

[54] **APPARATUS FOR MICROPOSITIONING AN OPERATIONAL MEMBER AND A WORKPIECE PLATFORM**

[72] Inventor: James A. Clark, Mendon, N.Y.

[73] Assignee: Bausch & Lomb Incorporated, Rochester, N.Y.

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[51] Int. Cl. F16m 13/00

[58] Field of Search 125/30.5; 51/166 TS; 248/44, 248/122, 124, 178, 179, 180, 183, 184, 476, 274

[56] **References Cited**

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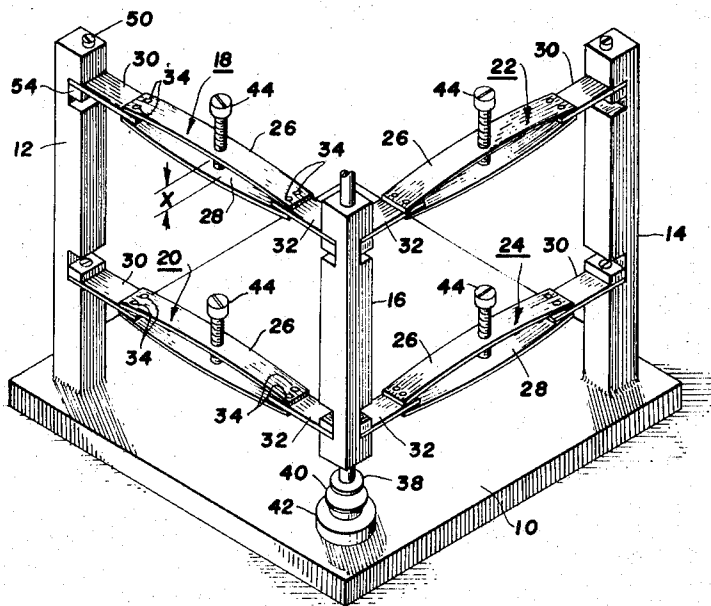
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Primary Examiner—William H. Schultz
Attorney—Frank C. Parker and Bernard D. Bogdon

[57] **ABSTRACT**

Apparatus for micropositioning an operational member and a workpiece platform comprises either a fixed platform or a fixed operational member. In the fixed platform, four arms, each arm comprising a pair of substantially rigid coextensive resilient sections, extend between support posts affixed to the workpiece platform and a suspended operational member to angularly and translationally position the operational member relative to the workpiece platform by varying the extending length of each arm from the support posts by varying the spacing between each pair of resilient sections proximate their midpoints. In the apparatus for aligning the workpiece platform relative to the operational member, the platform has adjustable legs for angularly positioning the platform relative to the operational member and substantially rigid resilient translating legs fixed relative to the operational member, engaging the workpiece platform for translating the platform relative to the operational member by varying the length of each leg extending between its fixed point and the platform.

