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(54) GAS TURBINE ENGINE MOUNTING STRUCTURE WITH SECONDARY LOAD PATHS

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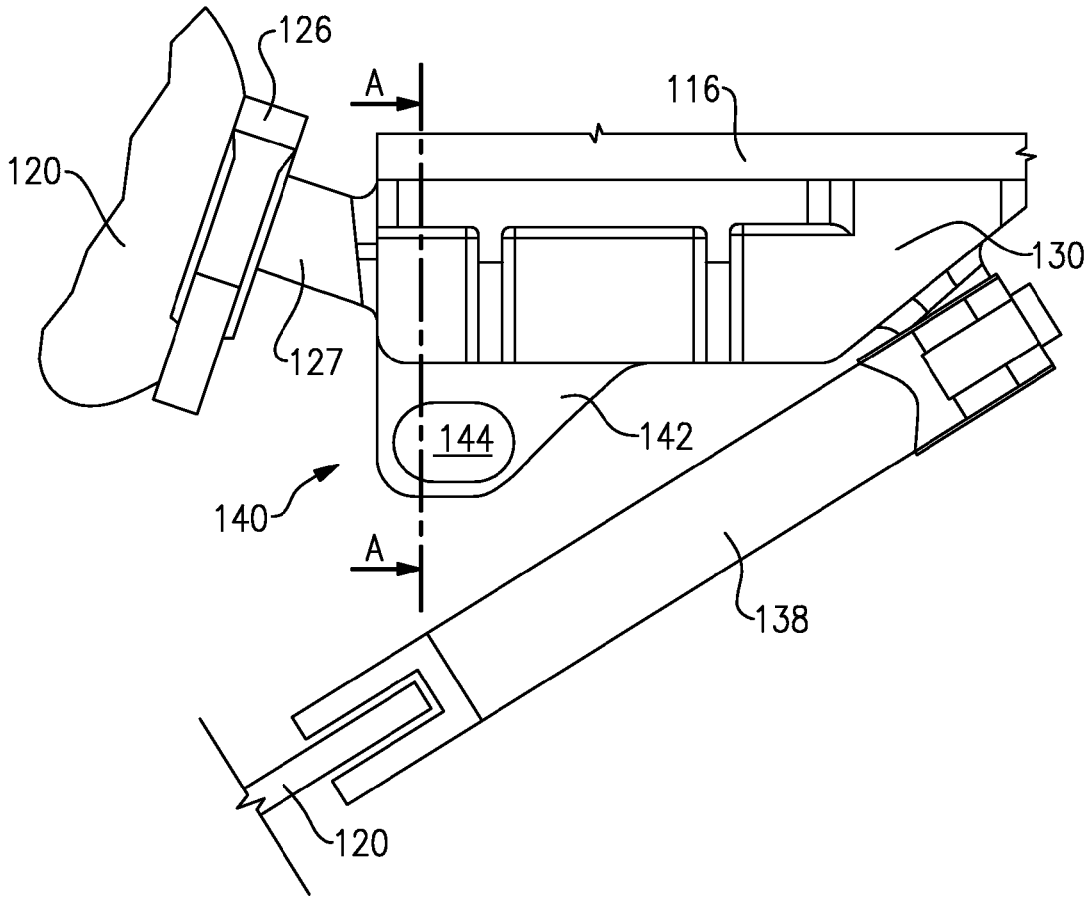
(57) **ABSTRACT**

A connection for mounting an aircraft engine to an aircraft pylon includes a plate to be connected to a portion of an engine, and a body that extends rearward from the plate. A back-up connection, including a pin positioned within a slotted hole, is provided between the portion of the engine and the body. When there is a normal connection between the plate and the body, there is clearance between the pin and the slotted hole.



