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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

REPLY TO
ATTN OF: GP

TO: USI/Scientific & Technical Information Division
Attention: Miss Winnie M. Morgan

FROM: GP/Office of Assistant General Counsel for
Patent Matters

SUBJECT: Announcement of NASA-Owned U. S. Patents in STAR

In accordance with the procedures agreed upon by Code GP and Code USI, the attached NASA-owned U. S. Patent is being forwarded for abstracting and announcement in NASA STAR.

The following information is provided:

U. S. Patent No. : 3,574,448

Government or
Corporate Employee : Univ. of California
Berkeley, Calif.

Supplementary Corporate
Source (if applicable) :

NASA Patent Case No. : XNP-08907

NOTE - If this patent covers an invention made by a corporate employee of a NASA Contractor, the following is applicable:

Yes ☒ No ☐

Pursuant to Section 305(a) of the National Aeronautics and Space Act, the name of the Administrator of NASA appears on the first page of the patent; however, the name of the actual inventor (author) appears at the heading of Column No. 1 of the Specification, following the words ". . . with respect to an invention of . . ."

Elizabeth A. Carter

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Enclosure
Copy of Patent cited above

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FACILITY FORM 602

United States Patent

[11] 3,574,448

[72] Inventors T. O. Paine
Deputy Administrator of the National Aeronautics and Space Administration in respect to an invention of;
Harry W. Petersen, Oakland; Raymond O. Laurie, Sand Leandro, Calif.

[21] Appl. No. 824,042
[22] Filed May 13, 1969
[45] Patented Apr. 13, 1971

[54] ADJUSTABLE MOUNT FOR A TRIHEDRAL MIRROR
5 Claims, 8 Drawing Figs.

[52] U.S. Cl. 350/310, 350/102, 350/288
[51] Int. Cl. G02b 5/08
[50] Field of Search 350/6, 12, 288, 292, 299, 297, 310, 102; 356/106, 110

[56] References Cited
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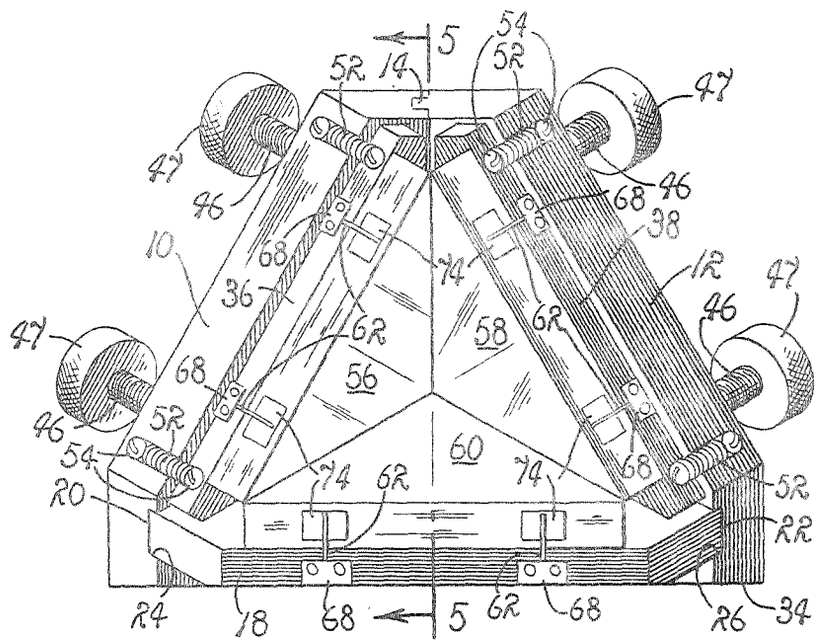
ABSTRACT: An adjustable mount for a trihedral mirror of the type including three contiguous mirror segments having reflecting surfaces operatively arranged in mutually normal planes and particularly suited for use in interferometers, characterized by the utilization of an alloy, such as that commercially available under the trade name Invar, to form a pair of rigidly coupled and normally disposed side plates having a bottom plate fixedly secured thereto along a pair of intersecting edge portions. Each of the side plates adjustably supports a backup plate through screw-threaded adjusting screws, also of Invar, and a plurality of tension springs connected therebetween, with each backup plate, as well as the bottom plate, being provided with a plurality of extended and tensioned links of music wire joined at spaced intervals to the edge surfaces of an adjacent mirror segment in a manner such as to preclude an interruption of impinging beams of light, whereby each of the mirror segments can be adjusted by manipulating the adjusting screws, while heat-induced error is rendered negligible, so that the reflecting surfaces may be adjusted to assume a fixed, mutually normal relationship with minimum deviation error.



