United States Patent

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[54] **TELESCOPE MOUNTING SYSTEM**
8 Claims, 11 Drawing Figs.

[52] U.S. Cl. 350/83, 308/9, 350/55, 350/85
[51] Int. Cl. G02b 23/16
[50] Field of Search .... 350/82, 83, 85, 10, 55, 18; 33/73 E, 73 F; 308/9

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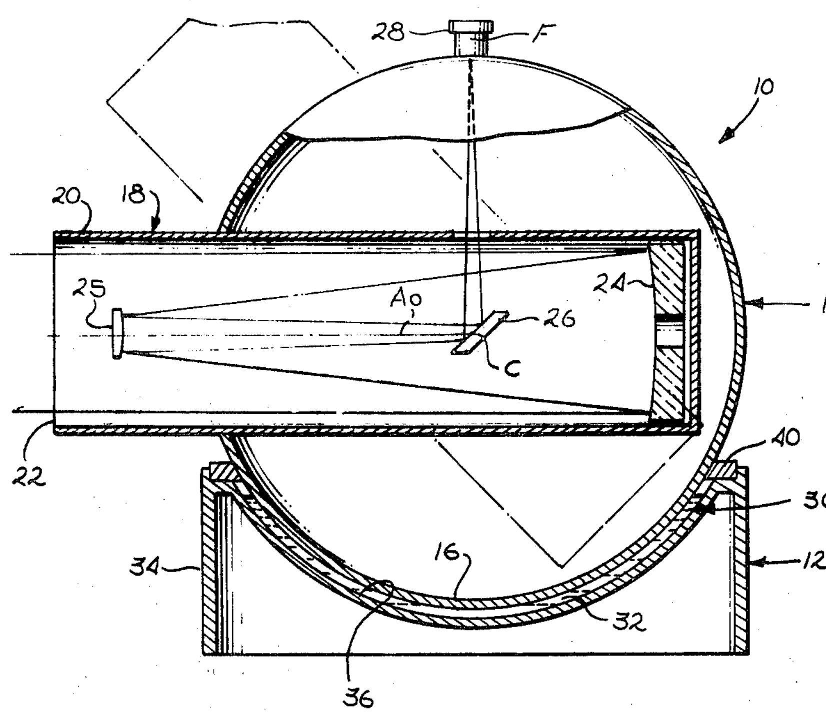
ABSTRACT: A telescope mount is provided having a supporting base and a generally spherical telescope housing swiveled in the base. The supporting base has an upwardly opening basin receiving the lower portion of the telescope housing and containing a fluid-bearing medium in which the housing floats. The mount is equipped with means for rotating the telescope housing in a tracking mode about an inclined polar axis passing through the center of the housing parallel to the earth's axis of rotation and independently rotating the housing in an elevating mode about a horizontal declination axis extending through the center of the housing normal to the polar axis.



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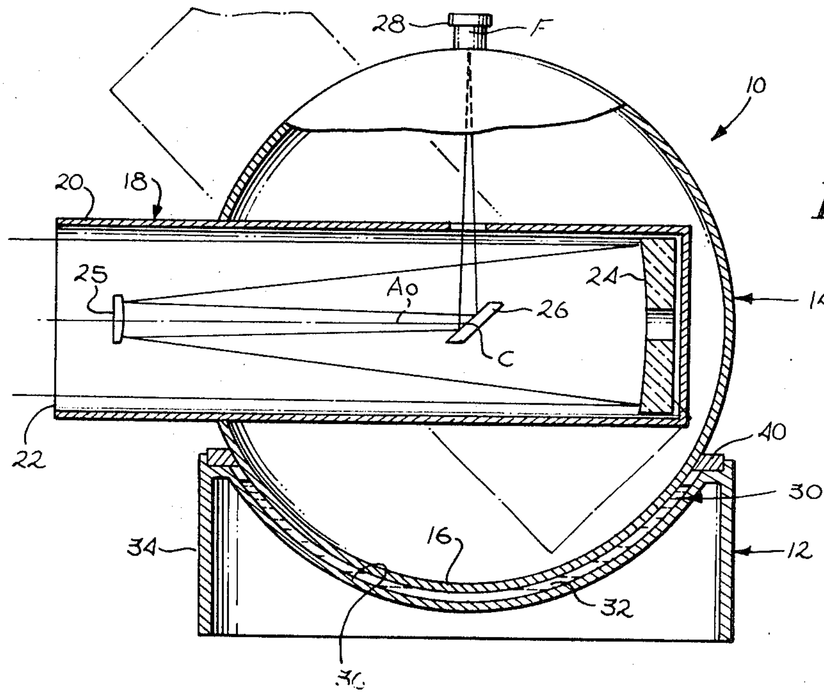


Fig.1

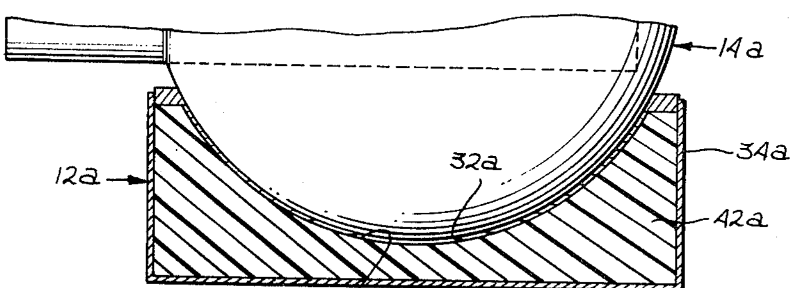


Fig.2

Fig. 3

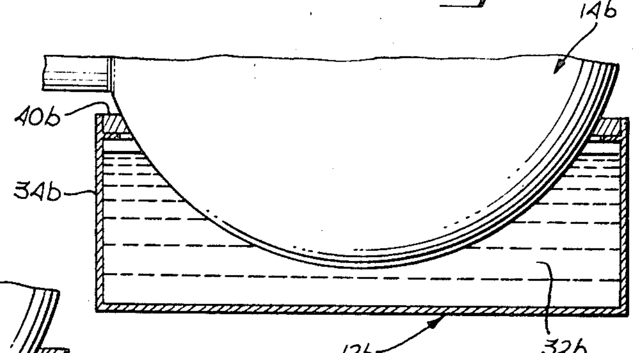
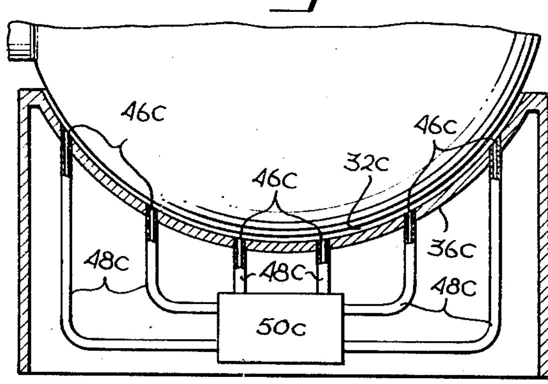


Fig. 4



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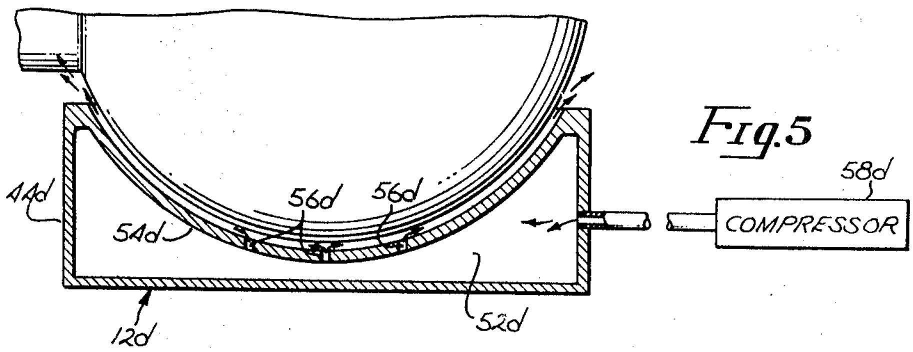

