United States Patent [19]

Tubbs

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[54] **OPTICAL BENCH**

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[52] **U.S. Cl.** ..... **248/466,** 35/19 B, 350/255, 356/256

[51] **Int. Cl.** **G02b 27/32**

[58] **Field of Search** ..... 248/466, 176, 184, 248/429, 214; 35/19 B; 356/256; 350/245, 246, 247, 252, 255

[56] **References Cited**

UNITED STATES PATENTS

2,803,986	8/1957	Choiniere et al.	248/466
3,216,678	11/1968	Foedisch	248/466
3,327,408	6/1967	Lindberg et al.	356/256
3,574,468	4/1971	Herman	356/256

OTHER PUBLICATIONS

Laser Focus – Page 11 – Aug. 1968 – Ardel Inst. Ad.

Optik – pages 680–686 – Vol. 21, No. 12 – Dec. 1964 – Optischer Baukasten – F. Aurin.

Primary Examiner—Marion Parsons, Jr.

Attorney—Ford W. Harris, Jr. et al.

[57] **ABSTRACT**

An optical bench comprising parallel, horizontal primary and secondary ways and a plate-like carrier seated on and slidable longitudinally along two of the ways. A secondary way is circular in cross section and is provided thereon with a longitudinally slidable collar having an external circumferential groove with side walls perpendicular to the ways. The carrier has a notch providing oppositely facing edges respectively receivable in diametrically opposed portions of the groove and engageable with the inner wall of the groove, such edges of the notch being vertical. With this construction, two of the ways fix the vertical position of the optic axis of an optical element on the carrier, while the notch edges in engagement with the inner wall of the groove in the collar fix the horizontal positions of the optic axis. The side walls of the groove maintain the carrier penpendicular to the ways.

In practice, there are two of the circular ways in laterally spaced, parallel relation and each is equipped with at least one of the collars mentioned. One carrier on the optical bench will have its notch in engagement with a collar on one of the circular ways, while the next carrier on the bench will have its notch in engagement with a collar on the other circular way, the configuration of the carriers being such that each carrier clears the collar on the opposite circular way. With this construction, optical elements on the two carriers can be placed in very close proximity to each other.

9 Claims, 8 Drawing Figures

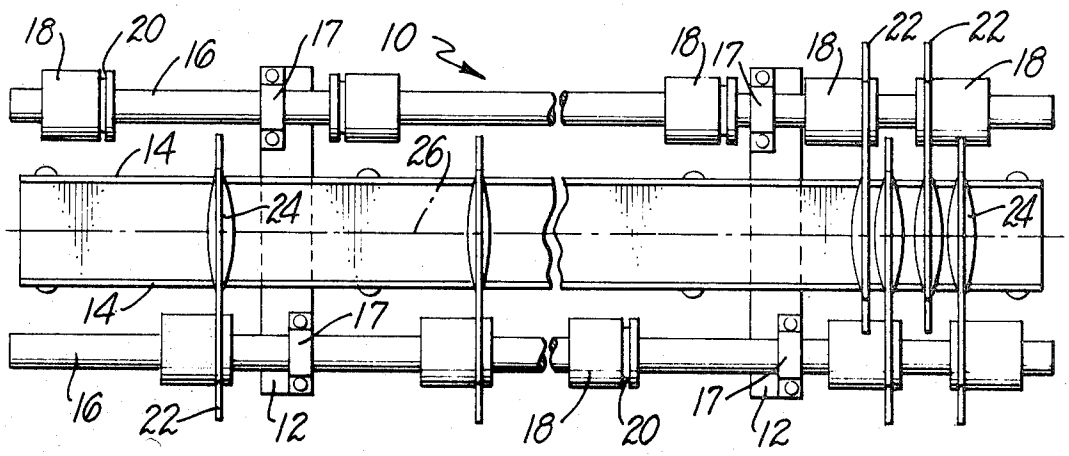


FIG. 1.

