at less than £100,000,000 per annum, apart from the manufacturing and industrial advantages of a cheap and efficient electric power supply. The reconstruction committee lays special emphasis upon the part which power will play in the cost of manufacture and in the matter of international industrial competition to which all countries are devoting. such great attention. The economies resulting from the supplying of power to industry through the agency of the electric motor is everywhere recognized. In the factories erected for the production of munitions during the war, 95 per cent. of the machinery was driven by means of electricity. The committee, therefore, points out that the problem is not so much how to apply power to tool or process as the case may be, but how best to generate and distribute the electric power required.

Technical Difficulties in Great Britain

As some indication of the technical difficulties to be overcome in Great Britain, it may be cited that in Greater London alone there are 70 different authorities, 70 generating stations,—with 49 systems of generation, 10 different frequencies, 24 different distribution voltages and 70 methods of charging and prices. It is not surprising to learn that under such conditions the average size of unit is under 700 k.w., and the average size of station less than 6,000 k.w. In addition there are 9 traction stations used chiefly for supplying power to the rapid transport systems.

The committee recommends that, instead of over 600 districts as at present, Great Britain should be divided into some 16 districts, in each of which there should be one authority dealing with all the generation and the main distribution. For each district there would be a standard frequency and voltage for the trunk mains, into which power stations situated at the most advantageous sites would feed, and into which could be fed also power derived from surplus gas or waste heat. Especial attention would be given to the development of power at the pit mouth, where coal which it does not pay at present to bring to the surface might economically be utilized. The main steam power stations would be very large, probably 150,000 h.p. or over, with units of from 20,000 h.p. to 50,000 h.p. They would be constructed preferably outside the centres of population in situations where ample area could be obtained to permit the erection of by-product recovery plants and in some cases the establishment of electro-chemical industries.

There is at present being considered by the government of the United Kingdom, a bill to give effect to many of the recommendations of this committee.

United States Taking Action

In regard to the centralization of plants at or near the coal mines, L. H. Rittenhouse, Chief of the Power Section, Production Bureau of the United States Fuel Administration, briefly states as follows:—

"There are a number of large modern central station electric power plants, installed in the various coal regions of this country. The purpose for which these were built was that of supplying electric energy to the coal mines for the purpose of operating their machinery in the production of coal. Among some of the more important of these plants may be mentioned: The Virginian Power Co., Charleston, West Virginia; The Logan County Light & Power Co., Logan, West Virginia; The Appalachian Power Co., Bluefield, West Virginia; The West Penn Power Co., Pittsburg, Pa.; and others.

"These companies have large turbo-generators, some up to 20,000 k.w. capacity, and, of course, are more economical than the many isolated plants at the various collieries which have been supplanted by these modern stations. As an investment proposition, they apparently pay the owners a good return and most of those mentioned, as well as others, were in operation before the war. The government encouraged the operation of, and additions to these central power plants during the war through the activity of the power section of the production bureau. Not only was the conservation in coal recognized as a necessary and worth while result, but the saving in labor and in iron and steel that was brought about by the operation of large units was recognized and full advantage taken in the planning of new and additional power facilities in the respective coal fields. In other words, it was impossible for an individual coal operator to install a small or medium size power plant if central station service was available. This policy was maintained through our co-operation with the Electrical and Power Equipment Section of the War Industries Board, which section had complete jurisdiction over all power house apparatus."

Power Plants in Coal Districts

Respecting the still broader question of conservation through the elimination of a great deal of the coal distribution by construction of power plants in the coal districts, the electric energy being transmitted to the various industrial centres of the country over high tension transmission lines, Mr. Rittenhouse continues:--

"To a certain extent, this result is accomplished by the power stations referred to above, as they transmit at voltages up to 66,000 and over distances reaching 100 miles in some cases. However, these plants are primarily intended to supply the energy required in the coal mines themselves and most of them are at too great a distance and of insufficient capacity to economically distribute power to large industrial centres along the eastern seaboard. It will only be a question of time, however, before large super-stations will be constructed in some of the coal fields, particularly those near the congested industrial sections in the east, and full advantage taken of the opportunity to burn the culm or refuse coal, together with the advantage of distribution at high voltage to industrial centres. The government has fully recognized the desirability of the adoption of the above plan, in that there will be a saving in coal consumption, man-power, transportation, etc. Indeed, this very problem had been approached just previous to the signing of the armistice."*

Heating by Electricity

Before passing to the concluding portion of our discussion, may I briefly state, with respect to the restricted possibilities of electric heating, that for years past I have been emphasizing the comparatively limited use which can be made of electric energy as a wholesale substitute for coal for heating,—including the heating of buildings. The sooner it is realized that hydro-electric energy can never as a heating agent be an adequate substitute for coal for the citizens of Canada, the sooner will action be concentrated upon sources from which real relief may be derived—there is no use entertaining hope towards a source from which no sufficient relief can come. It may be recalled that at our annual meeting in November, 1917, I stated that "The extent to which electric energy will be available for heating has been much overrated and, realizing the underlying physical limitations, one cannot be enthusiastic respecting the extent to which it may be utilized."

The underlying principles governing in this electrical heating proposition are simple.

In order to determine what is technically termed the mechanical equivalent of heat, J. P. Joule, an Englishman, about 1850—and subsequently a number of other experimenters—ascertained the number of foot-pounds of energy required to raise one pound of water one degree Fahrenheit. In their simplest form, the experiments consist of confining a known quantity of water in an insulated vessel and transmitting to the water by means of agitated vanes—like a churn—the energy developed by a known weight falling through a given distance. Taking into consideration the

*Consult "Electricity will not Replace Coal," by Arthur V. White, in "Industrial Canada," Toronto, April, 1918; also, by the same author, "Coal Problem of Canada Demands National Action—A Solution of a Vital National and International Question" in The Monetary Times Annual, 4th Jan., 1918, pp. 25 et seq. See The Monetary Times, 1st March, p. 18; also, "Possibilities Ahead of the Gas Industry as Revealed by a Digest of Reports from Various Sources," by G. W. Allen in "Proceedings of 11th Annual Meeting of the Canadian Gas Association." 1918.