Water-Power in the United States*

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III. NORRIS AND WHEELER DAMS

ON the side of the North American continent opposite to the valley of the Columbia River lies another notable valley—the Tennessee Valley, mainly in the State of that name, but also including parts of Mississippi, Alabama, Georgia,

designed and in part executed along the course of the River Tennessee and its tributary the River Clinch. Perhaps the most notable of these, until recently, was the Wilson Dam, 137 ft. high and 4,860 ft. long, impounding a reservoir with a capacity of half a million acre-feet and generating

Fig. 1.

GENERAL VIEW OF THE NORRIS DAM ON THE CLINCH RIVER, TENNESSEE, SHOWING THE POWER HOUSE AND IMPOUNDED LAKE.

North Carolina, Kentucky and Virginia, with a basin comprising 40,600 square miles. For the co-ordinated development of this great territory, considerably larger than the whole of Ireland, a special body, the Tennessee Valley Authority, has been created by U.S. Congress with the duty of improving navigation, controlling floods, generating hydro-electric power and arresting soil erosion. For this purpose a series of ten dams of varying heights, and at irregular intervals, has been

power to the extent of 261,400 horse-power. The Wilson Dam was completed in 1925; but since that date, two other and even more striking dams have come into existence, the Norris Dam and the Wheeler Dam, completed as recently as last year.

Of the two, the Norris Dam (Fig. 1) located on the Clinch River in north-eastern Tennessee, about 25 miles north-west of Knoxville, is the loftier and impounds a reservoir of greater capacity. The impounded area is more than 50 square miles, with

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a shore line of over 700 miles, winding in and out of many valleys formed by the hills above the dam. The reservoir capacity is 2,570,000 acre-feet at normal water-level, but may attain a maximum of 3,400,000 acre-feet. The dam itself is a straight mass-concrete structure, with a total length along its crest of 1,872 ft. It has a height of 265 ft above the lowest foundation level and is 204 ft. thick at the base. The spillway, confined within side walls of concrete, discharges into a concrete hydraulic 'jump pool', which extends 215 ft. down-

length of 6,335 ft.—1,475 ft. more than the Wilson Dam and 4,463 ft. more than the Norris Dam. It is located on the Tennessee River, 275 miles above Paducah, Kentucky, where the Tennessee joins the Ohio. Situated at the upper end of Wilson Lake, it is $15\frac{1}{2}$ miles above the Wilson Dam at Muscle Shoals. It impounds a volume of water aggregating 1,260,000 acre-feet in a reservoir which has a shore line of 951 miles.

The dam is a gravity concrete structure, with the above mentioned length of 6,335 ft. composed,

Fig. 2.

DOWNSTREAM VIEW OF THE WHEELER DAM ON THE TENNESSEE RIVER IN ALABAMA.

stream from the toe of the dam. Along the crest of the spillway, between two 12-foot concrete piers, are three hydraulically-operated steel drum gates, each 100 ft. long, designed to retain water at flood peak-level.

Though primarily a flood control and navigation work for the Tennessee and Mississippi Rivers, the Norris Dam is provided with power-generating plant consisting of two 66,000 horse-power generators. The cost of the entire installation was 35 million dollars (£7,000,000).

The Wheeler Dam (Fig. 2) is not remarkable for its height, which is only 72 ft., but it has a

successively, of a non-overflow section 177 ft. long, 613 ft. power house, another non-overflow section 718 ft. long, 2,700 ft. of spillway, 1,756 ft. of non-overflow, 162 ft. of navigation lock structure and a final non-overflow section of 209 ft. to the north bank of the river. The spillway is divided into sixty bays, each bay being surmounted by a radial gate, 15 ft. high and 40 ft. long.

The power plant is of the outdoor type, with no housing over the crane or the generating units, the generators being protected from the weather by metal covers. The station is designed to accommodate eight main generating units of an

aggregate capacity of 360,000 horse-power. Only two units of 45,000 horse-power each, have as yet been installed. The system came into operation on November 9 last.

