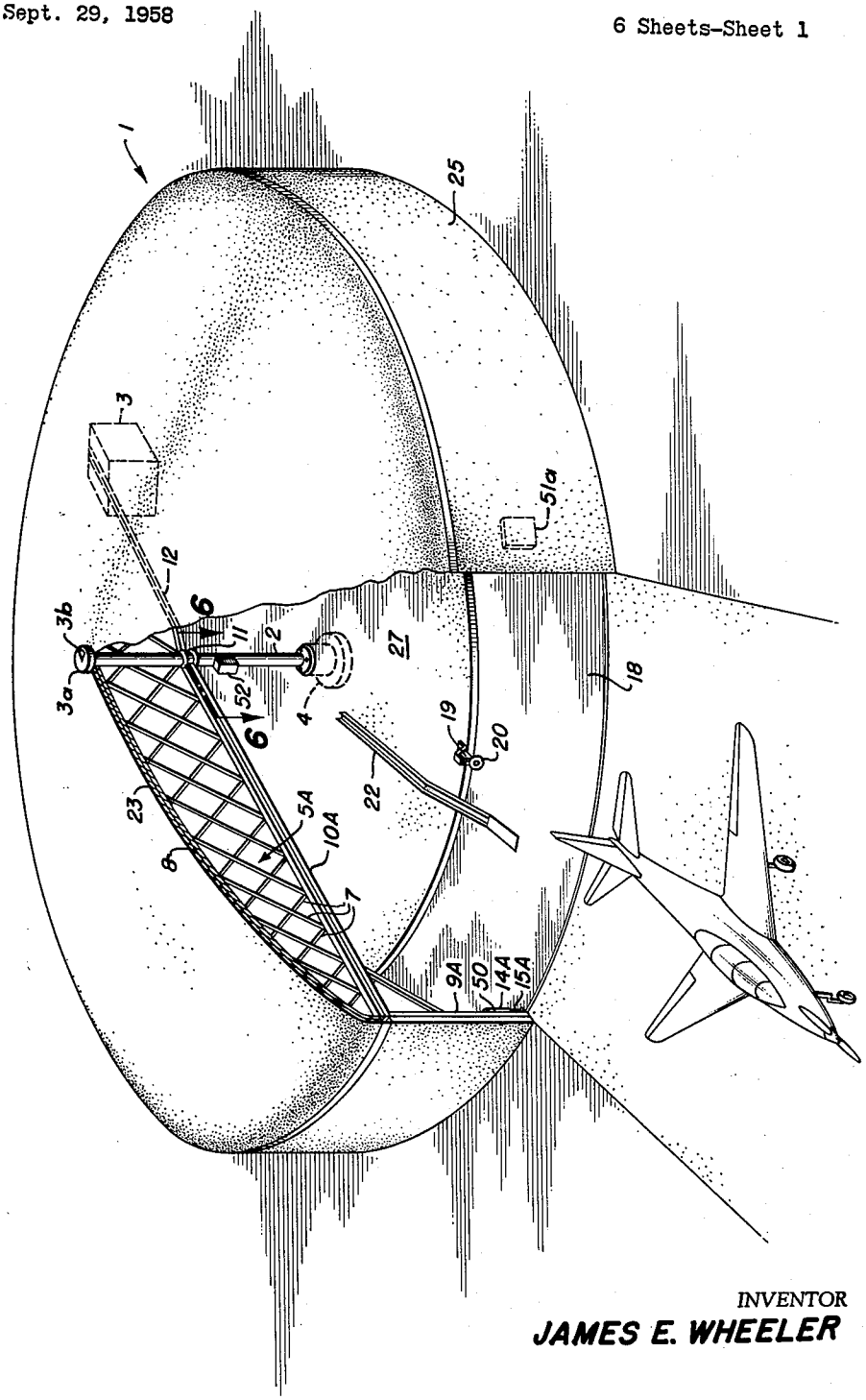
Jan. 29, 1963 J. E. WHEELER 3,075,654

CIRCULAR AIRPLANE HANGAR

Filed Sept. 29, 1958 6 Sheets-Sheet 1

FIG. 1



INVENTOR
JAMES E. WHEELER

BY Stevens, Davis, Miller & Mosher
ATTORNEYS

Jan. 29, 1963 J. E. WHEELER 3,075,654

CIRCULAR AIRPLANE HANGAR

Filed Sept. 29, 1958 6 Sheets-Sheet 2