OBJECTS AND SUMMARY OF THE INVENTION

The present invention overcomes the aforementioned difficulties by providing an adjustable mount for a trihedral mirror in which there is utilized an alloy having a very small coefficient of thermal expansion to provide a rigid structure for supporting screws and spring-biased plates upon which is mounted mirror segments having surfaces adapted to be aligned by manual adjustment.

Accordingly, an object of the instant invention is to provide an improved adjustable and rigid mount for a trihedral mirror.

Another object is to provide an improved mount for a trihedral mirror adapted to be manually adjusted without introducing error resulting from the presence of body heat.

Another object is to provide an adjustable mount for a trihedral mirror of a type including three contiguous triangular segments of a mirror surface, each mirror segment being disposed in a plane substantially perpendicular to the planes of the other two segments and being supported by structure including rigidly connected plates and adjusting screws, formed of an alloy having a small coefficient of thermal expansion, for accommodating and adjustable displacement of the surfaces of the mirror segments while inhibiting an introduction of heat-induced error.

PATENTED APR 13 1971

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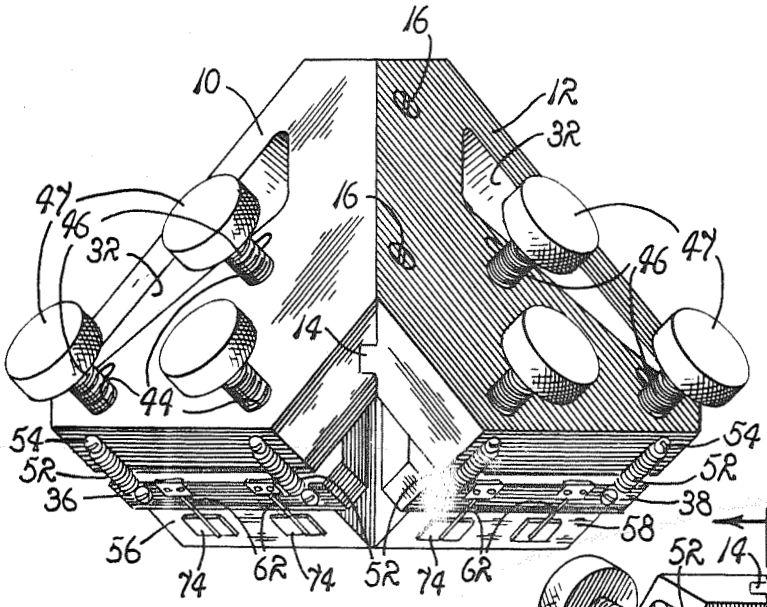

FIG. 1.