Fig. 5

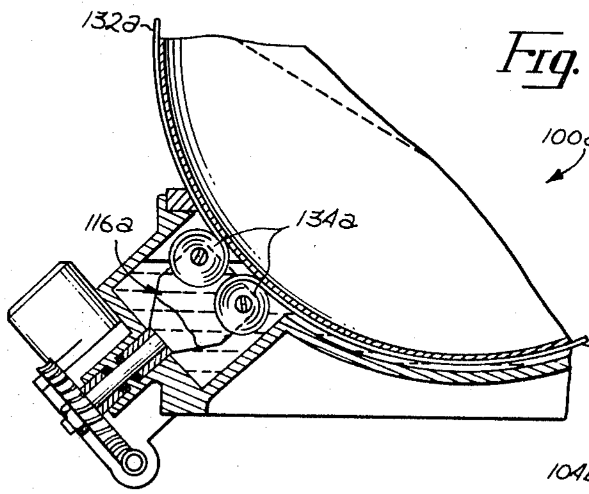

Fig. 9

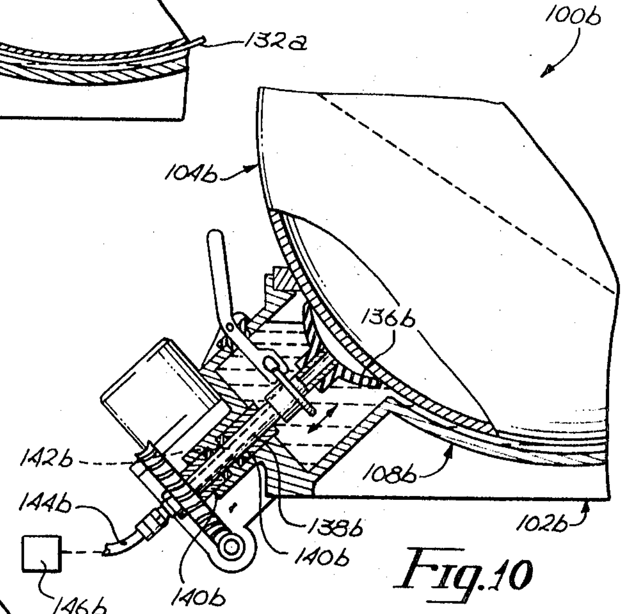

Fig. 10

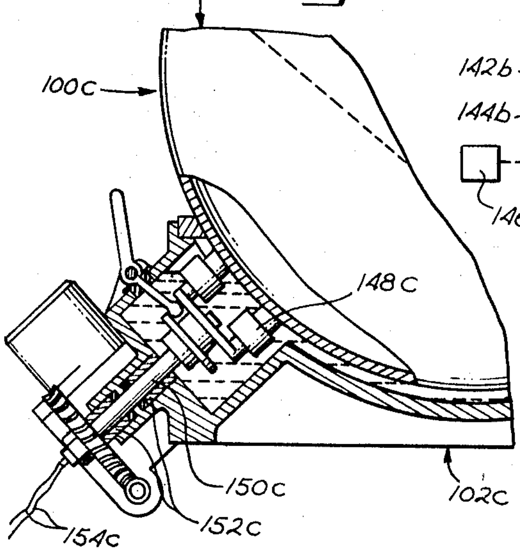

Fig. 11

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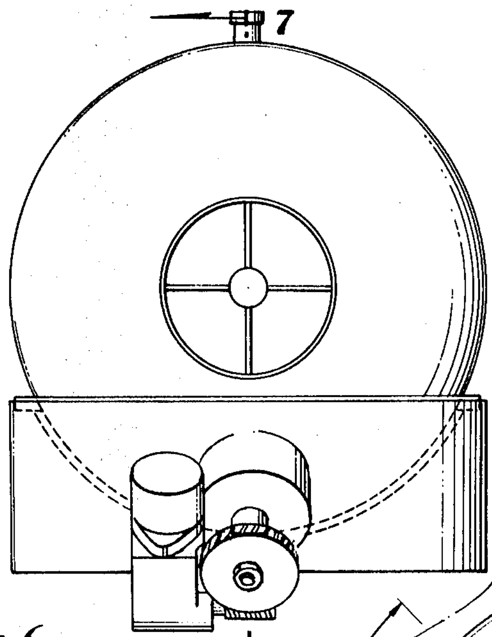

Fig. 6

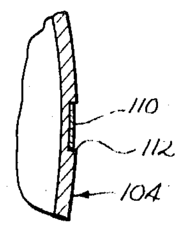

Fig. 8

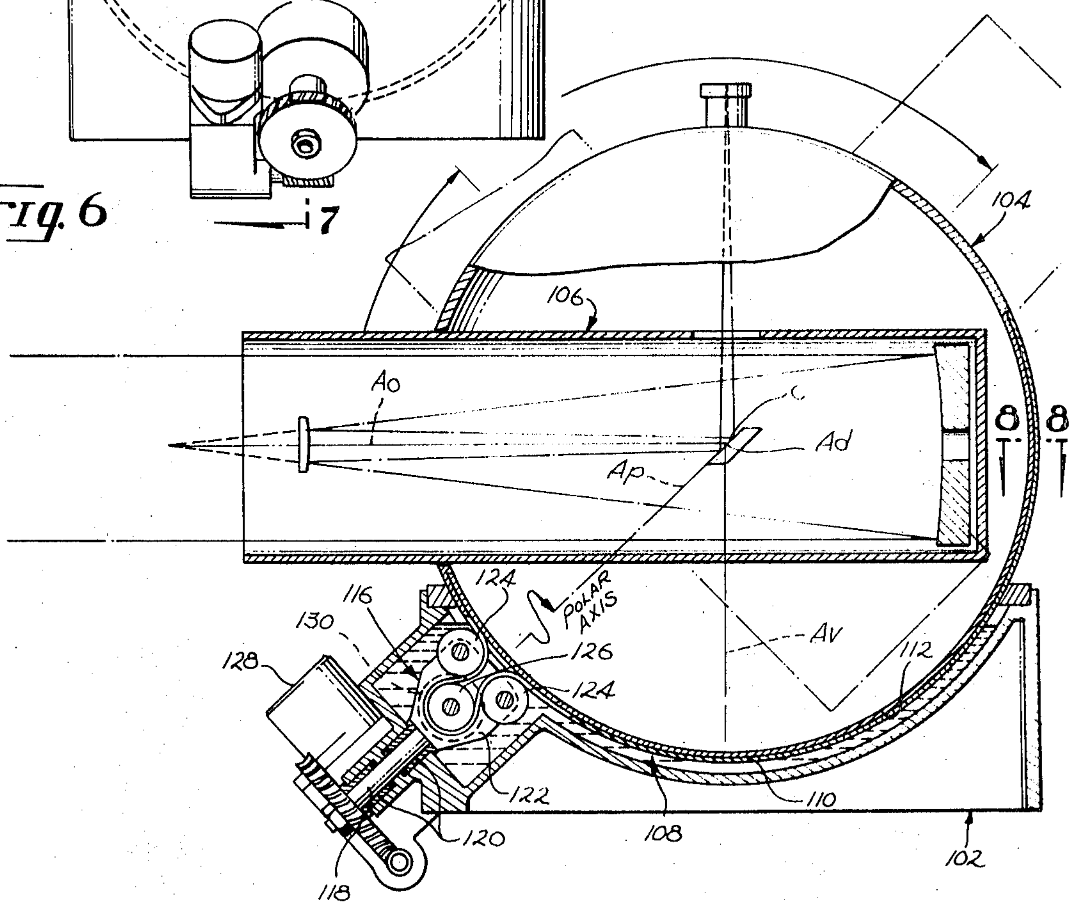

Fig. 7

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TELESCOPE MOUNTING SYSTEM

Background of the Invention

1. Field of the Invention

This invention relates generally to telescopes and more particularly to a novel telescope-mounting system.