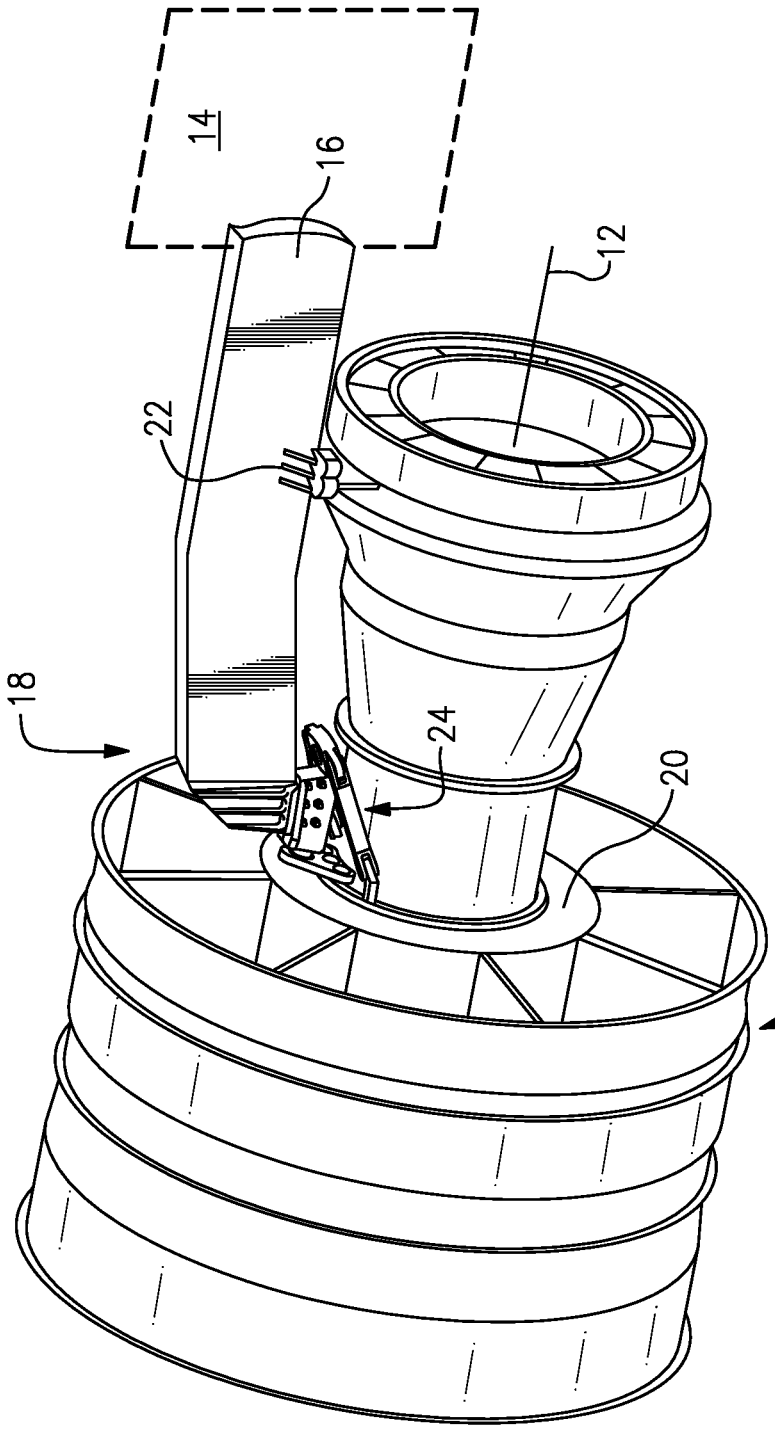


FIG.1
Prior Art

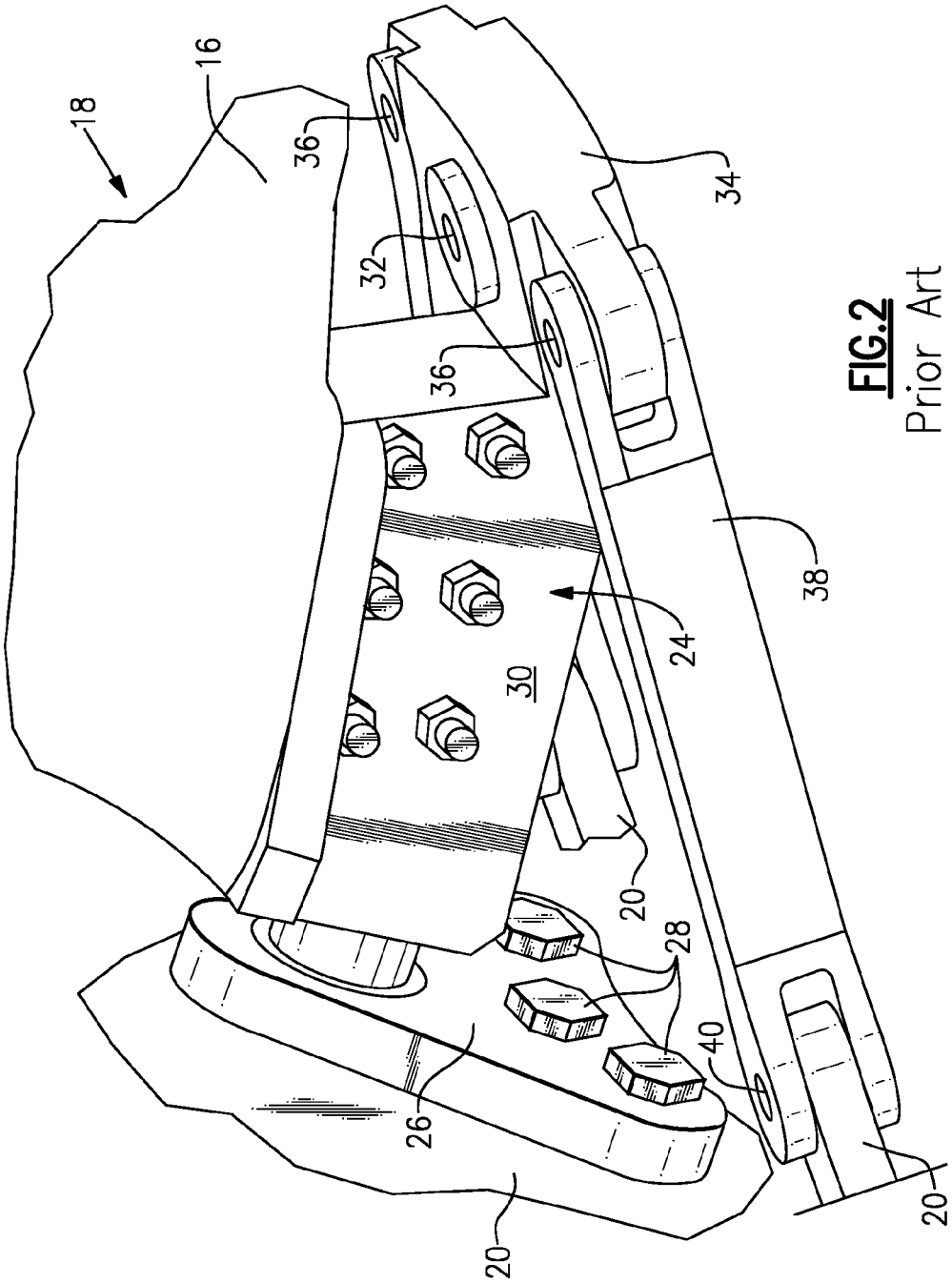


FIG.2
Prior Art

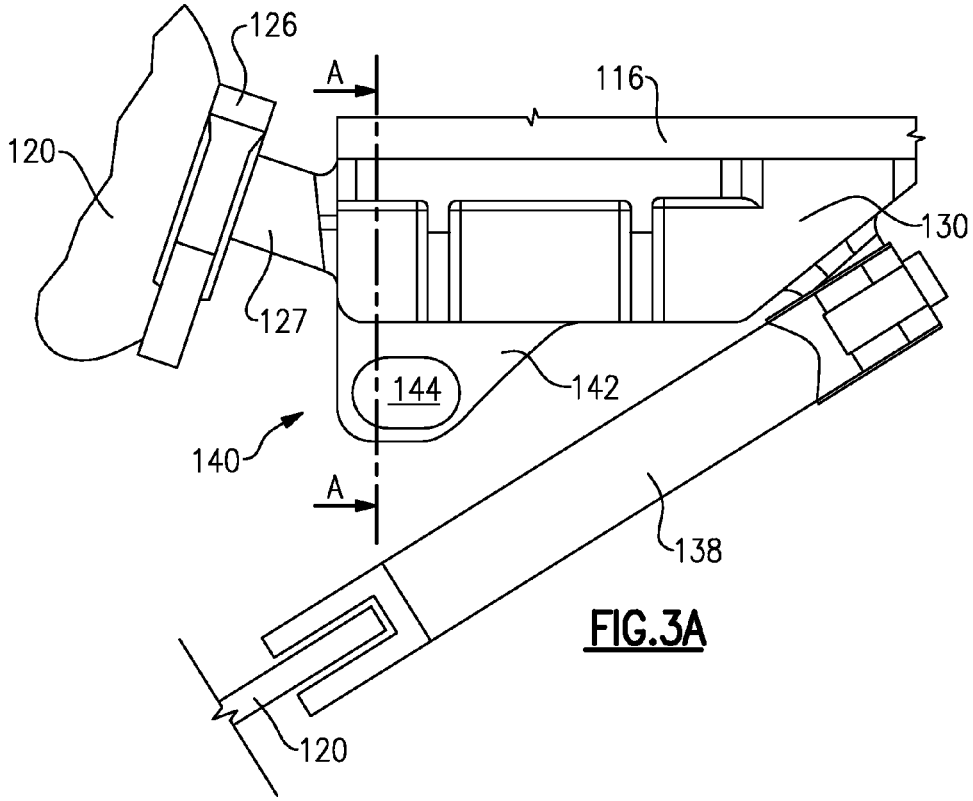

126
A
116
120
130
127
144
142
140
A
138
120

FIG.3A

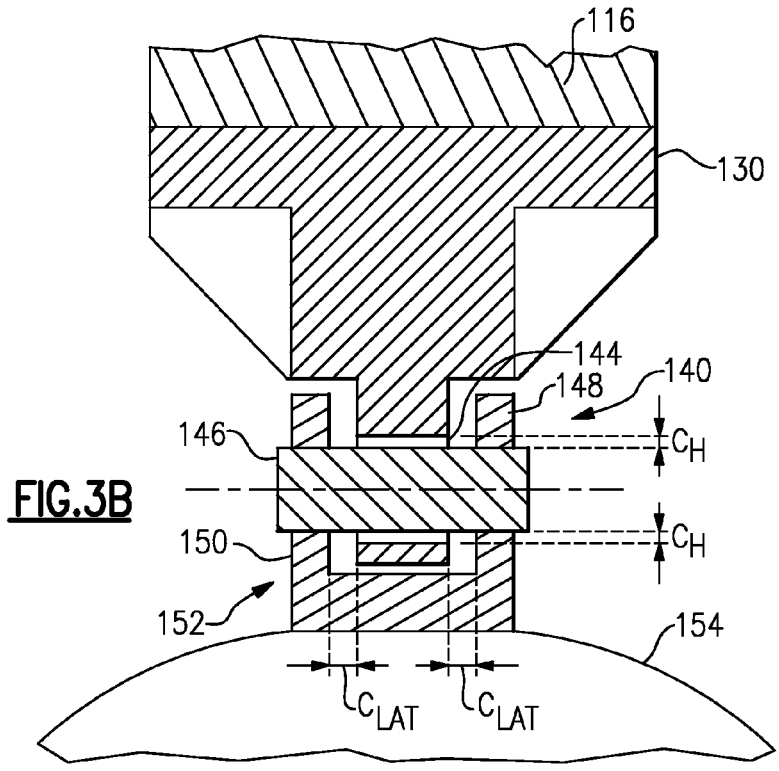

116
130
144
140
148
146
C_H
C_H
150
152
154
C_{LAT}
C_{LAT}

FIG.3B

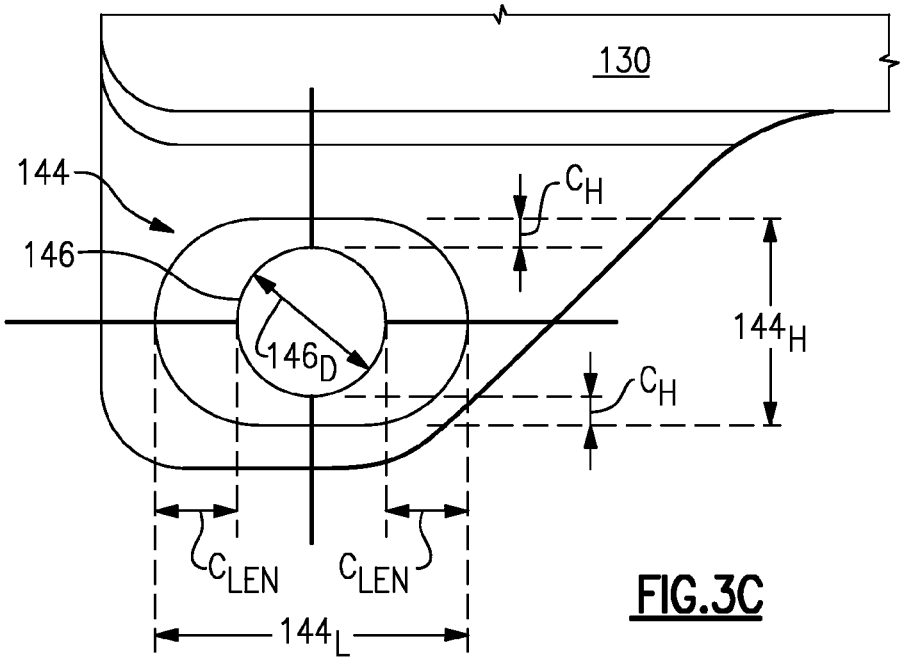

130
144
146
C_H
146_D
144_H
C_H
C_{LEN}
C_{LEN}
144_L

FIG.3C

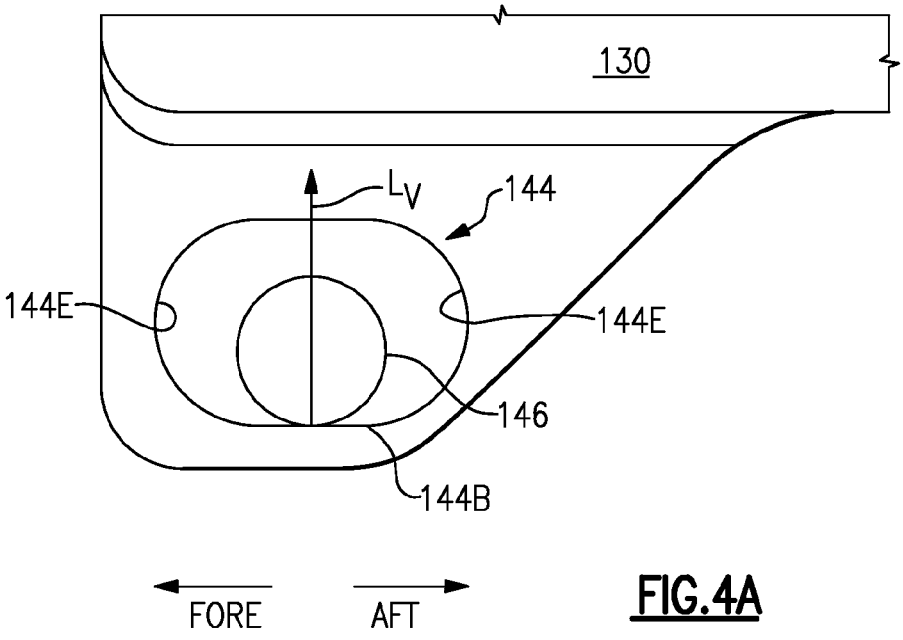

130
L_V
144
144E
144E
146
144B
FORE
AFT

FIG.4A

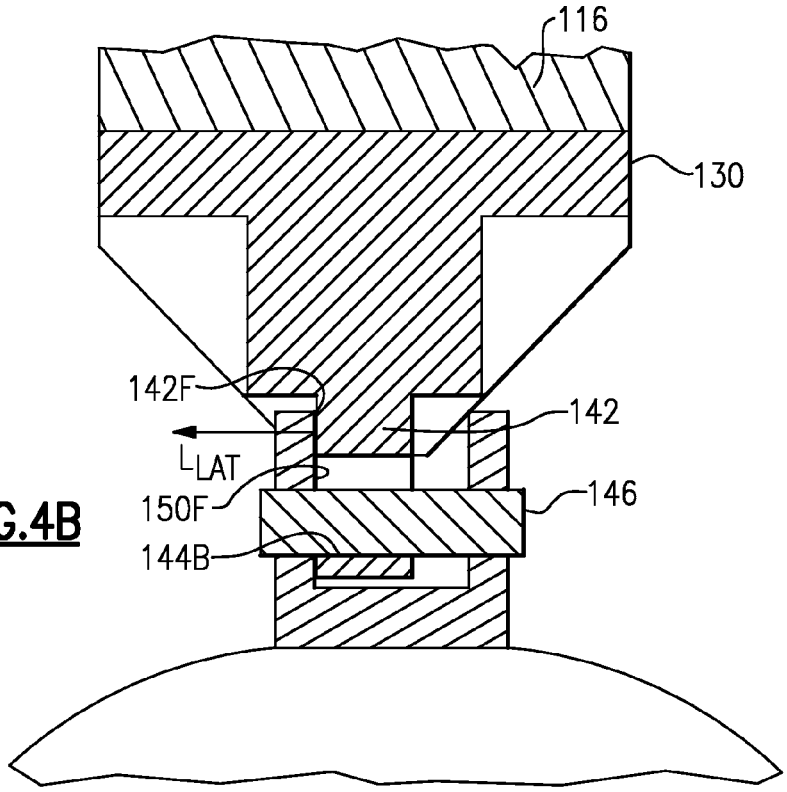


FIG.4B

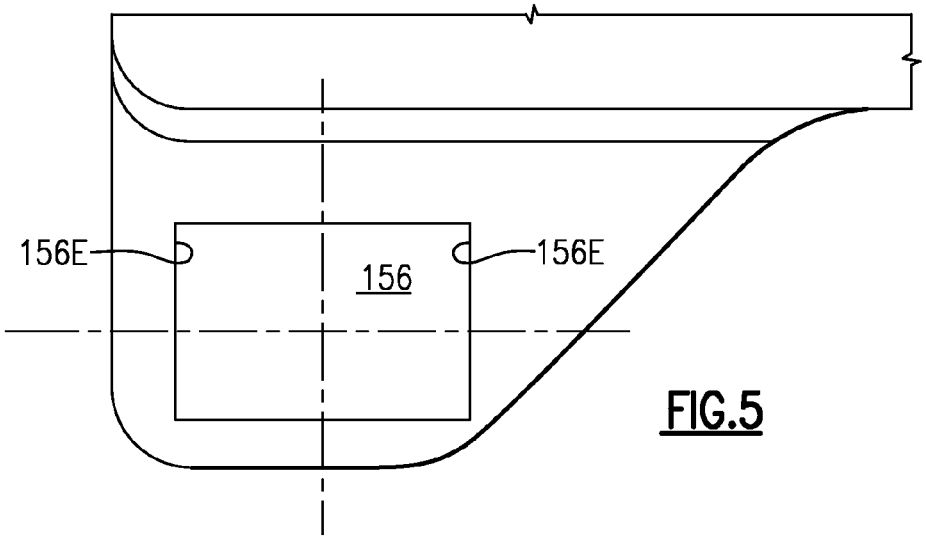


FIG.5

GAS TURBINE ENGINE MOUNTING STRUCTURE WITH SECONDARY LOAD PATHS

BACKGROUND OF THE INVENTION

[0001] Gas turbine engines are typically mounted to an aircraft by attaching a pylon to an aircraft frame, and attaching the engine at forward and rear locations to the pylon.

[0002] A structure, known as a wiffle tree or balance beam, is utilized to provide a path for engine thrust loads between a pair of thrust links and the mount body. Further, a shackle plate is mounted between the compressor housing and mount body to provide vertical and lateral load paths.