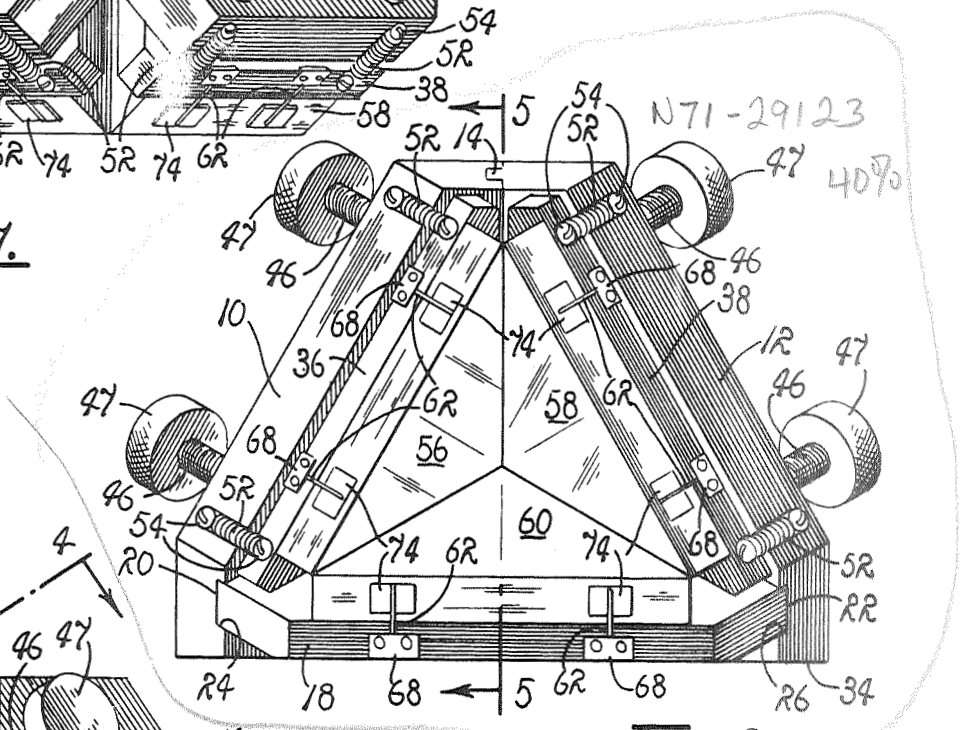

FIG. 2.

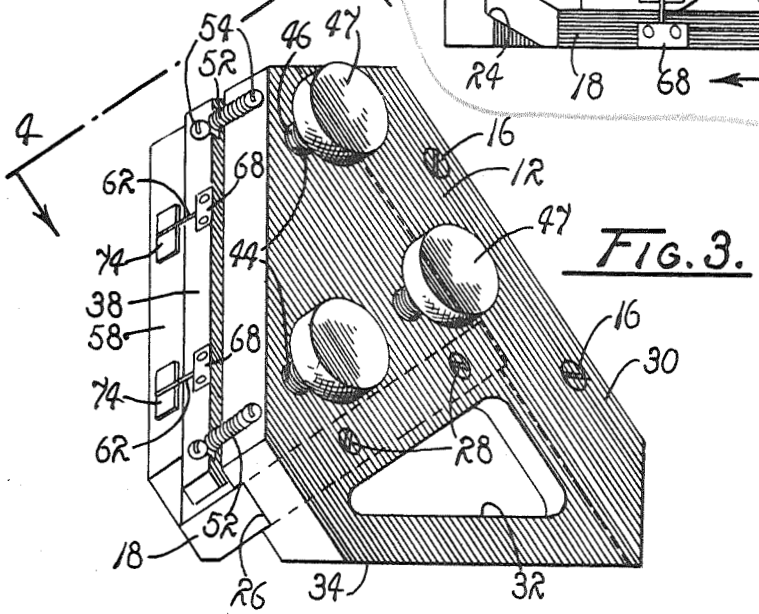

FIG. 3.

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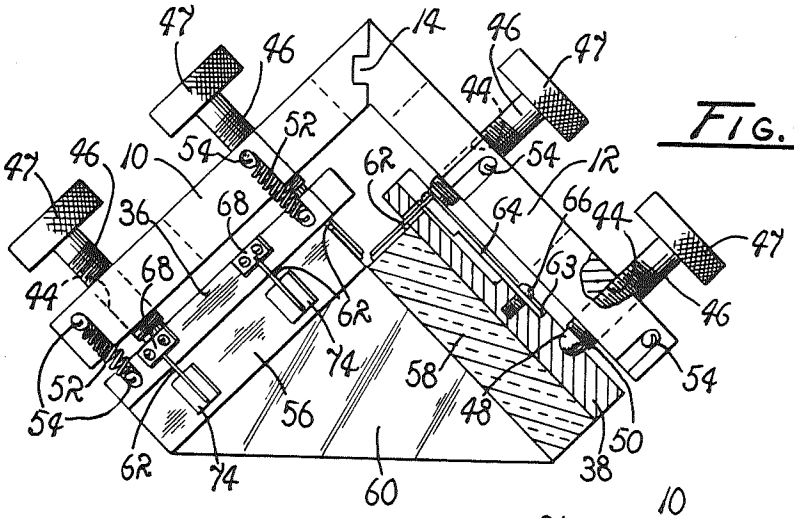

FIG. 4.

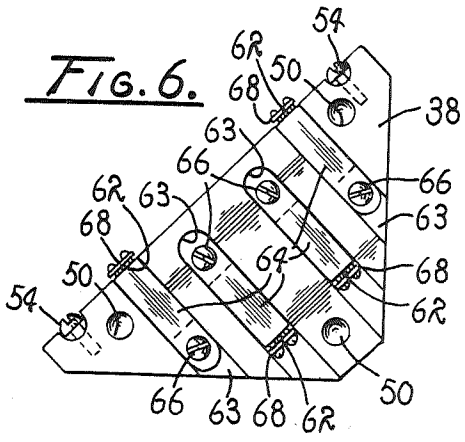

FIG. 6.

