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Kozak

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(54) **INTERCHANGEABLE-CORE ADJUSTER ASSEMBLY FOR OPTICAL MOUNTS**

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Related U.S. Application Data

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(51) **Int. Cl.**
F16B 35/00 (2006.01)

(52) **U.S. Cl.** **403/362**; 411/393

(58) **Field of Classification Search** 403/299, 403/362; 411/338, 339, 393, 173, 175, 174, 411/80.5, 80.6; 359/813, 819, 822, 811
See application file for complete search history.

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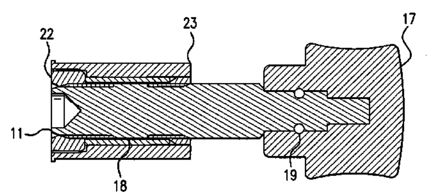
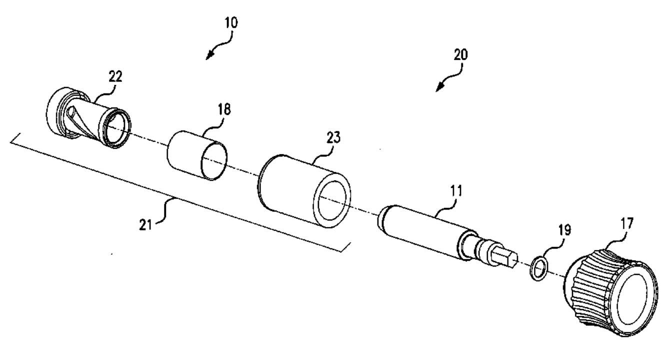
(57) **ABSTRACT**

The interchangeable-core adjuster assembly for optical mounts comprises a carrier bushing and an internally-threaded core bushing that fits snuggly inside the carrier bushing. The carrier bushing is fixedly fitted into the hole the stage plate of the optical mount, and the core bushing slides inside it. The core bushing is irrotatably locked into position within the carrier bushing by conjugate key-keyway structures on carrier and core bushings. While the carrier bushing remains in the stage plate of the optical mount, the core bushing can be removed and replaced with another core bushing having a different pitch. In this way, the same mount may be used with either fine adjuster screw or ultra-fine adjuster screws by simply interchanging core bushings having the corresponding pitches.

