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A PORTABLE MERCURIAL BAROMETER.

By Captain H. H. P. DEASY.

THIS barometer, which was first used by Dr. J. Norman Collie, F.R.S., Professor of Chemistry, Pharmaceutical Society of Great Britain, consists of two glass ends of the same diameter, 0.4 of an inch, joined together by specially made rubber tubing of very small bore, capable of withstanding a long-maintained vacuum. The upper end is about 2.5 inches long, and contains an air-trap, into which all the air that may accidentally enter the barometer, either through the tap leaking, through the rubber tubing, or through either of the joints, must find its way. The lower or reservoir end is about 4.5 inches long, and has an air-tight tap about an inch below the broad part. These ends are forced into the rubber tubing, and, as an additional precaution against leakage, copper wire is bound round the joints. The scale is cut on an aluminium bar, along which two carriages, to which the barometer is attached, move up and down, and they can be clamped to the bar at any place (*vide* diagrams). By means of the verniers attached to the carriages, which are divided to 0.002 of an inch, it is very easy to estimate the height of the mercury to 0.001 of an inch.

To use the barometer, the carriages are put on the scale bar; the lower one is clamped at the bottom of the bar, and the upper one some inches higher up; the barometer is attached to the carriages by clamps which fit over the joints; the rubber cap is removed from the reservoir end, the tap opened, the verniers put in the middle of their runs, and the upper carriage moved up the bar until there is a vacuum. By means of the screws on the right of the mercury, the verniers are moved up or down until the top of the mercury at each end is in line with the edges of the rings attached to the verniers, and which fit round the glass ends. The rubber cap on the reservoir end is merely to prevent the small quantity of mercury, which should be left above the tap when it is closed, from being shaken out when travelling.

To pack up the barometer, lower the upper carriage *very slowly* until the mercury has touched the top of the glass; then detach the barometer from this carriage, and either let the upper end hang vertically below the reservoir, or detach the reservoir end from its carriage and raise it till the barometer hangs vertically. By this means the barometer is completely filled with mercury, and then the tap must be closed. The reason for doing this is to render it quite impossible for air to enter the barometer when it is not in use, as when thus filled and packed away the mercury is endeavouring to get out of the barometer. This is easily proved by carrying out the above directions, laying the barometer down on the ground or table, etc., raising the reservoir end, and opening the tap, when the mercury will at once rise in the reservoir. The barometer, with a thick soft cap at each end, is packed in a rectangular box about $11\frac{3}{4} \times 9\frac{1}{2} \times 3\frac{1}{4}$ inches, coiled round a partition containing the carriages, a small bottle of mercury, a small exhaust-pump, and a very small tin of composition to apply to the tap if required. A short length of tubing is put at the bottom of the box, and is required

THE BAROMETER IN
ITS NORMAL WORK-
ING POSITION.

to connect the pump to the barometer in case of air getting in, but the pump is seldom required. The total weight of this box and barometer, etc., is about $7\frac{1}{2}$ lbs. The scale-bar and travelling-case weigh about $6\frac{1}{2}$ lbs. Casella, who is the sole maker, is now making a lighter scale-bar and lighter carriages, so the total weight of the new instruments complete will be reduced.

If the instrument is packed as I described—in a well-padded box—it is quite unnecessary to take any further care with it when travelling. Should a traveller wish to carry a spare barometer, it can be carried in a well-padded box about $8\frac{1}{4}$ inches square by $4\frac{5}{8}$ inches deep, weighing, when full, about $3\frac{3}{4}$ lbs.

It was in a box of this description that I carried the barometer, which was exhibited before the Royal Society on May 19, 1897, on my recent journey into Western Tibet, of which country about 24,000 square miles were surveyed by me and the sub-surveyor, who was detailed by the Survey of India to accompany me. This particular instrument was used about two hundred and eighty times, and required to be pumped only twice. It was carried—chiefly on mule-back—over thirty-three passes, varying in height from 11,500 to over 19,200 feet, and was sent from Umballa to Bombay as an ordinary parcel, and thence shipped as ordinary cargo to London, where it arrived quite safely.

This instrument withstood a very severe test, to which it was accidentally submitted in India. It slipped off the seat of the carriage in which I was driving, and fell on to the metalled road. Although the best pace of hired animals in India is not very rapid, it was on this occasion quite sufficient to prove that this barometer, packed as described, can safely undergo a considerable amount of very rough usage. I would like to allude to the alleged drawbacks to this barometer, and to reply to them.

First, it takes a long time to set it up and take readings. I admit that the directions are somewhat lengthy, but it does not take long to carry them out—only about ten minutes to unpack, set up, read, and repack.

Second, it may require pumping often. I used one about 280 times, and it required pumping only twice, and the older the instrument the less likely is it to require pumping. Leakage would, of course, occur more easily when high pressures were being measured.

Third, it is hard to exhaust from it any air that may accidentally get in, and, besides, it takes a long time. This operation is not difficult, and, with a proper pump, should not take half an hour to perform.

Fourth, the presence of air in the instrument causes false readings. I compared the readings of my barometer, with air in the air-trap, with those of two standards, and all three readings were identical. As long as air does not go beyond the air-trap, the readings are not affected thereby.

