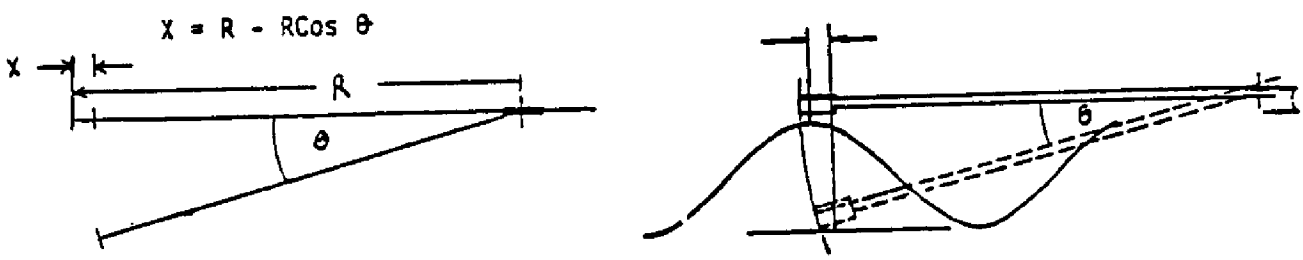
WARP/WOW

As a tonearm travels over a warp in the record, it moves over an arc equal to the angle Ø, as shown in the figure below. The effective length of the arm changes by the cosine "Ø" multiplied by the length of the tonearm. When the arm goes over a warp, the position of the stylus moves ahead or behind the centerline of the record, because of the arc it must go through. This change in position changes the pitch or frequency of the sound being reproduced.

GENERAL RELATIONSHIPS FOR A GIVEN SIZE

1. The longer the tonearm, the less significant warp wow becomes.
2. Warp wow increases with increasing Ø.

For the Model Two, the pivot point is fixed by the air bearing just above the surface of the record, which minimizes warp wow.

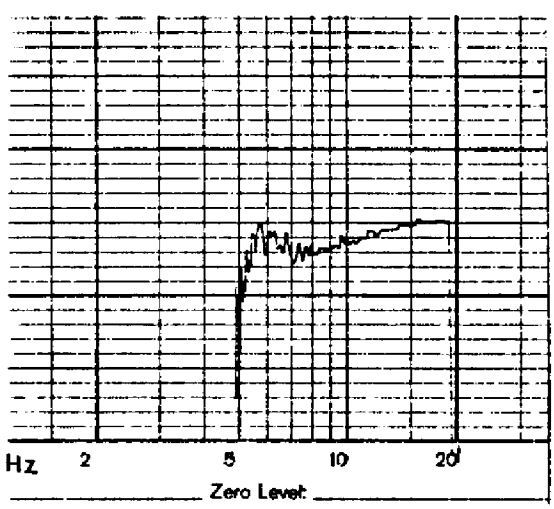


THE EFFECTS OF A WARP ON TONEARM LENGTH

LOW FREQUENCY RESONANCE MEASUREMENTS

The curve below shows the typical response for the vertical resonance of the tonearm. This was done with a medium-high compliance cartridge (30 X 10^{-6} cm/dyne) with a mass of 7 grams and two counterweights (15g + 15g). This counterweight combination gives a vertical effective mass for the tonearm of about 12 grams, which results in a resonant frequency of 6 hz (measured).

Horizontally, the resonant frequency will be much lower because of the tonearms higher mass (30 grams). The horizontal resonant frequency is damped by the decoupling spring and is very well controlled.



TONEARM EFFECTIVE MASS

For conventional pivoted tonearms, the effective mass of the arm is its moment of inertia about its axis of rotation divided by the cartridge distance from the pivot point squared, and is almost the same for all directions of motion.

For the Model Two, this is the case vertically, but for the horizontal plane, the effective mass is the mass of the arm. This is because the arm has no pivot point horizontally. The result is a tonearm with low effective mass vertically and high effective mass horizontally.

