the smallest resistance coil. It is usual also to adjust the resistances of the thermometers so that their fundamental intervals are con­venient multiples of this unit, generally either 100, 200, 500, or 1000, so that the bridge-wire may read directly in degrees of tem­perature on the platinum scale. It is easy to get a scale of 10 cms. or more to the degree, and it is not difficult with a suitable galvano­meter to read to the ten-thousandth part of a degree. The length of the bridge-wire itself need not be more than 20 or 30 cms., as the balancing resistances enable the scale to be indefinitely ex­tended. Thus the instrument possesses the great advantage over the mercury thermometer that the most open scale may be easily secured without unwieldy length, and without restricting the range of each thermometer.

26. *Errors and Corrections.—*It is most instructive to consider the errors and corrections involved in platinum thermometry on the same lines as those on which the corresponding errors of the mercury thermometer have already been treated.

I. The changes of zero of the mercury thermometer arise chiefly from the small expansibility of mercury combined with the im­perfect elasticity of the containing tube. In platinum thermo­metry the containing tube has nothing to do with the reading, and the effect of any possible strain of the fine wire of the coil is minimized by its small dimensions and by. the large temperature­coefficient of the increase of resistance, which is more than twenty times greater than the coefficient of apparent expansion of mercury in glass. It is not surprising, therefore, that the changes of zero of a platinum thermometer should be practically negligible, pro­vided that the wire is not strained and contaminated with impurities. It is probable that with ordinary care the changes of zero due to exposure to any given limits of temperature are in all cases less than the limit of accuracy of observation, due to other causes at the extreme limit of the range considered.

II. *The fundamental interval* of each thermometer must be determined as usual by observations in ice and steam, and a correc­tion must be applied by the method already described in the case of the mercury thermometer. The difference of the temperature of the steam from 100° C. should be determined on the platinum scale by the approximate formula

*dpt1*=∙985*dt*1=∙0362(H-760)-∙000020(H-760)2 (26)

III. *Pressure Correction.—*The effect of change of pressure on a platinum thermometer of the ordinary tube form is of course nothing, as the wire itself is not exposed to the pressure. Even if the wire is naked and directly exposed to large changes of pressure, the change of reading is almost inappreciable. Similarly there is no source of error analogous to the effects of capillarity, which are so troublesome with delicate mercury thermometers.

IV. *Stem 'Exposure.—*The reading of a platinum thermometer with compensated leads depends only on the temperature of the coil of wire forming the bulb, and not on the temperature of the stem, provided that the immersion is sufficient to avoid errors due to conduction or convection along the stem. It is desirable that the top of the bulb should be immersed to a depth equal to from three to ten times the diameter of the tube, according to the accu­racy required.

V. *Scale Correction.—*The reduction to the thermodynamical scale may be effected, within the limits of probable error of the most accurate measurements at present available, by the very simple difference formula (25) already given, over the whole range from -100° C. to +1100° C. This is in striking contrast with the mercury thermometer, Which requires a cubic formula to cover the range 0° to 200° C. with equal accuracy. The value of the constant *d* in the formula varies but little, provided that the wire be fairly pure and the thermometers properly constructed. In order to determine its value in any special case, it is best to take an observation at the boiling-point of sulphur (S.B.P.) for tempera­tures above 0° C., or at that of oxygen for temperatures below 0° C. down to -200° C. It appears probable that there is a point of inflection in the curve of resistance-variation of platinum and some other metals in the neighbourhood of -200° C., and that the formula does not apply accurately below this point. It has become the custom to assume the boiling-point of sulphur (S.B.P.) under normal pressure to be 444-53° C., as determined by Callendar and Griffiths, using a constant-pressure air thermometer, and to take the rate of change of temperature with pressure as ·082° per mm. from Regnault’s observations.. According to experiments made at Kew Observatory with platinum thermometers (Chree, *Proc. R.* S., 1900), the rate of change is somewhat larger than that given by Regnault’s formula, namely, about ·090° per mm., and it appears desirable to determine this constant with greater accu­racy. The difference between the above formulae reaches a tenth of a degree if the barometer differs by 12 mm. from 760 mm. The uncertainty in the absolute boiling-point of sulphur, however, is probably somewhat greater than one-tenth of a degree, on account of the uncertainty of the expansion correction of the gas thermometer *(Phil. Mag.,* December 1899). The thermodynamical correction of the gas thermometer, which amounts to half a degree at this point, is also to some extent uncertain, on account of the extrapolation. Provided, however, that some exact value of the S.B.P. is chosen for reference, for the reduction of observations with platinum thermometers, the results so reduced will be strictly comparable, and can be corrected at any subsequent time when the value of the S.B.P. is more accurately determined. The boiling-point of oxygen, may be taken as -182∙5° C. with sufficient approximation for a similar purpose.

