The last stop was made at the Eildon Weir, on the headwaters of the Goulburn River, where the Utah Construction Co. of the United States, on behalf of the Victorian Government, is enlarging the capacity of the existing weir from 306,000 acre ft. to 2¾ million acre ft.; the enlarged dam will make possible the generation of 120,000 kilowatts of hydro-electric power.

On arrival in Melbourne, with a temperature of 90° in the shade, delegates, while a little dusty and dishevelled, were agreed that they had gained an appreciation, which would not have been possible in any other way, of some of the problems and possibilities of the Australian environment.

ELECTRIC WHALING

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IT is appropriate that recent publicity given to the electric harpoon should come in the centenary year of this method of killing whales. On March 30, 1852, Dr. Albert Sonnenberg and Phillip Rechter, of Bremen, Germany, patented an 'electric whaling apparatus' which was to be installed in a conventional open whaleboat of the period[1,2]. The hemp whale-line, bearing a wire conductor, was to be fastened to the whale with the customary hand harpoon: thereupon the hand-operated induction machine would generate "so formidable a power that no living being can resist the same"; the current was to return through the water to the boat, specially copper-bottomed for this purpose. This apparatus, although doubtless impracticable and never tried out, clearly embodied the essentials of the modern development.

The hand harpoon of those days was to be eventually ousted by a heavy projectile, bearing an explosive grenade in its barbed head, and fired from a cannon mounted in the bows of a small steam vessel. Developed by the Norwegian, Svend Foyn, between 1864 and 1873[3], this bomb-harpoon, persisting virtually unaltered, has made possible the modern whaling industry. It has, however, various disadvantages. The maximum range is not much more than thirty yards. The bursting grenade spoils some of the meat, and frequently ruptures the gut, thereby releasing the intestinal flora and so accelerating decomposition of the carcass: sometimes the hoggers of a meat-meal plant are damaged by overlooked splinters of a grenade. (It may be said at once that these processing drawbacks are quite overcome by an electrocution technique.) The industry would also profit by a method which killed more whales in a given time, and which reduced the losses from sinking of a proportion of grenade-killed whales before they can be ranged alongside a catcher and inflated with air. Finally, and not least important, there is the suffering inflicted by the bomb-harpoon: it may kill outright, but usually the killing takes ten or twenty minutes and sometimes much longer.

Most promise of improvement seems to lie in electric whaling. Early experiments with the electric harpoon, in 1881 and 1904, were unsuccessful, but in 1929 a German engineer called Weber became interested and a company, A/S Elektrisk Hvalskytning, was formed in Oslo. The company did not forget to consult American experts on the electric chair. Eventually four fin whales were electrocuted. Weber improved his apparatus and by 1938 the electric harpoon is said to have accounted for about two thousand whales during six expeditions north and south[4].

Weber committed suicide in 1945; but some account of his methods has been published[5,6]. A fundamental need was to safeguard the gunner and the catcher crew. The conventional harpoon gun was therefore fitted with a recoil switch, so that the circuit was not completed until the harpoon had left the gun. A dynamo generated 200 volts at 50 cycles: the current varied according to the position of the hit. The heart and lungs took 78–90 amp. and death was instantaneous. More usual, and considered most effective, was a hit in the dorsal muscle which took 35–60 amp. Death ensued between ten seconds and two minutes afterwards, and could be recognized by the collapsing of the flippers and the opening of the mouth. The abdomen took more current (80–90 amp.). A 'partial hit', with one barb projecting and shorting to the sea, caused a load of 100 amp.; but might only paralyse and not kill the whale. A miss naturally short-circuited the current.

With a good hit, this is a merciful method of killing. Furthermore, the electrocuted whales usually float, tetanus overcoming them while their lungs are still full of air. Of two hundred electrocuted whales, the catcher *Star 14* lost only two from sinking[7]. Perhaps most significant in an industry where time is everything during a restricted season, operators claimed that the time spent in securing a hit, killing the whale, heaving-to, inflating and flagging the whale, and finally resuming the chase, was reduced from around forty-five minutes in grenade whaling to ten minutes in electric whaling.

Nevertheless, in pre-war years the electric harpoon was not regarded seriously by Norwegian gunners, perhaps not least because of a tale I heard in the south of an electrocuted blue whale which, being secured alongside the whalecatcher, suddenly became embarrassingly alive.

Since the Second World War there has been renewed interest in electric whaling. The main reviving impetus has come from Britain, and a statement describing some recent progress has been released by the General Electric Co., Ltd. At present the firm of United Whalers, Ltd., is co-operating with the G.E.C. and with manufacturers of guns, ropes and cables, in a vigorous programme to develop the electric harpoon. Norway shares the revival, and the Electrohval Company in Oslo maintains liaison with the British investigators. Japan is also experimenting with electrical methods, in conjunction with a 'flattened-head' harpoon said to diminish ricochet without impairing penetration[8].

