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Historical and descriptive anecdotes of steam-engines, and of their inventors and improvers

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Chapter twenty-nine.

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CHAPTER TWENTY-NINE.

"NATURE IN HER PRODUCTIONS SLOW, ASPIRES
BY JUST DEGREES TO REACH PERFECTION'S HEIGHT;
SO MIMIC ART WORKS LEISURELY TILL TIME
IMPROVE THE PIECE, OR WISE EXPERIENCE GIVE
THE PROPER FINISHING."

Somerville.



A SINGULAR attempt to deviate from the beaten track, and employ another agent than steam to raise a piston, was made in 1791, by Mr. Robert Street, who described an apparatus, in which turpentine falling on a hot iron was raised into vapour, that was afterwards inflamed in a cylinder beneath a piston, which was raised by the impulse of its expansion. Street considered this could be used as a prime mover, with as much economy as steam.

A still better application of a similar idea was made by M. de Rivaz in 1807. A cylindrical vessel $4\frac{1}{2}$ inches in diameter was fitted with a piston. At the bottom of this cylinder was a smaller one also fitted with a piston, the rod of which descended downwards, and was attached to the middle of a horizontal lever, by which it might be moved upwards or downwards. This piston had a perforation which was closed with a valve opening downwards; from the top of the small

cylinder, a short tube passed horizontally outwards, having a skin bag filled with hydrogen gas fixed at its external end. This tube had also a cock with two passages, one of which admitted the hydrogen, and the second common air, and its third position prevented all external communication.

To charge this apparatus with the explosive mixture, the lower piston is to be raised by the lever until it touches the upper piston, which will cause all the air between the two to be expelled through the lower valve, which is to be opened for that purpose. When it is made to descend, the cock in the horizontal pipe is opened, and it will draw in at pleasure a quantity of hydrogen gas, and of common air, in the proportions of sixty inches of hydrogen, and one hundred and twenty of common air, or thirty inches of "vegetable hydrogen," mixed with one hundred and eighty inches of common air, sufficient to work a piston of eleven pounds weight regularly. De Rivaz moved a locomotive carriage by the power he derived in this manner: he also inflamed the gaseous mixture, by transmitting the electric spark to a button, from which it was conveyed sideways through a thick wire, to a plate at the bottom of the upper piston; "the explosion instantly took place, and the piston was driven far upwards, when the dose of the fulminating mixture was sufficiently powerful." The apparatus, it is clear, may be charged with any kind of aëriform and concrete substances capable of explosion.

For this scheme a patent was granted by the French government in 1807, but it was not published before 1824, four years after the period when an idea of procuring a motive power from the inflammation of a mixture of air and hydro-

gen, was carried into practice by the Reverend Mr. Cecil of Cambridge. In 1820 this gentleman exhibited a model of his machine, and in the same year gave a minute and detailed description of its construction and effects, in the "Transactions of the Cambridge Philosophical Society." From this lucid account the description and drawing is extracted: indeed, nothing can be fuller or better developed than this fine essay, which considered as the production of one whose ordinary pursuits are far removed from those connected with the combination of machinery, it is one of the most estimable first attempts with which we are acquainted.

