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EVALUATION OF THE MINIFON AS A COUNTERMEASURES DATA RECORDER

A. Q. Tool

RADIO DIVISION II

1 June 1953

NAVAL RESEARCH LABORATORY
Washington, D.C.

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Countermeasures Branch
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ABSTRACT

The general characteristics of the "Minifon" recorder are described. An evaluation of the machine is made with regard to its use as a countermeasures recorder. Its major limitation is poor speed stability of the wire transport mechanism. In addition, it has limited frequency response, low signal to noise ratio, and high distortion.

PROBLEM STATUS

This is an interim report; work on this problem is continuing.

AUTHORIZATION

NRL Problem No. 39R06-10
RDB Project NE 071-240-5

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EVALUATION OF THE MINIFON AS A COUNTERMEASURES DATA RECORDER

INTRODUCTION

The general countermeasures recording problem involves basic investigations to determine the most suitable sound recording mediums, techniques and mechanisms for use in electronic countermeasures applications. This work includes the study of various recorders to determine their suitability for use as countermeasures data recorders. In this report the German made "Minifon" pocket recorder has been evaluated to determine its ability to meet the requirements for this type of use. A limited evaluation of this equipment has been made. It is believed, however, that sufficient data has been taken to determine the recorder's performance for countermeasures applications. Further information on the "Minifon" recorder has been given by Mr. Theroux in an ATIC internal memorandum.[1]

RECORDER ASSEMBLY

The "Minifon" is a small completely self contained battery operated wire recorder-reproducer manufactured in Germany and available on the open market. It is small in size weighing only two and one-half pounds and measuring seven inches long, four and one-half inches wide and two inches deep. It is intended to be carried on the person. To achieve this small size and light weight only the most essential mechanical and electrical components are used. The recorder is enclosed in a plastic case as shown in Figure 1 and in Figure 2 with the protective cover removed. The basic elements of which this recorder consists are a wire transport mechanism driven by a small d.c. motor, a three tube amplifier used for both record and reproduce functions and a small permanent magnet for erasing. For a general view of the layout of these components see Figures 3 and 4.

1) "Minature Wire Recorder (Minifon)" ATIC Memorandum dated 13 Jan 1953 Serial Number T53-031

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WIRE TRANSPORT SYSTEM

The wire transport mechanism is driven by a direct current motor which draws approximately 100 ma at 9 volts. Mr. Theroux gave a value of 60 ma at this voltage in his comments and this difference is possibly due to his testing of a later model recorder or the fact that the current drain is dependent on the adjustment of the friction brake. This drain increases to rather large values for slow wire speeds and for this reason, the wire should be run no slower than 10 or 12 inches per second. Also, the wire should not be run at maximum speeds since as the batteries become weaker the reproduction of this speed will not be possible because of the lower battery voltage. The motor is connected to a counter-shaft by means of a spring belt and pulleys having approximately a two to one speed reduction. A worm on the counter-shaft drives either of two worm gears depending on whether forward or reverse motion of the wire is desired. The wire direction is selected by the operation of a lever on one side of the recorder (see Figure 2). This lever also applies a friction brake to the reel from which the wire is being taken. The forward direction worm gear is connected directly to the take-up reel which serves as the wire drive capstan for record and playback. The rewind worm gear is connected to the supply reel by way of a gear chain consisting of six gears which gives a small increase in rewind wire speed over the forward speed. Level winding on both the take up and supply reels is accomplished by an up and down motion of the head at a rate determined by the wire speed. This motion is achieved by a heart shaped cam driven from the counter-shaft at all times. Wire speed is controlled by a friction brake and fly-ball governor attached directly to the motor shaft. The position of the friction brake and thereby the wire speed is adjusted by means of the speed control lever on top of the recorder (see Figure 2). With 9 volts dc applied to the motor the forward wire speed can be adjusted from 6.6 to 19 inches per second and the rewind wire speed from 8 to 26 inches per second. Wire speed versus drive motor voltage was checked by recording a 1000 cycle tone from a Hewlett-Packard 650A test oscillator on the wire with 9 volts on the motor and a wire speed of 12 inches per second. This voltage was then reduced in steps and the frequency of the played back signal was checked to determine the reduction in wire speed as shown below:

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Motor Voltage volts dc.	Frequency of Played Back Signal (cps.)	Wire Speed in In/Sec
9.	985	11.81
8.5	930	11.17
8.0	870	10.43
7.5	810	9.73
7.0	740	8.87
6.5	660	7.92
6.0	590	7.07
5.5	480	5.76

Because of the wow and flutter the accuracy of these measurements is believed to be approximately ± 5%. For a plot of wire speed versus motor voltage see Figure 5. Wire speed is directly proportional to motor supply potential with this drive so considerable speed change is caused by 1 volt variation in motor voltage. For this reason when the recorder is used for a data recorder it is suggested that a standard frequency tone be recorded immediately prior to or after the desired signal and if possible at several intervals during a long recording.

Wow and flutter measurements were made in the Minifon using a Furst Electronics Wow meter and a 1000 cycle signal recorded from the Hewlett-Packard 650A test oscillator. The wow meter measures one half of the peak-to-peak frequency deviation and expresses it in percent of the average frequency of the input signal and has a maximum scale reading of 2 percent. The wow and flutter of the recorder exceeded this 2 percent value and therefore placed the meter off scale. It was estimated, however, that the flutter was between 2 and 4 percent most of the time. This compares to less than one-half of one percent for most American commercial wire and tape recorders. The long term flutter (less than 1/3 of a cycle per second) appeared to be about 5.0 percent.

Sufficient wire is contained on the supply reel for about two and one half hours of recording at the slow speed although only enough for approximately 15 minutes of recording was supplied with this machine. The recording wire has a diameter of approximately 0.002 inch as compared to the 0.004 - 0.0046 inch diameter of American wire and as a result the wire is somewhat more fragile. This is considered an undesirable feature since considerable difficulty has been experienced with wire breakage during the operation of recorders using the larger wire.

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RECORD-REPRODUCE AMPLIFIER

The audio amplifier contained in the equipment is of the resistance coupled type employing three tubes and is used for both record and playback. The complete circuit of the amplifier was not traced since it was thought some injury to the unit might occur during dismantling. A complete schematic diagram of the "Minifon" has appeared however, in a recent issue of a popular radio magazine.[2] Switching of the amplifier from record to reproduce is performed by a switch integral with the input-output jack and controlled by the length of the plug on the microphone or headphone cord. One plug is longer than the other causing the switch to reverse functions when it is used. When recording, the record-reproduce head is switched directly into the plate circuit of the final amplifier tube and the current drawn by this tube is apparently used as direct current bias during recording. For reproducing the head is connected to the grid of the first amplifier tube and an output transformer is switched into the plate circuit of the final amplifier for coupling to the headset. Frequency response of the amplifier alone was not checked.

ERASE MECHANISM

Erasure is accomplished by means of a small permanent magnet which is manually moved into place against the wire. This magnet is situated between the record-reproduce head and the take-up reel so that erasing must be performed on rewind. There is no provision for automatically removing the erase head from the wire when forward motion is resumed so extreme care must be taken to remove the erase head from the wire or the newly recorded signal will be inadvertently erased. Erasure is complete but a high residual noise level is present on the wire after erasing. This is characteristic of permanent magnet erase systems.

PERFORMANCE DATA

The distortion, frequency response and signal to noise data were taken at a wire speed of 12 inches per second. Distortion is high resulting from the use of dc rather than supersonic bias. At a frequency of 500 cycles per second, with maximum record gain and an input of 3 millivolts rms, visual distortion of approximately 10 percent was observed using an oscilloscope. The record gain was reduced so that 5 millivolts rms gave this amount of distortion and all tests were made with this gain setting. Increased input signal levels gave increased signal to noise ratios and greater output; however, the distortion was also increased. The frequency response and signal to noise data taken are shown in Figure 6. As can be seen on the curve the output decreases toward the low frequencies at the rate of approximately 8 db per octave. This rate

2) Radio and Television News for May 1953 page 38 by Harvey Sampson

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approximates the 6 db per octave caused by the head output being proportional to the first derivative of the flux, indicating that no low frequency emphasis is employed in the playback amplifier. The output is a maximum at 2500 cycles where it reaches a signal to noise ratio of about 16 db tapering off to a ratio of 0 db at 300 and 6500 cycles. Playback emphasis of the lower frequencies would be of little value due to the low signal to noise ratio in this region. High frequency output could be raised by increasing the wire speed at a sacrifice of recording time. The distortion and signal to noise ratio could be improved considerably by the use of supersonic bias and erase probably permitting the advantageous use of low frequency post-emphasis. This would require another tube which would increase the filament drain and approximately double the plate battery drain. The frequency response and signal to noise ratio as shown are adequate for voice recording and somewhat useful for data recording of signals which fall in the frequency range from 300 to 6500 cycles.

