

Fig. 1.

A represents the vertical shaft on which the hemispherical cups are supported.

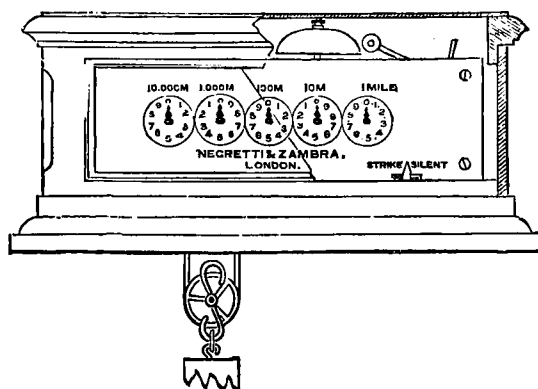


Fig. 2.—RECORDING INSTRUMENT—EXTERIOR.

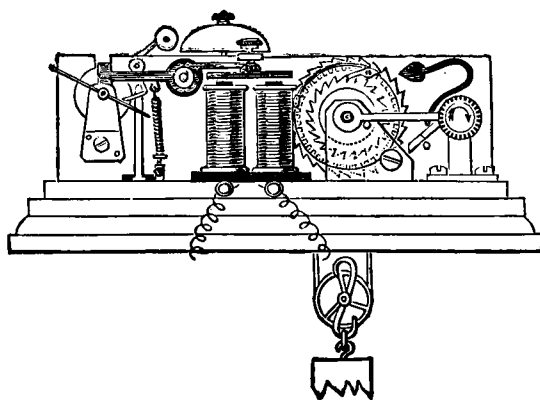


Fig. 3.—RECORDING INSTRUMENT—INTERIOR.

HALL'S ELECTRO-MAGNETIC ANEMOMETER.

SYMONS'S

MONTHLY

METEOROLOGICAL MAGAZINE.

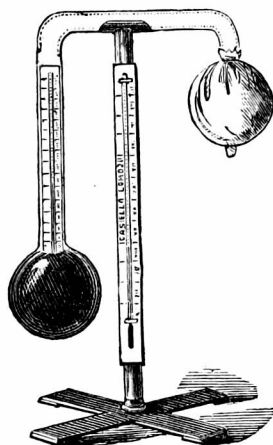
LXXII.]

JANUARY, 1872.

[PRICE FOURPENCE,
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DEW-POINT AND OTHER HYGROMETERS.

DANIELL'S hygrometer, on the ground both of priority of design and generality of adoption, claims first notice in the group of hygrometers of which the action depends on the evaporation of ether. Its construction and mode of use will be readily understood from the accompanying engraving.



The longer leg contains a small thermometer, the bulb of which is in the centre of the black glass ball, which terminates that leg. The other and shorter leg terminates also in a glass ball, which however is covered with fine muslin. The tube and balls, before hermetical closure, are exhausted of air, and a small quantity of very pure ether is placed in them. By applying the warm hand to the muslin-covered ball, and gently tilting the whole instrument, all the ether may be driven into the black ball, which will become about one-third full. The mode of observation consists in dropping a little ether on to the muslin covering of the short bulb; the cold thus produced condenses the vapour of the internal ether, and promotes evaporation from that contained in the black ball, which thereby becomes cooler, and as soon as, by the continuance of this process, the exterior

been adequately tested. We are sorry that so able a man as Mr. Rowell should thus forget himself. We claim some experience of scientific men, and we deny that there is an atom of foundation for the idea which Mr. Rowell entertains, and not only do we deny it as a general principle, but even in Mr. Rowell's specific case. We cannot spare room to discuss the matter fully, but we do not believe that had Mr. Rowell been a duke, a bishop, or a fisherman, it would have made one iota of difference in the reception of his theories.

The fragmentary nature of the pamphlet before us, the mingling of various subjects, and the fact that the author has burned some of his own papers, combine to render the work by no means easy to review. But the basis of the whole seems to lie in the following sentence :—

“When expanded by heat, the increase of the surface of particles of water giving them a greater capacity for electricity, they are buoyed up into the air by their coating of electricity ; that if condensed near the earth's surface, the extra quantity of electricity is withdrawn, and the vapour falls as dew, &c. ; but if it rises out of the electrical attraction of the earth, and is then condensed, the electricity being insulated, forms an atmosphere around each particle of vapour, which surcharge of electricity not only suspends the vapour by its lightness, but also repels the neighbouring particle of vapour, and prevents the formation of rain ; and on the removal (by any cause) of the electricity inclosing the vaporous particles, the repulsion is removed, and the particles attract each other, and form rain.”

Evidently this proposition is more one for the consideration of physicists than meteorologists, and we decline to express an opinion upon it. But the author proceeds to explain various phenomena by this hypothesis, and with respect to evaporation writes as follows :—

“As heat expands the particles of water, it increases their capacity for electricity ; therefore, all other circumstances being alike, the greater the heat the greater the evaporation.”

