

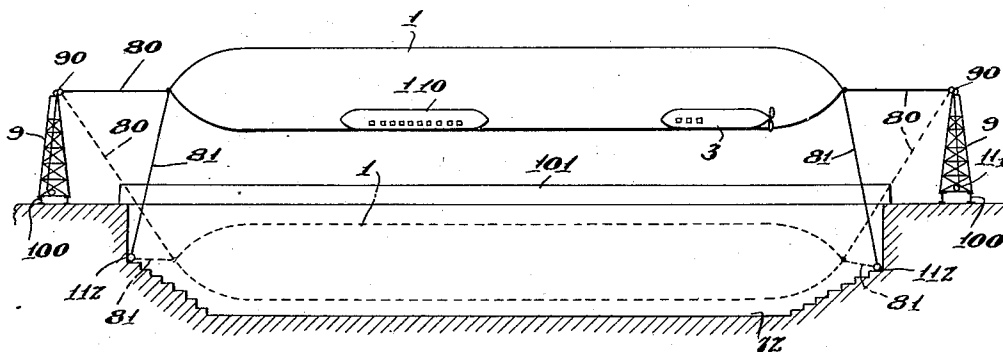
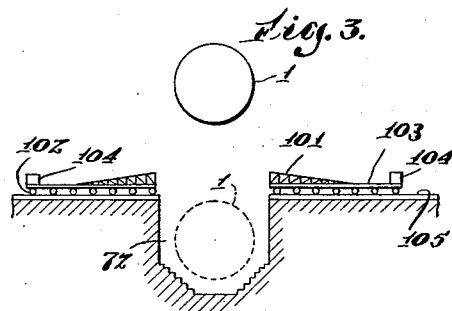
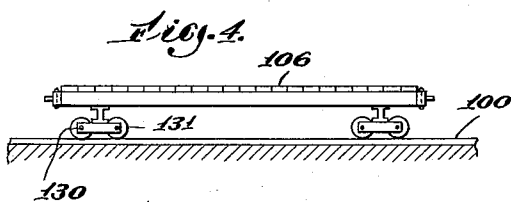
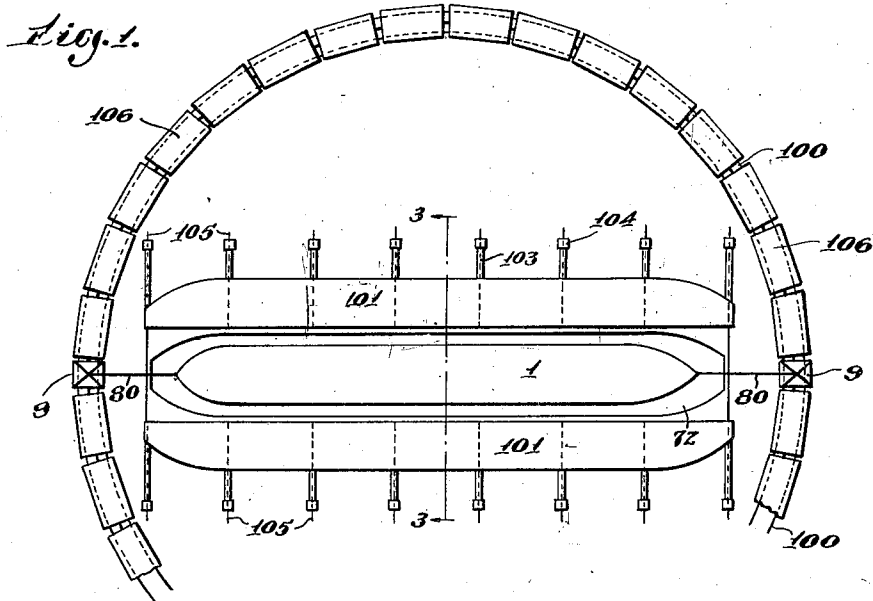
April 12, 1932.

