WILLIAM BRUNTON'S LOCOMOTIVE

Extract from "Engineer's and Mechanic's Encyclopaedia"

by Luke Hebert published in 1836.

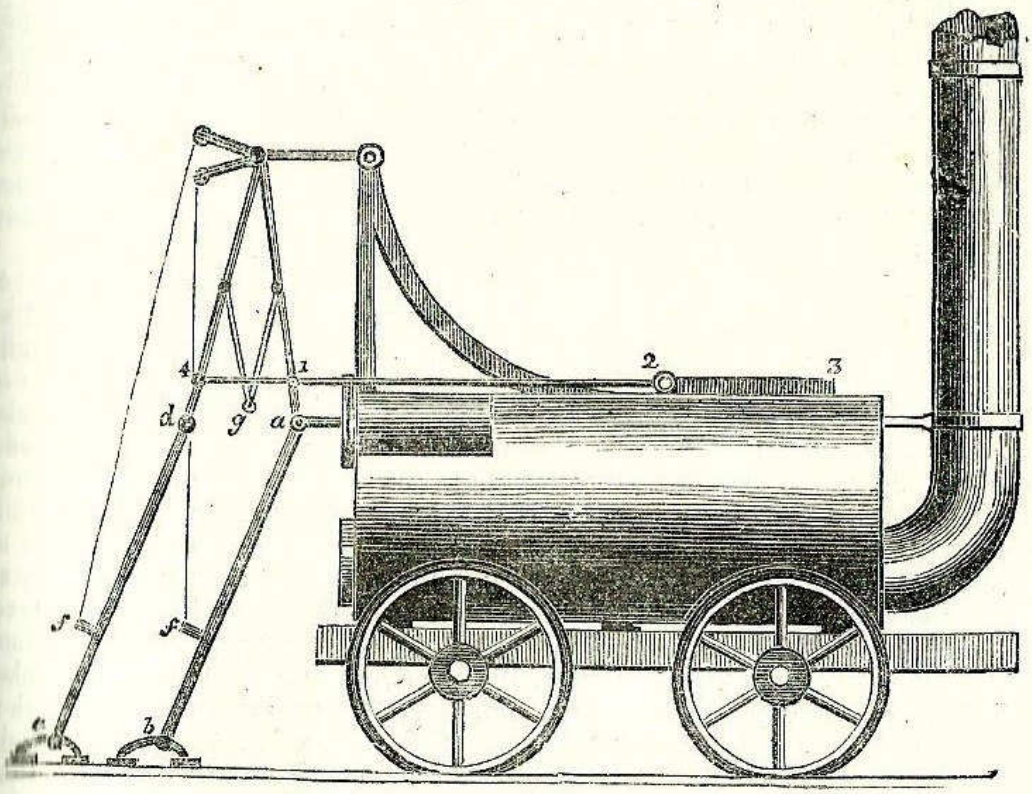
running wheels as already described; and it was found that their resistance to slipping upon the rails was the utmost power it could exert in drawing waggons after it, which in this instance was carried to the extreme; for although the friction was equal to the drawing forward the train of eighteen waggons, *after they were fairly in motion*, it did not overcome their *vis inertia* until after a considerable *slipping* of the wheels of the carriage.

We have introduced this notice of the earliest experiment made with the engine of the Messrs. Chapman, because it exemplifies, in the clearest manner, that precise inclination of the plane upon which the *smooth* wheels of a carriage, bearing a certain weight, will slip round, without advancing the machine. It also proves the *necessity* in such cases of increasing the friction of the opposing surfaces, either by augmenting the weight, or by some contrivance resembling those suggested by Trevithick in his specifications, which Dr. Lardner repeatedly in the course of his work treats as an absurd attempt to remedy an "*imaginary* difficulty."

