Development of Fall 2002 Model ECLIPSE AVN9902HD

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HDD Navigation built-in HDD/DVD/MS VGA-AV System　AVN9902HD

Satellite images provided by Japan Space Imaging Corporation.

Abstract

Despite the stagnating in-car audio system market, the car navigation system market has shown rapid growth over the past few years. Our company has steadily developed the market since introducing the world's first AVN Unit in 1997. In the spring of 2002, we attracted the attention of the market by adopting a VGA display and developing a highly detailed satellite photomapping navigation system. Sales leveled off, however, due to a rapid drop in prices and a shift in market interest from DVD to HDD navigation systems. To overcome this situation, we will further develop the advantages of VGA and introduce new AVN technology that supports silicon audio (Memory Stick) and dual hard disk drive configurations for navigation and Music Juke.

1 Introduction

In the spring of 2002, our company released a new AVN(Audio Visual Navigation) unit into market, equipped with a VGA (Video Graphics Array) that achieves high resolution that is at least four times that of a conventional display. The beauty of the picture has been received well by the market.

Currently, market demand for car navigation systems is heading in two bipolar directions (highly functional products and low-cost products), with our company's VGA-equipped AVN belonging in the highly functional product category. To further meet market demand, we have strived to create highly functional products that have never existed before. Therefore, we developed the AVN9902HD, a system that is equipped with a navigation HDD, music HDD, and Dolby Digital and DTS decoder, as well as a route display, own-vehicle position display, and travel function that are supported by IKONOS satellite imagery.

This report introduces the system's functions and technology.

Satellite images provided by Japan Space Imaging Corporation. **JSI**

Fig.1 AVN9902HD

Note: The IKONOS satellite is the world's first commercial earth observation satellite. It was launched in September 1999 from Vandenberg Air Force Base in the United States.

It can take high-quality photographic images around the globe at a resolution of 1 meter.

2 Product overview

The following is a summary of the Eclipse 2002 fall model "AVN9902HD".

Standard component

External size: 2-DIN (W180× H100× D165 mm)
Mass: 3.3 kg
Installed drive: DVD/HDD
Operation method: Main unit operation (touch screen control + front panel switch)
                 Remote control operation

Display unit

6.5-type wide VGA display
Screen size: W144× H78.2 mm
Pixels: 1,152,000 (H2400× V480)
Display function: Multi-window function

AV unit

Fig.2 Audio menu

Radio (AM/FM/FM multiplex)
Television (1-62 ch, multi-channel support)
CD (CD-R/RW support)
DVD video playback
MP3 playback
Memory Stick playback
Music Juke recording and playback (with auto titling function)
CD database (230,000 titles)
VTR input, rear seat TV output

Navigation unit

HDD navigation
Satellite shot function (route display, own-vehicle position display/travel)
Multi-window function
Built-in FM-VICS
2-media VICS unit accessory

Sound quality unit

Sound field control/graphic EQ/position selector
Dolby Digital (5.1 ch), DTS (5.1 ch) support
50W× 4 amps

System upgrade equipment

    CD changer

    MD changer

    Center speaker

    Subwoofer

    ETC (electronic toll collection) unit (automatic toll collection system for high-speed roads)

    Rear view camera

    10-key remote control

3   *Main features*

This section describes the main features of the system.

3.1 Twin HDD

This system is equipped with two separate 20-GB HDDs, one for navigation and one for audio. Two are used in order to support an expansion of the satellite imagery area and to support version upgrades. Another advantage is that recorded music can still be used even if the navigation HDD is removed when a map is updated.

3.2 Music Juke function

This system utilizes a recording function. The 20-GB HDD can record up to 3,000 songs and can support both digital and analog recordings. Digital recordings must be on a CD. Once a CD is inserted, recording starts automatically. Switching between automatic recording and manual recording is also possible. Digital recording supports background recording. This makes it easy to record a CD while watching TV or listening to the radio. When digitally recording, the user can search a (230,000-item) title database on the HDD, based on the CD's TOC information. If the value calculated from the TOC matches the value attached to the database title information, attribute information such as the album title, track title, artist's name, and genre name can be assigned (auto titling). This function includes six play mode patterns. The design enables the user to select a playback method that suits his or her taste and makes it easy to select a song from among a vast number of songs. This improves convenience and differentiates the system from those of other companies (Figure 3).

