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3,822,943

United States Patent [19]

Mason

[11] **3,822,943**

[45] **July 9, 1974**

[54] **APPARATUS FOR ESTABLISHING A VISIBLE PLANE OR FAN OF LIGHT**

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[22] Filed: **Feb. 28, 1973**

[21] Appl. No.: **336,697**

[52] **U.S. Cl.** ..... **356/138,** 356/247, 350/285, 350/289, 331/94.5 A

[51] **Int. Cl.** **G01b 11/26**

[58] **Field of Search** ..... 356/138, 153, 167, 172, 356/247; 350/285, 289; 331/94.5 A

[56] **References Cited**

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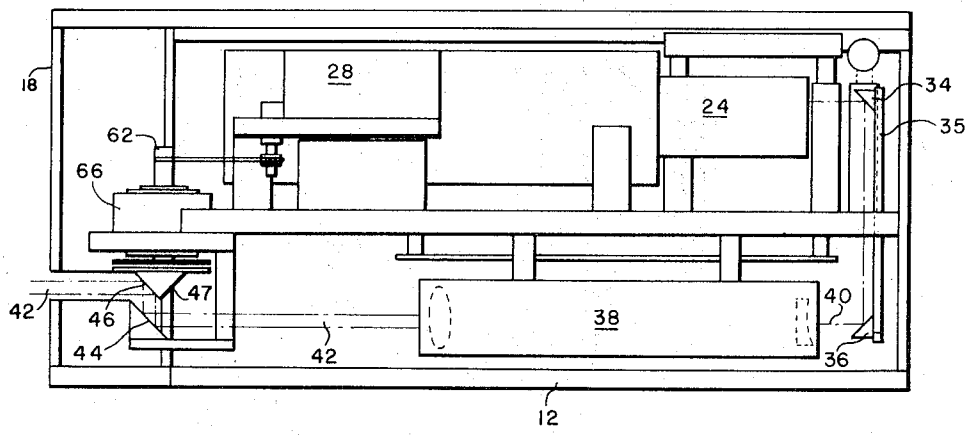
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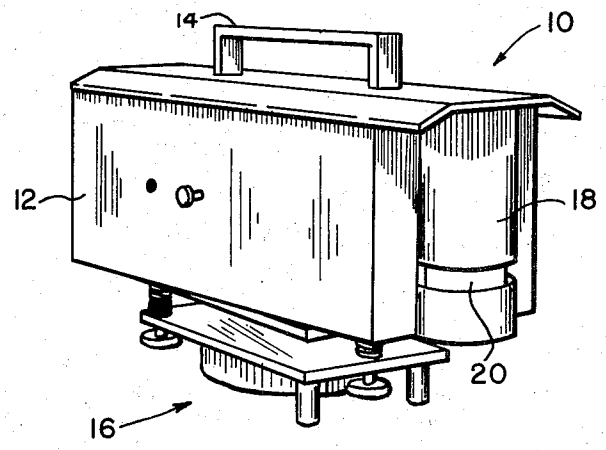
Primary Examiner—Ronald L. Wibert
Assistant Examiner—Paul K. Godwin
Attorney, Agent, or Firm—Cameron, Kerkam, Sutton, Stowell & Stowell

[57] **ABSTRACT**

An apparatus for establishing a visible plane or fan of light. The plane is generated by sweeping out a beam of light produced by a laser. The apparatus is leveled by conventional means such as liquid levels, and the plane of light thus establishes a horizontal (or vertical) reference plane useful in building construction.