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1,853,777

METHOD OF AND APPARATUS FOR BERTHING AIRSHIPS

Original Filed Sept. 21, 1921 3 Sheets-Sheet 1



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3 Sheets-Sheet 2

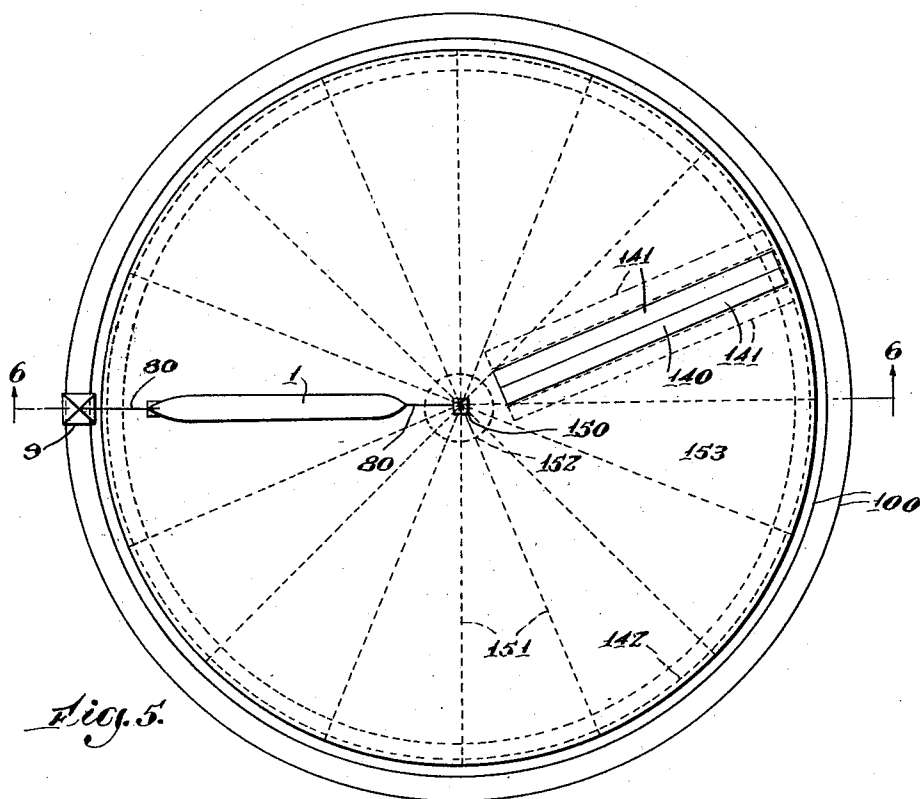


Fig. 5.

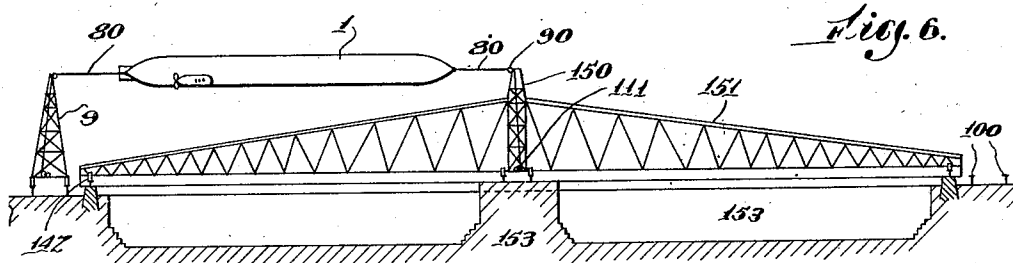


Fig. 6.