CONCLUSIONS

The Minifon, because of its small size and light weight, has the obvious advantage of being transportable to almost any conceivable location where it is desired to record any information. It is certainly suitable for recording voice conversations between two or more people any time the microphone can be placed sufficiently close to all parties concerned. Some measure of success should be achieved in the recording of signal data if the signals to be recorded fall in the frequency range from 300 to 6500 cycles and are not extremely critical as to wow, flutter, and some speed variations. Such precautions as recording a standard frequency signal should be observed, however, if the absolute frequency of the recorded signal is important. As previously mentioned it would be possible to modify the design to effect material improvement of the signal to noise ratio and lower the distortion. It appears, however, that no simple means for improving the speed stability of the wire transport mechanism is available. Therefore, it is not believed that the above modification is warranted.

The model tested is an early production unit and it is understood that some improvements have been made in the subsequent production units.

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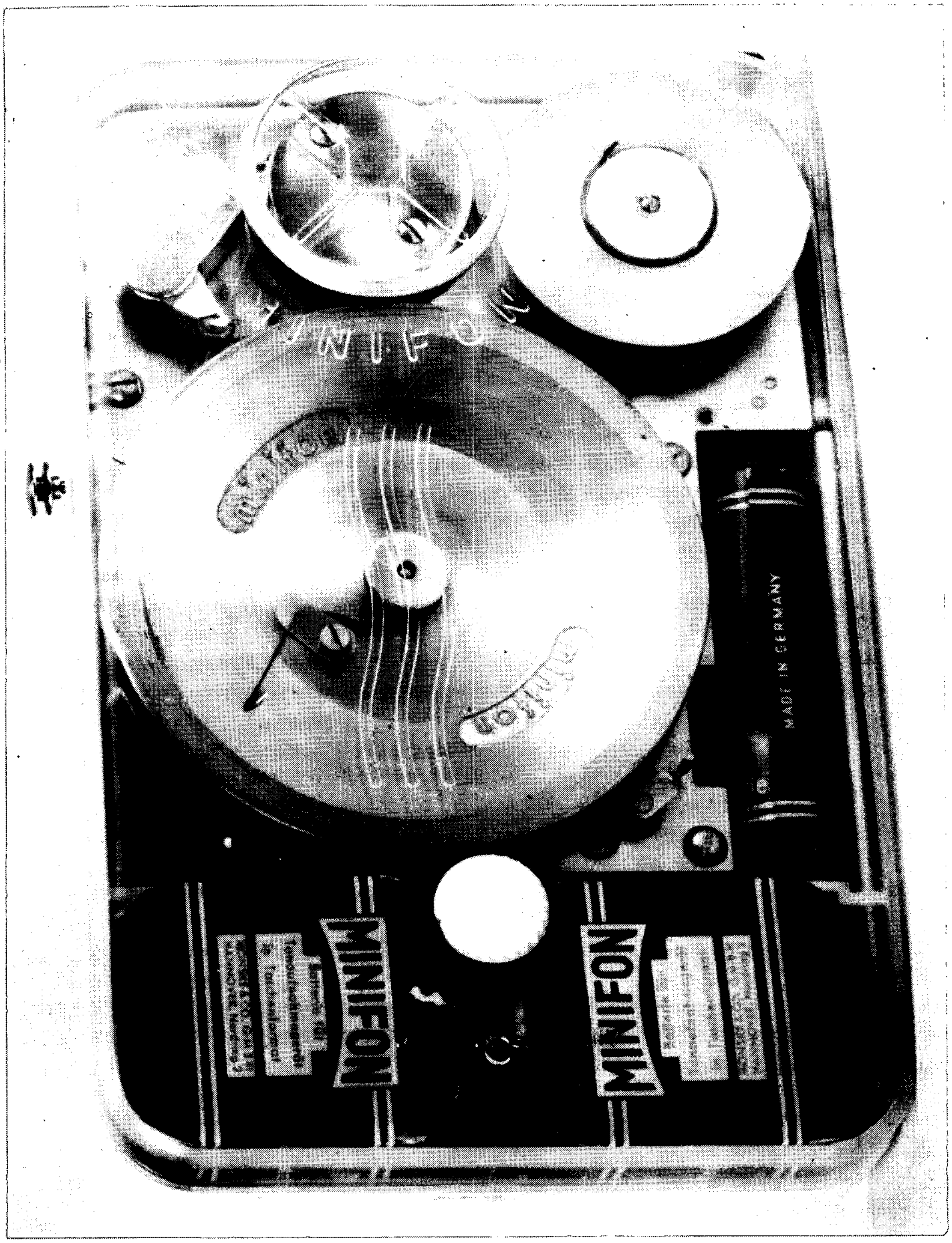