VI. *Calibration Correction.—*The calibration of the resistance box and the bridge-wire corresponds to the calibration of the stem of the mercury thermometer, but the process is much simpler for several reasons. It is more easy to obtain a uniform wire than a uniform tube. The scale of the wire is much more open, it corre­sponds to a very small part of the whole scale, and the process of calibration is easier. One box when calibrated will serve for any number of thermometers of different ranges and scales, and covers the whole range of temperature (see Calibration).

27. *Electrical Precautions.—*The platinum thermometer is so far superior to the mercury thermometer in all the points above enumerated that, if there were no other difficulties, no one would ever use a mercury thermometer for work of precision. . In using a platinum thermometer, however, some electrical training is essen­tial to obtain the best results. The manipulation and adjustment of a delicate galvanometer present formidable difficulties to the non-electrical observer. Bad contacts, faulty connexions, and defective insulation, are not likely to trouble the practised elec­trician, but present endless possibilities of error to the tyro. A useful discussion of these and similar details is given in the paper by Chree already referred to. Bad insulation of the pyrometer and connexions can. easily be detected, in the compensated instru­ment already described, by disconnecting one of the C leads from the battery and one of the *P* leads from the bridge-wire. Under these conditions the galvanometer should not deflect if the insula­tion is perfect. Defective insulation is most likely to be due to damp in the thermometer at low temperatures. This source of error is best removed by drying and hermetically sealing the ther­mometers. Trouble from bad contacts generally arises from the use of plugs for the resistance coils. If plugs are used, they must be specially designed so as not to disturb each other, and must be well fitted and kept very clean. Mercury cups with large copper terminals, well amalgamated, as used with standard resistance coils, are probably the simplest and most satisfactory method of changing connexions. Accidental thermoelectric effects in the circuit are a possible source of error, as with the thermocouple, but they are always very small if the thermometer is properly con­structed, and are relatively unimportant owing to the large E.M.F. available. In any case they may be completely eliminated by reversing the battery. The heating effect of the current through the thermometer is often negligible, but should be measured and allowed for in accurate work. With a current of ·01 ampere the rise of temperature should not ex­ceed 1/100 or 2/100 of a degree. With a delicate galvanometer it is possible to read to the ten- thousandth of. a degree with a current of only ·002 ampere, in which case the heating effect is generally less than 1/1000 of a degree. It can be very easily measured in any case by changing from one cell to two, thus doubling the current in the thermometer, and quadrupling the heating effect. The correction is then applied by subtracting one- third of the difference between the readings with one and two cells from the reading with one cell. The correction is always very small, if a reasonably sensitive galvanometer is. used, and is frequently negligible, especially in differential work, which is one of the most fruitful applications of the platinum thermometer.

28. *Construction of Thermometers.—*One of the chief advantages of the platinum thermometer for research work is the endless variety of forms in which it may be made, to suit the particular exigencies of each individual experiment. It is peculiarly suited for observing the average tem­perature throughout a length or space, which is so. often required in physical experiments. For this purpose the wire may be disposed in a straight length, or in a spiral, along the space in question. Again, in observing the temperature of a gas, the naked wire, on account of its small mass and extremely low radiative power, is far superior to any mercury thermometer. The commonest form of platinum thermometer (fig. 7), and the most suitable for general purposes, contains a. coil B from ½ in. to 2 in. long, wound on a cross of thin mica, and enclosed in a tube, about ¼ to ½ in. in diameter, of glass or porcelain according to the temperature for which it is required. The pyro­meter leads and the compensator leads are insulated and kept in place by passing through mica disks fitting the tube, which serve also to prevent convection currents up and down the tube. The protecting tube of glass or porcelain is fitted with a wooden head A carrying four insulated terminals, PP, CC, to which the pyrometer