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COMMERCE OF THE TWENTIETH CENTURY.

XII.—THE FUTURE OF POWER.

(By N. S. Shaler, dean of Lawrence Scientific School, Harvard University.)

IT IS an interesting fact that all the forms of energy which have been and which, so far as we can see, can possibly be turned to use in the service of man, do not come from or reside in the earth, but are transitory visitants from the celestial realm. The first of these forms of energy to be utilized, that of the winds, in propelling ships or turning windmills, is altogether due to the mementary, though incessant, beating of the heat waves of the sun, which gives to the air movement which it would absolutely lack but for that visitation of energy. The streams that turn our mill wheels render to our water wheels the same might of the sun which served to lift the water to the high places of the land. The fuel we burn, whether it be wood, coal, rock oil or natural gas, is serviceable because various kinds of living organisms were enabled by appropriating solar energy to separate carbon from oxygen and to store it in their bodies. In effect, we recover in the process of burning, in which oxygen is recombined with the carbon, the energy that ancient plants expended in pulling the atoms of these elements apart in building their frames. Thus, while it is not strictly true that our coal beds are fossil sunshine, it is true that they are due to the sunshine of ancient days.

POWER FROM TIDES.

There is one interesting exception to the rule that the power which men may harness came from the sun. This is found in the tides. These oscillations in the level of the ocean lift their waters along the coastline of the continent twice each day to the average height of perhaps four feet, and at many places, especially about the north Atlantic, to several times that altitude. While these surgings of the sea are partly due to the attraction of the sun, and in some theoretical measure to that of everybody in the celestial realm, they are mainly brought about by the gravitative pull of the moon. In fact, the share of the tidal action due to our satellite is about nine-tenths of the whole. Until the steam engine was well developed and coal cheaply distributed, mills driven by the tide existed in New England and elsewhere, but the fact that the high and low water does not come at the same hours on summer days made it difficult to adapt them to any industries. They are now passing out of use if they have not altogether passed already, though, as we shall note hereafter, they may in time be most important to the interests of man.

THE EARTH'S INTERNAL HEAT.

It has been suggested that in the internal heat of the earth there exists a store of energy which may in time be turned to vast account. There can be no doubt as to the amplitude of this store. A mere trifle of it, which, by its taking away, would have no other effect than to lessen the diameter of the sphere by a few feet and shorten the length of the day by a fraction of a second, would probably serve for all the needs of man during his sojourn on our planet. There is even as little doubt that it is beyond the capacities of existing or imaginable art to tap this store of power. Clearly we cannot expect to harness the volcano, nor can we hope to sink any kind of wells to the depth where the temperature would be high enough to generate an available pressure from steam. Except in occasional places a boring would have to be sent down to the depth of between 10,000 and 20,000 feet to find the required heat; and long before such depth was attained the firmest rock urged by pressure would probably fill the opening. Even if the apparatus for generating steam were installed and for a time successful the neighboring rocks would soon be cooled to a relatively low temperature. In a word, we must be content to rest the future of our larger activities, as those of our bodies rest, on the energy that comes to us from the celestial realm. It is surely a noble and, as we shall see, wise confidence.

WHEN COAL GIVES OUT.

In making our reckoning on the future of power we may at once note that the resources on which we now mainly depend is evidently not to be counted on for any considerable period. In our coal beds, natural gases and rock oils, large as the stores appear in statistics and with all due allowance for what may be undiscovered, it is evident that we have no enduring source of supply. At the present rate of increase in what we may term the dynamic requirements of man the lifetime of fuel-fed engines is a matter of centuries rather than of millenniums. No finer reckoning is possible, but a review of the facts makes it seem altogether probable that in less than a thousand years, perhaps in less than half that time, the supply of buried fuels of all kinds will be so far exhausted that men will have to betake themselves to the other sources of power that the heavens send us. Let us consider how far these are likely to meet the needs as regards quantity and endurance.

UTILIZING THE WINDS.

Looking first to the movements of the air, let us consider how far they, through the method of the windmill, may help the coming needs of men. At present this engine, though of great and rapidly-extending use for pumping water when the amount required is small, is generally condemned as a more general resource. This condemnation is due to the lack of continuity of its work. When the wind is blowing at a moderate rate it would not be difficult to install an acre of ground machines which would yield many thousand horse power. In many parts of the world the average dynamic value of the wind that passes over such an area within the height to which windmills might be lifted is sufficient to take the place of several tons of coal burned per diem. There is power enough in the fitful yet everlasting wind if it could be turned to account to serve all the conceivable commercial needs of man.

