United States Patent

[11] 3,581,437

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[54] **AIRCRAFT HANGAR DOOR**
14 Claims, 11 Drawing Figs.

[52] **U.S. Cl.** **49/118,** 49/27, 49/40, 49/149, 49/362
[51] **Int. Cl.** **E05f 15/14,** E05f 17/00
[50] **Field of Search** 49/27, 28, 40, 41, 116, 118, 119, 120, 121, 123, 168, 149, 360, 362; 160/185

[56] **References Cited**
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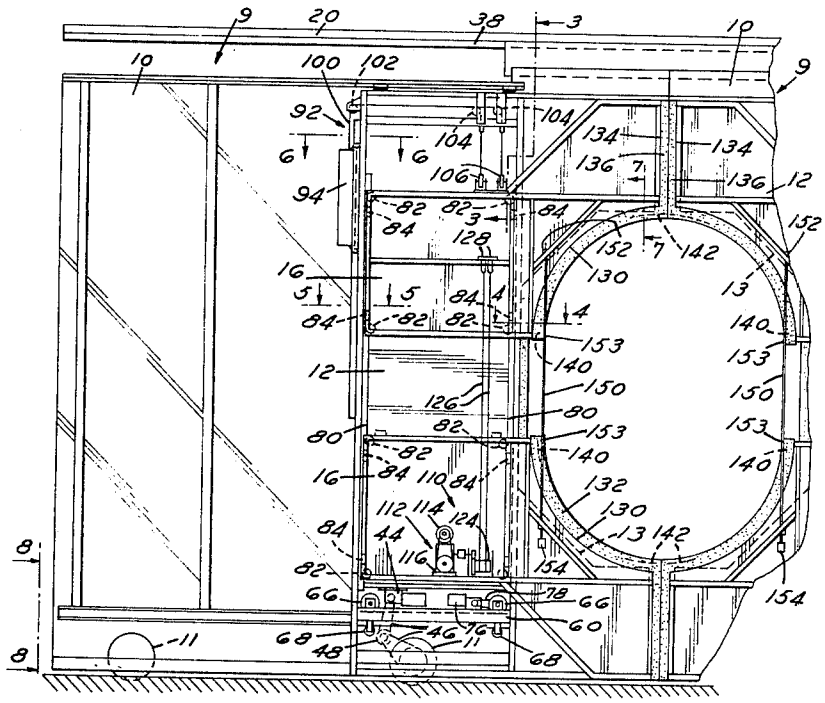
ABSTRACT: An adjustable closure adapted for use with aircraft hangar doors for fitting around an aircraft fuselage projecting through the space between the doors. Each door has a horizontally movable carrier. A pair of closure elements are mounted on each carrier and have recesses shaped to fit around the fuselage. The closure elements on each carrier are adjustable toward and away from one another and are substantially free floating vertically in response to vertical movement of the fuselage.



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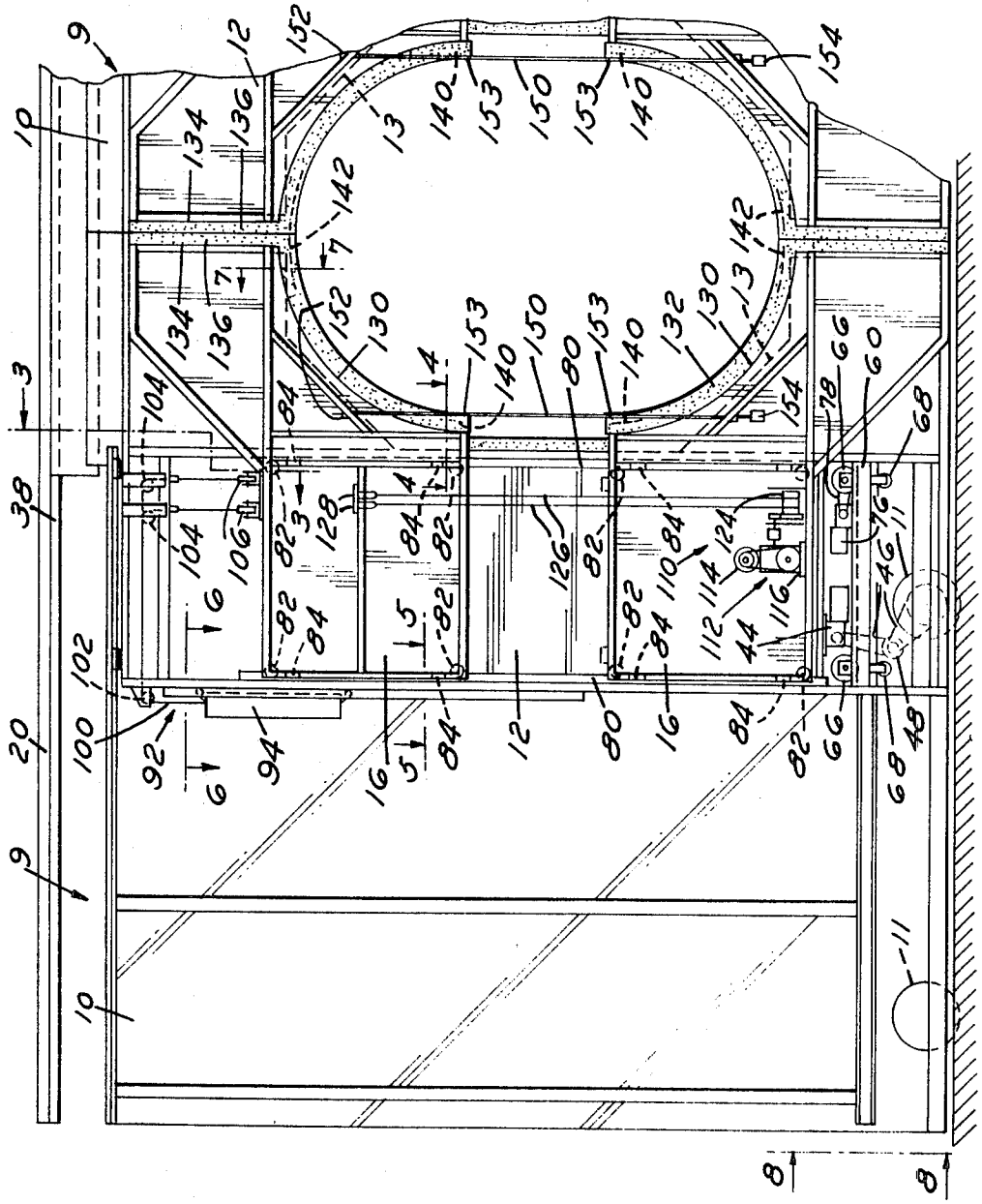

