

**United States Patent** [19]  
**Van Sant**

[11] **Patent Number:** 4,856,871  
[45] **Date of Patent:** Aug. 15, 1989

[54] **REPLACEABLE LASER AND LENS ASSEMBLY**

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[21] **Appl. No.:** 91,182

[22] **Filed:** Aug. 31, 1987

[51] **Int. Cl.<sup>4</sup>** ..... G02B 7/02

[52] **U.S. Cl.** ..... 350/253; 369/122

[58] **Field of Search** ..... 350/502, 571, 417, 252,  
350/253; 369/122

[56] **References Cited**

**U.S. PATENT DOCUMENTS**

4,504,935	3/1985	Jansen	358/213
4,551,760	11/1985	Bendell	358/213
4,587,563	5/1986	Bendell	369/32
4,685,303	8/1987	Branc et al.	369/19 X
4,815,059	3/1989	Nakayama et al.	369/45

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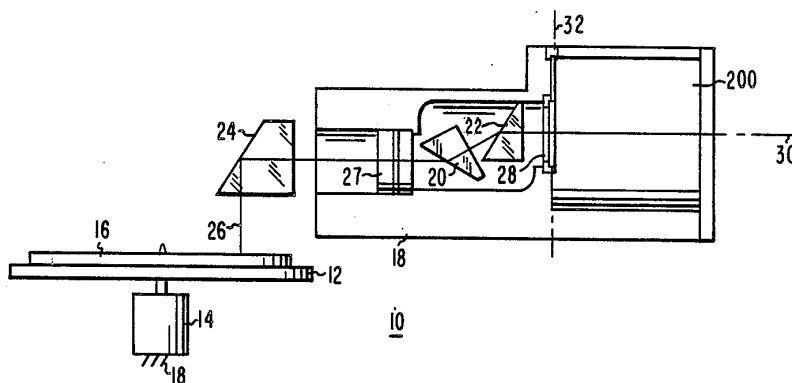
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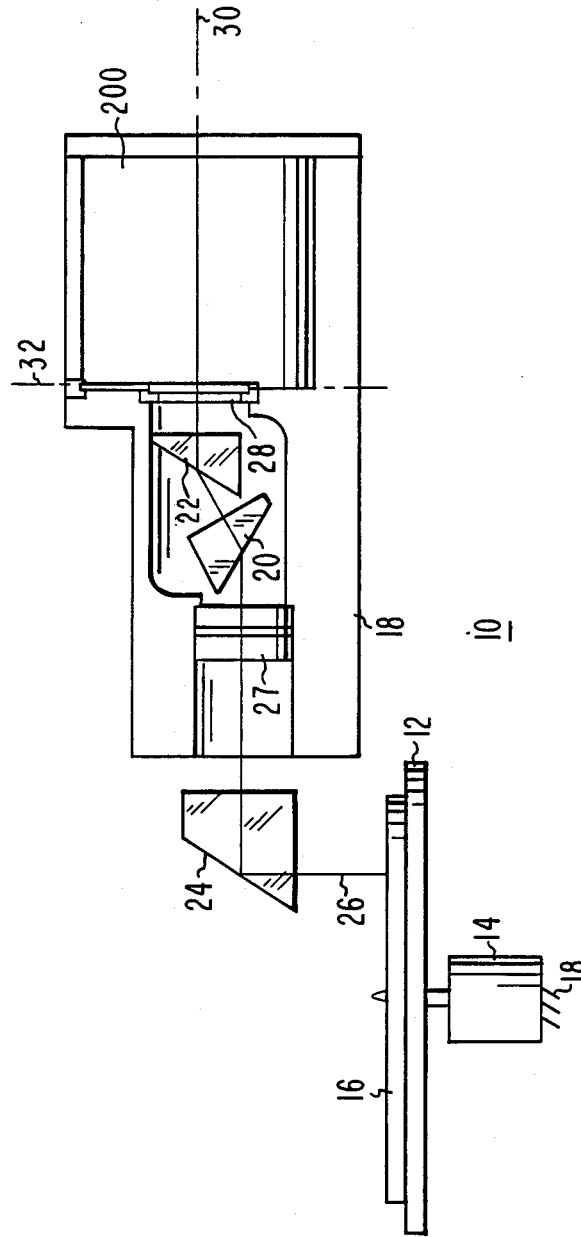
[57] **ABSTRACT**

An optical recorder such as a data recorder has an interchangeable, prealigned laser diode/lens module

arrangement which can be readily replaced without complex realignment of the recorder. The module includes a cylindrical outer housing/heat-sink, and a tiltable yoke within the outer housing/heat-sink. A heat pump such as a thermoelectric element has a hot side coupled to the yoke, and also has a cold side. A combination mount is at least thermally cantilevered from the cold side of the thermoelectric element, and is thermally isolated from adjacent structures. A laser diode is bonded to a structure within the combination housing, and a lens is loosely mounted at the light-emitting end of the combination housing. The module is prealigned by operating for a period sufficient to achieve thermal stability in a fixture which is dimensionally identical to the optical recorder with which the module is to be used. When thermal stability has been achieved, the yoke is tilted, and the position of the lens is adjusted in order to achieve focus at a selected location relative to the reference plane. The lens is then secured in the selected position. That position will remain constant or substantially constant as the ambient temperature changes. This enables the optical recorder to be operated at any ambient temperature needing virtually no adjustment to the optical alignment.

20 Claims, 6 Drawing Sheets





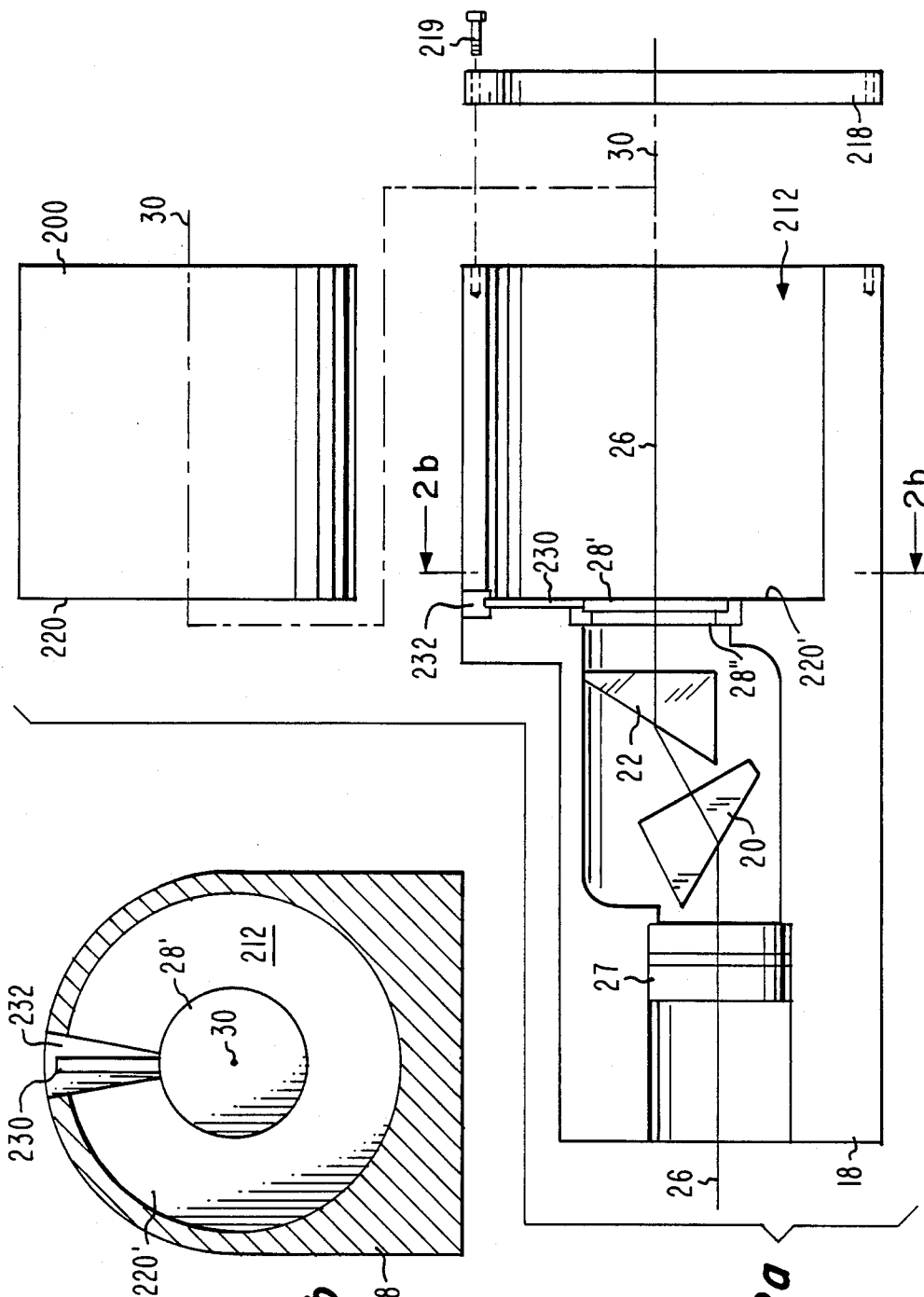


Fig. 2b

Fig. 2a

## REPLACEABLE LASER AND LENS ASSEMBLY

This invention was made with Government support under Contract No. F30602-85-C-0193 awarded by the Air Force. The Government has certain rights in this invention.

This invention relates to an assembly of a light-emitting device such as a laser diode with a focussing lens, which is arranged as a modular unit which focusses the light emitted at a predetermined distance from a reference plane.

Modern data techniques may require the handling and storage of large amounts of high-rate data. For example, data processing and storage at rates in excess of tens of megabits per second may be required. Optical disc recorders have been devised for recording and reproducing data at such high data rates by means of focussed light beams. Permanent optical storage discs for archival purposes are known in which recording is accomplished by a high-intensity focussed data-modulated light beam, which forms a permanent pattern of data-representative pits on the record track. The pits have a reflectivity which differs from that of the surrounding surface of the disc medium, and their presence or absence may be detected by the changes in the magnitude of the light reflected by the recorded