surrounding the gauge, a thermometer *(p,* fig. 22) with a very small bulb, was attached to the scale at the middle of its height: by this instrument, the flow of water through the casing of the gauge was regulated so as to keep the temperature nearly constant, and any deviations from a constant temperature were ascertained and noted, that the proper correction might be applied. The correction for the expansion of the air in the gauge, by a rise in its temperature during the progress of the experiments, was made according to the rules furnished by the rate of expansion of the gases, as determined by Gay Lussac, extended to compressed air by the experiments of Davy. The correction for the changes of height of the mercurial column, within the range to which the temperature was suffered to increase, could not have been appreciable if acting entirely, and the counteracting effect of the expansion of the glass further justified its being neglected. For similar reasons no reference was made to the effects of heat on the mercury in the cistern i, on the cistern itself, and on the water within the pipe communicating with the boiler.

In most of the researches of the committee, refinements in the mode of using the common thermometer would have been out of place. Results which might be obtained with little additional labour, and which would be interesting in both a practical and scientific point of view, were not to be neglected, and to some of them great accuracy was essential. In the questions of the first class, the thermo­meters were provided with wooden scales, and were graduated by immersion up to the point at which the scale commenced, the scale and upper part of the tube being exposed to the air : this was proper, as they were intended to be immersed in mercury nearly up to the scale. These instruments were examined after coming from the maker’s hands, and the instrumental error ascertained. The tubes in which the thermometers were placed, and which contained mercury, were at first placed horizontally in one of the ends of the boiler ; this had the advantage of rendering the tube for indicating the temperature of the water entirely independent of the steam, and thus any difference between the temperature of one and the other might be more effectually ascertained, than when the tube giving the temperature of the water passed through the steam. The position of these instruments interfered so much with other parts of the apparatus, and so much in convenience and danger of error was experienced from the separation of the column of mercury in the thermo meter, that these tubes were not used after the first weeks of experiment, and two vertical tubes, placed as already shown, were substituted for them.

The thermometers used, when the relation between the temperature of the steam and water, and the elasticity of the steam were to be observed in conjunction with some of the subjects more directly under the cognizance of the committee, had much pains bestowed upon them.

The scales (M and N,) were metallic, and surrounded by glass tubes, fitting into a cup *a',* through the bottom of which the stem of the thermometer passed water tight ; a pipe *b' c, fig.* 20, from the side of each cup, and provided with a stopcock *d,* regulated the flow of water through the enveloping tubes : a tight connexion above with a reservoir (O) served, as in the case of the gauge, to supply the tubes with water. Small thermo meters on the back of the scale of the large ones, showed the temperature of the water which surrounded them. The enveloping tubes being filled with water at 60°, the position of the boiling point of water and of the fusing point of tin, were used to verify the accuracy of graduation. The latter point, which is high upon the scale of the thermomoter, having been very accurately determined, and being easily and with certainty ascertainable, serves as an excellent check upon the graduation. The greatest error within the limits just stated, was in one instrument, three-fourths of a degree, and in the other one degτee of Fahrenheit. The scales were graduated from two to two degrees, one quarter of a degree being readily estimated upon them. The corrections required by this examination were made through the medium of a table prepared for the purpose. In order to call the attention to the temperature of the water sur rounding the scales, this temperature was recorded from time to lime, when the height of the thermometers was observed, At no time did the rise of temperature, permitted in the water, make it necessary to apply a correction for the expansion of the scale. None was required for the cooling effect of the water around the stem upon the mercury, owing to the method of verifying the scale.

The other parts of the apparatus, less general in their use, as the water-gauge, safety-valve, fusible plate appa ratus, &c., will be more conveniently described in connexion with the experiments for which they were devised.”

34. With this apparatus, and these precautions, a series of experiments were made, the results of which are contained in the following tables :—

The Table, No. 1, contains the temperature observed by the thermometer in the water, corrected for the error of the graduation ; the temperature of the scale of the thermo meter, with a view to show that it was not allowed to vary too considerably ; the observed height of the mercury in the gauge, reduced to its mean height ; the temperature

Table, No. I.—Of the Elastic Force of Steam at different Temperatures.

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Temperature of steam. | Temp. of scale of ther­mometer. | Height of mercury in air gauge. | Temperature of air in gauge. | Volume of air in observed tem­perature. | Volume of air at 48o Fahrenheit. | Elasticity of air in inches of mercury. | .01 Height of gauge. | Height + .01 height. | Height + .01 height —1.29 inches. | Total elasti­city in inches of mercury. | **Elastic force** in atmos­phere of 30 inches. |
| Fah.° | Fah.° | Inches. | Fob.° | Vols. | Vole. | Inches. | Inches, | Inches. | Inches. | Inches. | Atmos. |
|  |  | 3.99\* | 62 | 8.33 | 8.101 | 27.26 | .04 | 4.03 | 2.74 | 30.00 | 1.00 |
| 2621/4 | 63 | 15.04 | 74 | 393 | 3.737 | 59.09 | .15 | 15.19 | 13.90 | 72.99 | 2.43 |
| 2681/2 | 71 | 16 34 | *"* | 3.43 | 3.259 | 67.76 | .16 | 16.50 | 15.21 | 82.97 | 2.76 |
| 2751/2 | " | 1734 | " | 3.05 | 2.898 | 76.20 | .17 | 17.51 | 16.22 | 92.42 | 3.08 |
| 2861/2 | " | 18.94 | " | 2.44 | 2.319 | 95.23 | .19 | 19.13 | 17.84 | 113.07 | 3.77 |
| 2961/2 |  | 19∙94 | " | 2.05 | 1.948 | 113.36 | .20 | 20.14 | 18.85 | 132.21 | 4.41 |
| 2981/2 | 73 | 20.11 | " | L99 | 1.891 | 116.76 | .20 | 20.31 | 19 02 | 135.80 | 4.53 |
| 302 |  | 20.44 | " | 1.86 | 1.767 | 124.98 | .20 | 20.64 | 19.35 | 144.33 | 4.81 |
| 305½ | 76 | 20.79 | 75 | 1.73 | 1.641 | 134.57 | .21 | 21.00 | 19.71 | 154.28 | 5.14 |
| 3131/4 | 79 | 21.39 | » | 140 | 1.422 | 155.30 | .21 | 21.60 | 20.31 | 175.61 | 5.85§ |
| 3173/4 | 80 | 21.64 | " | 1.405 | 1.332 | 165.79 | .22 | 21.86 | 20.57 | 186.36 | 6.21 |
| 3203/4 | *"* | 21.79 | 76 | 1.347 | 1.275 | 173.20 | .22 | 22.01 | 20.72 | 193.92 | 6.46 |
| 3273/4 | " | 22.24 | " | 1.176 | 1.113 | 198.41 | .22 | 22.02 | 20.73 | 219.14 | 7.30 |
| 3333/4 |  | 22.69 | " | 1.004 | 0.950 | 232.46 | .23 | 22.92 | 21.63 | 254.09 | 8.47 |

\* This observation shows the height of the gauge before the experiment, corrected for the height of the barometer, Mean of four observations Mean of two observations. Mean of two observations.