem 30 of handle 28 shown in Fig. 4.

The threaded stem 30 of the handle 28 is capable of screwing into threaded hole 26. The handle 28 includes a cap 32 which has a knurled surface to enable adequate
15 gripping of the handle 28 by an operator in use. The cap 28 also includes a recess 34 for receiving an elastic annular member 40 to bias the pin guide 18 towards the LPT shaft 20 as will be described further below.

The shaft of the pin guide 18 is square shaped in
20 cross-section and is dimensioned such that it is able to slidably fit into the square shaped cross-sectional holes 12 provided on the support ring 10.

The support ring 10 is made from steel and may be made by lathe machining.

25 Referring to Fig. 5, to assemble the alignment tool 8, three pin guides 18 are inserted through each of the three holes 12. For each of the pin guides 18, a respective cap 28 is connected to each pin guide 18 by screwing the threaded stem 30 into the corresponding
30 threaded engagement hole 26. The size of the cap 32 prevents the pin guide 18 from sliding toward the shaft when the cap 32 abuts the surface edge of the holes 12 as will be described further below. Additionally, the fork arms 24 prevent the pin guide 18 from being removed from

the support ring 10 as the size of the fork arms 24 about the inner surface edge of the holes 12 as the pin guide 18 slides away from the LPT 18 shaft 20.

Referring now to Fig. 6, there is shown a perspective
5 close-up view one of the pin guides 18 being used to align a connector pin in the form of shouldered pin 36 in a recess 38 (shown by dashed lines) of the LPT shaft 20.

The shouldered pin 36 has a circular body with a flat middle section 36A for mating with corresponding mating
10 holes of the radial bumper bearing. The head 36B of the shouldered pin 36 is square-shaped. .

The shouldered pins 36 are inserted into holes 38 of the LPT shaft 20 after the support ring 10 is located such that the side 16 is mounted to the end of the LPT shaft
15 20. The support ring 10 is rotated around so that the pin guides 18 and their respective engagement forks 24 are respectively disposed over the head 36B of the shouldered pins 36.

The shouldered pins 36 have a square shape in cross-
20 section and are dimensioned to be inserted into mating holes 38 provided the LPT shaft 20. The angular position of the three pin guides 18 on the support ring 10 correspond to the angle of the hole of the bumper bearing 22. As such, the fork arms 24 are capable of engaging the
25 head .36B of the shouldered pins 36.

The pin guides 18 are moved in a direction that is transverse to the longitudinal axis 42 (refer to Fig. 8) of the LPT shaft 20. The fork arms 24 engage around the head 36B and surround the middle section 36A to ensure
30 that the shouldered pins 36 do not move and are held precisely in place for mating with corresponding the holes (not shown) on the radial bumper bearing 22.

The square shape of the shaft of the pin guide 18 permits unhindered sliding movement but very minimal

rotational movement through holes 12 and hence facilitates quick engagement and disengagement of the fork arms 24 with the shouldered pin 36.

5 The pin guide 18 enables partial installation of the shouldered pins 36 and the radial bumper bearing 22 while ensuring good engagement without misalignment.

It will be appreciated that the alignment tool 8 can control the angular position of the shouldered pin 36 so that the hole of the bumper bearing 22 are in total
10 alignment with the shouldered pins 36 during installation.

The three pin guides 18 and their respective fork arms 24 can be disengaged after connecting with the radial bumper bearing 22 by simply sliding the three pin guides
15 18 away from the shouldered pins 36 in a direction away from the shaft. This is simply done by pulling the cap 32 away until the engagement forks 24 are fully retracted into the support ring 10. This ensures no interference with the LPT shaft 20 before removing the support ring 10.

20 Referring to Fig. 7 there is shown the support ring 10 with an elastic rubber annular member 40 extending around the support ring 10 and located in each of the recesses 34 of the caps 32 of the three pin guides 18. The rubber annular member 40 impart a biasing force to the
25 pin guides 18 to bias them towards the LPT shaft 20. The pin guides 18 thereby travel in a transverse direction to the longitudinal axis of the LPT shaft 20. The advantage of the rubber annular member 40 is that it imparts an equilateral biasing pressure force to pin guides 18.

30 It is also will be appreciated that rather than using rubber annular member 40, other embodiments may use some other biasing mechanism, such as a spring arranged to impart of biasing force.

Referring to Fig. 8, there is shown the alignment tool 8 being used to align the shouldered pins 36 that are inserted into holes 38 provided in the LPT shaft 20. As the tool 8 maintains the alignment of the shouldered pins 36, the holes of the main engine radial bumper bearing 22 are mounted to the middle section 36B (refer to Fig. 6) of the shouldered pins 36. The radial bumper bearing 22 is connected to a main engine bearing 44. Once the bumper bearing 22 has been connected to the LPT shaft 20, the alignment tool 8 can be released therefrom by moving the handle 28 away from the longitudinal axis 42 of the shaft 20.

Applications

It will be appreciated that the alignment tool 8 can be used to correct and maintain the alignment of the shouldered pins 36 during mating with the radial bumper bearing 22 and the LPT shaft 20. It will also be appreciated that the fork arms 24 minimize torsional forces imparted to the head of the shouldered pins 36, thereby improving alignment during assembly of the bumper bearing 22 to the LPT shaft 20.

