

this apparatus is denoted by an instrument having an index moving round a dial plate. Steam of 26 atmospheres being suddenly admitted, the index was observed, during repeated trials, to register a pressure as high as 36 atmospheres, and then to recede until it remained stationary at 26 atmospheres, which was the pressure in the generator.

The results of these various experiments are arranged in two tables, exhibiting an analysis of the elements into which they may be resolved.

Single  
pumping  
and crank  
engines.

The author then proceeds to point out the different circumstances of the pumping and crank engines, in respect of their realizing, beneficially, the steam's percussive action. In the latter, this instantaneous action takes place (as the indicator diagrams show) when the connecting rod and crank are in one vertical line, so that it is inefficiently expended; the centre, by the agency of the fly wheel, not having been passed. In the former, the load and frictional resistance alone oppose the descent of the piston; the piston is free to move, and the steam's action is wholly efficient in impelling it; and, whatever the amount of the percussive action, it will be accounted for in the effect.

Springing  
of cylin-  
der covers.

A remarkable confirmation of the conclusions arrived at, and the views advanced by Mr. Parkes in his previous communication, had been furnished by Mr. W. West. The cylinder cover of the Fowey Consols engine, 80 inches in diameter, and weighing 4 tons, springs upwards at the centre  $\frac{5}{32}$ nds of an inch, on the sudden admission of steam, which in the boiler has a pressure of 49.7 lbs; and  $\frac{2}{32}$ nds or  $\frac{1}{4}$ th of an inch, the steam in the boiler being 61.7 lbs.; but no change of form, or springing, occurs when the steam is let on gradually, and fills the cylinder at the same pressure as that in the boiler.

The author adduces many other facts in illustration and confirmation of his views; as, the oscillation of the mercury in steam and vacuum gauges; the audible sounds produced in a steam pipe on suddenly checking the motion of the elastic fluid by shutting a cock; the curious phenomena connected with the impact of elastic fluids on each other, particularly those observed by Mr. Greener on firing gunpowder in long open-ended barrels; and, in conclusion, suggests whether these remarkable facts may not serve to assist in elucidating some of the very difficult and apparently inexplicable phenomena, connected with the explosion of steam boilers.

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Mr. Lowe. Mr. Lowe had recently made some experiments, which in his opinion confirmed Mr. Parkes's views on this interesting subject.

A pressure gauge, attached to a line of gas pipes, showed, when the communication was slowly opened, a pressure of four inches column of water; but it invariably exhibited a maximum of oscillation of full six inches column on the sudden opening of the small stop cock between the pipe and the gauge. Vibrations  
of gas  
pressure  
gauges.

In a line of pipes, full of gas, the whole volume of gas received an impulse on suddenly opening the valve at one end, and the passage of the undulating wave was indicated by the sudden and successive depression of the water in the gauges along the whole line.

Mr. Homersham could not agree with Mr. Parkes as to the effect due to what he termed the "percussive action of steam:" he believed that the superior economy of the Cornish Engines, as far as related to the action of steam in the cylinders, would be found to be due to the amount of the expansion of the steam; which depended, not only upon the opening and closing of the steam valve, but also upon the greater or less area of the aperture of the throttle valve. It was evident, that on closing the steam valve, the space between it and the throttle valve would be filled with steam of a density nearly, or quite, equal to that in the boiler; therefore, on the first admission of the steam into the cylinder, it might be presumed to act upon the piston with that pressure: considering, likewise, that a short interval of time necessarily occurs for setting in motion the beam, with the heavy pump rods appended to it; but immediately the piston starts, expansion takes place, as the throttle valve prevents the steam from following the piston freely, so that a greater degree of expansion must take place when the steam is at a higher density; for the throttle valve being then more closed, offers a greater resistance to the steam following the piston. The indicator diagram of the East Crinnis Engine showed this effect to a certain extent, although neither in that nor in the diagram of the Huel Towan Engine was there nearly the same degree of pressure exhibited in the cylinder at the commencement of the stroke, as in the boiler; but it was evident that those diagrams could not be relied upon, as they did not account for the whole duty done by the engines, either on the percussive or the expansive principle. Mr. Ho-  
mersham.

Assuming a bushel of coal to weigh 94 lbs., as generally reckoned in Cornwall, and that 1 lb. of coal would evaporate  $10\frac{1}{2}$  lbs. of water, it could readily be shown, that the quantity of water converted into steam by one bushel of coal, would, when expanded in a cylinder, during  $\frac{1}{20}$  of the stroke, lift upwards of 257 million lbs. one foot high in one minute; which was a much greater duty than was realised by any Cornish engine.

Mr. S.  
Seaward.

Mr. Seaward allowed that Mr. Parkes had clearly shown, that a certain amount of effect was due to the sudden impact of the steam upon the piston of a pumping engine. Whether the term "percussion," as applied to this action, was the proper one, he would not then examine; but the effects shown to have been produced, and the phenomena attendant upon the exhibition, were so remarkable, that he conceived the subject to merit the most deliberate investigation of engineers as well as philosophers. He had previously objected to the theory, on the ground that the effect could only be in the ratio of the weight of the steam multiplied into its velocity; but he believed the subject must be examined in a different manner; and although the principle must always have existed, it was only in consequence of modifications in the application of steam, that the effects had been so fully developed.

Mr.  
Parkes.

Mr. Parkes mentioned, that since his paper had been written, he had found an experiment which was strictly analogous to his proposition. It was related by Mr. Robins, who was so justly celebrated as a mathematician and philosopher, and first discovered that the gas evolved from gunpowder was a permanently elastic fluid.

"When gunpowder is fired in an exhausted receiver, the mercurial gauge instantly descends upon the explosion, and as suddenly ascends again. After a few vibrations, none of which, except the first, are of any great extent, it fixes at a point which indicates the density of the inclosed gas."

He considered this result as corroborating those obtained by himself, as well as justifying the comparison he had drawn between the instantaneous action of gunpowder gas and steam. Mr. Robins's words precisely described the steam's action, as traced on the indicator diagram exhibited.

The springing of the cylinder cover referred to, and in the manner stated, must, he thought, satisfy every one, that the steam's instantaneous action far exceeded in effect that of its simple elastic force, which was proved to have been unequal to produce any change in the parallelism of the cover.

Expansion  
of steam.

As regarded Mr. Homersham's investigation of the power of the steam in the Huel Towan Engine, it was correct that the initial steam was in a state of expansion during  $\frac{1}{20}$ th of the stroke, but not all the steam, for it had not all entered the cylinder until the piston had travelled through nearly  $\frac{5}{20}$ th of the stroke. His calculations were, therefore, hypothetical, and not in accordance with the facts of Mr. Henwood's experiment.