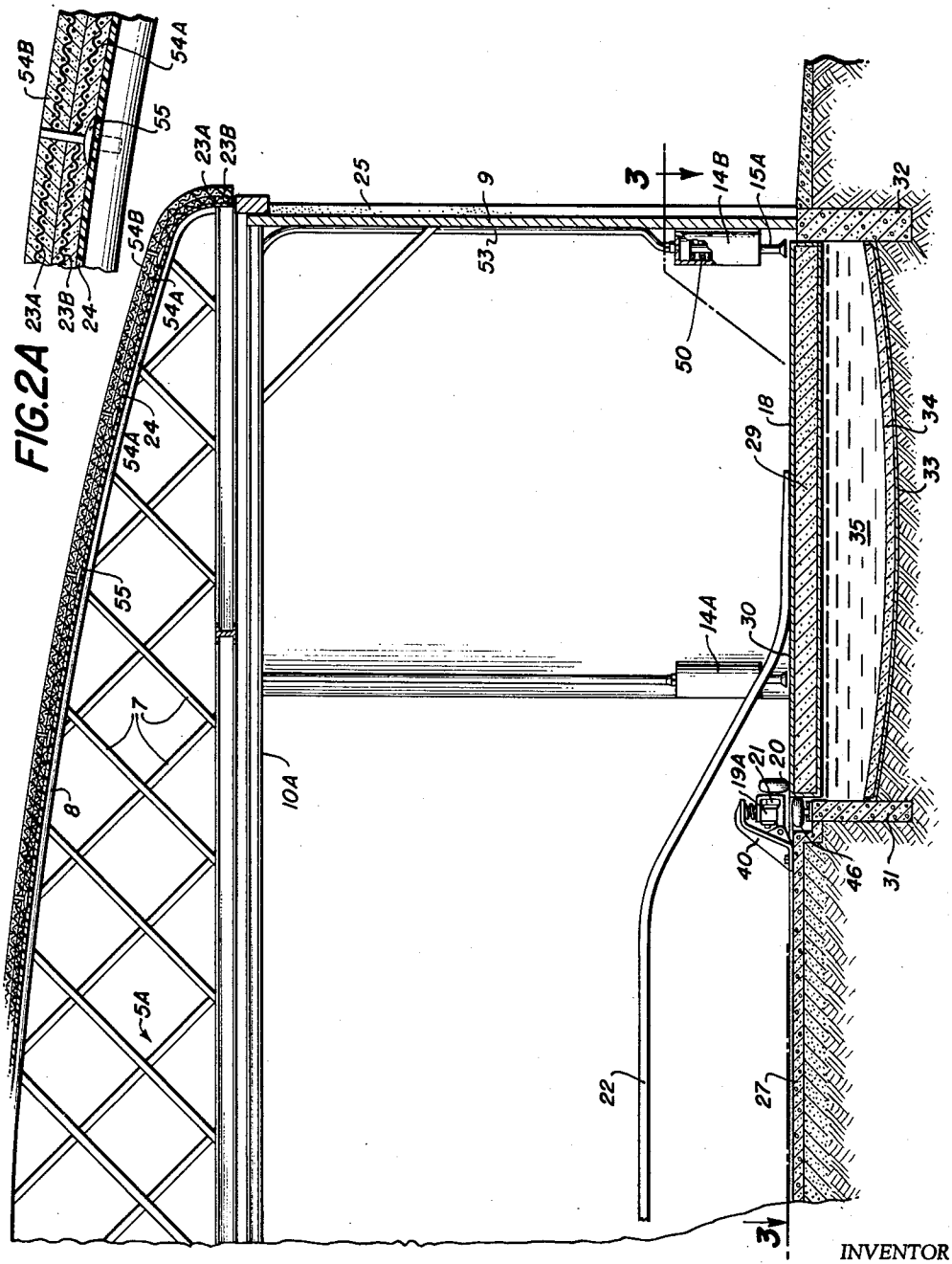


FIG. 2A

FIG. 2

INVENTOR
JAMES E. WHEELER

BY Stevens, Davis, Miller & Mosher
ATTORNEYS

Jan. 29, 1963 J. E. WHEELER 3,075,654

CIRCULAR AIRPLANE HANGAR

Filed Sept. 29, 1958 6 Sheets-Sheet 3

FIG. 3

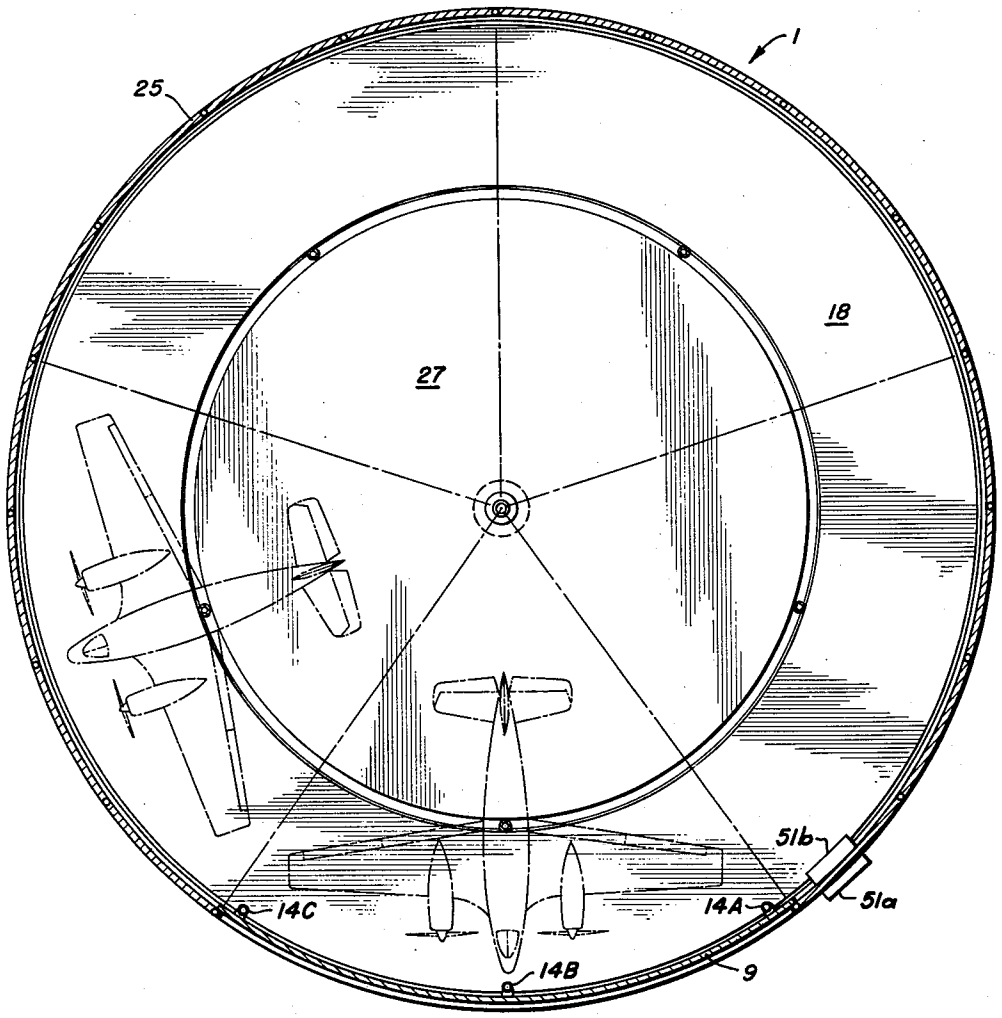
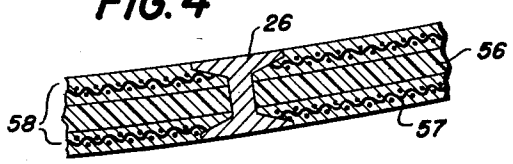


