

which enables us to convey a load of 200 tons at a cost of fuel scarcely exceeding that of the corn and hay which the original pack-horse consumed in conveying its load of 3 cwt. an equal distance.

It was chiefly in this locality that the railway system, was thus reared from earliest infancy to full maturity, and amongst the many names associated with its growth, that of George Stephenson stands pre-eminent.

In thus glancing at the history of railways we may observe how promptly the inventive faculty of man supplies the device which the circumstances of the moment require. No sooner is a road formed fit for wheeled carriages to pass along, than the cart takes the place of the pack saddle: no sooner is the wooden railway provided than the waggon is substituted for the cart, and no sooner is an iron railway formed, capable of carrying heavy loads, than the locomotive engine is found ready to commence its career. As in the vegetable kingdom fit conditions of soil and climate quickly cause the appearance of suitable plants, so in the intellectual world fitness of time and circumstance promptly calls forth appropriate devices. The seeds of invention exist, as it were, in the air, ready to germinate whenever suitable conditions arise, and no legislative interference is needed to ensure their growth in proper season.

The coal-fields of this district, so intimately connected with the railway system, both in its origin and maintenance, will doubtless receive much attention from the Association at their present meeting.

To persons who contend that all geological phenomenon may be attributed to causes identical in nature and degree with those now in operation, the formation of coal must present peculiar difficulty. The rankness of vegetation which must have existed in the carboniferous era, and the uniformity of climate which appears to have prevailed almost from the Poles to the Equator, would seem to imply a higher temperature of the earth's crust, and an atmosphere more laden with humidity and carbonic acid than exist in our day. But whatever may have been the geological conditions affecting the origin of coal, we may regard the deposits of that mineral as vast magazines of power stored up at periods immeasurably distant for our use.

The principle of conservation of force, and the relationship now established between heat and motion, enable us to trace back the effects we now derive from coal to equivalent agencies exercised at the periods of its formation. The philosophical mind of George Stephenson, unaided by theoretical knowledge, saw that coal was the embodiment of power originally derived from the sun. That small pencil of solar radiation which is arrested by our planet, and which constitutes less than the 2,000-millionth part of the total energy sent forth from the sun, must be regarded as the power which enabled the plants of the carboniferous period to wrest the carbon they required from the oxygen with which it was combined, and eventually to deposit it as the solid material of coal. In our day, the reunion of that carbon with oxygen restores the energy expended in the former process,

and thus we are enabled to utilize the power originally derived from the luminous centre of our planetary system.

But the agency of the sun in originating coal does not stop at this point. In every period of geological history the waters of the ocean have been lifted by the action of the sun and precipitated in rain upon the earth. This has given rise to all those sedimentary actions by which mineral substances have been collected at particular localities, and there deposited in a stratified form with a protecting cover to preserve them for future use. The phase of the earth's existence suitable for the extensive formation of coal appears to have passed away for ever; but the quantity of that invaluable mineral which has been stored up throughout the globe for our benefit is sufficient (if used discreetly) to serve the purposes of the human race for many thousands of years. In fact, the entire quantity of coal may be considered as practically inexhaustible. Turning, however, to our own particular country, and contemplating the rate at which we are expending those seams of coal which yield the best quality of fuel, and can be worked at the least expense, we shall find much cause for anxiety. The greatness of England much depends upon the superiority of her coal in cheapness and quality over that of other nations; but we have already drawn from our choicest mines a far larger quantity of coal than has been raised in all other parts of the world put together, and the time is not remote when we shall have to encounter the disadvantages of increased cost of working and diminished value of produce.

Estimates have been made at various periods of the time which would be required to produce complete exhaustion of all the accessible coal in the British Islands. These estimates are extremely discordant; but the discrepancies arise, not from any important disagreement as to the available quantity of coal, but from the enormous difference in the rate of consumption at the various dates when the estimates were made, and also from the different views which have been entertained as to the probable increase of consumption in future years. The quantity of coal yearly worked from British mines has been almost trebled during the last twenty years, and has probably increased tenfold since the commencement of the present century; but as this increase has taken place pending the introduction of steam navigation and railway transit, and under exceptional conditions of manufacturing development, it would be too much to assume that it will continue to advance with equal rapidity. The statistics collected by Mr. Hunt, of the Mining Records Office, show that at the end of 1861 the quantity of coal raised in the United Kingdom had reached the enormous total of 86 millions of tons, and that the average annual increase of the eight preceding years amounted to 2½ millions of tons. Let us enquire, then, what will be the duration of our coal-fields if this more moderate rate of increase be maintained.

By combining the known thickness of the various workable seams of coal, and computing the area of the surface under which they lie, it is easy to arrive at an estimate of the total quantity comprised in our coal-bearing strata. Assuming 4,000 feet as the greatest depth at which it will ever be possible