Because of this, the low frequency resonance of the arm/cartridge will be different for each plane of motion. The rise in reponse at resonance is usually about 4dB vertically and about 2dB horizontally.

Calculating the resonant frequency of the tonearm:

$$F_{res} = \frac{1}{2\pi\sqrt{C_o\,(M_a + M_c)}}$$

C_o = Compliance of Cartridge in cm/dyne

M_c = Mass of Cartridge (gms.)

M_a = Mass of Arm
5g Vertical
30g Horizontal

VERTICAL TRACKING ANGLE ADJUSTMENT (VTA)

Several articles have appeared which address the area of cartridge performance, Vertical Tracking Angle, (VTA), and Stylus Rake Angle (SRA). We have designed the Model Two tonearm to optimize the vertical tracking angle of a cartridge.

The angle that a cutterhead stylus is placed at when a record is cut results in an included angle in the final disc. This included angle must be duplicated with the reproducing stylus or distortion will result. The problem today lies in standardization of the angle by record manufacturers and corresponding standardization by cartridge manufacturers. Presently most records are cut with resulting vertical angles between 15 and 20 degrees. The average vertical angles of cartridges manufactured today is slightly higher than 22 degrees. The result of this mismatch is less than optimum performance for many cartridges.

Although the vertical energy contained in a record represents approximately 40% of the total energy on the record (60% lateral). The Distortion levels we are dealing with are quite high. In some cases, the vertical performance with certain types of distortion can be improved from 2.5% to 1% or less. (Who would accept an amplifier performance figure of 2.5% THD at 1khz?) In most cases, optimizing the vertical tracking angle will not affect the lateral performance (or frequency response, and

tracking abilities) of a cartridge and the result is an overall improvement in cartridge sound and imaging. However, attention must be paid to both vertical and lateral performance.

There are many other parameters which affect the performance of a cartridge vertically and horizontally (stylus rake angle, tracing distortion, tracking distortion, stylus geometry, etc.). Some suggest that Stylus Rake Angle is the most important parmeter, and if corrected the cartridge performance will be best. We do not know the answer, but we do know that for a given cartridge you cannnot adjust one without changing the other. The correct vertical tracking angle is by no means the only way to improve phono cartridges, but we believe standardization would represent an important step toward optimizing this medium.

CARTRIDGE VTA TEST EXAMPLES

In the following test, the vertical angle of the cartridge is changed and the vertical performance is measured. The angle of a cartridge for optimum vertical performance does not necessarily match the angle for optimum lateral performance. Usually the cartridge will perform best at some compromise angle which is noted. According to most studies, minimum vertical distortion indicates that you are close to the optimum angle. The test record used is the CBS STR 112 which was cut with a resulting vertical angle of 16 degrees.

IM TEST - A standard vertical IM test was used to compare cartridge performance at different VTA's. A distortion figure is taken by observing the FM content above the 4Khz reference tone and noting how far down these components are with repect to this tone. Most IM distortion figures for phono cartridges are measured by disregarding the first FM component and measuring how many dB down the 2nd component is above the 4Khz reference.

SQUARE WAVE TEST - Vertical square waves are displayed on the spectrum analyzer. The harmonic content of a square wave should contain no even ordered harmonics. The presence of even order components indicates certain types of cartridge tracing problems, part of which are vertical. These display the ability of a cartridge to resolve complex harmonic structures accurately.

RATIO in dB	% of READING	RATIO in dB	% of READING
20, (40;60)	10% (1% .1%)	30 (50,70)	3.16% (.31,.031%)
21	8.9	31	2.87
22	7.94	32	2.51
23	7.08	33	2.24
24	6.31	34	2.00
25	5.62	35	1.78
26	5.01	36	1.59
27	4.47	37	1.41
28	3.98	38	1.26
29	3.55	39	1.12

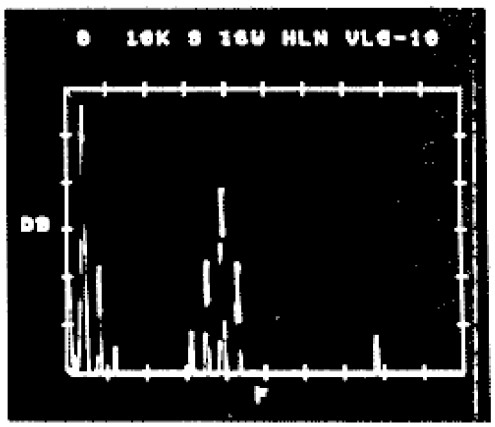
Figure 20 Chart for Conversion from dB's to Percentage Readings

dB DIFFERENCE	ADD TO HIGHER LEVEL
Same (0dB)	3.01
1 dB	2.54
2	2.13
3	1.76
4	1.46
5	1.19
6	.97
7	.79
8	.64
9	.51

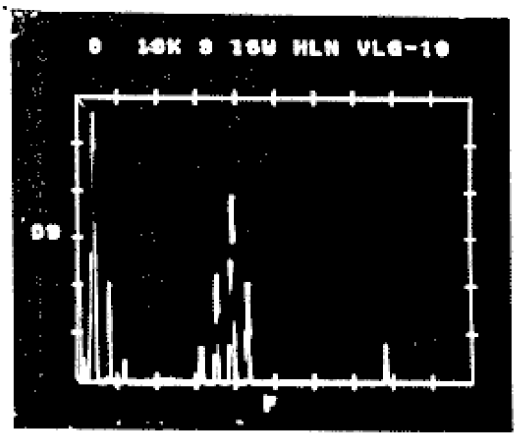
IM TEST EXAMPLE

Measured VTA=22 degrees

cartridge parallel to surface



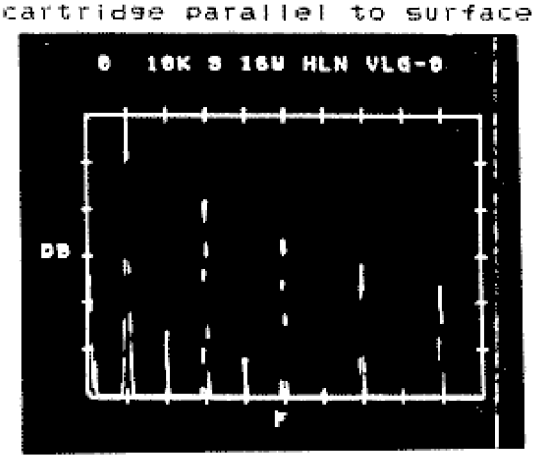
cartridge angle 3 back



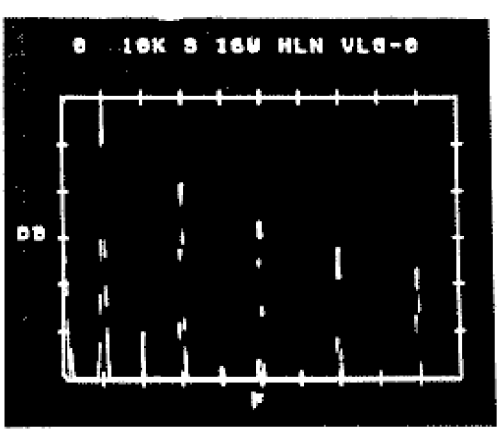
This test shows only a slight improvement (1dB) in IM distortion when the cartridge is tilted to correct for its vertical tracking ange. Distortion for the second FM component improved from -35dB to -36dB, an insignificant amount.

SQUARE WAVE TEST

cartridge parallel to surface



cartridge angle 3 back

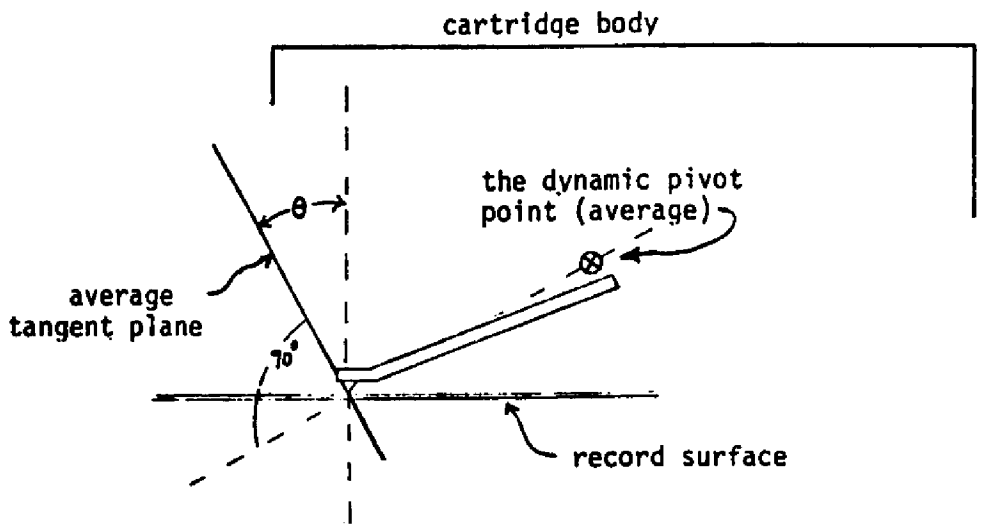


This test revealed a 5dB improvement in the cartridges ability to reject higher even order harmonics of a square wave. The lateral performance (not shown) also improved slightly (frequency response remained the same). You would probably want to use this cartridge with the headshell tilted back about 3 degrees to optimize its vertical angle.

HOW TO USE THE TONEARM TO SET THE VTA

For the example we will use a hypothetical situation which represents what the user will probably encounter with records and phono cartridges presently made.

Our records have been cut with vertical angles of 20 degrees and our phono cartridge has a measured VTA of 21 degrees (from a test report). There is a difference of 1 degree, so the performance of this combination vertically may not be optimum. From the figure, the angle "0" must be reduced by 1 degree in order to match the vertical angles on our records.



THE VERTICAL TRACKING ANGLE θ

Use the VTA dial (set the lever at 0 degrees) and set the height of the tonearm such that the tonearm wand is parallel to the surface of a record. Then adjust the VTA dial to -1 degrees. This will match the cartridge's vertical angle with that of the record.

CONCLUSIONS

1. Not all cartridges will be improved by using them at some angle other than the intended design angle. (The top of the cartridge parallel to the surface of a record.)

2. The European record vertical cutting angle standard closely matches the vertical angles present in phono cartridges today. There is a need for a universal record cutting standard which closely matches this.

3. If the measured vertical tracking angle of a cartridge is high (greater than 22 degrees) its vertical performance will probably be improved by tilting it back (2 or 3 degrees) (front goes up) to match present vertical angles on records.

4. If the measured vertical tracking angle of a cartridge is 18 to 20 degrees, it will probably perform best when its top is mounted parallel to the surface of the record.

5. Some cartridges are very sensitive to small changes in VTA, others are not.

REFERENCES

1. J. White and A. Gust, "Three FM Methods for Measuring Tracking Angles of Phono Pickups," J. Audio Eng. Soc., Vol. 27, No. 9 (1979 Sept.).

2. J. White and A. Gust, "Measurement of FM Distortion in Phonographs," J. Audio Eng. Soc., Vol. 27, pp 121-133 (1979 Mar.).

3. B.B. Bauer, "Vertical Tracking Improvement in Stereo Recording," Audio (1963 Feb.).

4. L. Feldman, "Understanding Turntable Specifications," Radio Electronics, Vol. 51, No. 2 (1980 Feb.).

5. S. K. Pramanik, "Understanding tonearms," Audio, Vol. 64. No.6 (1980 June).

6. C. Schrock, "The Tektronix Cookbook of Standard Audio Test," Tektronix Publication, (1975).

7. J.B. Halter and J.G. Woodward, "Measurement of Distortion Due to Vertical Tracking Angle Errors in Stereodisk Systems," J. Audio Eng. Soc., Vol. 12, pp 8-14 (1964 Jan.).

WARRANTY FORM

NAME.....

STREET ADDRESS.....

P.O. BOX.....

CITY/STATE.....

ZIP CODE.....

HOME PHONE NUMBER.....

DEALER PURCHASED FROM.....

DEALER ADDRESS.....

DATE PURCHASED.....

TONEARM MODEL NUMBER.....

TONEARM SERIAL NUMBER.....

Please provide the above information and return to the following address:

Eminent Technology, Inc.

P.O. Box 6894

Tallahassee, FL 32314

USA

WARRANTY

Eminent Technology, Inc. warrants the Model Two Tonearm to be free from defects in performance, materials and workmanship for a period of 30 days from the date of purchase. Within that period, any failure of the Model Two Tonearm will be corrected without charge for parts, labor or transportation from the factory. After this period, pending receipt of the warranty form, filled out and mailed to Eminent Technology postmarked no later than one month after purchase, the above warranty will be extended to three years for parts and one year for labor. This warranty is transferable. The obligation of Eminent Technology under the terms of this warranty does not extend to:

(1) Any Model Two not installed or operated in accordance with the instructions contained in this manual.

(2) Any Model Two while under performance testing or after being used in such a test by any facility or personnel not authorized by Eminent Technology.

(3) Any other component part connected to or operated in conjunction with the Model Two.

(4) Any traumatic damage, accidental damage or damage incurred in shipping or to defects which upon examination by Eminent Technology and in its sole opinion have been caused by abuse, neglect, improper or abnormal installation or operation for extended periods in industrial applications.

This warranty is not applicable if any part of the Model Two has been removed or taken apart, repaired, altered or modified by anyone not receiving prior authorization in writing by Eminent Technology nor if the serial numbers have been defaced or rendered illegible.

If an Eminent Technology product is removed from any country in which the original consumer purchase was made, Eminent Technology distributors and authorized dealers in any subsequent country are not obligated by the terms of this warranty. Eminent Technology reserves the right to incorporate design refinements and changes to its existing products without notice or obligation.

If practical, these design modifications will be incorporated into existing units for a reasonable charge.

Eminent Technology expressly does not warrant or insure for loss of use of the tonearm due to failure or periods of repair. Warranty repairs will be carried out by the factory. The Model Two must be returned prepaid in its original factory carton:

EMINENT TECHNOLOGY

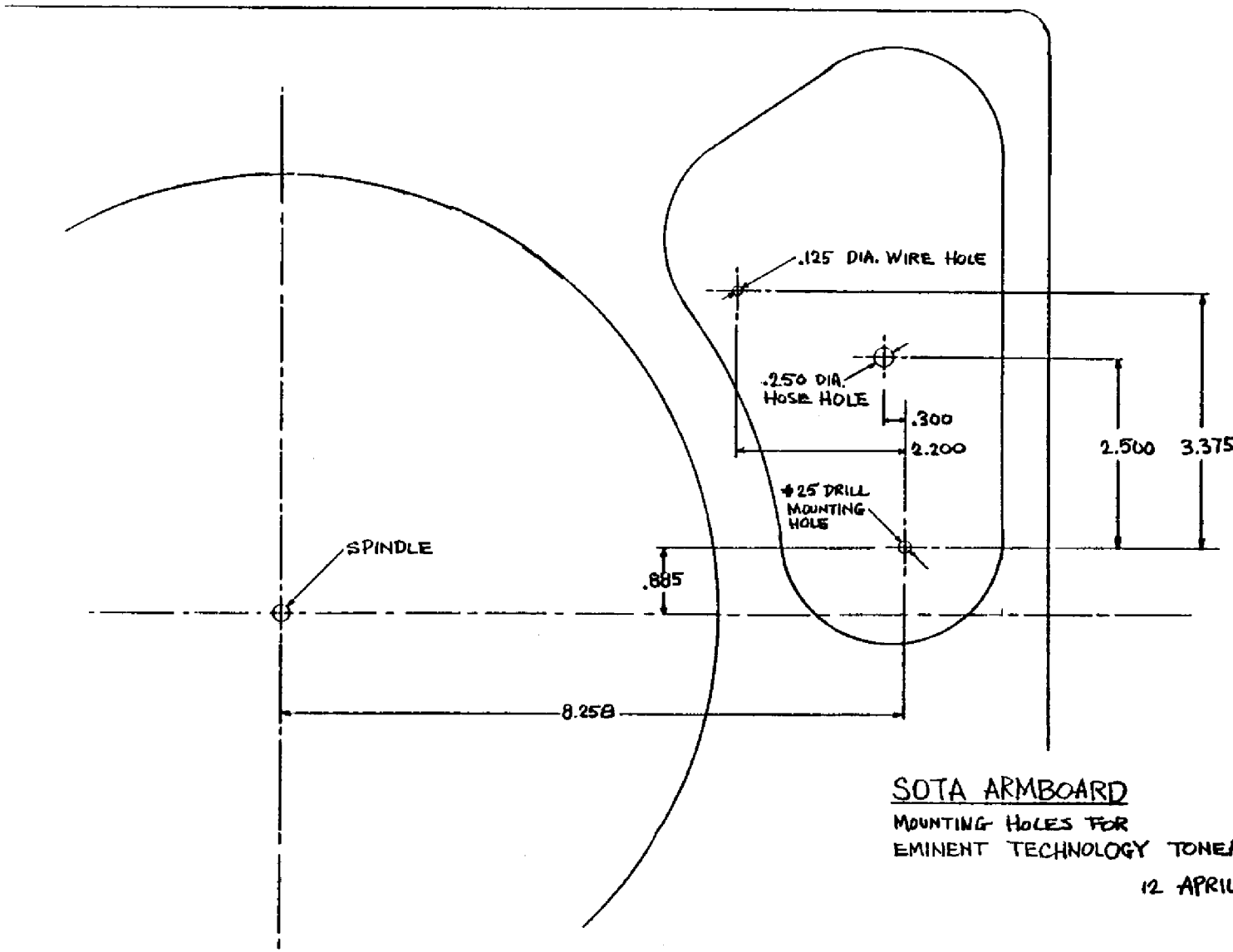
PO BOX 6894

TALLAHASSEE FL 32314

HANDLING OF LEAD COUNTERWEIGHTS

The lead counterweights used in the tonearm can be handled infrequently without cause for concern. Prolonged handling of lead and exposure to skin should be accompanied by good personal hygiene procedures. Wash hands after handling.