11 Claims, 8 Drawing Figures



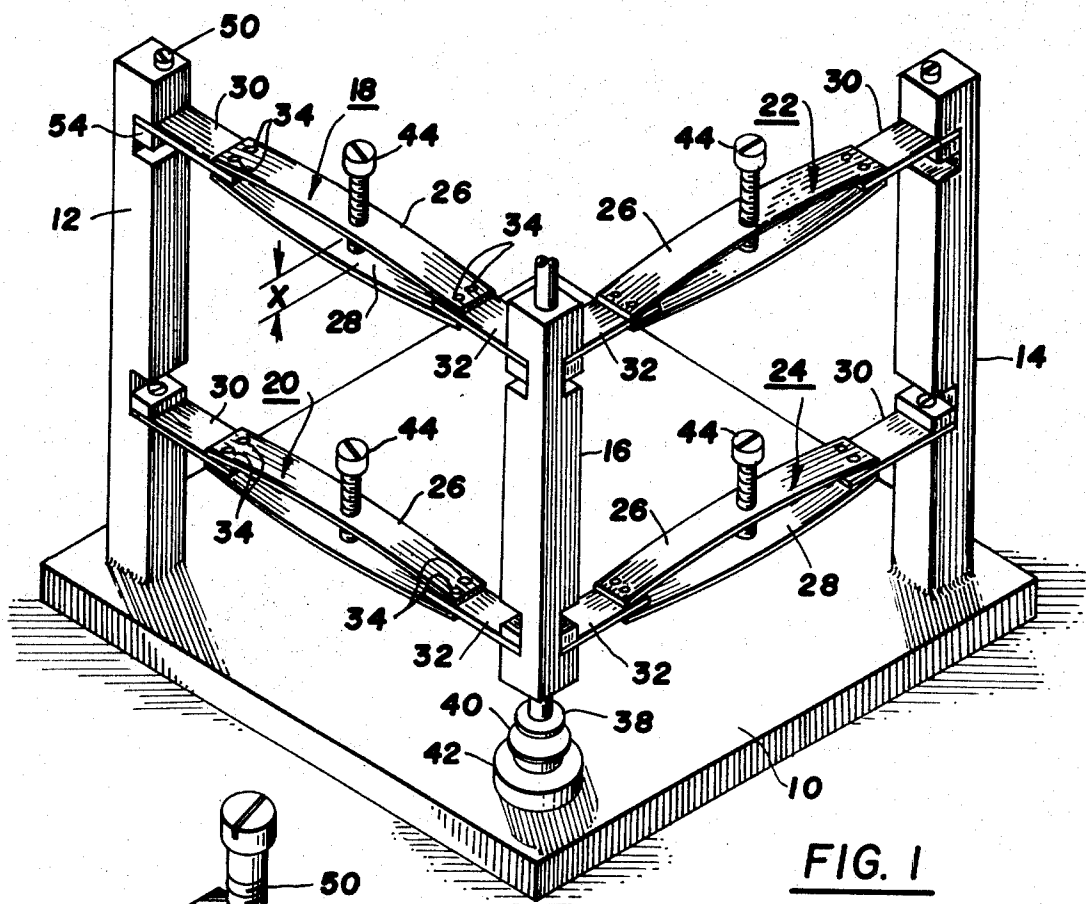


FIG. 1

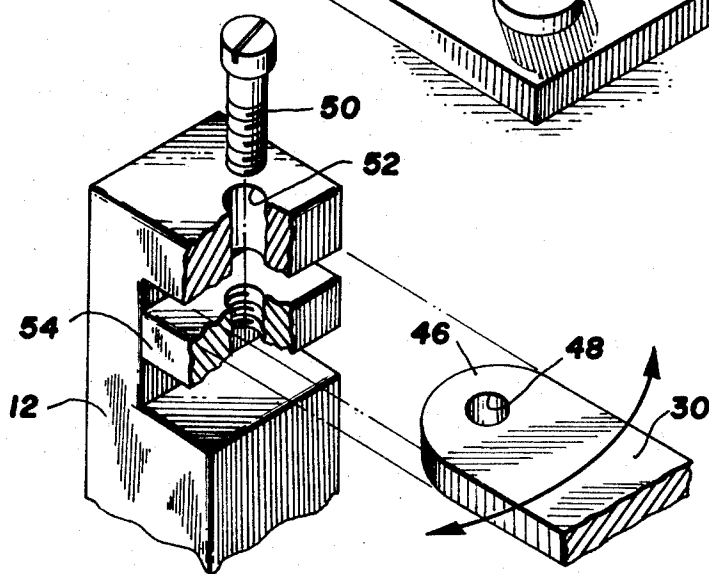


FIG. 2

JAMES A. CLARK
INVENTOR.