and unrecorded portions of the disc in response to a low-intensity read light beam. Reusable recording media are also known in which a data-modulated high-intensity light beam makes reversible changes in the polarization characteristics of the medium surface. Such media may be erased by the annealing effect of a gradually-decreasing intensity erase light beam. Reading is accomplished in one such system by comparing the polarization of the reflections from recorded and unrecorded portions of the surface of the medium when illuminated by a low-intensity read light beam.

In optical data recorders, the light-emitting device is often a solid-state laser diode or array of laser diodes. At the present state of the art, such laser diodes have light-emitting characteristics as a function of drive current which change from time to time as the diodes age. Also, probably because of the relatively high electrical drive required to achieve the intense light required for recording onto the record medium or for erasing erasable media, the laser diodes are subject to failure. When a laser diode of a laser diode array fails, it may be possible to switch to an unused diode of the array. Ultimately, however, the laser diode or laser diode array must be replaced.

When the laser diode or laser diode array of a recorder is replaced, the light-emitting point of the replacement diode(s) must be placed in precisely the same position as that of the previous diode in order to achieve focus at the surface of the disc, or the optical system must be realigned in order to achieve the desired performance. Exact placement of the laser diode is difficult to accomplish because the laser diode, when in operation, may produce a great deal of heat, which changes its temperature and that of the surrounding support structures. As known, the dimensions of the support structures may change under the influence of temperature, thereby affecting the point of focus. Realignment of the optics may require specialized test fixtures, and may also require the changing of lenses.

The recorder may be used at a location at which specialized optical alignment gear and techniques are

not readily available. In that event, the data recorder in which the laser diode has failed must be returned to the factory for installation of a new laser diode(s) and for realignment. As a result, the data recorder is unavailable to its user for a protracted period, or the user must keep on hand spare units, which may be a considerable expense, as well as requiring inventory control.

It is desirable to arrange an optical data recorder with a light-emitting module which can be readily interchanged by relatively unskilled personnel.

## SUMMARY OF THE INVENTION

A data recorder/playback apparatus (recorder) using a light-sensitive medium includes means for generating relative motion between the medium and a light beam. A mutually orthogonal reference plane and reference axis are provided in the recorder, and an optical system accepts light leaving the reference plane parallel with the reference axis and translates it to the medium. A modular combination of a light-emitting device and a lens includes a second mutually orthogonal reference plane and axis, and is prealigned to cause the light to leave parallel with the second axis, and to focus at a predetermined distance from the reference plane. The reference plane and axis of the modular combination are readily made congruent with the reference plane and axis of the recorder, so that any prealigned modular combination may be used with the recorder, without further complex alignment.

According to another aspect of the invention, the modular combination includes a focussing lens and a light-emitting device which may require cooling during operation. A heat pump including a cold surface and a hot surface is adapted to be energized for cooling the light-emitting device. A first mechanical and thermal coupler is coupled to the cold surface of the heat pump, to the light-emitting device, and to the lens, for holding the lens in a selectable position on the axis and before the light-emitting device, at least thermally cantilevered from the cold surface of the heat pump. The first mechanical and thermal coupler is constructed from materials, dimensioned and thermally isolated from adjacent structures such that, during operation, a substantially uniform temperature is maintained over the entirety of the first mechanical and thermal coupler. A second mechanical and thermal coupler is connected to the hot side of the heat pump for holding the first mechanical and thermal coupler and its associated lens and light-emitting device, and the heat pump, at least thermally cantilevered in position with the axis substantially orthogonal to a reference plane, and for sinking heat received from the hot side of the heat pump. The selectable position of the lens is selected, and the lens is fixed in the selected position, under normal operating conditions, with the light beam focussed at a predetermined distance before the reference plane.

## DESCRIPTION OF THE DRAWING

FIG. 1 is a simplified schematic view of an optical recorder including an optical disc recording medium, a motor for spinning a turntable, a recorder housing, a common reference plane and common axis, a modular light source, and an optical system;

FIGS. 2a and 2b, referred to jointly as FIG. 2, illustrate in FIG. 2a a simplified schematic view, partially exploded, of the optical system including a common reference plane and axis, the recorder housing and the modular light source of FIG. 1, and in FIG. 2b illus-

trates a cross-section of the recorder housing illustrating the reference surface and axis;

FIG. 3 is an exploded perspective or isometric view of the modular light source of FIGS. 1 and 2, illustrating a cylindrical module housing which mates with the recorder housing of FIGS. 1 and 2 to make the reference planes and axes congruent, first and second mechanical and thermal coupling elements coupled to the cold and hot sides, respectively, of a thermoelectric cooler, a laser diode and mount, and a lens and lens mount;

FIGS. 4a, 4b and 4c, referred to jointly as FIG. 4, are cross-sections of the module housing of FIG. 3;

FIGS. 5a, 5b and 5c, referred to jointly as FIG. 5, are elevation, cross-sectional and plan views, respectively, of the second mechanical and thermal coupling element of FIG. 3;

FIGS. 6a and 6b, referred to jointly as FIG. 6, are axial and cross-sectional views, respectively, of the first mechanical and thermal coupling element of FIG. 3;

FIGS. 7a, 7b and 7c, referred to jointly as FIG. 7, in FIGS. 7a and 7b are laser-side and rear, respectively, perspective or isometric views of the laser diode mount of FIG. 3, and an end view of the laser diode illustrating its relationship to the axis; and

FIGS. 8a and 8b, referred to jointly as FIG. 8, are axial and cross-sectional views, respectively, of the lens mount of FIG. 3.

### DESCRIPTION OF THE INVENTION

FIG. 1 is a simplified schematic representation of an optical disc recorder/playback arrangement (recorder) 10. Recorder 10 of FIG. 1 includes a turntable 12 driven by a motor 14 for rotary motion. Motor 14 is fixed to the housing 18 of the recorder. A photosensitive disc 16 is mounted on turntable 12 for rotation therewith. Also fixed to housing 18 of the recorder is an optical system including beam expanding prisms 20 and 22, a further prism 24 having a mirrored face for reflecting a light beam or beams, illustrated as a line 26, toward the disc, spectrum limiting wave plates and gratings illustrated together as 28, and other optics represented as 27 required to translate a light beam 26 entering the optical system along or parallel with an optical axis 30 to the disc. Translation of the light beam(s) may include control of the polarization, focussing or defocussing in response to operating mode, beam expansion or contraction, control of the cross-sectional dimensions, beam splitting or combining, offset position and other functions required for operation of the recorder.