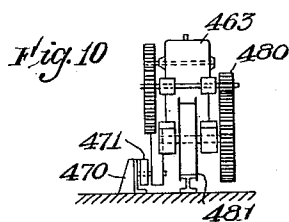


Fig. 10

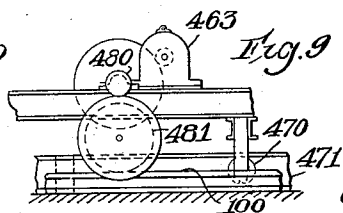


Fig. 9

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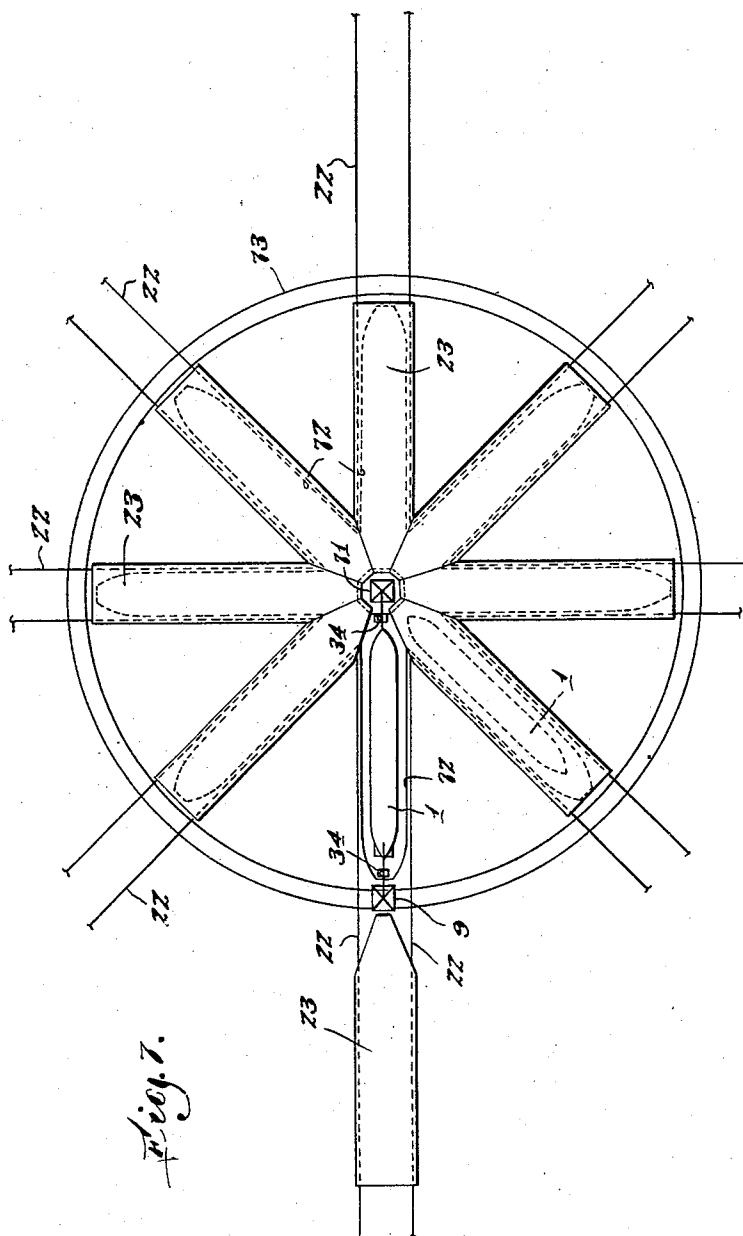


Fig. 7.

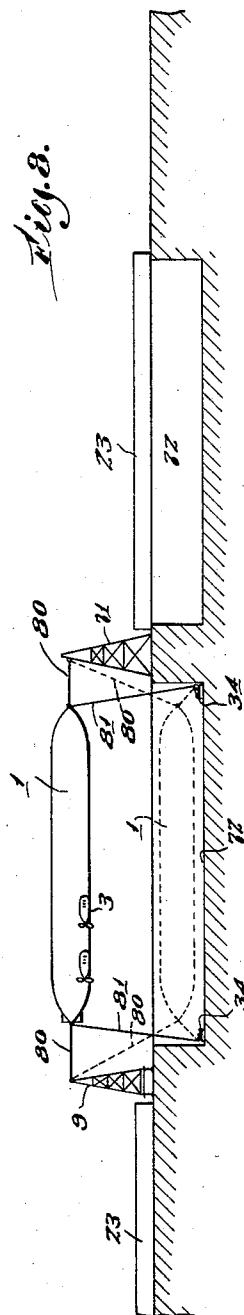


Fig. 8.