FIG. 4



INVENTOR
JAMES E. WHEELER

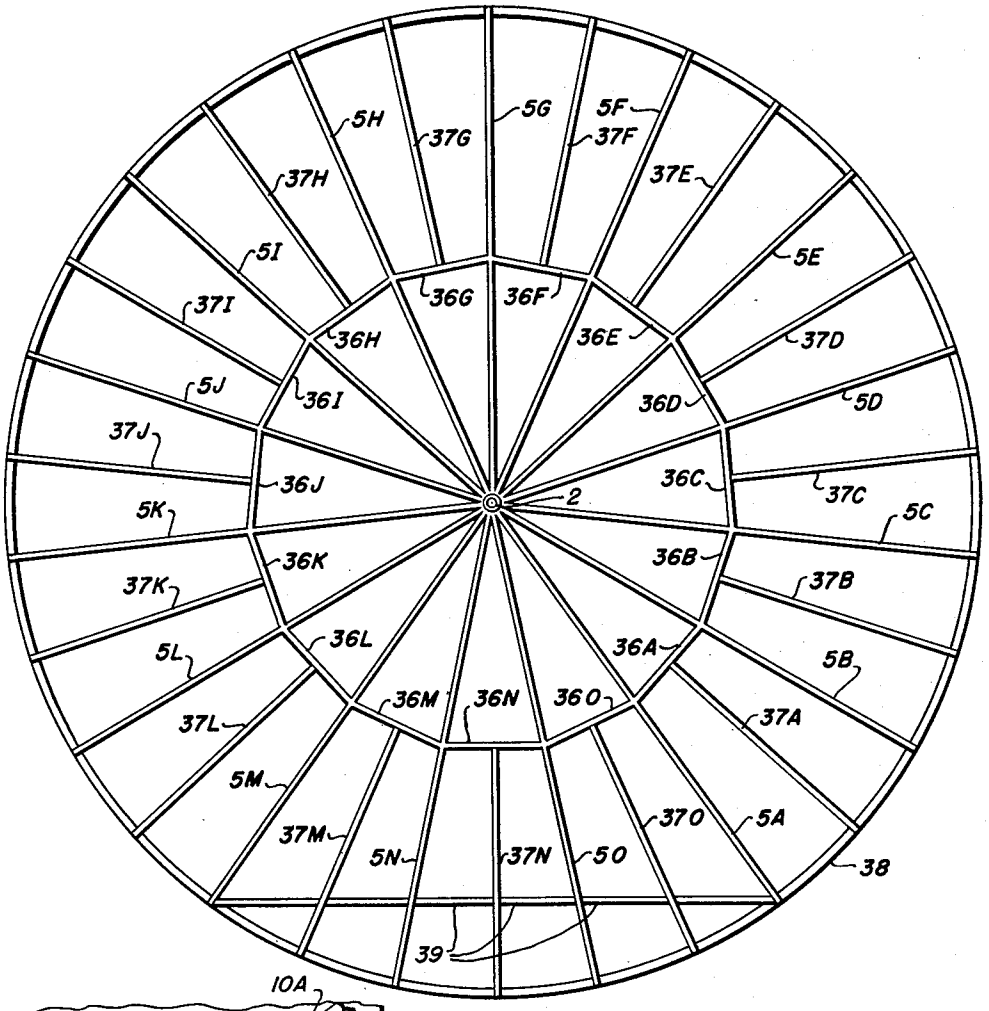
BY Stevens, Davis, Miller & Mosher
ATTORNEYS

