residual effect on soils. If a quick result is not expected, wasted or deteriorated land can be improved from the nitrogen point of view by covering it with vegetation or grass and leaving it undisturbed for a number of years. In this way the carbonaceous substances from the decaying vegetation are oxidized and assist in the fixation and conservation of soil nitrogen ; thus the nitrogen status is improved.

[1] Dhar and Mukerji, NATURE, **138**, 1060 (1936).
[2] Dhar, presidential address to the National Academy of Sciences, December 1935 and January 1937.
[3] Russell, "Soil Conditions and Plant Growth" (1931), p. 362.
[4] Nemec, *Forstwiss. Cbl.*, **53**, 49, 147 (1931).
[5] Dhar and Seshacharyulu, *Proc. Nat. Acad. Sci. India*, **11**, 97 (1941).
[6] Mërse, *Mass. Agric. Exp. Sta. Bull*, No. 33 (1936).
[7] Dhar, NATURE, **134**, 572 (1934).

THE TENNESSEE VALLEY AUTHORITY

AN EXPERIMENT IN REGIONALISM

By K. S. LOMAX

IT was on May 18, 1933, that the Act of Congress setting up the Tennessee Valley Authority became law. Through lack of effective planning to meet the successive floods, through unscientific farming and consequent loss of rich top soil, depression and destruction had spread throughout the valley of the River Tennessee and its tributaries—an area almost as large as England, with abundant natural resources including iron ore, coal, oil, timber, chemicals, fertilizer constituents, ceramic and aluminium clays, pigments and abrasives. Little was done until Franklin D. Roosevelt was elected president in 1932, and he suggested to Congress legislation to create a Tennessee Valley Authority. In 1933 the system consisted only of the Wilson Dam and nitrate plant at Muscle Shoals which had been started to satisfy the need for nitrates in 1917 and had a capacity of 39,000 kw. Now in 1943 projects are under construction which will increase the capacity of the system to more than two million kw., provide flood control storage of 15 million acre-feet and a nine-foot navigational channel from the mouth of the Tennessee to its upper reaches at Knoxville, 650 miles away.

Flood control, navigation, and the production of cheap and plentiful electric power are not the only activities of the Tennessee Valley Authority. It is a unique experiment in regional development. Its subsidiary activities include the development of agriculture, soil conservation, the encouragement of animal husbandry, the re-forestation of denuded areas, the development of phosphate fertilizers, investigation of the mineral resources of the area, the development of native kaolins for use in high-grade pottery, the development of additional uses for electricity in agricultural processes, the encouragement of co-operatives for collecting, grading and marketing agricultural products, the encouragement of recreational areas, the improvement of housing, education, and public health throughout the area.

The history of the Tennessee Valley Authority, however, has not been without controversy. There were forty-one law suits in the first five years of its existence, two being taken to the Supreme Court, where the T.V.A. was upheld on all counts. It was established that utilities had no monopoly and the Government had the right to sell electric power from flood control dams in competition with private interests. Then in 1939 difficulties arose within the board of three which managed the Authority, the chairman accusing his two colleagues of moral and ethical lapses. The outcome was that President Roosevelt dismissed the chairman and Congress ordered an investigation into the affairs of the T.V.A. The majority report of this inquiry cleared the Authority of the charges against it and concluded that "The Authority should be regarded as a settled and established institution in the Valley. Its construction programme should be carried to completion so that money already invested may not be wasted or inadequately supported by revenue. The agricultural, forestry, public health and other regional development programmes of the Authority are generally acknowledged to be beneficial to the region and to the nation as a whole and should be continued. The Authority has already demonstrated the value of unified river control under public management. It is on the way to full demonstration of the practicability of promotional rates for domestic electric service which may be adopted as well by private utilities as under public ownership."

The T.V.A. experiment has been called "costly". It has been argued that it benefits a fraction of the country at the expense of the rest and that it introduces Government competition with private enterprise. It has been questioned whether a single authority can deal adequately and efficiently with such diverse objectives as navigation, flood control, power production and the many subsidiary activities. The bitterest animosity has been caused, however, by the policy of using T.V.A. power as a "yardstick" to determine "fair" prices for power privately generated elsewhere.

On the other hand, the T.V.A. is a bold imaginative scheme of regional development. It indicates a new approach to the problems of such an area, and its achievements have already been notable, not least among these being the raising of the standard of living throughout the Valley. There are obvious economies to be gained from a multi-purpose project applied to such a large natural system, and there are great advantages in being able to transfer organization and equipment from one dam construction project to another. Undoubtedly an important factor in the ability to produce abundant power at low cost is the fact that the Tennessee Valley Authority was started in a period of depression when labour and materials were cheap.

One of the most significant factors in T.V.A. development and one which we, thinking in terms of post-war reconstruction and possible reform of the structure of local government, will watch with special interest is the technique of administration. There are many units of local government in the area—the Authority embraces, for example, seven States and one hundred countries—and while the T.V.A. is above them it does not supersede them. The official relationships between the T.V.A. and the States, counties, districts, and municipalities of the area are many and varied, ranging from informal agreements to detailed legal contracts. There has been from the start a high degree of co-operation between the T.V.A. and both the local units of the area and also other Federal agencies, and it can be said that an unusual degree of initiative on the part of local units and of citizen participation has been encouraged. The third annual report of the T.V.A.

puts it admirably: "The planning of the river's future is entrusted to the T.V.A. The planning of the valley's future must be the democratic labour of many agencies and individuals and final success is as much a matter of general initiative as of general consent. The T.V.A. has no power or desire to impose from above a comprehensive plan for the social and economic life of the Valley."