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# UNITED STATES PATENT OFFICE

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## METHOD OF AND APPARATUS FOR BERTHING AIRSHIPS

Original application filed September 21, 1921, Serial No. 502,127. Divided and this application filed March 17, 1931. Serial No. 523,251.

This invention relates to methods of and apparatus for berthing airships. More particularly, it relates to a system by which an airship approaching a station from any direction may expeditiously be made fast to suitable mooring apparatus, turned to a proper position and direction for berthing, lowered to the level of the ground, and housed in a chamber. The housing chamber may be a hangar or shelter pit. One feature of the invention resides in the raising and lowering of the moored ship by mechanism while it continues moored and, if it so happens, lying across the wind.

In the past, airships have been moored to fixed masts, and, when moored, have been free to move at the level of the mast head with the wind. This has involved serious disadvantages, because fixed mooring towers lack the "flexibility" which is so desirable for the mooring and berthing of large airships, because it has been impossible to remove airships to hangers without first releasing them from the masts and pulling them to earth, and because at mast-head levels airships are frequently subjected to wind stresses of greater magnitude than at the ground level. It is an object of this invention to eliminate these and other disadvantages.

Briefly stated, the present invention provides for the mooring of airships between two towers, at least one of which may be movable. It further provides for lowering the airship, under control, by mechanism and tackle by a "burtoning" method. Conveniently, housing equipment may be located near or even between the towers, and, if not so positioned upon arrival, the tower or towers may conduct the airship to the housing location.

In the accompanying drawings, forming a part hereof, which are more or less diagrammatical,

Figure 1 is a plan showing two mooring towers on a track encircling a shelter pit, spacer cars being employed to maintain the towers diametrically opposed;

Figure 2 is a side elevation of the same, the pit being shown in medial section;

Figure 3 is a cross-section on the line 3—3 of Figure 1;

Figure 4 is a side elevation on a larger scale of a spacer car;

Figure 5 is a plan showing a circular shelter pit with revolving roof, a mooring tower at its center, another mooring tower movable on a track encircling the pit, and an opening through the roof for the entrance and exit of airships;

Figure 6 is an elevation corresponding to Figure 5, the pit and its roof being shown in section on line 6—6 of Figure 5;

Figure 7 is a plan showing several shelter pits located radially about a central mooring tower with a second mooring tower movable on a track encircling these shelter pits; and

Figure 8 is an elevation in medial section corresponding to Figure 7.

Figure 9 is a side elevation of tower moving means; and

Figure 10 is an end elevation of the same.

In the drawings, Figures 1, 2 and 3 show a shelter pit 72 conforming in general in its horizontal cross-sections to the horizontal cross-sections of airship 1, with space allowed for clearance and workman between sides and bottom of shelter pit and the airship. Around this shelter pit there may be a horizontal circular track 100 on which are movable two towers 9. A number of spacing cars 106, acting as struts and ties between towers, may be used for maintaining the mooring towers 9 in diametrical relation at opposite ends of any diameter of the circle on which they travel.

A roof 101 over the shelter pit is movable transversely, as regards the shelter pit, on tracks 105. As represented in Figures 1 and 3 this is in two sections which meet over the middle of the pit, comprising truss beams running on wheels 102 and having extensions 103 to the rear to counterbalancing weights 104, so that on a cantilever principle each roof section covers half of the span with the projecting part overbalanced by the weight.

