LETTERS TO THE EDITOR.

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Power from the Sun.

IN the very interesting Trueman Wood lecture delivered at the Royal Society of Arts on December 10, Sir Oliver Lodge discussed the utilisation of solar radiation, and recommended, as the best method of effecting this purpose, the promotion of agriculture of every kind. According to Sir Oliver Lodge, the green leaves of trees and vegetables generally are able to absorb and utilise solar energy without much regard for any hampering limit to efficiency such as the second law of thermodynamics, but in saying this he appears to be unaware of the researches of Dr. Horace Brown, who has shown that the actual amount of energy stored is less than 2 per cent. of that which reaches the vegetation.

Now the total amount of solar energy intercepted by the earth is prodigious, being in the aggregate some 200 billion h.p., or, on an average, about 4,000,000 h.p. per square mile of that portion of the earth's surface that is exposed not too obliquely to the sun's rays. Absorption by the clouds and by the atmosphere, though important, is not so great as might be expected, with the result that even in this latitude and in this climate the energy constantly received throughout the hours of daylight exceeds 1000 h.p. per acre.

If, then, some method could only be devised for efficiently converting this energy into a form in which it could be readily applied for motive power and other purposes, the gain and the convenience would be enormous; for, to take a single instance, sufficient energy to run all the machinery in a factory throughout the working day could be collected from an area in many cases not greater than that subtended by the factory's roof.

Now, of course, for reasons which Sir Oliver Lodge fully discussed, it is hopeless to expect to be able to effect anything of this nature with the heat engine, for with this we should scarcely reach the 2 per cent. efficiency nearly attained by vegetation. But is there any need to allow the radiation to turn itself into heat at all? Solar radiation, as is well known, consists of electromagnetic waves in the æther—waves exactly similar in kind to those employed in wireless telegraphy. The only difference is that, whereas the length of the waves used in wireless telegraphy is a matter of hundreds or thousands of metres, the wavelength in the case of solar radiation is only a very minute fraction of a millimetre.

Even with wireless waves the resulting frequency is too great to allow of the electric currents they induce being directly utilised. The telephones and other instruments employed offer too much impedance to allow such currents to pass, while, apart from this, no mechanical device could move with sufficient rapidity to respond to such frequencies. In wireless telegraphy, however, a method has been devised for converting these rapidly alternating or oscillating electric currents into currents which, though pulsating, are unidirectional. This is accomplished by the application of thermionic or crystal rectifiers or non-return valves, which only allow the currents in one direction to pass and suppress altogether the currents in the opposite direction. In this way the comparatively useless high-frequency oscillatory currents are converted into rapidly pulsating unidirectional currents which behave like continuous currents, and will operate telephones and other electromagnetic devices. Moreover, though in wireless telegraphy it is customary to use the currents in a single direction only, and to suppress the inverse currents altogether, there is no difficulty about utilising both currents by turning them into separate circuits with valves set opposite ways. Under such conditions, seeing that the separate valves let through their respective currents with but little loss, the efficiency of the conversion from the radiant energy absorbed to that utilisable in the form of electric current is quite high, probably not less than 50 per cent., and perhaps considerably more.

Is it too rash to suggest the possibility of some analogous method being applicable to convert into utilisable electric currents the electromagnetic waves of which the radiant energy from the sun consists? The method is quite successful with wireless waves having frequencies of millions per second, but can it be applied to the sun's waves, the frequency per second of which is of the order of billions? No doubt the problem is a difficult one, but we live in an age of marvels, and what would have been said of modern wireless methods only a few years ago?

One thing seems certain. The energy in the sun's radiation is there, and there, too, in most abundant quantity. To make use of it, moreover, requires no Maxwellian "demon" such as is necessary to render available the general stock of heat energy at uniform temperature. Nor, again, does what is suggested run counter to any thermodynamical law such as would preclude full advantage being taken of the great efficiency that is rendered possible by the enormous temperature of the sun.

Anyway, the problem of the application of solar radiation to the production of power otherwise than by means of heat engines seems worthy of attention, and is a problem that would appear much more likely to meet with a speedy solution than the difficult and obscure question of the liberation and utilisation of the internal energy of the atom.

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Heat of Reaction and Gravitational Field.

A SIMPLE relation between the variation of mass in a physical change of state or chemical reaction and the rate of variation with gravitational potential of the corresponding change of total internal energy can be deduced as follows:—Let m_1 and m_2 denote the masses of the initial and final states of the chemical system and Q the heat evolved, say at constant temperature and pressure, and at the gravitational potential Z. Considering the following isothermal cycle:

(*a*) State 1 to state 2 at Z,
(*b*) State 2 at Z to state 2 at Z+δZ,
(*c*) State 2 to state 1 at Z+δZ,
(*d*) State 1 at Z+δZ to state 1 at Z,

and equating the total change of energy to zero, we get the equation

$$\left(\frac{\partial Q}{\partial Z}\right)_{p,t} = m_1 - m_2.$$

For all ordinary reactions, experiment has shown that $m_1 - m_2$, if not zero, must be very small. It follows, however, from the theory of relativity that if the reaction be exothermic $m_1 > m_2$, whilst if it be endothermic $m_1 < m_2$. Hence in the former case $\frac{\partial Q}{\partial Z}$ is positive, whilst in the latter case it is negative. If we can apply the energy theory to the highly exenergic