Sept. 10, 1968 A. A. BRACCINI ETAL 3,401,390

ADJUSTABLE POSITIONING AND SUPPORT DEVICE FOR ANTENNA REFLECTOR PANELS

Filed May 28, 1965 2 Sheets-Sheet 1

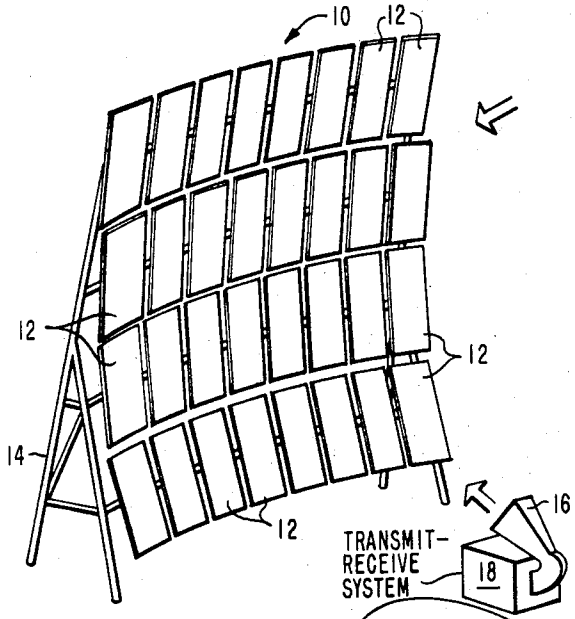


FIG.-1

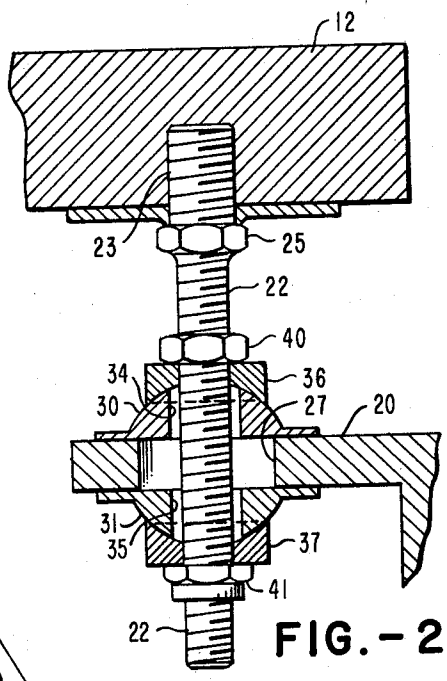


FIG.-2

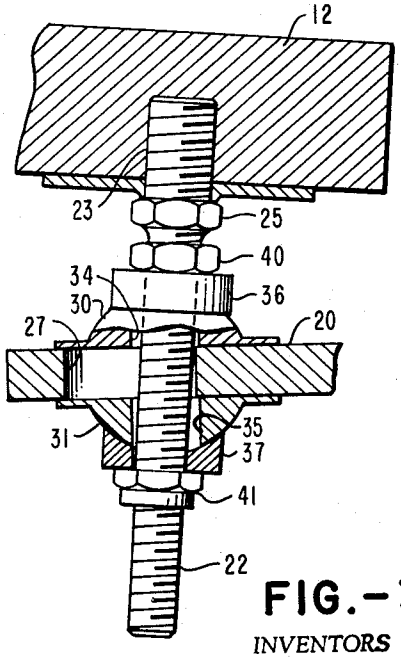


FIG.-3

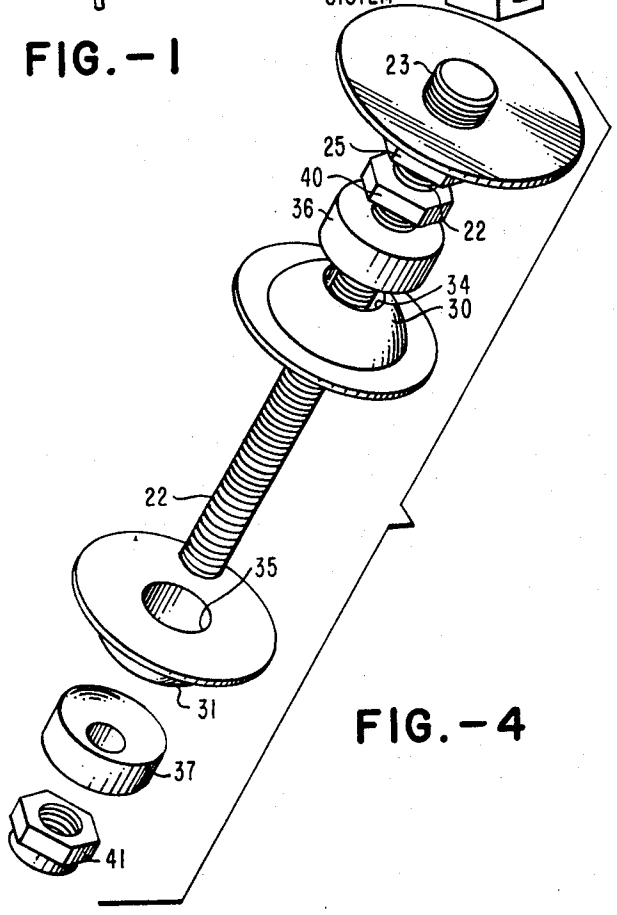


FIG.-4

INVENTORS
ALFONSO A. BRACCINI
DONALD R. CARR

BY Fraser and Boguski

ATTORNEYS

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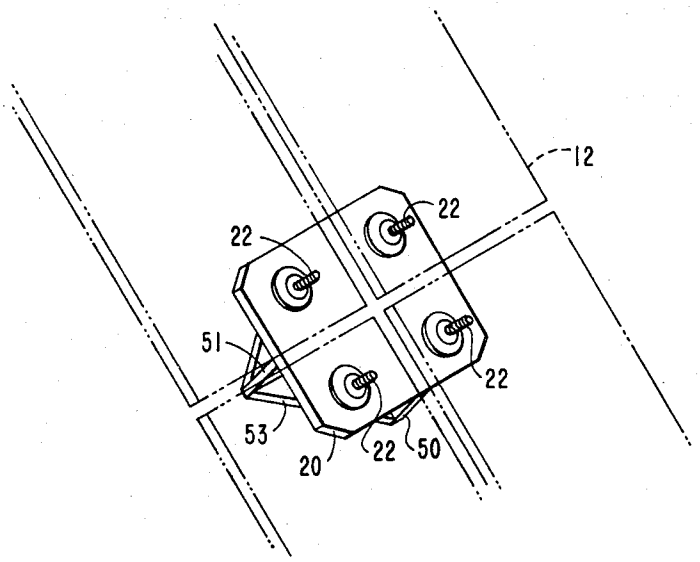


