(No Model.)

H. L. CALLENDAR.

TELETHERMOMETER.

No. 462,371. Patented Nov. 3, 1891.

Fig. 2.

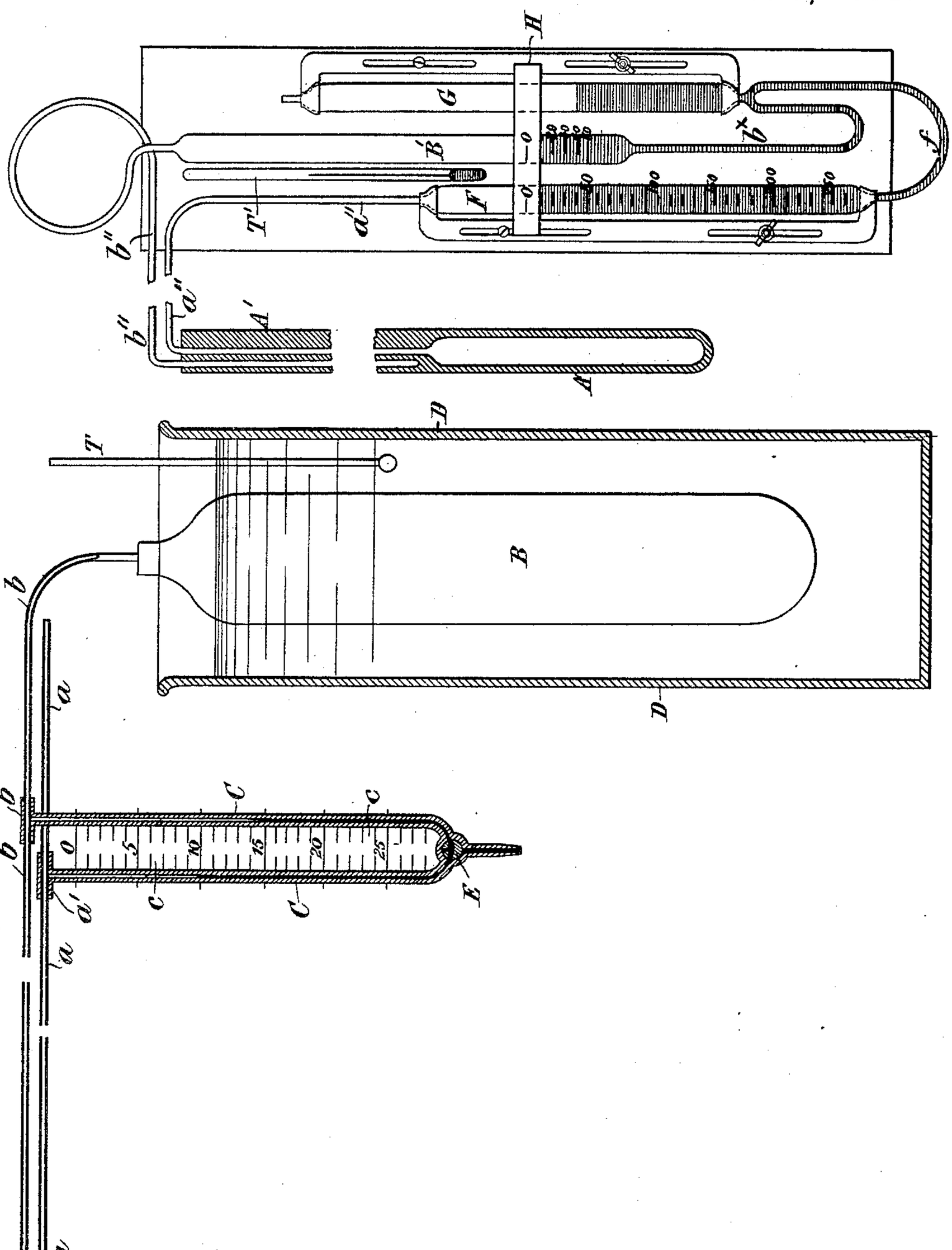

Fig. 1.

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TELETHERMOMETER.

SPECIFICATION forming part of Letters Patent No. 462,371, dated November 3, 1891.

Application filed June 20, 1891. Serial No. 396,960. (No model.)

To all whom it may concern:

Be it known that I, HUGH LONGBOURNE CALLENDAR, Fellow of Trinity College, Cambridge, a subject of the Queen of Great Britain, residing at 2 Princes Mansions, Victoria Street, in the city of Westminster, London, England, have invented certain new and useful Thermometers, of which the following is a specification.

This invention relates to a method of compensating thermometers to render the readings independent of the temperature of the tubes connecting the bulbs to the indicating apparatus. The connecting tubes may therefore be of a considerable length—say one hundred feet or more.

Figure 1 is a sectional elevation of the apparatus in its simplest form. Fig. 2 shows a modification peculiarly adapted for high temperatures.

A is the bulb containing dry air which is exposed to the temperature it is desired to measure. This bulb is connected to one end of a tube *a*, whose other end is closed, but near this end the tube is connected at *a'* to one leg of a pressure-gage.

B is a second bulb, and containing a mass of air equal to that in the bulb A. It is connected to one end of a tube *b*, whose other end is closed. The tube *b* is of the same size as the tube *a* and lies parallel and close to it so that the two are always at the same temperature. It is connected at *b'* to the other leg of the pressure-gage C. The bulb B is preferably placed in a vessel D containing liquid which can either be kept at a fixed temperature or whose temperature can be read by an ordinary thermometer T in it. The pressure-gage C consists of a bent tube containing liquid, such as sulphuric acid, and is provided with a scale *c* for reading the height of the sulphuric acid in one or other of the legs which is preferably graduated in degrees of temperature. It is convenient to make the scale movable in a groove, so that by setting the observed temperature of the bulb B opposite the level of the acid on the side *b'* the level of the acid on the other side will indicate the temperature of the bulb A; or the temperature of the bulb B may be set to a fixed mark midway between the levels of the acid in the two tubes, in which case only one limb of the gage need be exposed. Preferably this would be the limb connected to the bulb B, so that a rise in temperature of the bulb A may make the acid rise in the exposed limb.