In operation, the airship 1 approaches and is made fast to one of the towers 9, this being accomplished by any of the well known methods of mooring the airship. The tower may

be prevented from tipping over under stress by having a track 471 made with flange facing downward, and providing wheels 470 engaged under it as shown in Figures 9 and 10, or other suitable means may be used. The towers 9 are then moved about the track 100, means being provided for effecting such motion, until the airship, tethered to one tower and lying in the direction of the wind, also lies between the two towers. The free end of the ship is then moored to the second tower. The motor which moves the tower on its track may be of any suitable type, an example of one such, with associated mechanism, being seen in Figures 9 and 10, where the motor 463, operating through gearing 480 in the base portion of the tower 9 drives wheels 481, resting on tracks 100.

The airship 1 may, if desired, be allowed to remain moored to the towers 9, but usually it will be found preferable to move the towers 9 around the circle 100 until the airship 1 overlies the shelter pit 72. When this has been done, the airship may be lowered into the shelter pit and covered by the roof 101. While in the shelter pit, the airship is protected from the weather, and, at the same time, use of the towers 9 for the mooring of still another airship is possible.

Figures 5 and 6 show an annular shelter pit 153 having a radius greater than the length of airship 1 to be housed. A large circular roof covers this shelter pit, this roof being supported on a central pier 152 and on circular track 142 extending around the pit and concentric therewith. A mooring tower 150 at the center of the shelter pit is attached to the roof and revolves therewith. A second mooring tower 9 is movable on the circular track 100.

In operation, an airship is brought up head-on to the wind to the central mooring tower 150 and attached thereto, after which the tail tower 9 is moved around to the leeward of the airship and the connection 80 is made therewith. An opening 140 is provided in the large circular roof with movable covering 141 over this opening, which covering may be moved back to the dotted line position, thus permitting a clear opening through the roof for the vertical entrance and exit of airships at any part of the circular pit. A pit of this description may be used for the housing of a large number of airships, with only a single pair of mooring towers.

Figures 7 and 8 show a rigid tower 71 at the center of a track 73 laid in a large circle, having a radius greater than the length of the airship 1 to be moored. On this circular track there is movable a second mooring tower 9. There are a number of shelter pits 72 built along radial lines within said circular track 73. These are provided with movable roofs 23. Flexible connections 80 fasten the airship between the towers 71 and 9. A second

set of ropes 81 lead from the head and tail ends of the airship to control means 34 located at the bottom of the shelter pit.

With the airship moored between the towers, the procedure is to move the towers until the airship either overlies the desired shelter pit or is in a position to be moved into an adjacent hangar. By then paying out ropes 80 and hauling in ropes 81, a safe means is provided for the lowering of the airship from its moored position to the level of the towers to its berthed position within the shelter pit. "Burtoning" the ship in this way has the great advantage that, as to the exact position of its two ends, the ship is at all times under control of mechanism having abundant strength, notwithstanding its continued buoyancy, and in spite of winds or owing to unequal distribution of weights and buoyant units on board.

Obviously, modifications may be made without departing from the inventive thought. Thus it is possible to employ in place of the shelter pit a shelter shed on the ground's surface, opening at its upper portion in such manner as to admit the airship from above. Also, the tracks may be dispensed with and towers otherwise mounted so as to be propelled around a suitable circular or other path, for example, on suitable caterpillar treads or their equivalent. Other changes may also be made, as, for example, using masts of other kinds in place of those shown, and, if desired, using in the arrangement of Figure 1 spacing cars to complete a half circle, rather than enough to fill the entire track.

In the claims, the term "tower" is used inclusively with the object of describing in broad language any form of upstanding mast, tower or like device which may be employed in the practice of the invention.

The subject matter of this application constitutes a division of our copending application 502,127, filed September 21, 1921, for "means for mooring and housing airships." It is intended that the patent to mature from the present application shall cover, by suitable expression in the appended claims, whatever features of patentable novelty reside in the several species of the invention herein disclosed.