Fifth, one critic—a very competent one—considered the handle of the tap, the neck joining it to the tap, very fragile. This is the strongest kind of handle, and the quality of glass used is exceedingly tough, so that there need not be any fear of the handle being wrenched off. Spare taps may be carried and easily fitted in place of a broken one.

Sixth, an error of reading would occur, owing to the meniscus of the mercury in the narrow top and bottom cisterns. This would not be the case, for the reading in the upper part of the barometer would be too high by exactly the same amount as that in the bottom part, and the two errors would counterbalance one another.

Seventh, there is no attached thermometer. Not required for all ordinary purposes, as, by exposing the instrument thoroughly for a few minutes, it will then have the same temperature as the surrounding air, which is easily ascertained

by suspending a thermometer from the clamp-screw of the upper carriage, or from any other place close to the instrument.

Eighth, the rubber tubing becomes stiff in cold weather, and will not last long. The tubing of the barometer which I used in Tibet was perfectly pliable at a temperature of $\pm 0^{\circ}$ Fahr., and did not show any tendency to becoming stiff. Time alone will prove for how long this tubing, which is made of the very best materials, will last; but I should think it will remain perfectly good for several years, and it can easily be replaced without returning it to the maker.

Ninth, the mercury soon becomes dirty and discolours the glass. Yes; but only in the reservoir end, which is open to the air, and it is easily cleaned with a piece of cotton-wool attached to a wire or stick.

Tenth, if, by any means, a large quantity of air got into the instrument, it might easily get above the air-trap and render the barometer useless until the

THE UPPER CARRIAGE AND VERNIER,
WITH BAROMETER ATTACHED.

THE LOWER CARRIAGE AND VERNIER, WITH
RESERVOIR END OF BAROMETER ATTACHED.

mercury was re-boiled. Quite recently, while testing a piece of new tubing which was thought to be defective, the barometer was set up and left open, with about half an inch of vacuum, during the night. On examining it next morning, the upper part was found full of mercury, the air-trap was full of air, and there was a considerable amount of air in the tubing as well.

Having referred to the alleged drawbacks, I think it will not be out of place for me to mention that this kind of barometer requires no special care when packed as described by me; is capable of withstanding a considerable amount of rough usage, exposure to great changes in temperature, without being opened; is very easily and rapidly set up and read; the error, if any, is constant, and it will last for several years without requiring new tubing. A spare barometer of this pattern, which

reached me when I was on my way to Tibet, having proved defective owing to a faulty tap, I filled it in a temperature of about $+25^{\circ}$ Fahr., at Rimdi, near Changchenmo, in Ladak, and sent it by coolie over two passes about 18,000 feet high to Leh, and thence by parcels post to London, over three passes varying in height from 11,500 to 13,600 feet, and through India in the month of June, when it is reasonable to suppose that it was subjected to a temperature of about 100° Fahr., probably higher. This instrument, which in all probability experienced a change of temperature of about 75° Fahr., reached Dr. Norman Collie in London quite safely.

NOTE BY DR. J. NORMAN COLLIE, F.R.S., ETC.

The barometer mentioned above by Captain H. H. P. Deasy ought to be of considerable use as a field instrument, chiefly on account of the ease with which it can be packed and carried about without fear of damage. The ordinary mercurial barometer is an unwieldy instrument to use, and must be constantly looked after during transport; in this new form of mercurial barometer, the stem being flexible obviates most of the objections which can be urged against the ordinary form of barometer.

During a mountaineering expedition to the Himalayas in the summer of 1895, I first used one of these flexible-stem barometers. The instrument was packed in a quarter-pound tobacco-tin, and usually carried in the pocket of my coat; for a scale a pocket steel measure was used, and my ice-axe, and two indiarubber rings to clamp the barometer on to the axe, served as a support for the instrument. Of course the readings were only approximately accurate to within, perhaps, a tenth of an inch, and do not for one moment compare with those obtained by the perfected instrument used by Captain Deasy. The instrument, however, has lasted well. Since 1895 it has been lying about in a cupboard, but it is still in a perfectly usable condition, and I shall take it with me on an expedition this summer to the Selkirks, in Western Canada.

Appended is a table of comparisons of two patent portable barometers with two standard barometers.

HEIGHT IN MILLIMETRES.

Barometers.	I.	II.	III.	IV.
June 11, 1897	767.6	767.4	767.3	767.4
June 12, 1897	767.5	767.4	767.2	767.4

I. Barometer at University College (chemical laboratory).

II. Barometer at Pharmaceutical Society (chemical laboratory).

III. Barometer used during trip to Tibet, 1896.

IV. Barometer used in Himalayas (Kashmir), 1895.

NOTE.—There was a minute bubble of air in Barometer III. Barometers II., III., and IV., were all read in the same room, which was about 30 feet higher than the room at University College in which Barometer I. was read.

THE SOCIETY'S ADDRESS TO THE QUEEN.

WE give in this month's number of the *Journal* a reduced facsimile of the Address presented to the Queen, on the occasion of the completion of the sixtieth year of Her Majesty's reign. Necessarily the colour embellishments are omitted.