From all the information that we can glean in tracing out the early history of locomotion, this remarkable circumstance constantly presents itself,—that when Trevithick's carriages with smooth wheels were employed upon levels, or slightly inclined planes, invidious comparisons with others having cogs were made against the former, because, as was asserted, they slipped and could not ascend such acclivities as the latter; and this, notwithstanding Trevithick first suggested by his "cross grooves and fittings to railroads" the very principle of the cogs, in a less objectionable form, and "all other appliances to boot" of the engine and boiler, contained in the said locomotive! Thus Trevithick lost many orders, and they were given to those who adopted all the essentials of his plans, without acknowledgment, and employed them as the basis of their structures. And when, after the lapse of years, it was found out by these *gentlemen* that smooth wheels had sufficient "bite" of the rail in most circumstances, they made that fact appear to be their own discovery; notwithstanding it is stated in Trevithick's specification of 1802, and was confirmed by his practice; which practice they at first condemned with one general voice; and when, at last, they were compelled to practise it also, they endeavoured to make it appear as vastly superior to Trevithick's mode of surrounding his wheels "with heads of nails, bolts, and claws," which he never used at all! These ungenerous proceedings against the most eminent mechanic of his time appear to have been going on unchecked from 1802 up to the present time, 1836. The only way we have of accounting for this circumstance is, that Trevithick was engaged during many years of his patent right in constructing his high-pressure engines and pumps for recovering the drowned mines of Peru, which undertaking he afterwards personally directed, and succeeded in accomplishing, to the astonishment of the Peruvians. He was subsequently appointed engineer to the royal mint at Lima; and on his arrival at South America, he was received with such enthusiastic gratitude, that the lord warden proposed to "erect his statue in silver." The earth now covers the mortal remains of this eminent man; but his memory will never die: for, to use the words of Mr. Gordon, he has left behind him "a name as inseparably connected with high-pressure steam and locomotion, as that of James Watt with the condensing engine and rotary movement."

We now come to the description of a machine of great singularity, and which strongly attests the ingenuity of the contriver, Mr. William Brunton, of the Butterly Iron Works, in Derbyshire, and for which he took out patents. It consists in a curious combination of levers, the action of which nearly resembles that of the legs of a man in walking, whose feet are alternately made to press against the ground of the road or railway, and in such a manner as to adapt themselves to the various inclinations or inequalities of the surface. The following engraving represents this engine, which the inventor called his "MECHANICAL TRAVELLER." The boiler is nearly similar to that which we last described. The cylinder *a* is placed on one side of the boiler; the piston rod is projected out behind horizontally, and is attached to the leg *a b* at *a*, and to the reciprocating jointed bent lever above; at the lower extremity of the

leg *a b*, feet are attached by a joint at *b*; these feet lay a firmer hold on the ground, being furnished with short prongs, which prevent them from slipping, and are sufficiently broad to prevent their injuring the road. On inspecting the drawing, it will be seen that when the piston rod is projected out from the cylinder, it will tend to push the end of the lever or leg *a* from it, in a direction parallel to the line of the cylinder; but as the leg *a b* is prevented from moving backwards by the end *b* being firmly fixed upon the ground, the reaction is thrown upon the carriage, and a progressive motion given to it, and this will be continued to the end of the stroke. Upon the first reciprocating lever is fixed at 1, a rod, 1 2 3, sliding horizontally backwards and forwards upon the top of the boiler; from 2 to 3 it is furnished with teeth, which work into a cog-wheel, lying



horizontally; on the opposite side of this cog-wheel a sliding-rack is fixed, similar to 1 2 3, which, as the cog-wheel is turned round by the sliding-rack 1 2 3, is also moved backwards and forwards. The end of this sliding-rod is fixed upon the other reciprocating lever of the leg *d e*, at 4. When, therefore, the sliding-rack is moved forwards in the direction 3 2 1, by the progressive motion of the engine; and, when the piston-rod is at the farthest extremity of the stroke, the leg *d e* will be brought close to the engine; the piston is then made to return in the opposite direction, moving with it the leg *a b*, and also the sliding-rack 1 2 3; the sliding-rack, acting on the toothed wheel, causes the other sliding-rod to move in the contrary direction, and with it the leg *d e*. Whenever, therefore, the piston is at the extremity of the stroke, and one of the legs is no longer of use to propel the engine forward, the other, immediately on the motion of the piston being changed, is ready, in its turn, to act as a fulcrum or abutment for the action of the moving power, to secure the continued progressive motion of the engine. The feet are raised from the ground during the return of the legs to the engine, by straps of leather or rope fastened to the legs at *f f*, passing over friction sheaves, movable in one direction only, by a ratchet and catch, worked by the motion of the engine. The feet are described of various forms in the specification, the great object being to prevent them from injuring the road, and to obtain a firm footing, that no jerks should take place at the return of the st oke, when the action of the engine came upon