FIG. 1

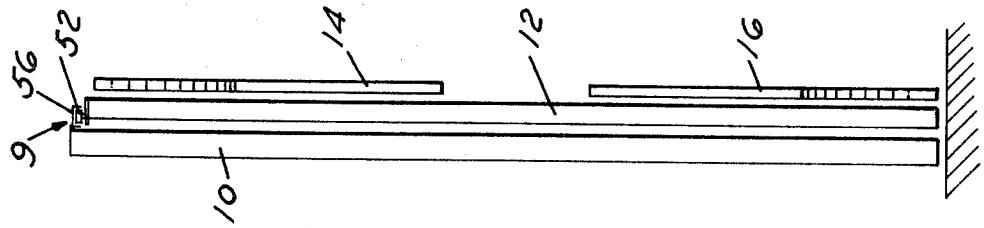

FIG. 2

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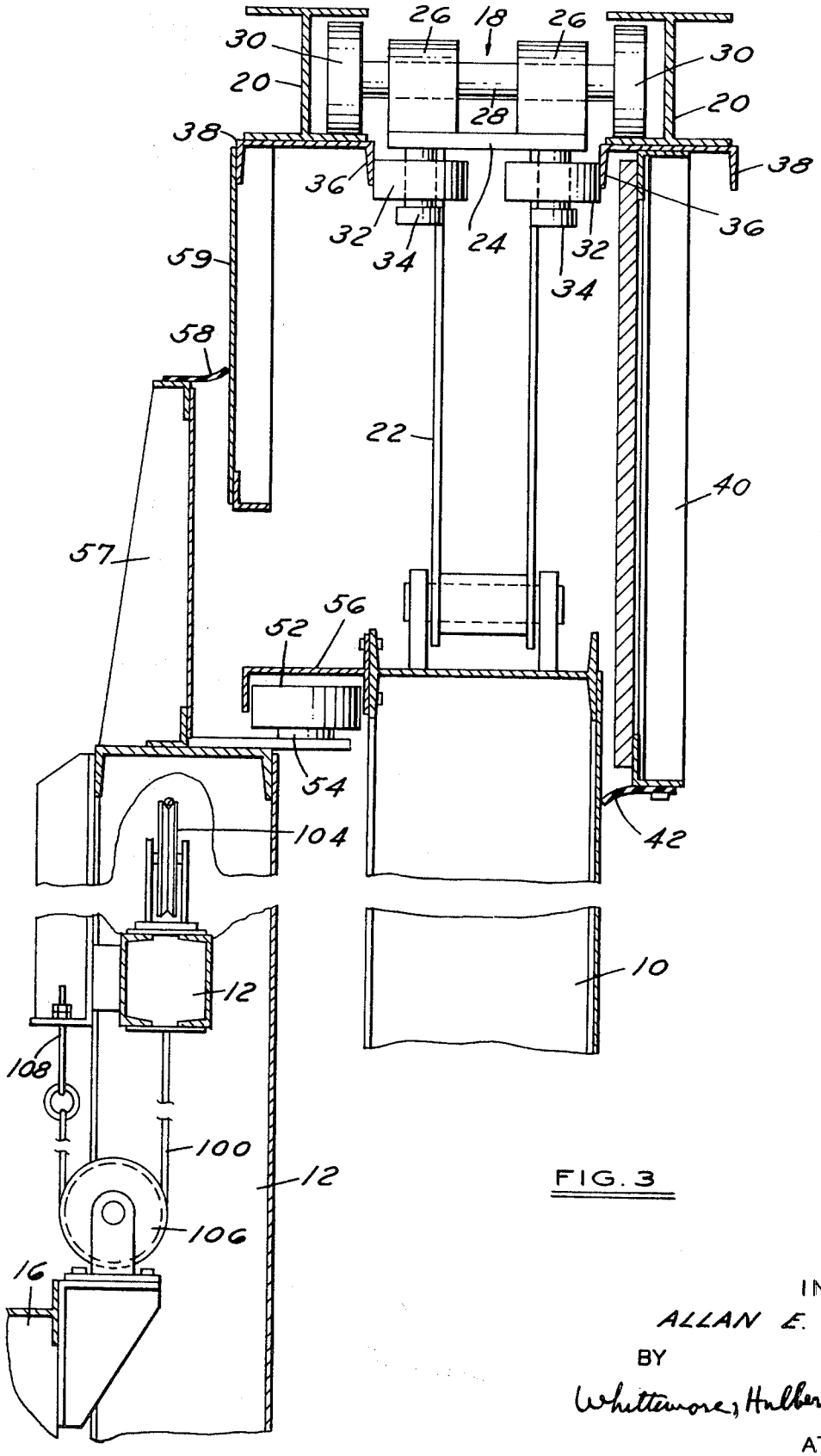

