CANADIAN WATER POWERS.*

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CIVILIZED man differs from uncivilized man in the amount of power which he uses. The Bedouin in the Arabian desert supplies all his own power. The needs of civilized communities, however, incident upon their higher scale of living can exist only when immense stores of power can be made available. Hence the demand for power—modern comfort is based upon it.

The various sources of power are: Atomic power (the immense stores locked up in the Molecule); heat of the earth's interior; the sun's heat; movement in the atmosphere, *i.e.*, wind power; movement in the hydrosphere, *i.e.*, water power; heat development by chemical changes, *e.g.*, oxidation of coal, oil, gas.

All three of the last mentioned—wind, water and the power derived from burning coal, etc.—are really derived from the sun.

Dr. Prichett is responsible for the statement that on a clear day, when well above the horizon, the sun delivers upon each acre of the earth's surface exposed to its rays the equivalent of 7,500 h.p. working continuously.

Water Power.—This is, of course, really a form assumed by the energy given out from the sun in the form of heat. For the water falls from a height to which it has been raised when under the influence of the sun's heat; the water of the ocean is evaporated, raised into the air as clouds which condense as rain in the higher lands.

Rain falling on the earth (according to Dr. McGree in U.S.A.) may be divided as follows: (*a*) Run-off = ⅓, (*b*) fly-off = ½, (*c*) cut-off = 1/6. This sinks into the earth or is taken up into the structure of plants. The tissue of plants of annual growth consists of 75% of water (about).

It is the "run-off" only with which we are concerned The rain water which falls on low plateaus and level land standing about sea level gives rise to streams which are of little value for water powers—it is that which falls on higher land and mountain slopes which gives rise to streams with considerable head to which we look for power. But this is not necessarily of value as a source of energy. A stream to be of value must have a large flow, a flow which is comparatively uniform throughout the year and one which has a very considerable fall. Speaking generally, we may say that the effective flow of a stream is the amount of its discharge at low water, for the supply of power, if it is to be used for the ordinary purposes for which power is required, must be practically uniform throughout the year—the chain, so to speak, is no stronger than its weakest link.

This comparative uniformity of flow is secured by the maintenance of a forest cover about the head waters of the stream or by the creation of a sufficiently large storage basin there, in which the surplus water of one portion of the year may be stored and allowed to increase the normal flow during that part of the year when there is a relatively smaller rainfall. The former is a natural feature which must be maintained; the latter is usually an artificial device which can only be secured by a large expenditure of money.

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Results of Deforestation.—If the lumberman is allowed merely to remove the larger trees for merchantable timber, no harm is done, for the forest still survives. But if, through his operations, he leaves the tops and branches of the trees in such a way as to make the forest a prey to fire, it almost always is burnt. The ground thus laid bare in some rocky lands has the soil washed off and all possibility of restoring its forest growth vanishes. In other cases the growth which comes even after years is thin and of relatively little value. Fire follows fire and the drainage conditions of the country become completely changed. The water which falls as rain rapidly drains off, causing the rivers to run as violent torrents which rapidly subside and are followed by periods in which the flow of the stream is enormously reduced. This gives rise to disastrous floods at some seasons of the year and lack of water at others. The actual amount of the run-off is also increased at the expense of the cut-off—the amount and level of the ground water is lessened and the vegetation of the country suffers correspondingly.

This has taken place in many of the United States rivers as a result of deforestation and the clearing of land for agriculture. For instance, on the Mississippi the run-off 50 years ago was 19,500,000 million cubic feet, while it is now 22,000,000 million cubic feet. This has resulted in disastrous floods in recent years, as that of Dayton, Ohio. The damage caused by the floods of the Ohio River in 1913—largely concentrated in the two cities of Dayton and Hamilton, Ohio—was somewhat over $180,000,000.

To protect some of our more important streams, the Dominion and Provincial Governments have set aside certain large areas about their head waters as permanent forest reserves or national parks. These areas, in recent years, have been greatly increased on the recommendation of the Commission of Conservation. The total area of the Dominion forest reserves at the present time is 35,804 square miles and the total area of national parks in Canada is 4,114.25 square miles. In the forest reserves no land can be taken up for settlement, and the forest cover will be permanently preserved, while in the national parks the game is also preserved, so that they become sanctuaries for the wild animals of the country. One of the most important of these forest reserves is that on the eastern slopes of the Rocky Mountains in Alberta, which will not only protect the catchment areas of the rivers flowing through the great plains but will also supply timber to the future population of this great district.

This action of the Government is worthy of all commendation. Other reserves should be added to those which have been already set aside, as, for instance, the tract about the head waters of the Winnipeg River recently recommended by the Commission of Conservation, the area being one which is unfit for settlement, but of great importance in connection with the equalization of the flow of this river on which such enormous water powers are now being developed and which have such an important bearing on the welfare and future of the province of Manitoba.

In addition to the maintenance of forests on the catchment area of rivers, the presence of large reservoirs at the head waters of rivers also tends to maintain a uniform flow. These may be natural lakes, as in the case of the St. Lawrence, which owing to the enormous size of the lakes in which it takes its origin, has a more uniform flow than any other river in North America or perhaps in the world. But when lakes are not present, they may be, and are in certain cases, formed by the construction of dams in the upper courses of rivers. This has been done on the Ottawa, St. Maurice and other rivers in Canada.