there are earthquakes without proportionable ſubſidences, there the caverns and ducts under-ground remaining open and unchoaked, the ſame cauſe, which occaſioned the firſt, has room to revive and renew its ſtruggles, and to repeat its deſolations or terrors; which is moſt probably the caſe of Liſbon. I am, Sir,

Your moſt affectionate

and obliged humble Servant,

Wm. Borlaſe.

X. *Experiments on applying the Rev. Dr.* Hales's *Method of diſtilling Salt-water to the Steam-Engine. By* Keane Fitzgerald, *Eſq*; *F. R. S.*

Read Feb. 17. 1757.

ON reading Dr. Hales's account of purifying ſalt water, by blowing ſhowers of air thro', it occurred to me, that ſomething of the kind might be applied with advantage to the ſteam or fire-engine, by increaſing the quantity of ſteam, and conſequently diminiſhing the quantity of fuel otherwiſe neceſſary.

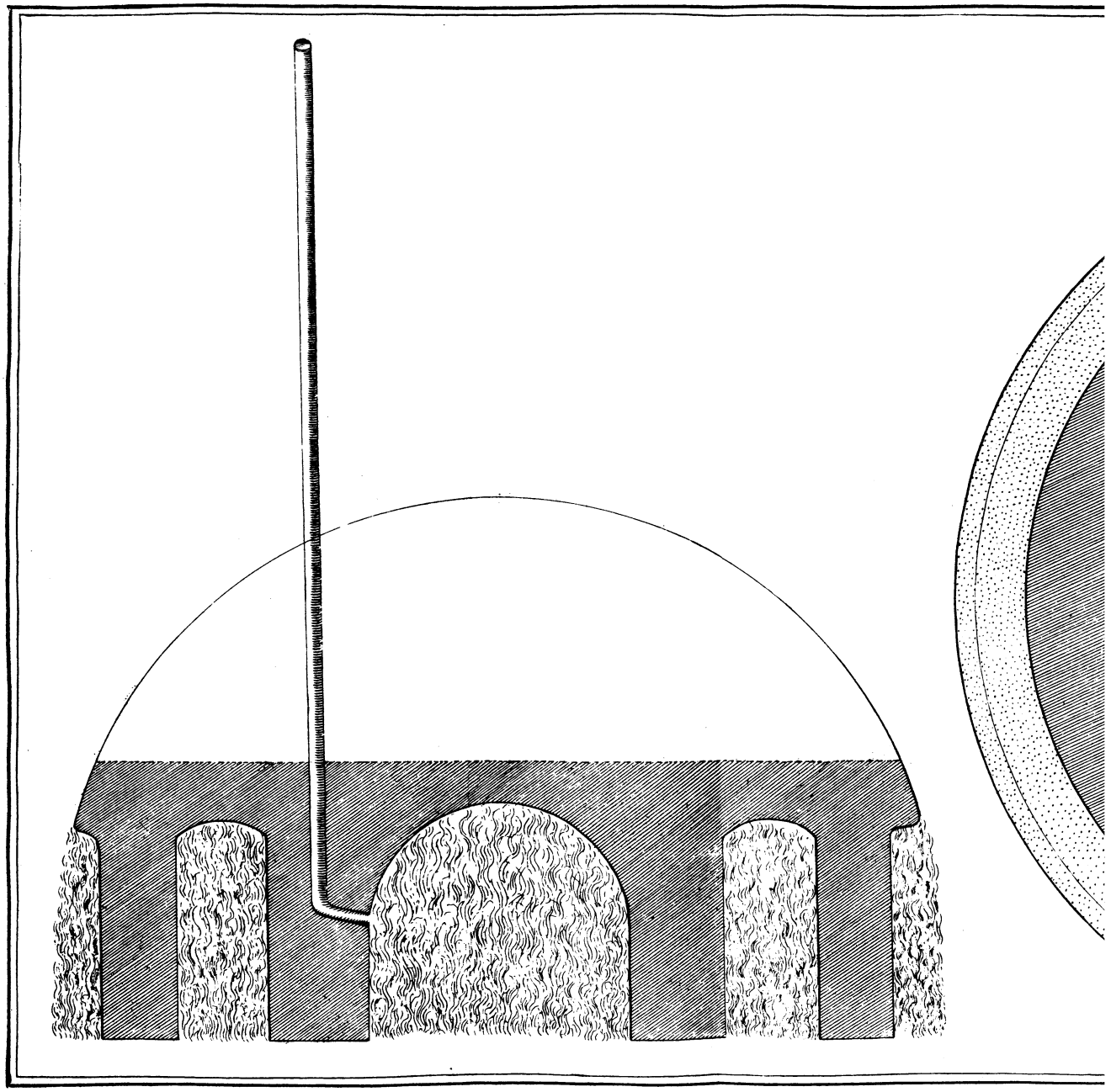
As the ſtrength of ſteam raiſed from boiling water is always in a fluctuating ſtate, and, by the beſt experiments hitherto made, has never been found above $\frac{1}{10}$ ſtronger, or weaker, than air; I was in doubt, whether ſteam, produced by this method, would