FIG. 3

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FIG. 4

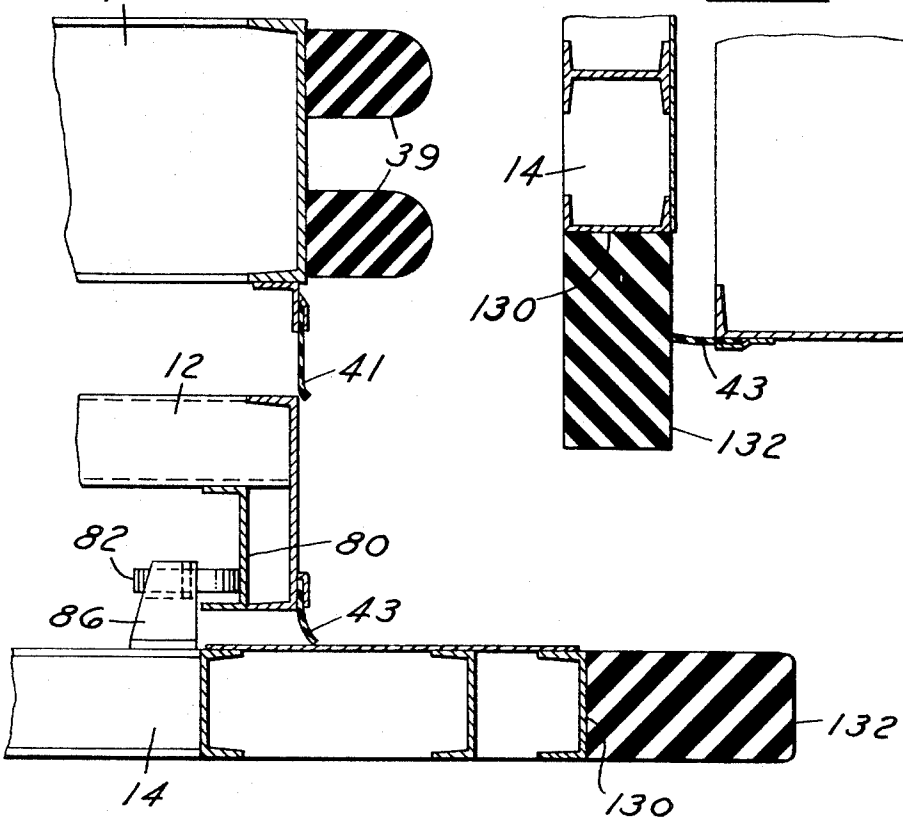

FIG. 7

FIG. 5

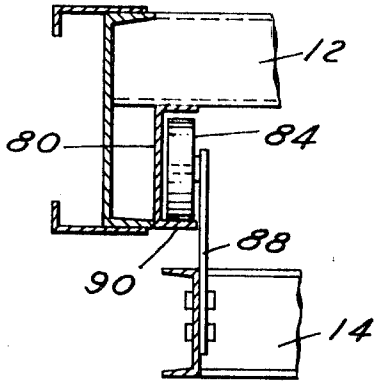

FIG. 6

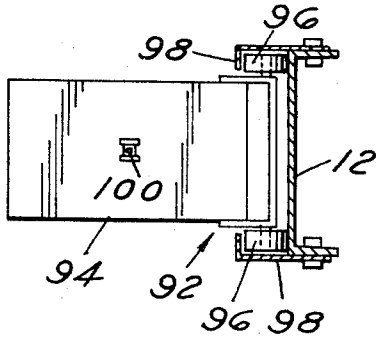