BY
BERNARD D. BOGDON
ATTORNEY

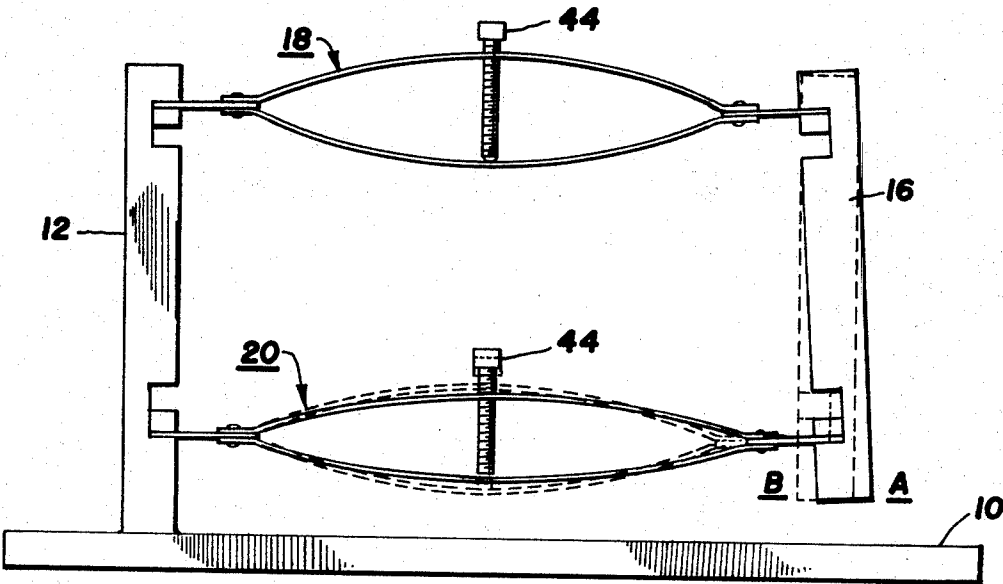


FIG. 3

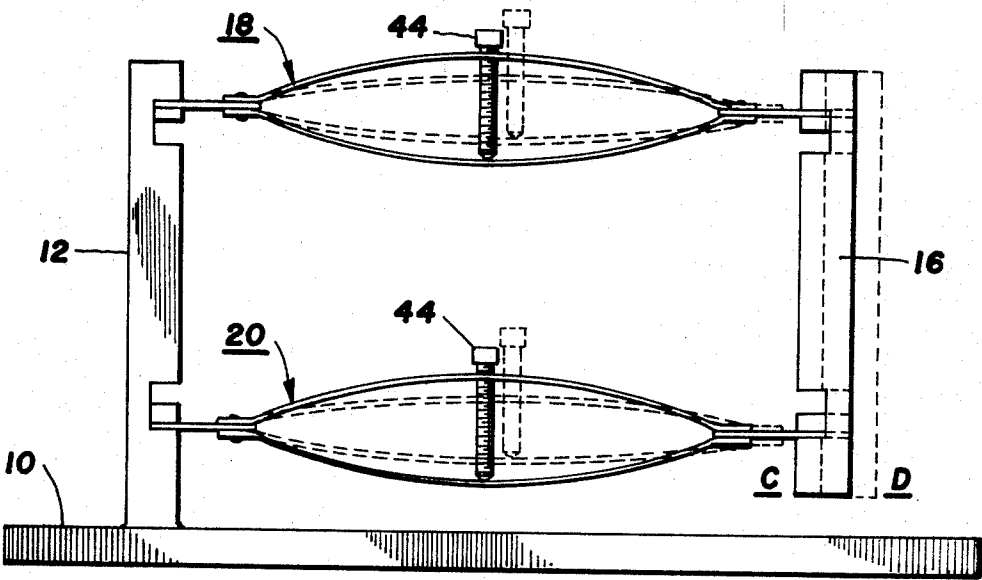


FIG. 4

JAMES A. CLARK
INVENTOR.