4 Claims, 8 Drawing Figures





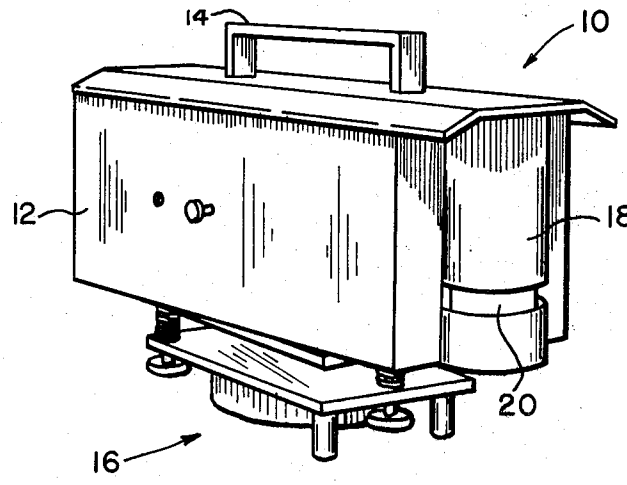


FIG. 1

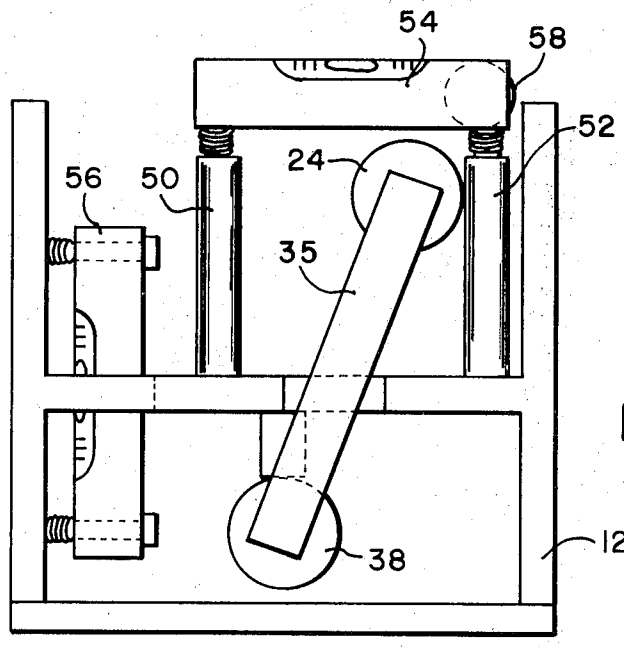


FIG. 4

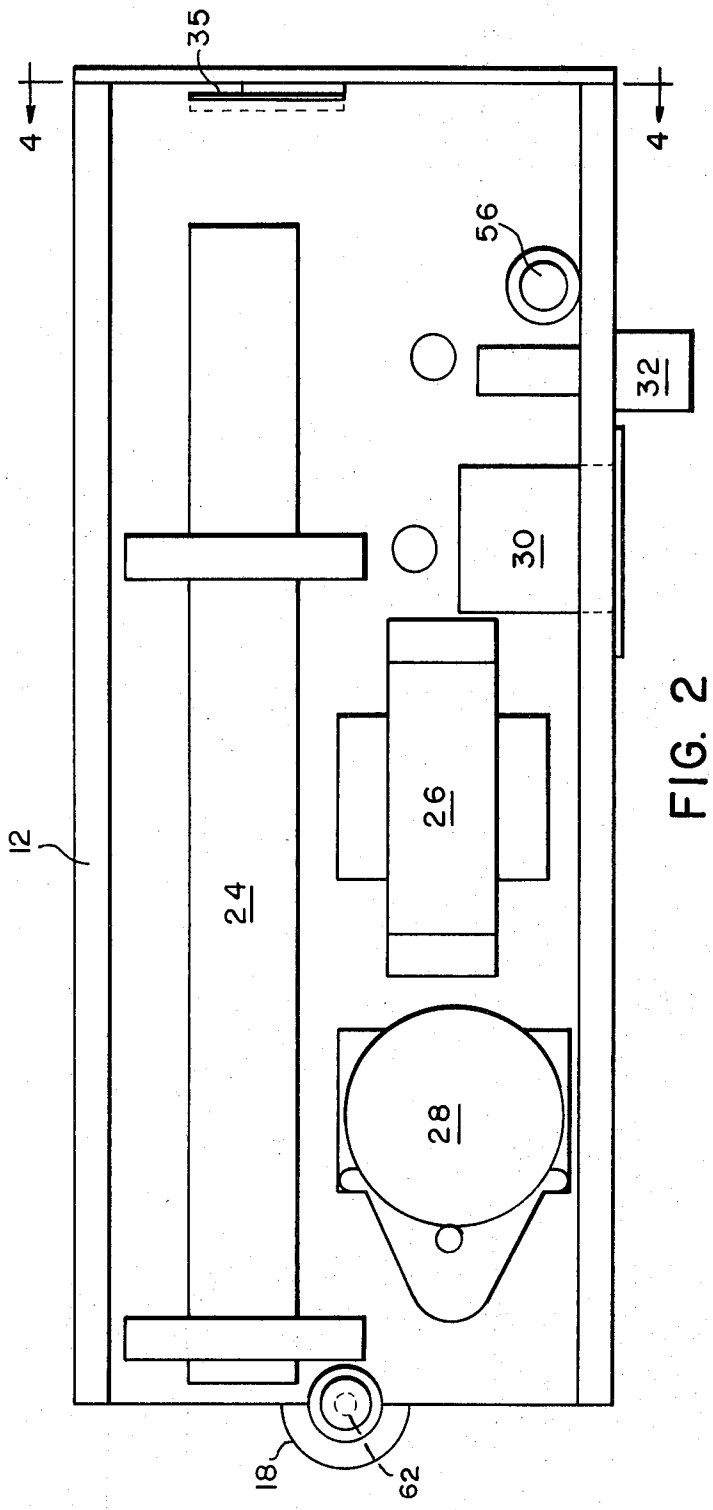


FIG. 2

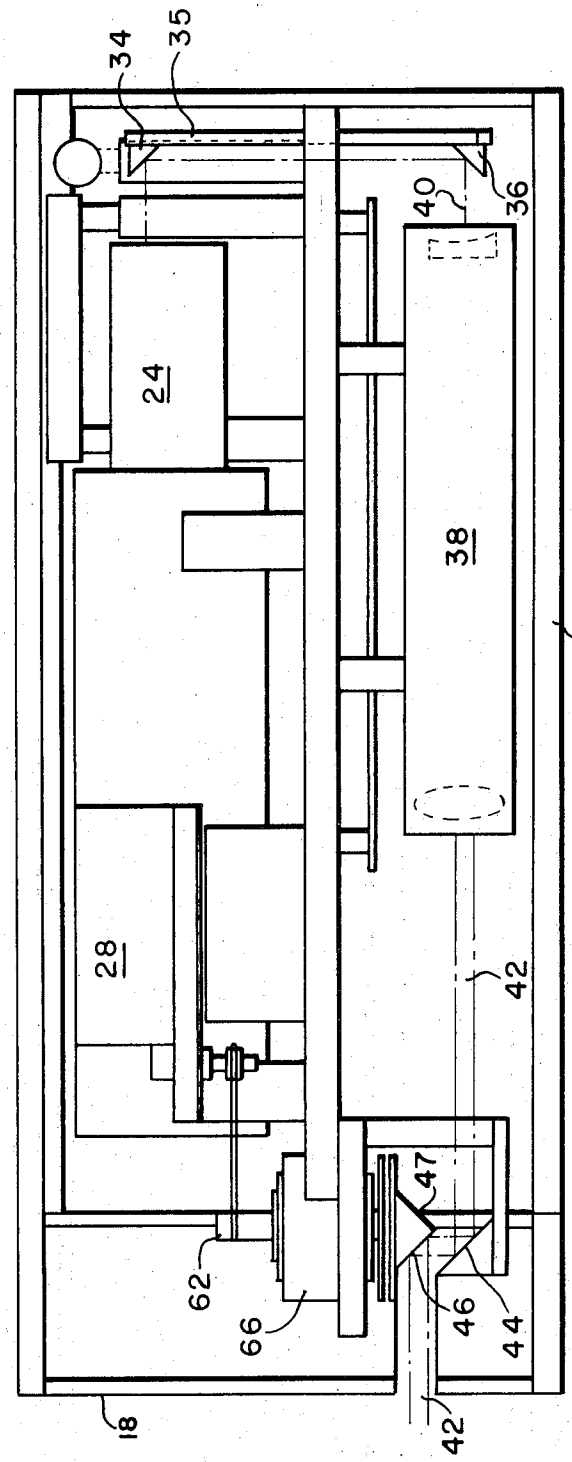


FIG. 3

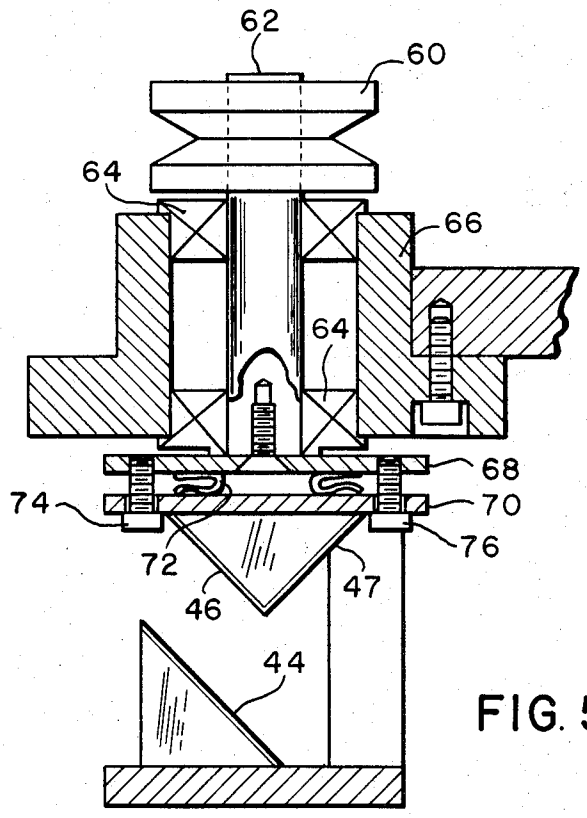


FIG. 5

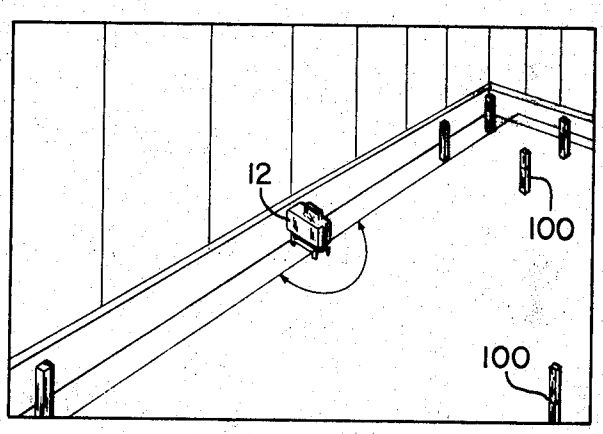


FIG. 6

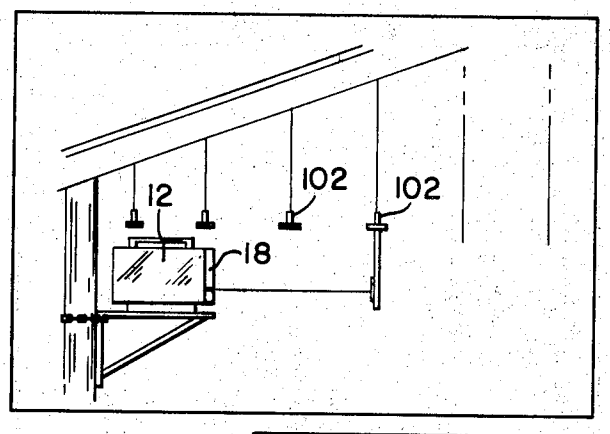


FIG. 7

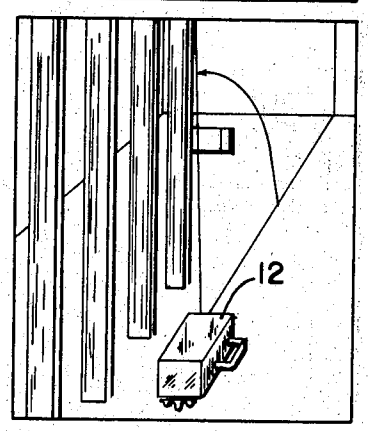


FIG. 8

APPARATUS FOR ESTABLISHING A VISIBLE PLANE OR FAN OF LIGHT

This invention relates to an optical apparatus which displays special utility in the construction arts. The apparatus produces a plane of visible light, generated from a laser source, the plane defining a reference plane which may be either horizontal or vertical.

