The lamp was now applied at such a distance from the vessel as to warm it slowly, and make the water boil, the steam escaping for some time through the safety-valve. A heavy weight was then sus pended on the steelyard ; such as it was known that the vessel would support, and, at the same time, such as would not allow the steam to force the mercury out of the long tube. The thermometer began im mediately to rise, as also

the mercury in the tube

MN. Their correspondent stations are marked

in the following table.

|  |  |
| --- | --- |
| Temperature. | Elasticity. |
| 212° | 0.0 |
| 220 | 5.9 |
| 230 | 14.6 |
| 240 | 25.0 |
| 250 | 36.9 |
| 260 | 50.4 |
| 270 | 64.2 |
| 280 | 76.0 |

This form of the experiment is much more susceptible of accuracy than the other, and the measures of elasticity are more to be depended on. In repeating the experi­ment, they were found much more constant ; whereas, in the former method, differences occurred of two inches and upwards.

\* We may now connect the two sets of experiments into ne table, by adding to the numbers in this last table the constant height 29∙9, which was the height of the mercury in the barometer during the last set of observations.

|  |  |  |  |
| --- | --- | --- | --- |
| Temperature. | Elasticity. | Temperature. | Elasticity. |
| 32° | 0.0 | 160 | 8.65 |
| 40 | 0.1 | 170 | 11.05 |
| 50 | 0.2 | 180 | 14.05 |
| 60 | 0.35 | 190 | 17.85 |
| 70 | 0.55 | 200 | 22.62 |
| 80 | 0.82 | 210 | 28.65 |
| 90 | 1.18 | 220 | 35.8 |
| 100 | 1.6 | 230 | 44.5 |
| 110 | 2.25 | 240 | 54.9 |
| 120 | 3.0 | 250 | 66.8 |
| 130 | 3.95 | 260 | 80.3 |
| 140 | 5.15 | 270 | 94.1 |
| 150 | 6.72 | 280 | 105.9 |

26. In the mean time, however, Mr Watt had been led, in the course of his invention of the steam-engine, to make experiments on the elastic force of steam, of which he has given the following account, and which was annexed by himself to Dr Robison’s original article in this work.

In the winter of 1764-5, I made experiments at G1as gow on the subject, in the course of my endeavours to improve the steam-engine, and as I did not then think of any *simple* method of trying the elasticities of steam at temperatures less than that of boiling water, and had at hand a digester by which the elasticities at greater heats could be tried, I considered that, by establishing the ratios in which they proceeded, the elasticities at lower heats might be found nearly enough for my purpose. I there fore fitted a thermometer to the digester, with its bulb in the inside, placed a small cistern with mercury also within

the digester, fixed a small barometer tube with its end in the mercury, and left the upper end open. I then made the digester boil for some time, the steam issuing at the safety-valve, until the air contained in the digester was supposed to be expelled. The safety-valve being shut, the steam acted upon the surface of the mercury in the cistern, and made it rise in the tube. When it reached to 15 inches above the surface of the mercury in the cis tern, the heat was 236° ; and at 30 inches above that surface, the heat was 252°. Here I was obliged to stop, as I had no tube longer than 34 inches, and there was no white glass made nearer than Newcastle-upon-Tyne. I therefore sealed the upper end of the tube hermetically, whilst it was empty, and when it was cool immersed the lower end in the mercury, which now could only rise in the tube by compressing the air it contained. The tube was somewhat conical ; but, by ascertaining how much it was so, and making allowances accordingly, the following points were found, which, though not exact, were tolerably near for an *aperçu.* At 29½ inches (with the sealed tube) the heat was 252°, at 75½ inches the heat was 264°, and at H0½ inches 292°. (That is, after making allowances for the pillar of mercury supported, and the pillar which would be necessary to compress the air into the space which it occupied,

these were the results). From these elements I laid down a curve, in which the abscissae represented the tempera tures, and the ordinates the pressures, and thereby found the law by which they were governed, sufficiently near for my then purpose. It was not till the years 1773—4, that I found leisure to make further experiments on this sub ject, of which, though I do not consider the results as accurate, I shall give an account here, as they were in point of date prior to any others that I was then acquainted with.

A tin pan, of about five inches in diameter and four inches deep, had a hole made in its bottom, near one side, and in this hole was soldered a socket somewhat conical, which nearly fitted a barometer tube with which the experi­ments were to be made. This tube was about 36 inches long, and had a ball at one end about 1½ inches diameter, the contents of which were nearly equal to those of the stem of the tube ; some paper was lapped round the tube near the ball, and it was forced tight into the conical socket of the pan, so that the ball was within the latter, at such a height that it might be immersed in water. The tube and pan were then inverted, and the ball was filled with clean mercury, and the stem with distilled water fresh boiled. The tube was re-inverted, so that the ball and pan were uppermost ; the lower end of the tube being shut by the finger, the water ascended into the ball, and the mercury occupied the tube. The lower end of the Iatter being then placed in a cistern of mercury, and released from the finger, the mercury and water descended, and the ball was Ieft partly empty : being agitated in this position, and let stand some time, much air was extricated from the water ; the tube was inclined as much as it could be, and again inverted, the air let out, and its place supplied with boiling water. It was again •placed with the ball uppermost, the end of the tube stop ped, the pan filled with hot water which was made to boil by means of a lamp, the lower end of the tube being