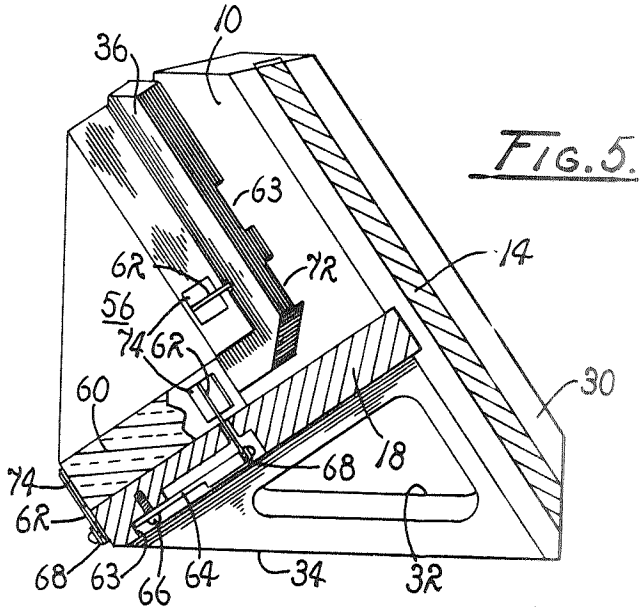

FIG. 5.

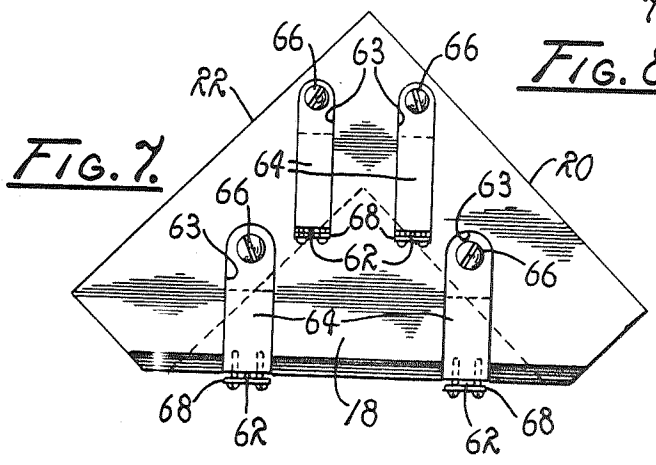

FIG. 7.

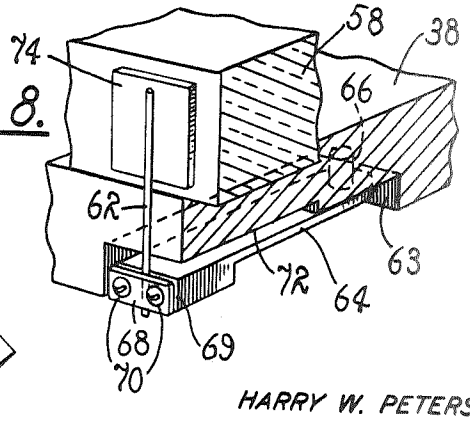

FIG. 8.

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ADJUSTABLE MOUNT FOR A TRIHEDRAL MIRROR

ORIGIN OF INVENTION

The invention described herein was made in the performance of work under a NASA contract and is subject to the provisions of Section 305 of the National Aeronautics and Space Act of 1958, Public Law 85-568 (72 Stat. 435; 42 USC 2457).

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates to supports employed in optic systems and more particularly to an adjustable mount for a trihedral mirror and adapted to be employed in an interferometer.

2. Description of the Prior Art

The prior art includes numerous devices having various arrangements of springs, clips, screw-threaded adjusting studs and the like for adjustably supporting optic devices, such as mirrors, in various types of optic systems. However, in the field of interferometry, where light beams must be separated and again combined, error in alignment is of primary concern. Frequently, optic alignment is so critical that heat from the human body introduces alignment error in the supporting structure employed for the reflecting surface, particularly where surface alignment manually is accomplished. In instances where attempts have been made to overcome the effects of body heat through use of mechanical linkages, complexity is introduced and precision of control sacrificed, particularly where mechanical linkage backlash is encountered.