The individual projects, which have been described above, form part of an organized design for the utilization of the resources of the whole of the Tennessee watershed, by means of storage reservoirs in the headwaters, which will retain the run-off during the rainy season and release it during the dry season, so regulating the flow during the whole year to suit the requirements of navigation and to remove the danger of flooding.

Another interesting and important feature of the undertaking is the arrest of soil denudation. Under the influence of heavy rainfall, millions of tons of fertile top soil are removed from the hillsides, and further large quantities are lost by sheet erosion

on the plains. This silt would normally be transported by the river currents over long distances, but the interposition of a series of dams causes it to settle and enables it to be reclaimed. But, going a step further back in preventive measures, the Authority is engaged in treating the eroded hillsides and encouraging the growth of vegetation with the aid of plant foods, and in particular, phosphates. At Muscle Shoals, a demonstration unit has been built to produce triple super-phosphate from the raw phosphate rock found in central Tennessee. The electric power used for this purpose is derived from the hydraulic energy converted at the impounding dams.

The information on which the foregoing article has been based has been courteously supplied by the Tennessee Valley Authority, to which also I am indebted for the photographic illustrations.

Natural and Artificial Membranes

THE late Sir William Hardy was responsible for the foundation of the Colloid Committee of the Faraday Society, the duties of which were periodically to call meetings at which biologists, physicists and chemists could meet to discuss topics of mutual interest. The fifth meeting of this character was held on April 22-24 at University College, London, under the presidency of Prof. M. W. Travers of Bristol and the chairmanship of Prof. R. A. Peters of Oxford, the subject of discussion being membranes, their properties and functions. This particular meeting was graced by the presence of a number of distinguished foreigners, amongst whom we may include Dr. Ancel Keys of Rochester, Min., L. R. Blinks of Stanford, Mrs. Brooks of Berkeley, Cal., Prof. E. Gorter of Leyden, Prof. R. Collander of Helsingfors, Prof. E. Manegold of Dresden, Prof. Kurt H. Meyer of Genthod-Genève, Dr. W. Teorell of Uppsala and Dr. W. Wilbrandt of Bern, who all took part in the discussion. We were also pleased to note the presence of Profs. H. Mark and W. Ostwald, constant visitors to these meetings. It was to be regretted that several distinguished scientific workers were unable to present their papers; these included Profs. A. Krogh, Newton Harvey, E. Ponder, W. J. V. Osterhout and Cole.

It was clear from the contributions and from the discussion that in spite of the importance, both structural and functional, of membranes in organized living systems, we are still a long way from obtaining a complete description of the microstructure of even one of these or a general

interpretation of their behaviour. It would appear that all natural membranes are composite in the sense that they contain both a lipid-like and a non-lipid component. The structural relationship of the components to each other is still *sub judice*. Exponents were not lacking of the extreme view of complete stratification of each component, one possibly in a monolayer, as well as those who upheld the view of a systematic mosaic or even haphazard intermingling. Some species of interaction, at least between the components of each 'phase', appears necessary to account for the physical properties of the complete membranes.

Whilst cationic and anionic permeability of the protein component of the membrane and the 'solubility of organic substances' in the lipid component, as well as the ionic partition as defined by the Gibbs - Donnan membrane equilibrium are readily understandable in general terms, it appeared to many that these now well-recognized and important factors do not suffice to account for all the observed phenomena. So many questions were asked by our biologist friends at the meeting for the consideration of the physicist and chemist that it seemed difficult at times to realize how much progress had been made since the first meeting summoned by the Colloid Committee. There were three questions raised of unusual interest to many non-specialists present, to which no generally satisfactory answers could be given. These were the apparently abnormal behaviour of the potassium ion, the origin of bio-electric phenomena and the mechanism of narcosis.