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FIG. 8

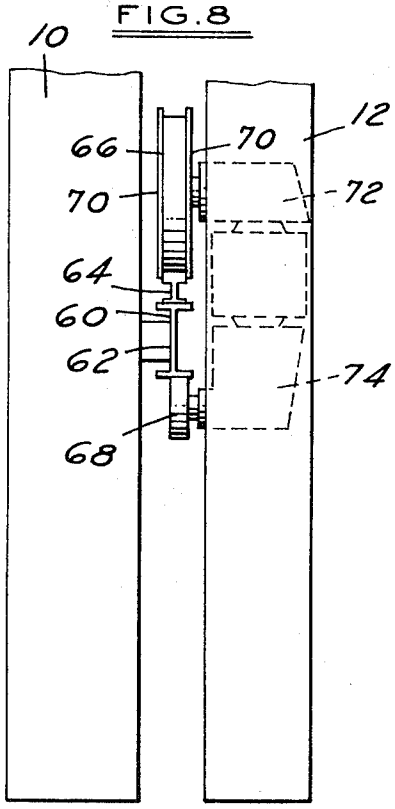


FIG. 9

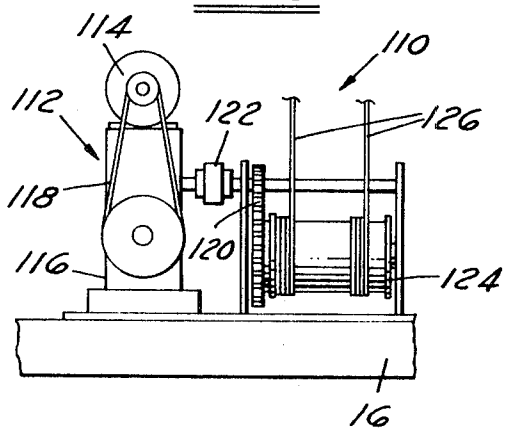
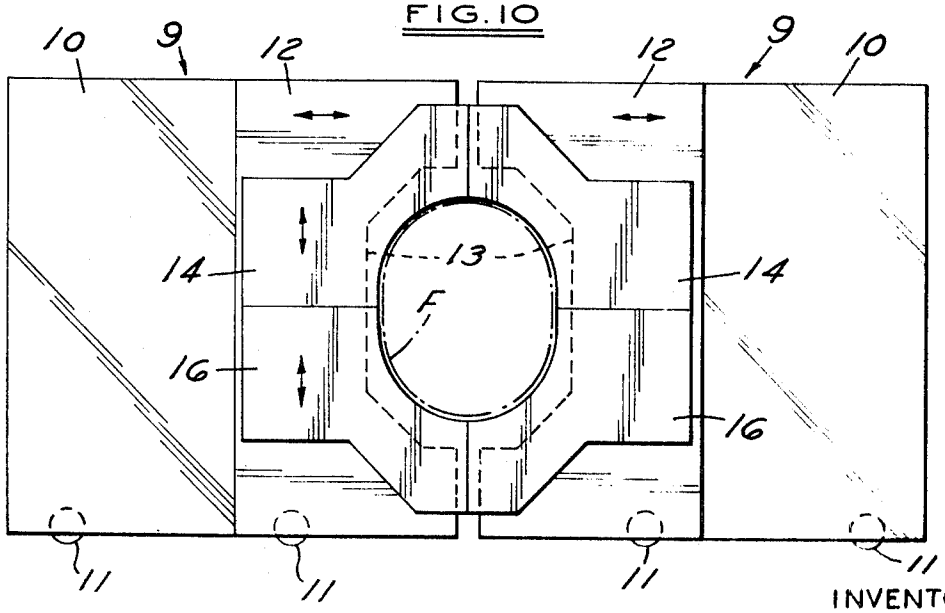