* * * * *

“Evaporation from ice is owing to the coldness and dryness of the air separating the minute particles of the surface ; when obtaining their coating of electricity, they are rendered sufficiently buoyant to be carried off by a brisk wind.

“Evaporation from ice, snow, or even water, at very low temperature, is trifling except during windy weather.”

We fail to see here any approach to agreement with the recent results of Mr. Dines' experiments.

Again,—

“The concussion caused by a flash of lightning from such a cloud (that is, with its particles pressed nearly into contact) will easily explain the cause of the heavy dash of rain which follows the flash of lightning.”

We were not aware that it had been decided that the heavy dash of rain *followed* the lightning. We have often heard the point discussed, and have generally understood the conclusion to be that the rain is the cause, and the lightning the effect, but that owing to the relative velocity of light and rain drops, the effect is seen before the cause.

In his paper on “The Cause of Storms,” and in most of the later papers in the pamphlet, which are chiefly reprints of his earlier works, Mr. Rowell exhibits the same ability as in many parts of his “Essay on the Cause of Rain.”

The Laws of the Winds prevailing in Western Europe. By W. CLEMENT LEY. Part I. 8vo, 164pp, 27 plates. Stanford.

THE development of what may be described as synchronous, or still better, as chartographic, meteorology is bearing its natural fruit in advancing with rapid strides our knowledge of the "Laws of the Winds." Our Meteorological Office have not yet given us daily, or, like our Transatlantic brethren, *tri-daily* weather-maps, but we understand that we are to have them. Meanwhile, hard workers like Mr. Ley make the maps for themselves, and perhaps in so doing learn their details more thoroughly than if they had them ready to their hands. In the book before us Mr. Ley gives us the first part of the results of ten years' study of synoptic charts of Western Europe. After a brief introduction, in which he points out "the constantly accumulating testimony to the invariability of Ballot's law," and its bearing upon previously accepted theories, he passes on to state his views as to (1) the cause of the formation of the areas of barometric depression which so frequently traverse Western Europe, and (2) the reason of their normal eastward progression. The author's abstract of his views is so clearly expressed that we cannot do better than quote the paragraphs:—

"1. Extensive precipitation occurring in a region of atmosphere previously approaching a condition of tranquillity, is the primary factor of every system of baric depression, with its resulting atmospheric circulation, retrograde in the Northern, and direct in the Southern hemispheres.

"2. Such an atmospheric circulation being established, the changes in their capacity for aqueous vapour which its currents undergo in consequence of the unequal distribution of solar heat, tend to propagate the depression in an Eastward direction."

Mr. Ley is silent as to the originality or otherwise of these propositions, and we therefore infer that they are purely and simply the results to which he has been led, he being probably unaware that a somewhat similar but far less complete form of Proposition I. was published some 30 years since by Mr. Rowell of Oxford. The second proposition we have never seen before.

The body of the work is devoted to illustrating these propositions, which we consider extremely well done—our only objection being to the extreme neatness of the charts. We of course do not object to neatness *per se*, but we think isobars should *always* have their value marked upon them. We think the employment of colour for the principal isobars a good plan, but that it was a mistake to use blue and green in a work which many persons would like to study by artificial light. Mr. Ley's scale runs thus—28·50 orange, 29·00 green, 29·50 red, 30·00 blue, 30·50 brown. We hope that his idea will be copied, but that the chromatic scale will receive further consideration. At first sight it would appear desirable to reject either blue or green on account of insufficient distinction, and that stronger contrasts than red, orange, and brown might be adopted, while we do not see any objection to using a thick black line, and if required, a broken or dotted one of either black or any other colour. We do not presume to decide off-hand on the system of the future, but are of opinion that it should be carefully considered and universally adhered to.

REVIEWS.

Observations upon the Climate of Uckfield, constituting a Meteorological Record for the District from 1843 to 1870. Prognostics of Atmospheric Changes, and some Vital Statistics. By C. LEESON PRINCE, M.R.C.S., F.R.A.S., F.M.S. 8vo, 240 pp., 1 plate. Churchill.

THE reciprocal obligations of meteorology and the medical profession date back at least as far as Hippocrates, and have never been more extensive than at the present day; and well, indeed, is it that this is the case, for it is hard to say whether its benefits to therapeutics or meteorology have been the greater. The work before us is an illustration of this correlation of the sciences, for though essentially a meteorological work, it also claims a place on the shelves of medical men, not merely as a treatise on local climate, in which respect it is very good, but because scattered through it are pithy hints, and at the close some important remarks on the geography of phthisis.

