ing with the boiler, is a second tube (*c*) of the same height, but large enough to have a space of an inch or more clear between the two, at the bottom of this outer tube is a small pipe for the escape of the steam; it may be three-quarters of an inch in diameter at the orifice. Lastly, a cap tube (*d*) closed at top, is made to fit the exterior tube, and slide upon it tightly enough to stand at any height at which it may be set. In the centre of the top of this latter tube is made an orifice large enough to receive a common quart bottle cork, and a short neck soldered on to hold it firmly. The boiler then being half or two-thirds filled with hot rain or snow water, the thermometer is passed through a cork, and slipped down through the orifice just mentioned, until the ball nearly, but not quite, dips in the water, the exterior tin tube being at the same time drawn out so that no more of the tube of the thermometer is above the cork than is absolutely necessary. The apparatus is then set over a braizer's furnace or something of the same nature, until the water boils briskly and the steam by degrees expels the whole of the air, and escapes freely by the pipe left for the purpose. If the size of this escape pipe is properly proportioned, which does not appear to be a matter of much nicety, the vessel will now be filled with steam of an elasticity precisely represented by the Barometric pressure at the moment; and the mercury in the thermometer, rising just above the cork, will stand at the boiling point. It is desirable to ascertain whether the escape tube is rightly proportioned by partially stopping it; if two or three such alterations of its size have no visible effect upon the reading of the thermometer, we may be satisfied. In finished instruments a mercurial syphon guage is attached.

The following table, calculated by M. Regneault, contains the true temperature of steam, of elasticity corresponding to the barometric pressures annexed; in other words, the temperature which should be indicated by a thermometer plunged in the steam of such a vessel as is described above, when the elasticity of such steam, (measured by the exterior Barometer) is equal to the pressure stated. The English equivalents of the French measures are given for convenience.

TEMPER'TURE.		PRESSURE.		Diff.	TEMPER'TURE.		PRESSURE.		Diff.
Cent.	Fahr.	Millim	Inches.	Inch.	Cent.	Fahr.	Millim	Inches.	Inch.
°	°				°	°			
99.0	210.20	733.21	28.8671		100.0	212.00	760.00	29.9218	
99.1	210.38	735.85	28.9710	.10 9	100.1	212.18	762.73	30.0293	.1075
99.2	210.56	738.50	29.0753	.104	100.2	212.36	765.46	30.1367	.1074
99.3	210.74	741.16	29.1798	.104	100.3	212.54	768.20	30.2447	.1080
99.4	210.92	743.83	29.2846	.104	100.4	212.72	770.95	30.3529	.1082
99.5	211.10	746.50	29.3903	.105	100.5	212.90	773.71	30.4615	.1037
99.6	211.28	749.18	29.4956	.106	100.6	213.08	776.48	30.5705	.1090
99.7	211.46	751.87	29.6017	.106	100.7	213.26	779.26	30.6800	.1095
99.8	211.64	754.57	29.7080	.106	100.8	213.44	782.04	30.7894	.1094
99.9	211.82	757.28	29.8147	.106	100.9	213.62	784.83	30.8994	.1100
100.0	212.00	760.00	29.9218	.107	101.0	213.80	787.63	31.1096	.1102

Suppose then that the mean of several readings of the thermometer over the boiling water is 211 ° .50; the Barometer, reduced to 32 °, giving a pressure of 29.826 at the time. The temperature of steam, of elasticity equal to 29.826, we see by the above table, falls between 211 ° .82 and 212 ° .00: it will be precisely 211 ° .84, which is, therefore, the true temperature, and the thermometers reads 0 ° .34 too low: this is not, however, the true *boiling point*, the pressure being less than the standard pressure; the reduction is—

$$0.18 + \tfrac{99}{150} = 1.16$$

The true boiling point upon this thermometer, is, therefore, 211 ° .66 instead of 212 °, showing, as before, an error of graduation of —0 ° .34. As one-tenth of a degree is a very sensible quantity in the scale of these thermometers, and the perfect fixity of the mercury in the steam, as long as the pressure remains the same, enables an observation to be made with great precision: the above apparatus can be employed for determining differences of level, upon occasion—allowing 511 feet for the first degree, 513 feet for the second, 515 feet for the third—from 212 ° downwards: but the observer must be careful in this climate to choose very settled weather for the purpose, or a change of the Barometer may introduce an error larger than the quantity to be measured.

The freezing and the boiling points of the standard thermometer should be verified occasionally, and all other thermometers carefully compared with it, at several points on the scale. So little have even the best instruments of the best makers, heretofore justified in all cases, their title, or their cost, that instances have been recently adduced of the Standard Thermometers of more than one Observatory, being a degree or two in error at the extremes of their scales. That of Toronto was found to be 1 ° .8 too high at —10 °, that of Makerstoun to be 0 ° .97 too high at 90 °, it cannot be therefore too strongly insisted on at the outset of Meteorological Observations, that the accuracy of the instrument demands the first care.

II. *Position of Thermometers.*—The object of the register being to obtain the true temperature of the air of the locality; the thermometer must be guarded, first, from influences which affect the instrument more than they affect the air; its power of radiation and absorption being greater; secondly, from causes which make the air in which it is immersed, an unsuitable example of the temperature of the neighbourhood. As when, for example, it is placed in a narrow court yard, with buildings sometimes reflecting heat, sometimes evaporating moisture, all round it. It should be placed on the north side of a building to avoid reflected heat; but where there is a free circulation of air, otherwise such a situation is apt to be damper, and therefore colder than is natural: at the same time it should itself be secured from wind. It should be detached six inches *at least*, from the wall or other support, and fixed, not hung, upon a bracket. The almost universal practice of English observers is to place the bulb at four feet above the ground. The official instructions to the observers in Prussia, (Regent's Reports, 1850,) direct, however, the height to be not less than twelve or fifteen feet,—a first floor window is therefore not inadmissible, and has indeed been selected in several instances, where local circumstances made it convenient, by the able superintendent of the State Meteorological Observations of New York and Massachusetts, Professor Guyot. The decrease of mean temperature, as we ascend, being only one degree for 280 feet or thereabouts, a difference of ten or twelve feet would be entirely insignificant, were it not that the air within a few feet of the ground is warmed by day and cooled by night, by causes which vary sensibly within that range. Thus a thermometer fully exposed to the sky, at *one* foot above long grass, was found by Mr. Glaisher in his elaborate experiments on radiation, (Phil. trans. 1847,) to read at night 1 ° .68 *lower* than it would have done, but for the abstraction of heat, by the grass, from the air in contact with it, to compensate for its own loss of heat by radiation into space.

At two feet, it read 1.32 lower,
four " " 1.18 lower,
six " " 1.03 lower,
eight " " 0.73 lower,

than the standard, and he was led to the important conclusion, that "if a thermometer be freely suspended in the air with its bulb at the height of thirteen feet above the soil, and far from any object to reflect heat to it, its readings will represent the true temperature of the air at the time, and much more truly than those of any one placed near the ground, or within a few feet of walls or buildings." The thermometer in this situation is not supposed to be protected from the sun or from rain. It has also