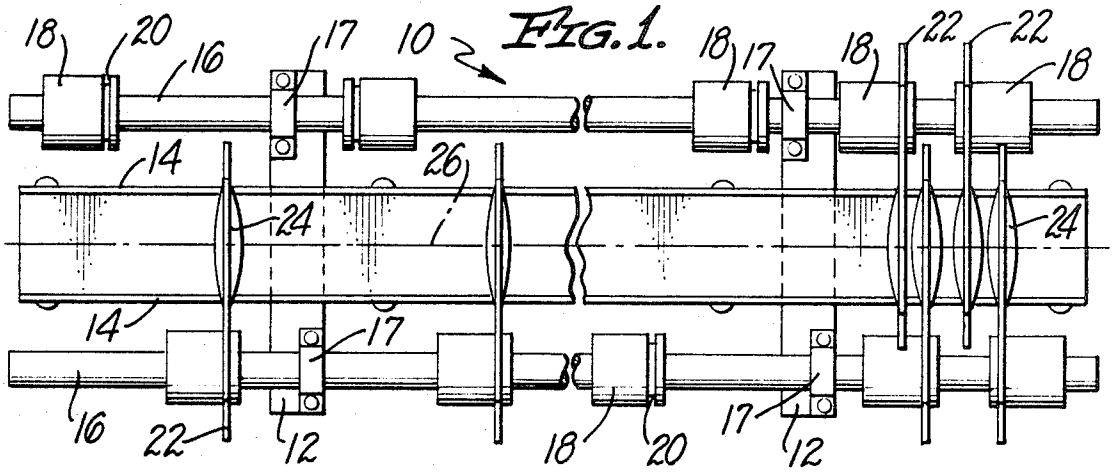


FIG. 2.

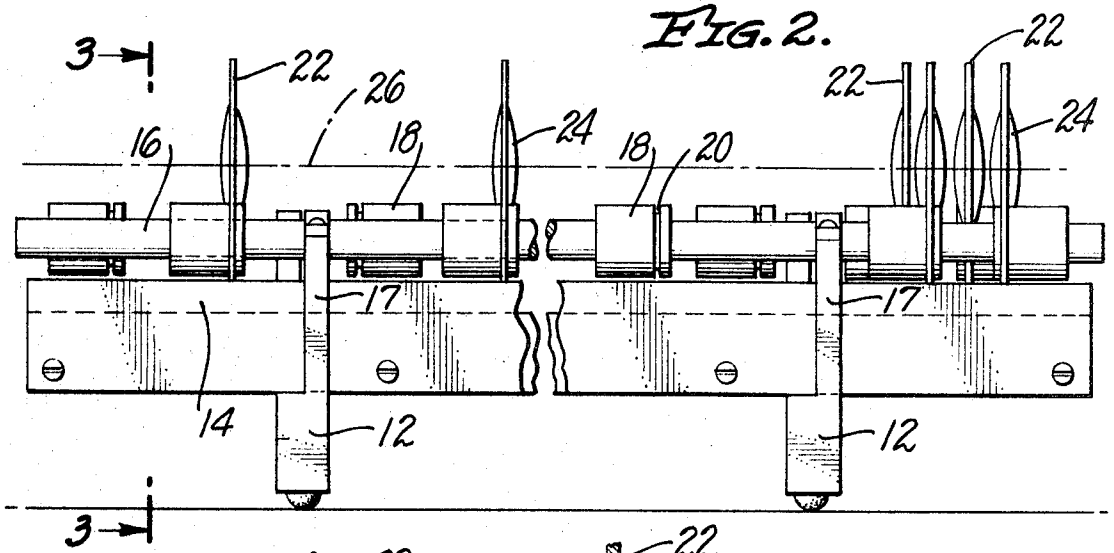


FIG. 3.

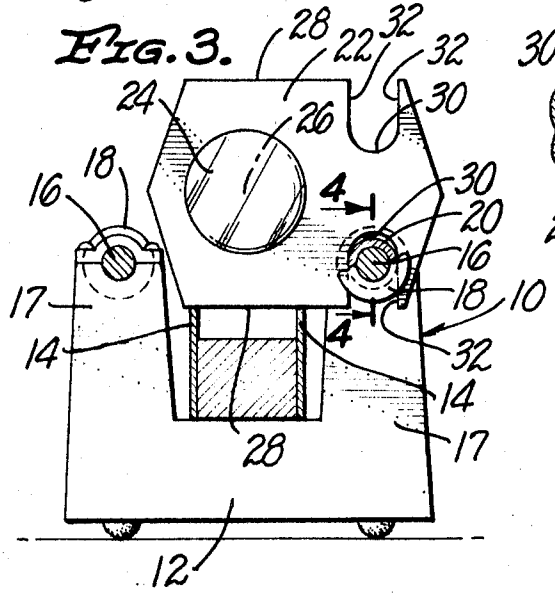


FIG. 4.

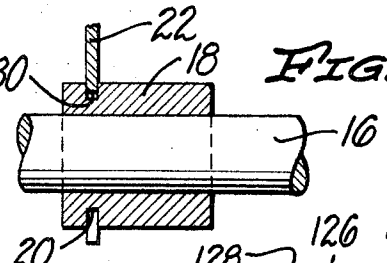


FIG. 5.

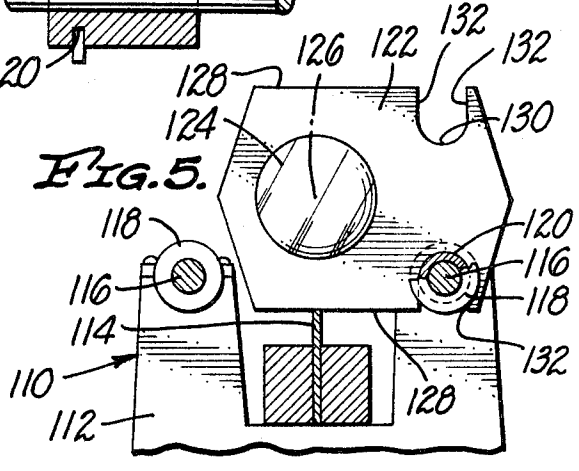


FIG. 7.

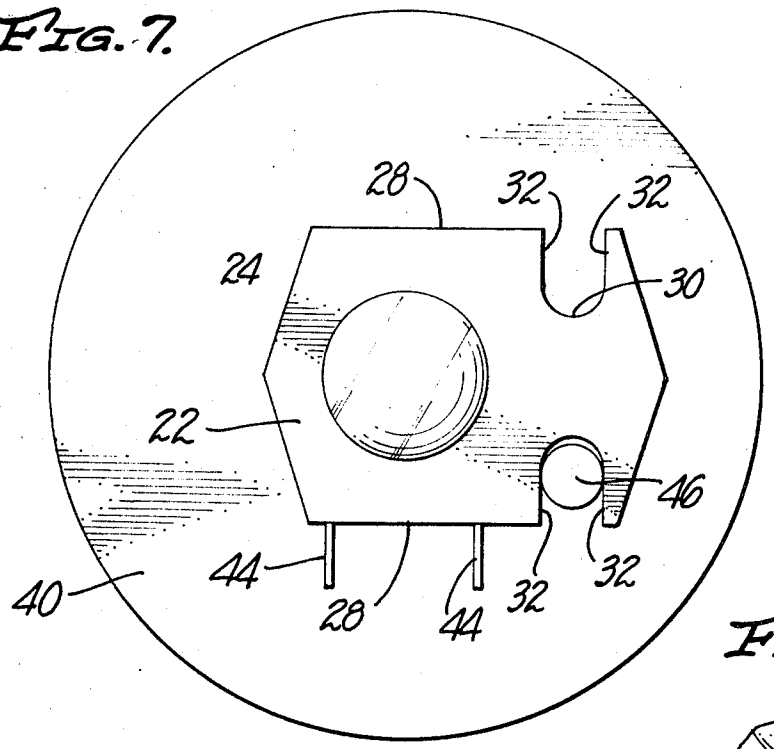


FIG. 6.