FIG. 10



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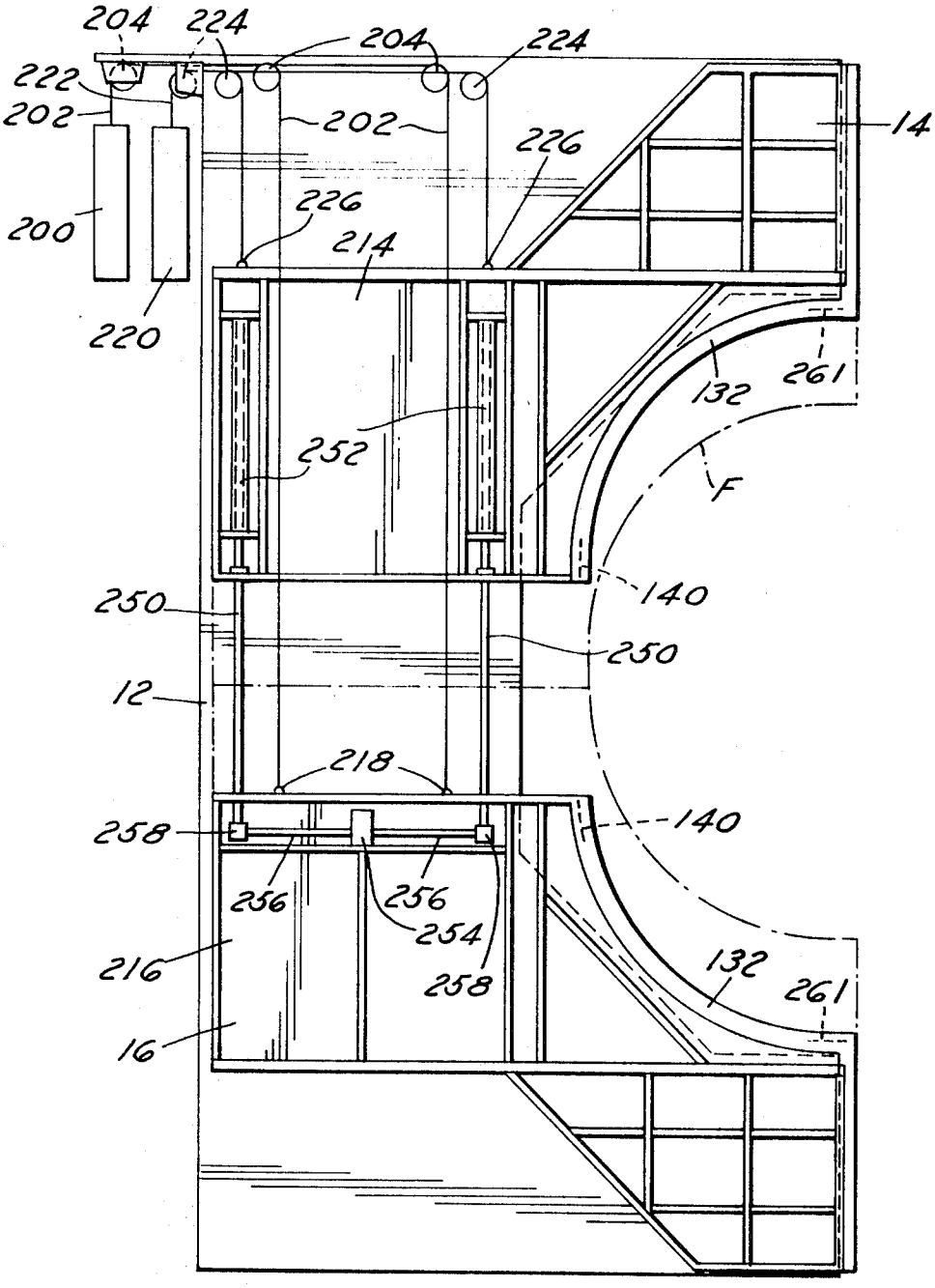

FIG. 11

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AIRCRAFT HANGAR DOOR

BACKGROUND OF THE INVENTION

The invention is an improvement on the adjustable closure disclosed in U.S. Pat. No. 2,739,645.

SUMMARY OF THE INVENTION

One object of this invention is to provide an improved adjustable closure for fitting around an aircraft fuselage projecting through the space between the doors of an aircraft hangar.

Another object is to provide an adjustable closure comprising closure elements for closing the space between the aircraft hangar doors and the fuselage, and means mounting the closure elements on the doors to permit substantially free floating movement thereof in response to movement of the fuselage.

Another object is to provide an adjustable closure in which the closure elements are mounted for substantially free floating movement vertically in response to vertical movement of the fuselage.

Another object is to provide upper and lower closure elements mounted on each door, and means for moving the closure elements relatively toward and away from one another.

Another object is to provide moving means for the upper and lower closure elements in the form of adjustable threaded members.

Another object is to provide single counterbalancing means for the upper and lower closure elements on each door member, being connected to the upper closure element.

Another object is to provide means for moving the upper and lower closure elements comprising a flexible linear member suspending the lower closure element from the upper closure element, and means for increasing and decreasing the effective lengths of the linear members to cause the upper and lower closure elements to move relatively away from and toward each other.

Another object is to provide a horizontally movable carrier on each door member upon which the vertically movable upper and lower closure elements are mounted.

Another object is to provide pressure sensitive means for rendering inoperative the power drives for the carrier and the closure elements in response to excessive pressure contact of a closure element with the fuselage.

Other objects and features of the invention will become apparent as the description proceeds, especially when taken in conjunction with the accompanying drawings, wherein:

FIG. 1 is a fragmentary inside elevational view of aircraft hangar door assemblies including door members having horizontally movable carriers and vertically movable closure elements mounted on the carriers adapted to fit around an aircraft fuselage projecting through the space between the door members. The closure elements are shown open, i.e., vertically spaced apart.