BY
BERNARD D. BOGDON
ATTORNEY

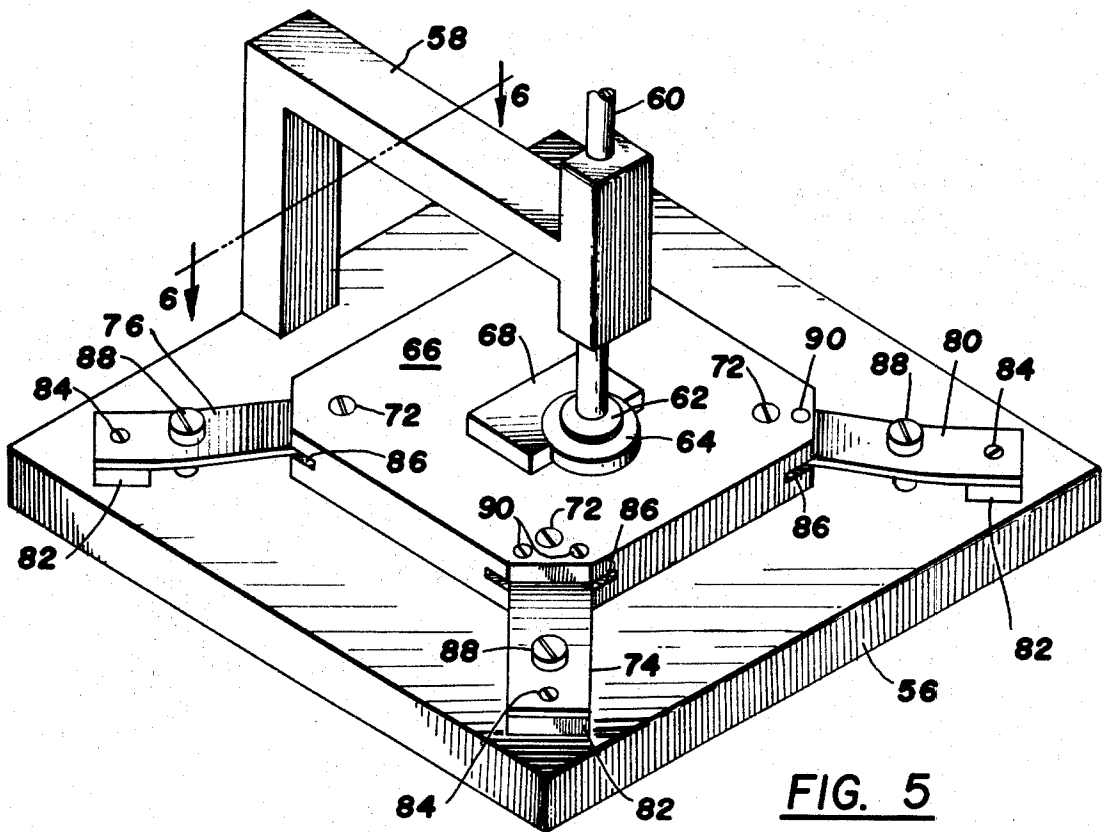


FIG. 5

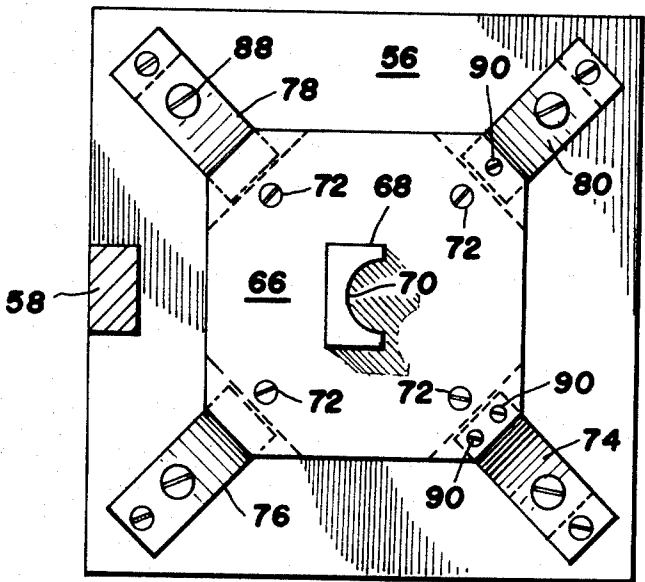
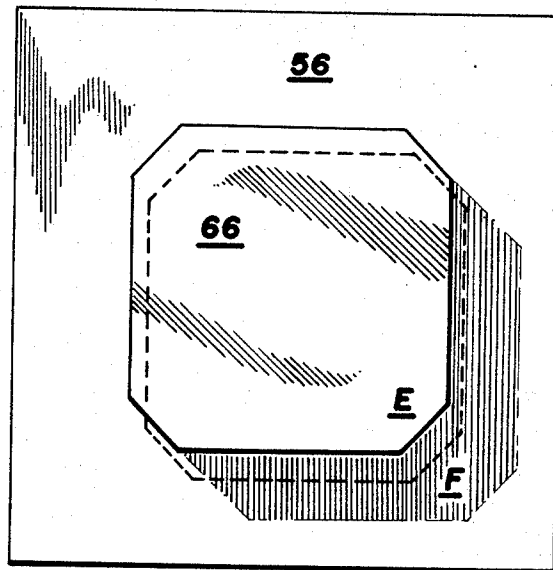
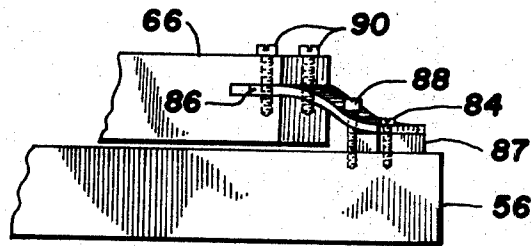


FIG. 6

JAMES A. CLARK
INVENTOR.

BY
BERNARD D. BOGDON
ATTORNEY



JAMES A. CLARK
INVENTOR.

BY
BERNARD D. BOGDON
ATTORNEY

APPARATUS FOR MICROPOSITIONING AN OPERATIONAL MEMBER AND A WORKPIECE PLATFORM

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to alignment apparatus and more particularly to apparatus for angularly and translationally micropositioning an operational member and a workpiece platform.

2. Description Of The Prior Art

Micropositioning adjustment devices for accomplishing accurate alignment are generally expensive to manufacture because of tightly held tolerances and frequently require that extreme care be used in their handling due to their generally fragile construction and sensitive mechanisms. Frequently numerous sensors are necessary to monitor alignment during the operation of related machinery to insure that alignment is maintained. It is often the case where frequent operational shutdowns are necessary in order to check on the accuracy of the alignment and to make any necessary adjustments. Sensitive equipment monitoring devices are very costly and generally do not lend themselves to industrial environments involving the mass production of parts at very great accuracies.

SUMMARY OF THE INVENTION