Figure 1 - Top View of Minifon with Cover in Place

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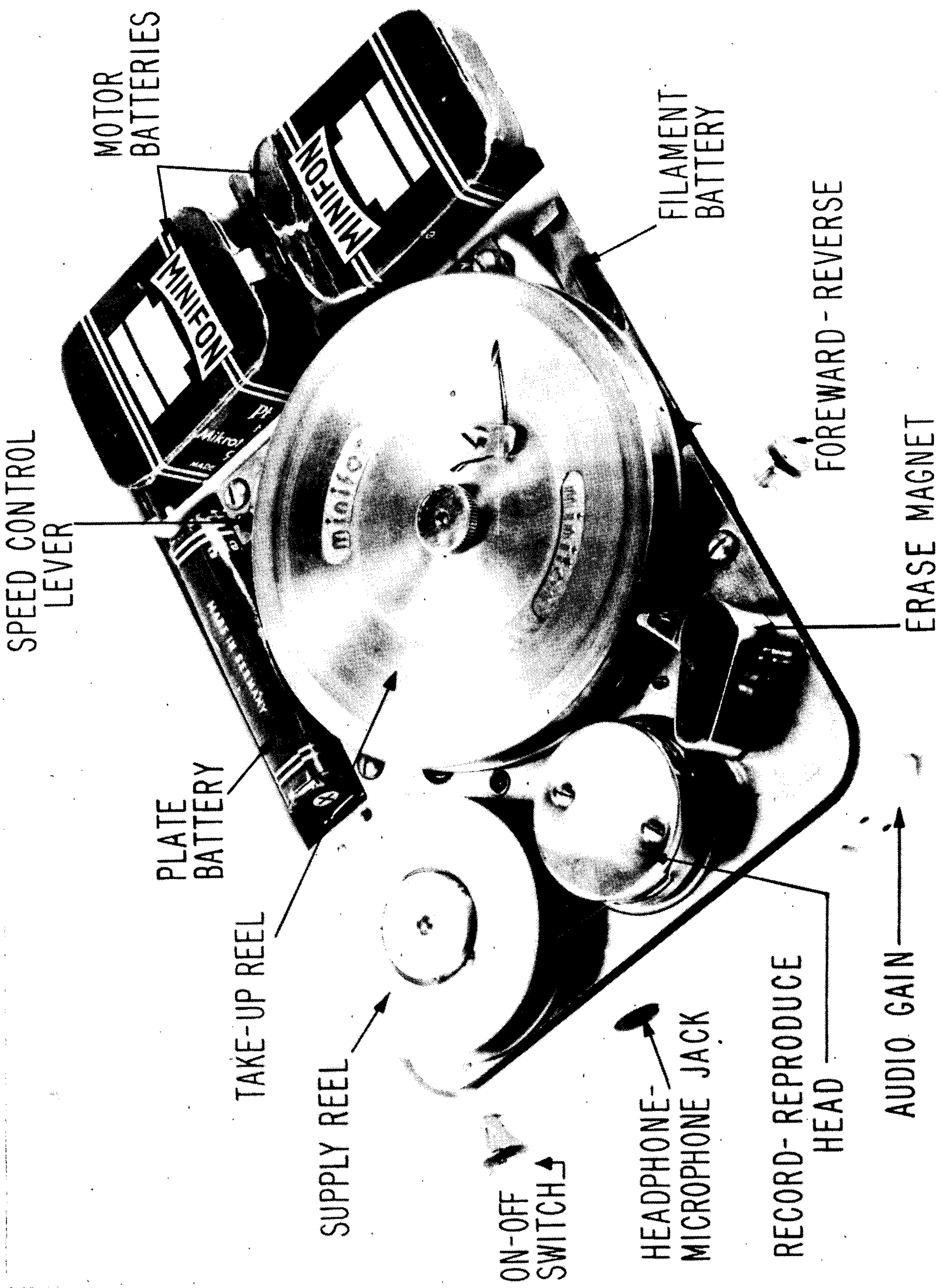