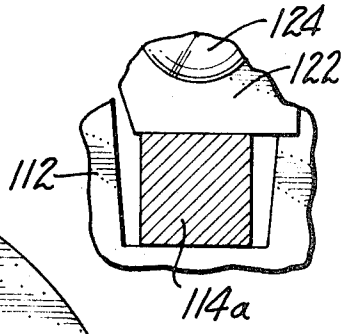
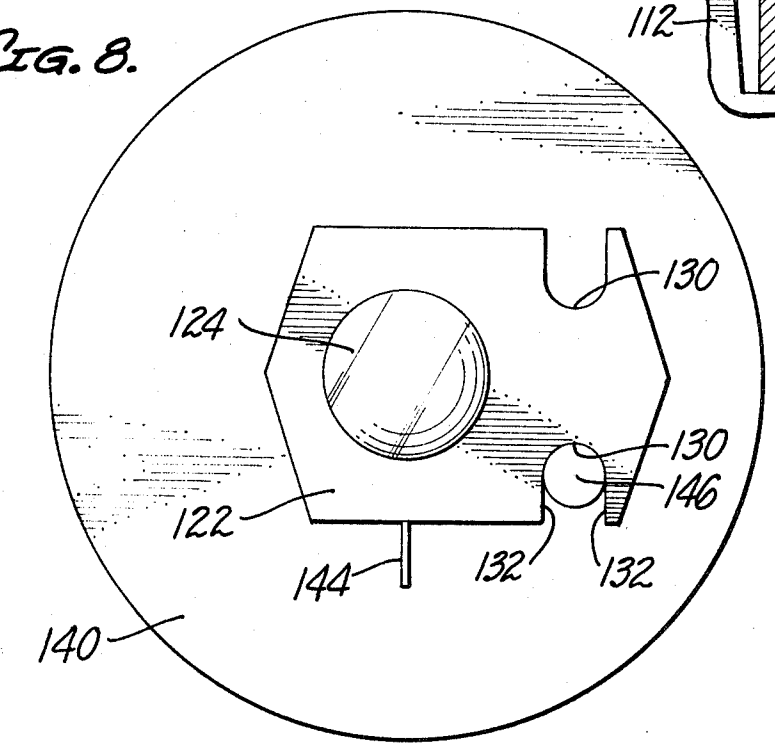


FIG. 8.



OPTICAL BENCH

BACKGROUND OF INVENTION

The present invention relates in general to the optical bench art and, more particularly, to a horizontal optical bench capable of having a plurality of optical element carriers mounted thereon with the optic axes of the carriers coinciding with the optic axis of the bench.

SUMMARY AND OBJECTS OF INVENTION

Important general objects of the invention are to provide an optical bench wherein optical elements mounted on adjacent carriers may be positioned in very close proximity to each other along the optic axis, and wherein the carriers may be installed and removed, or reversed in position, quickly and easily.

More particularly, a primary object of the invention is to provide an optical bench which includes, and the invention may be summarized as including: parallel, horizontal primary and secondary ways; an optical element carrier seated on and slidable longitudinally of two of the ways; one of the ways being circular in cross section and having thereon a longitudinally slidable collar provided with an external circumferential groove with side walls perpendicular to the ways; and the carrier having a notch providing oppositely facing edges respectively receivable in diametrically opposed portions of the groove and engageable with the inner wall of the groove, the edges of the notch being vertical. With this construction, the two ways on which the carrier is seated fix the vertical position of the optic axis, and the opposed edges of the notch fix the horizontal position of the optic axis. The side walls of the groove in the collar maintain the carrier, which is preferably a flat plate, perpendicular to the ways.

As will be apparent, the carrier may be installed and removed quickly and easily with the foregoing construction, which is an important feature of the invention.

Another object is to provide an optical bench of the foregoing nature wherein there are two ways of circular cross section in laterally spaced, parallel relation, each circular way being provided thereon with one or more of the collars mentioned. Adjacent carriers are positioned with their notches in engagement with collars on the respective circular ways, each carrier clearing the collar or collars on the opposite circular way. With this construction, adjacent optical elements may be brought into very close proximity, which is an important feature of the invention.

An object in connection with one embodiment of the invention is to provide an optical bench of the foregoing nature wherein there are two primary ways supporting the carriers, and two circular ways having collars engageable by the carrier notches. A related object is to provide rectangular primary ways on which the carriers are seated, such rectangular ways being oriented with their longer cross section dimensions vertical.

An object in connection with another embodiment is to provide a single primary way on which each carrier is seated, the inner end of the notch in each carrier in this instance being seated on the inner wall of the circumferential groove in a collar on the circular way. Thus, the circular way in this instance assists the primary way in fixing the vertical position of the optic axis, the circular way also fixing the horizontal position of the optic axis.

Yet another object is to provide a construction wherein each carrier is symmetrical about a horizontal axis perpendicular to the optic axis. Thus, each carrier has two oppositely oriented notches one capable of engaging a collar on one circular way and the other capable of engaging a collar on the other circular way, opposite edges of the carrier being selectively seatable on the rectangular primary way or ways. Thus, each carrier may readily be reversed in position.

An additional object of the invention is to provide a fixture for mounting an optical element on the carrier, comprising a turntable having a vertical axis of rotation and upstanding bosses on the turntable simulating the ways of the optical bench and against which the carrier is seatable.

The foregoing objects, advantages, features and results of the present invention, together with various other objects, advantages, features and results which will be evident to those skilled in the optical bench art in the light of this disclosure, may be achieved with the exemplary embodiments of the invention illustrated in the accompanying drawings and described in detail hereinafter.

DESCRIPTION OF DRAWINGS

In the drawings:

FIG. 1 is a plan view of an optical bench which embodies the invention;

FIG. 2 is a side elevational view of the optical bench shown in FIG. 1;

FIG. 3 is a transverse sectional view taken as indicated by the arrowed line 3—3 of FIG. 2;

FIG. 4 is an enlarged fragmentary sectional view taken as indicated by the arrowed line 4—4 of FIG. 3;

FIG. 5 is a view similar to FIG. 3, but showing an alternative embodiment of the invention;

FIG. 6 is a fragmentary view similar to FIG. 5, but showing another alternative;

FIG. 7 is a plan view of a fixture for centering an optical element on a carrier of the embodiment of FIGS. 1 to 4; and

FIG. 8 is a plan view of a fixture for centering an optical element on a carrier of the embodiment of FIG. 5.

DESCRIPTION OF EXEMPLARY EMBODIMENTS OF INVENTION

Referring initially to FIGS. 1 to 4 of the drawings, illustrated therein is an optical bench 10 of the invention which includes longitudinally spaced supports 12 carrying parallel, horizontal primary and secondary ways 14 and 16, there being two of each in the embodiment under consideration. The primary ways 14 are rectangular and have their longer cross sectional dimensions vertical for maximum stiffness in the vertical direction. The secondary ways 16 are disposed laterally outwardly of and above the primary ways 14 on upward extensions 17 of the supports 12, and are circular in cross section.

On and slidable longitudinally of the circular ways 16 are cylindrical collars 18 respectively provided therein with external circumferential grooves 20 which are relatively narrow as compared to their depth and the side walls of which are perpendicular to the ways 14 and 16.

The optical bench 10 includes plate-like carriers 22 adapted to support optical elements 24 with their optic axes coinciding with the optic axis 26 of the bench. The optic axis 26 is located above the ways 14 and the ways

16, these ways being symmetrical about a vertical plane containing the optic axis.

Each carrier 22 has opposed horizontal, primary edges 28 seatable on and slidable longitudinally along the rectangular ways 14, thereby fixing the vertical position of the optic axis 26. The primary edges 28 of each carrier 22 respectively have opposed notches 30 each having oppositely facing edges 32 perpendicular to the primary edges 28 of the carrier. The opposed edges 32 of the notches 30 are aligned, as will be clear from FIG. 3 of the drawings.