Our duty is, however, with the work as a local meteorology, and as such we consider that it takes high rank; not surpassing Howard, but having few, if any other equals. It is impossible in the limits of a brief review, to do more than indicate its contents, and make a few passing comments. In the introductory remarks the author gives a sketch of his observatory, and of the instruments in position, with details as to their heights, &c. The following paragraph strikes us as indicating a singular fact:—

“The funnel of the rain gauge has a diameter of 12 inches, and is elevated six feet above the surface of the ground. This height above the ground has been maintained during the whole of the observations, without any appreciable difference in the amount collected in it, and from one of Glaisher's rain gauges, the funnel of which was only four inches above the ground.”

Referring to the British Association Report for 1867, p. 456, we find the following remarks on the pedestal gauge:—

“Gauge correct. Good position in centre of town. . . . Would be rather sheltered if lower.”

From this one might suspect that in Mr. Prince's comparative observations, the lower gauge did not have a fair chance, but we do not think that that is the solution of the anomaly, because a record was kept very near to Mr. Prince's observatory at that of Mr. Brodie, Moulsey Gore, whose gauge was very well exposed, and only six inches above the ground, with the following result:—

Year.	Uckfield Observatory.			Moulsey Gore.		
1865	38·97	...	...	39·35
1866	33·79	...	...	33·40
1867	30·48	...	...	30·48
1868	30·51	...	...	31·78
Mean	33·44	...	...	33·75

Shewing a deficiency of only 0·31 in. or about one per cent. instead of five or six per cent., which is the case almost everywhere else. It is just

possible that Mr. Prince's six-foot gauge may have a round, or rather flat rim, and that the excess thus obtained neutralizes the decrease due to its elevation above the ground. We shall be glad to see this little uncertainty removed. Meanwhile we may note, *en passant*, that the consistency of the records we have quoted is an indication of the thorough trustworthiness of Mr. Prince's observations.

On page 13 our author explains the short method of averaging barometric and other columns with amounts of small variability, which he discovered for himself, but which we thought had been in general use by computers from time immemorial. In the latter part of this chapter there are several handy rules for the barometric measurement of heights, not exceeding 2,000 or 3,000 feet. This is followed by chapters on the general meteorological character of the several months of the year, together with various excellent and useful tables relating to local temperature, and remarks in reference thereto, on hygrometry, rainfall, and wind. Another gives an account of the leading features in the meteorology of each month from 1843 to 1870. The next is devoted to weather prognostics, and contains a translation of the "Diosemeia" of Aratus, which, though not strictly literal, departs therefrom mainly when the insertion of a few words renders more distinct the meaning of the poet. Without pretending to point out sentences which we should alter, we think that those who are accustomed to the easy diction of the Greek original, or acquainted with Böhle's Latin, or Lamb's flowery English translation, will agree with us that Mr. Prince has felt somewhat hampered by his desire to be at once literal and meteorological. His object, however, has been meteorological, and from that point of view we have no fault to find; on the contrary, we consider it will be interesting and useful to all who are not familiar with the original. The work concludes with a short chapter on the vital statistics of Uckfield and adjacent parishes.

Taken altogether the work is one of considerable utility and excellence, in many respects a good example, and one which must take its place on the shelves of all who desire to be acquainted with the climate of the South-east of England.

Papers on the Cause of Rain, Storms, the Aurora, and Terrestrial Magnetism, reprinted from the Edinburgh New Philosophical Journal, &c., with an Appeal for a Consideration of the Theory advanced. By G. A. ROWELL, Honorary Member of the Ashmolean Society, &c. 8vo, 58 pp., 1 plate. Williams and Norgate.

It is by no means every writer whose papers are accepted for publication by the *Edinburgh Philosophical Journal*, whose proposals have been approved by such men as Sabine, Wheatstone, Sir John Franklin, Baden Powell, and others; and who is an honorary member of the Ashmolean Society. Mr. Rowell has received all this recognition, and now sends us a pamphlet, complaining that "class feeling was the great bar to a fair consideration of my opinions," and that his "social position" (whatever that may be) has been the reason why his theories have not

of the black glass ball is cooled to the temperature of the dew-point, its bright surface will be dimmed ; the internal thermometer is then to be read and again a few seconds afterwards, when the dimness disappears ; it is *assumed* that the mean of these two temperature readings is identical with that of the black glass on which the dew is deposited.

The thermometer attached to the pedestal of the instrument is intended to give the air temperature at the time of observation.

This instrument, as its name implies, was designed by Professor Daniell, F.R.S., and was described by him in the year 1820. At the time of its invention, we are not aware that anything at all approaching to its equal as a measure of atmospheric moisture had been designed, and the chorus of opposition with which it was met by the admirers of Saussure's air hygrometer was as unreasonable as it was unsuccessful ; we think, however, that the accuracy of Daniell's instrument has subsequently been overrated ; owing to the necessarily small size of the enclosed thermometer it is impossible to read accurately small fractions of a degree, and we think it quite open to question whether the internal thermometer really is at the same temperature as the outer glass surface ; added to which the necessary proximity of the observer's person must influence the results.

We may possibly recur to this subject when treating of some other instruments, similar in principle, but widely different in detail.

