Correspondence

An Unidentified VLF Station

SIR,—During a search of the VLF portion of the radio spectrum for transmitting stations which might serve as sources of "whistler-mode" signals, we observed a transmission on 14·9 kHz which presented some puzzling propagation effects.

Its origin is unknown, and we have been unable to identify the operating agency or the location of the transmitter itself.

We have plotted the diurnal phase variations of the transmitted frequency for about six months, and, by correlating this information with the sunrise and sunset terminators which produce the major phase variations, we have determined that the signals arrive from the direction of the Gulf of Alaska (about 30° true). The great circle distance from Lower Hutt is indefinite, except that it is more than 8,000 kilometres.

Variations of signal strength suggest that at least a portion of the path is subject to PCA events. The station cannot be in Europe or Africa, or its signals would be received along the short great circle path, which can be readily identified by means of the sunrise–sunset phenomena.

There is some evidence that the frequency is controlled by an oscillator which is corrected daily by reference to an atomic standard.

The station is using one of a group of six frequencies used by an unidentified agency during 1969 to transmit a repetitive sequence of short dashes, similar to the well known Omega format, except that the pattern consisted of six intervals over 3·6 seconds, as against the Omega pattern of eight intervals over ten seconds.

No information on the transmission described, or its "navigational" predecessors, which ceased transmission in January 1970, has been noted in the technical or scientific press, and any information on the existing transmissions on 14·9 kHz known to other scientific workers in this field would be welcomed by this laboratory.

Yours faithfully,

M. C. PROBINE

Physics and Engineering Laboratory,
DSIR,
Private Bag,
Lower Hutt,
New Zealand.

Topology and Metallurgy

SIR,—In a recent publication[1], L. Barrett and C. Yust review the applications of topology to metallurgy. From it, it is clear that metallurgists have been laggard in using topology: after a pioneering paper by C. S. Smith in 1951 (ref. 2) on the analysis of grain shapes in a polycrystal, only some 15 to 20 of the papers which have been published up to now on this problem, on the sintering process and on the study of interfaces in a two-phase material, have applied topological theorems.

This lack of enthusiasm is really surprising because, by its very nature, topology seems to be a very appropriate tool to deal with metallurgy, a brand of science that proposes the "wary analysis of non-living complexity"[3], "a perpetual balancing act between the realistic and the tractable"[4]. As Barrett and Yust put it: "Often mathematics, particularly applied mathematics, is thought of in terms of analytical formulae yielding quantitative results. (Topology) is of a more qualitative nature, offering newer concepts as the means of describing physical phenomena. . . . These concepts yield a fresh viewpoint and unifying relationships among apparently diverse structures". In typical metallurgical problems as complex as work-hardening, recrystallization, creep and the like, metallurgists have been so busy—and not very successfully as yet !—looking for analytical formulae that they have overlooked the possibility that perhaps topological relationships were more apt to answer their questions. I do not see any epistemological reason why nature must abhor topology. And in fact I would like to suggest that perhaps nature loves topology, as is shown by what I would call the "topological structure" of one of the most important relationships in physical chemistry, very well known, respected and used by all kinds of metallurgists: Gibbs's rule of phases.

Gibbs's rule possesses a striking similarity with Euler's theorem (which gave rise to the discipline of topology): If we call V the number of vertices, E the number of edges and F the number of faces of a polyhedron, then Euler's theorem states that $V-E+F=2$. But if V is now the number of phases, E the number of independent components and F the number of degrees of freedom of a physico-chemical system, Gibbs's rule states that $V-E+F=2$.

It can, of course, be said that this similarity is merely an accident, a formal curiosity without any further consequence, and that, besides, Gibbs's rule is not more than a useful "recipe", deduced from a system of analytical equations establishing the equilibrium conditions of a system of V phases and E components with F degree of freedom. But the important thing to realize is not how the "recipe" is usually deduced, but its very nature: just as Euler's theorem makes possible a "geometry without metrics", Gibbs's rule permits one to analyse equilibrium without measuring anything. It provides a powerful means of dealing with the many variables of the equilibrium of any complex system. To evaluate how powerful it is, it is enough to try to imagine metallurgy without Gibbs's phase rule.

Are there many other topological relationships in the realm of metallurgy? According to Barrett and Yust, there are very few, and these do not seem to be as important as Gibbs's phase rule. This paucity is not strange, because it seems that metallurgists have not been looking very hard for applications of topology to their science.

Yours faithfully,

JORGE A. SABATO

Departamento de Metalurgia,
Comision National de Energia Atomica,
Buenos Aires, Argentina.

[1] Barrett, L., and Yust, C., *Metallography*, **3**, 1 (1970).
[2] Smith, C. S., *Metal Interfaces* (Amer. Society for Metals, Cleveland, 1952).
[3] Smith, C. S., *A historical view of one area of applied sciences: metallurgy, Applied Science and Technological Progress* (National Academy of Science, USA, 1967).
[4] Cahn, R. W., *Discovery*, 41 (July 1965).