3.3 Satellite shots (IKONOS satellite imagery navigation)

Starting with the 2002 summer model, "IKONOS satellite imagery" was adopted for navigation. With the current system, however, three new functions were added in order to raise the quality of the satellite shots. First, in contrast to the fixed satellite image displays that have been used in the past, a screen scroll that appears on the satellite image display has been developed, making it possible to use satellite imagery with the feel of an ordinary map. Next, own-vehicle position tracking, a guided route display, and a heading-up function were added. With route guidance it is possible to display essential navigation functions such as enlarged intersection maps and lane displays. The development of such functions has had a great impact on customers, providing realism that was lacking in past navigation systems, as well as practicality and ease of use (Figures 4 and 5).

Fig. 4 Navigation screen display (example)

Fig. 3 Play mode

Fig. 5 Photo of route guidance

3.4 Multi-window function

Applications from the 2002 summer model that received favorable reviews from customers were retained, and their functions were upgraded.

The 2002 summer model had a three-drive configuration that jointly utilized a map disc and DVD video with the DVD drive. Since the new system employs HDD navigation, it is now possible to display maps and DVD videos on two screens. This original function, which is not used by any other company, has improved convenience (Figure 6).

Fig. 6 Dual-screen display of map and DVD video

3.5 Support for DVD video 5.1-channel surround sound

Each year as DVDs have grown in popularity, there has been a growing number of requests from people who would like to play DVD videos in their vehicles. Although several of our company's AVN systems support DVD videos, this new system is not only equipped with the conventional functions but has a built-in 5.1-channel surround sound decoder, which improves the functional level.

With the addition of 5.1-channel support, the system can individually output the sound of each speaker that has been recorded on a DVD. As a result it is possible to provide the vehicle interior with acoustic space that is brimming with more presence than past systems produced.

Fig. 7 Speaker size switching screen/SP distance adjustment screen

If the center speaker and subwoofer (sold separately) are connected, 5.1-channel surround sound can be experienced. Also, when the presence or absence of the speakers is set up, the system can also support a down mix function that can produce optimal audio output (Figure 7).

A conventional AVN could determine the listening position in a simplified way by using a position selector. The new system, however, is equipped with a time alignment function, which can adjust the orientation in further detail, and a speaker level adjustment function. These functions make it possible for the user to enjoy powerful 5.1-channel audio with more balanced orientation (Figures 7 and 8).

Fig. 8 SP level adjustment screen

3.6 MP3 harmonizer

This system is equipped with an MP3 harmonizer function, which is related to sound quality. The purpose of this function is to correct the sound quality by compensating for broadband signals that do not exist within the MP3 source. It does so by taking signals that generate harmonics from the MP3 source and adding them to the original signals.

3.7 Memory Stick support

This unit can play ATRAC3-format music with a Memory Stick and features "Pic-CLIP," which can customize wallpaper. A form of semiconductor memory, it is used in various types of home appliance products and is thought to be a medium that can grow in popularity in the future.

In closing, the aforementioned functions are essential for a flagship model.

4 System configuration

The AVN9902HD was designed with the basic configuration of the VGA model that was commercially available in the summer of 2002 (AVN8802D). It also supports HDD navigation, audio server function [1], and Dolby/DTS 5.1-channel surround sound during DVD video playback [2].

(A detailed configuration is shown in the block diagram of Figure 13.)

The HDD is a 20-GB type and is used to store large-capacity maps, music, and wallpaper data.

Figures 9 thru 12 show each drive (DVD, HDD), assembly of each circuit board, and finished audio board/server A board.
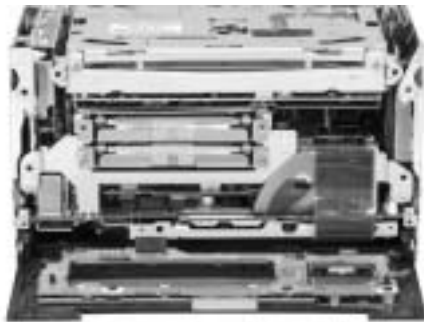
Fig.9 Deck mechanisms

1 Function (Music Juke) that records/plays from CD/FM/AM/TV/CD-MD-CH and plays Memory Stick

2 Requires subwoofer and center speaker sold separately.
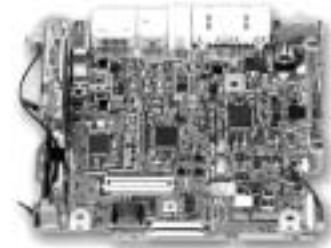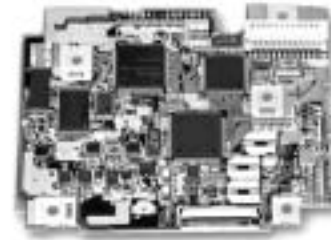

