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#### ULTRASONIC MONITORING OF DECOMPRESSION

SIR,—We have read with interest the report by Mr. Walder and his co-workers (April 27, p. 897) on the use of an ultrasonic-pulse technique to indicate the presence of bubbles in the body during or following decompression. Their method relies on the increased attenuation (not necessarily all due to dissipation as they suggest, but probably partly due to reflection) which the bubbles produce in an ultrasonic wave propagating through a fold of skin. Although this method appears to

represent a useful step forward, we wish to suggest that a much more sensitive indicator would be the increase in the level of the second harmonic of the ultrasonic wave as bubble formation sets in.

If the amplitude of an ultrasonic wave propagating in a fluid is not infinitesimal, there is inherently some non-linearity in the propagation<sup>1</sup> which leads to the production of harmonics of the wave. At normal amplitudes in normal liquids, however, the relative level of the harmonics is very small. But if bubbles are present, even though very small and very few, the non-linearity of propagation is greatly increased, and the relative level of harmonics is correspondingly increased.<sup>2</sup> The second harmonic normally has the greatest amplitude and consequently is the one chosen for observation. It seems reasonably evident that the increase in second-harmonic level would be detectable well before the bubble density has become great enough for the change in attenuation of the fundamental wave to be detected. It would, moreover, be an easier matter to present a simple pointer indication of the harmonic increase than of the attenuation increase, for which Mr. Walder and his co-workers propose an oscilloscopic indication.

It is hoped to arrange some experimental work on animals shortly.

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1. Tucker, D. G. *J. Sound Vib.* 1965, 2, 429.

2. Welsby, V. G. University of Birmingham, Department of Electronic and Electrical Engineering memorandum no. 359, 1968.