INSULATION OF HEATING SYSTEMS

A. C. PALLOT gave a Cantor Lecture to the Royal Society of Arts on "Thermal Insulation at Medium Temperature" on November 23; the lecture, which included many topics of current interest, has now been published[1].

In a bulletin on heat insulation issued by the Ministry of Fuel and Power, it was pointed out that "In the national drive for fuel economy there is probably no single factor, which is common to all industries using heat in its many diverse applications and can produce a greater saving in fuel, than efficient insulation. The reduction of heat loss by insulation is a practical means of achieving a substantial economy in fuel by using materials which are available and can generally be easily and quickly applied without interruption to operation or to process routine"[2]. Comparative neglect of insulation is apparent in many industrial, commercial, and domestic buildings. In some industrial premises taken over by the Government, all the calorifiers, pipes and connexions were devoid of lagging, long lengths of main steam piping were exposed to the weather and were completely bare, and the entire condensate was allowed to run to waste.

The temperature range 100–400° F. covers all normal heating, ventilation and hot-water supply systems, as well as many industrial steam installations, accounting for the use of 60 million tons of fuel yearly—a quarter of the total output of Great Britain. Even a small fractional saving of fuel by the use of insulation would mean a substantial economy in national resources. Many quantitative data given in the lecture show that a highly polished metal surface is quite a good insulator. A given thickness of insulation is more effective on a large pipe than on a small one. 'Insulation' with unsuitable materials may actually increase the heat loss from small-diameter pipes. The first layer of insulation is more effective than subsequent layers in spite of the fact that a greater volume of insulating material is needed for each successive concentric ring. Insulating materials in common use vary from crumpled aluminium foil, reducing radiation losses, to asbestos, magnesia, glass silk and slag wool, reducing losses by conduction. Even aluminium paint will save about half the normal radiation losses. Under ordinary conditions the domestic 25-gallon cylinder loses heat by radiation equivalent to about 5 lb. of fuel a day. Insulation of such a cylinder in constant use would save about half a ton of fuel per annum.

The physical factors affecting heat losses are simple compared with those involved in calculating the economic thickness of insulation. A calculation made of the thickness of a given insulator needed to save a definite percentage of the bare surface loss shows that the thickness diminishes as the temperature increases. This is contrary to ordinary practice, but the 10 per cent of heat still lost through the insulation increases rapidly with the working temperature and a thinner layer of insulation will allow this to pass. A calculation of the most economical thickness of insulation will have to take account of the annual cost of the heat produced and the interest and depreciation charges on the proposed insulation. Both internal and external temperatures will vary throughout the day as well as throughout the year. The cost of the heat lost will depend upon both the cost of fuel and upon boiler efficiency. Hours of operation per annum must be considered, for the loss of heat is continuous while the boiler is in use, but some plants work throughout the year whereas others work seasonally or intermittently. Among these factors the thermal conductivity is the simplest occurring in the calculations, examples of which are given. Special attention is given also to the use of emergency materials as substitutes for orthodox insulator which may be unobtainable in war-time.

In the second part of the lecture, dealing with the insulation of structures, it is pointed out that the modern tendency to build light structures may considerably increase the amount of fuel needed to keep their interiors at a comfortable temperature. Not only will thin walls and roofs allow easy transmission of heat but also, if the walls are at a lower surface temperature, a higher air temperature must be maintained inside. In a well-planned building the initial cost of insulation may be more than offset by the reduction in initial cost of a central heating system as well as by the subsequent reduced consumption of fuel. In addition to its thermal results, the insulation of buildings minimizes condensation, because of the higher surface temperatures. 'Pattern staining', due to the transfer of dust from the warmer to the colder areas of plaster, is reduced, and most thermal insulators are effective in absorbing sound. Furthermore, insulation of concrete roofs reduces expansion, which sometimes causes structural damage.

[1] *J. Roy. Soc. Arts*, **91**, 122 (1943).
[2] *Mines Dept. Fuel Efficiency Bulletin*, No. 2 (1942).

PREPARATION OF TEACHERS IN HEALTH EDUCATION

IT will be a happy day when we have in Great Britain a booklet corresponding to "Opportunities for the Preparation of Teachers in Health Education", issued by the U.S. Office of Education (Bulletin 1942, No. 1). Written in the form of a survey of twenty Teachers Colleges, ranging from Massachusetts to California, this work presents a bird's-eye view of the training of U.S. teachers in this vital subject. It is clear that "health education" is conceived by the U.S. Office of Education as something very different from the traditional 'hygiene', and it is to be hoped that as a result of the deliberations of the Board of Education's McNair Committee on the Training of Teachers, a similar breadth of vision will permeate the training colleges of Great Britain.

Among the obstacles to the achievement of adequate health education courses in the United States are listed the slowness of administrators to recognize the need for them and the lack of well-prepared health instructors —two causes potent also on this side of the Atlantic. Every training college lecturer and administrator in Great Britain should study carefully these detailed