OBJECTS AND SUMMARY OF THE INVENTION

The present invention overcomes the aforementioned difficulties by providing an adjustable mount for a trihedral mirror in which there is utilized an alloy having a very small coefficient of thermal expansion to provide a rigid structure for supporting screws and spring-biased plates upon which is mounted mirror segments having surfaces adapted to be aligned by manual adjustment.

Accordingly, an object of the instant invention is to provide an improved adjustable and rigid mount for a trihedral mirror.

Another object is to provide an improved mount for a trihedral mirror adapted to be manually adjusted without introducing error resulting from the presence of body heat.

Another object is to provide an adjustable mount for a trihedral mirror of a type including three contiguous triangular segments of a mirror surface, each mirror segment being disposed in a plane substantially perpendicular to the planes of the other two segments and being supported by structure including rigidly connected plates and adjusting screws, formed of an alloy having a small coefficient of thermal expansion, for accommodating and adjustable displacement of the surfaces of the mirror segments while inhibiting an introduction of heat-induced error.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a top plan view of a mirror mount embodying the principles of the present invention within which there is aligned a plurality of mutually perpendicular mirror surfaces.

FIG. 2 is a front view of the mount illustrated in FIG. 1, rotated 90° with respect to an axis extending laterally through the mount, illustrating an operative disposition for the reflecting surfaces of the mirror segments.

FIG. 3 is a side view of the mirror mount illustrated in FIGS. 1 and 2.

FIG. 4 is a partially sectioned end view, taken generally along line 4–4 of FIG. 3.

FIG. 5 is a partially sectioned side view taken generally along line 5–5 of FIG. 2.

FIG. 6 is a side view of the external surface of one of the backup plates employed in mounting the mirror segments.

FIG. 7 is an inverted plan view of the bottom surface of the bottom plate.

FIG. 8 is a fragmentary view, on somewhat an enlarged scale, of one of the plurality of the supporting members employed in securing the mirror segments to adjacent plates.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Turning now to FIG. 1, wherein is illustrated an adjustable mount for a trihedral mirror embodying the principles of the present invention, there is depicted a frame including a pair of contiguous side plates 10 and 12 having intersecting surfaces arranged in intersecting orthogonal planes. For reasons which are readily apparent, it is highly desirable to rigidly join those plates in a manner such as to preclude an initiation of alignment error. Therefore, a key-slotted coupling 14 is provided to extend between the abutting surfaces of the plates. In practice, a plurality of screws 16 also are employed in securing the side plates 10 and 12 into a rigidly fixed relationship thus to provide a rigid, unitary support structure.

Extending in a plane normal to both of the planes of the plates 10 and 12, there is arranged a bottom plate 18 of a right triangular configuration. The bottom plate is provided with intersecting side edges 20 and 22 seated within a pair of intersecting slots 24 and 26 machined in the intersecting surfaces of the side plates. While any convenient coupling means may be employed in joining the bottom plate 18 with the side plates 10 and 12, a plurality of screws 28 have been found to be quite practical.

In instances where the trihedral mirror mount is to be employed in interferometry, it is preferred that the support be adapted to retain the reflecting surfaces in planes inclined with respect to a horizontal axis. Therefore, each of the side plates 10 and 12 is provided with a base portion 30 having "lightening" holes 32 formed therein. The base portion is so configured as to be provided with a supporting surface 34 disposed in a plane which intersects the plane of the bottom plate 18 so that all of the reflecting surfaces are in planes which may incline with respect to any axis parallel the plane of the supporting surface.

Each of the side plates 10 and 12 serves adjustably to support one of a pair of backup plates 36 and 38, respectively. Each of the backup plates 36 and 38 if of a right triangular configuration and is supported coupled with an operatively associated side plate in a similar fashion. Therefore, a description of the coupling of a single one of the backup plates to the associated side plate is deemed adequate for providing an understanding of the mounting of both of the backup plates 36 and 38. Hence, in order to avoid repetition, a specific description of the coupling of the backup plates is limited to a description of the mounting of the backup plate 38.

The side plate 12 is provided with a plurality of screw-threaded openings 44 into which are threaded screw-threaded adjusting screws 46. The openings 44 are spaced in a triangularly configured arrangement so that the axis of each of the openings 44 extends through a corner portion of the adjacent backup plate so that the screws 46 may be extended through the openings into supporting engagement with the adjacent surface of the backup plate 38.

