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COLUMBIA UNIV DOBBS FERRY NY HUDSON LABS
ENERGY SPECTRUM LEVELS OF THE THUMPER TRANSDUCER.(U)
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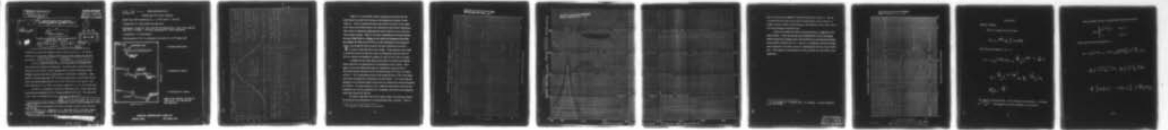
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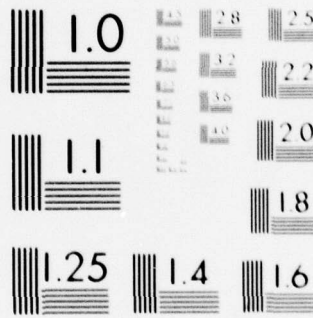
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MICROCOPY RESOLUTION TEST CHART
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FIG. 1A

PRELIMINARY DATA

EG&G Type ST-8 Sonar Thumper

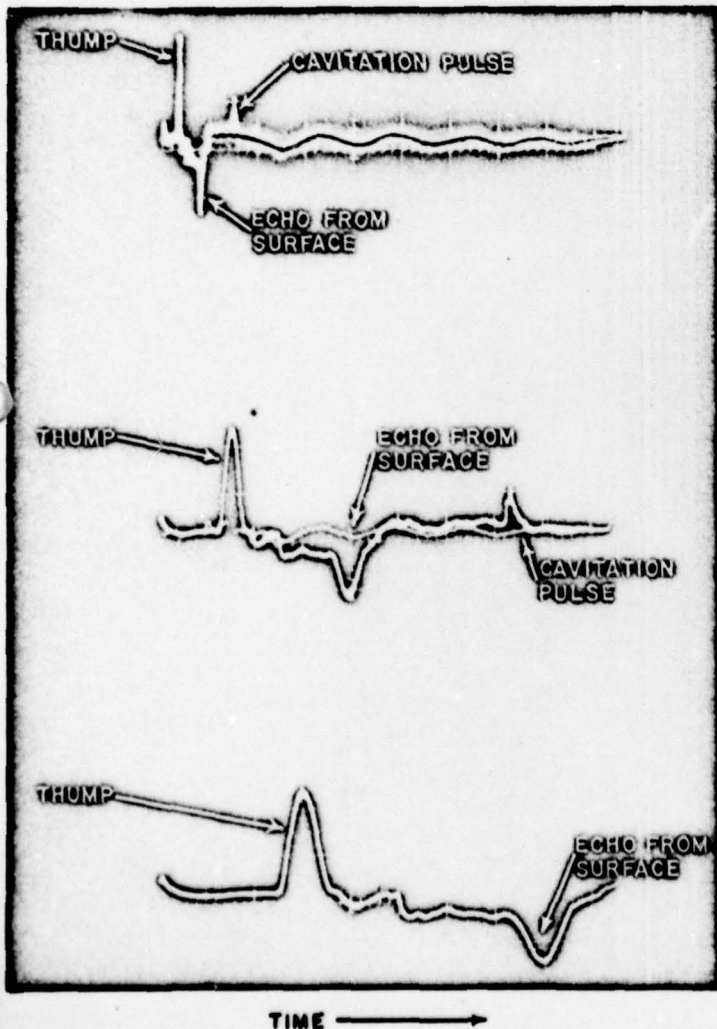
EG&G Type 2370 transducer No. 1, 4,000 volts C = 160 mfd.

Transducer 6 ft. below surface facing down.

Hydrophone, serial No. 100, Type BC 32 (Atlantic Res. Corp.) total capacity with 100 ft. of cable = .019 mfd, positioned 6 ft. below transducer.

Y deflection = 0.2 volts/square.

Peak pressure at 3 ft. is calculated to be about 0.5×10^6 dynes/cm².