In FIG. 2, elements corresponding to those of FIG. 1 are designated by corresponding reference numerals. FIG. 2a illustrates recorder housing 18, with a removable modular light source 200 insertable into a cavity 212 therein. FIG. 2b is a cross-section of the arrangement of FIG. 1a, with module 200 removed, taken in the direction of section lines 2b—2b. Modular light source 200 has the general shape of a right circular cylinder and it fits fully into a right circularly cylindrical cavity 212. Cavity 212 has a central axis 30. Since modular light source 200 has an external shape which is cylindrical to match the shape of cavity 212, modular light source 200 is also symmetrical about axis 30 when inserted into cavity 212, and may be rotated about the axis for adjustment. A cavity dust cover 218 covers the right end of cavity 212 and is held in place by screws, one of which is illustrated as 219. In operation, modular

light source 200 emits light beam(s) 26 congruent with or parallel with axis 30.

The left end of modular light source 200 as illustrated in FIG. 2a includes a flat reference surface illustrated as 220 which is orthogonal to axis 30. Surface 220 is congruent with a reference plane, and is hereafter referred to as reference plane 220 for modular light source 200. Cavity 212 includes matching flat reference surface or reference plane 220', against which reference plane or surface 220 mates when modular light source 200 is fully inserted into cavity 212. When assembled, therefore, the axes 30 are congruent and the reference planes 220 of cavity 212 and of modular light source 200 are congruent.

Also illustrated in FIG. 2 is a lever 230 fitted into a sectional notch 232 cut into recorder housing 18 to a depth, as viewed in FIG. 2b, below reference surface 220'. The inner end of lever 230 is attached to an optical grating 28' to permit small rotary positional adjustments thereof, for controlling polarization-sensitive characteristics of the light beam. A spectrum-limiting waveplate is illustrated as 28" in FIG. 2.

FIG. 3 is an exploded perspective or isometric view of modular light source 200 of FIGS. 1 and 2. In FIG. 3, an outer housing 410 of modular light source 200 has the exterior shape of a right circular cylinder centered on axis 30. At the left end of module housing 410 of FIG. 3, reference surface 220 defined by the end of module housing 510 can be seen to be annular, and coincident with a reference x-y plane which is orthogonal to axis 30. Housing 410 is formed from a thermally conductive material such as aluminum. As described below, housing 410 provides mechanical and thermal support for structures supporting the light emitting device, which may be a laser diode.

Housing 410, which is illustrated in axial and side cross-sectional views in FIGS. 4a and 4b, includes a through central cavity 412 having a cross-section over the principal portion of its length which includes mutually opposed first and second straight sides 414 and 416. Other portions 415, 417 of the interior of cavity 412 are curved or circular. Housing 410, as illustrated in FIG. 3, is partially cut away to reveal interior details. At the extreme rear end of housing 410 is a circular aperture 418 having a smaller diameter than the diameter between circular surfaces 415 and 417. A dust cover 320 is affixed to the rear of housing 410 by a plurality of screws, one of which is illustrated as 322, for covering aperture 418.

Referring to FIGS. 3 and 4, a pair of coaxial apertures 424, 426 are defined through the walls of housing 410, centered between the upper and lower sides of flat portions 414, 416. A further pair of curved through slots 428, 429 penetrate the walls of housing 410 with a radius centered on the axis of apertures 424, 426. As illustrated in the cross-section of FIG. 4c, the outer portion of the walls of housing 410 in the region around slots 428, 429 is undercut by depressions 427, 430, respectively, for the purpose of countersinking the heads of screws described below. A pair of coaxial jack screws 332, 332', with their common axis disposed parallel with the Y axis, are threaded into threaded through holes 434, 434', respectively, formed in the sides of housing 410, as illustrated in FIG. 3.

In FIG. 4a, threaded apertures 422' formed in the back wall of housing 410 are visible. Threaded apertures 422' accept screws 322 (FIG. 3) for holding dust cover 320 (FIG. 3) onto housing 410.

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