would be ſufficiently ſtrong for the purpoſe of the ſteam-engine.

I made an experiment firſt on a ſmall boiler, about 12 inches diameter, made in the ſhape of thoſe commonly uſed in ſteam-engines, with a funnel at the top, of about 1 inch diameter, for the ſteam to paſs thro'; the aperture of which was covered with a thin plate, fixt at one end with a hinge, and a ſmall leaden weight to ſlide on the other, in the nature of a ſteel-yard, to mark the ſtrength or quantity of the ſteam. A tin pipe made for this purpoſe, with ſeveral ſmall holes towards the end, paſſed from a ſmall pair of bellows, through the upper part of the boiler, to within about an inch of the bottom. The boiler was half filled with water, which covered the holes in the pipe about ſix inches. From the beſt obſervation I was capable of making with this machine, by blowing air thro' the boiling water, it produced about $\frac{1}{6}$ more ſteam than was produced by the ſame fire without blowing air thro'.

I then applied a machine of this kind to the engine at the York-buildings water-works, the boiler of which is 15 feet diameter. This is a patent-boiler, a ſection and plan of which is annexed. It has a double concave, with a kind of door-way or paſſage from one to the other, in order to let the flame paſs, as it were, thro' and round the water; by which means there is no-where above nine inches of water to be heated thro', tho' the boiler is ſo large; and which, by three years experience, has been found to require $\frac{1}{4}$ leſs fuel, than any other fire-engine of equal bigneſs.

I fixt



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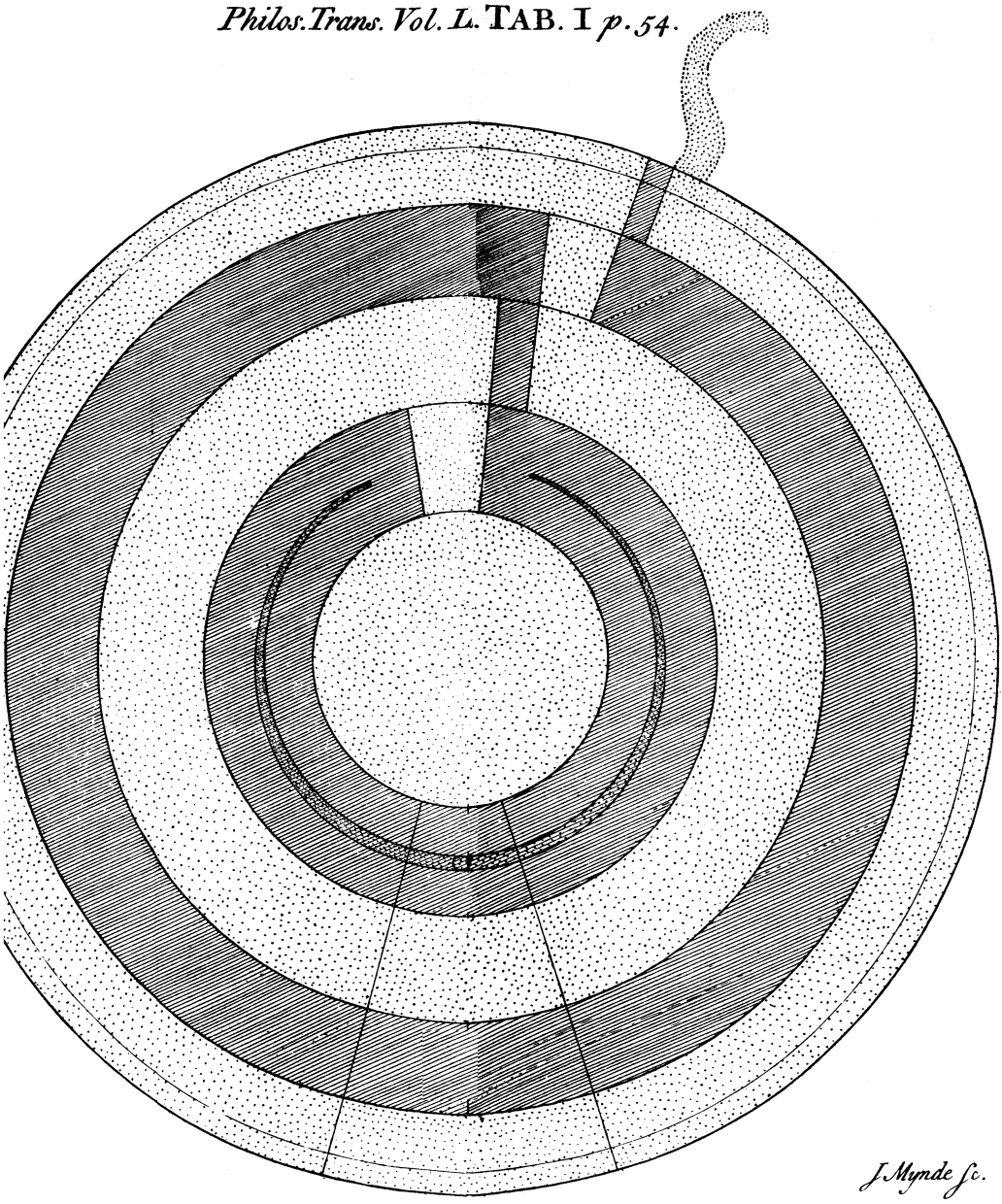

