(E) to the temperature of the water and steam within, so as to give to the thermometer F an indication of the temperature ; and, at the same time, the elastic force of the steam flowing or moving by would raise it in C to a certain number of inches, so as to cause the corresponding pressure. This apparatus is both appropriate and ingenious, and indicates considerable mechanical knowledge in its inventor, a physician of Winterthour in Switzerland. Un happily he lived too remote from the scene of the philosophical discoveries of that period, to adopt the precautions necessary to give value to his experiments. He allowed atmospheric air to mingle with the steam to such an extent as greatly to vitiate his results.

24. M. Betancourt visited England about the end of last century ; and having been employed to select ma chines, models, and drawings for the Spanish government, made himself acquainted with the use of steam in Great Britain at that period. On his return, he immediately undertook a series of experiments on the force of the vapour of water, alcohol, and other liquids, at various temperatures. His apparatus is tolerably perfect; and the precautions which he adopted for the removal of atmospheric air from intermixture with the vapour, give his experiments considerable value and precision. Some of his experiments were made in vacuo ; and he seems to have been one of the first philosophers who examined the production of steam at temperatures below the ordinary point of ebullition, under the pressure of the atmosphere His experiments extend from 32° up to 279°, being 67° above the ordinary boiling point.

His apparatus (Fig. 9) consisted of a spheroidal copper boiler A, about eight inches in diameter, fifteen inches high, and a tenth of an inch in thickness ; a flat cover was soldered on the top of it, and three apertures were formed into which were inserted a thermometer EC, a glass tube D, and a plug B for admitting water. The glass tube being bent downwards at F, was recurved upwards at G, leaving an upright stem, ten feet high, and hermetically sealed at the top, so as to leave a perfect vacuum in that end of the tube, over a column of mercury of about 30 inches in the two

branches of the recurvation at the bottom. The boiler was provided with a stopcock *b*, by which the air was extracted from the boiler pτevious to experiment, by means of an air-pump TV, communicating with W ; and when this was accomplished so as to obtain a vacuum on both ends of the mercurial column, the mercury stood, as in the figure, on nearly the same level in both its branches. The fire was instantly applied, and the crackling noise which followed informed him that the ebullition had commenced, and the steam in the boiler pressing on that end of the mercurial column nearest to it, raised the other in the vacuum a certain quantity above its outer level, indicating its elastic force, which gradually increased until it became at the usual heat of boiling water, equal to twenty eight French inches, the mean pressure of the atmosphere. The following table will enable us to estimate the value of these experiments ; it is given in degrees of Reaumur’s thermometer, of which 0° coincides with 32° of our common scale, and 80° with our boiling point 212° Fahren heit, each degree of Reaumur being equal to 21/4 of our scale. The pressure is in French inches of mercury :—

|  |  |  |  |
| --- | --- | --- | --- |
| Degrees of Fahrenheit. | Reaumur's Scale. | First Series of Observations. | Second Scries of Observations |
| 32° | 0° | Inches of Mercury. 0∙0 | Inches of Mercury 0∙0 |
| 43∙25 | 5 | 0∙05 | 0∙02 |
| 54∙50 | 10 | 0∙17 | 0∙15 |
| 65∙75 | 15 | 035 | 0∙35 |
| 7700 | 20 | 0∙62 | 0∙65 |
| 88∙25 | 25 | 1∙00 | 1∙05 |
| 99∙50 | 30 | 1∙50 | 1∙52 |
| 110∙75 | 35 | 2∙12 | 2∙15 |
| 12200 | 40 | 290 | 292 |
| 13325 | 45 | 4∙00 | 3∙95 |
| 144∙50 | 50 | 5∙50 | 5∙35 |
| 155∙75 | 55 | 7∙55 | 7∙32 |
| 16700 | 60 | 10∙10 | 9∙95 |
| 178∙25 | 65 | 13∙25 | 13∙20 |
| 189∙50 | 70 | 17∙50 | 16∙90 |
| 200∙75 | 75 | 22∙35 | 21∙75 |
| 21200 | 80 | 2860 | 2800 |
| 22325 | 85 | 3700 | 36∙45 |
| 234∙50 | 90 | 47∙20 | 46∙40 |
| 24575 | 95 | 58∙20 | 57∙80 |
| 25700 | 100 | 7240 | 7180 |
| 268∙25 | 105 | 84∙90 | 86∙80 |
| 279∙50 | 110 | 9800 | 9800 |

The slight deviation of these experiments from each other indicates considerable accuracy of experiment ; and the slight excess in the former of the two series is attributed to the formation of a less perfect vacuum at the commencement of the observations, arising from the smaller quantity of water in the boiler when the experiments were made.

It should, however, he noticed, that there is one omis sion of some importance in the experiments of M. Betan court. He inserts the *bare bulb* of his thermometer into the reservoir among the water, so as to suffer all the variations imposed on it by the varying elasticity of the steam. By following the method adopted by his predecessor, M. Ziegler, of inserting a metallic tube to sustain the pressure of the steam, and forming it into a mercurial bath for containing the thermometer, and so transmitting the heat of the steam to it without exposure to variable pressure, a source of considerable error might have been avoided. This precaution is essential to a good set of experiments on steam ; for a very slight pressure, even of the finger, on the bulb of a thermometer will raise it several degrees.

25. Of British philosophers, Dr Robison was one of the first to make accurate and systematic experiments on the