THE WEATHER FROM JANUARY 1 TO JANUARY 7, 1872.

THE rough, unseasonable, and disturbed conditions of the atmosphere during the week seem to claim some notice in these pages. We gather the following notes from various sources, and arrange them in the order of date :—

1st.—Edinburgh was visited by a very severe gale, which seems to have prevailed over a wide extent of country. The streets were rendered dangerous through the falling of slates and chimney cans. Several accidents occurred to pedestrians, but none of a very serious character. The hydraulic machinery foundry of Messrs. Brown Bros., situated between Edinburgh and Leith, was blown down. The loss is estimated at £4,000 or £5,000.

3rd.—A gale began at Falmouth about 8 p.m., lasting till 3 a.m. on the 4th.

4th.—A storm burst over Manchester and its neighbourhood at an early hour in the morning. The wind began to blow hard soon after midnight, and subsequently there was a heavy fall of hail, the stones being as large as marbles. About three a.m., lightning and thunder followed, the flashes of lightning succeeding each other with great rapidity, and being very vivid, and the wind blowing with great fury. The direction of the storm was from south-east to north-west. About half-past 4 o'clock, after an unusually heavy peal of thunder, a

fire was discovered issuing through the roof of St. Mary's Church, St. Mary's-road, Crumpsall.

A terrific thunderstorm broke over the city of York between 5 and 6 a.m., which seems to have been general throughout Yorkshire and Lancashire. Rain and hail fell in torrents, while the lightning was very vivid, and the peals of thunder were very loud. We have not heard of any particular damage in this neighbourhood resulting from the storm.

At Sheffield, about 5 a.m., slight shocks of earthquake were distinctly felt in several parts. Some persons resident in the south-western part of the town state that they were sensibly lifted in their beds by the shock. The thunderstorm was raging at the time, and in the course of it a blade-striker named Howson was killed by the lightning.

At Horbury, in the West Riding, the storm commenced about 4 o'clock a.m. Considerable damage was done to property, in various parts of the town. Buildings were shaken to their foundations by the thunder. Many persons got out of bed and ran partly dressed into the open streets, thinking the place was being visited by an earthquake. The large mill chimney of Mr. W. Ward was struck by the lightning, which threw down a quantity of bricks from the top of the chimney. These fell through the slates of the roof of the drying-house, and then through the floors successively.

At Malton, in early morning, a very heavy storm of rain and hail raged with fearful violence. It was accompanied by loud and frequent peals of thunder, and lightning also flashed vividly at intervals. The rain and hail fell in torrents for some time, and the public grates in the borough were most of them stopped up by the stones and mud which washed down. The streets were, consequently, almost knee-deep in several places, and were like miniature rivers till the storm abated. About half-past 9 a.m. a second storm came on, when it was almost as dark as night.

At 10 p.m. a decided shock of earthquake at Highbridge, Burnham, Somerset.

5th.—Violent thunderstorm, with nearly an inch of hail, at Portsmouth at 7.30 p.m. Lightning in London at 9.30 p.m.

6th.—Three claps of thunder at Cambridge at 0.45 a.m.

MAIDEN NEWTON, DORSET.—Gale, of unusual force, from 8 a.m. of the 4th till 5 a.m. of the 5th. Sudden squall of rain, with fireball and thunder, 4.30 p.m. Severe thunderstorm from 6 to 7.15 p.m., lightning frequent, and from all quarters of the compass. Jan. 6th. Remarkable darkness from 8 to 10.30 a.m. Very sharp thunderstorm, 8.40 to 8.55; five flashes within one mile. No great amount of rain has fallen here, about 0.3 in. each day. There has been little oscillation of the wind, which has varied only a few degrees south or north of west, throughout the whole of the electrical disturbance.

We think that the American plan of marking the areas of high and of low pressure, with the words "High" and "Low" respectively, is better than that of denoting them by the letters A and B. And lastly, as the author lays so much stress upon the fall of rain as the cause of baric depressions, we think it would have added to the utility of the work had some further indication of the distribution and amount of rain been given than the occasional presence of the letter P. As to the work itself, there is no doubt that it is an extremely able one, and that the facts quoted support the author's views to an extent which will make refutation difficult. The instances quoted as typical cases are also very well chosen. We desire to call special attention to three charts of the mean tracks of baric minima in March, August, and December, whose resemblance to and differences from, the run of the isotherms for those months are equally suggestive and instructive. We recommend the work to the attention of meteorologists in this and other countries, and look forward with pleasure to the publication of Part II.

UNDERGROUND TEMPERATURE.

To the Editor of the Meteorological Magazine.

SIR,—I have but little hesitation in replying in the affirmative to Mr. Malet's query in your November number. It is needless for me to enlarge upon the arguments which he has brought against the theory of central fire; but there are some others which I think I can adduce against this doctrine, of the existence of which its very supporters have said, "There is no geological proof."