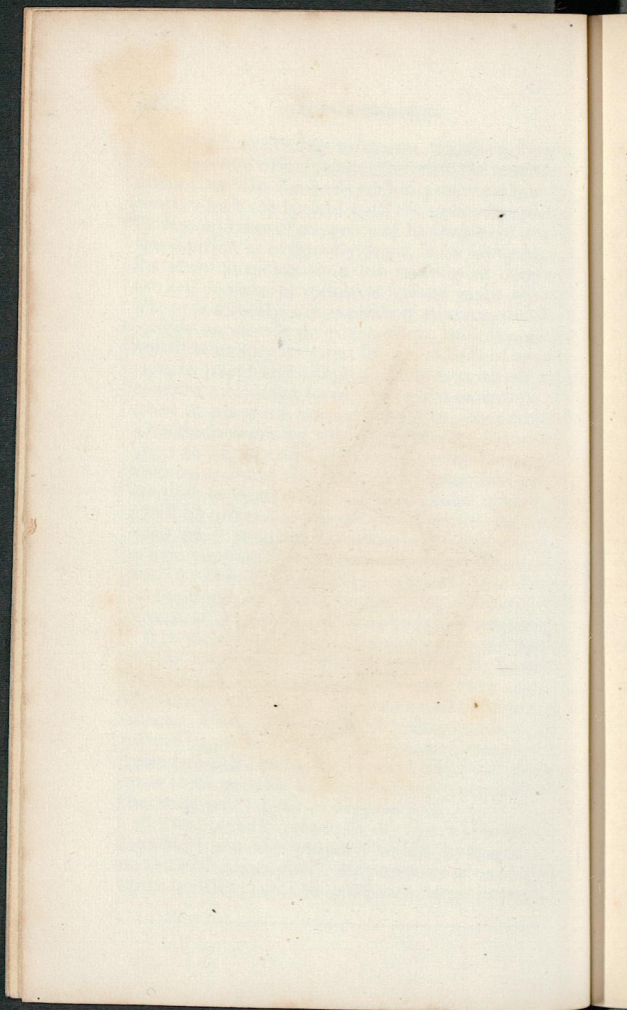
"It may safely be laid down," says Mr. Cecil, "as a principle, that any explosion may be safely opposed by an elastic force, (the force of condensed air for example,) if the elastic force has little or no inertia connected with it; on the contrary, the smallest quantity of inertia exposed to an exploding mixture *fully ignited* is nearly equivalent to an immovable obstacle. Thus a small quantity of gunpowder, or a mixture of oxygen and hydrogen, may be safely ignited in a large close vessel filled with air; for the pressure of the exploding substance against the sides of the vessel can never be much greater than the elasticity of the air which it condenses.

"If a small quantity of card, or a piece of paper, be inserted in the middle of a gun charged with powder only, the gun will commonly burst upon being fired: for in this case the powder after being fully ignited comes to act upon a body at rest having inertia; and such a body cannot be moved out of the way in an indefinitely small time, without a force indefinitely great; or it is equivalent to an immovable obstacle.

“Of all exploding mixtures, therefore, having the same field of expansion, those are the most dangerous, and the least adapted to produce a moving force, which are ignited with the greatest rapidity. Thus a mixture of oxygen and hydrogen, of which the ignition is extremely rapid, is far less adapted for such purposes than the mixture of common air and hydrogen, which is ignited more slowly. There is scarcely any exploding mixture which is ignited so slowly as gunpowder; this, therefore, notwithstanding its great force and field of expansion, is peculiarly adapted to produce either momentum or moving force: but great care must be taken to place the mass opposed in close contact with the powder, so that the exploding force may begin to act upon it the instant the ignition commences, and that the action may cease before the ignition is completed. In a common musket, if a ball be placed at a short distance, the gun will burst, as it becomes an immovable obstacle. It is here supposed that the exploding mixture has itself no inertia, or that it is capable of following up the body, on which it acts with a velocity incomparably greater than that body can acquire.”

A small steam-engine, not exceeding the power of one man, cannot, Mr. Cecil found, be brought into action in less than half an hour; and a four-horse engine in less than two hours preparation. The engine in which hydrogen gas is employed to produce moving force, was intended to unite two principal advantages of water and steam, so as to be capable of acting in any place without the delay and labour of preparation.

“The general principle of this apparatus is founded upon the property which hydrogen gas mixed with atmospheric air possesses of exploding upon ignition, so as to produce a large imperfect



vacuum: if two and a half measures, by bulk, of atmospheric air be mixed with one measure of hydrogen, and a flame be applied, the mixed gas will expand into a space rather greater than three times its original bulk. The products of the explosion are a globule of water formed by the union of the hydrogen with the oxygen of the atmospheric air, and a quantity of azote, which in its natural state constituted 1.556 of the bulk of the mixed gas. The same quantity of azote is now expanded into a space somewhat greater than three times the original bulk of the mixed gas; that is, into about six times the space which it before occupied: its density, therefore, is about one sixth, that of the atmosphere being unity. If the external air be prevented, by a proper apparatus, from returning into this imperfect vacuum, the pressure of the atmosphere may be employed as a moving force, nearly in the same manner as in a common steam-engine; the difference consists merely in the way of forming the vacuum.