This invention overcomes the deficiencies of a significant number of prior art devices and provides a unique method of adjustment and apparatus for adjustment which is economical to manufacture and operate, stable under a great number of environmental conditions and reliable to the extent that monitoring devices are generally not necessary. The invention provides adjustable length support arms which are extensible from a fixed base or column to a member such as a workpiece platform of an operating mandrel. The apparatus provided for by this invention are ideally suited for use, for example, in the manufacture of optical lenses.

In the case of the adjustable length support arms extending to carry an operating mandrel, a plurality of arms may be provided to angularly position the mandrel with respect to a fixed base and to translate the mandrel for very accurate alignment of, for example, an operating point on the mandrel and a workpiece supported by the base. Accuracy in the angular and translational alignment of the axis of the operating mandrel is only limited by the quality of the finish on the surfaces from which measurements are taken and the quality of the measuring equipment. The scope of the invention encompasses adjustable leveling devices for substantially transversely aligning a "floating" workpiece platform for operational orientation with a fixed mandrel. As a second step, adjustable length arms affixed to a base fixed relative to the operating mandrel are adjusted to translate the workpiece platform for orientation with the operational mandrel to thereby provide for very accurate angular and translational alignment.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of an alignment apparatus according to the principles of the present invention for aligning an operating mandrel;