FIG. — 5

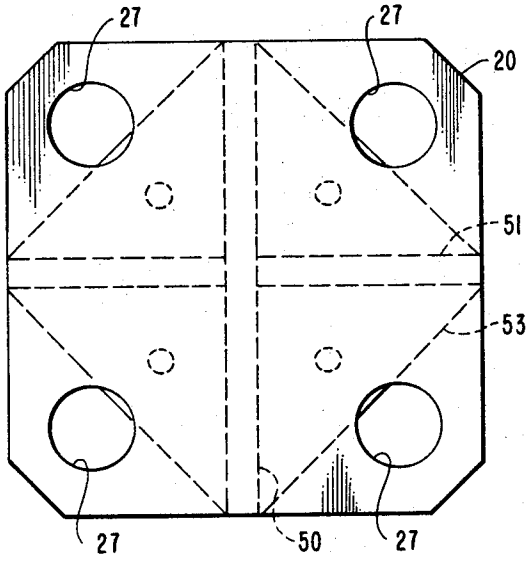


FIG. — 6

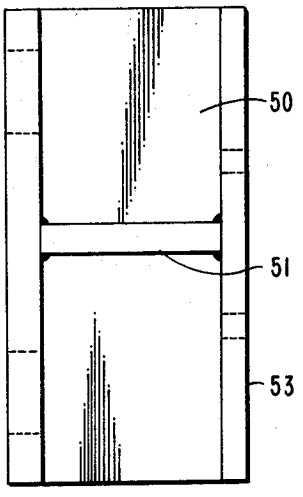


FIG. — 7

INVENTORS
ALFONSO A. BRACCINI
DONALD R. CARR
BY
Fraser and Bogucki
ATTORNEYS

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ADJUSTABLE POSITIONING AND SUPPORT DEVICE FOR ANTENNA REFLECTOR PANELS

Alfonso A. Braccini, La Mesa, and Donald R. Carr, Lemon Grove, Calif., assignors to Whittaker Corporation, a corporation of California