I. The low temperature of the sea at great depths. At the depth of 1,200 fathoms at the equator, the temperature of $39\frac{1}{2}^{\circ}$ has been found, and also at all lower depths; where then does the inherent central heat commence? If the increasing heat of certain *gaseous* strata, at the trifling depth of 2,400 feet, is brought forward to prove the existence of a central heat, how much more powerful is the argument which can be adduced against it, viz., that at the depth of 7,200 feet, and at lower depths, a temperature of $39\frac{1}{2}^{\circ}$ only has been found. Is it not, to say the least, highly improbable that the increasing heat is caused by a central fire, instead of by gaseous strata?

II. The cessation of volcanic eruptions. Allowing this theory, how can we account for the cessation of volcanic eruption, and if it be said because the central fire is diminishing, why then do fresh ones break out?

Again, if the local basin theory is accepted as accounting for this phenomenon, there is the potent argument against it, of what possible material, as our hardest rocks are expelled as lava, can these "solid partitions" be formed?

I could bring further arguments to testify in favour of Mr. Malet's suggestion, but am reluctant to intrude longer on your space.

Your obedient servant,

F. R. HAWKES-MASON.

Wereham, Norfolk.

DISCORDANT MAXIMUM TEMPERATURES.

To the Editor of the Meteorological Magazine.

SIR,—Can you or any of your correspondents inform me what variations, if any, are due to the size of the bulb of a mercurial thermometer? I have for some years been taking all my observations in duplicate, and I want to discover the cause of the difference in the readings of the two maximum thermometers. The one by maker A, has a bulb more than twice the size of the other, by maker B, (Phillips' principle), both are Kew verified. I append a table of the variation in each month, of the corrected readings since May 1870; adding that the readings of the two minimum thermometers are almost identical. Which thermometer is right? Which wrong? the positions are on either side of a Glaisher Stand, and an error of a degree or thereabouts, makes a difference in the range, both mean daily and extreme. How is the error to be discovered without breaking the series of observations? I shall be grateful for any explanation.

And am faithfully Yours,

J. INGLEBY MACKENZIE, M.B. Cantab. F.M.S. &c.

P.S. My rainfall up to Oct. 31st, 26·07 inches.

	Max. A.	Max. B.	Diff.		Max. A.	Max. B.	Diff.
	deg.	deg.	deg.		deg.	deg.	deg.
May, 1870	59·9	60·1	+0·2	February, 1871.	48·5	49·5	+1·0
June	67·9	68·0	+0·1	March	50·3	51·5	+1·2
July.....	72·6	72·5	+0·1	April	54·5	55·6	+1·1
August	69·3	69·7	+0·4	May	59·2	60·3	+1·1
September	64·6	65·5	+0·9	June	63·0	63·2	+0·2
October	58·6	59·6	+1·0	July.....	65·8	66·0	+0·2
November	49·1	50·1	+1·0	August ..	69·8	70·7	+0·9
December ...	40·0	40·4	+0·4	September	62·9	63·6	+0·7
January, 1871...	39·9	40·8	+0·9	October	57·3	58·2	+0·9

SNOWFALL REGISTRATION.

To the Editor of the Meteorological Magazine.

SIR,—May I be allowed to suggest that, in entering the amount of melted snow in the register of rainfall (daily), the same be entered in coloured ink—violet, for instance—we might then dispense with the prefix “S” mentioned in the “condensed instructions” which appear at the head of this form, and thereby give, if I may so speak, a clearness to the register. The eye could easily embrace the whole of such registrations at once, and the different periods of snowfall would be far more intelligible. The adoption of any course which would bring about such a result must, I think, commend itself. In adopting the suggestion I have here made, the only precaution necessary is to use some colour which may be readily distinguished from the red used for dewfall. The same colour should of course be used by all observers.—Faithfully yours,

JOHN JAMES HALL, F.M.S.

Fulwell, near Twickenham.

HALL'S ELECTRO-MAGNETIC ANEMOMETER.

To the Editor of the Meteorological Magazine.

SIR,—Having some time since experienced considerable difficulty in using the ordinary form of Robinson's Anemometer, owing to the want of sufficient exposure, I directed my attention to, and succeeded in devising, an electrical arrangement to overcome this difficulty, and at the same time introduced an efficient means for the determination of interval or horary velocities. This instrument was first exhibited, and described by me in a paper read before the British Association, Section A (mathematics and physics), Liverpool, 1870.*

The following is a brief *résumé* of its principles and construction :—The anemometer consists essentially of two parts, which are respectively termed the velocity apparatus and registering apparatus. The first is an ordinary set of Robinson's hemispherical cups, which move in a horizontal plane, and communicate their motion downwards by a vertical arbor into a brass box, where it is reduced in angular velocity, and causes an ebonite contact-disc, or *commutator*, in which two platinum contact-pins are fixed, equidistant from one another, projecting on either side of it, to revolve in 0·1 mile (vide Fig. 1). An insulated metallic lever, having a platinum working-face, which best resists corrosion caused by the action of the atmosphere or dust, stands on either side of the disc ; so that, upon the completion of every 0·05 mile, one or other of the contact pins comes in contact with the two levers which form the terminals, and completes the circuit. The levers are then raised a few degrees (of circles whose radii they represent), and, after the transit of the pin, fall back to their normal position, ready to be taken up by the next pin, and so on.