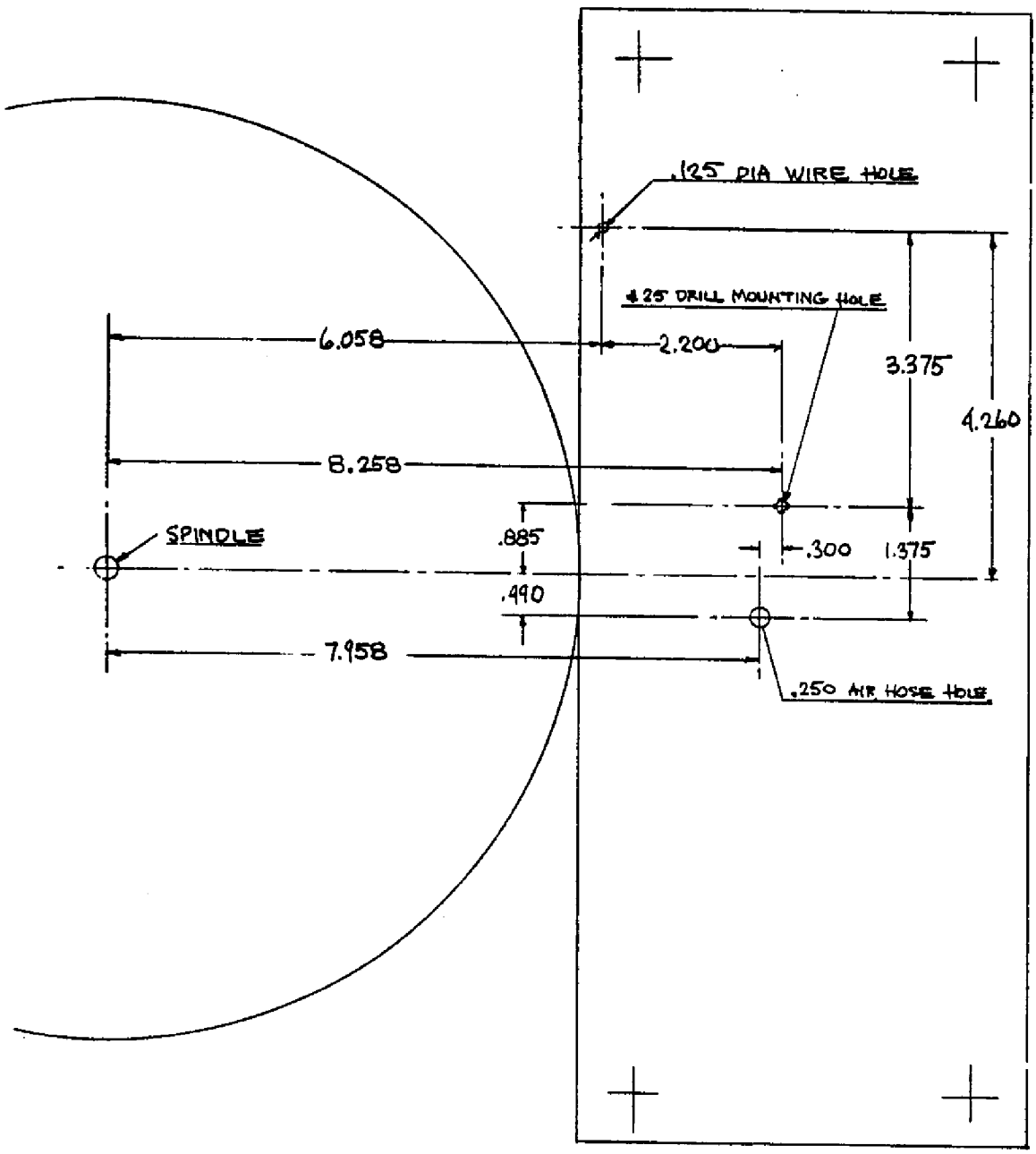
Do not allow children to handle or ingest these weights. If one is swallowed by anyone, induce vomiting and refer to a physician.