We claim:

1. In equipment for housing airships, the combination of a housing chamber; a roof, movable so as to open and to close the chamber; means applicable for controlling the descent of an airship into and its ascent from said chamber; and two mooring towers, one at each end of the chamber.

2. In equipment for housing airships, the combination of a housing berth; means, movable so as to open and to close the berth; means applicable for controlling the entry

of an airship into and its sortie from said berth; and two mooring towers, one at each end of the berth.

3. In equipment for housing airships, the combination of a housing chamber; a roof, movable so as to open and to close the chamber; means applicable for controlling the descent of an airship into and its ascent from the chamber; a mooring tower at one end of the chamber; a horizontal, circular track having said tower as a center and having a radius greater than the length of the pit; and a second mooring tower for the same airship movable on the circular track, with power means for moving it thereon.

4. In equipment for housing airships, the combination of a shelter pit of suitable size to house an airship; a roof, and ways on which the roof may be moved so as to open and close the pit; means for moving the roof along said ways; a mooring tower; a track encircling the pit; a second mooring tower movable along said circular track; said two towers being adapted for mooring the same airship.

5. In equipment for housing airships, the combination of a mooring tower; a horizontal, circular track having said tower as its center and a radius greater than the length of the airships to be housed; a second mooring tower, movable around the circular track; power means applicable thereto for producing such movement; and tackle for fastening an airship between said mooring towers.

6. In equipment for housing airships, the combination of a shelter pit; a movable roof and fixed ways whereon it may be moved so as to cover and uncover the pit; a circular track around said pit; a head tower movable on said track, power means applicable thereto for producing such movement, and tackle for fastening an airship to said head tower; a tail tower, also movable on the circular track, with power means applicable thereto for producing such movement and tackle for fastening an airship to said tail tower; and ropes with power means applicable thereto for controlling the descent of an airship into the pit and its ascent thence; all of which equipment is so co-ordinated that an airship may be kept tied and under constant control during the operations of coming into and setting forth from the shelter pit.

7. In equipment for housing airships, the combination of an enclosed housing space whose top may be opened to permit the passage of and closed for the protection of an airship; two mooring towers, one at each end of the enclosure; means for fastening the fore and aft ends of an airship between the two towers and over the enclosure; and tackle with power means applicable thereto for controlling its passage into and out of the enclosure.

8. In equipment for housing airships, the

combination of a circular shelter pit having a radius greater than the lengths of the ships to be housed and a depth greater than the height of such ships; a horizontal, circular track around said pit and concentric with it; a fixed roof support at the center of the pit; a revolving roof covering the pit and carried on the central support and a circular track; an opening in said roof to permit the entrance and exit of an airship, said opening having its longitudinal axis along a radius of the circular roof; means for closing said opening; a mooring tower at the center of the roof; a second mooring tower located over the circular track, at the opposite end of the roof opening from the central tower; means for revolving said roof and one of said towers together; and means for controlling the descent of an airship into and the ascent of same from the shelter pit.

9. In equipment for housing lighter-than-air craft, the combination of a mooring tower; a curved, horizontal way encircling said tower as a center; a second mooring tower, movable on said way, these two being adapted to holding the opposite ends of a lighter-than-air craft; and a hangar for the craft located within the space enclosed by said way.

10. In equipment for housing lighter-than-air craft, the combination of a curved, horizontal way enclosing a ground area; two mooring towers, at least one being movable on said way and both being adapted to hold the opposite ends of a lighter-than-air craft; and a hangar within the area enclosed by said way.

11. In equipment for mooring lighter-than-air craft, the combination with a curved, horizontal way encircling a fixed center of two towers, one of which is at the fixed center and the other of which is movable on the way, said towers being adapted to cooperate in the mooring of lighter-than-air craft.

12. In equipment for mooring lighter-than-air craft, the combination of a curved, horizontal way and independently supported two towers, at least one of which is movable on said way and both of which are adapted and so positioned relatively to each other as to cooperate in the mooring of lighter-than-air craft, the base of one being at a distance from the base of the other.