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ABSTRACT OF THE DISCLOSURE

The mechanism for positioning antenna reflector panels in a selectable position and attitude relative to a backup structure includes a mounting bracket attached to the backup structure. Each panel has an elongated stud member affixed thereto and extending through an enlarged aperture in the mounting bracket. A pair of base members have convex outer bearing surfaces and flat inner bearing surfaces which when urged together positively engage the opposing surfaces of the bracket about the aperture. Central openings of substantially greater diameter than the stud member extend through the base members to permit angular displacement of the stud member relative to the bracket surfaces. A pair of clamping members having concave inner bearing surfaces for frictionally engaging the convex outer spherical surfaces of the base members are adjustably positioned along the length of the stud member on opposite sides of the base members. The clamping members are moved toward one another to force the abutting bearing surfaces in positive frictional engagement with one another to fix the panel in the desired position relative to the mounting bracket.

This invention relates to mechanisms for the selective adjustment of a member relative to a given frame of reference, and more particularly to devices for adjusting the positions and attitudes of individual reflector panels in a large antenna system.

Modern antenna systems for high power or high gain applications often take the form of a plurality of individual reflectors mounted to define an array having a large reflecting area. The array is typically curved so as to provide desired beam shaping of transmitted energy, or focusing of received energy, or both. Inasmuch as electromagnetic wave energy is focused and directed in a fashion which is strictly analogous to the laws of optical physics, each reflector panel must be properly positioned relative to the other panels as well as to the radiating source or excited element in order for the antenna to have high gain and a desired pattern characteristic.

In some systems of this kind, the reflectors are fixed directly to a backup structure, and therefore must be fitted together with a high degree of precision. Because of the costs involved in attaining the needed accuracy with large structures, it has been found preferable for many applications to use a lower cost backup or support structure, not as precisely aligned but adequately structurally strong, and to mount individual panels so that they may be held in different positions and attitudes relative to the plane of the reflective surface. This type of structure requires that the reflector panel be movable through significant but relatively small distances along each of several axes, and also angularly relative to the focusing point of the antenna. It will be understood that the reflector panel comprises an essentially planar segment of the total antenna array which generally follows a parabolic curvature.

The type of reflective antenna system which uses individually adjustable reflector panels has advantages in versatility, because the system may be used for different purposes, or the effective aperture or size of the system

may be enlarged or reduced by changing the number of reflector panels. While costs can be reduced by using individual standardized reflector panels and a backup structure which need not be precisely positioned, most of this advantage can be lost if complicated positioning and support structures for the reflector panels are required. The support system must permit the necessary adjustments, as well as provide adequate structural rigidity for the panels, but do so while using a minimum number of standardized parts.

It is therefore an object of the present invention to provide an improved mounting and positioning system for individual reflector panels in an antenna system.

Another object of the present invention is to provide improved means for positioning individual reflector panels in a reflective antenna system, both within the plane of the reflective system, and in a direction normal to the plane of the reflective system, as well as through a range of angular positions.

A further object of the present invention is to provide a simple and adequately strong support and adjustment mechanism for individual reflector panels in a large antenna system made up of a plurality of such panels.

These and other objects of the present invention are achieved by a reflector panel mounting system which is attachable to a support member on the backup structure, and includes an external movable mechanism supporting an internal mechanism that is itself movable. In one specific example, a pair of base members having arcuate surfaces are urged together to engage the support member about an included aperture. The base members internally receive a stud to which the reflector panel is coupled, and provide adequate internal clearance for the stud, to enable the panel to be positioned in varying attitudes relative to the focusing point of the antenna, as well as at different positions in a direction normal to the plane of the reflective system. The base members are themselves movable within the plane of the system relative to the included aperture, so that substantial freedom of movement along three orthogonal axes and in attitude can be achieved for the reflector panel. The entire assembly is held firmly in a selected position by members engaging the stud on opposite sides of the base members and forcing the opposite base members into firm contact with the support member. In all positions the device provides adequate bearing and frictional surface contact for rigidity under high load conditions.

In accordance with another aspect of the invention, a mounting and positioning system of extreme simplicity is formed by disposing the support member on the backup structure as a bracket mounted to retain a cluster of panels. Each panel is supported at one corner in a manner such that the panels do not interfere with each other although all panels in the cluster may be independently adjusted.

