PRICE 1/- NET.

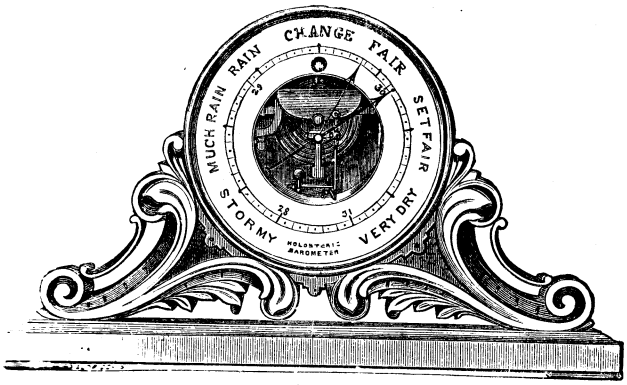
THE

ANEROID BAROMETER

HOW TO BUY AND HOW TO USE IT.

WITH THE NEW ALTITUDE TABLES BY THE ASTRONOMER ROYAL.

"FOR CONSIDERING THE WEATHER."—*Shakspere.*



BY A FELLOW OF

THE METEOROLOGICAL SOCIETY.

FIFTIETH THOUSAND.

LONDON:
HOULSTON AND SONS,
PATERNOSTER SQUARE.

MDCCCCII

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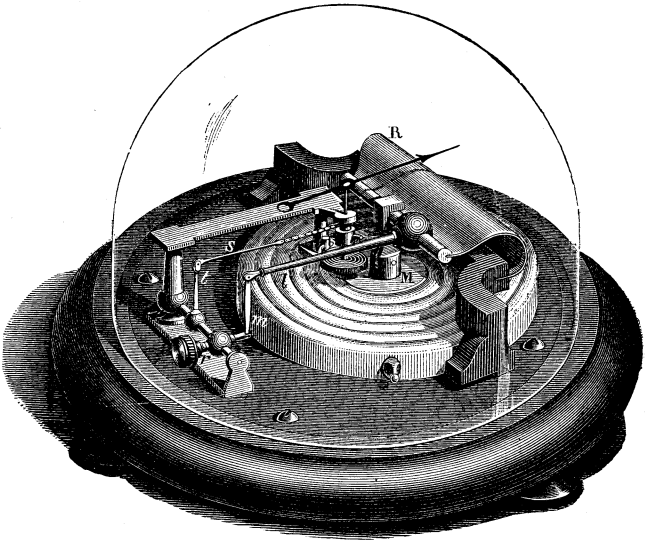

MECHANISM OF THE ANEROID BAROMETER.

FORTY-FIFTH THOUSAND.

BY A FELLOW OF

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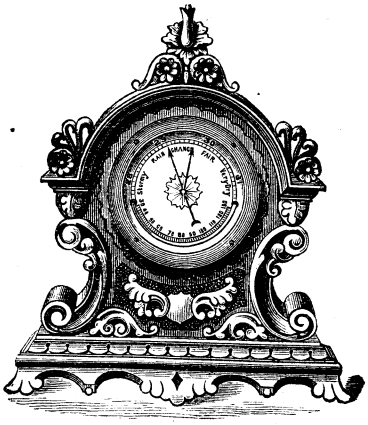
PREFACE.

A GENERAL conviction that the personal comfort, if not safety, of every one may be promoted by a foreknowledge of the weather has developed a growing taste for such instruments as enable observers to foretell meteorological changes, and given a great impetus to the manufacture of that form of Barometer known as the Aneroid.

The favourable reception accorded to the earlier editions of this pamphlet has encouraged the writer to make important modifications, not only in the letterpress, but by the introduction of new engravings. For most of the latter he is indebted to the courtesy of large manufacturing firms. The vignette on the title-page, from Deschanel's Physics, is reproduced by permission of Messrs. Blackie & Son.

The writer has still kept in view the original aim of this brief treatise, which was to explain what an Aneroid Barometer is, and what are its advantages over the more established Mercurial Barometer, by showing that, as a simple "weather indicator," it is equal to, and in many respects superior to some of the varieties of Mercurial Barometer; that even in its least expensive forms its appearance is elegant and compact, and that since the removal of the restrictions of patent rights the instrument has been much improved, and is procurable at such prices as to place it within the reach of all.

[*Entered at Stationers' Hall*]



2.
Scale about 1-6th.
SILVERED DIAL ANEROID,
In Carved Oak Mounting.

A consideration of the principle of the Mercurial Barometer, invented by Torricelli in 1643, will assist the reader in comprehending the working of the Aneroid; and this will best be done by imagining ourselves at the bottom of an ocean of air, about forty-five miles deep, the surface of which suffers agitation and rolls in waves, as do the waves of the sea. It must not, however, be supposed that the fluctuations in the height of the mercurial column represent the height and depth of surface waves of air. "The barometer," says Admiral Fitzroy, in his *Barometer Manual*, "shows whether the air is getting lighter or heavier,

or is remaining in the same state. The quicksilver falls as the air becomes lighter, rises as it becomes heavier, and remains at rest in the glass tube while the air is unchanged in weight. Air presses on everything within about ten miles of the world's surface like a *much* lighter ocean, at the bottom of which we live—not feeling its weight, because our bodies are full of air, but feeling its currents, the winds. The weight of the air, or force of its pressure, is nearly fifteen pounds to the square inch; and the cause of the variations in its weight, as indicated by the oscillations of the barometer, is to be sought for, according to Muller, in the unequal and constantly varying distribution of *heat* over the earth's surface. As the distribution of heat constantly varies, the equilibrium is likewise disturbed at every moment, and currents of air arise, which strive to restore the balance. The air is thus in constant motion, sometimes more heated, and then lighter; and at other times more cooled, and consequently denser. As it contains sometimes more sometimes less vapour, the pressure of the columns of air will also be exposed to continual changes, indicated by the barometer."

The practical end in view of using a barometer is to learn how to translate these indications in such a manner as to enable the observer to "foretell weather."

The Aneroid Barometer is admitted by the highest authorities to be fully equal to this object, and there can be no doubt that it is an instrument which, from the ingenuity displayed in its construction and the accuracy of its indications, is entitled to the highest confidence from the public; and it is hoped that the details herein set forth may aid in dissipating the

doubts as to its efficiency which have been needlessly entertained, and thus raise the Aneroid Barometer to that position in public estimation to which it is fully entitled.

There is one feature in which this instrument possesses an advantage over all other forms of weather indicators, viz., its compact circular form, by which it recommends itself at once as a convenient companion for tourists for measuring the height of mountains. It is made as small as a shilling, and may be worn as a charm attached to the watch chain; as large as a church clock, and of all intermediate diameters being equally accurate in every size, possessing in some instances sufficient delicacy to indicate the variation of pressure between the height of an ordinary table and the ground. The very light metal Aluminium suggests itself as a suitable material for the indicating needle or pointer of these larger Aneroids.

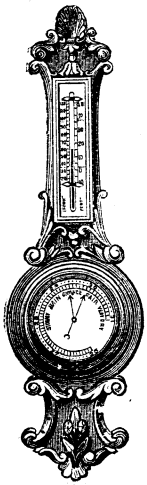
The word aneroid is derived, in an anomalous way, from the Greek privative *a* and *neros*, wet. The invention of the Aneroid Barometer was attributed to Conté in 1798, and to Vidi about 1844, and excited much attention in 1848-9. By its means the pressure of the air is measured without the use of liquid as in ordinary instruments, the source of the indications being a cylindrical metal box exhausted of air, the undulations of which, resulting from the varying pressure of the atmosphere, are transmitted, by delicate multiplying levers, to an index moving on a scale. By an increase of pressure the top is pressed inwards, and when, on the contrary, a diminution of pressure takes place, a movement in an opposite direction is the result.

The late Admiral Fitzroy says: "Aneroids are now made so portable that a pilot or chief boatman may carry one in his pocket, as a railway guard carries his timekeeper; and thus provided, pilots cruising for expected ships would be able to caution strangers arriving, if bad weather were impending, or give warning to coasters or fishing-boats."

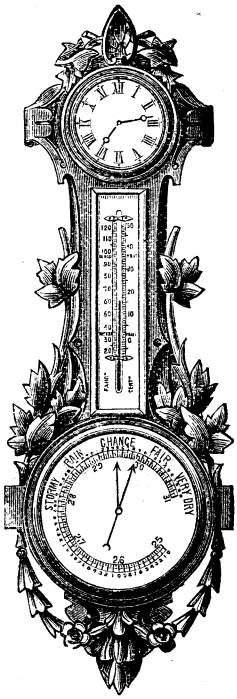
The same authority says the Aneroid is quick in showing the variation of atmospheric pressure, and to the navigator who knows the difficulty, at times, of using the barometer, this instrument is a great boon, or it can be placed anywhere quite out of harm's way, and is *not affected by the ship's motion*, although faithfully giving indication of increased or diminished pressure of air. In ascending or descending elevations, the hand of the Aneroid may be seen to move (like the hand of a watch), showing the height above the level of the sea, or the difference of level between two stations.

The late Admiral Fitzroy further says: "*The Aneroid is an excellent weather-glass, if well made.* Compensation for heat or cold has lately been introduced by efficient mechanism. In its *improved* condition it is fit for measuring heights as far as 5,000* feet with approximate accuracy; but as a *weather-glass* only it is *exceedingly valuable*, because it can be carried anywhere; and if now and then compared with a good mercurial barometer it may be relied on sufficiently. I have had one in constant use for ten years, and it appears to be as good now as at first."

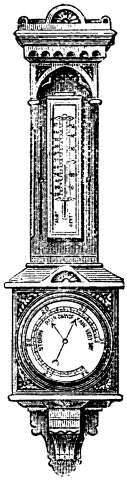
* Since this opinion was expressed by the late Admiral Fitzroy, Mountain Aneroids, fully compensated for temperature, have been made to yield reliable indications up to 16,000 feet.



3.
Scale about 1-8th
HALL ANEROID,
with Attached
Thermometer.



4
Scale about 1-6th.
DRAWING-ROOM ANEROID
AND CLOCK.



5.
Scale about 1-8th.
LIBRARY ANEROID
with Attached
Thermometer.

Colonel Sir Henry James, R.E., of the Ordnance Survey Department, has issued a series of *Instructions for taking Meteorological Observations*, and in speaking of the Aneroid Barometer, he says:—"This is a most valuable instrument; it is extremely portable. I have had one in use for upwards of ten years, and find it to be the best form of barometer as a 'weather-glass' that has been made."

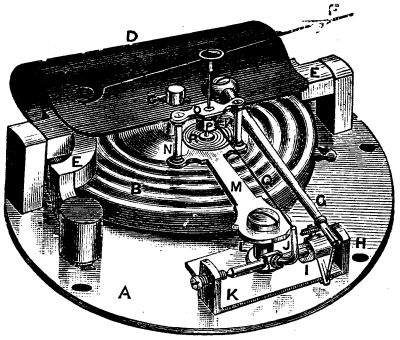
James Glaisher, Esq., F.R.S., one of whose objects in making balloon ascents was "to compare the readings of an Aneroid with those of a Mercurial Barometer up to five miles," says: "The Aneroid readings from all the observations made in the several ascents may be safely depended upon, and also that an Aneroid can be made to read correctly to pressures below twelve inches, and even to the second place of decimals."

Mr. J. H. Belville, of the Royal Observatory, Greenwich, says that "its movements were always consistent. It was a delightful companion, and highly useful, its indications preventing many an excursion which would have ended in disappointment."

Captain Sir Leopold McClintock, in his account of his voyage in search of Sir John Franklin's party, states that atmospheric changes were indicated first by the Aneroid, then by the Sympiesometer, and lastly by the Mercurial Barometer, thus adding further valuable proof of the superior sensibility of the instrument now under consideration.

In considering the construction of the Aneroid, the details and the mechanism of which are shown on the title page, and in fig. 6, the indications obtained by the motion of the needle on the dial will first claim attention. These arise from the pulsations or throbbings of the *vacuum chamber* B,* which is composed of two discs of corrugated German silver, firmly soldered together, to each of which is firmly soldered a brass centre,—one with a thread on it, to screw the chamber to the *base-plate* A; the other plain, with a hole drilled

* The letters are those in fig. 6, *not* the title page.



6

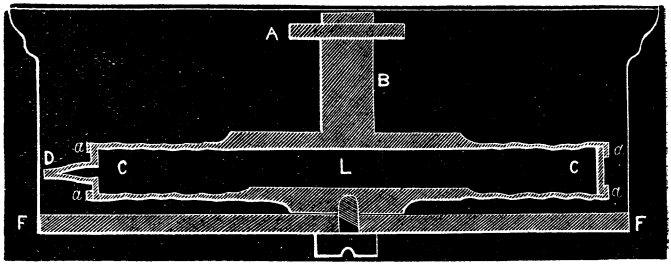
Scale about $\frac{1}{2}$.

MECHANISM OF THE ANEROID.

across it, to receive a *knife-edge* C, which suspends the vacuum chamber from a *powerful spring* D, as seen in the drawing. On these principally depends the action of the instrument. The *base* or *foundation* plate A is of iron or brass, and circular in form; to, this the vacuum chamber previously described is firmly attached, while a strong *iron carriage* E, fixed across the chamber, supports the *main-spring* D, which, acting in direct opposition to the undulations of the *vacuum chamber* B, give rise to the variations of the *needle* F, right and left on the *dial.*

The system of levers by which the slight undulations of the vacuum chamber are transmitted to the index needle will now receive attention.

To the *main-spring* D is attached the *main lever* G, a compound bar of steel and brass about two inches in length, which serves the double purpose of connecting the action of the vacuum chamber and spring to the indicator and of compensating for any error which might arise from sudden changes of temperature. To

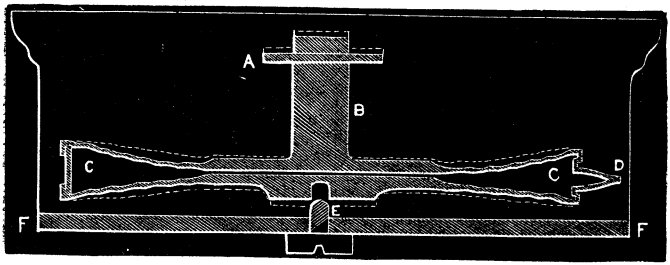


7.
Scale full size.
SECTION OF VACUUM CHAMBER BEFORE EXHAUSTION.

the end of this arm is attached a small *rod of steel* to connect it to the *regulator*, which is furnished at its centre with a *vertical arm* of brass, by which it communicates with the movement.

The movement is furnished with a stout *base-plate* K, of brass, the projecting ends of which are turned up at right angles with the bottom; to the centre of this base-plate a *short brass pillar* is screwed, bearing a *projecting arm* M, also of brass, at the end of which are *two smaller brass pillars* N, supporting a *thin plate of brass* O, between which and the flat arm works *the arbor* P, on which is fixed the hand. A piece of *fine chain* Q, such as is used in the delicate works of small watches, is attached to and works round the arbor P, and on the rise or fall of the levers, a fine *hair-spring* of coiled steel R, one end of which is attached to one of the pillars N, tends to keep the hand in its proper position.

The *regulator* I, works between the bent-up ends of the base-plate, and supports a vertical *brass arm* J, to the upper end of which is attached the end of the *fine chain* which works round the arbor.

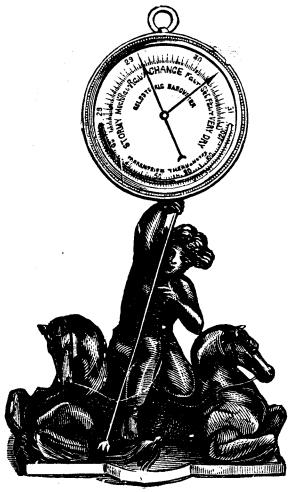


8.
Scale full size.
SECTION OF VACUUM CHAMBER EXHAUSTED OF AIR

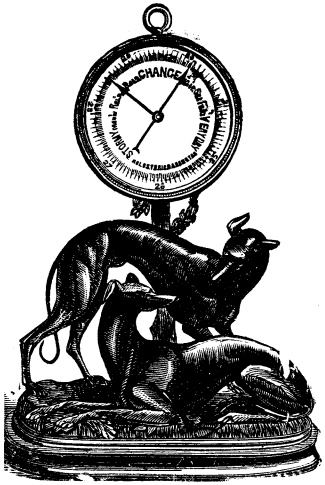
The connection having been made between these various parts, the entire movement is then screwed to the iron foundation-plate A, to which the vacuum chamber has been previously fixed; the multiplicity of levers in the "movement" is then connected with the main lever attached to the main-spring by means of a *fine steel rod* at the end of the main lever, and the communication being thus rendered complete between the various parts of the instrument, it is ready for the final adjustment of the dial and hand.

By this mechanism, a very small motion of the corrugated sides produces a large deviation of the index hand; $\frac{1}{200}$ of an inch causing it to turn through 3 inches.

Figs. 7 and 8 are sections of the vacuum chamber, a perspective view of which *in situ* is shown at B, fig. 6, page 9. A is the V-shaped pin which rests on the main-spring (D, fig. 6), B is the socket in which it rests, and this is firmly soldered to the upper surface of the chamber CC, the lower side of which is as firmly attached to the base-plate. The overlapping of the thin corrugated German silver is shown at *a a a a*,



9.
Scale about 1-6th.
PARLOUR ANEROID.



10.
Scale about 1-6th.
ARLOUR ANEROID.

while the tube through which the exhaustion is made is shown at D. Fig. 8 shows the result of exhausting the air; this will not seem surprising when it is remembered that the external surface of an Aneroid of moderate dimensions sustains a pressure of between 50 and 60 lbs., and the state of tension to which it is brought when screwed up to the dotted lines, Fig, 8 will enable the reader to understand its extreme readiness to pulsate in response to the varying pressure of the atmosphere; these being dependent on the perfection of the vacuum chamber and the accurate adaptation of the various parts of the instrument to each other.

Compensation for temperature is effected by filing away half the thickness of the main lever or arm, and

replacing the brass thus removed by an equal bulk of steel. This will be recognised at once as being the same in principle as the method adopted by Earnshaw in the construction of the compensating balance of chronometers. The importance of compensation, especially for Pocket or Mountain Aneroids, will become apparent when it is remembered that the removal of an Aneroid from the dressing-table in the colder Alpine regions to the pocket will alter the temperature quite 30° F., and it has been found that a difference of 30° of temperature, without the compensating arrangement, raises the needle through one-tenth of a degree, while with the same increment of heat after the introduction of the steel, the hand remains stationary.

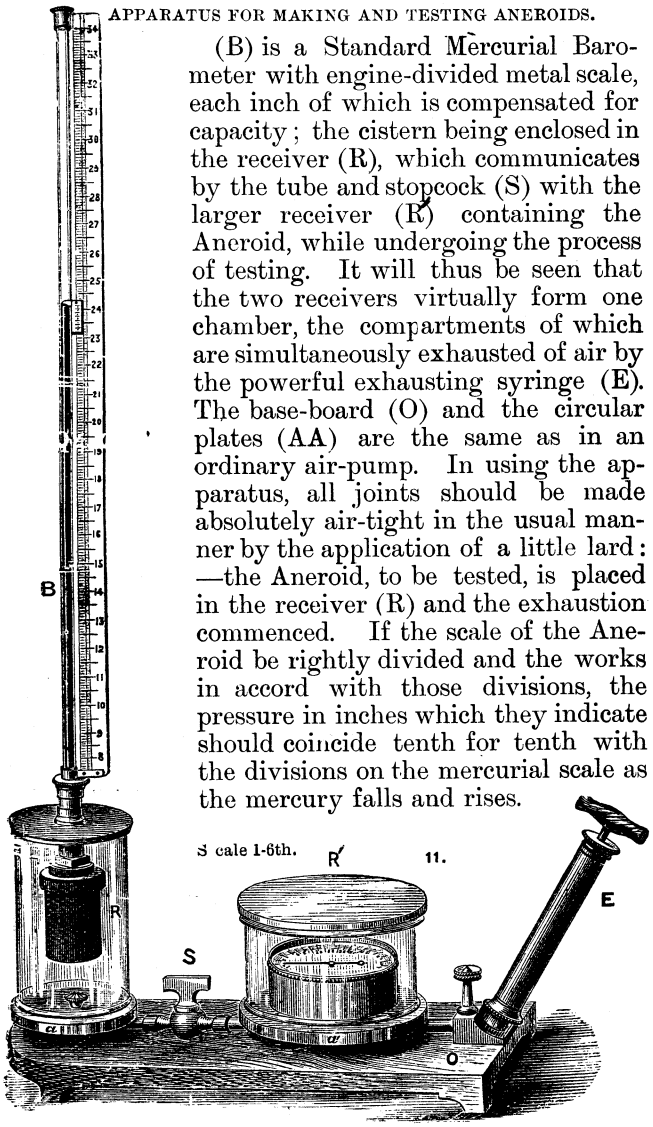
The instrument being now screwed into its case, is next tested under the air-pump to ascertain its range, or the number of inches it will indicate to the circle, after which the dial is divided and engraved, and being placed in position, the needle is attached to the arbor, and the portion of the scale to which it should point is ascertained by reference to the scale of a Standard Mercurial Barometer, with which it is made to agree *exactly* by a slight turn of the adjusting screw connected with the carriage which supports the main-spring.

Before reading, gently wave the instrument to and fro to remove *possible* errors of friction, take the reading with the face of the instrument in a horizontal position, and use one eye, which should be held vertically over the needle.

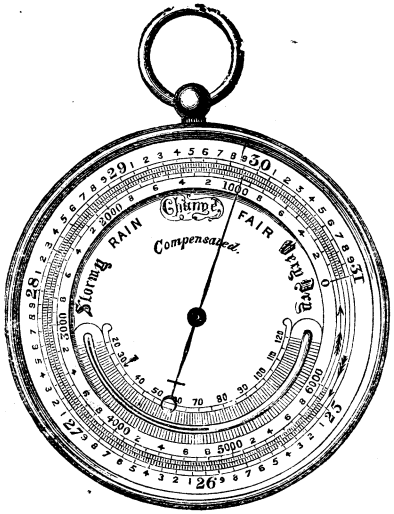
The mode of graduating and testing an Aneroid cannot fail to be interesting, and is admirably illustrated by fig. 11 on the next page.

APPARATUS FOR MAKING AND TESTING ANEROIDS.

(B) is a Standard Mercurial Barometer with engine-divided metal scale, each inch of which is compensated for capacity; the cistern being enclosed in the receiver (R), which communicates by the tube and stopcock (S) with the larger receiver (R′) containing the Aneroid, while undergoing the process of testing. It will thus be seen that the two receivers virtually form one chamber, the compartments of which are simultaneously exhausted of air by the powerful exhausting syringe (E). The base-board (O) and the circular plates (AA) are the same as in an ordinary air-pump. In using the apparatus, all joints should be made absolutely air-tight in the usual manner by the application of a little lard:—the Aneroid, to be tested, is placed in the receiver (R) and the exhaustion commenced. If the scale of the Aneroid be rightly divided and the works in accord with those divisions, the pressure in inches which they indicate should coincide tenth for tenth with the divisions on the mercurial scale as the mercury falls and rises.



Scale 1-6th. 11.



12.
Scale full size.
THE MOUNTAIN ANEROID.
"Up to the mountain top and mark."—*Shakspere.*

In order to secure reliable indications from this extremely sensitive instrument, it is desirable that, like its associated aids to meteorological observation, it should be suspended or fixed in a place where sudden changes of temperature are not likely to occur. If this precaution be observed, the indications of a *compensated* instrument may be accepted as thoroughly reliable, notwithstanding the objections which have been urged against the variations of the Aneroid Barometer from the effect of temperature, since these seldom exceed a tenth of an inch in a range from 28° to 80°, to which extent a Mercurial Barometer would doubtless be affected under similar circumstances.

This instrument may be purchased in the three

diameters of $1\frac{1}{4}$, $1\frac{1}{2}$, and $1\frac{3}{4}$ inches, which may fairly be regarded as "Watch Aneroids;" and though an expensive mounting is by no means essential, they are supplied by opticians in silver shut up cases, in every respect like a hunter's watch, and when graduated for heights, they form most convenient and useful companions for tourists. Nor is their usefulness necessarily confined to Alpine or highland tourists, since advantage may be taken of the extreme sensibility possessed by the Aneroid, and referred to at pages 5 and 26, to estimate the difference of altitude between the place of business and the private residence of the owner, and other similar applications.

An instance indicative of the *correct* indications of a well-made Aneroid is worthy of mention. A tourist in Egypt, ignorant of the height of the principal pyramid, ascended it "armed" with a pocket Aneroid, and noting its indications at the base and summit. On consulting his guide-book the height indicated was found to agree exactly with that obtained by trigonometrical survey and by the Mercurial Barometer.

In conducting scientific investigation and comparison it is of course necessary to exercise extreme accuracy; but for the purpose of the general tourist an approximation to correctness is all that is desired; it will therefore be regarded as an advantage that the Mountain Aneroid requires no correction for temperature, and may be used with the following valuable tables for the determination of heights furnished by Professor Airey, the late Astronomer Royal, and by whose kind permission they are reproduced in this pamphlet.

"This Table is intended more particularly for the graduation of Aneroids with a circle of Measures in

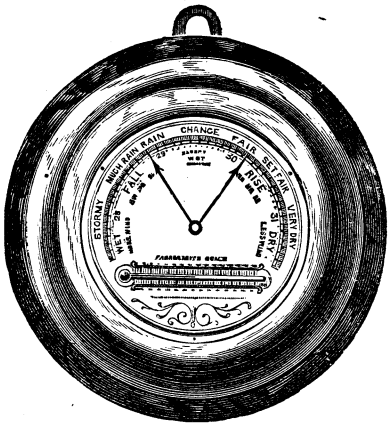
Feet concentric with the ordinary circle of Barometric Height measured in Inches. The circle of Feet is to be read off, at the upper and lower stations, by the Index; and the rule for measuring the height will be:—Subtract the reading at the lower station from the reading at the upper station; the difference is the height in Feet.

"The Table supposes the mean temperature of the atmosphere to be 50° Fahrenheit or 10° Centigrade. For other temperatures the following correction must be applied:—Add together the temperatures at the upper and lower station. If this sum, in degrees of Fahrenheit, is greater than 100°, *increase* the height by $\frac{1}{1000}$ part for every degree of the excess above 100°; if the sum is less than 100°, *diminish* the height by $\frac{1}{1000}$ part for every degree of the defect from 100°. Or if the sum in Centigrade degrees is greater than 20°, *increase* the height by $\frac{1}{550}$ part for every degree of the excess above 20°; if the sum is less than 20°, *diminish* the height by $\frac{1}{550}$ part for every degree of the defect from 20°," (see pages 18 & 19.)

Some Mountain Aneroids have a moveable scale in addition to the usual barometer scale, which is a fixture. The moveable scale is one of altitudes, and is designed especially for showing on the dial, without the aid of pencil and tables, the height of any given place above another. All that is necessary in using it is to set the index or zero to where the hand of the instrument points. On ascending a mountain, the hand of course travels backward, and as each division represents 100 feet, an *approximate* indication of the ascent is thus readily obtained. The thermometer which is usually attached admits of the temperature being observed and

Height in Feet.	Aneroid or Corrected Barometer.	Height in Feet.	Aneroid or Corrected Barometer.	Height in Feet.	Aneroid or Corrected Barometer.
ft.	in.	ft.	in.	ft.	in.
0	31·000	2000	28·807	4000	26·769
50	30·943	2050	28·754	4050	26·720
100	30·886	2100	28·701	4100	26·671
150	30·830	2150	28·649	4150	26·622
200	30·773	2200	28·596	4200	26·573
250	30·717	2250	28·544	4250	26·524
300	30·661	2300	28·491	4300	26·476
350	30·604	2350	28·439	4350	26·427
400	30·548	2400	28·387	4400	26·379
450	30·492	2450	28·335	4450	26·330
500	30·436	2500	28·283	4500	26·282
550	30·381	2550	28·231	4550	26·234
600	30·325	2600	28·180	4600	26·186
650	30·269	2650	28·128	4650	26·138
700	30·214	2700	28·076	4700	26·090
750	30·159	2750	28·025	4750	26·042
800	30·103	2800	27·973	4800	25·994
850	30·048	2850	27·922	4850	25·947
900	29·993	2900	27·871	4900	25·899
950	29·938	2950	27·820	4950	25·852
1000	29·883	3000	27·769	5000	25·804
1050	29·828	3050	27·718	5050	25·757
1100	29·774	3100	27·667	5100	25·710
1150	29·719	3150	27·616	5150	25 663
1200	29·665	3200	27·566	5200	25·616
1250	29·610	3250	27·515	5250	25·569
1300	29·556	3300	27·465	5300	25·522
1350	29·502	3350	27·415	5350	25·475
1400	29·448	3400	27·364	5400	25·428
1450	29·394	3450	27·314	5450	25·382
1500	29·340	3500	27·264	5500	25·335
1550	29·286	3550	27·214	5550	25·289
1600	29·233	3600	27·164	5600	25·242
1650	29 179	3650	27·115	5650	25·196
1700	29·126	3700	27·065	5700	25·150
1750	29·072	3750	27·015	5750	25·104
1800	29·019	3800	26·966	5800	25·058
1850	28·966	3850	26·916	5850	25·012
1900	28·913	3900	26·867	5900	24·966
1950	28·860	3950	26·818	5950	24·920
2000	28·807	4000	26·769	6000	24·875

Height in Feet.	Aneroid or Corrected Barometer.	Height in Feet.	Aneroid or Corrected Barometer.	Height in Feet.	Aneroid or Corrected Barometer.
ft.	in.	ft.	in.	ft.	in.
6000	24·875	8000	23·115	10000	21·479
6050	2 ·829	8050	23·072	10050	21·440
6100	24·784	8100	23·030	10100	21·401
6150	24·738	8150	22·988	10150	21·361
6200	24·693	8200	22·946	10200	21·322
6250	24·648	8250	22·904	10250	21·283
6300	24·602	8300	22·862	10300	21·244
6350	24·557	8350	22·820	10350	21·205
6400	24·512	8400	22·778	10400	21·166
6450	24·467	8450	22·736	10450	21·128
6500	24·423	8500	22·695	10500	21·089
6550	24·378	8550	22·653	10550	21·050
6600	24·333	8600	22·611	10600	21·012
6650	24·288	8650	22·570	10650	20·973
6700	24·244	8700	22·529	10700	20·935
6750	24·200	8750	22·487	10750	20·896
6800	24·155	8800	22·446	10800	20·858
6850	24·111	8850	22·405	10850	20·820
6900	24·067	8900	22·364	10900	20·782
6950	24·023	8950	22·323	10950	20·744
7000	23·979	9000	22·282	11000	20·706
7050	23·935	9050	22·241	11050	20·668
7100	23·891	9100	22·200	11100	20·630
7150	23·847	9150	22·160	11150	20·592
7200	23·803	9200	22·119	11200	20·554
7250	23·760	9250	22·079	11250	20·517
7300	23·716	9300	22·038	11300	20·479
7350	23·673	9350	21·998	11350	20·441
7400	23·629	9400	21·957	11400	20·404
7450	23·586	9450	21·917	11450	20·367
7500	23·543	9500	21·877	11500	20·329
7550	23·500	9550	21·837	11550	20·292
7600	23·457	9600	21·797	11600	20·255
7650	23·414	9650	21·757	11650	20·218
7700	23·371	9700	21·717	11700	20·181
7750	23·328	9750	21·677	11750	20·144
7800	23·285	9800	21·638	11800	20·107
7850	23·242	9850	21·598	11850	20·070
7900	23·200	9900	21·558	11900	20·033
7950	23·157	9950	21·519	11950	19·996
8000	23·115	10000	21·479	12000	19·959



3.

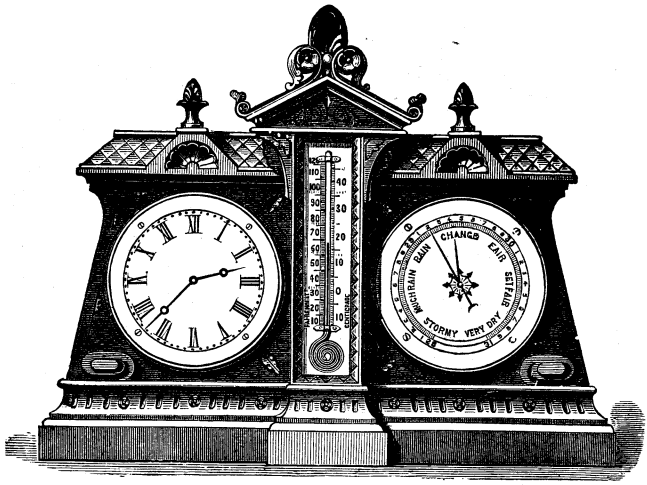
Scale about 1-6th

YACHTING ANEROID WITH ENAMELLED DIAL.

recorded. If the zero of the moveable scale be set to coincide with 31 inches, the scale of feet may be used as a fixed scale, and will correspond with Professor Airey's new Table, which shows the corresponding numbers of elevation in English feet, and of the readings of Aneroid or corrected Barometer in English inches.

Other Mountain Aneroids are furnished with a small *magnetic* compass; the indications of which should be received with some reserve on account of the aberrations caused by the steel portions of the instrument. To reduce these to a minimum the ordinary steel hand is replaced by a gold one.

Fig. 14 shows a very elegant and useful combination of Barometer, Thermometer and Timepiece. The



14.

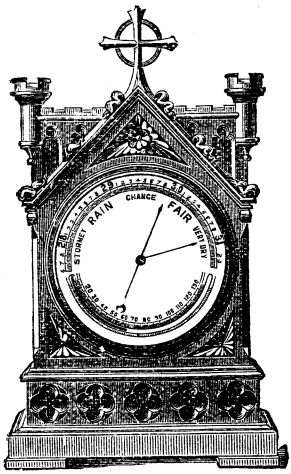
Scale about 1-6th.

COMBINED ANEROID AND CLOCK WITH THERMOMETER.

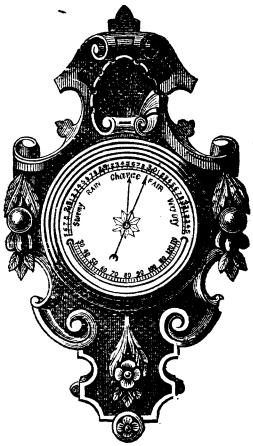
Thermometer having a spiral bulb, is graduated to the Fahrenheit and Centigrade scales, and the Barometer is compensated for temperature. The mounting is of carved oak, and is sometimes made in walnut and rosewood.

If this or any other form of Aneroid be *recently* made, it will require occasional adjustment, until the parts have worked together for some time. This can be readily done by turning the adjusting screw at the back of the instrument, comparing it at the same time with the readings of a Standard Mercurial Barometer, when opportunity offers.

The circular form and varying diameter of the Aneroid Barometer afford opportunities for the exercise of artistic taste in the style of mounting, and some



15.
Scale about 1-5th.
CHURCH ANEROID.



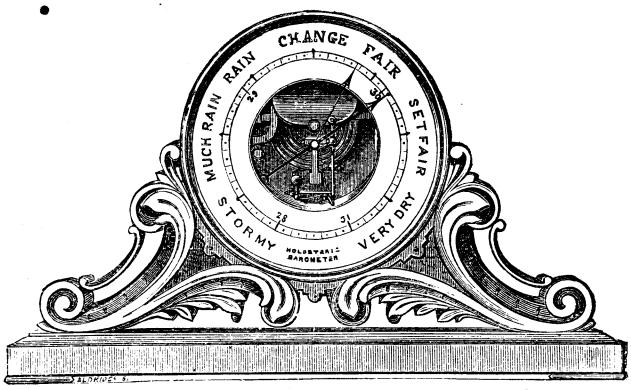
16.
Scale about 1-5th.
DINING-ROOM ANEROID.

illustrations of the more generally accepted patterns are introduced in this Manual.

To these may be added the statement that the material of which the mountings are made is varied. Where elaborate carvings are introduced, walnut, fig. 15, oak, fig. 16, mahogany and rosewoods are used. In the less ornate mountings, the metals gold, silver, aluminium, and gilded or lacquered brass are employed. Cast metal mounts bronzed to imitate oxidized copper are also used and are very elegant.

The sizes in the stock of most opticians vary from $2\frac{1}{2}$ inches to $3\frac{3}{4}$ inches in diameter, and these, still retaining the character of portability, may be styled "Pocket Aneroids."

Increasing in diameter still further, there will be found sizes, from $4\frac{1}{2}$ to 8 inches in diameter, which,



17.
Scale about 1-4th.
COUNTING-HOUSE ANEROID WITH OPEN-FACED DIAL.

from the legible lettering and figuring on their scales, are so suitable for use by mariners that they have been called Marine or Yachting Barometers.

Beyond these there are the still larger diameters of 10 inches, 14 inches, and 16 inches, for fixing in the hall or counting-house, and the Coastguard or Factory Aneroid, varying from 18 inches to 24 inches in diameter. These, however, will seldom be found in stock, but would be readily made to order by the opticians who keep the smaller sizes.

This variety of sizes may be classified under the five different heads of Cardboard, Enamel, Metal, and Open and Closed Dials. The cardboard dial is affixed exclusively to the cheapest form of instruments, but it need not be assumed on that account that they are less accurate than metal, since the error (if any) would arise, not in the material on which the scale is en-

graved, but in the manner of attaching it to the metallic portion of the instrument, and for this the security of the purchaser must be the character and standing of the house where the purchase is made. The scales on metal dials being engine-divided specially for each instrument are of course more correct than those just described.

Those instruments which are furnished with enamel dials are especially adapted for use at sea, on account of the incorrodible nature of the porcelain surface.

Patterns are now being produced, and may be obtained at most opticians, having great similarity in external appearance to the Wheel Mercurial Barometer, but smaller in size. To such as prefer this form, these will recommend themselves as suitable for suspension in the entrance hall or lobby, see page 7.

With such authorities as those which have been cited on pages 8 and 9, no hesitation need now be felt in employing the Aneroid Barometer as a weather indicator, and in making daily records of its indications, especially if the precaution be adopted of comparing it at intervals of twelve months with a Standard Mercurial Barometer, usually possessed by the opticians supplying the instrument.

In view of this it has been deemed desirable to append an Explanatory Card by Admiral Fitzroy, and to recommend the purchase of a very handy little note-book sold by opticians, with pencil and india-rubber band complete. It is called the "Pocket Meteorological Register and Note-Book,"* and by its aid the most interesting diagrams may be made, showing the fluctuations of the barometer, etc., from day to day.

* By Richard Strachan, F M S.

EXPLANATORY CARD.

BY THE LATE VICE-ADMIRAL FITZROY, F.R.S., ETC.

WEATHER-GLASSES.

THE BAROMETER RISES	THE BAROMETER FALLS
for Northerly wind (including from North-west, by the *North*, to the Eastward) for dry, or less wet weather,—for less wind,—or for more than one of these changes :— EXCEPT on a few occasions when rain, hail, or snow comes from the Northward with *strong* wind.	for Southerly wind. (including from South-east, by the *South*, to the Westward), for wet weather,—for stronger wind,—or for more than one of these changes :— EXCEPT on a few occasions when *moderate* wind with rain (or snow comes from the Northward.
For change of wind toward Northerly directions,— A THERMOMETER FALLS.	For change of wind towards Southerly directions,— A THERMOMETER RISES.

Moisture or dampness in the air (shown by an hygrometer) increases BEFORE rain, fog, or dew.

On barometer scales the following contractions may be useful :—

RISE	FALL
FOR	FOR
NORTH	SOUTH
N.W.—N.—E.	S.E.—S.—W.
DRY	WET
OR	OR
LESS	MORE
WIND.	WIND.
EXCEPT	EXCEPT
WET FROM	WET FROM
NORTH.	NORTH.

(In South Latitude read South for North)

Add one-tenth of an inch to the observed height for each hundred feet the barometer is above the half-tide level.

The *average* height of the barometer in England, at the sea-level, is about 29.94 inches; and the *average* temperature of air is nearly 50 degrees (London latitude).

The Thermometer falls about one degree for each three hundred feet of elevation from the ground but varies with wind.

"When the wind shifts against the sun,
Trust it not for back it will run."

First rise after very low
Indicates a stronger blow.

Long foretold—long last.
Short notice—soon past.

NOTE.—In the desire to express as much as possible in a few words, on account of the contracted space on barometer scales, a little obscurity has been unavoidably introduced, *e. g.*, "except wet from N.E." It means that, though the barometer may rise and indicate fair weather, it is uncertain, *if* the wind be N.E.; an important point to be remembered when using the barometer as a weather-glass.

As illustrative of the sensitive nature of the Aneroid in comparison with the sluggish action of cheaper forms of mercurial barometer, it may be mentioned that it shows, in a most interesting manner, the various inclines on a line of railway, even at the utmost speed of the engine. This has been observed by the writer, and notable instances of it occur in this country at Sydenham, between Sevenoaks Junction and Rochester, and at Meopham on the London, Chatham, and Dover line. Instances of this kind could be cited *ad infinitum* and the action is still more striking on the Continent; while anyone desirous of testing this quality of *superior sensitiveness* in the Aneroid may do so by ascending, Aneroid in hand, from the basement to the attic of his house, note the gradual fall of the index hand from "fair" to "change," and thus calculate the height of his dwelling by direct barometric observation.

The word "change" on barometer scales is considered by some as being placed too low at 29·5, the mean height of the barometer being nearer 30. This is so fully acknowledged by the French, that they place it at 76 centimetres, which corresponds nearly with the mean height of the barometer in England.

RULES FOR FORETELLING WEATHER.

ADAPTED FOR USE

WITH ANEROID BAROMETERS.

A RISING BAROMETER.

"Fair weather after you."—*Shakspere.*

A "rapid" rise indicates unsettled weather.

A "gradual" rise indicates settled weather.

A "rise" with dry air, and cold increasing in summer, indicates wind from Northward; and if rain has fallen better weather is to be expected.

A "rise" with moist air, and a low temperature, indicates wind and rain from Northward.

A "rise" with southerly wind indicates fine weather.

A STEADY BAROMETER.

"Many can brook the weather that love not the wind."—*Shakspere*

with dry air and seasonable temperature, indicates a continuance of very fine weather.

A FALLING BAROMETER.

"So foul a sky clears not without a storm."—*Shakspere.*

A "rapid" fall indicates stormy weather.

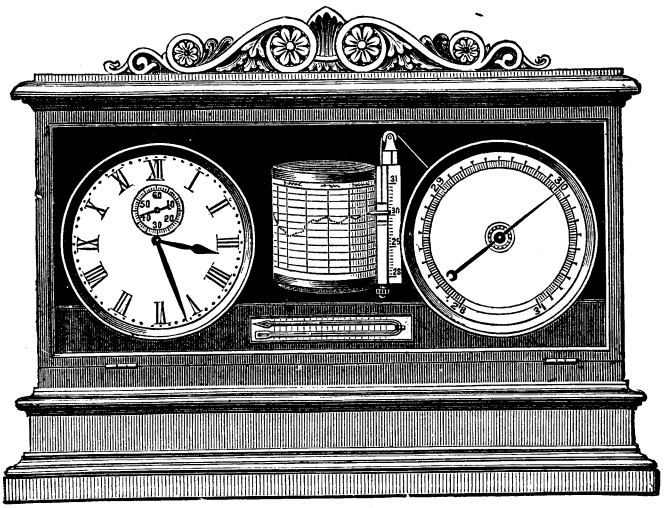
A "rapid" fall, with westerly wind, indicates stormy weather from Northward.

A "fall," with a northerly wind, indicates storm, with rain and hail in summer, and snow in winter.

A "fall" with increased moisture in the air, and the heat increasing, indicates wind and rain from Southward.

A "fall" with dry air and cold increasing (in winter) indicates snow.

A "fall," after very calm and warm weather, indicates rain with squally weather.



18
Scale about 1-8th.
BAROGRAPH, OR SELF-RECORDING ANEROID BAROMETER.

THE HOURLY SELF-RECORDING ANEROID BAROMETER.

This instrument is designed to show the various fluctuations which may have taken place in the Barometer in the interval between any stated hours of observation. It consists of an Aneroid Barometer and an eight-day clock, each with eight-inch dials, between which is placed a vertical cylinder four inches in diameter, having a paper attached to it ruled to coincide with the Barometer scale, and divided vertically into seven principal and seven minor divisions, indicated by darker and lighter lines. The dark lines represent the noon, and the lighter lines the midnight of each twenty-four hours. The paper thus lasts one week, the cylinder turning on its axis

once in that time. Near the paper an ever-pointed pencil guided by a metal rod is moved up and down as the action takes place in the Aneroid, and at every hour the pencil is made to mark the paper by simple mechanism connected with the clock. A system of levers in connection with the clock produces a smart tap or blow on the Aneroid movement three times in every hour to overcome any slight friction, and insure a due response to the pulsations of the vacuum chamber.

By this means a black dotted curved line is produced, showing at a glance the height of the Barometer—whether it is falling or rising—for how long it has been doing so, and at what rate the change is taking place—whether at the rate of one tenth per hour, or one-tenth in twenty-four hours, facts which can only be obtained by very frequent and regular observations from an ordinary Barometer, but which are nevertheless essential to a trustworthy "weather forecast."

The instrument has the advantage of freedom from complication, and is designed especially to suit the general public; it is handsome in appearance, and not easily put out of order, being admirably adapted for public libraries, the reading-rooms of clubs, &c., as well as for use by meteorological observers generally.

The writer has had one of these self-recording Aneroids tested by daily comparison for five weeks with the Standard Mercurial Barometer at the Royal observatory at Greenwich, and the greatest variations during that time did not exceed ·002 of an inch. He subsequently read a paper on the subject before Section B of the British Association for the advance-

ment of Science on the occasion of its meeting at Exeter in August, 1869, thus bringing it into well-deserved notice.

WEATHER WISDOM.

The following are a few of the more marked signs of weather, described in the late Admiral Fitzroy's valuable Weather Book :—

Whether clear or cloudy, a rosy sky at sunset presages fine weather; a sickly-looking *greenish* hue, wind and rain; a dark (or *Indian*) red, rain; a red sky in the morning, bad weather or much wind (perhaps rain, a grey sky in the morning, fine weather; a high dawn, wind; a low dawn, fair weather.

A "high dawn" is when the first indications of daylight are seen above a bank of clouds. A "low dawn" is when the day breaks on or near the horizon the first streaks of light being very low down.

Soft-looking or delicate clouds foretell fine weather with moderate or light breezes; hard-edged, oily-looking clouds, wind. A dark, gloomy blue sky is windy, but a light, bright blue sky indicates fine weather. Generally, the *softer* clouds look, the less wind (but perhaps more rain) may be expected; and the harder, more "greasy,' rolled, tufted, or ragged, the stronger the coming wind will prove. Also—a bright yellow sky at sunset presages wind, a pale yellow wet; therefore, by the prevalence and kind of red, yellow, or other tints, the coming weather may be foretold very nearly; indeed, if aided by instruments, almost exactly.

Small inky-looking clouds foretell rain; light scud clouds driving across heavy masses show wind and rain; but if alone may indicate wind only.

High upper clouds crossing the sun, moon, or stars, in a direction different from that of the lower clouds, or the wind then felt below, foretell a change of wind *toward their direction.*

After fine clear weather, the first signs in the sky of a coming change are usually light streaks, curls, wisps or mottled patches of white distant clouds, which increase, and are followed by an overcasting of murky vapour that grows into cloudiness. This appearance, more or less oily or watery, as wind or rain will prevail, is an infallible sign.

Usually, the higher and more distant such clouds seem to be, the more gradual, but general, the coming change of weather will prove.

Light, delicate, quiet tints or colours, with soft undefined forms of clouds, indicate and accompany fine weather; but unusual or gaudy hues, with hard, definitely outlined clouds, foretell rain, and probably strong wind.

Misty clouds, forming or hanging on heights, show wind and rain coming, if they remain, increase, or descend. If they rise, or disperse, the weather will improve or become fine.

Dew is an indication of fine weather, so is fog. Neither of these two formations occur under an overcast sky, or when there is much wind. One sees fog occasionally rolled away, as it were, by wind, but seldom or never *formed* while it is blowing.

Remarkable clearness of atmosphere near the horizon, —distant objects, such as hills unusually visible, or raised (by refraction)—and what is called "a good *hearing* day" —may be mentioned among signs of wet

if not wind, to be expected. Much refraction is a sign of easterly wind veering southward.

More than usual twinkling of the stars, indistinctness or apparent multiplication of the moon's horns; haloes, "wind-dogs," and the rainbow, are more or less significant of increasing wind, if not approaching rain with or without wind. "Wind-dogs" are fragments or pieces (as it were) of rainbows (sometimes called "wind-galls") seen on detached clouds.

Observers should be advised to *mark* a true E. and W. line, *about the time of the equinox*, by the sun at rising or setting, and by it give their bearings or directions of wind. And they should take its direction from that of the *lower* clouds (when they are not very distant), compared with that of vanes and smoke, in preference to any other indication.

Much more care is required in noticing the veering, backing, shift, turn, or gyration of the wind, than has usually been thought necessary. Very rarely has the way the wind *went round* been noticed in ordinary registers, though of material consequence.

While saying so much of the Mercurial Barometer, it would be an injustice to the Aneroid not to mention that fourteen years' experience of this small and *very* portable barometer—at sea, on land, and travelling—has induced its *high* recommendation (when *set properly*) as an excellent weather-glass for small vessels or boats.

NOTE.—In measuring altitudes, it is desirable that the Aneroid should be kept as nearly as possible at a uniform temperature, and should be allowed to acquire this temperature before starting on a day's excursion.

William Kidler & Son, Ltd., Manchester House, 164, Aldersgate Street, London, E.C.