Jan. 29, 1963 J. E. WHEELER 3,075,654

CIRCULAR AIRPLANE HANGAR

Filed Sept. 29, 1958 6 Sheets-Sheet 4

FIG. 5



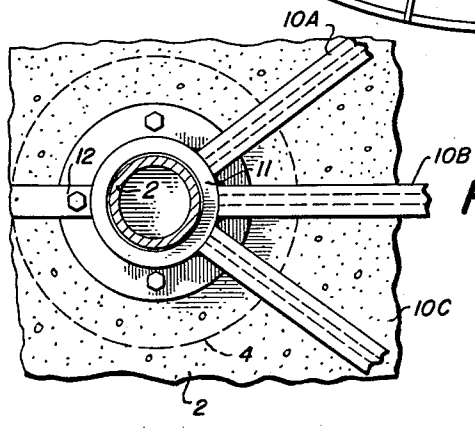


FIG. 6

INVENTOR
JAMES E. WHEELER

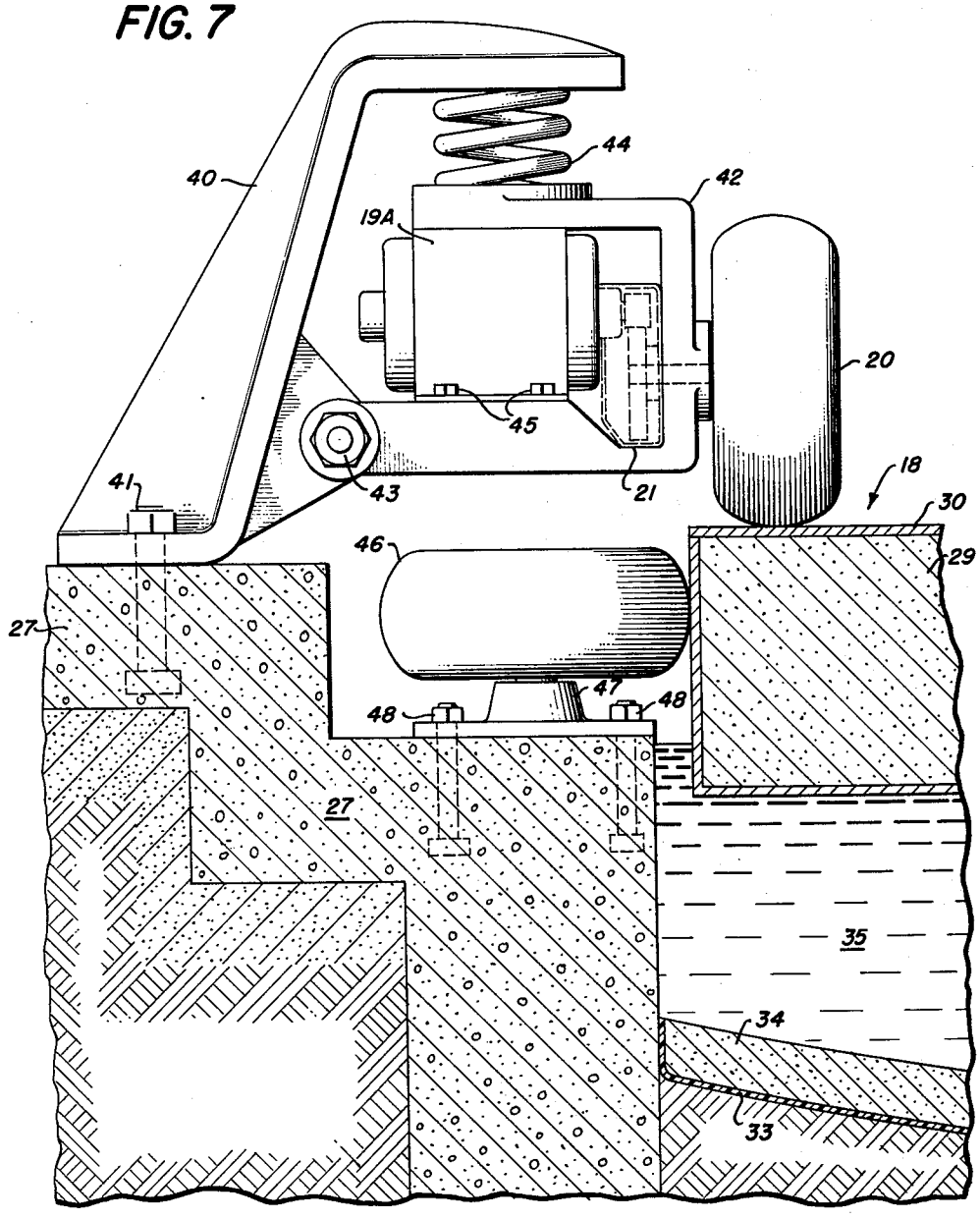
BY Stevens, Davis, Miller & Mosher
ATTORNEYS

Jan. 29, 1963 J. E. WHEELER 3,075,654

CIRCULAR AIRPLANE HANGAR

Filed Sept. 29, 1958 6 Sheets-Sheet 5

FIG. 7



INVENTOR
JAMES E. WHEELER

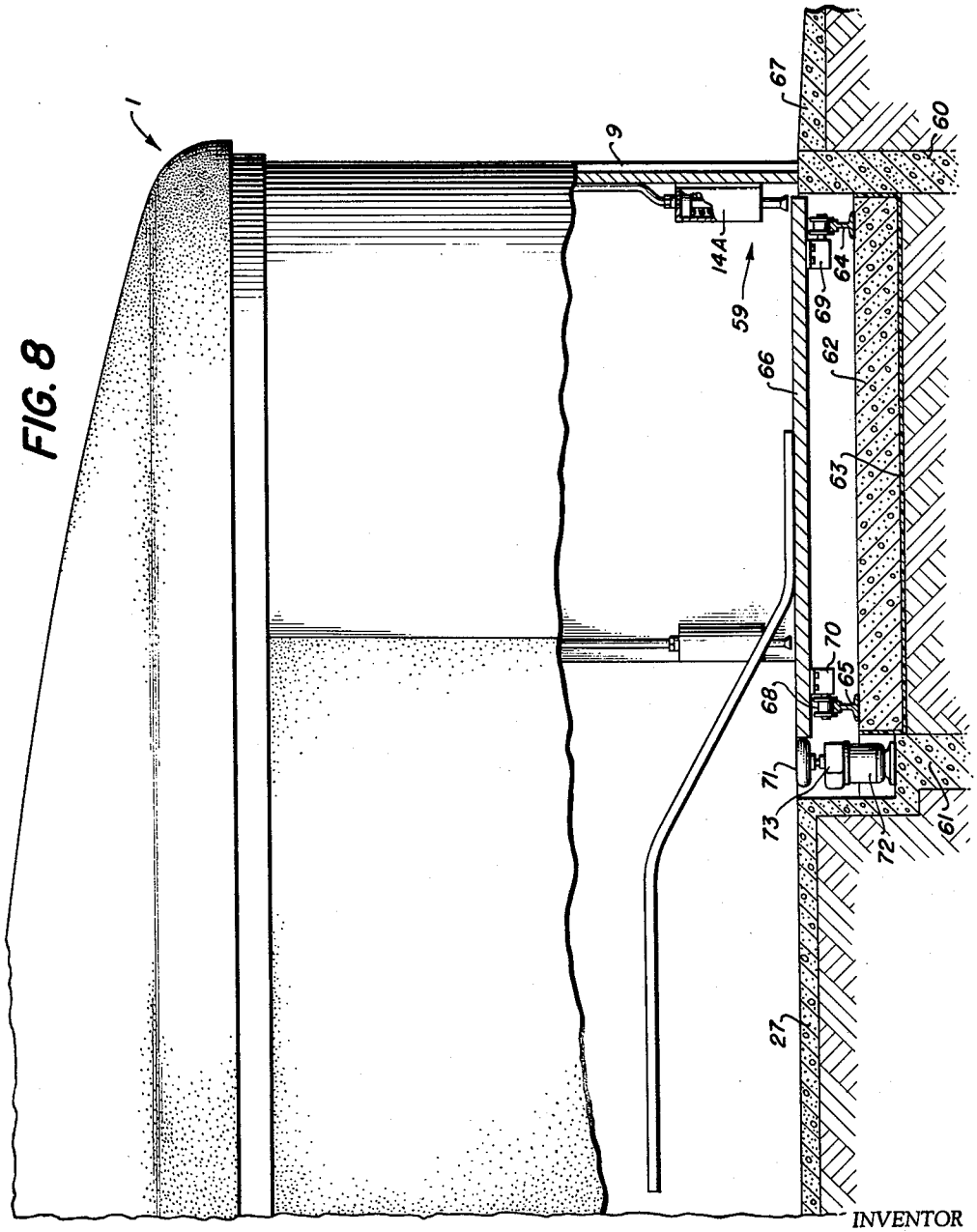
BY Stevens, Davis, Miller & Mosher
ATTORNEYS