5 milliseconds/square

1 millisecond /square

0.5 millisecond /square

Made on the Atlantis, January 18,
1960 by Dr. J.B. Hersey and
Gary Hayward.

EDGERTON, GERMESHAUSEN & GRIER, INC.

BOSTON, MASS.

LAS VEGAS, NEV.

2

Figure 2 is a plot of the relative spectrum and shows that the main thump has most of its energy in the frequencies between 20 and 1000 cps. The two broken line plots show how an increase in the width of the main pulse would improve the efficiency at the lowest frequencies. This result is obtained by adjusting the peak pressure so as to keep the total energy constant. Then we see that a doubling of the present thumper pulse width leads to a change in the useful low-frequency band from the original 20-1000 cps to 20-700 cps and a doubling of the energy per cycle, even though the peak pressure has been reduced by the factor $\frac{\sqrt{2}}{2}$ in order to keep the same total energy. If the thumper pulse width is made four times as long, the useful low-frequency band becomes 20-500 cps, and the low-frequency energy per cycle is four times as large.

In addition to the main thump pulse there is a damped oscillation which appears to be characteristic of the thumper source itself. Here again a curve was fitted to the data for calculation of the spectrum.² The actual energy spectrum levels in units of ergs/cm²/cycle are shown in Fig. 3. For comparison purposes the energy spectra of the main thump pulse and a blasting cap or detonator are also shown.³ It is clear that the thumper is an extremely weak sound source in comparison with the detonator of 0.002 lb. It is also obvious in Fig. 3 that the main thump would be submerged by the 123-cps oscillation on recordings restricted to the frequency band from about 90 to 150 cps.

In order to get some idea of the useful range of the thumper source, its pressure level spectrum at 10 kiloyards has been computed. This re-

³See Appendix B for details of calculation.

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sult is compared to Knudsen's⁴ ambient noise curves in Fig. 4. We can conclude from this that for sea state one the thumper can be used up to ranges of about 5 miles, but the energy in the band from about 150 to 300 cps will be submerged in ambient noise.

There are several important conclusions that are suggested in the above results. First, we can get improved efficiency in the interesting band of frequencies between about 150 and 500 cps by increasing the thump pulse width by a factor of 2 or 4. Second, a considerable amount of energy may be gained for the thump pulse by eliminating the thumper plate oscillation. This might be accomplished by using a thicker and, therefore, more rigid plate.

⁴V. O. Knudsen, R. S. Alford, and J. W. Emling, J. Marine Research 7, 410-429 (1948).

APPENDIX A

Spectra of Pulses

Assume a sound pulse of the form

$$p(t) = p_0 e^{-\beta^2 t^2} = \frac{1}{2\pi} \int_{-\infty}^{\infty} S(\omega) e^{j\omega t} d\omega$$

The Fourier transform of $p(t)$ is

$$S(\omega) = p_0 \int_{-\infty}^{+\infty} e^{-\beta^2 t^2} e^{-j\omega t} dt = p_0 e^{-\frac{\omega^2}{4\beta^2}} \int_{-\infty}^{+\infty} e^{-(\beta^2 t^2 + j\omega t - \frac{\omega^2}{4\beta^2})} dt$$

$$= \frac{p_0}{\beta} e^{-\frac{\omega^2}{4\beta^2}} \int_{-\infty}^{+\infty} e^{-(\beta t + j \frac{\omega}{2\beta})^2} \beta dt = \frac{2p_0}{\beta} e^{-\frac{\omega^2}{4\beta^2}} \int_0^{\infty} e^{-x^2} dx$$

$$= \frac{\sqrt{\pi}}{\beta} p_0 e^{-\frac{\omega^2}{4\beta^2}}$$

The relative spectrum of Fig. 2 was obtained by normalizing, i. e., dividing by $\frac{\sqrt{\pi} p_0}{\beta}$, and taking 20 times the logarithm of this quantity.

Similarly, the energy spectrum level of the damped oscillation is

$$E(\omega) = \frac{1}{2\pi} \frac{P_0^2}{\rho c} \frac{\omega_1^2}{(\alpha^2 - \omega^2 + \omega_1^2)^2 + (2\alpha\omega)^2}$$

These are the formulae used in constructing Fig. 3 for energy spectrum levels.