2. Prior Art

A variety of telescope-mounting systems, or telescope mounts as they will be referred to herein, have been devised. One of the most common telescope mounts is known as an equatorial mount. Such an equatorial mount embodies a two axis gimbal system having an inclined rotation axis which parallels the earth's rotation axis and a second horizontal rotation axis which intersects the inclined axis at right angles to a vertical plane containing the latter axis. The inclined axis is referred to as the polar axis and the horizontal axis is referred to as the declination axis. Rotation of the mount about the declination axis adjusts the elevation angle of the telescope. Rotation of the mount about the polar axis moves the telescope in a rotary tracking motion. The equatorial mounting system is preferred for the reason that it permits tracking of celestial objects by simple rotation about the polar axis with the telescope fixed at a given elevation about the declination axis. Because of the convenience of tracking, professional and amateur telescopes, alike, have been mounted in this manner for centuries. Other types of telescope mounting systems have been devised. Such other systems, however, have not been commonly accepted, primarily because of their complexity of tracking.

While the equatorial telescope mount is preferred because of its simplicity of tracking, even this mount presents certain problems in its design and construction. The greatest problem of the equatorial mount, for example, has been the awkwardness of the supporting structures as dictated by the axis arrangement of the two axis gimbal system embodied in the mount. Thus, because the polar axis is inclined to the horizontal and the declination axis extends horizontally at right angles to the polar axis, the conventional equatorial telescope mount requires complex cantilevered structures to satisfy the critical rigidity requirements of telescope optical systems. These cantilevered structures, in turn, pose difficult engineering design tasks. Thus, flexure or bending of the telescope tube and its associated supporting structure is considered, by astronomers, to be one of the most common and serious deficiencies of equatorial telescope systems. The traditional method of providing the requisite rigidity has been to increase the masses of the telescope mounting system. Some manufacturers of telescope mounting systems, in fact, stress as a sales feature the massiveness of their telescope mounts. However, increasing the mass of a telescope mount greatly increases its complexity and cost and results, in effect, in pyramiding of the mass of the mount owing to the necessity of providing the latter with increased rigidity and strength to sustain the increased mass. This mass pyramiding action is compounded by the fact that it creates the need for counterweights, and counterweights for the counterweights, in order to provide the finished telescope-mounting system with the requisite balance and stability.

Summary of the Invention

The present invention provides an improved telescope-mounting system, or telescope mount, which avoids the above noted and other deficiencies of the existing mounts. In this regard, it will become evident from the ensuing description that the present telescope mount is characterized by relative simplicity of construction, lightweight rigidity, and relatively low cost of manufacture. To this end, the telescope mount is equipped with a supporting base and a telescope housing having a lower spherically curved portion swiveled in the base. In the particular embodiments of the invention which have been selected for presentation in this disclosure, for example, the telescope housing has a generally spherical shape. The actual telescope structure is contained within this housing. Insofar as the present invention is concerned, the present telescope mount may be employed with any type of telescope. The particular telescopes disclosed herein are reflecting telescopes having a telescope tube extending diametrically across the inside of the spherical telescope housing in such a way that the open light-receiving end of the tube is exposed or protrudes through an opening in the wall of the housing. This tube contains the various optical elements which are characteristic of a reflecting telescope. The eyepiece of the telescope may be mounted in various positions, either on the projecting end of the telescope tube or in the wall of the telescope housing.

One important aspect of the invention is concerned with a fluid-bearing system for the spherical telescope housing. According to this aspect of the invention, the housing floats in a fluid-bearing medium, which may be either a liquid or a gas. The present disclosure presents several different fluid-bearing systems for the telescope mount. Some of these bearing systems may be classified as hydrostatic systems and others as hydrodynamic or air-bearing systems. These bearing systems are designed to reduce, to an absolute minimum, the frictional forces active between the telescope housing and its supporting base, thus to permit relatively free swivel movement of the housing relative to the base.

As will appear from the ensuing description, a simple version of the present telescope mount may comprise a spherical telescope housing freely swiveled in the supporting base in such a way as to permit manual rotation of the housing in any direction relative to the base. Another important aspect of the invention, however, is concerned with providing an equatorial telescope mount in which the swivel motion of the telescope housing relative to the supporting base is constrained to rotation about an inclined polar axis and independent rotation about a horizontal declination axis. This equatorial telescope mount, like the simple telescope mount referred to above, may be designed to permit manual rotation of the telescope housing about either or both its rotation axes. Preferably, however, the telescope housing is motor-driven at least about its polar axis.

In this regard, a third important aspect of the invention is concerned with providing various unique driving means for driving the telescope housing in rotation about its polar and declination axes. These driving means are uniquely arranged and constructed to provide, with the housing and supporting base, a relatively simple, low cost, lightweight, and yet extremely rigid and stable overall telescope mount.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a vertical section through a telescope mount according to the invention;

FIG. 2 is a fragmentary vertical section through a modified telescope mount according to the invention;

FIG. 3 is a fragmentary vertical section through a further modified telescope mount according to the invention;

FIG. 4 is a fragmentary vertical section through a further modified telescope mount according to the invention;

FIG. 5 is a fragmentary vertical section through a further modified telescope mount according to the invention;

FIG. 6 is a top plan view of a further modified telescope mount according to the invention;

FIG. 7 is an enlarged section taken on line 7—7 in FIG. 6;

FIG. 8 is an enlarged section taken on line 8—8 in FIG. 7;

FIG. 9 is a fragmentary section through a further modified telescope mount according to the invention;

FIG. 10 is a fragmentary section through a further modified telescope mount according to the invention; and

FIG. 11 is a fragmentary section through a further modified telescope mount according to the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In general terms, the invention provides a telescope-mounting system or mount, represented in FIG. 1 of the drawings by the mount 10, having a supporting base 12 and a telescope housing 14. Housing 14 has a lower spherically curved portion 16 which is swiveled in the base for rotation of the housing relative to the base about the center C of curvature of the lower spherically curved housing portion 16. Contained within the housing is a telescope structure 18 proper. The illustrated telescope structure, or telescope, as it will be hereinafter referred to, constitutes a conventional coude focus cassegranian type telescope including a tube 20. Telescope tube 20 has an open light-receiving end 22 which may protrude a distance from the housing, as shown. The central axis of this tube coincides with the optic axis A_0 of the telescope. Telescope axis A_0 passes through the center of curvature C of the lower spherically curved housing portion 16. Mounted within the opposite end of the telescope tube 20 is a concave primary mirror 24 which receives, through the open light-receiving end of the tube, the light from the object being viewed. The incident light is reflected forwardly to a mirror 25 and then rearwardly to a diagonal mirror 26. Mirror 26 is oriented at a 45° angle relative to the axis of the tube to reflect the incident light laterally of this axis to the coude focus point F. An eyepiece, camera, or other accessory may be located at this focus point to receive the optical image of the object being viewed. In actual practice, the diagonal mirror 26 may be angularly adjustable to locate the coude focus F at different preselected stations containing, respectively, the eyepiece, camera, and other accessory. In the illustrated telescope, it is assumed that the diagonal flat 26 is fixed and reflects its incident light to an eyepiece 28 through which the optical image may be viewed.

One important aspect of the invention relates to the unique swivel mounting of the spherically curved telescope housing 14 in the supporting base 12. This unique mounting permits essentially ball and socketlike universal swivel rotation of the housing relative to the base to point or aim the telescope 18 at any selected portion of the sky. Also, the housing may be rotated in any direction at the proper speed to track any object in space, including natural celestial objects, artificial satellites, and the like.

Conceivably, the supporting base 12 of the telescope mount 10 could be provided with a spherically curved mechanical bearing surface, or other suitable mechanical bearing means to swivelly support the spherically curved telescope housing 14. According to another important aspect of the invention, however, the telescope mount is provided with a fluid bearing means or system 30 including a fluid bearing medium 32 in which the telescope housing 14 floats. As will become evident from the ensuing description this fluid bearing support of the housing may be accomplished in various ways and may utilize various fluid-bearing media, including both liquids and gases.

The particular telescope mount 10 under discussion has an essentially hydrostatic bearing system 30 which utilizes water or other liquid as the fluid-bearing medium 32. Thus, referring in greater detail to the telescope mount 10, the telescope housing 14 is a hollow sphere having its geometric center located at C. The supporting base 12 has an upper, upwardly opening basin 34. The bottom wall of this basin is spherically curved to a radius which approximates, and is preferably slightly greater than, the radius of the spherical telescope housing 14. Contained within the basin is a liquid which constitutes the fluid bearing medium 32. This liquid may comprise water, oil, or other suitable liquid. The vertical depth of the basin 34, at its center, is such that when the spherical telescope housing 14 is concentrically positioned within the basin, so that the geometric center C of the housing coincides with the center of curvature of the lower spherically curved basin wall 36, the liquid 32 exerts on the housing a buoyant force equal to the weight of the housing and its contained telescope 18. Under these conditions, the liquid provides, between the housing and basin, a relatively thin film or layer on which the housing floats. Preferably, the supporting base 12 is also equipped with a combined bearing and damping ring 40 to retain the telescope housing 14 in centered or concentric relation to the basin 34 and to damp vibration and other small amplitude disturbing motions of the housing. This bearing ring is attached to the supporting base 12 about the rim of its basin 34 and is internally dimensioned to bear slidably against the telescope housing 14 with a light rubbing contact when the housing is centered in the basin. The bearing-damping ring 40 may be constructed from any suitable low friction, and preferably slightly resilient material.

The telescope tube 20 extends diametrically across the inside of the spherical telescope housing 14 and is rigidly attached to the housing in any convenient way. The open light-receiving end 22 of the tube protrudes through an opening in the spherical wall of the housing, as shown. The location of the eyepiece 28 is determined by the telescope optics and may be mounted on the external end of the telescope or in the wall of the telescope housing, depending upon the particular optical system employed.

It is evident at this point that the telescope housing 14 is swiveled in the supporting base 12 for rotation of the housing in any direction relative to the base about the center C of the housing. The housing floats in the film or layer of the liquid 32 which thus provides an essentially zero friction bearing for the housing. As a consequence, the telescope housing 14 may be rotated and positioned relative to the base with great ease, regardless of its weight, by exerting finger pressure on the wall of the housing. The bearing-damping ring 40 constantly centers the housing relative to the basin 34 of the supporting base, damps vibration and other undesirable motions of the housing, and frictionally retains the latter in any given position of adjustment. Another function of this ring is to prevent or inhibit loss of the liquid 32 from the basin 34.

FIGS. 2–5 illustrate modified telescope mounts according to the invention having alternative fluid-bearing systems. In FIG. 2, the basin 34*a* of the supporting base 12*a* is generally rectangular rather than spherical in vertical section. Positioned within the basin is a resilient material 42*a* having an upper spherically curved surface 44*a* of the same radius as the wall of the earlier described basin 34. The spherical telescope housing 14*a* floats on a film or layer of liquid 32*a* which is contained within the upper depression or cavity of the resilient material 42*a*. By way of example, this resilient material may comprise foam plastic which is cast in place within the basin 34*a*. The bearing-damping ring 40 of the earlier described telescope mount may be eliminated or retained, as desired, in the modified telescope mount of FIG. 2.

In FIG. 3, the basin 34*b* of the supporting base 12*b* has the same shape as the basin 34*a* just described, but the resilient material 42*a* is omitted from the basin. The entire basin 34*b* is filled with a liquid 32*b* in which the telescope housing 14*b* floats. In this case, the basin mounts a combined bearing-damping ring 40*b* for centering and damping undesirable motions of the telescope housing, as before.

All of the above described fluid-bearing arrangements constitute, in effect, hydrostatic bearing systems. FIGS. 4, 5 illustrate two dynamic fluid-bearing systems which may be utilized in the present telescope mount. FIG. 4, for example, illustrates a hydrodynamic bearing system in which the supporting base 12*c* has an upper spherically curved basin 34*c*, very much like the basin 34 described earlier. Opening through the bottom wall 36*c* of the basin 34*c* are a number of fluid ports 46*c* which communicate through conduits 48*c* to a pump 50*c*. Certain of the conduits connect to the pump intake and the remaining conduits connect to the pump discharge. In this case, a liquid-bearing medium 32*c* is continuously circulated, by the pump 50*c*, through the narrow space between the telescope housing 14*c* and the basin wall 36*c* to both float and support the housing and damp undesirable motions of the housing. The liquid is preferably a relatively viscous liquid, such as a heavy oil, to enhance its damping properties. By properly arranging the fluid ports 46*c* , the liquid 32*c* may be induced to circulate in such a way as to retain the telescope housing 14*c* generally centered without the aid of the bearing ring 40. If desired, however, the bearing ring may be retained.

The fluid-bearing system illustrated in FIG. 5 is essentially an air-bearing system. In this case, the basin 44d of the supporting base 12d has an internal manifold cavity 52d bounded at its top by a spherically curved wall 54d. Opening through this wall to the manifold cavity 52d are one or more openings 56d. A pump or blower 58d is provided to constantly supply air or other gas under pressure to the cavity. This air or gas passes through the wall opening or openings 56d to the region between the basin wall 54d and the telescope housing 14d and then flows outwardly in all directions through this region to atmosphere. This air or gas flow provides an air-bearing film on which the housing effectively floats. As before, the bearing-damping ring 40 may be retained or eliminated, as desired.

The telescope mounts described thus far permit free rotation of the spherical telescope housing in any direction by hand and are suitable for short term celestial observations, tracking satellites and other artificial and natural objects which follow an uncertain trajectory or path across the sky, and for other similar uses. For more accurate and prolonged celestial observations, however, it is necessary to retain the optic axis of the telescope at a fixed elevation angle and to drive the telescope at a constant speed about an axis of rotation, referred to as the polar axis, parallel to the earth's rotation axis, such that the telescope will continuously point or aim at the object being viewed. A further important aspect of the present invention is concerned with, and FIGS. 6–11 illustrate several different types of telescope mounts according to the invention for, achieving this tracking function. As noted earlier, such telescope mounts are commonly referred to as equatorial mounts. Each of the present equatorial mounts illustrated may utilize any one of the bearing systems described above. Accordingly, the bearing systems will not be redescribed with reference to each equatorial telescope mount, and it will be assumed that each mount employs the hydrostatic bearing system illustrated in FIG. 1.

Referring first to FIGS. 6–8, there is illustrated an equatorial telescope mount 100 embodying a supporting base 102 with a spherically curved basin 103 and a spherical telescope housing 104 like those described above, which is swiveled in the basin by means of a narrow bearing film, as before. Housing 104 contains a telescope 106, also like that described above. Accordingly, it is unnecessary to redescribe these parts in detail. Telescope mount 100 has means 108 for constraining motion of the telescope housing 104 relative to its supporting base 102 to rotation about a polar axis A_p and independent rotation about a declination axis A_d. Polar axis A_p passes through the center C of the telescope housing 104 at an acute angle relative to the optic axis A_o of the telescope 106, such that the polar axis will parallel the earth's rotation axis when the telescope mount is properly oriented. As is well known, the angle of the polar axis relative to the horizontal is equal to the local earth's latitude. The declination axis A_d passes through the center C normal to a plane containing the polar and optic axes A_p, A_o. The telescope housing 14 is rotated about the declination axis A_d to adjust the elevation of the telescope 106. The housing is rotated about the polar axis to track a celestial object, i.e., to retain the telescope pointed at the object for a prolonged period of time.

The particular telescope housing constraining means 108 illustrated includes a web or band 110 extending circumferentially about the underside of the telescope housing 104 within a groove or channel 112 in the housing. This groove has a depth and width just slightly greater than the thickness and width, respectively, of the band 110. The longitudinal centerline of the groove is located in a plane normal to the declination axis A_d and containing the optic axis A_o of the telescope 106. The band 110 may be constructed of any suitable material and has its ends firmly attached to the telescope housing, as by rivets. Located within a chamber 113 at the underside of the basin 103 on the polar axis A_p, and opening to the narrow space between the telescope housing 104 and the basin, is a bracket assembly 116 having a shaft 118 which is rotatably supported on the base 102, by means of bearings 120, for turning on the polar axis. A pair of spaced parallel plates 122 are fixed to the upper end of the shaft 118 adjacent the telescope housing 104 in such a way that the plates parallel and straddle the polar axis. Rotatably supported between these plates, in generally tangential relation to the telescope housing 104, are a pair of spaced parallel rollers 124. A third roller 126 is rotatably supported between the plates with its axis disposed in a plane passing between the parallel to the rollers 124. Referring to FIG. 7, it will be seen that the band 110 passes from the housing groove 112, around one of the rollers 124, then around the roller 126, and then back around the other roller 124 to the groove 112. The band is tensioned to remain in firm contact with the rollers and to maintain the two rollers 124 in tangential contact with the telescope housing 104.

It is now evident that the constraining means 108 constrains the telescope housing 104 to rotation about the declination axis A_d and independent rotation about the polar axis A_p. During rotation of the housing about the declination axis, the band 110 moves endwise back and forth about and between the rollers 124, 126. During rotation of the housing about the polar axis, the entire bracket assembly 116 rotates in its shaft bearings 120.

As noted earlier, rotation of the telescope housing 104 about the declination axis A_d adjusts the elevation angle of the telescope 106. Tracking of an object across the sky is accomplished by rotation of the housing about the polar axis A_p. Conceivably, the housing may be rotated by hand about both axes. Preferably, however, the telescope mount is motorized to drive the telescope housing at least in its tracking mode of rotation about the polar axis. The particular telescope mount illustrated is motorized to drive the housing about both axes. To this end, a constant speed motor 128 is geared to the bracket shaft 118 to drive the bracket assembly 116 and hence the telescope housing 104, at a constant speed about the polar axis A_p and in the proper direction for celestial tracking. A second motor 130 is geared to the bracket roller 126 to drive the latter in either direction of rotation and thereby drive the band 110 endwise to rotate the telescope housing 104 about its declination axis A_d. It will be understood that suitable controls for these motors will be provided. In order to permit the telescope housing 104 to float freely on the fluid bearing embodied in the telescope mount, the driven gear on the bracket shaft 118, through which the latter is driven from the tracking motor 128, will be slidably keyed to the shaft, or other means will be provided for allowing sufficient endwise freedom of movement of the bracket assembly to enable floating of the housing.

The telescope mount 100a illustrated in FIG. 9 is similar to that just described except that the band 110 and band rollers 124, 126 are replaced by two negator springs 132a wound on rollers or drums 134a carried by the bracket assembly 116a. Drums 134a may be powered to drive the telescope housing 104a in rotation on its declination axis A_d. The housing is driven in rotation on its polar axis A_p in the same manner as the housing of the telescope mount 100.

Turning now to FIG. 10, there is illustrated a further modified telescope mount 100b according to the invention in which the telescope housing constraining means 108b comprises a suction cup 136b mounted on the end of a shaft 138b. Shaft 138b is supported on the base 102b, by means of bearings 140b, for rotation on the polar axis A_p. Extending through the section cup shaft 138b is an air passage 142b which opens at one end to the interior of the suction cup. The opposite end of the passage communicates, through a conduit 144b, to a vacuum pump 146b for evacuating the interior of the suction cup. In this particular embodiment of the invention, the suction cup 136b is normally detached from the telescope housing 104b to permit rotation of the housing about the declination axis by hand, or in some other way, to a desired astronomical orbit. The vacuum pump 146b is then operated to evacuate the suction cup 136b and effect attachment of the latter to the housing. The telescope housing 104b is then constrained to rotation about the polar axis A_p at the particular elevation angle to which the housing was initially adjusted. As in the previous embodiments of the elevation, the housing may be rotated manually about the polar axis, or the telescope mount may be motorized by gearing of a tracking motor to the suction cup shaft 138*b*.

The further modified equatorial telescope mount 100*c* illustrated in FIG. 11 is similar to that just described except that the suction cup 136*b* is replaced by a magnet 148*c*. The spherical telescope housing 104*c* is constructed, in this case, of a magnetic permeable material to which the magnet 148*c* will adhere by magnetic attraction. This magnet may comprise either a permanent magnet or an electromagnet energized from an external electrical power source. Magnet 148*c* is, in this case, an electromagnet slidably keyed on the end of a shaft 150*c* rotatably supported on the base 102*c*, by bearings 152*c*, for rotation on the polar axis A_p. Magnet 148*c* has leads 154*c* extending to the exterior of the base 102*c* for connection to a source of energizing current. It is now evident, therefore, that the magnet 148*c* may be detached from the telescope housing 104*c* by deenergizing the magnet to permit rotation of the housing about the declination axis to a desired elevation or astronomical orbit. The magnet may then be reattached to the housing by energizing the magnet to constrain the housing to rotation on the polar axis A_p. Here again, the telescope mount may be designed for manual tracking rotation or it may be motorized for power-driven rotation of the telescope housing about the polar axis.

It will be understood that in each of the above described equatorial telescope mounts of the invention, the telescope housing will have sufficient freedom of movement along its polar axis A_p as to permit the housing to float in the fluid-bearing medium of its fluid-bearing system.

While the invention has been disclosed in connection with certain of its preferred embodiments, it will be immediately evident to those skilled in the art that various modifications of the invention are possible within the spirit and scope of the following claims.

Having described the invention, what is claimed as new in support of letters patent is:

1. A telescope comprising:
a supporting base including an upwardly opening basin,
a telescope housing having a lower spherically curved portion swiveled in said basin for rotation about the center of curvature of said lower spherically curved housing portion,
a fluid-bearing system including a fluid-bearing medium within said basin providing a fluid-bearing support for said housing,
a telescope structure carried by said housing including telescope optics having an optic axis passing through said center of curvature for receiving light rays from a distant object along said axis, and an eyepiece for viewing said object; and
a combined bearing and vibration damping ring on said base about the rim of said basin slidably engaging said spherically curved housing portion to retain said housing centered in said basin.