The pressure-gage C is provided at the bottom with a three-way cock E, which serves for filling the bulbs and tubes with dry air at a suitable pressure and for introducing the requisite amount of sulphuric acid.

In cases where it is convenient to keep the bulb B at nearly the same temperature as the bulb A, as—for instance, in reading the temperature of a fermenting-vat or of a greenhouse at a distance—the bulbs are made of the same size, and the gage is adjusted so that both limbs read the same when the bulbs are at the same temperature.

For a thermometer to be used for indicating the temperature of the grain in a malt-kiln, the gage must have a range from 50° to 150° centigrade. In this case it is convenient to use a pressure-gage with somewhat wider tubes and filled with mercury. The bulb B may be kept at nearly the temperature of the air and its temperature observed as before; but in order that the compensation may be perfect when the bulb A is at a temperature of 100° centigrade the pressures must be equal at this temperature. Since the bulbs must contain the same mass of air, the volume of the bulb A must be made greater than that of the bulb B in the proportion of about three hundred and seventy-three to two hundred and ninety-three if the bulb B is kept at a temperature of about 20° centigrade. The compensation will then be sufficiently perfect for the purpose throughout the whole range of the instrument, provided that the volume of the bulb B be not less than five times that of the connecting-tubes. In this case the size of the degrees on either side of the sliding scale will be different, being directly proportional to the density of the air in the two bulbs. The degrees on the side of the gage corresponding with the bulb B will be to those on the other side in the proportion of three hundred and seventy-three to two hundred and ninety-three in the case above considered. The graduation 20° on the one scale will be opposite to the graduation 100° on the other scale. If the temperature of the bulb B dif-

fers from 20°, the adjustment is effected by sliding the scale as before. When the observed temperature of the bulb B is set opposite the level of the mercury on the side of the gage corresponding to the bulb B the reading on the other side will correctly indicate the temperature of the bulb A. The same method may be applied to the construction of a pyrometer for measuring any temperature, provided that the range to be covered is small. It is only necessary to proportion the bulbs A and B suitably; but for high temperatures, and for pyrometers which are required to work over a large range, it is preferable to arrange the pressure-gage as shown in Fig. 2, so that the pressures in the two bulbs A and B may be kept nearly equal.

Fig. 2 represents a form of pyrometer specially adapted for measuring high temperatures. In this arrangement the bulb A′ and its stem are preferably made of glazed porcelain. The stem may be of any convenient length, and is bored not only for the tube *a*, but also, as shown in the figure, to form the closed end of the tube *b″*. The tubes *a″* and *b″* communicate, as before, with the two bulbs F and B′ of the pressure-gage. The bulbs of the pressure-gage are made of wide bore and contain mercury. The upper part of the bulb B′, which is fixed, represents the bulb B of the former arrangement. The other bulb F of the pressure-gage is graduated in parts of equal volume and is capable of sliding up and down, so that its level can be adjusted till the pressures in the bulbs B′ and F are equal. The lower ends of the bulbs B′ and F communicate through flexible tubes $b^{\times}$ and *f* with a third bulb G, containing mercury and capable of sliding up and down, the upper end of which is open to the air. A horizontal straight-edge H is provided for showing when the level of the mercury is the same in both limbs of the pressure-gage.

In using the instrument the bulb A′ is exposed to the temperature to be measured, and the bulbs F and G are adjusted till the level of the mercury in both bulbs B′ and F coincide with the edge H. The reading of the bulb F gives the temperature by reference to a table supplied with the instrument.

In this form of instrument the compensation is always perfect, because the pressures in the bulbs A′ and B′ are adjusted to equality. It is therefore accurate over the whole range of temperature, provided that the bulb B′ contains the same mass of air as the bulb A′ and the bulb F together.

For accurate work a small correction has to be applied, according to the temperature of the air. This is shown by an attached thermometer T′, and the corresponding correction is given in the table supplied with the instrument.

It may be necessary to reset the instrument from time to time.

In resetting the instrument the bulb A′ is brought to the same temperature as the bulbs B′ and F. The bulb F is set at zero and the bulbs are filled with dry air at the same pressure. This is done by allowing the bulbs B′ and F to communicate with the air through a drying-tube (not shown in the drawings) and adjusting the level of the mercury in the bulbs B′, F, and G up to the level H.

I would state that I am aware that it has been proposed to ascertain the temperature of the tube connecting the bulb of a thermometer to the index by providing a second tube parallel and in close proximity to it and connecting this second tube to a pressure-gage; but in this arrangement the thermometer-tube was not connected to this pressure-gage and the compensator-tube was not connected to a bulb containing an equal mass of air to that in the bulb of the thermometer, so that the compensation could not be made automatic.

I wish it to be understood that I do not claim the use of the compensator-tube, but the arrangement whereby the compensation is rendered automatic.

What I claim is—

1. A thermometer having two tubes in close proximity throughout their lengths connected to separate bulbs and communicating with different ends of the same pressure-gage.

2. In a thermometer, the combination of two tubes in close proximity throughout their lengths, separate bulbs to which the tubes are connected, a pressure-gage, with different ends of which the tubes communicate, the upper part of one limb thereof forming one of the bulbs, whereas the limb connected to the other bulb is movable up and down in order that the volume of air it contains may be adjusted.

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