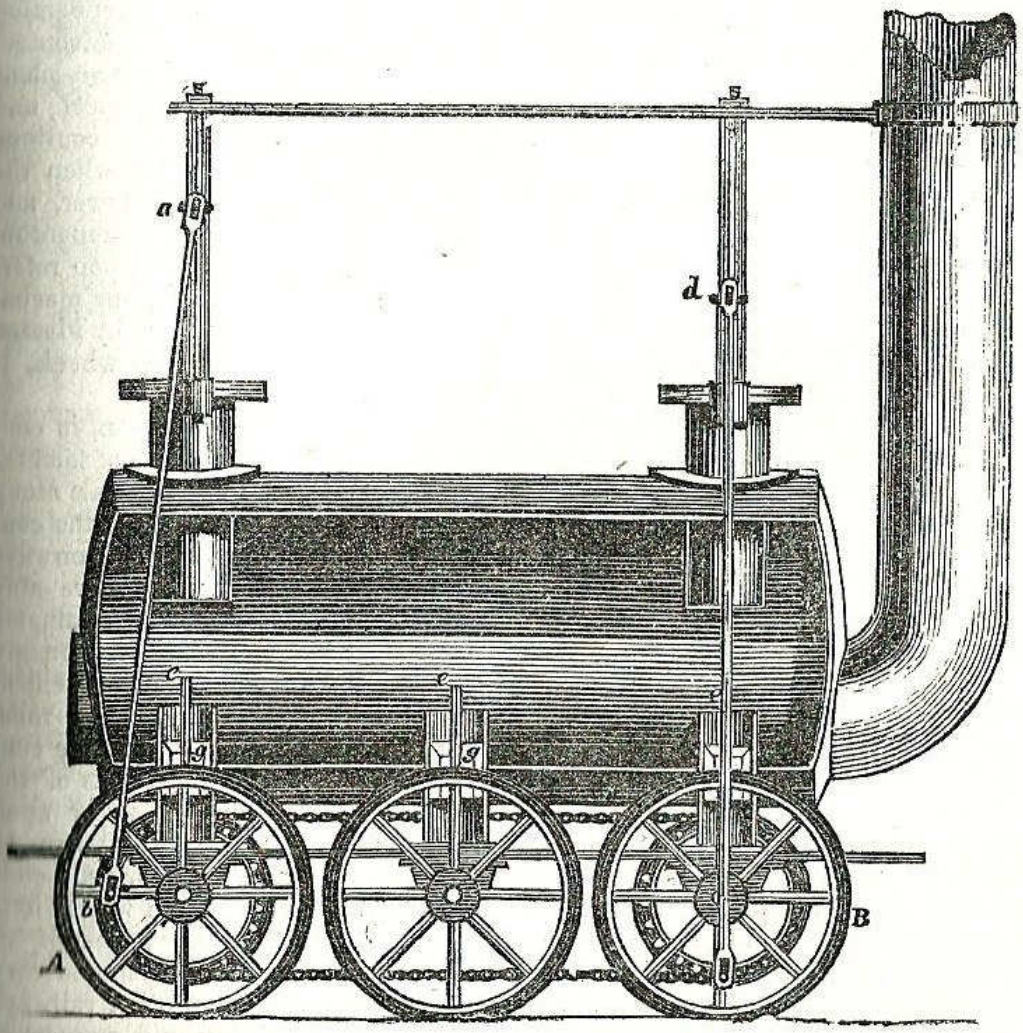
them; for this purpose they were made broad, with short spikes to lay hold of the ground.

It is proper to record that this strange machine was actually put to work. The boiler was a cylinder of wrought-iron, 5 feet 6 inches long, 3 feet in diameter, and of such strength as to be capable of sustaining a pressure of upwards of 400 pounds per square inch. The working cylinder was 6 inches in diameter, and the piston had a stroke of 24 inches; the step of the feet was 26 inches, and the whole machine, including water, weighed about 45 cwt. When placed upon a railway, Mr. Brunton found that it required to move it, at the rate of two and a half miles per hour, a power equal to the constant pressure of 84 pounds. He then applied a chain to the hinder part of the machine, by which, as the machine moved forward, a weight was raised at the same time and rate; and he found that with steam equal to 40 or 45 lbs. pressure upon the square inch, the machine was propelled at the rate of two and a half miles per hour, and raised 112 lbs. at the same speed; thus making the whole power 896 lbs. at two and a half miles, which, at 150 lbs. the horse power, is equal to about six horses; but the machine was only designed to insure 4 horses' power, and to work upon a railway rising one in thirty-six. The late Mr. David Gordon, in 1824, much improved the mode of operating with these substitutes for horses' feet; and Mr. Gurney, in 1825, copied them very closely, as before noticed; both of whose patents will be hereafter described.