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I fixt a pipe of an inch and a half diameter to a pair of double bellows three feet diameter; which pipe reached about one foot under the ſurface of the water in the boiler, to the end of which are fixed horizontally two branches, each about eight feet long, tapering from one inch diameter to about $\frac{1}{4}$ of an inch. Theſe branches are bent in a circular manner, as in the plan, to anſwer the form of the concave, and are perforated with ſmall holes about four inches diſtant at the thickeſt part, and decreaſing gradually in diſtance, to within $\frac{1}{4}$ of an inch, towards the ſmall end. The reaſon of theſe branches being made taper, and the diſtance between the holes decreaſing to the ſmall end, was in order to give the greater power to the air forced by the bellows to diſcharge the water lodged in ſuch a length of pipe; and I obſerved by this method, that the water was gradually forced thro' the holes to the end of each branch, and ſeemed to throw an equal quantity of air thro' the water.

The length of the pipe, to which the branches are fixed horizontally, is about 18 feet to the noſle of the bellows: notwithſtanding which length, the ſteam, that paſſed thro' the pipe into the bellows, was ſo hot before the water boiled, as to force thro the leather: but this I eaſily remedied, by fixing a braſs cock of one inch and a half diameter to the pipe, which hindered the ſteam from aſcending, until the engine was ready to work; and being opened, the air continually keeps it cold until the engine has done working; then the cock muſt be ſhut again.

The bellows is worked by means of a ſmall lever, and pullies applied to the great lever of the fire-engine,