Figure 2 - Top View of Minifon with Cover Removed

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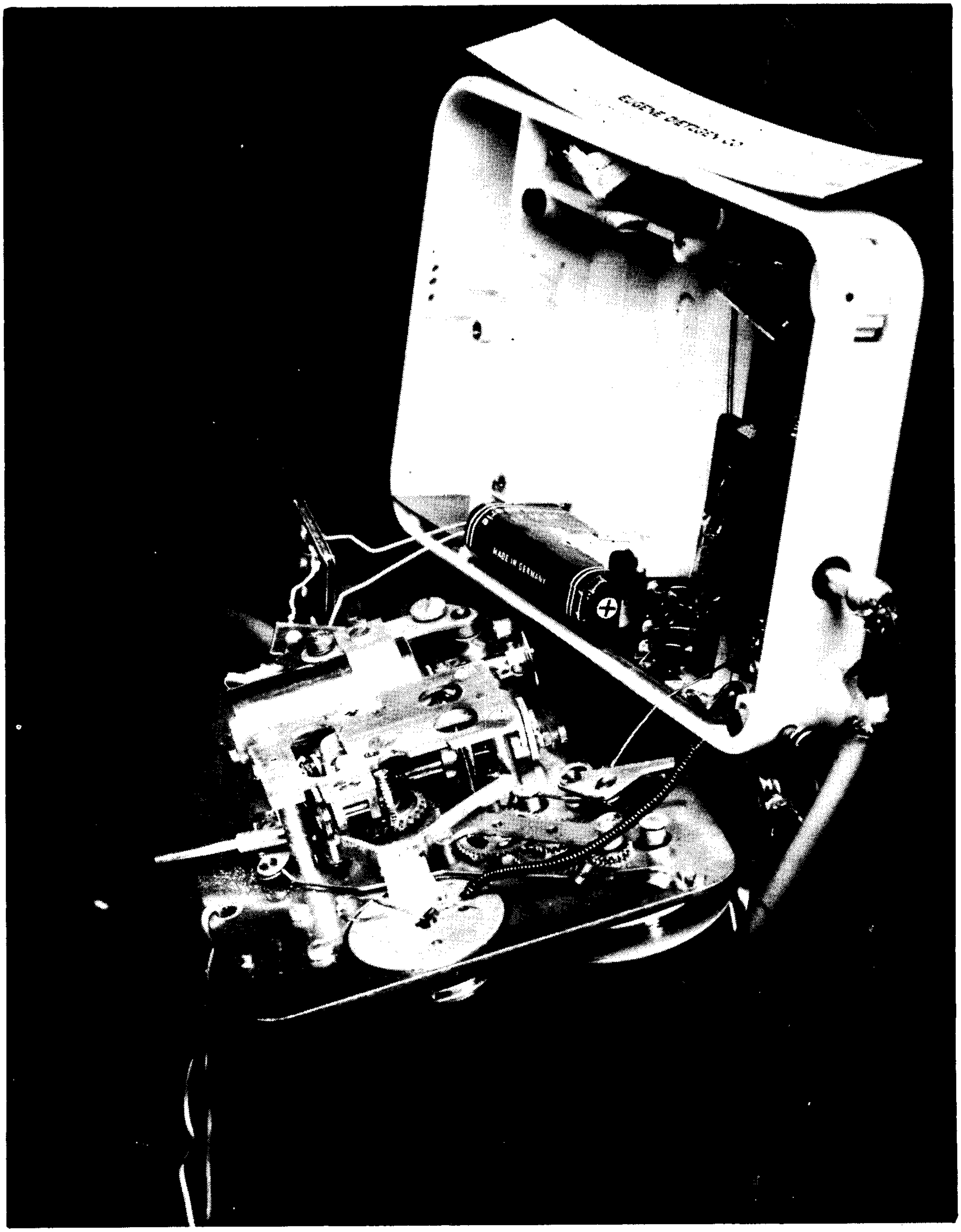