“ Any quantity of pure hydrogen gas will produce more than five times the effect of the same bulk of steam, and in practice their disproportion is still greater. It is here supposed that steam produces by condensation a perfect vacuum equal to its own bulk, but this is far from being the case; much of the power is lost by needless condensation, by the escape of steam through the piston, besides a considerable deduction for working an air-pump, and two water-pumps, which are necessary to a steam-engine: if a close cylinder, ten inches long and two inches in diameter, be made of thin tin, seamed up one side, and close soldered, the ends being well secured, it will easily sustain without bursting the whole force of the exploding

mixture: the internal pressure against the sides of the vessel, in this case, is about one hundred and eighty pounds to the square inch, or twelve atmospheres nearly; but if an explosive mixture, having a pressure of twelve atmospheres, be allowed to expand into a space rather more than three times its original bulk, its initial force is at an end, and it balances the weight of the atmosphere equal to fifteen pounds on the square inch, for the exploding force varies as the square of the space occupied by expanding fluid. The model of this gas engine was found to work very freely when hydrogen did not exceed one fifth of the mixed gas; but its greatest effect was obtained when hydrogen formed two sevenths of the mixture."

A, B, C, D, a long, narrow, vertical cylinder, divided into two parts at *a, b, d*, so that the upper part A, B, *a, b*, may be one third part of the whole cylinder. In the partition *a, b, d*, is a large circular hole, covered by a choke valve, turning upon an axis *a, b*, which passes through a small stuffing-box at *a*, on the side of the cylinder. At the point *e*, in the axle *b, a*, produced is an upright handle *e, f*, connected by a cross bar, *f, r*, with the lever *q, r, s*, moveable about *q*. In the upper division A, B, *a, b*, of the cylinder, is a piston *g, h, k*, connected by two upright rods F, H, G, K, jointed at their extremities with the horizontal frame N, L, H, moveable about the fixed axle L, M. The frame is connected at the point N, with a crank on the axle P, Q, which carries a fly wheel at P. Immediately above the partition *a, b, d*, a pipe *n, o*, enters the cylinder from a vessel containing hydrogen gas, which is mixed with common air by an apparatus already described. Upon the pipe *n, o*, is a stop-cock, which is opened upon the appulse of the piston to the partition

a, b, d, and shut again upon its appulse to the top of the cylinder. At *C, D*, is a light valve *R, S, T*, described above, moderately air tight and opening downwards.

The piston, during its ascent, draws in from the pipe *n, o*, a charge of mixed gas, which is exploded on the appulse of the piston to the top of the cylinder by the flame of a gas-light absorbed at the touch-hole *c*, which is opened for a single instant by the motion of a small sliding plate. The common air is expelled from the lower division *a, b, C, D*, of the cylinder at the valve *R, S, T*, leaving an imperfect vacuum density, one sixth in the whole cylinder, *A, B, C, D*. The piston descends from = *A*, to *a*, by the pressure of the atmosphere, and is raised again by the momentum of the fly-wheel, being followed in its ascent by a fresh portion of mixed gas, drawn in from the pipe *n, o*. The upper division *A, B, a, b*, is a cylinder of brass, accurately bored; the lower division *a, b, A, C, D*, requires no accuracy of bore and but very little strength. It may, therefore, be made of sheet copper, with a strong flange at the bottom, presenting a flat face to the valve *R, S, T*. To remedy the noise which is occasioned by the explosion, the lower end of the cylinder, *A, B, C, D*, may be buried in a well; or it may be enclosed in a large air-tight vessel: this vessel will be filled with condensed air, expelled, together with a quantity of water from the cylinder *a, b, C, D*. This condensed air may be made to co-operate with the vacuum in working the engine, and will occasion a considerable increase of power without adding to the friction.

“ In the model, power is had from the pressure of the atmosphere upon an imperfect vacuum; but an engine may be constructed to work with an

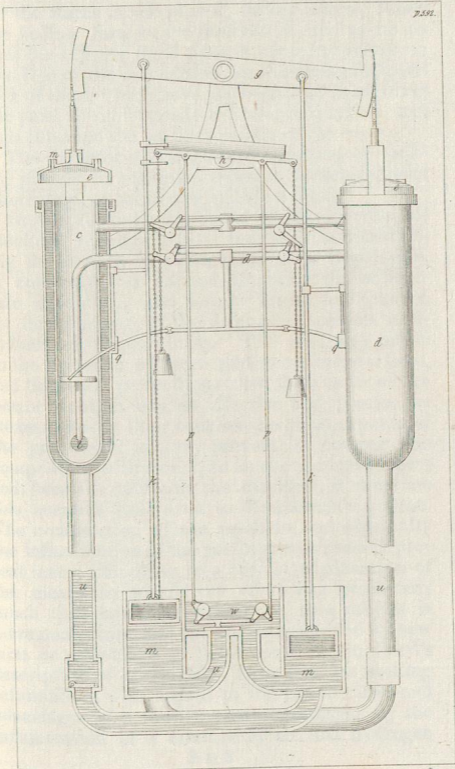
exploding force only, or by the exploding force and pressure of atmosphere jointly."