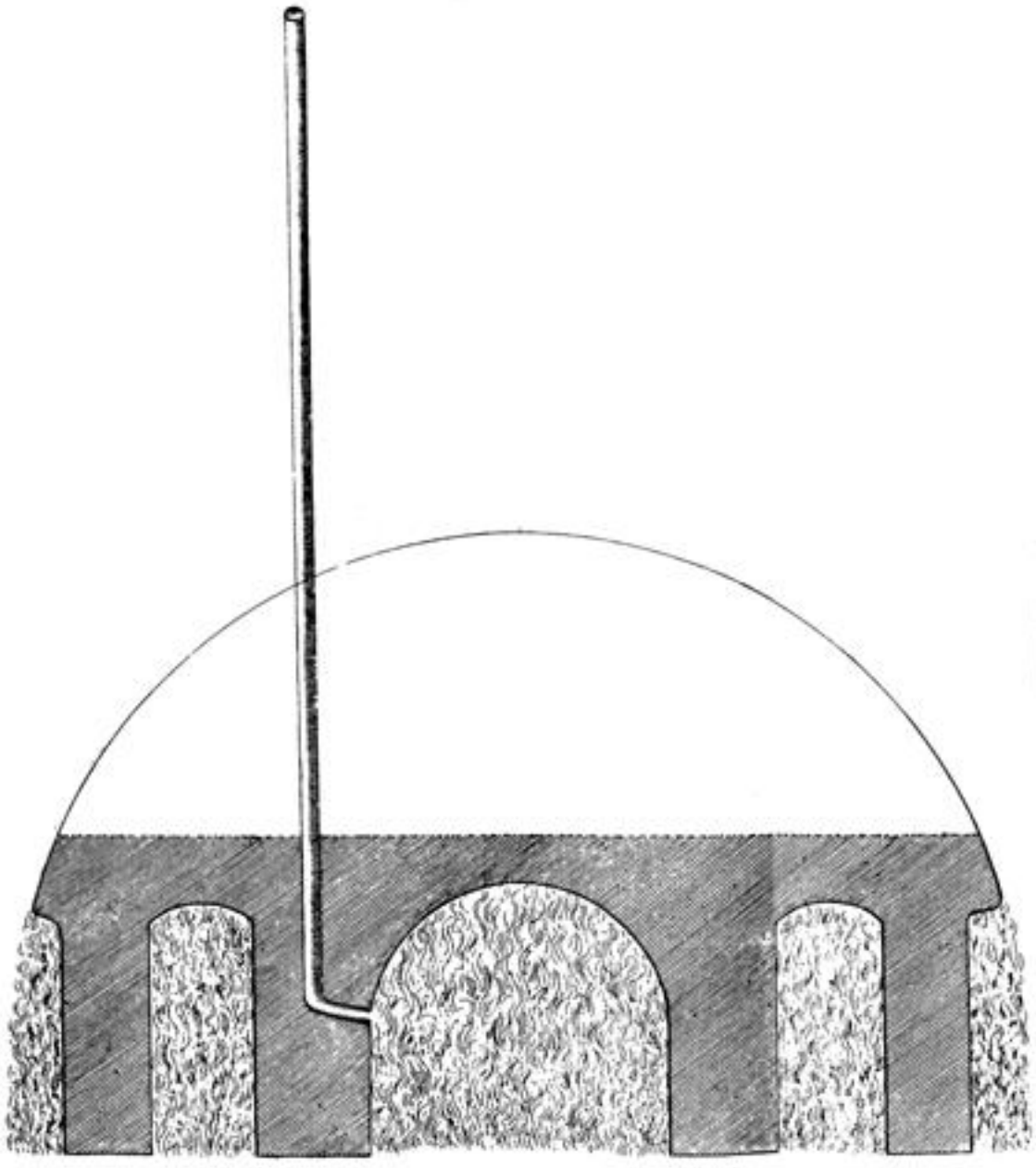
engine, which keeps a continual blaſt whilſt the engine works; the ſtrength of which is increaſed or diminiſhed, by adding or taking off the weights on the bellows.