13. In equipment for handling aircraft, the combination comprising an upstanding tower having in its upper portion means for attachment of lighter-than-air craft, and in its lower portion a mobile ground connection, the said elements being organized as a mobile mooring unit, and arranged with free space about the mooring in all horizontal directions for endwise approach of an airship.

14. In equipment for handling aircraft, the combination comprising a structure upstanding, solitary, on a vertical axis, to a height adapting it for the mooring of lighter-than-

air craft; equipment thereon to facilitate the mooring; and a basal support, movable over the ground from place to place, on which the mooring is carried and is secured.

15. In equipment for handling lighter-than-air craft the combination of a tower having a ground base and an elevated mooring for craft in air above the ground, with a tractive connection of the tower to the ground, and a motor in said connection whereby the tower may move its moored craft from place to place over the ground.

16. In equipment for mooring lighter-than-air craft, a tractor tower comprising the combination of a tower; mooring means for the craft to the tower; means whereby the tower is mobile over the ground, while standing upright with craft moored to it; and power means for thus moving it.

17. In equipment for mooring and housing airships, the combination of a plurality of mooring towers adapted for the mooring of an airship between them; a berth for an airship; and means for lowering an airship to a position within said berth and for elevating it therefrom while said airship is moored to said towers.

18. In equipment for mooring airships; the combination of a horizontal track comprising a circle having a diameter greater than the length of the airship to be moored; two mooring towers separate from each other and movable on said track; power means applicable for producing such movement; a structural frame, movable around the circular track, connecting the two towers and maintaining them diametrically opposite each other at all positions around the circle; and elevated mooring means located on each tower; whereby the equipment is adapted to hold an airship between said towers over any diameter of the circle.

19. In equipment for mooring airships, the combination of a mooring tower; a horizontal, circular track having the said tower as its center and a radius greater than the lengths of the airships to be moored; a second mooring tower, movable by power around the circular track; means on each tower adapted for holding an airship; and power means for controlling said means.

20. Means for launching and landing moored airships comprising two mooring towers set at a distance apart sufficient for the ship to rise and fall between them, with its axis toward them; ropes, one extending from the top of each tower to the nearby end of ship and one extending thence to the base of the same tower, thereby holding each ship end at an elevation determined by its ropes; and means at each end of the ship for paying out the one and for simultaneously taking in the other rope at that end, coincidentally with the like action at the other end of the ship, whereby the ship can be main-

tained approximately horizontal while being launched or landed.

21. In equipment for housing airships, the combination of a housing chamber and means to cover and uncover said chamber; a horizontal track encircling said chamber; two towers, one movable thereon and having power means for controlling its movements on the track and means whereby said airship may be held suspended between the two towers, and, meanwhile, be brought to a position over said chamber, whence it may be lowered into said chamber under control.

22. In equipment for housing airships, the combination of a housing chamber and means to cover and uncover said chamber; two mooring towers, one at each side of said chamber; two connecting devices on said towers, one on each tower; tackle for fastening an airship between the two connecting devices; whereby said airship may be held suspended between the two towers, and while thus suspended may be brought to a position over said chamber and be lowered into said chamber under control.

23. In equipment for mooring, controlling, and housing airships at a station, the combination of two mooring towers adapted for the mooring of an airship between them; a housing structure for an airship; and power means for lowering said airship to a position within said housing structure and for elevating it therefrom while said airship is moored between said towers.

24. In equipment for mooring and controlling airships, the combination of two independent mooring towers; first flexible connections between an airship and towers, attached to the towers toward the top thereof; second flexible connections to said airship, having their respective points of attachment close to said towers; and mechanical means for hauling in and paying out said flexible connections independently of each other; whereby said airship may be moored to said towers, and, while thus moored, may be raised and lowered and its pitch determined under mechanical control.

Signed at San Bernardino, California, this eleventh day of November, 1930.

WILFRID V. N. POWELSON.  
WARREN TRAVELL.