2. A telescope comprising:
a supporting base including a spherically curved wall forming an upwardly opening basin,
a spherical telescope housing swiveled in said basin for rotation about the center of said housing,
a fluid-bearing system including a relatively thin fluid-bearing film of generally uniform thickness between said basin wall and telescope housing supporting said housing in spaced relation to said basin wall,
said basin having a chamber below said basin wall and opening upwardly through said wall into the space between said wall and housing on a polar axis through said center at an acute angle to a vertical axis through said center;
a telescope structure carried by said housing including telescope optics having an optic axis passing through said center of curvature for receiving light rays from a distant object along said axis, and an eyepiece for viewing said object; and
means for constraining the movement of said housing relative to said base to rotation about said polar axis and permitting rotation of said housing about a declination axis extending through said center normal to a plane containing said polar axis, vertical axis and optic axis including a bracket in said chamber rotatably supported on said base for turning on said polar axis, and coupling means joining said bracket and housing for rotation of said housing with said bracket on said polar axis and rotation of said housing relative to bracket on said declination axis.

3. A telescope according to claim 2 wherein:
said coupling means comprises means for constraining said housing to rotation on said declination axis relative to said shaft and base.

4. A telescope according to claim 2 wherein:
said coupling means is releasable to release said housing from said shaft for unrestrained rotation of said housing on said declination axis relative to said shaft and base.

5. A telescope comprising:
a supporting base including an upwardly opening basin,
a telescope housing having a lower spherically curved portion swiveled in said basin for rotation about the center of curvature of said lower spherically curved housing portion,
a fluid-bearing system including a fluid-bearing medium within said basin providing a fluid-bearing support for said housing,
a telescope structure carried by said housing including telescope optics having an optic axis passing through said center of curvature for receiving light rays from a distant object along said axis, and an eyepiece for viewing said object,
means connected between said housing and base for constraining the movement of said housing relative to said base to rotation about a polar axis passing through the center of curvature of said lower spherically curved housing portion at an acute angle relative to a vertical axis passing through said center and independent rotation about a declination axis extending through said center normal to a plane containing said polar axis, vertical axis, and optic axis, and
said last-mentioned means comprising a bracket assembly supported on said base for rotation about said polar axis and including a pair of rollers disposed in generally tangential relation to said lower spherically curved housing portion, a third roller positioned between and offset from said pair of rollers, a band extending circumferentially about said lower housing portion in said plane within a circumferential groove in said housing portion, said band extending from said groove around one roller of said roller pair, then between said pair of rollers and around said third roller, then back between said pair of rollers and around the other roller of said roller pair to said groove, and means securing the ends of said band to said housing in such a way as to maintain said band in a taut condition.

6. A telescope comprising:
a supporting base including an upwardly opening basin,
a telescope housing having a lower spherically curved portion swiveled in said basin for rotation about the center of curvature of said lower spherically curved housing portion.
a fluid-bearing system including a fluid-bearing medium within said basin providing a fluid bearing support for said housing,
a telescope structure carried by said housing including telescope optics having an optic axis passing through said center of curvature for receiving light rays from a distant object along said axis, and an eyepiece for viewing said object,

means connected between said housing and base for constraining the movement of said housing relative to said base to rotation about a polar axis passing through the center of curvature of said lower spherically curved housing portion at an acute angle relative to a vertical axis passing through said center and independent rotation about a declination axis extending through said center normal to a plane containing said polar axis, vertical axis, and optic axis, and

said constraining means comprising a bracket assembly supported on said base for rotation on said polar axis, a pair of parallel drums mounted on said bracket assembly, and a pair of negator springs extending circumferentially about and terminally attached to said housing.

7. A telescope comprising:

a supporting base including an upwardly opening basin,

a telescope housing having a lower spherically curved portion swiveled in said basin for rotation about the center of curvature of said lower spherically curved housing portion,

a fluid-bearing system including a fluid-bearing medium within said basin providing a fluid-bearing support for said housing,

a telescope structure carried by said housing including telescope optics having an optic axis passing through said center of curvature for receiving light rays from a distant object along said axis, and an eyepiece for viewing said object,

means connected between said housing and base for constraining the movement of said housing relative to said base to rotation about a polar axis passing through the center of curvature of said lower spherically curved housing portion at an acute angle relative to a vertical axis passing through said center and independent rotation about a declination axis extending through said center normal to a plane containing said polar axis, vertical axis, and optic axis, and

said constraining means comprising a shaft rotatably mounted on said base for turning on said polar axis, a suction cup on the end of said shaft adjacent said housing, and means for selectively evacuating said suction cup to effect attachment of said cup to said housing.

8. A telescope comprising:

a supporting base including an upwardly opening basin,

magnetically permeable telescope housing having a lower spherically curved portion swiveled in said basin for rotation about the center of curvature of said lower spherically curved housing portion,

a fluid-bearing system including a fluid-bearing medium within said basin providing a fluid-bearing support for said housing,

a telescope structure carried by said housing including telescope optics having an optic axis passing through said center of curvature for receiving light rays from a distant object along said axis, and an eyepiece for viewing said object,

means connected between said housing and base for constraining the movement of said housing relative to said base to rotation about a polar axis passing through the center of curvature of said lower spherically curved housing portion at an acute angle relative to a vertical axis passing through said center and independent rotation about a declination axis extending through said center normal to a plane containing said polar axis, vertical axis and optic axis, and

said constraining means comprising a shaft mounted on said base for turning on said polar axis, and magnetic means on the end of said shaft adjacent said housing adapted to be magnetically attached to and released from said housing.