The manner in which Mr. Samuel Brown produced a power, from the inflammation of a mixture of air and hydrogen gas, was similar in his first trials to the method shewn by Cecil: but here his second and greatly improved mechanism will be selected for description.

The inflammable gas is conducted by a pipe *a*, to a burner *c*, fixed in a cylinder *c*, which is inclosed by a another cylinder *d*, having a groove made at its upper part, into which a cover *e* falls; this cover has a small valve *n* opening outwards. The pipe *f* opens a passage for the atmosphere, and the inner cylinder *c*; *g* is a vibrating lever to which the covers are attached; *h* another vibrating lever or cylinder, which acts to open and shut the cocks on the pipes *f*, *a*; *i*, a pipe proceeding from the inner cylinder into a reservoir; *k*, *l*, two rods attached to the greater vibrating lever, having hollow floats at their other extremity, which rise and fall in the reservoirs *m*, *m*; *o*, *o*, valves opened by the rods *p*, *p*; *q*, a valve on a pipe *r*; *s*, a pipe proceeding from the gas pipe at both ends; the gas is kept constantly inflamed. Gas is admitted through the holes in the burner *c*, and flowing into the open cylinder mixes with the air, and at the same time the valve *q* being opened, the flame communicates to the mixture of gas and air in the cylinder—at the moment of inflammation the cover is pressed down, and the valve *q* is closed, a part of the heated air escapes through the valve in its top; the water from the reservoir rises up the pipe *r*, and flows into the inner cylinder, whence it escapes through the pipe *t* upon a wheel, or into a reservoir; during this operation, the cover of the other cylinder is being lifted up,

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for the water in the pipe *u*, falling into *w*, raises the hollow float in the reservoir *m*, and in its ascent the tappets fixed upon it open the valves on that side of the mechanism, and reversing the position of those which have just been described, bring the parts of the opposite cylinder into action, and thus continue the working stroke of the engine.

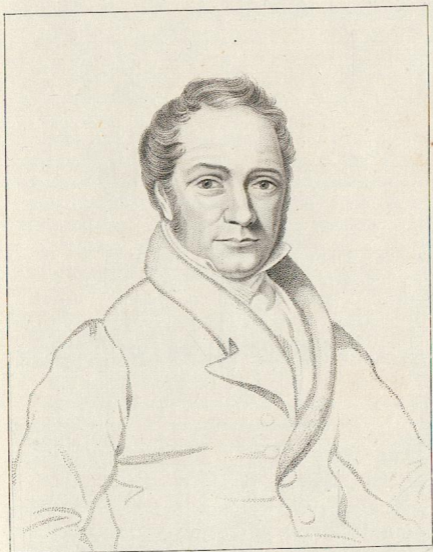
The inventor also explained a method of working pistons, by making a vacuum in each cylinder alternately, either above or below them.

Brown, although he failed in introducing his machine, received liberal assistance in establishing its powers, by experiment on a large scale. A company was formed to carry the scheme into execution, and ample funds were placed, for that purpose, at the disposal of certain individuals of respectability. The trial was made in the presence of these parties to move a boat, and they were perfectly satisfied that, as far as the power went, it was as effective and precise as steam. But in their opinion the great expense of the gas would entirely prevent its coming into competition with steam, as an economical power; and, from the nature of the machine, it must on this account yield even to Newcomen's engine. The construction of the machine, and especially the inflammation of the gas in an open vessel, present many difficulties to a correct explanation of the means by which the effect was produced; much that has been written on this subject is mere conjecture, and the discussion added no new facts or reasonings to those contained in Cecil's description of his model. They who are seeking information, with regard to the peculiarities and advantages of a motive power produced by the inflammation of a mixture of air and hydrogen

gas, will find it worth their pains to refer to Cecil's account of his experiments.

In adjusting the claims of Cecil and Brown, the first it must be remembered exhibited and described his model in 1820. Brown said nothing of his before 1823, and a greater time elapsed before his model was exhibited to the public; but if priority of idea be due to the machine of the scholar, Brown's supplies parts which make it more practical. And though the claim of invention rests with Cecil, Brown must be commended for his emendations. By producing combustion in an open vessel, Brown insured the most perfect safety to the apparatus; but probably this alteration cannot be considered to have been an improvement, when viewed with reference to the economical application of the exploding mixture.





BROWN.