It is particularly important to note that the screws 46 are to be manipulated for purposes of adjustment. Therefore, each of the screws 46 is provided with a knurled knob 47 and terminates in hemispherically configured surface 48 which defines a distal hemispheric bearing surface. Therefore, it should be apparent that the screw 46 is, in practice, threadingly extended or retracted through the opening 44 by manual actuation for displacing the bearing 48 to preselected dispositions relative to the inner surface of the side plate 12.

Each of the bearing surfaces 48, when extended, provides a stop against which the backup plate 38 is seated. The backup plate, in turn, is provided with a plurality of hemispherically-shaped bearing-surfaced sockets 50 arranged adjacent to the corners of the plate for receiving therein the surfaces 48. Hence, it will be appreciated that each of the backup plates 36 and 38 operatively is supported in spaced relationship with the adjacent side plate by the screws 46 as they are extended into

the sockets 50, so that in order to adjust the position of the backup plate, relative to the side plate, it only is necessary threadingly to advance or retract the screws 46 by a manual actuation. The provision of manually actuated adjusting screws serves to simplify the aligning procedures.

However, in order to assure that the backup plates 36 and 38 are secured in a desired engaging relationship with the bearings 48 of the screws 46, a helical tension spring 52 is coupled between each of the backup plates and the adjacent side plate by any convenient means such as screw-threaded anchor pins 54. Therefore, it is to be understood that the backup plates 36 and 38 are continuously urged into engaging contact with the distal ends of the adjusting screws 46 by the biasing action of the tension springs 52. Consequently, a "fine adjustment" of the angular position of each of the backup plates 36 and 38 may be made simply by manually displacing the screws 46, as the bearing surfaces 48 are seated in the receptacles 50 and continuously urged into a mated relationship through the applied tension springs.

Each of the backup plates 36 and 38, as well as the bottom plate 18, functions as supporting structure for operatively supporting one of a plurality of congruent mirror segments 56, 58 and 60. The segments are of a right triangular configuration and are operatively disposed within the path of a beam of light being projected from a given source.

Since the mirror segments are to be disposed in the path of the beam of light being projected along a given path, for acquiring certain intelligence through the use of interference rings and the like, it is highly desireable that the mirror segments 56, 58 and 60 be supported by structure which does not obstruct or interfere with light beams being projected to and from the reflecting surfaces of the mirror segments. Furthermore, it is highly desirable that the means employed in supporting the segments be such as to be capable of operatively supporting the mirror segments in preselected alignment. Therefore, to achieve such mounting, a plurality of links 62, formed of any convenient material such as music wire, is provided to extend from the edge surface of the mirror segments 56, 58 and 60 to be operatively supported at the adjacent backup plates 36 and 38, and the bottom plate 18, respectively.

As better illustrated in FIGS. 6 through 8, each of the backup plates 36 and 38, as well as the bottom plate 18, includes a plurality of laterally spaced, elongated recesses 63, within each of which there is pinned a leaf spring 64. Each of the springs 64 is pinned at its first end by a convenient screw-threaded pin 66. The distal end of each of the springs 64 is provided with a clamp 68, including a pair of adjacent plates 69, into which there is extended one end of a link 62. While any convenient coupling may be employed for joining the wire 62 with the clamp 68, a pair of spaced threaded screws 70, FIG. 8, is threadably inserted into the end portion of the leaf spring 64 so that the plates 69 are forced into securing engagement with the segment of music wire.

Although not deemed to be mandatory, it is preferred that the leaf springs 64 be afforded extensive displacement relative to the plane of the recesses 63 so that the links 62 may be reciprocated or biased under the influence of the leaf spring 64. Therefore, each of the recesses 63 is further provided with an elongated terminal section 72 of increased depth for accommodating an inward flexing of the leaf spring 64, whereby the segments of music wire may be displaced in opposing axial directions under the influence of the spring 64.

The distal ends of the links 62 are secured to the edge surfaces of mirror segments 56, 58 and 60 through supporting tabs 74. The tabs 74 are formed of a thin-gauge sheet material, preferably brass, soldered to the distal end of the associated segments of music wire and are secured by a convenient epoxy to the face of the edge surface of the mirror segments.

Recalling that each of the mirror segments is of a right triangular configuration, it is preferred that the edge surface defining a hypotenuse for each of the mirror segments be provided with a pair of links 62 and tabs 74, for supporting the mirror segment along that surface, while each of the legs is provided with a single link and tab arranged adjacent to the right angle intersection, as better illustrated in FIGS. 5, 6 and 7, so as to maximize the support while minimizing connecting structure.