Abortion Act in Action

SIR,—Since the publication of my letter on May 16 (*Nature*, **226**, 673; 1970) more recent official figures[1] have shown that abortion deaths in 1969 were in fact a little up on 1967, the last full year under the old law.

In England and Wales, 10 deaths were directly attri-

buted to legal therapeutic abortions in 1969, not including 4 registered under the Act as resulting from legal operations after illegal or spontaneous abortions. In addition, 8 deaths "from other underlying causes after legal abortion operations" were registered under the Act. Of the latter, 4 resulted from conditions (congenital heart disease; cancer of rectum; cerebral haemorrhage; acute myocarditis) which were probably the reasons for, rather than the results of, the abortion operations. But the other 4 (3 pulmonary embolisms; 1 respiratory obstruction while recovering from anaesthetic) seem themselves more or less directly attributable to the operation, in the sense that these deaths probably would not have occurred had the pregnancies not been terminated. So there were certainly 10 deaths, and probably 14, resulting from legal abortions in 1969.

Also "a further 25 deaths were classified as directly due to abortions other than under the Act"[2] so that the total for all abortions (legal, illegal and spontaneous) was certainly 35 and probably up to 39 in 1969, as compared with 34 for 1967. It is true that 1967 seems to have been a good year, since the Registrar General recorded 53 abortion deaths for 1966, and 50 for the transitional year 1968 (4 months under the old law and 8 under the new); but plainly there is here as yet no good evidence of any dramatic reduction in mortality resulting from the Abortion Act 1967, as has sometimes been claimed.

Yours faithfully,

C. B. GOODHART

Gonville and Caius College,
Cambridge.

[1] Crossman, R., *Hansard (Commons)*, written answers, col. 560 (May 28, 1970).
[2] Crossman, R., *Hansard (Commons)*, written answers, col. 272 (March 23, 1970).

Blue Streak's Record

SIR,—I should be interested to know by what criterion you judge Blue Streak to be "unreliable" as the first stage of the Europa launcher (*Nature*, **227**, 425; 1970). Ten successful firings out of ten seems to me to deserve a slightly kinder description.

Yours faithfully,

R. H. W. BULLOCK

Ministry of Technology,
Prospect House,
100 New Oxford Street, London WC1.

MR BULLOCK is right. Blue Streak is reliable. But there is nothing to modify the assertion in the leading article that it is otherwise unsuitable as a starting point for a comprehensive European space programme.—Editor, *Nature*.

Obituaries

Professor F. T. von Brücke

FRANZ THEODOR VON BRÜCKE, professor of pharmacology and toxicology at the University of Vienna, died on March 24, 1970, at the age of 62, after a short illness.

Brücke's capability for independent research was soon apparent from a paper on the epiphyseal cartilage of long bones which he published while he was a medical student. His later development was profoundly influenced by such distinguished teachers as Otto Loewi and H. H. Dale, under whose guidance he gained experience in the pharmacology of the central and peripheral autonomic nervous system, an area of research to which he devoted the greater part of his life. It was therefore no accident that he was drawn to the Vienna school of pharmacologists, pioneered by H. H. Meyer and his successors, E. P. Pick and R. Rössler, whom he followed to the chair in 1948.

As early as 1935, Brücke recognized the antagonism of bulbocapnine to some of the central effects of apomorphine, an interesting observation in view of the now established interrelationship between dopamine, apomorphine and bulbocapnine. This led later to studies on the different patterns of release of epinephrine from the adrenal medulla after electrical stimulation of the hypothalamus and occlusion of the carotid sinus. An observation of far-reaching theoretical importance was that small amounts of acetylcholine, injected into the skin, elicited a pilomotor response, whereas larger amounts abolished the effect of sympathetic stimulation.

Brücke investigated the effect of denervation of the superior cervical ganglion of the cat as manifested in its sensitivity to adrenaline and acetylcholine and in cholinesterase depletion. Investigations into the innervation of the rabbit cardia led him to postulate the presence of adrenergic fibres in the vagus and cholinergic fibres in the splanchnic nerve. The induction of spasm of the rabbit cardia following severance of the vagus proved to be a simple device for the evaluation of spasmolytic agents. Brücke also studied the influence of acidity and basicity on the cardiac glycosides and described the importance of the binding of digitoxin to protein.

With the increase in his administrative responsibilities as chairman of a large research and teaching department, Brücke's own involvement in laboratory work decreased in later years, but he continued to stimulate research among his students and co-workers. His ability to generate enthusiasm attracted talented young investigators who have since taken up important academic positions in Europe, the USA and Canada. Under Brücke's direction the Vienna school embarked on a broad investigation of dicholinesters of dicarboxylic acids as muscle relaxants which led to the introduction of succinyldicholine into anaesthesiology. Another line of inquiry initiated by Brücke was the investigation by electroencephalography of hippocampal activity in the rabbit.

Brücke was recognized as an outstanding authority in matters of public health and in his capacity as an adviser to the pharmaceutical industry. His editorship of the *Wiener Klinische Wochenschrift* won for the journal a high reputation; his communications, both oral and written, sparkled with lucidity and wit. It is no exaggeration to say, too, that his acumen and foresight spared his country the ravages of thalidomide.