Figure 3 - Bottom View of Wire Transport Mechanism

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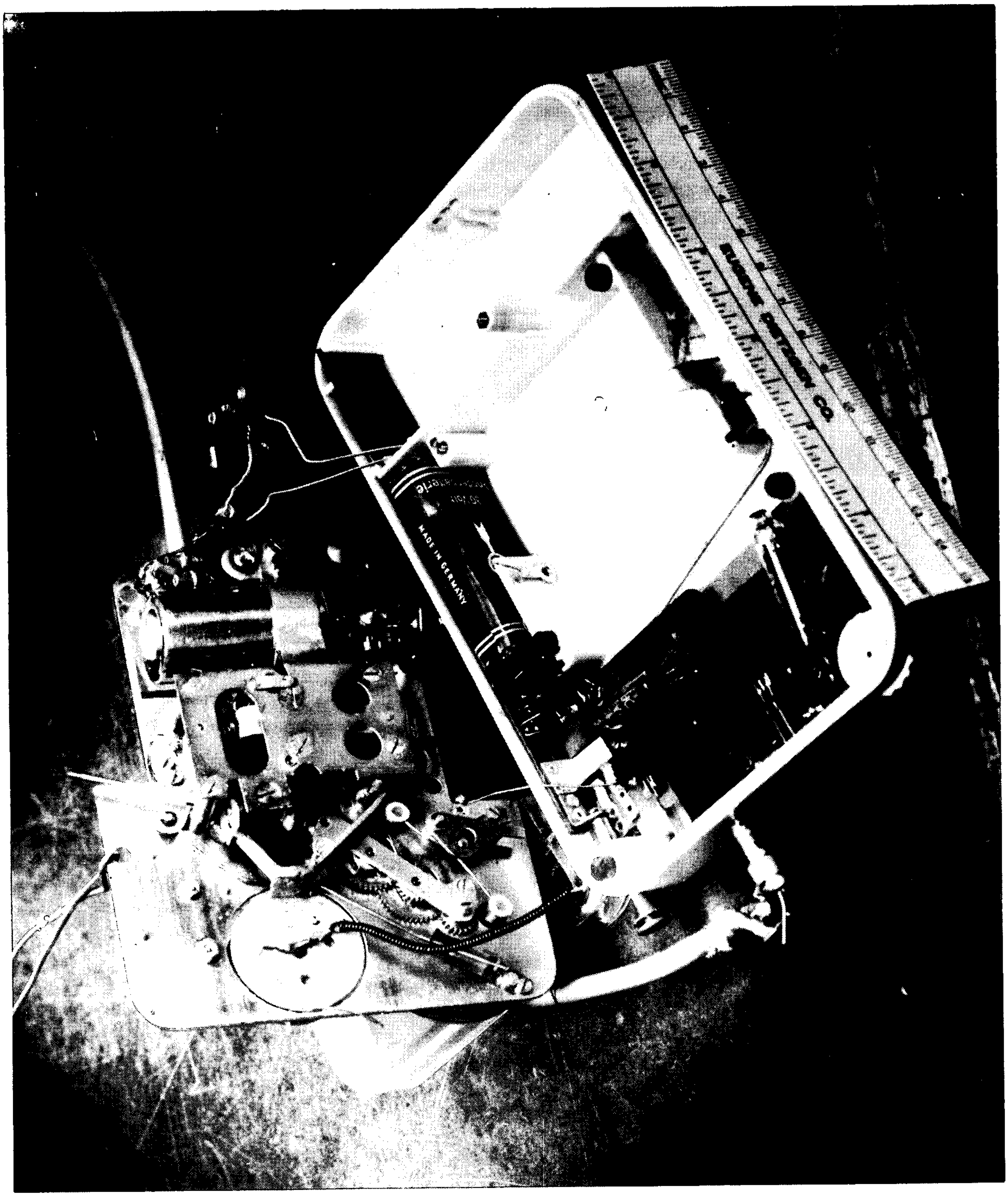

