Science and Practical Arts.

THE STEAM ENGINE.

WITH ILLUSTRATIONS.

Intending from time to time to furnish instruction and entertainment to our junior readers in several branches of the Elements of Natural Philosophy and Mechanical Science, we will commence with some account of a machine which is, more than any other, identified with the commerce and manufacturing industry of Europe and America—a machine exhibiting a series of contrivances which, "in exquisite and refined ingenuity, stand without a parallel in the annals of mechanical science," and producing a saving of labour and a productiveness of mechanical power without a parallel in the annals of Commerce and Manufactures. Our limits confine us to a few explanations and facts.

The STEAM ENGINE is a mechanical contrivance by which fuel of any kind may be made, by means of water, to execute any kind of labour. The motive power of this mechanical contrivance, or the power by which the steam engine is put in motion, is that of STEAM, or *vapour of water*.

Let us consider, first, how this power is *produced*, and secondly, how it is *applied* in the working of the steam engine.

Heat expands most substances by separating the particles of which they are composed. Thus it separates the particles of metals, wax, &c. Its effects upon water are most remarkable. The particles are totally separated; they are converted into an invisible gas or vapour, called *steam*; and their extension is wonderfully increased.

The temperature at which water is converted into steam under the ordinary pressure of the atmosphere is 212°. The steam thus formed has a bulk about *seventeen hundred* times that of the water which is evaporated to produce it; or a cubic inch of water expands to about a cubic foot of steam.

The *mechanical force* which is developed by this conversion of water into steam is very great, and is in proportion to the degree of temperature at which steam is formed. Steam formed at a temperature of 212°, has a mechanical force equal to the pressure of the atmosphere—that is about 15lbs. on every square inch of surface exposed to it; formed at a temperature of 251°, the elastic or mechanical force of steam is equal to the pressure of two atmospheres; formed at a temperature of 292°, it has a tension of about four atmospheres, or a mechanical force of 60 lbs. to the square inch of surface exposed to it. The only limit to the power of steam is the strength of the vessel or boiler in which it is generated. The pressure of steam, as usually employed, is about that of two or three atmospheres. When the tension of steam exceeds three atmospheres, it is called *high steam.*

As steam engines when first brought into use were chiefly applied to work pumps for draining, and for mills which had been previously worked by horses, their power was estimated by a comparison with that of the horses which they superseded. Steam engine builders were, therefore, accustomed to contract to supply engines capable of executing the same work as had been previously executed by a certain number of horses. It was found, on experiment, that a strong horse, working for eight hours per day, could perform a quantity of work equal in its mechanical effect to raising 33,000 lbs. one foot per minute, or 1000 lbs. thirty-three feet per minute. This is the unit of engine-power which is generally adopted.

As to the mechanical force which the evaporation of a given quantity of water is capable of producing, the following are a few of the many curious facts which writers on the steam-engine have stated;—

A *pint of water* may be evaporated by *two ounces of coals.* In its evaporation, it swells into two hundred and sixteen gallons of steam, with a mechanical force sufficient to raise a weight of *thirty-seven tons* a foot high. The steam thus produced has a pressure equal to that of common atmospheric air; and by allowing it to *expand,* and *by virtue of its elasticity, a further mechanical force* may be obtained, at least *equal in amount to the former.* A pint of water, therefore, and two ounces of coal, are thus rendered capable of doing as much work as is equivalent to raising seventy-four tons a foot high.

The circumstances under which the steam engine is worked on a *railway* are not favourable to the economy of fuel. Nevertheless, a pound of coke (charred pit-coal,) burned in a locomotive engine will evaporate about five pints of water. In their evaporation they will exert a mechanical force sufficient to draw two tons weight on the railway a distance of one mile in two minutes. Four horses working in a stage-coach on a common road are necessary to draw the same weight the same distance in six minutes.

A train of coaches weighing about eighty tons, and transporting two hundred and forty passengers with their luggage, has been taken from Liverpool to Birmingham, and back from Birmingham to Liverpool, the trip each way taking about four hours and a quarter, stoppages included. The distance between these places is ninety-five miles. This double journey of one hundred and ninety miles is effected by the mechanical force produced in the combustion of four tons of coke, the value of which is five pounds. To carry the same number of passengers daily between the same places by stage-coaches on a common road, would require twenty coaches, and an establishment of three thousand eight hundred horses, with which the journey in each direction would be performed in about twelve hours, stoppages included.

The circumference of the earth measures twenty-five thousand miles; and if it were begirt with an iron railway, such a train as above described, carrying 240 passengers, would be drawn around it by the combustion of thirty tons of coke, and the circuit would be accomplished in five weeks.

The great pyramid of Egypt stands upon a base measuring seven hundred feet each way, and is five hundred feet high, its weight being twelve thousand seven hundred and sixty millions of pounds. Herodotus states, that in constructing it one hundred thousand men were constantly employed for twenty years. The materials of this pyramid would be raised from the ground to their present position by the combustion of about four hundred and eighty tons of coal.*

The great and peculiar property of steam on which these its amazing mechanical agencies depend, *is its power of exerting a high degree of elastic force, and losing it instantaneously.*

2. Let us now turn to the mechanism, by means of which the expansive force of steam is applied to useful purposes. The *facts* that mechanical force is produced in the *conversion of water into steam*—that a further mechanical power arises from the *expansion of steam*—that steam may be instantaneously reconverted into water, contracting its dimensions from a cubic foot to a cubic inch, and thereby producing a vacuum—are *discoveries;* but the mechanism on which the useful application of those natural forces depends, is an *invention.* The discovery of the several facts relative to the mechanical powers and properties of steam is due to several discoverers; and the different parts of the various and complicated mechanism by which these forces are rendered universally available as a

* *Lardner's Steam Engine, Steam Navigation, and Railways.*