It is known in the construction arts to employ a swept-out laser beam for purposes of establishing a generally horizontal reference plane. A reference plane may be either horizontal or vertical and displays utility in a wide variety of areas in the construction arts, such as pouring concrete up to a desired level, and establishing the height of various components of a roof or ceiling with respect to a reference datum or level.

The prior art is aware of the use of a rotating laser beam in the surveying and map-making arts. For example, U.S. Patent 3,588,249 issued to Studebaker discloses a transit supported on a plurality of legs and carrying a conventional source of laser beam energy. The laser beam is directed upwardly and strikes a pentaprism. The pentaprism is rotated continuously over a full circle by an electric motor. By leveling the head of the tripod, the laser beam emergent from the pentaprism thus establishes a horizontal reference level. The continuously rotating laser beam strikes a plurality of target devices which may be placed, for example, on various mobile construction vehicles, reference level rods, etc. While apparently satisfactory for its intended purpose, the construction shown in the Studebaker patent does not display complete versatility. For example, it is not apparent how to obtain a vertical reference plane of light with the Studebaker apparatus. A reference vertical plane is often desirable in the construction arts when, for example, it is desired to vertically align a prefabricated wall panel. Further, the use of a pentaprism significantly increases the cost of a device constructed in accordance with the teachings of the Studebaker patent. Such prisms require high optical quality glass because light is transmitted through them.