Fig.10 Main circuit board finished product

Fig.11 Server A circuit board finished products (parts mounted side)

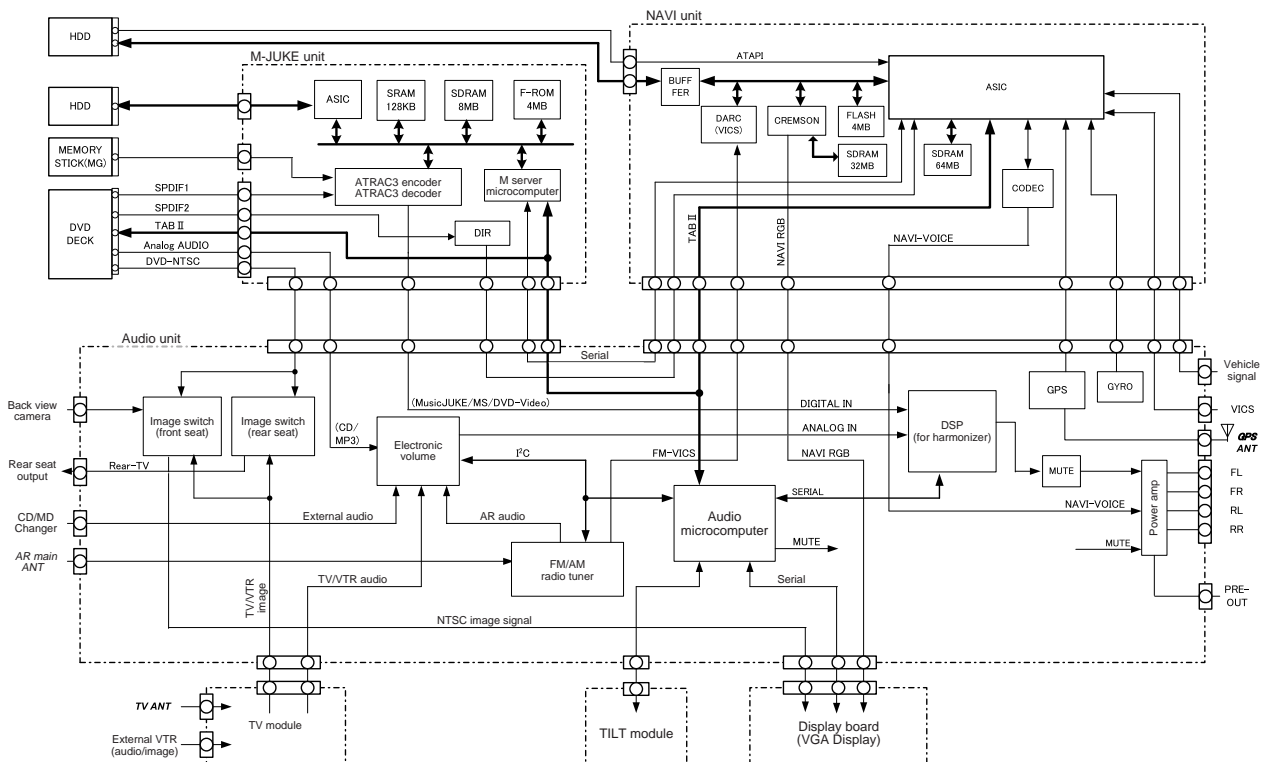Fig.12 Server A circuit board finished products (solder side)

Fig.13 Circuit block diagram

5 Technical development items

This report introduces new items that have recently been developed (audio server, HDD, Dolby Digital and DTS).

5.1 Development of audio server function (system)

The audio server function (Music Juke), first incorporated with the AVN9902HD, automatically assigns a title to data that has been recorded from a CD [3]. It also has six play modes, including artist, genre, and recording date.

Analog voice recording is also possible, and up to 3,000 tracks of data can be stored in the HDD.

5.1.1 Recording/playback function

In order to record and play CDs and analog audio, ATRAC3 encoder/decoder LSI was adopted, compressing data size to approximately one tenth.

During a CD digital recording, digital data that is output from the DVD drive is directly encoded, making it possible to record without the effects of noise.

The Memory Stick utilizes Magic Gate authentication technology and encryption, and is thus compatible as a mechanism that protects the copyright.

The unit uses openMG technology as copyright protection technology for handling music data, making it possible to play music. (It can also download wallpaper data.)