FIG. 2 is a semidiagrammatic elevational view of a door assembly as viewed from the left in FIG. 1.

FIGS. 3, 4, 5, 6 and 7 are fragmentary sectional views respectively, taken on the lines 3–3, 4–4, 5–5, 6–6 and 7–7 in FIG. 1.

FIG. 8 is a fragmentary view taken substantially on the line 8–8 in FIG. 1.

FIG. 9 is an enlarged fragmentary view of a portion of FIG. 1, showing the means for relatively moving the closure elements toward and away from each other.

FIG. 10 is a diagrammatic elevational view of the door assemblies shown in FIG. 1, showing the aperture in closed position.

FIG. 11 is an elevational view of a door assembly having a modified construction.

The aircraft hanger door assemblies 9 are diagrammatically illustrated in FIG. 10 where they will be seen to include a pair of door members 10 movable horizontally toward and away from each other on ground wheels 11 between closed and open positions. In the closed position illustrated in FIG. 10, the door members substantially close an opening in an aircraft hangar, and in the open position of the door members, the opening in the aircraft hangar is substantially unobstructed to permit an aircraft to be moved into or out of the hangar. Upon each door member 10 there is mounted a horizontally movable carrier 12, and upon each carrier 12 there are mounted an upper closure element 14 and a lower closure element 16. The upper and lower closure elements 14 and 16 are movable vertically toward one another so as to fit around the fuselage F of an aircraft and close the space between the door members and the fuselage. The door assemblies 9 are mirror images of one another, and therefore similar parts have been given the same reference numbers.

Referring now more particularly to FIGS. 1—3, each door member 10 has a head guide 18 for guiding the horizontal movement thereof. As seen particularly in FIG. 3, the hangar structure includes the horizontal laterally spaced I-beams 20 which extend along the top of the hangar opening. The head guide for each door member 10 includes the support structure 22 carried by the door member and having a truck 24 at the upper end upon which the bearing blocks 26 are mounted. Shafts 28 carried by the bearing blocks 26 have end rollers 30 rotatable on horizontal axes and running on the bottom flanges of the I-beams 20 to support the trucks 24. Guide rollers 32 mounted on vertical stub shafts 34 depending from plate 24 engage the inner flanges 36 on the inverted channels 38 carried by the I-beams 20 to guide the door members 10 during their opening and closing movements. The hangar has a fixed frame 40 extending beneath one of the channels 38 which is provided with a seal 42 engageable with the door members 10.

Referring to FIG. 4, the door members 10 may have cushions 39 on their leading edges and additional seals 41 engaging carriers 12. Carriers 12 may also have seals 43 engaging the closure elements.

The door members are driven horizontally between open and closed positions by any suitable means such as by a drive including a motor 44 mounted on each door member 10 having a transmission consisting of chains 46 and sprockets 48 to one of the floor-engaging wheels 11. The motor 34 is reversible to drive the wheel 11 and hence the door member in opposite directions and may be manually controlled by an operator.

Each carrier 12 is mounted on a door member 10 for horizontal movement relative to the door member. As shown in FIGS. 1 and 10, the opposed leading edges of the carriers 12 are recessed as indicated at 13 to clear the fuselage of an aircraft when the carriers 12 are brought together. Referring to FIGS. 1, 2 and 3, the carrier 12 has a plurality of guide rollers 52 along its upper edge mounted for rotation on the vertical shafts 54. The rollers 52 fit in the inverted horizontal channel guides 56 secured to and extending horizontally along the upper edges of the door members 10. An upwardly extending frame structure 57 on each carrier 12 has a seal 58 engaging a depending frame structure 59 fixed to the hangar.

Referring to FIGS. 1 and 8, each door member 10 has a horizontal track 60 mounted on its inner surface consisting of an I-beam 62 and a rail 64 secured to the top of the I-beam 62. Each carriers 12 has the top and bottom rollers 66 and 68 engageable with the track 60 to support the carrier 12 during its horizontal movement. The upper rollers 66 are grooved rollers so that the annular flanges 70 thereof straddle the top flange of the rail 64. The lower rollers 68 engage the bottom flange of the I-beam 62. The rollers 66 and 68 turn on horizontal axes and are supported by bearing blocks 72 and 74 mounted upon the carrier 12. An electric motor 76 is mounted on each carrier 12 and has a suitable chain and sprocket transmission 78 to one of the rollers 66. The motor 76 is reversible and may be controlled manually to drive the carrier 12 horizontally in either direction.

The upper and lower closure elements 14 and 16 for each door member 10 are supported for vertical movement on the associated carrier 12. Referring to FIGS. 1, 4 and 5, each carrier 12, has a pair of laterally spaced guide channel tracks 80.

Each closure element is provided with four tilt rollers **82** and four wind rollers **84** which engage the tracks **80** to guide the vertical movement of the closure element. The tilt rollers **82** are supported by brackets **86** for free rotation on horizontal axes extending transversely of the door members and roll on the webs of the tracks **80**. The wind rollers **84** are mounted on the closure elements by brackets **88** for free rotation on horizontal axes extending parallel to the direction of movement of the door members and roll on the flanges **90** of the tracks **80**.

A single counterbalancing means is provided on each carrier **12** for substantially exactly counterbalancing the weight of the two associated closure elements **14** and **16**. The counterbalancing means is generally designated **92** and comprises a counterweight **94** guided for vertical movement on the carrier **12** by rollers **96** on the counterweight engaging tracks **98** on the carrier. Cables **100** extend from the counterweight **94** up over pulleys **102** on the carrier and then horizontally to pulleys **104** also on the carrier. The cables then pass downwardly under pulleys **106** carried by the upper closure element **14** and then upwardly and are secured to anchorages **108** rigid with the carrier.

The means for relatively moving the upper and lower closure elements of each door toward and away from one another and generally designated **110**, is also the means by which the lower closure element **16** is suspended from and supported by the upper closure element **14**. Referring to FIGS. **1** and **9**, such means comprises a motor drive **112** mounted on each lower closure element **16** which may comprise a reversible electric motor **114** and a gear box **116** driven by a chain **118** from the motor. Suitable gearing **120** from the output shaft **122** of the gear box rotates a drum **124** mounted on the lower closure element **16**. A pair of cables **126** wrapped on the drum **124** extend upwardly and are terminally secured to the anchorages **128** on the upper closure element **14**. The motor **114** is manually controlled and it will be apparent that by operating the motor in one direction or the other, the distance between the upper and lower closure elements may be either increased or decreased.

It will be understood that the counterweight **94** on each door member substantially exactly balances the weight of the two associated closure elements **14** and **16** and their related parts. Thus very little upward or downward force applied to either one or both of the closure elements **14** and **16** will cause the two closure elements to be raised or lowered accordingly.

EAch closure element has a recessed leading edge **130** which is generally in the shape of an arc to conform to the contour of the aircraft fuselage F. A cushion **132** is provided along each recessed edge **130** which cushion may if desired be extended upwardly along the upper leading vertical edges **134** of the closure elements as indicated at **136**. Referring to FIG. **1**, it will be noted that when the door members **10** are closed and the carriers **12** are brought together, the cushioned recessed leading portions of the two upper closure elements come together to form substantially a semicircle adapted to close the space above an aircraft fuselage, and the two cushioned leading recessed portions of the lower elements likewise come together in substantially a semicircle to close the space beneath the aircraft fuselage.

Preferably, pressure sensitive switches **140** and **142** are provided in the cushions **132** to protect the aircraft fuselage from excessive pressure contact. The switches **140** are in the circuit to the associated carrier drive **76** and the switches **142** are in the circuit to the associated closure element drive **114**. When any of these switches is actuated by excessive pressure, the motor drive with which it is associated is rendered inoperative or is deactuated to prevent further movement of either the carrier or the closure element in a closing direction with respect to the aircraft fuselage.

Each carrier **12** has a flexible linear member which may be a nylon cord **150** secured at its upper end at **152** to the carrier and having a weight **154** at its lower end. This nylon cord is adapted to contact the side of the aircraft fuselage when the carrier is advanced, indicating to the operator that the carrier has been advanced to the proper position. These cords are normally secured to carriers **12** in positions such that they extend along the ends **153** of the cushions **132**.

In operation and assuming an aircraft fuselage is projecting through the hangar opening between the door assemblies **9**, the door members **10** are moved in a closing direction toward one another by operation of the motors **44** to a predetermined position which may be indicated by a mark on the floor, for example. The door members **10** are shown in their closed positions in FIGS. **1** and **10**. Then the carriers **12** are advanced by motors **76** toward one another to the positions illustrated in FIGS. **1** and **10**. The carriers will usually be advanced until the nylon cords **150** contact the sides of the aircraft fuselage.

The motor **114** is then operated to bring the upper and lower closure elements **14** and **16** on each carrier toward one another by shortening the cables **126** connecting the two. In the event that the counterweight **94** is slightly heavy, the result will be an initial upward movement of the lower closure element **16** into contact with the lower side of the aircraft fuselage, followed by a downward movement of the upper closure element **14** into contact with the upper surface of the aircraft fuselage. If, on the other hand, the counterweight is slightly light, the upper segment will first descend into contact with the fuselage followed by an upward movement of the lower closure element. Thus when the first closure element to advance contacts the fuselage, the closing movement is transferred to the other element so that they both close upon the fuselage.

As noted, pressure switches **140** and **142** are provided in the cushions **132** to deactuate motor **76** or motor **114** in the event that the operator should advance either the carriers **12** or the closure elements **14** and **16** too far and subjects the aircraft fuselage to more than a predetermined limit of pressure contact.