It is important to note that through the use of the spring-biased links 62, the mirror segments are urged under constant tension toward the associated backup plates, whereby adjustment is facilitated with no supporting structure being disposed in a beam interrupting disposition.

While the position of the bottom plate 18 is fixed, relative to the side plates 10 and 12, positioning of the mirror segments 56 and 58 readily is achieved simply by altering the position of the backup plates 36 and 38, through an axial displacement of the screws 46. This positioning imposes a variation in the planar position of each of the reflecting surfaces relative to the other reflecting surfaces, so that each reflecting surface of the segments can be brought into substantially coplanar alignment with a plane extending normal to the plane of the other two reflecting surfaces.

Since, for the sake of simplicity in design, the positioning of the reflecting surfaces of the mirror segments is achieved by manual actuation of the screws 46, it is desirable that effects of body-generated heat be reduced to a negligible level so that after an alignment of the reflecting surfaces has been achieved, the alignment may be maintained without requiring compensation for loss of heat. Thus, an alloy having a small coefficient of thermal expansion is utilized wherever practical. In practice, the adjusting screws, plates and coupling screws have been satisfactorily fabricated from a commercially available metal known as Invar.

OPERATION

It is believed that in view of the foregoing description, the operation of the device will be readily understood and it will be briefly reviewed at this point.

While the mount of the instant invention may be employed in mounting various types of reflecting surfaces in systems wherein it is desired that minimum position error be encountered, the mount as precisely employed is utilized in interferometers. As a practical matter, by employing an Auto Collimator to align the mirrors, it has been found that alignment precision, within an angle of one-half of one second, is readily achieved and maintained when employing the aforedescribed mount.

With the unitary structure, defined by the side plates 10 and 12, serving to support the adjusting screws 46, backup plates 36 and 38 and the mirror segments 56 and 58, through the links 62 and leaf springs 64, aligning adjustment of the reflecting surfaces is achieved simply by manually adjusting the position of the bearing surfaces 48 of the adjusting screws 46 until the reflecting surfaces of all three mirror segments are brought into coplanar alignment with mutually perpendicular intersecting planes so that all of the reflecting surfaces are arranged in a mutually perpendicular relationship.

With the mirror surfaces being disposed to define right angles therebetween, the mount is supported so that the mirror surfaces thereof are disposed within the path of a projected beam, whereby a beam may be reflected between the various reflecting surfaces and projected from the trihedral mirror without introduction of significant error.

Therefore, it should be appreciated that the mount of the instant invention may be employed for adjustably positioning reflecting surfaces of mirror segments with accuracy in predetermined orientation without introducing alignment error.

Although the invention has been herein shown and described in what is conceived to be the most practical and preferred embodiment it is recognized that departures may be made therefrom within the scope of the invention, which is not to be limited to the details disclosed herein but is to be accorded the full scope of the claims so as to embrace any and all equivalent devices and apparatus.

We claim:

1. An adjustable mount for a trihedral mirror comprising:

a rigid frame including a bottom plate and a pair of side plates extended in substantially mutually perpendicular planes;

a pair of adjacently disposed backup plates, each backup plate being disposed adjacent to a side plate and arranged in a substantially parallel relationship therewith;

adjustable means coupling the backup plates with said side plates including a plurality of adjusting screws and cooperating spring members extending between each adjacently disposed backup plate and side plate, whereby the backup plates may adjustably be positioned relative to planes extending parallel to the planes of the adjacent surfaces of the side plates;

means including three congruent mirror segments; and

support means extended from said pair of backup plats and said bottom plate supporting said mirror segments in a mutually perpendicular relationship.

2. The amount according to claim 1 wherein the support means includes a plurality of links formed of music wire secured to the edge surfaces of the mirror segments, and biasing means connected with the segments of the music wire urging the mirror segments toward the backup plates and the bottom plate.

3. The mount according to claim 2 wherein the biasing means includes a plurality of leaf springs each having a screw-threaded clamp joining one end of a segment of music wire thereto.

4. The mount according to claim 3 wherein said the plates and adjusting screws are formed of an alloy having a small coefficient of thermal expansion for effectively precluding an introduction of heat-induced error.

5. The mount according to claim 1 wherein means defining a slot-and-key coupling is provided for joining the side plates into a rigid unitary member.