placed in the cistern, and released from the finger, the mercury descended into the cistern, but upon the water in the pan being suffered to cool, partly rose again into the tube. Much air was thus liberated, and more was got rid of by agitation, in the manner of the water hammer, and by leaving it standing for some time erect, until at last I got it so free from air, that when I raised it upright, it supported a column of mercury 34 inches high ; and no vacuum was formed until it was violently shaken, when it fell down suddenly and settled at 28.75 inches, but upon being inclined, a speck of air always remained, though, when it was expanded by a pillar of mercury 27 inches high, this speck was not larger than a pin’s head.

In this state, when the tube was perpendicular, I found the mercury to stand at 28.75 inches, the column of water above it was about 6½ inches, = half an inch of mercury. The whole then being 29.25 inches, when the stationary barometer stood at 29.4, the difference, or pillar supported by the elasticity of the steam = 0.15 inch. The water in the pan was then heated exceedingly slowly by a lamp, and stirred continually by a feather to make the heat as equal as possible. The results are shown in the following table :—∙

**Table No. I.**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Heats. | Elastici­  ties. | Heats. | Elastici­ties. | Heats. | Elastici­  ties. | Heats. | Elastici  ties. |
| 55° | Inches.  0.15 | 135° | Inches.  4.53 | 167° | Inches.  11.07 | 187° | Indies.  17.51 |
| 74 | 0 65 | 142 | 5.46 | 172 | 11.95 | 189 | 18.45 |
| 81 | 0.80 | 148 | 6.40 | 175 | 12.88 | 191 | 19.38 |
| 95 | 1.30 | 153 | 7.325 | 177.5 | 13.81 | 193.5 | 20.34 |
| 104 | 1.75 | 157 | 8.25 | 180 | 14.73 | 196.5 | 21.26 |
| 118  128 | 2.68  3.60 | 161  164 | 9.18  10.10 | 182.5  185 | 15.66  16.58 |  |  |

At this time (1774) I tried a set of experiments in the same manner on a saturated solution of common salt. When this solution was perfectly saturated by boiling, and was put into the tube, it precipitated a quantity of salt which disturbed the experiment. I was therefore obliged to take it out, and filter it, during which process it attracted moisture from the air, and appeared, by its boiling point, not to be perfectly saturated. Though it was more free from air than water is, yet it parted from what it contained with great difficulty, and would part with none when shaken as a water-hammer, though it opened in all parts of the liquor. The result of this experiment is contained in the annexed table :—

**Table No. II.—Stationary Barometer, 29.5.**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Heats. | Elastici­  ties. | Heats. | Elastici­  ties. | Heats. | Elastici  ties. | Heats. | Elastici­  ties. |
| 46° | Inches.  0.01 | 154° | Inches.  5.36 | 187° | Indies.  12.67 | 208° | Inches.  20.86 |
| 76 | 0.36 | 160 | 6.27 | 193.5 | 145 | 210 | 21.8 |
| 85 | 0.58 | 165 | 7∙2 | 195.5 | 15.34 | 212 | 2274 |
| 92 | 0.81 | 169 | 8.12 | 198.5 | 16.25 | 214 | 23.66 |
| 113 | 1.72 | 173 | 9.03 | 201.5 | 17.16 | 216 | 24.6 |
| 129 | 2.63 | 177 | 994 | 203.5 | 18.1 | 218 | 25 52 |
| 139 | 3 54 | 180 | 10.85 | 205.5 | 1903 | 220 | 26.5 |
| 147 | 4.45 | 183 | 11.76 | 207 | 19∙94 |  |  |

In the same manner I tried a set of experiments upon spirit of wine, the results of which are contained in the annexed table :—

**Table No. III.**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Heats. | Elastici­ties. | Heats. | Elastici­ties. | Heats. | Elastici  ties. | Heats. | Elastici  ties. |
| 34° | Inches,  0.22 | 120° | Inches.  7.12 | 146.5° | Inches.  15.03 | 164° | Inches.  22.59 |
| 40 | 0.929 | 124.5 | 8.46 | 148.5 | 15.974 | 166 | 23.53 |
| 67 | 1897 | 128 | 9.4 | 151 | 16.908 | 167 | 24.47 |
| 84 | 2.806 | 132 | 10.34 | 152.5 | 17.85 | 168 | 25.4 |
| 95 | 3.744 | 135 | 11.32 | 155 | 18.8 | 169 | 26.35 |
| 103 | 4.728 | 139 | 12.21 | 157 | 1975 | 171 | 27∙3 |
| 110 | 5.63 | 141.5 | 13.15 | 160 | 20.71 | Stat. Bar. 29.4 | |
| 114 | 6.58 | 144 | 14.1 | 162—5 | 21.65 |  |  |

Upon considering the probable cause of the difference, especially in the lower heats, between my experiments and those of Mr Southern, related in his letter annexed to this essay, I can only reconcilo them by supposing that the stationary barometer, with which the comparison was made, had its scale placed 0.2 of an inch too low, and by adding that quantity to the elasticities in table lst, they approach nearly to Mr Southern’s experiments.

If that conjecture is adopted, the same addition will be necessary to tables 2d and 3d, as they were compared with the same stationary barometer.

To determine the heats at which water boils when pressed by columns of mercury above 30 inches, a tube of 55 inches long was employed ; one end was put through a hole in the cover of a digester, and made tight by being lapped round with paper, and within the digester the end of the tube was immersed in a cistern of mercury. A thermometer was fixed in another opening, so that the bulb was in the inside of the digester, and the stem and scale without ; and the bulb was kept half an inch from the cover of the digester by a wooden collar. The cover being fixed on tight, and the digester half filled with water, it was heated by means of a large lamp.

The air in the upper part of the digester expanding by heat, the column of mercury in the tube was considerably raised by that expansion before the water boiled. The air was let out, and the water heated to boiling ; still, however, some air remained, for the mercury stood at 213½°. That deduction being made, the following table shows the heats and corresponding elasticitics.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Heats. | Elasti­  cities. | Heats. | Elasti­  cities. | Heats. | Elasti  cities. | Heats. | Elasti­cities. |
| 213° | 30 | 228° | 39 | 240° | 49 | 259° | 66 |
| 215 | 31 | 229.5 | 40 | 242.5 | 50 | 261 | 68 |
| 217 | 32 | 231 | 41 | 244.5 | 52 | 262.5 | 70 |
| 219 | 33 | 232.5 | 42 | 247 | 54 | 264.5 | 72 |
| 220.5 | 34 | 234 | 43 | 248.5 | 56 | 266.5 | 74 |
| 222 | 35 | 235 | 44 | 250.5 | 58 | 268 | 76 |
| 223.5 | 36 | 236.5 | 45 | 252.5 | 60 | 269.5 | 78 |
| 225 | 37 | 237.5 | 46 | 255 | 62 | 271 | 80 |
| 2265 | 38 | 238.5 | 47 | 257 | 64 | 272.5 | 82 |

In making these experiments, the digester was heated very slowly, and the heat was kept stationary as much as was possible at each observation, so that the whole series occupied some hours. The degrees of elasticity were observed by my friend Dr Irvine, whilst I observed those of the thermometer in all these experiments.

With the whole of the observations, I was, after all, by no means satisfied, as I perceived there were irregularities in the results which my more urgent avocations did not permit me to explore the causes of and to correct.

The matter remained in that state till 1796, when I requested Mr Southern to try them over again, in the