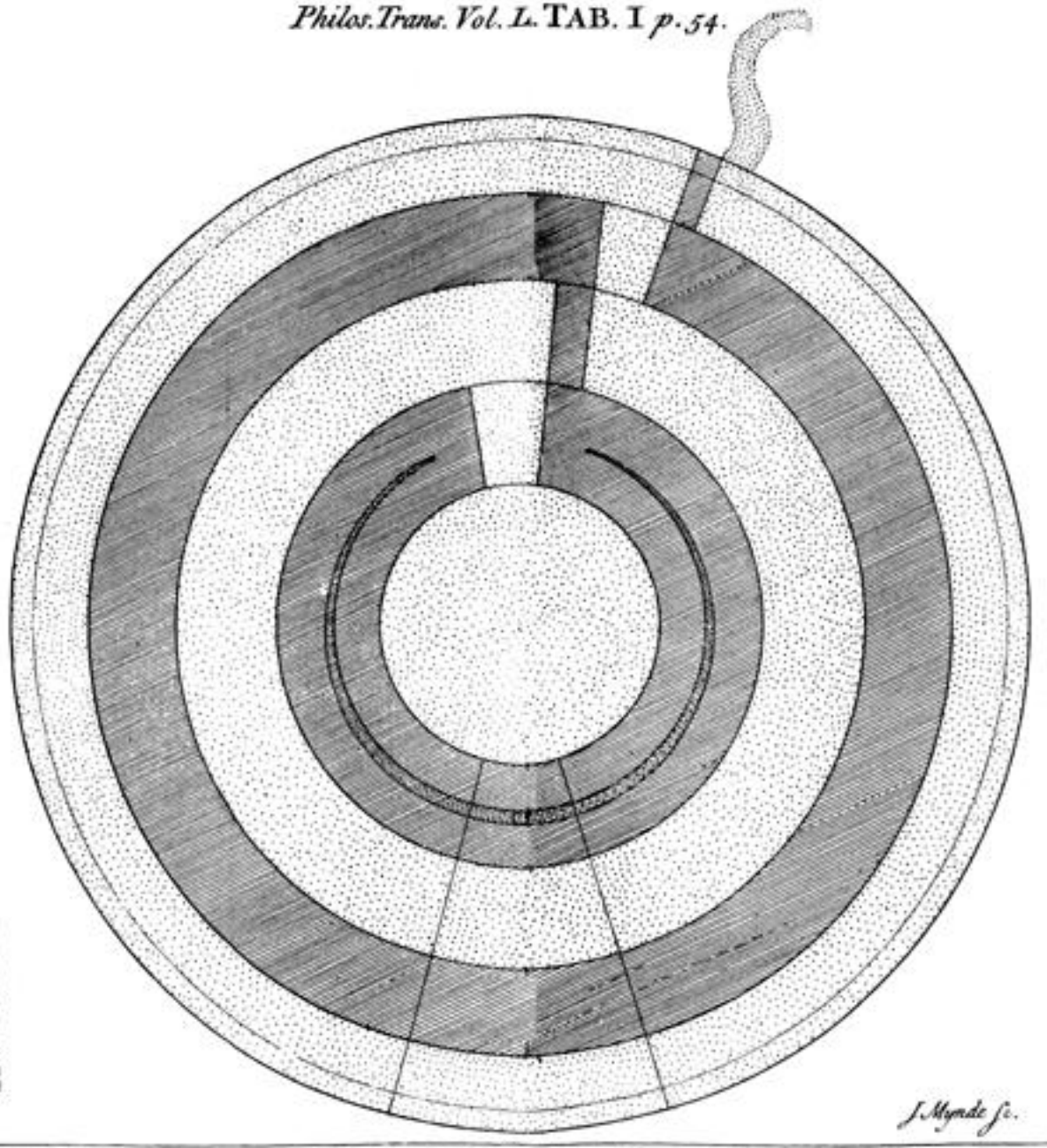
The effect produced, according to the beſt obſervations I could make, was, firſt, a very viſible alteration for the better in the working of the engine. When the fire was ſtirred, as it muſt be every time fuel is added, the ſteam generally became too fierce, which occaſioned great irregularity, and ſometimes, if not watched, great damage to the engine; and when the fire abated, the ſtroke became immediately much ſhorter, or ſtopped intirely, if fuel was not ſoon added: whereas, by blowing air thus thro' the water, it keeps, with any moderate care, an equal ſtroke to its full length, from the beginning to the end; and by that means diſcharges a conſiderably greater quantity of water. A proof of which was very evident, tho' I could not aſcertain the exact quantity: for the engine, before this improvement, ſupplied but two main pipes at once, which conveyed the water to the houſes ſerved by them; but ſince could not take off the quantity of water thrown up, part of which was obliged to be diſcharged into a third main.

As to the quantity of fuel, that may be ſaved by this method, it is not eaſy to determine from any experiment on this engine, the boiler and fire-place of which is made very different from all others, and the quantity of fuel already thereby greatly leſſened. The fire-place, which may be ſaid to be within the boiler, and is but barely large enough to contain a quantity of the roundeſt and ſtrongeſt burning coals ſufficient

ſufficient to work the engine, cannot in this be made leſs; and conſequently will not admit ſuch a ſaving from this model, as from one properly conſtructed for the purpoſe: a proof of which I made, by trying ſome coals of a weaker kind, which were alſo cheaper; but on trial were not ſtrong enough to work the engine, and had therefore been laid by. Theſe coals anſwered extremely well; and, as it was a ſlower-burning coal, I found the conſumption, whilſt they laſted, was between two and three buſhels leſs in every ſix hours, which is about the time the engine works each day: and I am ſatisfied, if the perſon, who attends the engine, would take the proper care, more coals could ſtill be ſaved. For at ſeveral different times, when I had the coals exactly meaſured, and marked the time, I conſtantly found, that it required half a buſhel in the hour leſs than he generally uſed, and the engine threw up as much water.

As this method of blowing air thro' boiling water, in order to increaſe the quantity of ſteam for a fire-engine, has, I believe, never before been attempted, and produces already a very good effect, I am in hopes it may be ſtill further improved.





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