Jan. 29, 1963 J. E. WHEELER 3,075,654

CIRCULAR AIRPLANE HANGAR

Filed Sept. 29, 1958 6 Sheets-Sheet 6

FIG. 8



INVENTOR

JAMES E. WHEELER

BY Stevens, Davis, Miller & Mosher

ATTORNEYS

United States Patent Office

3,075,654
Patented Jan. 29, 1963

3,075,654

CIRCULAR AIRPLANE HANGAR

James E. Wheeler, 2256 Kent Blvd. NE.,
Grand Rapids 3, Mich.

Filed Sept. 29, 1958, Ser. No. 763,974
6 Claims. (Cl. 214—16.1)

This invention relates generally to building structures and more particularly to the types of building structures which are intended for housing air-borne vehicles and the like. The invention disclosed and claimed herein may be considered an improvement over the subject matter contained in my co-pending application S.N. 691,404 filed upon October 21, 1957 and entitled Airplane Hangar, now Patent No. 2,964,144, issued December 13, 1960.

In present-day airport operation, the requirement for economical and easily constructed aircraft hangars has become acute. In many instances, the building costs which characterize modern-day construction projects render difficult if not impossible the task of protecting aircraft from the elements at a reasonable price. To remedy this condition, the present invention contemplates an ingenious technique for applying light-weight concrete aggregates to thin flexible films of plastic, canvas, or other equally suitable material. In certain prior art techniques for applying air-borne cementitious mixtures to such films, the resulting structure has been characterized by a high dome or arch intended to be self-supporting. Since such elevated structures are extremely undesirable for use in or near an airport, the present invention capitalizes upon the load bearing properties of conventional lattice-type trusses. As a result, it is possible to use small self-supporting panels, such as conventional sheathing or decking, between the individual trusses. For instance, lengths of a multicellular plastic material such as Styrofoam may be emplaced within such lattice trusses to form the required convex underlayer for the concrete roof surface which is then provided by the gunite or gunall methods.

In the inflation process which is required of many prior art processes, it is actually necessary to maintain a fixed or constant air pressure within a hermetically sealed enclosure. With the present invention, a high-volume low-pressure blower is employed, and the requirement for optimum hermetic sealing is eliminated. By using such a centrifugal or squirrel cage blower to pressurize the underside of the flexible film used in the present invention, ample support is provided during the hardening period for the thin-shell material which is used to support the later-applied concrete. For instance, with the materials and techniques of the present invention, pressures as low as .0087 pound per square inch are ample to support ½" of the light-weight material which is preliminary applied to the flexible film of plastic or canvas. The proper value of supporting pressure on the underside of the flexible film may be readily obtained by controlling the rate at which air is allowed to escape through an orifice at the vertex of the convex roof surface.

By using my invention in airport hangar construction techniques, the unit cost of fabricating such structures is drastically reduced. Moreover, there is provided an efficient technique for rapidly constructing hangars suitable for use in housing the type of private aircraft which are becoming increasingly popular for business purposes and the like. The invention in one aspect contemplates the use of a buoyant rotatable floor surface for displacing aircraft within such a hangar to positions remote from the closure aperture of the hangar.

According to another aspect of the present invention an annular floor surface is movably mounted upon a pair of circular tracks or rails for rotational motion with respect thereto.

Another object of this invention is to provide a hangar

structure which exploits the load supporting capabilities of a buoyant floor.

A further object of this invention is to provide a novel method and means for protecting air-borne vehicles from the elements.

A further object of the invention is to disclose structure and details for a wheeled annular hangar floor surface.

A still further object of the invention is to teach an ingenious system for retaining and/or displacing an arcuate hangar door by means which include hydraulically operable door jacks.

These and other objects and advantages of the present invention will become apparent from a study of the accompanying detailed description and drawings in which like numerals indicate like parts, and in which:

FIGURE 1 is a fragmenntary perspective view of a circular airplane hangar constructed according to the present invention.

FIGURE 2 is a vertical sectional view of the airplane hangar depicted in FIGURE 1, and shows a buoyant floor surface; FIGURE 2A is an enlarged sectional view of the roof construction.

FIGURE 3 is a sectional plan view of the airplane hangar taken along the lines 3—3 in FIGURE 2 and illustrates the details of the buoyant floor system.

FIGURE 4 illustrates a fragmentary sectional view of the hangar wall and shows the method of exploiting an H-shaped column with concrete-clad multicellular material such as Styrofoam in conjunction therewith.

FIGURE 5 shows the details of the steel work which is used in fabricating the roof structure of the hangar.

FIGURE 6 is a horizontal sectional view taken along the lines 6—6 in FIGURE 1, and looking in the direction of the arrows.

FIGURE 7 is an enlarged plan view of the tractive system provided by the invention for displacing the annular buoyant floor member.

FIGURE 8 is an enlarged sectional view of a type of hangar similar to that shown in FIGURE 1, and illustrates the details of the wheeled and track mounted annular floor surface provided by the invention.

Turning to the detailed description of the invention and more particularly to FIGURE 1 thereof, the numeral 1 has been used to indicate generally a circular airplane hangar constructed in accordance with the teachings of the present invention. This airplane hangar will be seen to include a central column 2 which may take the form of a hollow iron pipe or the like. The column 2 is provided with a vent cap 3*a* which is positioned at the uppermost end of the pipe. The cap 3*a* may include an orifice 3*b* of adjustable size for throttling air pressure passing therethrough at a predetermined rate. A concrete pier or footing 4 is provided in the earth beneath the column for the purpose of maintaining the column in a vertical position, and supporting a portion of the roof load.