The recording apparatus consists of a train of wheels and pinions working in a frame, or between two brass plates, the arbors of which project through a dial-plate, whereon the circles and figures are engraved, and carry the hands. These wheels are driven by a weight attached to a brass wheel or pulley, working on a double silk-line wound round a barrel to which the driving or great wheel is attached ; and a locking-pin disc, the pinion of which works in the *first* or one-mile wheel, is released at every contact of the cup-apparatus by an electro-magnet, which unlocks the pin-disc, and allows the first hand to advance 0·05 mile on the graduated dial, by a jump similar to the minute-hand in remontoire clocks.

† By turning "on" a "strike-silent" stop at the bottom of, and projecting from, the dial-plate, a hammer lever is brought into connection with the escapement, and strikes a bell at every contact ; therefore, the observer, in noting interval-velocities, may confine his visual attention to the seconds-hand of his watch or chronometer—a *centre*, or *split-seconds*, or *chronograph* would be preferable—while he counts the number of times that the bell is struck, each of which corresponds to

* An abstract of this paper was published in the *Meteorological Magazine*, November, 1870, Vol. V., p. 168. NOTE.—Where 1,500th mile appears, read 0·05 mile.

·05 mile. I have calculated and arranged a very comprehensive series of tables* (consisting of factors, by which to multiply the number of beats observed, to deduce at once the hourly velocity, also wind-velocities and their corresponding pressures) for use with this instrument.

The following formula (which has been re-arranged since the publication of British Association abstract, before referred to) will serve to deduce the hourly velocity from observations during intervals of minutes and seconds. Let T be the interval of observation in min. and sec. expressed decimally, shown by the watch or chronometer, and x the number of times T is contained in one hour, b number of beats on bell, ·05 unit of distance measured, and V velocity required; then

$$\frac{60}{T} = x$$

therefore

$$x \times b \times \cdot 05 = V$$

Therefore, supposing the bell is struck fifteen times in 1^m 30^s, expressed decimally 1.5^m, the hourly velocity will be

$$x = \frac{60}{1.5} = 40$$

therefore

$$V = 40 \times 15 \times \cdot 05 = 30 \text{ miles.}$$

By noticing the exact seconds upon which the first and last beats are struck, the results will be as accurate as if the instrument were capable of recording the one-thousandth part of a mile, while the battery power is less called into action, from which we may infer its elemental duration will be considerably longer. In noting velocities extending over long periods of time, the instrument is read in the same manner as the ordinary cup and dial, or Robinson's Anemometer, or as a gas meter.

The recording-instrument requires winding once for every 2,800 miles, but it may easily be arranged to run a greater distance.

For further particulars, I must refer to the *Proc. Meteorological Society*, XXXVII., Vol. V., p. 301, also to a lecture delivered by me on this subject at the British Horological Institute, June, 1871, *Horological Journal*, Vol. XIV., pp. 7, 13. This instrument was constructed from my plans by Messrs. Smith and Sons, clockmakers, Clerkenwell, and Messrs. Negretti and Zambra.

JOHN JAMES HALL, F.M.S.

SYSTEMATIC OBSERVATION OF AURORÆ.

To the Editor of the Meteorological Magazine.

SIR,—Though no one has taken up the subject of systematic observations on auroras, which I introduced in your pages some time ago, I hope there are some who would join in such an undertaking if it was commenced. I therefore suggest a few provisional rules to be attended to by those who co-operate.

* Not yet published.

1. Observations to be made at the exact hours and half-hours, Greenwich mean time, from twilight up to 10 p.m.

2. If there is an arch, the position of the apex of its central line should be noted with reference to the stars; or else its altitude should be ascertained carefully, and its azimuth approximately. If the lower or the upper edge of the arch is well defined, give similar particulars respecting it. State the width of the arch; state whether it is regular or not. If it is somewhat irregular, instead of its actual position, give that of an imaginary arch having its average position.

3. If there is any other very conspicuous feature, its position among the stars may be observed; care being taken to describe it sufficiently for it to be recognized in any account from another place. But the position of the corona, or point to which the rays converge, is of no value for determining the height of the aurora.

Observers must not consider themselves tied down to observe on every occasion; any observations, if made in accordance with these rules, may be useful.

The observations should be sent, from time to time, to you; or, if you prefer, I will take charge of them.—Yours truly,

T. W. BACKHOUSE.

West Hendon House, Sunderland, Dec. 7th, 1871.

STORM OF THE 20TH DECEMBER.

To the Editor of the Meteorological Magazine.