As for the chance of using wind power in a large way it probably depends, so far as determined by the present condition of mechanical arts, on the conversion of the energy thus explained into electricity and the gathering of it in storage batteries. In the existing state of this invention the cost of such storage power obtained by means of windmills would be altogether impracticable, yet there is hardly a discovery whose improvement and cheapening we can look forward to with more confidence than the storage battery.

POWER FROM RIVERS.

The principal source of power in the ages after the store of coal and other carbonaceous materials is exhausted is evidently to be the river systems of the great lands. The dynamic value of these streams is such that if efficiently applied it would afford many times as much power per capita as is now required by civilized peoples. To utilize this power to the practicable limit will require engineering construction on a scale vaster than any which have been undertaken. It will also be necessary to retain a large part of the flood waters at high levels and to discharge them slowly to the sea. To do this it will be necessary to convert a considerable portion of the arable lands into reservoirs, the greater part of such areas being necessarily withdrawn from tillage. Much of this stored water could, however, be used not only for power, but for irrigation, so that the net loss in the agricultural values of the country would not be great, if indeed there should be any loss at all.

INDUSTRIES MAY GO SOUTH.

The possibilities of obtaining power from the rainfall of any region are evidently in proportion to the amount of its precipitation and the height through which the water passes on its way to sea. As these conditions are at their best in mountainous districts, especially in the tropical belt regions, where coal is commonly in scanty supply, it is evident that when men come to depend on water wheels for energy there will be a great readjustment in the seats of industries. How far this change is to go will in large measure depend on the future gain in the methods of transmitting power by electric conductors. For while the use of electric-motor force has in no wise added to the list of the sources of energy open to men, it has greatly altered the conditions of its utilization and is in time to bring about a revolution in this regard. It may well be that the headwaters of the Nile will, in time, yield power to turn the mills of England, and that men of any region may share the energy which the sun sends to any other.

POWER FROM SUN'S RAYS.

It has often been proposed to gather the rays of the sun by reflectors upon a boiler so that the heat thus obtained could be turned into use by the steam engine. This device is clearly practicable. It has, indeed, in a small way been put to use. It is, however, doubtful if the project is at the present time as promising as that of utilizing the wind, for it is only the middle part of clear days perhaps, in any region except the starkest deserts, not more than one-fifth of the time, when the device would be effective. In proportion as lands are habitable they are likely to abound in streams which afford a far more convenient source of power. The only probable adaptation of this invention is to the needs of mining in very arid waterless and coalless countries; in such conditions it may serve well, but in a large reckoning it must be counted as the least important of all the sources of power.

METHODS OF UTILIZING TIDAL POWER.

We have already adverted to the dynamic value of the tides and suggested that to make avail of their power it appears necessary in some way to store in batteries the larger part of the energy they may be made to yield. A furtner inspection of the matter shows that there are two other means by which this vast agent can be made to afford constant power. The least important of these is by impounding large quantities of water when the tide is high, allowing it to discharge through the water wheels into basins emptied and closed at low tide. By such a system of basins on the shores when the tidal movement is considerable a great and constant production of energy might be obtained. A remoter and much larger possibility depends on the fact that along the shores of any continent the times of high tide are so varied that on some part of the coast dynamos without any water storage system could be efficiently worked. If conductors from these various places could be united the supply of energy might be kept constant. Though of less value than the streams or even the winds as a source of power the tides evidently deserve a place in our reckoning.

AVAILABLE SOURCES INEXHAUSTIBLE.

As for the continuance of the sources of energy at the service of man it may be said that other than the fossil carbons they will endure through all the ages that are possible to man. We have proof that as far back as the Cambrian time, which cannot well be reckoned as less than a hundred million years ago, the lords of the sky were doing their appointed work on the earth just as they now do it day by day. The sun's heat moved the winds and sent the rains; moon and sun swayed the sea so that the dynamic values existed much as at present. So far as we can foresee, like work will be done for a hundred million years to come. It is probable that the moon has ever been slowly going farther from the earth since it separated from that planet, so the tides may have lessened and in the future become gradually yet further diminished, yet the diminution is clearly very slow. The sun pretty surely has less heat to give than in the Cambrian days. It should have shrunk to a measurable extent, yet, with this shrinkage, it certainly becomes hotter, so it is doubtful if the planets now have a less share of its help than in the time when it first awoke life on the earth. It is, in a word, clear that so long as the sun sends us enough heat to make the earth fruitful, the winds and streams will afford man an abundant supply of power. When that mighty giving ceases, man, if he has not gone before, will needs depart into the great darkness.

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