According to the practice of this invention, these and other disadvantages of the prior art are overcome by the use of a laser beam sweep apparatus which is detachable from the leveling part of the device, to thereby permit rotation by 90° of the swept-out laser beam to establish a vertical reference plane. Further it has been found, according to this invention, that plane silvered mirrors may be employed which materially reduces the cost of the apparatus. The use of plane silvered surfaces as the reflecting elements for sweeping out the laser beam economically yields a plurality of reflecting surfaces so that the speed of rotation of the reflecting surfaces may be lower than the corresponding speed in prior art constructions such as the Studebaker construction. Lower rotational speeds hence place a correspondingly smaller burden on bearings and other associated elements in the rotational train to thereby yield longer operating life. They also make the beam more visible to the eye because they yield more light energy per area per unit time.

In the drawings:

FIG. **1** is a perspective view of the apparatus.

FIG. **2** is a top elevational view of the apparatus with the top cover removed.

FIG. **3** is a side or elevational view with one of the side panels removed.

FIG. **4** is a view taken along section **4**—**4** of FIG. **2.**

FIG. **5** is a partially schematic view showing a cross-sectional detail of certain rotating reflectors illustrated at FIG. **3.**

FIGS. **6, 7** and **8** illustrate typical uses of the apparatus in the construction arts.

Referring now to the drawings, the numeral **10** indicates generally the laser apparatus of this invention and includes a housing **12** provided with a handle **14** for carrying the apparatus. The numeral **16** denotes generally a conventional leveling mechanism whose purpose is to support the housing **12** and, by conventional screw mechanisms, to adjust the inclination of the base of the frame **12.** One end of the frame is provided with a semi-cylindrical wall **18,** the latter including a curved glass **20** through which a laser beam is adapted to pass.

Referring now to FIG. **2** of the drawings, the numeral **24** denotes a laser of any conventional construction and, in the preferred embodiment illustrated, may be defined as a helium-neon laser which projects red light. A transformer **26** and high voltage power supply is coupled conventionally to laser **24.** A motor denoted by the numeral **28** is positioned at one end of the interior of frame **12.** The numeral **30** denotes a connector to a source of power and a fuse housing **32** is provided. Referring now to FIG. **3** of the drawings, the numeral **34** denotes one reflecting surface mounted at an end of support bar **35,** the lower end of this bar carrying a second reflecting surface **36.** The numeral **38** denotes a laser beam expander, of conventional construction, which may include a plano-concave entrance lens and a convex exit lens, whose function is to expand laser beam **40** emanating from laser **24** from a diameter of approximately 1 millimeter to a diameter of approximately 1 centimeter. The primary function of the beam expander is to reduce the divergence of the laser beam. While the beam expander expands the diameter of the beam **10** times, it also reduces the annular divergence by a factor of **10.** This gives a smaller, brighter spot at a distance. (300 ft) The laser beam emanating from expander **30** is denoted by the numeral **42** and strikes stationary prism **44** having a silvered exterior reflecting surface at an angle of 45° to the horizontal. The numerals **46** and **47** denote adjacent silvered exterior surfaces which are rotated, as will be explained in more detail later. The faces **46** and **47** are at right angles to each other, the arrangement being such that upon reflection, beam **42** from surface **44** is reflected from surface **46** and sweeps out a beam approximately 180° in angular extent. When surface **46** rotates far enough such that it occupies the position of other surface **47,** the latter surface will now receive light from reflecting surface **44** and similarly will sweep out a beam approximately 180° in angular extent.

Referring now to FIG. **4** of the drawings, it is seen that laser tube **24** is slightly offset from the center of housing **12,** at the top portion thereof, while beam expander **38** lies approximately contrally of the lower portion of housing **12.** Mirror support bar **35** is thus angularly positioned with respect to the vertical. Posts **50** and **52** support liquid bubble level **54,** of conventional construction. The bubble levels **56** (FIG. **2**) and **58** as well as **54,** are viewed by corresponding openings in the

housing. The bubble level devices are luminated by wasted light from the laser.