SUMMARY OF THE INVENTION

[0003] In a featured embodiment, a connection for mounting an aircraft engine to an aircraft pylon has a plate to be connected to a portion of an aircraft engine, and a body extending rearward from the plate. There is a back-up connection between the portion of the aircraft engine and the body. The back-up connection includes a pin positioned within a slotted hole, with a clearance between the pin and the slotted hole when there is a normal connection between the plate and the body.

[0004] In another embodiment according to the previous embodiment, the pin contacts the slotted hole when there is a failed connection between the plate and body.

[0005] In another embodiment according to the previous embodiment, the pin contacts a bottom of the slotted hole when there is a failed connection between the plate and body.

[0006] In another embodiment according to the previous embodiment, the pin is supported by two lugs attached to the portion of the aircraft engine.

[0007] In another embodiment according to the previous embodiment, the body includes a tang at a lower end thereof, with the slotted hole provided in the tang.

[0008] In another embodiment according to the previous embodiment, the lugs are arranged on opposed sides of the tang. There is a clearance between the lugs and the tang when there is a normal connection between the plate and body.

[0009] In another embodiment according to the previous embodiment, one of the lugs contacts a respective one of the opposed sides of the tang when there is a failed connection between the plate and the body.

[0010] In another embodiment according to the previous embodiment, the slotted hole has a length from a first end to a second end. The slotted hole has a height from a bottom of the slotted hole to a top.

[0011] In another embodiment according to the previous embodiment, the length of the slotted hole is greater than the height of the slotted hole.

[0012] In another embodiment according to the previous embodiment, each of the length and height of the slotted hole is greater than a diameter of the pin.

[0013] In another embodiment according to the previous embodiment, the length of the slotted hole is arranged substantially parallel to an axis of rotation of the aircraft engine.