FIG. 2 is an enlarged exploded fragmentary sectional perspective view of a typical mounting of an adjustable length arm of FIG. 1;

FIG. 3 is a lateral view of the apparatus of FIG. 1 illustrating two positions of angular alignment of the operating mandrel;

FIG. 4 is a lateral view of the apparatus of FIG. 1 illustrating two positions of translational alignment of the operating mandrel;

FIG. 5 is a perspective view of a machine employing an apparatus according to the principles of the present invention for aligning a workpiece platform relative to an operating mandrel;

FIG. 6 is a sectional plan view of the machine of FIG. 5 along the plane of line 6—6 in FIG. 5;

FIG. 7 is a fragmentary lateral view of the workpiece platform and base of FIG. 6; and

FIG. 8 is a schematic illustration of two translational positions of the workpiece platform.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 1 illustrates an embodiment according to the principles of the present invention comprising a work-base 10 supporting transversely extending base pillars 12 and 14. To support an operating mandrel 16, extending transversely from pillars 12 and 14 are four adjustable length arms 18, 20, 22 and 24. Each adjustable length arm comprises two coextensive arm segments 26 and 28 having their respective ends rigidly affixed to end extensions 30 and 32 which are attached to either base pillar 12 or 14, as the case may be, and the operating mandrel 16, respectively. The arm segments 26 and 28 are affixed to the end extensions 30 and 32 in any suitable manner, such as by means of rivets 34. The operating mandrel 16, for example, carries a rotatable shaft 36 supporting a grinding head 38 for performing a grinding operation on a lens 40 mounted to a pedestal 42 affixed to the base 10.

As is obvious from the illustration in FIG. 1, the operating mandrel 16 can be translated and angularly positioned above the lens 40 simply by manipulation of an adjuster screw 44 which is threadably engaged with, for example, the arm segment 26. The adjuster screw 44 extends therethrough to bear against the inside surface of the arm 28 proximate the midpoint of the arm segments 26 and 28 to thereby vary, by manipulation, the spacing "X" between their inside surfaces to cause the extended length of each of the arms 18, 20, 22 or 24 to vary from its fixed mounting at either pillar 12 or 14 to the operating mandrel 16.

It will be appreciated that the spacing "X" of each arm 18, 20, 22 and 24 need not be the same and in practice generally will not be even under conditions of transverse alignment at near equal distances from the pillars 12 and 14 since the elements comprising each arm need not be critically dimensioned and assembled and generally will not be for economic reasons, hence structural dimensions will vary. The variations promote no detrimental consequences, however, because of the unique adjustment features.

Although the apparatus disclosed is primarily for micropositioning, it will be appreciated that for freedom of movement and/or relatively long translations from a given point, the arms 18, 20, 22 and 24

should be free to rotate at their point of attachment to the pillars 12 and 14 and the mandrel 16. Accordingly, as typically shown in FIG. 2, the engagement end 46 of the end extension 30 is semi-circularly formed and defines aperture 48 for rotatably engaging the base pillar 12. To this end a screw 50 passes through an aperture 52 formed in the base pillar 12 and the aperture 48 of the end extension 30 to threadably engage a rectangular retainer nut 54. The engagement of the end extension 32 is similar.

In practice, it is frequently desired to transversely dispose the operating mandrel 16 to the workbase 10. FIG. 3 illustrates, for simplicity, only two adjustable length arms, for example 18 and 20, in solid line construction extending unequal lengths between the base pillar 12 and the operating mandrel 16 to angularly dispose the operating mandrel 16 other than transversely to the workbase 10 at Position A. The length of adjustable arm 20 can either be shortened or lengthened merely by rotating the adjuster screw 44 in either desired direction. In the illustrated case the length of adjustable arm 20 is shortened to assume the broken line position. By shortening the length of adjustable arm 20 the bottom of operating mandrel 16 is thereby repositioned closer to base pillar 12. In so doing the operating mandrel 16 is transversely disposed to the workbase 10 at Position B. It is understood that the adjuster screw 44 of each adjustable arm 18, 20, 22 and 24 can be manipulated to position the operating mandrel at any selected angle to the workbase 10.