FIG. 5 of the drawings illustrates a construction which insures that the beams from reflecting surfaces **46** and **47** are deflected the same amount. Otherwise, each 180° of revolution would result in alternate raising or lowering of the beam. The numeral **60** denotes a pulley driven by a belt attached to motor **28.** Shaft **62** is supported by anti-friction elements such as ball bearings, schematically designated by the numeral **64.** These bearings are mounted in a housing **66.** Reflecting surfaces **46** and **47** are mounted on apertured plate **70.** Another plate **68** is mounted parallel to plate **70** and is spaced therefrom by means of a plurality of berylium copper springs denoted by the numeral **72.** Threaded fasteners **74** and **76** pass through the apertures in plate **70** and thread into plate **68.** Plate **68** is fastened to rotating shaft **52** by the indicated threaded fastener. It is seen that by adjusting threaded fasteners **74** and **76,** parallelism of plate **70** with respect to plate **78** is effected. This places reflecting surfaces **46** and **47** in proper relation so that the reflected laser beams from each lie in the same plane.

Reference now to FIGS. **6, 7** and **8** illustrates several of the uses to which the above-described apparatus may be put. In FIG. **6,** the apparatus is shown as applied to the pouring of concrete slabs. The rotating laser beacon or beam sweeps through approximately 180° and the beam provides a level reference plane of light over the pouring area. The illustrated pegs may be provided with targets, of conventional construction, and may be defined, for example, by a line **100** on a translucent sheet. The targets are set to the difference between the height of the beam and the final sub-grade elevation. The sub-grade is leveled until the spinning laser beam hits the line on the target anywhere in the pour area.

Referring now to FIG. **7,** the apparatus is illustrated as displaying utility in a suspended ceiling installation. With the level apparatus **12** set up at a known distance below finished ceiling height, a fan or plane of light is established parallel to the ceiling. By putting a target on each successive channel **102** as it is being hung, the laser beam intercepts the line on the target and indicates when the channel is level. A number of workers can accordingly utilize the laser beam at the same time anywhere within the enclosure being constructed.

FIG. **8** of the drawings illustrates the utility of the device for the purpose of establishing a vertical plane of laser light. Housing **12** is simply lifted off of leveling mechanism **16** and placed on its side. The leveling mechanism is then adjusted so that the swept out laser beam will lie in a vertical plane, as indicated by the bubble level indicators. A target may, successively, be placed against vertical wall beams. When a target is placed against the wall beams (or a prefabricated wall) and the rotating beam falls on a line on the target, the vertical beams will be straight and plumb. While convenient in many applications a target is not essential, as a yardstick or marked block of wood will serve as well.

The apparatus is calibrated at its place of manufacture so that the final fan of light generated by the laser beam is horizontal, as will be indicated by the bubble level indicators.

While the invention has been described with reference to a laser beam, any (collimated) light beam of relatively small cross-section may be employed. Hence the adjective laser in the claims is intended to embrace any such beam.

What is claimed is:

1. An optical apparatus for projecting a sweep laser beam, to thereby define a reference plane, the apparatus including,

a. a source of visible laser light,

b. a generally rectangular housing supporting and containing said laser source,

c. a leveling mechanism supporting said housing,

d. rotatable reflecting surface means for intercepting a laser beam from said laser source and causing the beam to repeatedly sweep out a light plane over angular areas, said rotatable reflecting surface means contains a plurality of reflecting surfaces and rotates about an axis extending along one wall of said housing, whereby a portion of said rotatable reflecting surface means extend beyond the plane of said one housing surface,

e. a generally semi-cylindrical wall attached to and extending out from said one housing surface, the axis of rotation of said rotatable reflecting surface means being substantially coincident with the longitudinal axis of said semi-cylindrical wall, whereby the rotatable reflecting surface means is housed by both the housing and the semi-cylindrical wall,

f. an optical window in said semicylindrical wall to permit egress of the laser light and to thereby sweep out 180° without interference from the housing.

2. The optical apparatus of claim **1** wherein said rotatable reflective surface means is defined by a plurality of planar reflecting surfaces which lie in intersecting planes, said reflecting surfaces rotatable about an axis parallel to a laser beam incident onto said rotatable reflecting surface means, whereby the planar reflecting surfaces repeatedly pass into and out of the laser beam path to repeatedly sweep out a reference plane of visible light.

3. The optical apparatus of claim **2** including a laser beam expander for increasing the diameter of a laser beam from said laser source, said beam expander positioned in the optical path of a laser beam from said laser source to said planar reflecting surfaces.

4. The optical apparatus of claim **2** wherein said planar reflecting surfaces are two in number and lie in planes at right angles to each other.

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