A better understanding of the invention may be had by reference to the following description, taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a simplified perspective view of an antenna system utilizing individually adjustable reflector panels;

FIG. 2 is a side sectional view of a mounting and positioning device in accordance with the invention, shown in a central position;

FIG. 3 is a side sectional view of the device of FIG. 2, showing an alternate position thereof;

FIG. 4 is an exploded perspective view showing a number of elements utilized in the arrangement of FIGS. 2 and 3;

FIG. 5 is a perspective view, partly broken away, of a support bracket utilized in the arrangement of FIGS. 2 and 3, showing the related panels in phantom;

FIG. 6 is a plan view of the bracket of FIG. 5, and;
FIG. 7 is a side view of the bracket of FIG. 5.

The system of FIG. 1 illustrates generally the manner in which a large reflective antenna system **10** is defined by an array of individually adjustable reflector panels **12**. A backup structure **14** for this system comprises a large frame, of suitable rigidity and built to generally accurate specifications, but without the degree of precision needed for the incremental areas defining the reflective surface. The electromagnetic wave transducer here comprises, by way of example, a horn **16** coupled to a transmit-receive system **18**, both of these units being conventional and therefore shown only in greatly simplified form. The reflector panels **12** mounted on the backup structure **14** define a surface which is appropriately configured for the desired antenna pattern, for either transmitted energy or incident energy, or both. Antennas of this kind may be extremely large, as of the order of 30 to 100 feet high and 50 to 150 feet wide in typical installations.

The individually positionable reflector panels **12** greatly simplify the problem of establishing and maintaining the desired focusing characteristics for the antenna system **10**. Inasmuch as the reflector panels **12** cover practically all of the available surface, the system has high efficiency for both transmission and reception.

The reflector panels **12** are each mounted as one of a cluster of four panels attached to a common support bracket **20** mounted (as by mechanical studs or welding) on the backup structure **14**. The brackets **20** are suitably spaced on the backup structure **14**, and a group of four central stud elements **22** couple the panels **12** individually to each common bracket **20**. The arrangement of FIGS. 2–4 illustrates for clarity the support arrangement for only one panel **12** on a given bracket **20**, whereas FIG. 5 shows the manner in which a cluster of four panels **12** is mounted and positioned on the given bracket **20**.

For each reflector panel **12**, the central externally threaded stud element **22** includes a base **23** seated within the reflector panel **12** and rigidly supporting the reflector panel and an integral hex nut **25** for torquing the stud element. The bracket **20** also includes an aperture **27**, preferably circular, for receiving the central stud member **22**. The central axis of the central stud member **22** may conveniently be taken as one reference axis for the mounting structure, and two orthogonally disposed radii extending outwardly from the central axis in the plane of the bracket **20** provide additional axes with respect to which the panel is to be moved. The bracket aperture **27** is substantially larger than the central stud member **22**, so that the stud member is free to move radially in any direction from the central axis of the aperture over a desired extent of travel. The stud member **22** is mounted on the bracket **20** within a separately adjustable assembly including a pair of base members **30**, **31**, one on each side of the bracket **20**, each of which includes a convex outer surface, here generally of hemispherical form, on the side opposite the bracket **20**. The base members **30**, **31** also have outwardly extending flange portions in engagement with the bracket **20** and sufficiently larger than the aperture **27** so that they maintain adequate frictional contact with the bracket **20**, irrespective of the radial position they occupy relative to the central axis. The spherical base members **30**, **31** also include central apertures **34**, **35** respectively which provide significant clearance for the central stud member **22**, and the arcs of the outer spherical surfaces form parts of a common sphere. A pair of outer spherical washers **36**, **37** each engaging the spherical surface segment of a different base member **30**, **31** and each having a concave surface segment mated with the spherical convex surface on the associated base member are fitted onto the central member **22**. A pair of lock nuts **40**, **41** are also threaded onto the central stud member **22** and engage the opposite sides of the spherical washers **36**, **37** to secure the assembly in a desired position and attitude.

As illustrated by the contrasting relations of the panel **12** relative to the bracket **20** in FIGS. 2 and 3, this assembly permits adjustment of the panel in three orthogonal directions, or axes, and also angularly with respect to the central axis. FIG. 2 illustrates the position in which the reflector panel **12** occupies a substantially central position along all three axes, and in which the panel also has an attitude normal to the central axis. In the position of FIG. 3, however, the assembly occupies several extreme positions, with the panel **12** being closest to the bracket **20** and at one radial limit and also tilted to a maximum angle in one direction. It will be appreciated that although the changes in position are relatively slight, they constitute major changes with respect to the antenna system **10**, and that ordinarily adjustments to the extent of the positions shown in FIG. 3 would not be utilized.