Figure 4 - Inside View Showing Record Reproduced Amplifier

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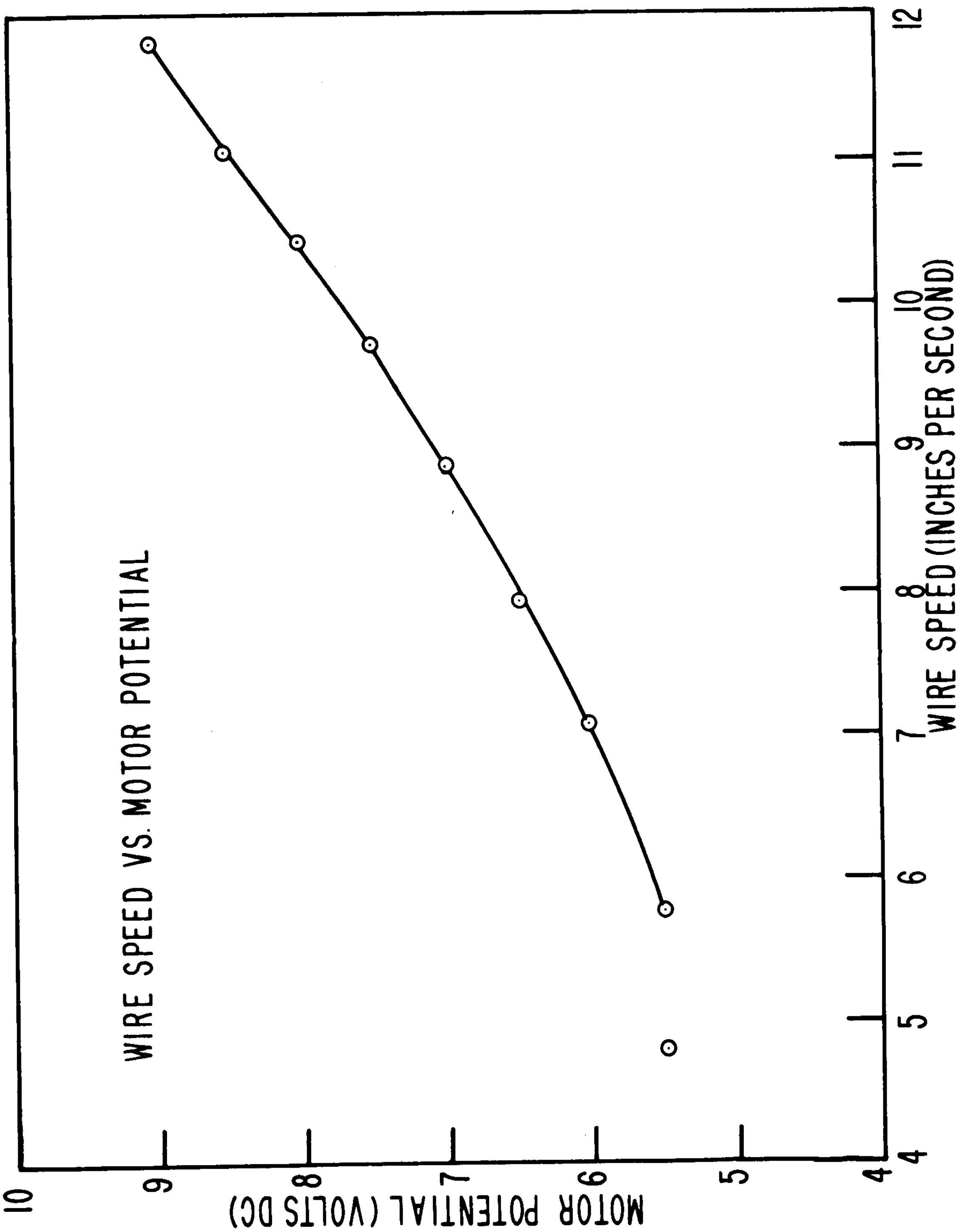