Somewhat to the left of the column 2, the reference character 5A has been used to generally designate a lattice truss having a plurality of criss-cross members 7 incorporated therein. The truss 5A is provided with an arched or bowed outer surface 8. The lattice truss 5A is one of fifteen such members. These members have been designated 5A through 5O and may be seen most clearly in FIGURE 5 of the drawings.

The hangar 1 also includes a door 9 which is held in its arc by a group of overhead brace members identified by the reference characters 10A, 10B and 10C. Only one of the brace members is visible in FIGURE 1, and reference to FIGURE 6 of the drawings is necessary for the purpose of appreciating the details of the several overhead brace members. The door 9 is ordinarily supported upon a circular ledge which forms the outer foundation for the hangar.

The overhead brace members for door **9**, as shown in FIGURE 6, are welded or otherwise secured to an annular ring member **11** which is rotatably journalled with respect to the central column **2**. A counterbalance brace member **12** forms a radial extension of the brace member **10B**. This brace member is welded or otherwise affixed to the ring member **11**, and may be provided with a partial counterbalance or counterweight **13** at the outer extremity thereof. The counterbalance **13** is characterized by a weight which may partially offset the downward thrust of the door **9** and brace members **10A**, **10B**, and **10C**.

It should be appreciated that in certain embodiments of the invention, such as that shown in FIGURE 8, the use of a track-supported floor in conjunction with hydraulic door jacks renders possible the elimination of the counterbalance **13**.

The door **9** is provided on its interior surface with a group of hydraulically actuated door jacks **14A**, **14B** and **14C**. The positioning and placement of the door jacks is perhaps seen most clearly in FIGURE 3 of the present drawings. These door jacks are provided with spring loaded rods **15A**, **15B** and **15C** respectively. These rods are adapted to move vertically downward to engage the upper surface of the arc of the floor subtended by the door surface shown in FIGURE 1 when this door is in closed position.

The three door jacks provided by the invention are mounted in spaced relationship upon the inner surface of the door **9**, as shown in FIGURE 3. Each individual jack takes the form of a hydraulic single action cylinder adapted to displace a spring loaded rod downwardly to contact the hanger floor. When each of the jacks is thus energized, the weight of door **9** is lifted vertically and the door is free to rotate with the rotatable hangar floor.

The door **9** may be lowered to its normal position by releasing the fluid pressure within the hydraulic door jacks. At this time, a compression spring of the type identified by the reference numeral **50** in FIGURE 1, retracts the spring loaded rod and returns the hydraulic piston within the door jack to normal position. This, of course, readies the door jacks for another cycle of operation.

The electrical actuation for the hydraulic system of the invention is physically accessible from the exterior as well as the interior of the hangar. Thus, in FIGURE 3, the outdoor switch box for the hydraulic system has been identified by the reference numeral **51***a*, with the indoor switch box designated by the reference numeral **51***b*. In operation, either switch box may be used to energize a hydraulic pump **52** secured to the central column **2**, in a manner illustrated most clearly in FIGURE 1. From the pump **52**, suitable fluid conduits **53** extend along the underside of the overhead brace members and down the interior surface of the door to connect with the door jacks **14A**, **14B**, and **14C**. Since the door **9** is capable of full 360° rotation, it will be appreciated that sufficient slack in the fluid conduits is provided.

Returning again to the detailed description of FIGURE 1, the numeral **18** has been used to indicate generally a buoyant annular floor surface. This floor surface can be rotated by means of a plurality of electrical motors, one of which is indicated in FIGURE 1 by the reference numeral **19**. It will be appreciated that the inventive structure actually employs five of such motors equidistantly spaced around the inner periphery of the buoyant annular floor surface **18**. The torque developed by the motor **19** is applied to the surface of floor **18** by means of a rubber wheel **20**. The rubber wheel **20** transmits tractive effort from the motor **19** via a gear reduction mechanism **21**, as seen most clearly in FIGURE 7. The floor surface **18** may include one or more tail wheel support members **22**. These members are welded or otherwise secured to the floor surface.

In the hangar structure shown in FIGURE 1, the numeral **23A** designates a curved roof surface formed of light-weight concrete aggregate or other equally suitable material which is applied by spraying such as by the gunite method or equivalent technique. The particular aggregate may comprise the substance which is commercially marketed under the name "Perlite," although the invention is, of course, by no means limited thereto. A flexible underlayer **24** of canvas, polyethylene, Pliofilm, or the like is used to support the molten aggregate as it it applied. It is believed that the placement and disposition of the underlayer **24** is best shown in FIGURE 2 of the present drawings. It should be appreciated in connection with the roof surface **23A** that a concrete aggregate such as Perlite can be employed over a sublayer or thin shell form of plaster of Paris **23B**. Under these conditions, it is merely necessary to provide the underlayer of plaster of Paris over the plastic film **24** prior to the application of the concrete aggregate.

In order to enhance the structural strength of the completed roof structure, one or all of the component layers may be applied over conventional reinforcing mesh, such as chicken-wire, hardware cloth, or other equally suitable expanded metal. Thus, in FIGURE 2, the reference numerals **54A** and **54B** designate sections of reinforcing mesh in the plaster of Paris and concrete aggregate layers respectively.

In order to secure the flexible underlayer **24** during inflation, and provide retention points for the reinforcing mesh in the various roof layers, a plurality of roof stays **55** are provided. These stays as shown in FIGURE 2, may protrude through the flexible layer as well as the plaster of Paris shell form to engage the reinforcing mesh in the outer layer **23A**. In constructing the roof surface of the hangar, the plastic underlayer is inflated and positioned by means of a positive air pressure in a manner which is explained more fully later in the present specification.