In a two part operation where both angular disposition and translation of the operating mandrel 16 is required, the procedure followed as referred to in FIG. 3 is preferably accomplished first. Translational repositioning of the operating mandrel 16 without affecting its angular orientation may be performed by manipulation of the adjusting screws 44 of both upper and lower extending arms 18 and 20. This operation is best illustrated in FIG. 4 where the mandrel 16 may be seen in two positions indicated by solid line Position C and broken line Position D, respectively. It will be appreciated that all arms 18, 20, 22 and 24 can be operated simultaneously, either manually or automatically, to translate the operating mandrel 16 bidirectionally, i.e. along imaginary X and Y coordinates.

For rigidity of the mandrel 16, four sets of adjustable length arms are preferred. However, it will be appreciated that certain adjustments can be accomplished with a fewer number of arms and with the arms affixed to the base pillars 12 and 14 and the mandrel 16 at other than oppositely disposed locations. The arm segments 26 and 28 are preferably formed of resilient materials such as tempered spring steel. Tempered spring steel is rigid to support, for example, the mandrel 16 but flexible to spread apart and change the extending length of each arm.

The embodiments illustrated in FIGS. 1-4 are directed to apparatus for positioning an operational mandrel relative to a fixed base. It is frequently necessary as dictated by the related machinery and environment to do the opposite and position the base relative to the mandrel. Accordingly, the embodiment illustrated in FIG. 5 is presented. A base 56 supports a machine head 58 carrying a rotatable shaft 60 having

an operating tool 62 for performing, for example, a boring or grinding operation upon a workpiece 64, such as a lens or a lens cell. For operation upon optical elements, it is generally preferred that the axes of optical elements be aligned with the axes of the operating tools. To this end, optical elements are mounted upon a work platform 66 and positioned to a support block 68 having a substantially circularly formed cut-out 70 comprising an arc of a circle for supporting a generally cylindrically shaped optical element 64. The work platform 66 is substantially square having chopped corners to form an unequal sided octagon and has located proximate each of its four chopped corners four height adjusting legs 72 threadably engaged with the work platform 66 and extending therethrough to engage the top surface of the base 56.

In operation each threaded leg 72 is rotated to vary the amount of its extension between the underside of the platform 66 and the top surface of the base 56 to vary the height of the surface of the platform 66. To transversely align the work platform 66 with the operating axis of the rotating shaft 60 coaxially supporting the operating tool 62, the height adjusting legs 72 are rotated to adjust the level of the top surface of the work platform 66 to achieve with the aid of any suitable measuring instrument perpendicular alignment between the periphery plane of the rotating shaft 60 and the top surface of the work platform 66. A gage suitable for use in achieving the perpendicular alignment is, for example, a Brown and Sharpe Electronic Indicator, Model 992 with an electric indicating head. This invention provides apparatus for accurately aligning and stabilizing the workpiece platform 66.

To translate the workpiece platform 66 relative to the axis of the rotating shaft 60 for alignment of a predetermined point on the workpiece platform 66 with the axis, there is provided four translating legs 74, 76, 78 and 80. One each is disposed at each of the four corners of the workpiece platform 66, as best seen in FIG. 6. Each of the four translating legs 74, 76, 78 and 80 is supported above the top surface of the base 56 by a riser block 82 and is affixed to the base 56 by means of a mounting screw 84 passing through one end of each of the translating legs and its riser block 82 to threadingly engage the base 56. For engaging the other end of each of the translating legs 74, 76, 78 and 80, four slots 86 are provided, one each in the lateral side at each of the corners of the platform 66. Each translating leg 74, 76, 78 and 80 is formed of resilient material and is variably extensible from its fixed mounting at screw 84 by means of an adjuster 88 extending through an aperture in each of the translating legs proximate their midpoint between their fixed mounting at screw 84 and their engagement with slot 86. The head of the adjuster 88 bears against the top surface of the leg and its shaft passes through the leg aperture to threadingly engage the base 56. Because each of the translating legs 74, 76, 78 and 80, as typically shown in FIG. 7 is bowed downward, it is not necessary during operation to use any additional means to maintain engagement between the ends of the height adjusting legs 72 of the workpiece platform 66 and the base 56 in order to hold the set leveled position of the platform 66.