[0014] In another embodiment according to the previous embodiment, the pin is positioned generally perpendicular to the axis of rotation of the engine.

[0015] In another featured embodiment, an aircraft has an engine mounted to an aircraft pylon. A connection mounts the engine to the pylon. The connection includes a plate connected to a portion of the, and a body extending rearward from the plate. A back-up connection is provided between the portion of the aircraft engine and the body. The back-up connection includes a pin positioned within a slotted hole, with clearance between the pin and the slotted hole when there is a normal connection between the plate and body.

[0016] In another embodiment according to the previous embodiment, the slotted hole has a length from a first end to a second end. The slotted hole has a height from a bottom of the slotted hole to a top. The length of the slotted hole is greater than the height of the slotted hole.

[0017] In another embodiment according to the previous embodiment, when there is a failed connection between the plate and the body, the pin contacts a bottom of the slotted hole without contacting either of the ends of the slotted hole.

[0018] These and other features of this application will be best understood from the following drawings and detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] The drawings can be briefly described as follows:

[0020] FIG. **1** is a perspective, schematic illustration of a typical attachment of an aircraft engine to an aircraft frame.

[0021] FIG. **2** shows detail of FIG. **1**.

[0022] FIG. **3**A illustrates a side view of the disclosed mount structure.

[0023] FIG. **3**B is a cross-sectional view taken along line A-A from FIG. **3**A.

[0024] FIG. **3**C is a close-up view of the back-up connection from FIG. **3**A when there is a normal connection between the shackle plate and the body.

[0025] FIG. **4**A is a view similar to FIG. **3**C, but illustrates a failed connection between the shackle plate and the body.

[0026] FIG. **4**B is a view similar to FIG. **3**B, but illustrates a failed connection between the shackle plate and the body.

[0027] FIG. **5** illustrates an alternate slotted hole that can be used with the disclosed back-up connection.