SIR,—The following particulars recorded at this station may be of interest:—

	Barometer.		Wind.		Cloud Direction	Air Temperature	
	Uncorrected	At. Ther.	Direction.	Force.		Dry Bulb.	Wet Bulb.
	deg.	deg.		lbs persq.ft		deg.	deg.
9 a.m.....	29·714	46	S.W.	0·1	...	46·4	45·3
11 „	·608	47	S.S.W.	11	·	...	...
12½ p.m.....	·488	47	S.W. by S.	13	...	...	...
1 „	·400	47	S.S.W.	14	...	45·8	45·8
2 „	·336	47	S.W. by S.	14	...	48·0	44·0
3 „	·304	47	S.W.	21	W. by S.	46·5	44·2
4 „	·288	48	S.W. by W.	16	W. by S.	45·3	43·1
5 „	·310	47	W.S.W.	15	W. by N.	44·0	42·5
6 „	·392	47	W.	...	W.N.W.	...	...
7 „	·500	46	W. by N.	...	N.N.W.	...	...

Air temperature max. 48°5. Height above the sea 172 feet.

From the changes that took place in the direction of the wind, it would appear that the storm was of a cyclonic character; that the vortex passed from west to east, and north of this station. A comparison of the cloud currents with those on the ground show that the central line of the vortex was inclined from the ground upwards in an advancing or south-easterly direction.

I am, Sir, your obedient servant,

J. R. MANN.

Osborne, Isle of Wight, Dec. 29th, 1871.

DECEMBER, 1871.

Div.	STATIONS. [The Roman numerals denote the division of the Annual Tables to which each station belongs.]	RAINFALL.					TEMPERATURE.				No. of Nights below 32°		
		Total Fall.	Difference from average 1860-5	Greatest Fall in 24 hours.		Days on which ·01 or more fell.	Max.		Min.				
				Dpth	Date.						In shade	On grass.	
							Deg.	Date.	Deg.	Date.			
		inches	inches.	in.									
I.	Camden Town	1·13	—	·37	·41	25	15	49·0	19	20·1	8	11 16	
II.	Maidstone (Linton Park).....	1·62	—	·21	·33	20	19	52·0	15	17·0	8	18 ...	
III.	Selborne (The Wakes).....	2·40	—	·35	·45	25	11	48·0	20	16·5	8	13 16	
IV.	Hitchen	1·15	—	·16	·34	19	23	47·0	18+	19·0	4	17 ...	
V.	Banbury	1·29	—	·38	·45	20	17	48·7	19	17·0	9	17 ...	
VI.	Bury St. Edmunds (Culford).....	·99	—	·50	·20	6	10	48·0	18+	8·0	8	13 18	
VII.	Bridport	2·53	—	·84	·46	28	13	50·0	14+	19·0	7	16 ...	
VIII.	Barnstaple.....	3·15	+	·03	·54	19	20	52·0	31	22·5	5	... ..
IX.	Bodmin	4·70	—	·54	·81	21	24	50·0	30	25·0	5	10 19	
X.	Cirencester	2·33	+	·04	·76	19	10	...	...	...	...	...
XI.	Shiffnal (Haughton Hall)	1·32	—	·36	·25	28	13	50·0	18	16·0	8	18 ...	
XII.	Tenbury (Orleton)	1·47	—	·99	·33	28	13	51·8	14	17·5	9	17 23	
XIII.	Leicester (Wigston)	1·23	—	·29	·35	21	13	49·0	18||	17·0	7	... ..
XIV.	Boston .....	...	...	...	...	...	...	...	...	...	...	...
XV.	Grimsby (Killingholme)	1·69	—	...	·45	20	19	49·0	30	20·0	8	7 ...	
XVI.	Derby.....	1·29	—	·26	·23	25	15	50·0	18	17·0	8	11 ...	
XVII.	Manchester	2·50	+	·17	·36	12	20	51·3	18	17·0	8,9	14 20	
XVIII.	York	2·12	+	·32	·60	30	10	...	...	...	...	...
XIX.	Skipton (Arncliffe)	4·64	+	·09	·55	28	15	48·0	20	12·0	8	17 ...	
XX.	North Shields	1·90	—	·30	·36	22	15	53·0	18	25·0	5,8	10 16	
XXI.	Borrowdale (Seathwaite).....	21·79	+	4·84	3·88	18	22	...	...	...	...	...
XXII.	Cardiff (Town Hall).....	...	...	...	...	...	...	...	...	...	...	...
XXIII.	Haverfordwest	4·58	—	·25	1·00	20*	12	50·6	29	18·2	4	13 15	
XXIV.	Rhayader (Cefnfaes).....	2·23	—	1·06	·56	27	8	54·0	...	15·0	...	6 ...	
XXV.	Llandudno... ..	2·29	+	·09	·38	28	17	56·4	18	25·6	8	2 ...	
XXVI.	Dumfries	3·84	+	·38	·90	24	17	53·0	18	17·0	5	11 ...	
XXVII.	Hawick (Silverbut Hall).....	3·16	—	...	·44	13	19	...	...	...	...	...
XXVIII.	Ayr (Auchendrane House) ...	5·06	+	1·04	·94	17	22	51·0	30	17·0	4	13 17	
XXIX.	Castle Toward .....	...	...	...	...	...	...	...	...	...	...	...
XXX.	Leven (Nookton)	1·98	—	·80	·44	13	15	...	...	...	...	...
XXXI.	Stirling (Deanston)	4·30	+	·10	·74	17	20	53·2	18	17·0	23	24 28	
XXXII.	Logierait	3·12	—	...	·55	13	15	...	...	...	...	...
XXXIII.	Ballater	·78	...	...	·25	3	6	52·0	18	14·5	8,23	18 ...
XXXIV.	Aberdeen	1·66	...	...	·43	28	19	54·6	18	27·4	22	8 29
XXXV.	Inverness (Culloden)	·88	...	...	·15	18	15	53·0	18	29·0	23	4 26
XXXVI.	Portree	11·61	—	4·02	1·86	17	29	...	...	...	...	...
XXXVII.	Loch Broom	5·04	...	...	·72	17	23	...	...	...	...	...
XXXVIII.	Helmsdale.....	1·44	...	...	·24	20	20	...	...	...	...	...
XXXIX.	Sandwick	3·98	+	·01	·50	19	28	54·2	18	28·7	6	6 14	
XL.	Cork	4·20	—	...	1·01	27	10	...	...	...	...	...
XLI.	Waterford	3·90	—	·52	1·40	24	15	52·0	19	27·0	6	10 ...	
XLII.	Killaloe	3·54	+	·05	·61	19	19	54·0	18	18·0	5,6	17 23	
XLIII.	Portarlington	1·82	—	1·38	·31	20	25	54·0	18	20·0	4	16 ...	
XLIV.	Monkstown	·91	—	1·71	·25	19	10	...	...	...	...	4
XLV.	Galway	2·44	...	...	·42	30	25	53·0	13§	20·0	5	9 ...
XLVI.	Bunninadden (Doo Castle) ...	3·60	...	...	...	...	...	...	...	...	...	...
XLVII.	Bawnboy (Owendoon) .....	...	...	...	...	...	...	...	...	...	...	...
XLVIII.	Waringstown	1·97	...	...	·24	21	19	54·0	18	19·0	4	15 27
XLIX.	Strabane (Leckpatrick)	2·58	...	...	·48	12	22	...	...	...	...	...