Although this mechanism contains a minimum number of parts, it has particular further advantages in structural rigidity and ease of adjustment. Movement of the panel **12** relative to the bracket along the central axis of the stud **22** is positively controlled by the threading of the various elements on the central stud **22**. Movement relative to the two axes which are normal to the stud **22** is determined by radial positioning of the base members **30**, **31** with respect to the bracket aperture **27**. No matter which position is used, the flanges on the base members **30**, **31** insure adequate surface for frictional restraint. When the panel **12** is tilted relative to the bracket **20** the force distributions may become asymmetrical. Nevertheless, because the spherical surface segments on the base members **30**, **31** mate with those on the washers **36**, **37**, there is adequate bearing surface and frictional restraint in all positions.

The mounting of the panels **12** in clusters of four relative to a given bracket **20** (as shown in FIGS. 5–7) enables a number of adjustments to be made at each bracket position, tthus limiting the setup time, as well as reducing the number of reference points needed in the backup structure **14**. Installation of a panel **12** requires merely the addition of a spherical base member **31**, the spherical washer **37** and the lock nut **41** on the back side of the assembly after the central stud member **22** is inserted through the bracket aperture **27** with the opposite members **30**, **36** and **40** already in position. The assembly is then fixed in place merely by threading and tightening the members **36**, **37**, **40** and **41** when the panel is in a desired position and attitude. Nevertheless, adequate structural rigidity is obtained in all positions which the panel **12** might occupy. The bracket **20** preferably comprises a flat plate having four symmetrical apertures **27**, and a pair of cross-pieces **50**, **51** supporting this plate on a base plate **53** coupled to the backup structure. It will be appreciated that static and dynamic forces, including particularly wind loading, act upon an appreciable length of lever arm coupled to the central stud member **22** and therefore introduce substantial twisting and other displacement forces. Because substantial frictional restraints are present in all axes of movement, the assembly arms remain fixed for any forces which are likely to be encountered. If it is necessary to withstand greater forces, the size of these elements need only be increased proportionately.

While there have been described above and illustrated in the drawings various forms of mounting and positioning mechanisms for affixing reflector panels to an antenna system, it will be appreciated that other modifications and variations are feasible within the scope of the invention and that all modifications and variations falling within the scope of the appended claims constitute part of the invention.

What is claimed is:

1. A mechanism for maintaining an antenna reflector

panel in a selected position and attitude relative to a backup structure comprising:

bracket means coupled to the backup structure having oppositely disposed bearing surfaces and a mounting aperture therethrough;

bearings means having inner bearing surfaces with contours conforming to those of the oppositely disposed bearing surfaces in the vicinity surrounding said mounting aperture for frictionally engaging the bracket means in a selected one of a limited range of positions along said bearing surfaces relative to the mounting aperture, said bearing means including a centrally disposed stud receiving aperture and oppositely disposed arcuate outer bearing surfaces;

elongated stud means affixed at one end to the panel and extending through said bearing means; and

retaining means coupled to the said stud means on opposite sides of said bracket means for frictionally engaging the arcuate outer bearing surfaces of said bearing means, to hold said stud means in fixed angular relation to said bracket means throughout a range of angular positions and to urge said inner bearing surfaces of the bearing means in a fixed position with said bracket means relative to the mounting aperture.

2. A mechanism for maintaining an antenna reflector panel in a selected position and attitude relative to a backup structure comprising:

bracket means coupled to the backup structure providing oppositely disposed bearing surfaces and a mounting aperture of predetermined size;

first movable means frictionally engaging the oppositely disposed bearing surfaces of said bracket means and spanning the aperture therein, said first movable means including an aperture of less than said predetermined size;

elongated second movable means engaged to fixedly support the reflector panel and extending at a selectable angle through the aperture in said first movable means;

and clamping means coupled to said second movable means at selectable positions along its length and frictionally engaging said first movable means about its aperture to maintain said second movable means at a fixed angle relative to said bracket means and to maintain said first movable means in a fixed position along said bearing surfaces relative to said mounting aperture.