The airplane hangar shown in FIGURE 1 includes a vertical concrete wall structure **25** which may be fabricated by the conventional method of disposing cement or concrete between appropriate forms. On the other hand, these walls may be constructed by positioning a suitable plastic film or underlayer around a group of spaced vertical columns, and applying a light-weight aggregate either by spraying or by a gunite technique. A preferred method of using spaced H-shaped columns **26** within the vertical walls is illustrated most clearly in FIGURE 4. In this figure, sections **56** of a suitable multicellular material such as Styrofoam are positioned between the respective H-shaped columns. The opposite surfaces of the multicellular sections are faced with a reinforcing material **57** such as a suitable 2" x 2" No. 12 wire mesh. Both sides of the wall section are then coated with an overlayer of air-borne cementitious material **58** by means of a process such as the gunite or gunall technique.

The floor surface exclusive of the buoyant annular portion in FIGURE 1 is designated by the reference numeral **27**. This portion of the hangar floor may comprise a layer of concrete which is poured or otherwise applied to fill the floor area between the column **2** and the inner edge of the buoyant annular floor surface **18**. The alternative method of employing a track mounted rotatable floor will be discussed more fully in connection with FIGURE 8.

Turning now to the detailed description of the buoyant annular floor surface **18**, reference to FIGURE 2 will now be made. In this figure, there is shown an annular disc **29** comprised of Styrofoam or other equally suitable multicellular buoyant material. The disc **29** is entirely encased in an exterior sheathing **30** of aluminum, stainless steel, or other suitably sturdy material. It should be understood that the use of the non-metallic sheathing would be deemed to fall within the spirit and scope of the present invention.

In the lower portion of FIGURE 2 there is shown a first circular concrete footing **31**. Somewhat beyond this footing, a second circular concrete footing **32** is illustrated.

The footing 32 will be seen to extend radially inward to form a support surface for the door 9. Between the footings, the earth has been tamped or compacted to form a convex surface, and a film or membrane 33 has been disposed thereupon. The membrane 33 may be composed of Pliofilm, polyethylene sheeting, or other equally suitable material. An overlayer of water-proof concrete aggregate 34 is disposed on the upper surface of the membrane 33. Such aggregate may be applied by conventional pouring techniques, or by the gunite method. Within the volume defined by the footings and the overlayer 34, a body of fluid 35 is provided. This fluid may comprise a liquid such as water, and is provided for the purpose of buoyantly supporting the annular floor surface 18. It will be appreciated that suitable constituents for preventing freezing may be added to the body of fluid 35, where the airplane hangar is situated in an intemperate climate.

Continuing with the detailed description and turning momentarily to FIGURE 5 for the details of the roof construction, it will be recalled that the lattice truss members have been designated by reference characters 5A through 5O. A plurality of purlins 36A through 36O are utilized in the roof structure within the lattice truss members to lend rigidity and structural strength thereto. A group of subtrusses 37A through 37O is affixed between the purlins and the outer channel member 38, respectively. In addition, a reinforcing truss 39 is secured between the lattice truss members 5M and 5A for the purpose of providing structural support at the door opening of the hangar.

Continuing with the detailed description of the invention, reference to FIGURE 7 will now be made for the details of the tractive system necessary for the rotation of the buoyant floor surface. In this figure, there is illustrated a bracket 40 which is secured to the concrete floor 27 by means of bolts 41 or other suitable fastening means. This assembly also includes a yoke 42 which is pivotally disposed with respect to the bracket 40 by means of the pivot bolt 43. A coil spring 44 is employed for the purpose of providing a resilient bias between the yoke 42 and the bracket 40. A reversible synchronous motor 19 is bolted to the yoke 42 by means of bolts 45. The motor 19 is one of a set of synchronous motors which is used to displace the annular floor surface from time to time. The reference numeral 21 identifies a gear reduction mechanism which is mounted to supply torque to a rubber wheel 20.

Directly beneath the yoke 42 there is illustrated a rubber idler wheel 46 which is pivotally mounted in a journal 47. The idler wheel 46 is one of a number of such wheels which serve to restrain the movement of the rotatable floor surface to a fixed orbit. The retention of the journal 47 in the floor surface 27 is accomplished by bolts 48. It will be appreciated that the assembly illustrated in FIGURE 7 is one of a group of duplicate units which are positioned around the periphery of the buoyant floor surface 18 for the purpose of simultaneously applying tractive force thereto.

Turning now to FIGURE 8 of the drawings, the numeral 59 has been used to indicate generally a sectional view of the embodiment of the invention which utilizes a wheeled and track mounted annular floor surface. In this drawing, it will be noted that the buoyant floor suspension has been replaced by an assembly which incorporates a plurality of wheels and tracks. The assembly shown in FIGURE 8 will be seen in this connection to include an outer footing 60 and an inner footing 61. Between the footings, a flat overlayer of concrete aggregate 62 has been disposed to cover a membrane 63 previously provided on the surface of the earth between the footings. The overlayer of concrete aggregate 62 is provided with a pair of circular tracks 64 and 65 securely affixed thereto.

An annular floor disc 66 is positioned directly above the flat concrete overlayer and associated tracks, and is capable of rotational displacement with respect thereto. To this end, the outer track 64 is engaged by a wheel 67 provided with flanges on both radial faces thereof. It will be appreciated in this connection that the double flanged wheel 67 comprises one of twenty such wheels which are spaced equidistantly around the outer portion of the underside of the annular disc 66.

In like manner, the inner track 65 is engaged by a double flanged wheel 68, which similarly comprises one of a group of twenty wheels spaced equidistantly on the inner portion of the underside of the annular disc 66.

The double flanged wheels employed in FIGURE 8 are capable of adjusting to minute differences in the circularity and elevation of the tracks 64 and 65. This is accomplished by journalling each wheel such as the wheel 67 in a spring biased floating shaft hanger 69. The inner wheel 65 is similarly journalled in a free floating shaft hanger 70. The shaft hangers 69 and 70 may comprise conventional units capable of allowing relative movement of the wheel and axle assemblies with respect to the circular tracks.