Mr. Wood, in his excellent *Treatise upon Railroads*, informs us that, in 1814, an engine upon Blenkinsop's plan (described at page 395) was constructed at the Killingworth Colliery, by Mr. George Stephenson, and tried upon that railroad. In that engine, it will be observed, that the cog-wheels upon the axis of the propelling-wheels are double the diameter of the smaller toothed-wheels, which derive their action from the reciprocating motion of the connecting-rod; consequently, the latter make two revolutions of each one of the cogged propelling-wheels. The experiments were made upon a piece of edge-rail, ascending about 1 yard in 450; and it was found to drag after it, exclusive of its own weight, eight loaded carriages, weighing altogether about 30 tons, at the rate of four miles an hour. The application of the two cylinders rendered the action of the engine regular, and secured the continual progressive motion, thus remedying, Mr. Wood observes, the imperfection caused by the irregular action of the single cylinder and fly-wheel. When the engine had been at work a short time, it was soon *found* that there was sufficient adhesion between the wheels and the rail to propel the carriage; but such was the lingering prejudice, that grooved sheeves were afterwards applied to the hinder travelling wheels of the engine, and similar grooved sheeves upon the fore-wheels of the convoy carriage containing the coals and water; both these were then connected by an endless chain; but this contrivance also was soon *found* to be unnecessary, and the adhesion of the wheels alone produced the desired effect. The communication of the pressure of the steam upon the piston, through the means of the connecting-rod and crank to the cog-wheels, produced great noise, and, in some parts of the stroke, considerable jerks; each cylinder alternately propelling, or becoming propelled by the other, as the pressure of the one upon the wheels became greater or less than the pressure of the other; and when the teeth became worn, they produced a rattling noise. For when the leverage of one crank became greater than the other, the latter was propelled by the other through the intervening wheels; but when the former approached towards the extremity of the stroke, its leverage became less and less, and the leverage of the latter became greater, as the angle between the connecting-rod and the crank increased; and, at a certain point, the latter preponderated. When a change in the action took place, the former was then the propelled, and the latter the propelling power. If any play or space existed between each tooth of the cog-wheels, the transition of this power from one side of the teeth to the other always occasioned a jerk; and this became greater as the teeth became more worn, and the space between them greater.

All these inefficient, expensive, and troublesome contrivances, our readers will perceive, were introduced to obviate "the assumed difficulty," which had

been *demonstrated* ten years before to have no existence. To get rid of the cumbrous wheels and p ions, and avoid the jerks and concussions consequent upon the last mentioned arrangement, we find Mr. Ralph Dodd and Mr. George Stephenson, aforesaid, both of Killingworth, taking out a joint patent "for various improvements in the construction of locomotive engines," which was dated February 28, 1815. It consisted of the application of *a pin* upon one of the spokes of the running wheels that supported the engine; the lower end of the connecting-rod being attached to the cross-beam, worked up and down by the piston. (The following engraving serves to explain this invention, although it belongs to the patented improvements subsequently introduced by Mr. Losh, in conjunction with Mr. Stevenson; Mr. Dodd's previous invention being combined therein.) *a b* represents the connecting-rod, the end *a* attached to the cross-beam, and the end *b* to one of the spokes of the wheel; in like manner the end *d* of the other connecting-rod is attached to the beam of the other piston, and the lower end to a pin fixed in the spokes of the wheel B. By these means the reciprocating motion of the piston and connecting-rod is converted, by the pin upon the spokes acting as a crank, into a rotatory motion, and the



continuation of this motion secured by the one pin or crank being kept at right angles to the other, as shown in the drawing. To effect this, the patentees had two methods;—to crank the axles, on which each of the wheels were fixed, with a connecting-rod between, to keep them always at the angle with respect to each other; or to use a peculiar sort of endless chain, passing over a toothed wheel on each axle. This endless chain consisted at first of one broad and two narrow links, alternately fastened together at the ends with bolts; the two narrow links