Fig.14 Memory Stick

5.1.2 Control microcomputer

A 32-bit RISC microcomputer has been newly adopted as the audio server control microcomputer. The microcomputer has an operating frequency of 40 MHz and is equipped with SDRAM for work (8 MB), flash ROM for program storage (4 MB), and SRAM for data backup (128 kB).

5.1.3 HDD interface

To connect the audio server control microcomputer and HDD (ATA), a bus bridge ASIC was newly developed, supporting PIO mode 4 [4] and single-word/multi-word DMA mode 2 [4].
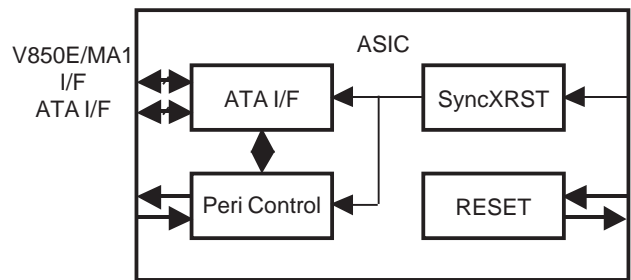
Fig.15 ATA ASIC ic

5.2 Development of audio server function (software)

The primary functions of the AVN9902HD are described hereinafter.

The mechanism supporting the Music Juke function (digital recording from CD to HDD, and playback) will be explained.

5.2.1 Digital recording of song data

When a digital recording of a CD is being made, the digital audio that is output from the DVD drive is compressed by the ATRAC 3 and recorded on the HDD in file units. When this occurs, the user can search a CD information database (CDDB) containing approximately 280,000 titles stored in the HDD based on the CD's TOC information. Album names, titles, and artist names from the song data are automatically assigned (Figure 16).
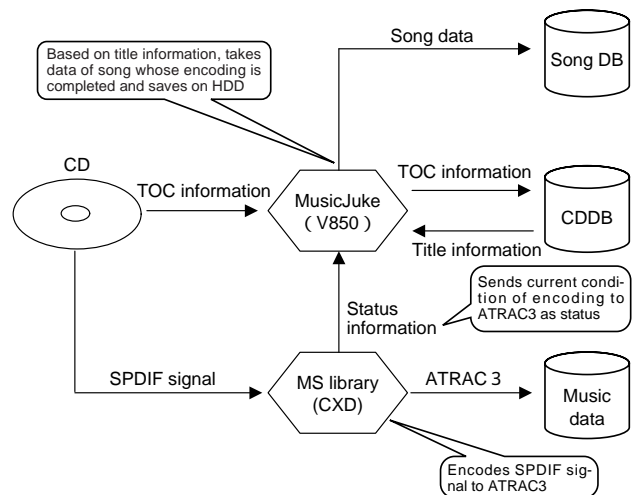
Fig.16 Music Juke recording (digital recording)

The user can also utilize the editing function to freely edit and register song information that has been automatically assigned.

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3 Stores a database containing approximately 230,000 titles (supplied from Gracenote).

4 The maximum (theoretical) transmission rate is 16.6 MB/sec. UltraDMA transmission is not supported.

5.2.2 Music Juke playback function

Song data that has been recorded on the HDD in file units is automatically stratified and controlled in six types of play modes according to the music control database. This makes it possible for the user to select and play music data in the desired play mode (artist, album, genre, etc.).
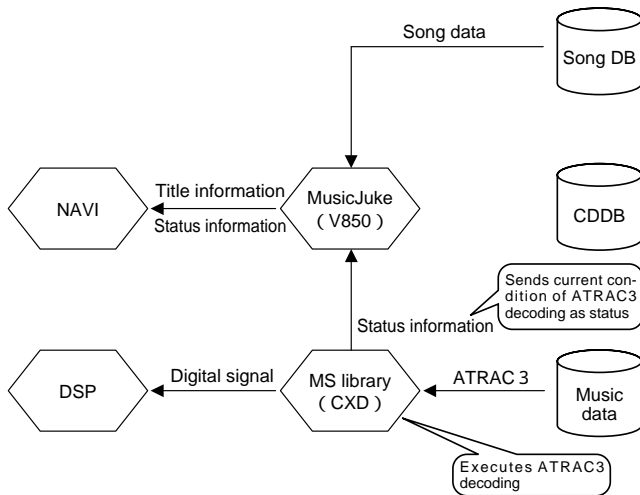

Fig.17 Music Juke playback

5.2.3 Handling of ACC OFF during data write operation

Since the AVN9902HD has a music data recording function, ACC OFF occurs frequently when data is being written. For this reason there is concern that data may be lost if a power failure occurs during a data writing operation.

There is particular concern that the music data stored on the HDD will no longer be playable or that another serious problem will occur if the following items become damaged, since they control the Music Juke recording and playback data:

File allocation table (FAT)

Song database

Key code (security code for Magic Gate authentication)

As a solution, a mechanism that saves this control data in duplicate was developed. Thus, if one set of the data becomes destroyed, the other set can still be used. This protects song information and music data that has been recorded on the HDD.

5.3 Development of Dolby and DTS 5.1-channel function

A decoder is incorporated inside the DVD drive. In combination with the DSPic on the audio board side, it outputs audio for the six channels independently. This makes it possible to express a sense of sound motion and a sense of space.
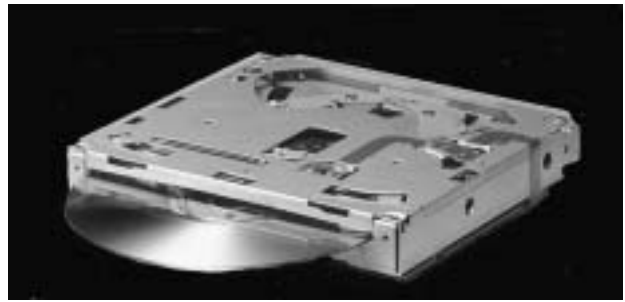
Fig.18 DVD deck mechanism

The newly adopted DVD video decoder LSI circuit is a single-chip LSI circuit whose core consists of a 64-bit DSP and 32-bit RISC CPU. It has an ATAPI IF with Front-end Drive, making it possible to play DVD videos, CDDA, MP3, and DTS-CDs. Dolby Digital 5.1-ch, DTS 5.1-ch, and Dolby Prologic functions are built into a single-chip LSI circuit for the voice decoder.
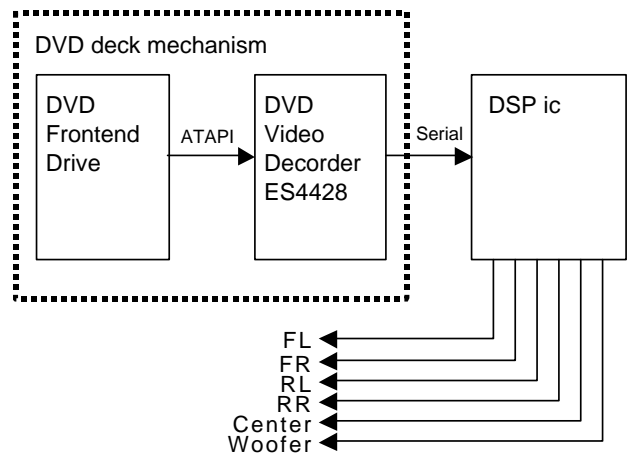

Fig.19 DVD video circuit block

5.4 Support for in-car installation

In order to incorporate the HDD into the AVN, the following items had to be tackled as priority issues during development:

Temperature measures

Vibration measures

Structure allowing HDD removal

5.4.1 Temperature measures

Since the HDD was originally developed for use with a PC, its operating temperature range was narrow. Thus, there was a large gap between its range and that of an AVN.

To enhance the HDD's start-up capability at low temperatures, efforts were made (with the cooperation of the manufacturer) to improve the spindle motor (SPM) inside the HDD.

Since the SPM supports the reading of high-density recorded data, a fluid bearing structure having minimal

rotational shaft runout was adopted. Changing the viscosity of the fluid (oil) improved the critical operating temperature on both the high and low-temperature sides by approximately 10 .

And though the data is magnetically recorded on a disc (magnetic medium), recording becomes difficult when the temperature is low because the holding strength of the magnetic medium increases. To heighten the reliability of data writing operations at low temperatures, a verify function was adopted. This function reads written data, verifies that the data is normal, and writes the next data.

To protect the HDD, the AVN utilizes a system that sets the operable temperature range and, by means of thermistor detection, stops the HDD when the temperature is outside the preset range.

The product is designed to be free of problems even when used in cold climates. When the operating temperature setting for the low-temperature side was being determined, consideration was given to various data, including the minimum atmospheric temperature of a cold-climate city in winter, rise in temperature inside the vehicle compartment when the heater is turned on in a very-low-temperature environment (-30), and the HDD's operating range.

5.4.2 Vibration measures

To secure vibration resistance in the HDD, it is necessary to increase the rigidity of the attachment point. However, when this product was being designed, the reapplication of the main unit also became a subject of discussion, and it became necessary to consider standardizing parts.

As shown in Figure 20, to increase the rigidity by reusing the main unit structure, a reinforcing holder was added to the HDD support. This achieved increased rigidity. To verify the effect of the reinforcing holder in a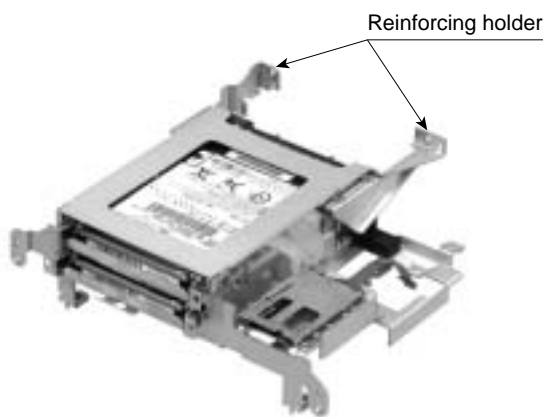 short time period, CAE analysis was utilized to verify that the increased rigidity met the design target value and to determine the holder's shape and fixed point.

During the evaluation of an actual vehicle, an actual-vehicle simulation test was conducted repeatedly, using a triaxial vibration testing machine and based on vehicle G-value data. Feedback of the results was also provided.

Reflecting these examination results, vibration resistance that does not obstruct the Music Juke recording/playback functions was achieved, even during driving tests conducted on poor, unpaved roads.

5.4.3 Structure allowing HDD removal

To enable HDD map data to be overwritten and permit easy removal of the HDD for maintenance, a removable-slide-type structure, as shown in Figure 21, was adopted for the HDD's installation in this system.

To be specific, a self-lubricating resin guide rail is fastened to the HDD mounting chassis. On the HDD side, the slide is fastened to a spring-like plate holder in a way that ensures rattle-free insertion into the guide rail groove, as well as the aforementioned vibration resistance. The structure is such that the slide can be removed and installed to the front and rear along the guide rails.

However, some problems are caused by the simplified removability of the HDD unit. For example, operation can be obstructed if the two HDDs are inserted in the incorrect position. Moreover, the HDD unit can become damaged if the product is removed or installed while the power is on.

Therefore, steps have been taken to resolve these potential problems. To prevent incorrect insertion, the top and bottom HDD slide holders are shaped in a way that prevents such incorrect insertion. To prevent removal when the power is on, a detection switch is set up for the cover over the HDD removal opening, and a protection circuit is installed, automatically switching to ACC-OFF if the cover is opened.
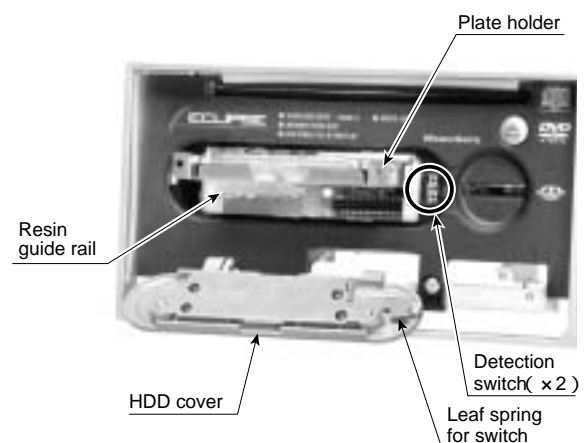

Fig.20 Chassis reinforcing holder

Fig.21 Removable HDD

Also, since the HDD cover's detection switch is in an important area for managing the product's power supply, two of them are used as a fail-safe measure. Thus, if either of them breaks down, the remaining switch can perform the function.

Incidentally, even if vibration or strain is added as a result of the switch actuator being pressed by the leaf spring, steps have been taken to ensure that consistent contact is maintained at all times.

6 ***Conclusion***

This report explained the aims of development and key points of the design of the "Eclipse 2002 fall model AVN9902HD."

We look forward to hearing favorable reviews from the market regarding the ease of using Music Juke (auto titling function that requires no media such as a CD or MD after recording), enjoyment received from the real sound presence created by the DVD video Dolby Digital 5.1-channel system, and the comfort of HDD navigation.

We also look forward to continuing to develop products sought by the market--products that enable people to "enjoy their automobile lifestyle."

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