By achieving improved alignment of the shouldered pins 36, the alignment tool 8 minimizes damage due to misalignment and also minimizes any undue wearing of the radial bumper bearing during repeated installations. It would be appreciated that this improved alignment provided by the alignment tool 8, increases the life cycle and performance of the bumper bearing 22 and the shouldered pins 36.

The improved alignment of the shouldered pins 36 for mating with the radial bumper bearing 22 reduces any instances of installation failure and thereby reduces installation time. This may result improved efficiency of

installation, particularly as the bumper bearing and the LPT shaft must be preheated prior to installation.

Additionally, it will be appreciated that due to the sliding arrangement of the pin guides, it is possible to
5 quickly assemble and disassemble the fork arms 24' to the end of the head of the shouldered pins 36.

It will be apparent that various other modifications and adaptations of the invention will be apparent to the person skilled in the art after reading the foregoing
10 disclosure without departing from the spirit and scope of the invention and it is intended that all such modifications and adaptations come within the scope of the appended claims.

Claims

1. An alignment tool for aligning connecting pins for connecting a shaft and a radial bearing, the shaft and the radial bearing respectively having at least two holes
5 for receiving the connecting pins, the alignment tool comprising:

an annular ring capable of being located between and about the shaft and the radial bearing; and

at least two engagement members extending through
10 and disposed around the annular ring and being capable of moving toward and away from the radial bearing surface, each engagement member having an engagement arm provided on a distal end thereof for retaining the connecting pins in alignment to enable the connecting pins to engage with
15 the respective holes provided on the shaft and the radial bearing.

2. An alignment tool as claimed in claim 1, wherein the two engagement members are capable of sliding through the
20 annular ring.

3. An alignment tool as claimed in claim 1, further comprising a biasing member to bias the at least two engagement members in a transverse direction toward the
25 longitudinal axis of the shaft.

4. An alignment tool as claimed in claim 3, wherein the biasing member is an elastic annular member mounted around the circumference of the annular ring and the at
30 least two engagement members.

5. An alignment tool as claimed in claim 1, wherein the connecting pins are shouldered pins.

6. An alignment tool as claimed in claim 1, wherein the connecting pins are substantially square shaped or substantially rectangular shaped in cross section.

5 7. An alignment tool as claimed in claim 1, wherein the engaging arms are shaped to engage the proximal end of the connecting pins.

8. An alignment tool as claimed in claim 1, wherein the
10 engaging arms comprise a pair of fork arms, the pair of fork arms being disposed from each other to enable engagement of the connecting pins therebetween.

9. An alignment tool as claimed in claim 1, wherein a
15 handle is provided on the proximal end of each engagement member.

10. An alignment tool as claimed in claim 1, wherein the
20 handle is of sufficient size to prevent transverse movement of the engagement member toward the longitudinal axis of the shaft when the handle contacts the annular ring.

12. An alignment tool as claimed in claim 1, wherein
25 three engagement members are disposed around the circumference of the annular ring at a substantially equal distance from each other.

13. An alignment tool as claimed in claim 1, wherein the
30 annular ring has a first radial dimension on a first side to enable it to be seated onto an end of the shaft.

14. An alignment tool as claimed in claim 13, wherein the annular ring has a second radial dimension on a

second side, opposite to the first side, to enable it to be seated onto a side edge of the radial bearing.

15. An alignment tool as claimed in claim 1, wherein the
5 engagement members are capable of moving radially to the longitudinal axis of the shaft.

16. An alignment system comprising:

a shaft having at least two holes for receiving at
10 least two connecting pins therein;

a radial bearing having at least two holes for receiving the at least two connecting pins therein; and

an alignment tool for aligning the at least two connecting pins for engaging the respective holes of the
15 shaft and the radial bearing, the alignment tool comprising: an annular ring capable of being located between and about the shaft and the radial bearing; and at least two engagement members extending through and disposed around the annular ring and being capable of
20 moving toward and away from the bearing surface, each engagement member having an engagement arm provided on a distal end thereof for retaining the at least two connecting pins in alignment to enable the connecting pins to engage with the respective holes provided on the
25 shaft and the radial bearing.

17. An alignment system as claimed in claim 16, wherein the shaft is the shaft of an aircraft engine.

30 18. An alignment system as claimed in claim 17, wherein the shaft is a low pressure turbine shaft.

19. An alignment system as claimed in claim 17, wherein the radial bearing is a main engine bumper bearing of an aircraft engine.

5 20. A method of aligning connecting pins for connecting a shaft and a radial bearing, the shaft and the radial bearing respectively having at least two holes for receiving the connecting pins, the method comprising the steps of:

10 locating an annular ring between and about the shaft and the radial bearing;

moving at least two engagement members extending through and disposed around the annular ring toward the radial bearing surface, each of the engagement members
15 having an engagement arm provided on a distal ends thereof; and

retaining the connecting pins in alignment with each of the engaging arms to enable the connecting pins to engage with the respective holes provided on the shaft
20 and the radial bearing.

21. A method as claimed in claim 20, comprising moving the at least two engagement members in a direction away from the radial bearing surface to release the engagement
25 arms from the connecting pins.