5 Claims, 7 Drawing Sheets





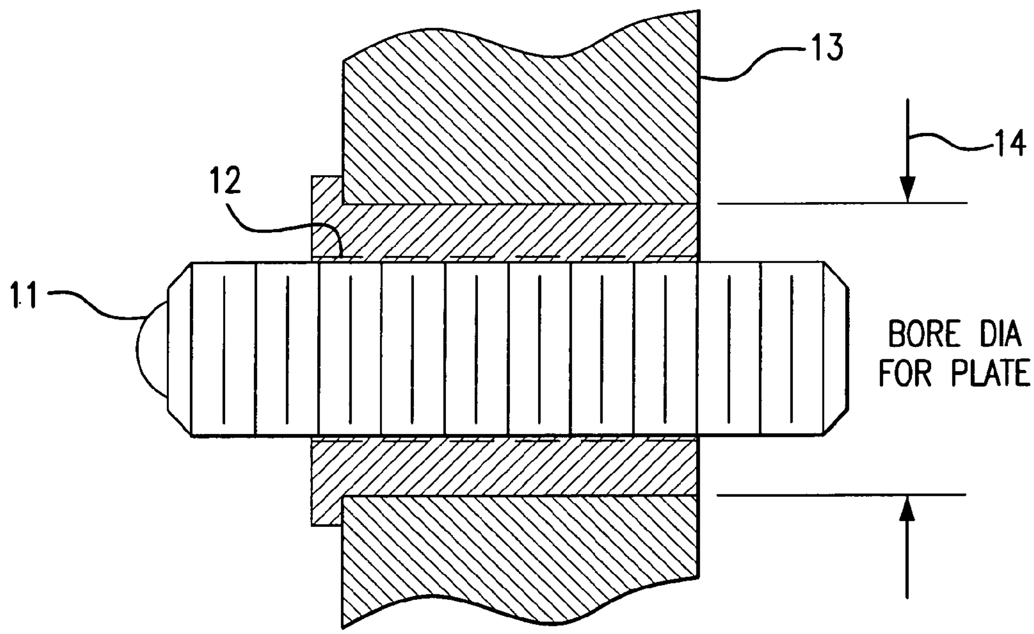


FIG. 1
PRIOR ART

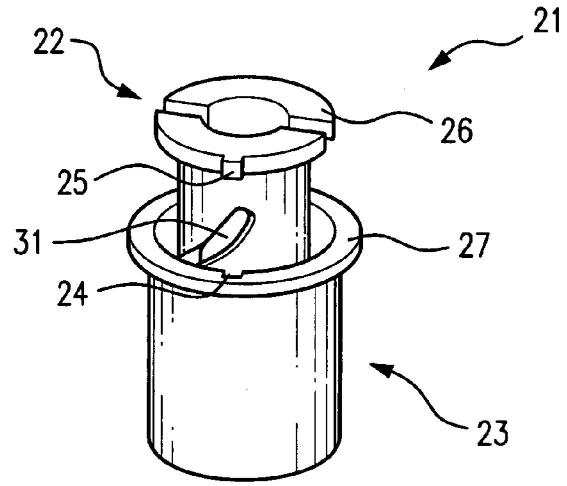


FIG. 2A

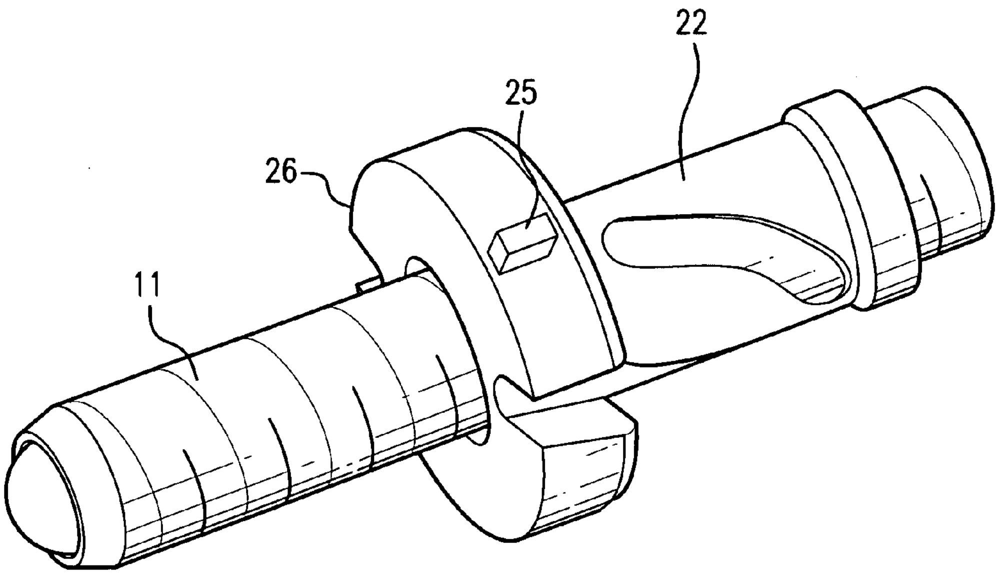


FIG. 2B

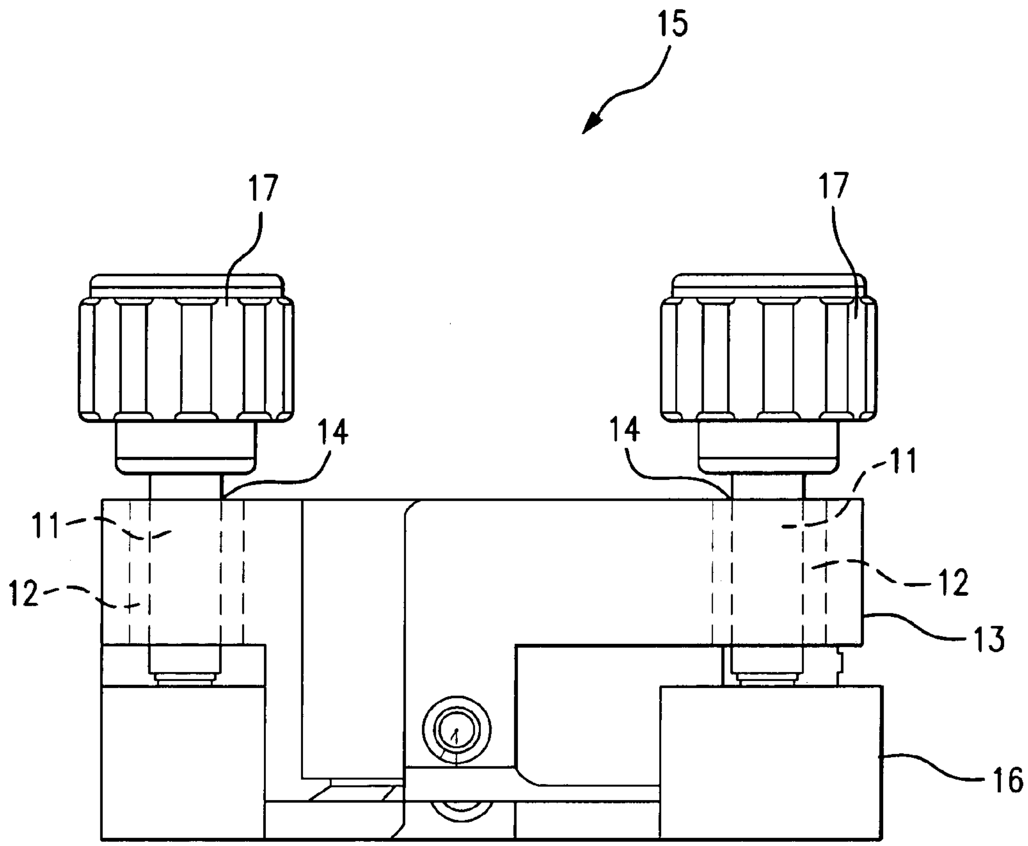


FIG. 3

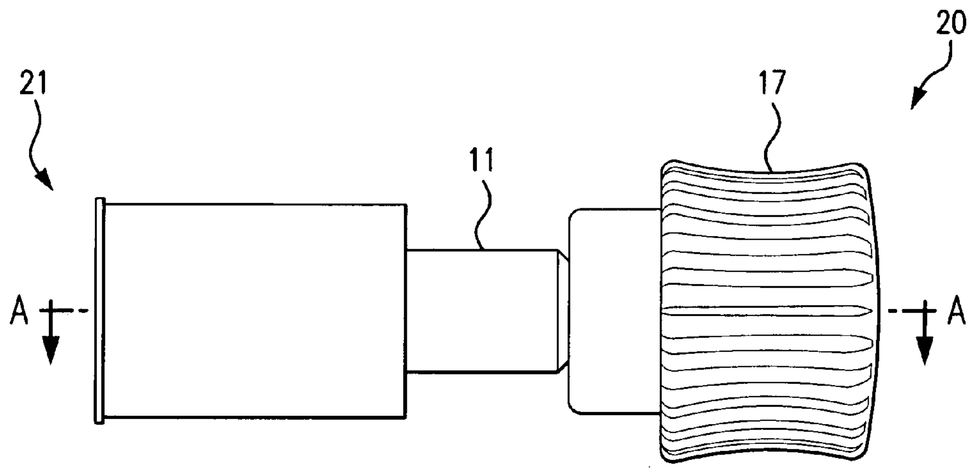


FIG. 4A

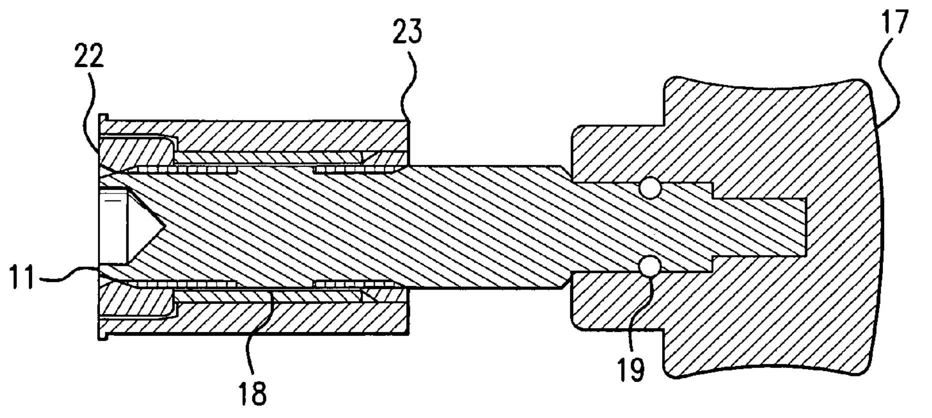


FIG. 4B

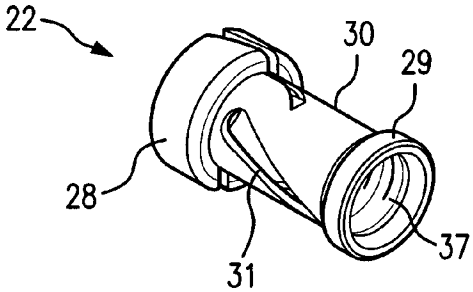


FIG. 5A

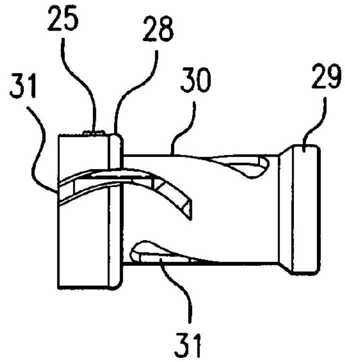


FIG. 5C

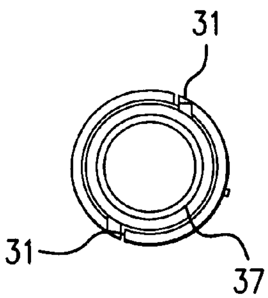


FIG. 5B