DETAILED DESCRIPTION

[0028] With reference to FIG. **1**, an aircraft engine **10**, generally defined about an engine axis of rotation **12**, is known to be mounted to an aircraft frame, shown schematically at **14**, through a pylon **16**. There is typically a forward mount structure **18**, which attaches the pylon **16** to a compressor housing **20**, as well as a rear mount structure **22**. It is possible that another portion of the engine **10**, other than the compressor housing **20**, could be used to mount the engine **10** to the pylon.

[0029] The forward mount structure **18** may include an arrangement **24** known as a "wiffle tree." As shown in FIG. **2**, the arrangement **24** includes a shackle plate **26** which is connected to the compressor housing **20**, here by a number of bolts **28**. A body **30** extends rearward from the shackle plate **26**, and is pinned at **32** such that it can pivot relative to a balance beam **34**. The balance beam **34** is pivotally mounted at **36** to a pair of thrust links **38**. Thrust links **38** are connected to the compressor housing **20** by pins **40**. Again, while the compressor housing **20** is shown, the thrust links **38** could attach to another portion of the engine **10**.

[0030] Forces from the compressor housing **20** are transmitted to the pylon **16** through the thrust links **38**, and the connection with the shackle plate **26**. The connection between the shackle plate **26** and the body **30** is primarily

responsible for reacting to vertical loads (such as from the weight of the engine), as well as lateral loads (such as those typically experienced during flight), while the body **30** reacts axial, or thrust loads, primarily by way of the thrust links **38**. If the connection between the shackle plate **26** and the body **30** should fail, reaction forces may no longer be properly directed between the engine **10** and the pylon **16**.

[0031] FIG. **3**A shows a back-up connection **140** (or, a "waiting" connection) to react to both vertical and lateral loads when there is a failed connection between the body **130** and the shackle plate **126**. To the extent not otherwise described or shown, the reference numbers in FIG. **3**A correspond to those of FIGS. **1-2**, with similar parts having reference numerals preappended with a "1."

[0032] The back-up connection **140** includes a tang **142** positioned adjacent to a lower end of the body **130**. The tang **142** is provided with a slotted hole **144**, within which a pin **146** is received, as illustrated in the cross-sectional view of FIG. **3**B. The pin **146** is supported within the slotted hole **144** by two lugs **148**, **150** which are part of a clevis arrangement **152** attached to an exterior of a compressor case **154**. The clevis arrangement **152** could be mounted to another portion of the engine. In the example shown, the length **144**L of the slotted hole **144** is arranged generally parallel to an engine axis of rotation, while the length of the pin **146** is oriented generally perpendicular to the engine axis of rotation.

[0033] The slotted hole **144** is non-circular, and includes a length **144**L greater than its height **144**H. Further, both the length **144**L and height **144**H are greater than a diameter **146**D of the pin **146**. In the example of FIG. **3**A the slotted hole **144** is shown with rounded ends, and may be referred to as a "race-track" hole because its shape resembles that of a race-track. In another example the slotted hole can include squared ends **156**E, as in the slotted hole **156** of FIG. **5**, although these squared ends **156**E could potentially cause undesirable stress concentrations at the corners. In either case, the slotted hole is, again, non-circular with a length greater than its height.

[0034] FIGS. **3**A-**3**C represent an "intact" condition in which there is a normal connection between the compressor housing **120** and the body **130** by way of the shackle plate **126**. In this condition, forces from the engine are reacted by the body **130** through its connection with the shackle plate **126**, as well as the connection between the body **130** and the thrust links **138**, as generally explained above.

[0035] In this "intact" condition, no force is transmitted from the engine to the body **130** by way of the back-up connection **140**. Instead, there is a clearance between the pin **146** and the slotted hole **144**, such that there is no contact therebetween. This clearance is represented between FIGS. **3**B-**3**C as clearance relative to the height C_H of the slotted hole **144** and clearance relative to the length C_{LEN} of the slotted hole **144**. There is further a clearance in a lateral direction C_{LAT} between the lugs **148**, **150** and the tang **142** such that, again, no force is transmitted between the engine and the body **130** via the back-up connection **140**.

[0036] Should the connection between the body **130** and the shackle plate **126** fail, however, the back-up connection **140** will react the vertical and lateral loads previously reacted by way of the connection between the shackle plate **126** and the body **130**. A failed connection between the shackle plate **126** and the body **130** is defined as any condition in which the body **130** can no longer react forces from the engine by way of the shackle plate **126** as it does in the intact condition described above. This includes cracking of the shackle plate **126**, the bolts holding the shackle plate **126** to the compressor housing **120** becoming unfastened, a fracture of the link **127** between the shackle plate **126** and the body **130**, etc.