The translating legs 76 and 78 are primarily for urging the work platform 66 downward toward the base

56. For translation, the leg 74 engages the slot 86 and is affixed therein by means of screws 90 passing through the bifurcated corner of the platform 66 and the end of the translating leg 74, as best seen in FIG. 7. This engagement insures a direct translational response when the adjuster 88 of leg 74 is rotated. At the remaining corner of the workpiece platform 66, the translating leg 80 engages the slot 86 and is affixed therein by means of a single screw 90 passing through the bifurcated section and the leg 80. The single screw attachment provides for pivoting of the platform 66 when it is translated.

It will be appreciated that for translation the adjusters 88 are rotated to vary the extensible lengths of the translating legs from their fixed points relative to the base 56. The adjusters 88 are rotatable any amount and slight rotational movement can provide for very accurate alignment of a predetermined point on the workpiece platform 66 with the axis of the rotating shaft 60.

The schematic of FIG. 8 illustrates translation of the workpiece platform 66 from a solid line Position E to a broken line Position F accomplished by rotation of the adjusters 88 of the translating legs 74 and 80.

Having thoroughly described my invention, as illustrated in the hereinbefore disclosed practical embodiments, I claim the following:

1. An apparatus for positioning in space a member relative to a base, comprising:

at least two adjustable length arms longitudinally extending from the member to means for supporting said adjustable length arms affixed to the base, each adjustable length arm having two coextensive sections and means for engaging said coextensive sections to said member and said means for supporting and further including means for adjusting disposed between each pair of coextensive sections to vary the distance between said pair of coextensive sections and thereby vary the distance between the member and said means for supporting.

2. The apparatus as defined in claim 1, wherein means for adjusting to vary the distance between the coextensive sections comprises an adjuster threadably engaged with one of the coextensive sections and disposed for bearing against the other coextensive sec-

tion.

3. The apparatus as defined in claim 1, wherein each coextensive section is resilient.

4. The apparatus as defined in claim 1, wherein one arm each is engaged to the member at opposite ends of the member.

5. The apparatus as defined in claim 1, further including a third adjustable length arm engaging the member and extending substantially transversely therefrom to further means for supporting said third adjustable length arm affixed to the base.

6. The apparatus, as defined in claim 5, wherein the third adjustable length arm comprises two coextensive sections longitudinally extending from the member to said means for supporting and means for engaging said coextensive sections to said member and said means for supporting.

7. The apparatus, as defined in claim 6, further comprising means for adjusting disposed between each pair of coextensive sections to vary the distance therebetween and thereby vary the distance between the member and the means for supporting.

8. The apparatus, as defined in claim 7, wherein the means for adjusting disposed between the coextensive sections comprises an adjuster threadably engaged with one of the sections and disposed for bearing against the other section.

9. An apparatus for positioning in space a member relative to a base, comprising: four arms longitudinally extending from the member to means for supporting said arms affixed to the base, each arm having a pair of coextensive sections including adjustable portions and means for engaging said coextensive sections to said member and said means for supporting and further including means for adjusting disposed between each pair of longitudinally extending sections to vary the distance between said pair of coextensive sections and thereby vary the distance between the member and said means for supporting.

10. The apparatus as defined in claim 9, wherein the coextensive sections are resilient.

11. The apparatus as defined in claim 10, wherein the means to vary the distance between the sections comprises an adjuster threadably engaged with one of the sections and disposed for bearing against the other section.

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