The opposed edges 32 of each notch 30 are receivable in the groove 20 in one of the collars 18. Either notch 30 may receive the grooved portion of a collar 18 on either circular way 16, by simply reversing the carrier.

As previously indicated, a primary edge 28 of each carrier 22 cooperates with the rectangular ways 14 to fix the vertical position of the optic axis 26. The edges 32 of a notch 30 in each carrier 22 cooperate with a collar 18 on one of the circular ways 16 to fix the horizontal position of the optic axis 26, the notch edges 32 being engageable with the inner wall of the corresponding groove 20 to accomplish this. It will be understood that the width of each notch 30 is only very slightly greater than the diameter of the inner wall of each groove 20. The thickness of each carrier 22 is very slightly less than the width of each groove 20, whereby the side walls of the groove maintain the carrier perpendicular to the ways 14 and 16 automatically.

It will be apparent from the foregoing that the carriers 22 may be installed very readily simply by placing them on the ways 14 with the edges of corresponding notches 30 in corresponding collar grooves 20. Similarly, the carriers may be reversed in position readily. In other words, the carriers may be turned 180° in transverse planes to engage them with collars 18 on the opposite circular way 16. Also, they may be turned over so that the opposite primary edge 28 and notch 30 of each engages the primary ways 14 and a collar on the same circular way.

To insure that only the rectangular ways 14 enter into fixing the vertical position of the optic axis 26, the notches 30 are deep enough that the inner ends thereof do not engage the inner walls of the collar grooves 20. In other words, only the opposed edges 32 of the notches 30 engage the inner walls of the grooves 20 in the collars 18. FIG. 4 illustrates how the inner end of a notch 30 clears the inner wall of a collar groove 20.

As perhaps best shown in FIG. 3 of the drawings, the portion of each carrier 22 opposite that which is in engagement with a collar 18 clears the opposite circular way 16. Consequently, two collars 18 can be positioned on the respective circular ways 16 substantially opposite each other, with two adjacent carriers 22 in engagement with the two substantially opposite collars. This construction permits placing two of the optical elements 24 in very close proximity to each other along the optic axis 26, as shown at the right ends of FIGS. 1 and 2, whenever this is necessary or desirable, which is an important feature of the invention.

As also shown at the right ends of FIGS. 1 and 2, at least some of the collars 18 may be positioned with their grooved ends adjacent each other. By utilizing a pair of adjacent grooves 20 on each way 16, as many as four optical elements 24 may be positioned in closely spaced relation.

Referring to FIG. 1, tthe support extensions 17 of each pair are longitudinally staggered. Thus, the grooves 20 in collars 18 on the ways 16 can be positioned more nearly opposite each other to obtain close spacings of the elements 24 above the supports 12, should this be necessary for a particular set up.

It will also be noted from FIG. 3 that each carrier 22 clears the support extension 17 for the way 16 opposite the way 16 which guides the carrier. This, in combination with the longitudinal staggering of the support extensions 17, eliminates any "dead spots."

Turning to FIG. 5 of the drawings, illustrated therein is an optical bench 110 which is similar to the bench 10. Consequently, the components of the optical bench 110 will be identified by reference numerals higher by 100 than those utilized for corresponding components of the bench 10.

In the optical bench 110, there is but one of the rectangular primary ways 114, this way being symmetrical about a vertical plane containing the optic axis 126. The vertical position of the optic axis 126 is fixed by engagement of one of the primary edges 128 of each carrier 122 with the rectangular way 114, and by engagement of the inner end of the corresponding notch 130 with the inner wall of the corresponding collar groove 120. As in the previous embodiment, the horizontal position of the optic axis 126 is fixed by engagement of the opposed edges 132 of the notch 130 with diammetrically opposed portions of the inner wall of the collar groove 120.

FIG. 6 illustrates a construction similar to that of FIG. 5, except that the narrow rectangular way 114 is replaced by a wide, substantially square way 114*a*.

In FIG. 7 of the drawings is illustrated a fixture for mounting an optical element 24 on one of the carriers 22. This fixture comprises a horizontal turntable 40 which is rotatable about a vertical axis and on which the carrier 22 may be placed. Projecting upwardly from the turntable 40 are rectangular bosses 44 simulating the rectangular ways 14, and a cylindrical boss 46 simulating the inner wall of one of the collar grooves 20. The carrier 22 is placed on the turntable 40 with a primary edge 28 thereof seated against the bosses 44, and with the boss 46 in the corresponding notch 30, as shown. The optical element 24 is then placed on the carrier 22 and positioned so that its axis coincides with the axis of rotation. The optical or mechanical tests required to place the axis of the optical element 24 in coincidence with the axis of the turntable 40 are well known to those skilled in this art and need not be described. After properly locating the optical element 24, it is suitably secured to the carrier 22 and, when the carrier is mounted on the optical bench 10, the axis of the optical element will coincide with the optic axis 26. It will be understood that if the optical element 24 is a transmitting element, the carrier 22 is provided with a suitable window therethrough.

In FIG. 8 is shown a fixture for locating an optical element 124 on a carrier 122 of the optical bench 110. This fixture includes a turntable 140 having a rectangular boss 144 simulating the way 114, and a cylindrical boss 146 simulating the inner wall of one of the collar grooves 120. The fixture of FIG. 7 is utilized in a manner similar to that of FIG. 6.

Although exemplary embodiments of the invention have been disclosed for purposes of illustration, it will be understood that various changes, modifications and

substitutions may be incorporated in such embodiments without departing from the spirit of the invention as defined by the claims appearing hereinafter.

I claim as my invention:

1. In an optical bench, the combination of:
a. two parallel horizontal ways;
b. an optical element carrier having a first edge seatable on and slidable longitudinally of one of said ways;
c. a slide on and movable longitudinally of the other of said ways and having oppositely facing groove portions the side walls of which are perpendicular to said ways; and
d. said carrier having oppositely facing edges respectively receivable in said groove portions and respectively engageable with the inner walls thereof.

2. In an optical bench, the combination of:
a. parallel, horizontal primary and secondary ways;
b. an optical element carrier having a primary edge seatable on said primary way and slidable longitudinally of said primary way;
c. said secondary way being circular in cross section;
d. a collar slidable longitudinally of said secondary way and having therein an external circumferential groove with side walls perpendicular to said ways;
e. said carrier having a notch providing oppositely facing edges respectively receivable in diametrically opposed portions of said groove and engageable with the inner wall of said groove; and
f. said oppositely facing edges of said notch being perpendicular to said primary edge of said carrier.

3. An optical bench as set forth in claim 2 wherein the inner end of said notch is seatable on the inner wall of said groove in said collar.

4. An optical bench according to claim 2 wherein there are two of said primary ways in parallel horizontal relation, said primary edge of said carrier being seatable on both of said primary ways.

5. An optical bench as defined in claim 4 wherein there are two of said secondary ways respectively disposed on opposite sides of and above said primary ways, each of said secondary ways having one of said collars thereon, said oppositely facing edges in said notch of said carrier being receivable in said groove in either of said collars.

6. An optical bench according to claim 5 wherein said carrier is provided with two of said primary edges on opposite sides thereof, and is provided with two of said notches on opposite sides thereof, either of said primary edges being seatable on said primary ways, and the oppositely facing edges of either of said notches being receivable in said groove in either of said collars.

7. An optical bench as set forth in claim 4 wherein said primary ways are rectangular in cross section with their longer cross sectional dimensions vertical.

8. An optical bench as defined in claim 2 wherein said carrier is a plate having an edge which defines said primary edge and in which said notch is formed.

9. A fixture for mounting an optical element on said carrier of claim 2, including:
a. a turntable having a vertical axis of rotation;
b. a primary boss on the upper surface of said turntable corresponding to said primary way and engageable by said primary edge of said carrier; and
c. a secondary boss of circular cross section on the upper surface of said turntable and corresponding to said secondary way and having diametrically opposed portions respectively engageable by said oppositely facing edges of said notch in said carrier.

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