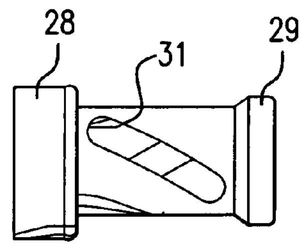


FIG. 5D

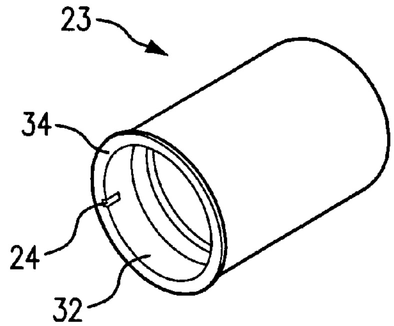


FIG. 6A

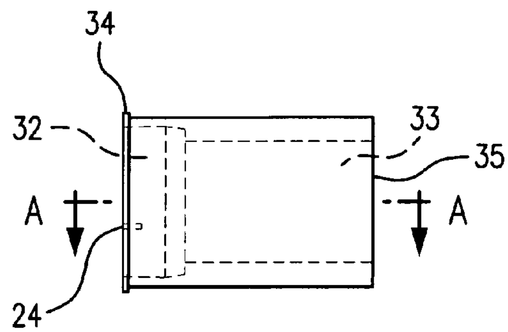


FIG. 6C

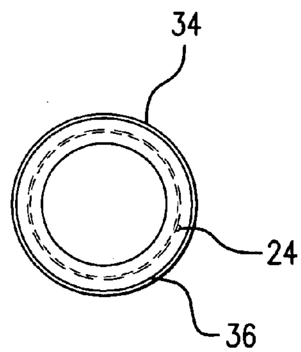


FIG. 6B

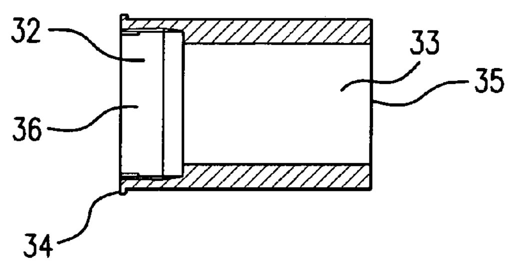


FIG. 6D

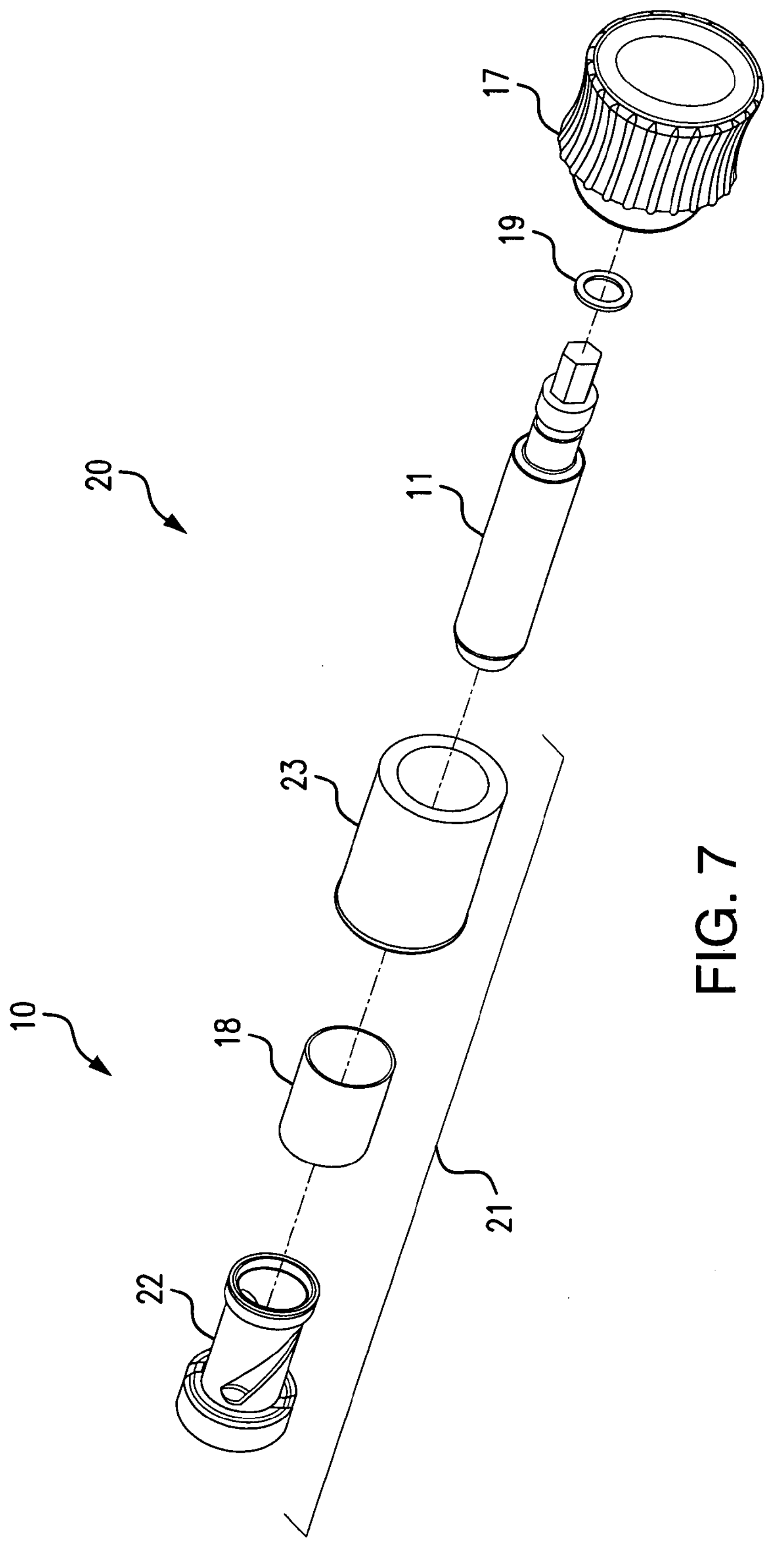


FIG. 7

INTERCHANGEABLE-CORE ADJUSTER ASSEMBLY FOR OPTICAL MOUNTS

REFERENCE TO RELATED APPLICATION

This application claims the benefit of the filing date of Provisional Patent Application No. 61/282,402, filed on Feb. 3, 2010.

BACKGROUND OF THE INVENTION

The present invention relates to precision optical mounts used to make ultra-fine adjustments to the positions and/or angular orientations of optical components.

Adjustable mounting apparatuses are commonly used in applications, such as interferometry and holography, in which precise positioning of optical components is essential. Such optical mounts typically comprise a pair of parallel plates: a base plate, which is rigidly fixed to a supporting base or surface, and a stage plate, on which optical components, such as mirrors, lenses, diffraction gratings, prisms, beam-splitters, light sources, and lasers, are mounted. Typically, the stage plate is coupled to the base plate by one or more compressive means—usually springs—which urge the two plates together. Countering the tensioning force of the springs are multiple kinematic adjustment members, which are typically fine pitch adjuster screws that control the position of the stage plate relative to the base plate.