The upper and lower closure are completely free floating, being substantially perfectly counterbalanced, so that if the fuselage changes its elevation, as in the event of a tire failure or when the aircraft is being loaded or unloaded for example, the closure elements will follow the fuselage and maintain a substantially closed space around the fuselage. It should be noted however that the distance separating the upper and lower closure elements will not change even though the fuselage moves up or down.

FIG. **11** illustrates a modification in which corresponding parts bear the same reference characters employed in FIGS. **1**—**10**. The essential difference in FIG. **11** is that the upper and lower closure elements of each door member are separately counterbalanced and are moved toward and away from one another by means of a rigid threaded connection.

Thus as shown, a counterweight **200** has cables **202** extending over pulleys **204** on the carrier **12** and then down to the lower closure element **216** where they are terminally connected at **218**. The counterweight **220** has a cable **222** extending up over pulleys **224** mounted on the carrier **12** and then down to the upper closure element **214** where they are terminally connected at **226**. The counterweights **200** and **220** respectively substantially perfectly balance the upper end lower closure elements **214** and **216**.

The means for moving the upper and lower closure elements toward and away from each other consists of the screws **250** and the threaded tubular members **252** into which the screws **250** thread. The threaded tubular members **252** are disposed vertically and are rigidly carried by the upper closure element **214**, and the screws **250** are carried by the lower closure element **216** for rotation although prevented from moving vertically with respect to the lower closure element. A manually controlled, reversible motor drive diagrammatically illustrated at **254** is provided and through the transmissions **256** and gearing **258** operates to rotate the screws **250** in either direction depending on whether it is desired to close the closure elements upon one another or move them apart. Suitable pressure-sensitive limit switches **261** are provided in the

cushions **132** to deenergize the motor drive **254** in the event of excessive pressure contact between the cushions and the fuselage.

It is apparent that the closure elements **214** and **216**, although individually counterbalanced, will be substantially free floating and capable of moving up and down as a unit with the aircraft fuselage should the aircraft fuselage change its elevation.

It will be understood that the other door assembly not shown, will be a mirror image of the one shown in FIG. **11**. It will also be understood that except for the differences specifically described and illustrated, the construcution in FIG. **11** is like that in FIGS. **1—10**.

What I claim as my invention is:

1. An adjustable closure for fitting around an aircraft fuselage and adapted for use with aircraft hangar door members movable toward one another to define a space therebetween for receiving the fuselage, comprising closure elements for at least partially closing the space between the door members and the fuselage, and means mounting said closure elements on the door members and permitting substantially free floating movement of said closure elements in response to movement of the fuselage.

2. The closure defined in claim **1**, wherein said mounting means includes counterbalancing means for said closure elements, and said closure elements are mounted for substantially free floating movement vertically in response to vertical movement of the fuselage.

3. The closure defined in claim **2**, wherein said closure elements include upper and lower closure elements mounted on each door member, and means for moving said upper and lower closure elements toward and away from one another.

4. The closure defined in claim **3**, wherein said moving means comprises adjustable threaded members.

5. The closure defined in claim **3**, including pressure-actuated means for rendering said last-mentioned means inoperative in response to excessive pressure contact of a closure element with the fuselage.

6. The closure defined in claim **3**, wherein a single counterbalancing means is provided for the upper and lower closure elements on each door member, being connected to the upper closure element.

7. The closure defined in claim **6**, wherein said moving means comprises a flexible linear member suspending the lower element of each door member from the upper element thereof, and means for increasing and decreasing the effective lengths of said linear members to cause said upper and lower elements to move relatively away from and toward each other.

8. The closure defined in claim **1**, wherein said mounting means includes a horizontally movable carrier mounted on each door member and counterbalancing means for said closure elements, said closure elements include upper and lower closure elements mounted for substantially free floating vertical movement on each carrier, and means for moving said upper and lower closure elements toward and away from each other.

9. The closure defined in claim **8**, wherein said moving means comprises adjustable threaded members.

10. The closure defined in claim **8**, wherein a single counterbalancing means is provided for the upper and lower closure elements on each carrier, being connected to the upper closure element.

11. The closure defined in claim **10**, wherein said moving means comprises a flexible linear member suspending the lower element on each carrier from the upper element thereon, and means for increasing and decreasing the effective lengths of said linear members to cause said upper and lower elements to move relatively away from and toward each other.

12. The closure defined in claim **11**, including pressure-actuated means associated with said closure elements for rendering said last-mentioned means inoperative in response to excessive pressure contact of a closure element with the fuselage.

13. The closure defined in claim **12**, wherein said closure elements have leading edges provided with cushions for contacting the fuselage, and said pressure-actuated means is embedded in said cushions.

14. The closure defined in claim **8**, including means for moving each of said carriers, and pressure-actuated means associated with said closure elements for rendering said last-mentioned means inoperative in response to excessive pressure contact of a closure element with the fuselage.