3. A mechanism for maintaining an antenna reflector panel in a selected position and attitude relative to a backup structure and comprising:

bracket means having oppositely disposed bearing surfaces coupled to the backup structure and including a mounting aperture;

a pair of bearing means having inner bearing surfaces engaging the opposite bearing surfaces of the bracket means and being larger than the mounting aperture, such bearing means also including oppositely disposed outer convex bearing surfaces and having central apertures;

a central stud member affixed at one end of the reflector panel and extending through the central apertures of the bearing means and the mounting aperture of the bracket means, and having substantial clearance relative to the central apertures of the bearing means, such as to occupy varying angular positions relative to the bearing means, and such that the bearing means can occupy varying radial positions relative to the central axis of the stud member, and the stud member can occupy varying longitudinal positions along its central axis relative to the bearing means; and

retaining means coupled to the central stud member and mating with the outer convex bearing surfaces of said bearing means, for coupling said bearing means to said central stud member and urging the inner bearing surfaces of said bearing means into positive frictional contact with the opposite disposed bearing surfaces of said bracket means surrounding said mounting apertures.

4. A system for positioning a plurality of reflector panels relative to an antenna backup structure and comprising the combination of:

a bracket member coupled to the antenna backup structure and having oppositely disposed bearing surfaces with a plurality of spaced apertures therein, a plurality of reflector panels, a plurality of stud members, each affixed adjacent one end of a different reflector panel, and each extending through a different aperture of the bracket member, and a plurality of mounting mechanisms, each coupling a different one of the central stud members to the bracket member and including a pair of base members having flat inner bearing surfaces for frictionally engaging the opposed bearing surfaces of said bracket member in a selected one of a range of different positions about the respective aperture, and clamping means adjustable along the length of the respective stud members and having internal spherical bearing surfaces for engaging the outer spherical bearing surfaces of said bearing members in a range of selected angular displacements and urging abutting bearing surfaces into positive frictional engagement with one another, whereby each of said reflector panels is variable with respect to the plane of the antenna structure, within the plane of the antenna structure, and angularly with respect to the plane of the antenna structure.

5. A rotatably positionable and laterally adjustable attachment mechanism for a panel comprising:

a support member including an aperture within which the attachment mechanism is to be mounted;

a stud member extending through the aperture in the support member, the stud member being substantially smaller than the aperture, and the stud member being adapted to engage and support the panel at one end thereof;

a pair of base members encompassing the stud member on opposite sides of the support member, the base members having convex arcuate surfaces facing outwardly from the support member, and having apertures for receiving the stud member which are substantially larger than the stud member;

a pair of washers, each disposed about the stud member against a different one of the base members, and having a concave arcuate surface mating with the arcuate surface of the adjacent base member; and

means engaging the stud member for urging the washers together to unify the structure.

6. A panel mounting and adjusting mechanism for coupling antenna reflector panels to associated backup structure elements having mounting apertures therein and comprising:

a panel attachment stud substantially smaller than a mounting aperture and passing therethrough, one free end of the panel attachment stud being coupled to support and control the position of an associated reflector panel;

a pair of base members, each having a convex spherical surface and each positioned on a different side of the backup structure element with the spherical surface facing outwardly therefrom, the base members being materially larger than the mounting aperture, and each having a central aperture larger than the panel attachment stud;

a pair of retaining washers, each having a concave spherical surface mating with the convex spherical surface of a different one of the base members and

including a central aperture receiving the panel attachment stud with a sliding fit; and

threaded means engaging the panel attachment stud on opposite sides of the retaining washers for urging said washers together to unify the structure.

7. A panel mounting and adjusting mechanism for coupling a reflector panel to a backup structure element of an antenna system and comprising:

a support bracket having at least one mounting aperture, the support bracket being positioned in a plane substantially parallel to and behind the desired reflective surface plane of the antenna reflector system;

a panel attachment stud substantially smaller than the mounting aperture and extending therethrough, one free end of the panel attachment stud being coupled to support the associated reflector panel in fixed relation thereto;

a pair of circular base members, each having a central aperture smaller than the mounting aperture but larger than the panel attachment stud, and receiving the panel attachment stud, each of the base members having a surface in engagement with the bracket member and an outer flange substantially larger than the mounting aperture, and each also including a convex spherical bearing surface segment on the side opposite the bracket member, the arcs of the spherical bearing surfaces of the bearing members forming parts of a common sphere;

a pair of retaining washers, each having a concave spherical surface mating with the convex spherical surface of a different one of the base members and each including a central aperture receiving the panel attachment stud with a sliding fit; and a pair of locknuts threaded onto the panel attachment stud on opposite sides of the two retaining washers and maintaining the washers, the base members and the stud in a unified rigid relationship irrespective of the radial position of the bearing members relative to the mounting aperture, the axial position of the stud relative to the bearing members, and the angular position of the stud relative to the bearing members.

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ELI LIEBERMAN, *Primary Examiner.*