In the prior art, as shown in FIG. **1**, the adjuster screw is threaded through the stage plate by means of a threaded bushing, wherein the pitch of bushing threads matches that of the adjuster screw. The threaded bushing is usually press fitted or adhesively bonded into a matching hole in the stage plate of the optical mount, such that the bushing cannot be removed once it is fitted into the mount. For fine resolution applications, the pitch of the adjuster screw and threaded bushing is typically 80 TPI. But in more demanding applications, in which ultra-fine resolution is needed, ultra-fine pitch of 0.10 mm may be required. While there is a need to to interchange adjuster screws of different pitches in an optical mount, however, the prior art threaded bushing does not allow this, but instead requires that the entire mount be changed, because the bushing has been irremovably fitted into the stage plate of the mount.

The present invention fulfills the need for adjuster pitch interchangeability by providing a multi-component adjuster assembly in place of the single-component bushing of the prior art. The adjuster assembly comprises a carrier bushing and an internally-threaded core bushing that fits snuggly inside the carrier bushing. The carrier bushing is fixedly fitted into the hole in the stage plate, and the core bushing slides inside it. The core bushing is irrotatably locked into position within the carrier bushing by conjugate key-keyway structures on the carrier and core bushings. Alternately, the core bushing can have exterior threading that threads into interior threading in the carrier bushing. While the carrier bushing remains in the stage plate of the optical mount, the core bushing can be removed and replaced with another core bushing having a different thread pitch. In this way, the same mount may be used with either fine adjuster screws (e.g., 80 TPI) or ultra-fine adjuster screws (e.g., 0.10 mm) by simply interchanging core bushings having the corresponding pitches.

SUMMARY OF THE INVENTION

The present invention is an interchangeable-core adjuster assembly for optical mounts. It allows the same optical mount

to use adjuster screws having different pitches. It also enables replacement of a damaged or defective bushing without replacing the entire optical mount. The interchangeable-core adjuster assembly has two principal components: a carrier bushing and a core bushing. The interior of the carrier bushing is congruent with the exterior of the core bushing, such that core bushing is snuggly but slideably insertable into the carrier bushing. Conjugate threading on the exterior of the core bushing and interior of the carrier bushing is also an option. Where such threading is not used, rotation of the core bushing within the carrier bushing is prevented by interlocking key-keyway structures in the core and carrier bushings. For example, there can be a key-way depression within the receiving end of the carrier bushing which mates with a key projection on the outer surface of the distal end of the core bushing, as depicted in FIG. **2**A. The adjuster screw threads into conjugate threading in the interior of the core bushing, as shown in FIG. **2**B.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is side cutaway view of the prior art adjuster screw and bushing for optical mounts.

FIG. **2**A is a perspective view of components and features of a composite bushing in accordance with the preferred embodiment of the present invention.

FIG. **2**B is a perspective view of an adjuster screw threaded through a core bushing in accordance with the preferred embodiment of the present invention.

FIG. **3** is a side profile view of a typical optical mount to which the present invention can be applied.

FIG. **4**A is a side profile view of an adjuster assembly in accordance with the preferred embodiment of the present invention.

FIG. **4**B is a cross-sectional view of the adjuster assembly of FIG. **4**A taken along the line A-A.

FIG. **5**A is an isometric view of a core bushing in accordance with the preferred embodiment of the present invention.

FIG. **5**B is a transverse projection view looking into the distal end of the core bushing of FIG. **5**A.

FIG. **5**C is a longitudinal projection view of the core bushing of FIG. **5**A.

FIG. **5**D is a longitudinal projection view of the core bushing of FIG. **5**A.

FIG. **6**A is an isometric view of a carrier bushing in accordance with the preferred embodiment of the present invention.

FIG. **6**B is a transverse projection view looking into the distal end of the carrier bushing of FIG. **6**A.

FIG. **6**C is a longitudinal projection view of the core bushing of FIG. **6**A.

FIG. **6**D is a cross sectional view of the core bushing of FIG. **6**C taken along the line A-A.

FIG. **7** is an exploded view of the adjuster assembly in accordance with the preferred embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. **3** depicts a typical optical mount **15** to which the present invention can be applied. The optical mount **15** has a base plate **16**, which is adjustably compressively coupled to a stage plate **13**. The stage plate **13** is configured to hold one or more optical components, such as mirrors, lenses, diffraction gratings, prisms, beam-splitters, light sources, and lasers.

Adjuster screws **11** are used to adjust the position and angle of the stage plate **13** relative to the base plate **16**. The finer the pitch of the adjuster screws **11**, the finer the achievable resolution of the position of the stage plate **13**, and hence of the optical components, relative to the base plate **16**. The adjuster screws **11** thread into bushings **12** having an internal threading that matches of the pitch of the external threading on the adjuster screws **11**. The bushings **12** occupy holes **14** bored through the stage plate **13**. Knobs **17** on the proximal ends of the adjuster screws **11** facilitate the turning of the adjuster screws **11**.

In the prior art, as shown in FIG. **1**, the adjuster screw **11** is threaded through the stage plate **13** by means of a standard single-component bushing **12** that is press fitted or adhesively bonded into a matching hole **14** in the stage plate **13**, such that the standard bushing **12** cannot be removed once it is fitted into the stage plate **13**.

In the present invention, an example of which is shown in FIGS. **2**A and **2**B, the single-component bushing **12** of the prior art is replaced by a composite bushing **21**, comprising a core bushing **22** and a carrier bushing **23**. The core bushing **22** fits, slideably but snuggly, inside the carrier bushing **23**, which is fixed within the hole **14** of the stage plate **13**. The stepped cylindrical exterior of the core bushing **22** is congruent with the stepped interior bore of the carrier bushing **23**, such that the core bushing **22** radially constricts as it is initially inserted into the carrier bushing **23**, and then, as the insertion is completed, expands within the bore of the carrier bushing **23** to engage the interior surface of the carrier bushing **23**. Optionally, the core bushing **22** can be slotted, as shown in FIGS. **2**A and **2**B, to facilitate its radial constriction as it is initially inserted into the carrier bushing **23**. Once insertion of the core bushing **22** into the carrier bushing **23** is completed, alignment of cooperating key **25** and keyway **24** structures, which can be located on cooperating distal contours **28** and **32** of the core **22** and carrier **23** bushings, respectively, prevents rotation of the core bushing **22** within the carrier bushing **23**.

The exemplary preferred embodiment of the interchangeable-core adjuster assembly **20** of the present invention is depicted in FIGS. **4**A and **4**B. The adjuster screw **11**, which is attached to the knob **17** by means of a compressible O-ring **19**, is shown fully threaded into the composite bushing **21**. As shown in the cross-sectional view of FIG. **4**B, the composite bushing in this embodiment consists of three components: the core bushing **22**, the carrier bushing **23**, and a bushing sleeve **18**. The bushing sleeve **18** is a cylindrical sleeve used to cover the medial neck **30** of the slotted core bushing **22** in order to contain lubricant from the adjuster screw **11** which extrudes through the bushing slots **31** (see FIGS. **5**A and **5**D).

The configuration of a slotted core bushing **22** of the preferred embodiment is depicted in FIGS. **5**A, **5**B, **5**C, and **5**D. The slotted core bushing **22** is configured with a proximal step **29**, a medial neck **30**, and a distal step **28**. The distal step **28** has a slightly larger diameter than the proximal step **29**, which in turn has a slightly larger diameter than the medial neck **30**. Arcuate oblong slots **31** are cut through the medial neck **30** and the distal step **28** of the core bushing **22**. The slots **31** enable the core bushing **22** to radially constrict for a tighter fit as it is inserted into the carrier bushing **23**. The slots **31**, in conjunction with the bushing sleeve **18**, also achieve a more uniform and consistent distribution of lubrication on the adjuster screw **11**. The proximal step **29** has a slightly larger diameter than that of the medial bore **33** of the carrier bushing **23**, such that the proximal step **29** radially constricts as the core bushing **22** is being inserted into the carrier bushing **23**, and then expands as it reaches the proximal aperture **35** of the carrier bushing (see FIG. **6**D), thereby stabilizing the longitudinal position of the core bushing **22** within the carrier bushing **23**.

The slotted core bushing **22** has internal threading **37**, which matches the pitch of the adjuster screw **11**. Since the core bushing **22** is removable from the carrier bushing **23**, it can be interchanged with another core bushing **22** having a different threading pitch to accommodate an adjuster screw **11** having any desired pitch. The core bushing **22** also has a male key **25** on its distal step **28**, which key **25** cooperates with a female keyway **24** within the distal bore **32** of the carrier bushing **23** (see FIGS. **6**A and **6**C), thereby preventing rotation of the core bushing **22** within the carrier bushing **23**.