British interest owes a good deal to the energy of Dr. H. R. Lillie, a surgeon who returned from the Antarctic whaling season of 1946–47 alarmed by the suffering caused among whales by the bomb-harpoon[9]. The Universities Federation for Animal Welfare took up his cause, and, led by Major C. W. Hume, they were able to interest United Whalers, Ltd., in the need for a more humane method and one which might also benefit the industry. Electric whaling was the obvious choice. A successful search was made for Weber's papers, and a catcher was equipped for electric whaling in time for the 1948–49 Antarctic

season. The experience gained suggested new departures, and next season United Whalers co-operated with Electrohval in two catchers fitted with different guns supplied respectively by Messrs. Westley Richards, Ltd., and the Konsberg Gun Factory. Sir Vyvyan Board, of United Whalers, Ltd., took part in this voyage. Last summer a further trial with the Westley Richards gun was made off Sao Thomé in the Gulf of Guinea.

In this post-war research, both Electrohval and the British workers have made progress in the difficult matter of electrifying forerunners and whale-ropes. The fact that electrocuted whales do not always float is sufficient to banish the optimistic suggestion that whale-lines need not be used in electric whaling. The main needs have been to overcome breakage due to differential stretch of forerunner and conductor, to reduce the weight of electrified ropes (for a heavy forerunner impedes the harpoon in flight), and to overcome the unlaying of the conductor by differential centrifugal forces acting when the forerunner flies out from its coil. Manilla, hemp, nylon and terylene have been tried. Nylon ropes, lighter and stronger than manilla, and less affected by extreme cold, are now favourites among post-war gunners, so it is important for the future acceptance of electrical methods that the Pirelli-General Cable Works, Ltd., have devised an extensible conductor which can remain intact during the 40 per cent or so stretch of nylon under strain.

In guns and harpoons two approaches are discernible. The more conservative development of Electrohval and the Konsberg Gun Factory has been to retain the standard gun, but to modify the electric version of the Svend Foyn harpoon. Especially with the smaller fin and humpback whales, the harpoon may completely pierce the animal, causing (as already mentioned) a heavy current leakage from the barbs. To remedy this, Weber had introduced a hinged tip as a stop to slew the harpoon round after penetration[4]. But the cumbersome harpoon-shaft or 'leg', when partially withdrawn from the blubber on a taut line, was still a source of current leakage, requiring heavy insulation. Electrohval have therefore developed the 'detachable leg' harpoon where the shaft falls away after the barbed electric head with attached fore-runner has fastened itself in the whale. The approach of United Whalers, Ltd., and associated firms has been to deviate from Electrohval in experimenting with a new gun, firing a new light-weight harpoon which has a flatter trajectory and longer range than the conventional harpoon weighing around 150 lb. The experimental gun, built by Messrs. Westley Richards, Ltd., fires on the spigot principle. One difficulty is to prevent, in the cramping tension of electrocuted muscle, the snapping of the new harpoon, which has to be made of high-tensile steel in order to combine strength with lightness.

Research and development continue. Other techniques are in the air, including carbon dioxide shells, and even rockets for possible helicopter whaling. But the electric harpoon undoubtedly combines humane killing with better preservation of whale products. It also shows real promise in reducing the time of hunting, and so shortening the season and reducing the enormous overhead costs in financing a modern expedition to the Antarctic grounds. Moreover, a shorter season could allow increased oil production within the International Whaling Convention's present limit of 16,000 blue whale units, since baleen whaling could start later and so take whales which have fattened through an Antarctic summer. Actually there is a limit to the late start because of deteriorating weather in late summer, and because there are indications of an influx of immature whales from lower latitudes at this time[10].

Whether electric whaling will find general adoption must ultimately depend upon the attitude of the whale-gunners. Until they are completely satisfied that the electric harpoon is superior, they are not likely to relinquish Svend Foyn's grenade, which has served them well for more than half a century of modern whaling.

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RECENT SOVIET PRONOUNCEMENTS ON MOLECULAR STRUCTURE

THE resolution adopted at the Moscow Conference on the Theory of Chemical Structure in Organic Chemistry, a translation of which appeared recently in *Nature*[1], while giving some insight into Soviet methods of treating scientific questions, gives little indication of the precise nature of the views endorsed by the Conference. A more complete picture can be formed by an examination of other Soviet publications, namely, a paper on the theory of the chemical bond by N. D. Sokolov[2], the report of a committee set up by the Institute of Organic Chemistry of the U.S.S.R. Academy of Sciences to consider the present state of the theory of molecular structure[3], a paper on the theory of organic chemistry by O. A. Reutov[4] (the foregoing papers appeared prior to the Conference), and also reports of the Conference by Reutov[5] and Sokolov[6]. Some relevant information derived from these publications is given below.

The proceedings at the Conference were based on the report of a second committee, set up by the Chemical Sciences Section of the Academy of Sciences under the chairmanship of A. N. Terenin; it had two members in common with the other committee of the Academy. Its report (though not available to me) is discussed and summarized in some of the papers cited[1,5,6], and it appears to be very similar to the first report, though covering a wider field.

There were two main topics at the Conference: the significance of the work of Butlerov, a Russian contemporary of Kekulé, and the unsound nature of the theory of resonance or mesomerism.

With regard to Butlerov, the following is quoted from Sokolov's summary[6] of the Terenin report:

"The basic principles of the theory of chemical structure, which is the foundation of chemistry, were developed by the Russian genius of chemistry, Aleksandr Mikhaylovich Butlerov. . . .

"These principles are: