by a cold sea for a long time, probably throughout the Tertiary Period".

¹ Nybelin, Orvar, Sci. Res. Norw. Antarctic Exped. 1927-1928 *et seq.*, No. 26 Det Norske Videnskaps-Akademi i Oslo, 1-76 (1947).

² Nybelin, Orvar, Sci. Res. "Bratæg" Expedition 1947-48, No. 2. Publ. No. 18 Fra kommandør Chr. Christensens Hvalfangst-museum Sandefjord, 1-32 (1951).

³ Roughton, F. J. W., and Scholander, P. F., *J. Biol. Chem.*, **148**, 541 (1943).

⁴ Wong, S. Y., *J. Biol. Chem.*, **77**, 409 (1928).

⁵ Van Dam, L., and Scholander, P. F., *J. Cell. and Comp. Phys.*, **41**, 3, 1-3 (1953).

⁶ Norman, J. R., "Discovery" Rep. 18, 1-104 (1938).

PROF. H. MUNRO FOX, Bedford College, London, writes the following comment on the foregoing article: Prof. Johan T. Ruud's study of the fishes with colourless blood will be a most interesting surprise to most zoologists, although a few knew of their existence¹. The fact that there are fishes lacking hæmoglobin is not, however, quite so astonishing as appears at first sight, for the following reason. More than thirty years ago Maurice Nicloux² showed experimentally that carp, pike and eels remained alive for four hours, "*pas très incommodés*", in water through which a mixture of air with 2 per cent carbon monoxide was bubbled. Such a gas mixture would quickly kill a man. The hæmoglobin in the fishes' blood was found to be about 90 per cent in the state of carboxyhæmoglobin, that is, incapable of transporting oxygen. The conclusion, although not drawn by Nicloux, is that many fishes when swimming quietly get enough oxygen for their needs in solution in the blood plasma, and they probably only require an additional supply with the aid of hæmoglobin when they are moving actively. Their hæmoglobin is an emergency precaution and the 'ice fish' do without this luxury. Doubtless, however, hæmoglobin is not a luxury but a necessity in the blood of such fishes as mackerel, which cannot get enough oxygen without swimming rapidly through the water³.

¹ Matthews, L. Harrison, "South Georgia", p. 36 (Wright and Marshall, 1931).

² Nicloux, M., *C.R. Soc. Biol. Paris*, **99**, 1328 (1923).

³ Hall, F. G., *Amer. J. Physiol.*, **93**, 417 (1930).

NEW SURGE GENERATOR AT THE NATIONAL PHYSICAL LABORATORY

By R. S. J. SPILSBURY

ON April 21 a ceremony was held at the National Physical Laboratory to inaugurate the new surge generator installed by H.M. Ministry of Works for the use of the Electricity Division of the Laboratory. The equipment was put into action by Sir Edward Bullard, director of the Laboratory, and caused to discharge across a chain of forty-five glass suspension insulators, the total length between end fittings being 20 ft. Thanks to the courtesy of the main contractors for the equipment, Messrs. Ferranti, of Hollinwood, the inauguration was followed by a luncheon, at which Sir Edward made a short speech, and Sir Vincent Z. de Ferranti replied.

The need for surge generators arises, of course, from the hazards to which overhead electricity transmission lines, and the transformers, cables, etc., connected to them, are subjected when lightning

strikes the conductors or their supporting towers. The effect is to raise the voltage of the line, in a time of the order of a millionth of a second, to a value limited in practice only by the breakdown voltage of some of the insulation, such as air gaps or strings of porcelain insulators: this voltage may be of the order of a million volts for 275-kV. lines. Similar effects occur when switches are operated, though these surges are usually less serious. The voltage step imposed travels along the line without much attenuation, and in due course reaches a transformer or cable. The effect on transformers is particularly serious, since the steep front of the travelling voltage wave causes most of the voltage to appear across the first few turns of the winding, and so to place a stress on the inter-turn insulation many times that which it has to withstand in normal service.

The increasing use of overhead transmission lines and the occurrence of breakdowns due to the causes mentioned above produced, many years ago, a demand for tests designed to simulate the effects of natural lightning, and the surge generator, in conjunction with a high-speed cathode-ray oscillograph, provided the necessary tool. Briefly, such a generator consists of a series of high-voltage condensers which are charged, through fairly high resistances, by a direct-current source of suitable polarity—the effects of positive and negative surges are not, in general, the same—and are then connected in series by the breakdown of air-gaps. The breakdown is initiated by applying a controlled voltage surge to one of the gaps. In this way a voltage impulse, reaching its peak in perhaps a millionth of a second, and decreasing to half this value in about 50 millionths of a second—values which have been internationally agreed as reasonably representative of those which occur in practice—can be applied to a test object.

The National Physical Laboratory has possessed apparatus of this type, built by its own staff, for many years, the open-circuit voltage of the generator being 2 million, and the energy stored in the condensers 20 kilowatt seconds, and, until recently, this has been adequate. Some little while ago, however, it became clear that new equipment was needed; partly because transmission voltages are rising—275 kV. is in use in Great Britain and 380 kV. on the Continent—and partly because the condensers that form the heart of the generator, and are heavily stressed in service, were showing signs of deterioration. It was therefore decided to install new plant, and to design this for the highest voltage that the size of the building allowed—3.2 million volts—so that it would be adequate for the foreseeable future. The dimensions of the main high-voltage laboratory are 120 ft. × 60 ft. × 45 ft. clear height; even so, it was necessary, in order to obtain adequate clearance, to excavate a large pit 8 ft. deep, in which the generator stands.

The apparatus has eight stages, each charged to a voltage of up to 400 kV. by a transformer and metal rectifier: the stored energy is 77 kW. Each stage consists of two condensers in separate housings, the stage capacitance being 0.12 microfarad. The circular ribbed porcelain housings, with empty porcelains to act as stage insulators, are assembled into a strong four-column structure, which also supports the 50-cm. diameter spheres that form the electrodes of the various air-gaps, and resistors for controlling the shape of the voltage impulse. A condenser is provided to form the high-voltage section of a capacitance voltage-divider, from which

the scaled-down voltage that is applied to the recording oscillograph is obtained.

A glass-fronted chamber, built out into the laboratory at the level of the first floor, houses a desk which incorporates all the controls, and the indicators for safety interlocks, etc. The controls include means for varying the voltage, reversing polarity, setting the inter-stage gaps to a value appropriate for the stage voltage in use, firing the generator at the desired instant, and earthing the apparatus between tests. A device is provided for starting the 'time-sweep' of the oscillograph just before the generator fires, so that the front of the wave is properly recorded. The oscillograph is housed in a steel shield near the control desk.

The new generator is believed to be the largest in Great Britain, and it should be a valuable addition to the research and testing equipment of the Laboratory.

harvest of results brought him a well-earned Ph.D. in 1950. The most significant discovery was the recognition of the fact that, although the complex bears the hall-marks of an intrusion (for example, it transgresses the structures of the country rocks and shows internal vertical lineations), the materials of the marginal part of the granitic mass are transformation products of the adjacent country rocks. Rutledge also made an important tectonic study of the Fannich Forest area in the Scottish Highlands. More recently he was engaged on similar tectonic and petrogenetic problems in New South Wales.

A geologist of initiative and distinction, Harold Rutledge was fearless in spirit and endowed with great vitality and power of endurance. His sudden death, just as he was approaching a period of solid achievement, is indeed a grievous loss. Deep sympathy will be felt for his widow and four-year-old son.

ARTHUR HOLMES

OBITUARIES

Dr. Harold Rutledge

DR. HAROLD RUTLEDGE was among the ill-fated passengers who lost their lives when an air-liner *en route* to London from Sydney crashed at Singapore on March 13. The news of his tragic death at the early age of thirty-three has deeply shocked all who knew him, and not least his many geological friends in Britain and Australia. Born on December 15, 1920, at Fairfield, Darlington, he was educated at Stockton Secondary School before entering Bede College in 1939 as a student of the University of Durham. He was elected senior student of the Science Laboratories at Durham, 1941-42, and obtained a first-class honours degree in geology in 1942. He was no less distinguished in university athletics and games—becoming a rugger blue—while his obvious capacity for leadership was recognized by his appointment as sergeant-major of the S.T.C. After graduation, Rutledge entered the Royal Engineers and was soon seconded to the Royal Bombay Sappers and Miners, 1943-46, with whom he saw active service in the Burma campaign, eventually with the rank of captain.

On demobilization, Rutledge spent nearly a year on the staff of the Atomic Energy Division of H.M. Geological Survey; but wishing to return to academic life, he accepted appointment in 1947 as assistant lecturer in geology at Nottingham. A year later I invited him to join the staff of the Grant Institute of Geology, University of Edinburgh, as lecturer in geology, and there he remained until 1952, when he was appointed senior lecturer under Prof. C. E. Marshall at the University of Sydney. He was an outstanding success as teacher and lecturer, clear and vigorous in style and able to inspire in his students the enthusiasm which he brought to all his interests. During his Edinburgh days he joined the Territorial Army as captain in the Military Geology Group (Royal Engineers) and attended manoeuvres in Germany and elsewhere.

Rutledge's main research work was concerned with the structure and petrology of part of the plutonic complex of Loch Doon (Galloway) and its metamorphic aureole. His active interest in this area began while he was still an undergraduate; but it was not until he returned to university life that his wish to study it in detail was fulfilled. The first

Prof. Marston T. Bogert

By the death of Marston Taylor Bogert at the ripe old age of eighty-six, American and international chemistry has lost one of its most charming and effective personalities. Bogert was educated at Columbia University, where later he became professor and finally professor emeritus of organic chemistry. His main chemical interests lay in the synthesis of heterocyclic compounds such as the quinazolines and thiazoles. He also conducted many investigations on the preparation of derivatives of such aromatic compounds as pyrogallol, thiophene, terephthalic acid, phenacetin and cinnamic aldehyde. He was interested in pharmaceuticals and perfumes, and among the four hundred papers in his name one finds such interesting topics as the relationship between odour and molecular structure.

Bogert was president of the American Chemical Society during 1907-8, and it was during this period that he, together with C. L. Parsons, then secretary of that Society, succeeded in forming the first divisions within the American Chemical Society—a far-sighted political act which in these latter years has undoubtedly greatly assisted in maintaining the cohesion in that vast organization. During the First World War, Bogert was invited to Washington to organize and serve as first chairman of the Chemistry Committee of the National Research Council. He was elected president of the Society of Chemical Industry for the year 1912, and in the years 1918-19 he served as colonel in the U.S. Chemical Warfare Service. After the Second World War, Bogert devoted much of his time and energy to the resuscitation of the International Union of Chemistry, and he was, in fact, the first American citizen to be elected president of that body.

Although somewhat feeble physically and attended by a nurse, Bogert went through the lengthy and trying public functions which attended the seventy-fifth anniversary meeting of the American Chemical Society in New York in 1951. As a public speaker or toastmaster, he displayed a mind capable of much wit and charm, and at scientific dinners the wise always attempted to get a seat near the man with the mauve tie, a sign that Bogert had attended the New York dinner in honour of Sir William Perkin. His loss will be felt by his many friends on both sides of the Atlantic.

ERIC K. RIDEAL