Campbell 2ed
(1-18)

See Report on
Warming and Ventilation
ordered by the House of Commons
to be printed 25 Aug 1851.

See the Registers kept at
No 8 Richmond Terrace to
this date March 1866.

See Frost & Fire Vol II 480
Edmonston & Douglas Ed 1865.

July 4. 1873 The Meteorological
department 18 Victoria Street
have got all the books kept at
the Board of Health to this date
and have taken up the
subject. Their first act
was to burn holes in one
of the books. JFC

7 May 1877. a paper sent to Good words

June 14. 1977. 5. Now placed at the Observatory Greenwich. See

[*From the* REPORT OF THE METEOROLOGICAL SOCIETY *for* 1857.]

Registrar General's report for 1876

Thermography Sept 22. 1883

ON A

NEW SELF-REGISTERING SUN-DIAL,

BY J. F. CAMPBELL, ESQ.

"General Board of Health, April 3rd, 1857.

"SIR,—According to your wish I send you the accompanying paper for presentation to the Meteorological Society.

"During a set of observations for the month of March, taken at Campden Hill, the sun shone with sufficient power to mark blackened India-rubber for 80 hours 5 minutes.

"The sun was above the horizon for 744 hours, and was therefore obscured 292. On some days, when the black bulb thermometer showed considerable radiant power, the dial was hardly marked; on other days, when the radiant power was less, the burning power was greater and more continued.

"The greater part of the sunshine shown on the instrument by the stronger markings was after noon, when the sun gets well out of the smoke. The bowl, at the Board of Health, which is always in the smoke, was not nearly so much marked as the one at Campden Hill.

"One further from London would probably have been marked to a much greater extent, and for much longer periods. On some days, when the sun was barely visible through a yellow fog in London, and when the dial was unmarked, the sun shone brilliantly a few miles from town.

"In taking these observations I have marked the yellow fogs with a similar colour.

"I also send three specimens of observations taken by fixing ribbon along the bowl in the sun's track; the first is for one day only, the 10th, the last two are for five days, and were placed one

over the other; an observer could by this plan take duplicate observations.

"The objection to the ribbon plan is the difficulty of fixing the material firmly and accurately in its place.

"It was the first plan tried, and but for the trouble it is the best for taking daily observations. Of course the ribbon must be fixed with something which will not melt in water and wash off on rainy days, and must be changed after sunset; India-rubber solution answers very well, but there are many other substances, such as coal-tar, which would do as well or better.

"These observations for March 1857, and the bowl exposed during the last cholera epidemics, together with the description of the instrument, will it is hoped serve to explain the use and the construction of the Registering Sun-dial.

"I am, Sir,

"Your obedient Servant,

"J. F. Campbell."

"*James Glaisher, Esq.*,
"*Secretary to the Meteorological Society.*"

Directions for constructing and setting a Registering Sun-dial.—The instrument is intended to show the periods at which the sun shines at the place where it stands during a whole day, or less clearly, during half a year. It may be read once a day at any fixed hour, as other meteorological instruments, say at 9 A.M.

It consists of—

1st. A spherical glass bottle with a short neck.

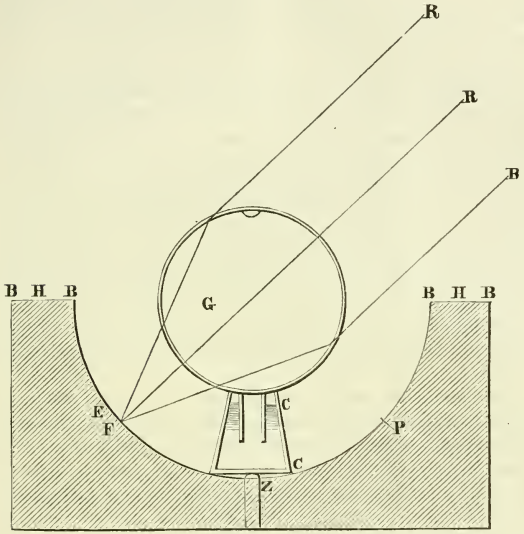
2nd. A stand.

3rd. A hemispherical bowl.

First, the Glass Globe.—This may be procured from any glass-blower at the cost of a few shillings. It is to be filled completely with some transparent fluid; if filled with water and a little acid, it will keep clear for a long period. It forms when filled with water a spherical lens, whose focal distance for parallel rays is about its own radius: a globe of 6 inches diameter, so filled, has a focal distance of 3. When quite full, either invert the bottle under water so as to prevent the entrance of air, or place a finger on the mouth of the bottle and insert the neck, mouth downwards, in the stand.