FIGURE 5

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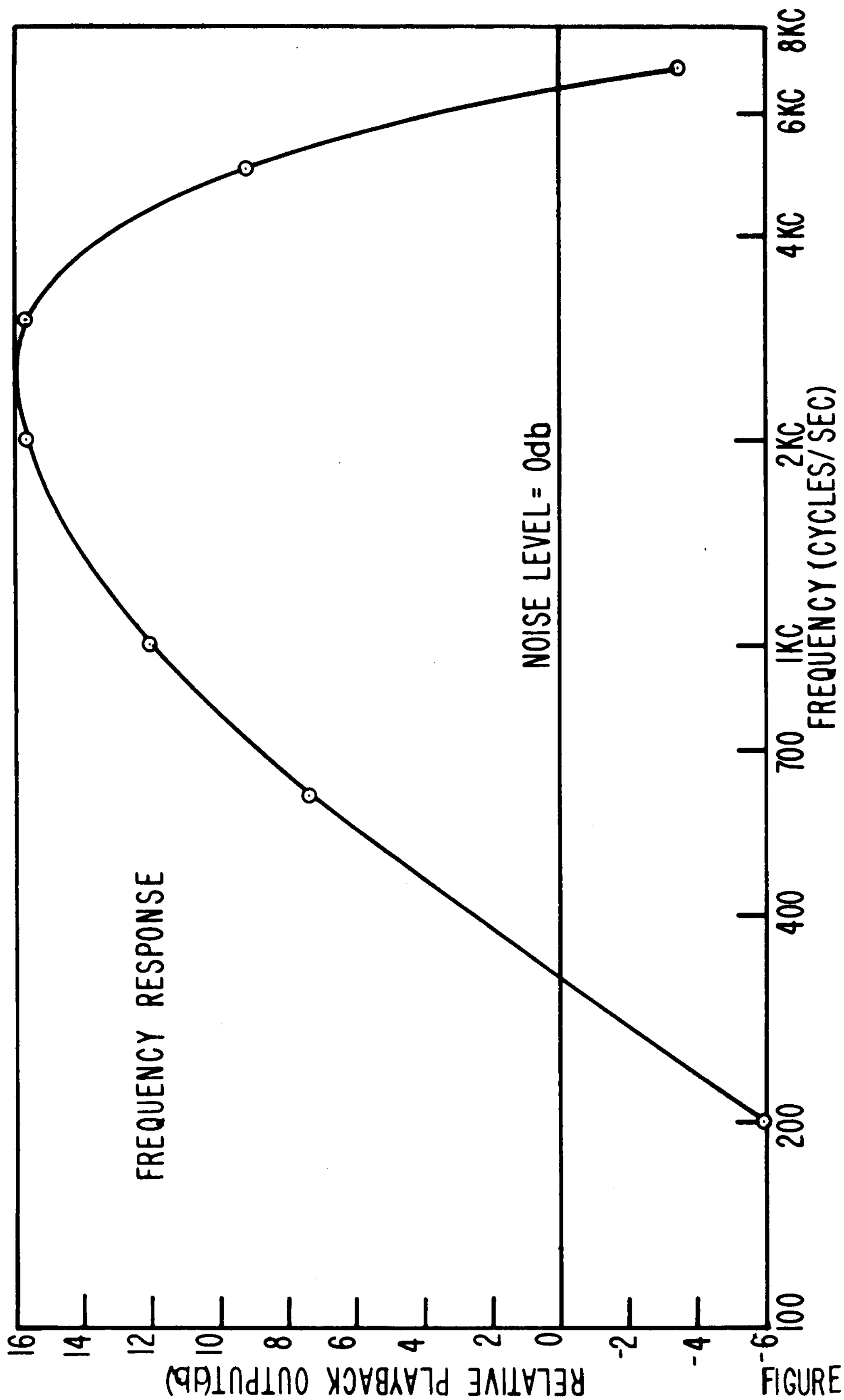

FIGURE 6

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