The configuration of the carrier bushing **23** of the preferred embodiment is depicted in FIGS. **6**A, **6**B, **6**C, and **6**D. The carrier bushing **23** has a distal flange **34** to retain the carrier bushing **23** securely within the hole **14** of the optical mount **15**. The carrier bushing **23** has a distal aperture **36**, into which the core bushing **22** is inserted, and a proximal aperture **35**, from which the proximal end of the core bushing **22** emerges upon complete insertion. Within the carrier bushing **23** are a distal bore **32** and a medial bore **33**, with the former having a slightly larger diameter than latter, in order to be congruent with the distal step **28** and medial neck **30** of the core bushing **22**. The carrier bushing **23** also has a female keyway **24**, which cooperates with the male key **25** of the core bushing **22**.

The adjuster assembly **20** in accordance with the exemplary preferred embodiment of the present invention **10** is shown in exploded view in FIG. **7**. The core bushing **22** slides inside the bushing sleeve **18**, which slides over the medial neck **30** of the core bushing **22**. Thus covered, the core bushing **22** then slides inside the carrier bushing **23** to form the composite bushing **21**. The adjuster screw **11** can then be inserted into the proximal end of the composite bushing **21** and then threaded into the internal threading **37** of the core bushing **22** by turning the knob **17**, which is connected to the proximal end of the adjuster screw **11** by means of the O-ring **19**.

Although the preferred embodiment of the present invention has been disclosed for illustrative purposes, those skilled in the art will appreciate that many additions, modifications and substitutions are possible, without departing from the scope and spirit of the present invention as defined by the accompanying claims.

What is claimed is:

1. For an optical mount having a stage plate compressively coupled to a base plate, an interchangeable-core adjuster assembly comprising:

a carrier bushing which is configured to be fixedly insertable into a hole in the stage plate of the optical mount;

a core bushing which is removably and compressibly insertable into the carrier bushing and which has internal threading of a particular pitch;

an adjuster screw which screws into the core bushing and which has threading that matches the pitch of the core bushing threading;

wherein the core bushing comprises an annular wall defining outer contours and inner contours, and the carrier busing comprises an annular wall defining outer contours and inner contours;

wherein the outer contours of the core bushing are congruent with the inner contours of the carrier bushing;

wherein the carrier bushing has a first axial bore defined by the inner contours of the carrier bushing, which first axial bore is concentric with the outer contours of the carrier bushing, and the core bushing has a second axial bore defined by the inner contours of the core bushing, which second axial bore is concentric with the outer contours of the core bushing, and the second axial bore is concentric with the first axial bore;

wherein the core bushing has one or more bushing slots, which enable radial constriction and expansion of the core bushing in response to radial forces on the core bushing as the core bushing is inserted into the carrier bushing, and which enable the core bushing to be compressibly insertable into the carrier bushing;

wherein the core bushing is interchangeable with one or more alternate core bushings, each having a different threading pitch;

wherein the adjuster screw is interchangeable with one or more alternate adjuster screws, each having a different pitch corresponding to the threading pitch of one of the alternate core bushings; and

wherein the outer contours of the core bushing define a medial neck, and wherein the core bushing further comprises a tubular bushing sleeve which fits snuggly over the medial neck, and wherein the bushing sleeve covers the bushing slots of the core bushing so as to contain lubricant that extrudes from the adjuster screw through the bushing slots.

2. The interchangeable-core adjuster assembly according to claim **1**, wherein the outer contours of the core bushing define a stepped cylindrical exterior and the first axial bore of the carrier bushing comprises a congruent stepped interior bore.

3. The interchangeable-core adjuster assembly according to claim **2** wherein the core bushing initially radially constricts as it is inserted into the carrier bushing, and then, as insertion is completed, the core bushing expands so that the stepped cylindrical exterior of the core bushing snuggly engages the stepped interior bore of the carrier bushing.

4. The interchangeable-core adjuster assembly according to claim **3**, wherein the bushing slots are arcuate oblong slots that are cut through the core bushing.

5. The interchangeable-core adjuster assembly according to any one of claims **1** through **4**, wherein an interior distal end of the carrier bushing has a female keyway which mates with a male key in an exterior distal end of the core bushing, thereby preventing rotation of the core bushing within the carrier bushing.

* * * * *