Secondly, the Stand.—This may be a small tumbler full of the same liquid as the globe. It should be narrow above, so as not to cut off the rays of light, and wider below so as to be steady. Its

height must be such, that, when placed in the bowl, the centre of the glass globe may coincide with the centre of the hemispherical bowl: in the case supposed its height must be 3 inches.



Scale 0·2 = 1 inch.

G. Glass globe; diameter 6 inches. Filled with water and a little acid.
B. Bowl of wood or stone or other material; diameter 12 inches.
C. Glass filled with water, in which the neck of the globe G is to be placed.
C C. Height of glass stand 3 inches.
R. Parallel Rays.
F. Focus.
P. Pole.
Z. Zenith.
H. Horizon.
E. Equator.

Thirdly, the Bowl.—This must be hemispherical, of a diameter of 12 inches for a water-lens of 6 inches, or of a diameter to be ascertained as described below, if the lens be filled with any other fluid.

The bowl may be made of various materials, but white stone appears to be the best: wood has been tried and answers well.

The Globe.—The stand and the bowl having been procured, and

the focal distance ascertained, the next step is to place the instrument *as a fixture*. Select a spot from which the largest extent of sky can be seen, place the bowl on a pillar or some firm base filled with water; when quite full, the horizon of the bowl is parallel to the horizon of the spot where it stands: when so placed, fix it as firmly as possible.

When fixed, take out the water and drop in a little mercury or other fluid, or a marble, and it will rest at the bottom of the bowl, which in the instrument is the zenith-point; mark the spot where the mercury rests; describe with a pair of carpenter's compasses a circle as large as the bottom of the stand, and place the stand in the circle with the globe upon it. The instrument is now set; and if a small bubble of air be left in the globe, it will be directly above the mercury. A perpendicular line drawn from it to the mercury will cut the common centre of the glass globe and of the bowl, and if produced so far, would touch that of the earth. If the diameter of the globe be 6 inches and that of the bowl 12, and if their surfaces be true, every part of the surface of the bowl will be 3 inches from the surface of the globe, and the instrument is ready for use.

Now, as the focal distance for parallel rays of a globe of 6 inches diameter filled with water, has been found to be about 3 inches, it follows that a reversed image of the sky will revolve round it at that distance, as the sky itself seems to revolve; and an image of the sun will seem to revolve on the surface of the bowl, opposite the sun itself, whenever the sun is visible, and will burn as it goes.

The glass is in fact a burning glass of considerable power, and the sun will burn a line as clearly as if drawn by a pencil on a surface of wood, or on one of stone covered with black oil-paint or black varnish, or other similar materials.

It is manifest that if a cloud obscures the sun at any period of the day, the line will be interrupted; and when the atmosphere is thick, the sun, even when visible, may have little or no burning power.

Photographic surfaces would probably be marked by the rays of the moon, and perhaps by those of the stars, so as to make the instrument register at night; but that experiment has not yet been tried.

To divide the instrument.—Wait for a sunny day: the sun, by burning the paint or varnish, will mark a line of the bowl from west to east, as he travels from east to west nearly parallel to the equator, and if the sky be clear, nearly touching the horizon at

both sides. When a line is so marked, remove the lens and stand from the bowl. From the points where the line drawn by the sun would touch the horizon of the instrument (that is, from points opposite to those where the sun actually rose and set on the horizon of the place), find two points which divide the horizon or edge of the bowl into equal parts, and are equidistant from the points of sunrise and sunset; they are due east and west. Take one-fourth of the circle formed by the edge of the bowl in the compasses, and from either the eastern or western point describe the meridian at right angles to the sun's course, as marked by the lens, touching the edge of the bowl at north and south, and passing through the pole and the zenith-points. From the bottom of the bowl (the zenith), previously found with a globule of mercury or with some other fluid, or a marble, measure on the meridian a number of degrees equal to the latitude of the place (if known), or (if not) known, observe the sun's position on the meridian at the equinox. Take one-fourth of the circle as before, and from the point last found on the meridian, that is where the meridian of the place and the equator of the instrument cross each other, describe the line of 6 o'clock. It will pass through the eastern and western points on the horizon, and will cross the meridian at the pole of the instrument. From the pole so found, at one-fourth of the circle as before, describe the equator; which, for such an instrument, may be drawn parallel to the sun's course, and which is parallel to it at the solstices. Divide the space between the eastern and western points along the equator into twelve equal parts; and from the points so found, describe with the compasses the meridian lines as on a globe. If carefully done, the divisions will give solar time with tolerable accuracy. The Almanac will give the corrections for mean time.

Now bore a hole for the escape of rain-water, replace the lens, and the instrument is ready for use.

