THE CHEMICAL ACTION OF AUDIBLE SOUND

Sir:

While investigating the bactericidal action of intense audible sound, a wide variety of interesting chemical reactions have been observed to take place. These have been produced using both the Gaines modification of the Pierce magnetostriction oscillator with a nickel tube[1] and a modified electro-magnetic oscillator with a stainless steel diaphragm of a type used by the Submarine Signal Company of Boston.

Solutions of Merck egg albumin, of four times recrystallized egg albumin and of synthetic plastein are almost instantly coagulated, at 30°. Solutions of agar and of starch, free from electrolytes, produce a little dextrin and reducing sugar. Sucrose in neutral solutions is hydrolyzed to glucose about twice as fast at 5° as ordinarily at the boiling point, while with a trace of acid the hydrolysis is complete and almost instantaneous. The hydrolysis of ethyl acetate is also accelerated and *n*-tetradecane and vegetable oils containing olein are cracked.

Inorganic halides in solution are oxidized to free halogen and hydrogen sulfide rapidly to sulfur by dissolved oxygen. In the former case the hydrolysis of the hypochlorite formed results in an increase of the *P*H. Even with an initial excess of acid, after five minutes of sonic vibration, hydroxides of Cu, Mn, Ni, Al and Cr are precipitated from their chlorides. In the presence of oxygen but in the absence of an excess of acid, ferrous chloride is rapidly oxidized and precipitated as ferric hydroxide which is thereby rendered unavailable for reduction by the nickel of the vibrator. In the presence of an excess of acid ferric ions are reduced by the nickel in spite of the fact that free chlorine is detectable. After cessation of vibration, any free chlorine remaining in solution is consumed in oxidizing ferrous ions. Mercuric chloride is rapidly reduced by the nickel to calomel, free chlorine and free mercury, the latter producing a rather permanent sol. Gold is precipitated from gold chloride. In general, with oxygen present, the anion in the metallic halides and sulfides is oxidized although, depending upon the relative position in the electromotive series, displacement or reduction of nickel by the metallic ion will also take place at a highly accelerated rate.

During the exposure to sound, a trace of nickel or stainless steel is dispersed. But the organic reactions are not due to metallic catalysis, since they progress in the presence of hydrogen sulfide, carbon disulfide, mercury salts and metallic mercury. The reactions may be due to a conversion of the sound energy into heat energy, which hypothesis we propose to test. The catalytic influence of the cavitation surfaces produced within the liquids can be excluded because at 4 to 10 atmospheres, where cavitation is suppressed, the reactions still progress.

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(1) Newton Gaines, *Physics*, **3**, 209–229 (1932).

It should be emphasized that these effects are produced by audible sound, the frequencies (1000–15,000) being of a far different order than any hitherto reported as influencing chemical reactions. Because of the relative ease of producing high energy densities in this range, it seems likely that such methods will prove to be useful.

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THE FORMULAS OF ANTIMONIC ACID AND THE ANTIMONATES

Sir:

In my recent discussion of antimonic acid [THIS JOURNAL, **55,** 1895 (1933)] I stated that its formula had not been previously recognized to be $HSb(OH)_6$. I have just learned that this statement is incorrect, for in 1929 Professor L. P. Hammett, in an interesting discussion of amphoteric hydroxides ["Solutions of Electrolytes," McGraw-Hill Book Co., New York, 1929, p. 108], wrote: ". . . the sodium antimonate whose crystallization is used as a test for sodium has exactly the right content of water so that it can be written $NaSb(OH)_6$."

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EXPERIMENTAL EVIDENCE FOR ACTIVATED ADSORPTION OF HYDROGEN BY CHARCOAL

Sir:

It was shown recently by Kingman [*Trans. Faraday Soc.*, **28,** 269 (1932)] and by Burstein and Frumkin [*ibid.*, **28,** 273 (1932)] that hydrogen is slowly sorbed by charcoal at higher temperatures (above 100°), whereas at room temperature only van der Waals adsorption is observed. The experiments described below give in our opinion a direct proof that hydrogen sorbed at higher temperatures remains on the charcoal surface and is not dissolved in the interior of the solid, as it was suggested for similar cases by Steacie and Ward.

Burstein and Frumkin [*Z. physik. Chem.*, **141,** 158 (1929)] found that charcoal heated in hydrogen to 1000° and cooled to room temperature adsorbs small quantities of alkali from an aqueous solution if protected from contact with oxygen. The mechanism of this process consists in an ionization of the hydrogen, the negative charge of the charcoal surface attracting the cations of the solution.

In connection with the problem of activated adsorption, it appeared