[0037] When there is a failed connection between the shackle plate **126** and the body **130**, the engine will drop relative to the body **130**. The pin **146** will likewise drop relative to the slotted hole **144**, and will contact a bottom **144**B of the slotted hole **144**, as illustrated in FIG. **4**A. The body **130** will then react to the weight of the engine, as well as any other vertical loads, by way of the connection between the pin **146** and the slotted hole **144**B, as schematically represented by the vertical load L_v.

[0038] Without the connection between the shackle plate **126** and the body **130**, the compressor housing **120** will move laterally relative to the body **130** depending on flight maneuvers, etc. As shown in FIG. **4**B, the body **130** reacts a lateral load from the engine, by way of contact between faces **142**F, **150**F of the tang **142** and the lug **150**, as represented schematically by the lateral load L_{LAT}. This is one example of a reaction of a lateral load, and it should be understood that the tang **142** is capable of reacting to a lateral load from either lateral side.

[0039] Accordingly, the back-up connection **140** is capable of reacting to both vertical and lateral loads, by providing a secondary path for these loads in addition to the normal load path between the shackle plate **126** and the body **130**.

[0040] Further, the back-up connection **140** is statically determinant in nature. Because the slotted hole is provided with a length **144**L greater than its height **144**H, and is thus non-circular, the body **130** does not react to loads in the fore and aft directions, such as thrust loads, by way of the back-up connection **140**. In other words, the length **144**L of the slotted hole is such that, when there is a failed connection between the shackle plate **126** and the body **130**, the pin **146** will not contact the ends **144**E of the slotted hole **144**. Accordingly, because the back-up connection **140** is statically determinant, the manner in which the back-up connection **140** reacts to critical load conditions can be relatively easily modeled.

[0041] Although the different examples have the specific components shown in the illustrations, embodiments of this invention are not limited to those particular combinations. It is possible to use some of the components or features from one of the examples in combination with features or components from another one of the examples.

[0042] One of ordinary skill in this art would understand that the above-described embodiments are exemplary and non-limiting. That is, modifications of this disclosure would come within the scope of the claims. Accordingly, the following claims should be studied to determine their true scope and content.

What is claimed is:

1. A connection for mounting an aircraft engine to an aircraft pylon comprising:

a plate to be connected to a portion of an aircraft engine, and a body extending rearward from said plate;

a back-up connection between said portion of said aircraft engine and said body, said back-up connection including a pin positioned within a slotted hole, there being clearance between said pin and said slotted hole when there is a normal connection between said plate and said body.

2. The connection as set forth in claim **1**, wherein said pin contacts said slotted hole when there is a failed connection between said plate and said body.

3. The connection as set forth in claim **2**, wherein said pin contacts a bottom of said slotted hole when there is a failed connection between said plate and said body.

4. The connection as set forth in claim **1**, wherein said pin is supported by two lugs attached to said portion of said aircraft engine.

5. The connection as set forth in claim **4**, wherein said body includes a tang at a lower end thereof, said slotted hole provided in said tang.

6. The connection as set forth in claim **5**, wherein each of said lugs are arranged on opposed sides of said tang, there being a clearance between said lugs and said tang when there is a normal connection between said plate and said body.

7. The connection as set forth in claim **6**, wherein one of said lugs contacts a respective one of said opposed sides of said tang when there is a failed connection between said plate and said body.

8. The connection as set forth in claim **1**, wherein said slotted hole has a length from a first end to a second end, and wherein said slotted hole has a height from a bottom of said slotted hole to a top.

9. The connection as set forth in claim **8**, wherein said length of said slotted hole is greater than said height of said slotted hole.

10. The connection as set forth in claim **9**, wherein each of said length and height of said slotted hole is greater than a diameter of said pin.

11. The connection as set forth in claim **9**, wherein said length of said slotted hole is arranged substantially parallel to an axis of rotation of said aircraft engine.

12. The connection as set forth in claim **11**, wherein said pin is positioned generally perpendicular to said axis of rotation of said engine.

13. An aircraft comprising:

an engine mounted to an aircraft pylon;

a connection mounting said engine to said pylon, said connection including a plate connected to a portion of said engine, and a body extending rearward from said plate; and

a back-up connection between said portion of said aircraft engine and said body, said back-up connection including a pin positioned within a slotted hole, there being clearance between said pin and said slotted hole when there is a normal connection between said plate and said body.

14. The aircraft as set forth in claim **13**, wherein said slotted hole has a length from a first end to a second end, and wherein said slotted hole has a height from a bottom of said slotted hole to a top, said length of said slotted hole is greater than said height of said slotted hole.

15. The aircraft as recited in claim **14**, wherein, when there is a failed connection between said plate and said body, said pin contacts a bottom of said slotted hole without contacting either of said ends of said slotted hole.

* * * * *