To read and register the instrument daily.—Divide a sheet of paper vertically into a number of divisions equal to the number of hours in the longest day in a month, and divide it by horizontal lines into as many divisions as there are days in the month. At the hour most convenient read off the marks made by the sun since last observations; mark them on the paper at the corresponding times, and paint out the marks made on the bowl. If none be made, darken all the space answering to a day on the paper. If the line marked on the bowl be an interrupted one, darken the spaces answering to the times when the sun was obscured or did *not* mark

the bowl. The white spaces will indicate the duration of sunlight.

To read the instrument once every half-year.—Make the bowl of hard wood, or cover the inside of a stone one with some substance which will not wash off, and which will melt at a strong heat, such as pitch, or black paint or varnish, or India-rubber solution blackened; bore a hole to let out rain-water, place the bowl level as above described and the lens in it, and leave it till next solstice. At the longest or shortest day a new wooden bowl or fresh coat of paint on one of stone will be required.

It will be useless to divide an instrument to be read twice a year till it has done its work. If the bowl be set level it will prove its own latitude, and mark lines enough for finding meridian, equator, and hour-circles at leisure; but the line marked by the sun on one day, will partially overlap that marked on the previous day, and in so far the instrument left to itself for six months will only give a rough estimate. Still, if the smoke of a town permanently obscures the horizon on one side, if there be any season more or less cloudy than another, or any period of the day, or year, at which the sun has more power than at others, a very fair estimate may be formed from the depth and position marked or burned on a hard wood bowl exposed from solstice to solstice.

There are many variations which may be made in this instrument. By making the bowl of ground-glass and setting it in a roof, a picture of the sky may be seen at any time of the day or night. The position of stars and the movements of clouds can be ascertained.

By making the bowl of a light material moved by a magnet, it might even be made to act at sea.

By filling the glass globe with different fluids, the focal distance may be varied. Salt and other substances added to water, will shorten the focal distance if the bowl be made too small for the globe.

If any liquid would bring the rays to a focus on the surface of the globe, the bowl would be unnecessary; but I am aware of no such liquid.

If spherical glass lenses could be made they would be better than liquid lenses; but so far as I can learn, spherical glass lenses have never been made, and they would probably be costly.*

* Since this paper was written, a spherical glass lens has been cast by a manufacturer at Manchester; the diameter is three inches, and the cost three shillings It appears to answer the purpose for which it was made.

The difficulty of making them does not appear insurmountable. Two planes revolving in opposite directions would grind a glass ball, which might be polished afterwards. Spheres are turned of other materials, and glass marbles nearly spherical are common; but till glass lenses are made, acidulated water-lenses will answer the purpose in summer or when it does not freeze. The water must be acidulated to prevent the growth of microscopical plants and animals, which, without it, soon convert a water-lens into a vivarium.

Canada balsam is perhaps the best fluid for liquid lenses, because it is not much altered by exposure to light, and to alternations of temperature; bought from wholesale dealers it is not very expensive. A globe filled with Canada balsam has been in use for some years at the Board of Health, and has registered on wooden bowls the small amount of sunshine which has visited London. When first put up, pieces of ribbon were fastened in the bowl; but from the difficulty of getting to the top of the house where the instrument is now placed, the daily reading was abandoned. One fact ascertained by observation is, that the smoke of London to the east takes a considerable amount of sunshine from the mornings.

The focus of a globe filled with any fluid may be found experimentally by placing it in the sun: a wafer on one point of a pair of compasses will burn at the focus, when the other leg is in contact with the glass.

The instrument is submitted to the Society in the hope that they may deem it worthy of their attention. The inventor will be glad to give any further information that may be required to enable others to construct and set up instruments as he has himself done; but if the contrivance be thought sufficiently important, some maker of instruments will probably construct accurately and of good materials, an instrument which will work better than a home-made production.

If it were in general use, the sunny and cloudy regions of the world might be laid down with greater accuracy, and deductions might perhaps be drawn from direct observations bearing on questions of general science foreign to this description of an instrument.

In 1875. Roscoe and Other tested the results got at the Board of Health and found a distinct connexion

between the sun's regularly varying
power, and sun spot periods
which recur periodically. -
The same result is got in 1879
from a reduction of Greenwich registers
of temperature to means. —
In the same year Jevons tried
to shew that periods of Commercial
prosperity and distress depend
upon the extra heat of sun spot
periods, which cause good
crops, and much commerce
which causes excess of production
in manufacturing regions, &
distress afterwards. People
ridiculed Jevons but that
Statistical authority may be
right. J.T.

Lent to the Editor
of Good Words May 7 79
To be returned to
J. F. Campbell.
Niddry Lodge
Kensington
London W

Sept 25. 1883 3 — 26 years
1857
This has grown into
a Volume Styled
Thermography. Published
Sept 22.