SOTA ARMBOARD

MOUNTING HOLES FOR
EMINENT TECHNOLOGY TONEARM 2

12 APRIL 1986

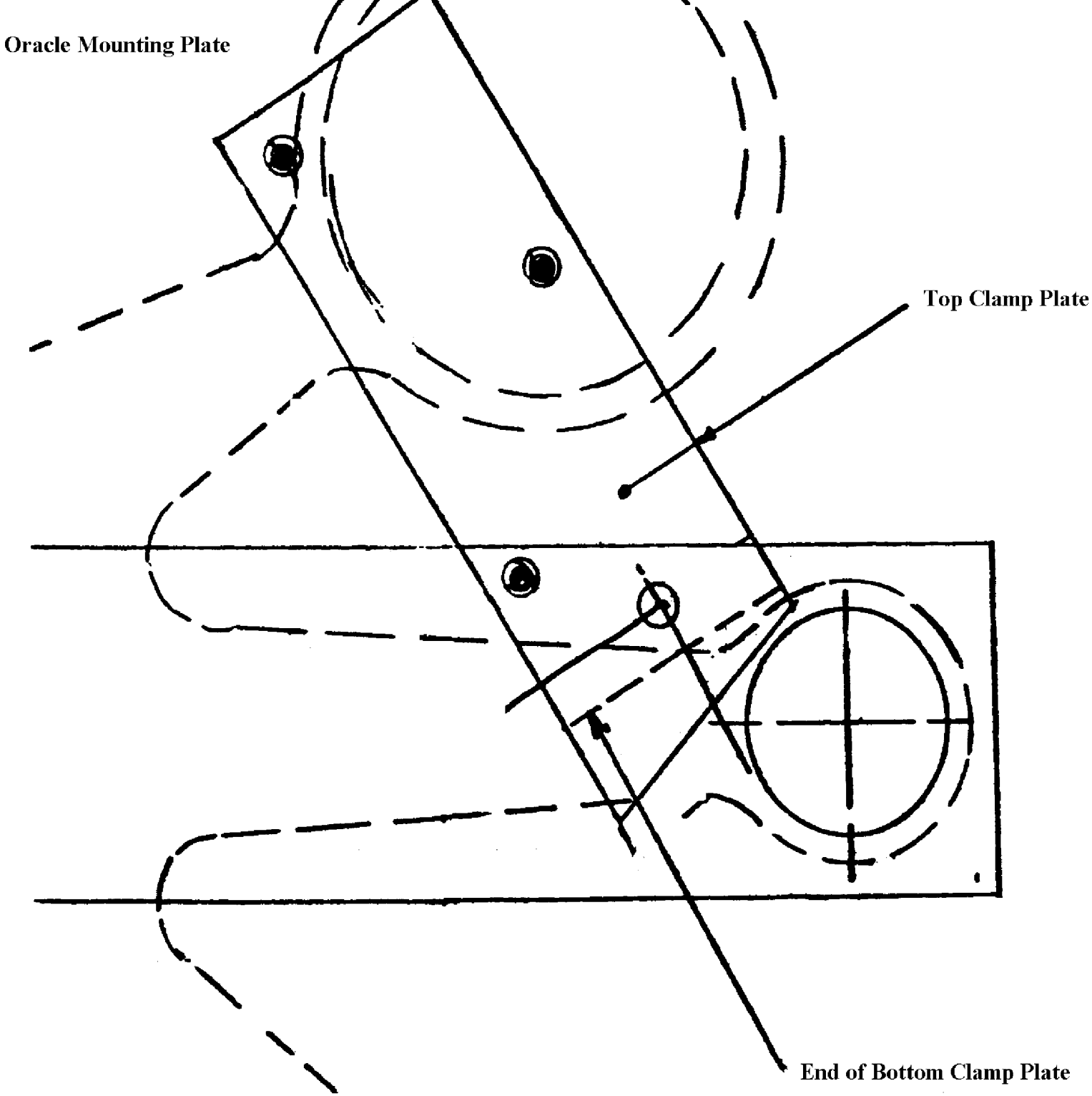


VPI ARMBOARD

MOUNTING HOLES FOR
EMINENT TECHNOLOGY TONEARM 2
12 APRIL 1986

We would appreciate any comments concerning this product and/or Owner's Manual. If you have any recommendations, comments or corrections, please address them to:

EMINENT TECHNOLOGY, INC.
P.O. BOX 6894
TALLAHASSEE, FLORIDA 32314


Oracle Mounting Plate
Top Clamp Plate
End of Bottom Clamp Plate