In order to retain the annular disc 66 in its orbit, five rubber-tired drive wheels are provided which contact the inner peripheral edge of the disc. The reference numeral 71 has been used to designate one such drive wheel in FIGURE 8. The wheel 71, along with the remainder of the drive wheels (not shown) are used to deliver torque to the annular disc 66. In order to accomplish this, a conventional reversible synchronous motor is employed in conjunction with a speed reducer unit at each drive wheel. In FIGURE 8, the motor and reducer unit have been designated by the reference numerals 72 and 73 respectively. It should be appreciated that the embodiment depicted in FIGURE 8 renders possible the omission of the type of stabilizer 40 illustrated in FIGURE 2. In this embodiment of the invention, the door 9 ordinarily is supported by the outer footing 60 which is characterized by ample radial thickness for such purpose. One or more hydraulic door jacks, such as the unit 14A, are relied upon to transfer the weight of the door to the annular disc 66 when simultaneous rotation therewith is desired. It will be understood in this connection that the structure and mode of operation of the hydraulic door jacks in FIGURE 8 is exactly the same as earlier described in connection with the previous figures.

In constructing circular airplane hangars according to the present invention, vertical steel H-shaped columns may be extended upwardly from the outer circular concrete footing, after the construction and placement of the buoyant annular floor surface has been effected. At this time, the steel work for the roof may then be secured in place. The vertical walls may be formed either by pouring concrete between spaced forms, or by spraying an airborne cementitious mixture onto members positioned to receive support from the vertical steel columns. Then, a suitable flexible film such as canvas, Pliofilm, polyethylene, or the like is disposed over the top of the steelwork for the roof. This film is retained over the lattice trusses by employing a plurality of individual roof stays which penetrate and secure the film in contact with the arched surface of the trusses. These roof stays, as earlier mentioned in the present patent specification, penetrate the flexible film as well as the layer of light-weight aggregate and the like, and remain permanently embedded therewithin. Moreover, the roof stays provide structural retention points for any reinforcing mesh which it may be desirable to embed within the outermost layer of concrete, the innermost thin shell layer of plaster-of-Paris, or both such layers. The reinforcing mesh for the innermost layer may take the form of galvanized metallic netting such as chicken-wire or hardware cloth which serves to add strength for supporting the outer layer of concrete during the hardening process. The reinforcing mesh for the outermost layer may be comprised of equally suitable

material, which will assist in forming a monolithic structure capable of resisting horizontal thrust loads and the like. A blower or fan is disposed within the hangar to pressurize the underside of the flexible film during the application of the roofing material thereto. During this time, a layer of light-weight concrete aggregate such as Perlite, or the like, may be applied directly by conventional spraying or gunite techniques. On the other hand, an under layer of plaster-of-Paris may first be applied to the plastic film in order to provide a sublayer on thin shell form for the light-weight concrete aggregate.

It should be appreciated in this connection that a layer of flexible material such as plastic may be caused to encase both the roof surface and the cellular wall surface in the first instance. With this modification of the inventive method, pressurization of the flexible material may be accomplished quite simply by regulating the rate at which air escapes through an orifice at the vertex of the dome roof. By this means, the necessity for perfect hermetic sealing is obviated entirely.

While I have described my invention clearly and concisely in terms most apt for hangar or aircraft housing structures, as required by the statute, it will be evident that many modifications and substitutions may be effected therein without departing from the spirit and scope of the appended claims. Moreover, it will also be evident that the practice of my invention in connection with structures employing gable-roofs, hipped roofs, or conventional roofs is perfectly possible, since the walls of such structures do not have to form a hermetically sealed chamber as a pre-requisite to successful roof construction. For this reason, such practice of the invention will be understood to fall squarely within the spirit and scope of the appended claims.

What I claim is:

1. An aircraft hangar of generally circular configuration which includes a partially enclosing wall, means defining a fluid-filled volume within said wall, an annular rotatable floor surface buoyantly disposed in said fluid-filled volume within said wall, a movable door mounted to form a part of said enclosing wall when closed and adapted to move simultaneously with said floor, means normally supporting said door external to said floor and means for mechanically transferring the weight of said door from said supporting means to said floor for simultaneous rotation therewith.

2. In a circular aircraft hangar provided with a wall defining surface comprised of cementitious material, an arcuate closure member mounted to seal an aperture in said wall defining surface between oppositely disposed vertical edges thereof, means defining a fluid-filled volume, a floor provided within said hangar buoyantly disposed in said fluid-filled volume for rotational motion therewithin, means normally supporting said closure member external to said floor and means including jack means for shifting the weight of said closure member from said supporting means to said floor for simultaneous movement therewith.

3. In a circular walled aircraft hangar provided with a movable floor and an arcuate closure member mounted to seal an aperture provided within said wall, foundation means external to said movable floor normally supporting said closure member, means selectively operative to lift the weight of said closure member from said foundation means to said movable floor for simultaneous movement therewith.

4. A circular walled aircraft hangar as recited in claim 3 wherein said selectively operable means comprises a hydraulically operated jack.

5. In a circular walled aircraft hangar provided with a movable floor and an arcuate closure member mounted to seal the aperture provided within said wall, foundation means external to said movable floor normally supporting said closure member, means fixed to said closure member selectively operable to engage said movable floor and lift the weight of said closure member from said foundation means onto said movable floor for simultaneous movement therewith.

6. In a circular walled aircraft hanger provided with a movable floor and an arcuate closure member mounted to seal an aperture provided within said wall, a circular foundation surrounding said movable floor supporting said wall and normally supporting said closure member, and means to lift the weight of said closure member from said foundation onto said movable floor for simultaneous movement therewith.

References Cited in the file of this patent

UNITED STATES PATENTS

1,773,656	Wasilkowski	Aug. 19, 1930
1,855,534	Williams	Apr. 26, 1932
1,861,461	Traube	June 7, 1932
2,255,511	Muller	Sept. 9, 1941
2,527,485	Long	Oct. 24, 1950
2,587,353	Marschak	Feb. 26, 1952
2,681,190	Thomson	June 15, 1954
2,780,366	Henseleit	Feb. 5, 1957
2,806,277	Hand et al.	Sept. 17, 1957
2,871,544	Youtz	Feb. 3, 1959