stance will generally be known. Now the number of organic compounds known is of the order of 250,000 and of inorganic compounds probably some 40,000. With the above numbers in view, it is clear that at present the chances of identifying an *unusual* substance with the help of any available index are negligible. In the case of organic compounds, a really comprehensive index is obviously out of the question. Anyone tackling a specific identification problem in a specialized field would be more likely to succeed by taking X-ray photographs of a number of related compounds, particularly as the compound may not have been prepared before. It is also clear that unless the task of expanding these indexes is taken very seriously, more comprehensive compilations including other physical properties would be of greater practical value, assuming always that this problem of identifying unknown substances is sufficiently important to justify the labour involved.

Now although the X-ray index is likely to grow much more rapidly than the other two, it suffers from a grave disadvantage. Certain large groups of compounds, for example, complex oxides and sulphides and alloy systems, are notable for their variable compositions and hence variable lattice constants and intensities of reflexions. This is a serious matter in a classification based on the spacings and intensities of lines on powder photographs. It must be remembered that the X-ray index, being purely a 'fingerprint' system which does not add to our knowledge of any physical constants, must be judged solely on its merits as a means of identification. Before much more time and money are spent on such projects it would seem advisable to consider (*a*) the actual or potential practical value of any index, bearing in mind the points raised above, and (*b*) the most desirable form of index, that is, the nature and arrangement of the data therein.

A. F. WELLS.

22D Palatine Road,
Manchester, 20.

[1] *Nature*, **144**, 298 (1939).
[2] *Nature*, **154**, 349 (1944).
[3] *Nature*, **149**, 437 (1942).
[4] *Nature*, **150**, 738 (1942).

Hydrogen Overvoltage as a Factor in the Corrosion of Metallic Couples

CONSIDERABLE confusion has been caused in the past by neglect of the influence of the hydrogen overvoltage on the corrosion current between metallic couples in electrolytes.

It would seem that there should be no current flow unless the potential difference on open circuit is greater than the hydrogen overvoltage at the cathode; but that when the potential difference is higher than the overvoltage, the current should depend on the difference between the two.

Work at present in progress confirms this view, and we may quote the case of magnesium alloy and copper in sea water. Copper is far removed from magnesium in the electromotive series and has a fairly low overvoltage. A couple of copper and magnesium alloy should thus give a large corrosion current; this, in fact, has been found to be the case.

By amalgamating the copper with mercury, which has a high overvoltage, and in addition is far from magnesium in the electromotive series, the corrosion current is reduced to a very small value. This value, in fact, is much smaller than that obtained with a magnesium/zinc couple, in spite of the fact that zinc is comparatively close to magnesium in the E.M.F. series.

It may be added that the known effect of surface roughness of the cathode on the overvoltage is found to have the expected effect on the corrosion current.

Where ready access of oxygen is possible, the hydrogen overvoltage is accordingly reduced, and the corrosion current is able to reach a higher value in such localities.

L. F. LEBROCQ.
H. C. COCKS.

"Halfway",
Onslow Crescent,
Woking,
Surrey.

Difference Tones

THE interesting question raised by Prof. F. Allen's letter in *Nature* of July 21 is whether the difference tones he observes are present in the air or whether they exist only in the auditory system of the listener. If the loudspeaker to which the two oscillators are connected (whether in series or parallel is only a matter of impedance matching) is strictly linear in its amplitude response, then no combination tones, sum or difference, will be produced. The ear, on the other hand, is far from linear in its amplitude response; so when two high-pitched tones are heard together, the difference tone is often clearly audible while the sum tone may be less easily distinguished or above the limit of audibility, depending on the pitch of the beating tones. However, if the loudspeaker is non-linear, combination tones will be physically present in the air nearby and could be detected by a linear tuned sound analyser. If this is not available it should be possible to feel or even see the low frequency vibration of the loudspeaker diaphragm when the two tones are nearly in synchronism.

A. J. KING.

Research Department,
Metropolitan-Vickers Electrical Co., Ltd.,
Trafford Park,
Manchester, 17.
July 25.

Transplantation of the Heart

FOR a number of years, my laboratory has been studying the problem of transplanting the heart of vertebrate animals. In the animal kingdom many necessary prerequisites exist for carrying out this important, and at first sight impossible, operation. The first stage, 1938–42, was my work on cold-blooded animals—frogs and fishes. After a number of experimental variants and the perfection of the operation technique, I succeeded in transplanting to a frog a second heart taken from another animal; I planted the second heart in the same pericardium as the heart of the host. Animals with two hearts showed no differences from control frogs, and experienced biologists invited to examine them were unable to distinguish one from the other. Two-hearted frogs went through the usual nuptial period in spring, and cast their spawn in the ordinary way.

As this series of experiments proved successful, I then began the next series, the purpose of which