* And 28. † And 19. ‡ And 18, 20, 30. § And 19, 29. || And 30.
+ Shows that the fall was above the average ; —that it was below it.

Mr. Stow's latest observation, having often noticed the tail of a shower (seen against the sky) hang like a fringe cut at an angle to the line of rainfall. We have here, then, a tendency to approximation of rain-drops, which must have a *constant* effect on elevation differences.

Once more,—to argue the matter inversely,—if the best definition of rainfall is “the drops that water the earth,” we may expect to find the means adapted to that end. Accordingly we do find that from the greater resistance of the air,—due (1) to accelerated velocity of fall, and (2) to increased density of the air itself,—there is a constantly increasing pressure, which, as it is proportionally less the larger the drops are, favours (if it does not produce) condensation and coalescence. And hence we may infer that the normal state of the atmosphere is adapted to conduct rainfall of constantly increasing density at an approximately uniform medium velocity to the ground.

In exceptional cases of heavy rain, where complete precipitation has occurred in the upper strata, with no distributive action of wind below, may not the resistance of the air due to greater velocity of fall, subject the drops to greater *friction* than the cohesion of their surface-particles can bear, and so tend to diminish their size? I think it highly probable that in this direction also the atmosphere is a *regulator* of rainfall.

Yours faithfully,

HUGH INGRAM.

Steving, Dec. 30, 1871.

To the Editor of the Meteorological Magazine.

SIR,—Will you allow me to give a short explanation of some parts of my letter in your November number, which have been objected to by some of your correspondents in your December number?

My argument is, shortly, this:—

1. The velocity of the wind is greater at an elevation than it is on or near the ground.

2. The greater the velocity of the wind, the more the rain is deflected from the vertical.

3. Therefore the path of rain at any particular height makes a greater angle with the vertical than it does near the ground.

4. The greater the angle with the vertical, the smaller the area of aperture (to use Mr. Stow's expression) a horizontal gauge presents to the falling rain, as very clearly shown by him at page 207.

5. The greater the horizontal space between the drops, the fewer the drops caught by a horizontal gauge, but not the “sole cause” for it, as stated at page 203.

6. Therefore, the greater the angle which the path of the rain at any height makes with the vertical, the less rain will a horizontal gauge catch, and the angle generally increasing with the height, is generally a cause for the amount caught decreasing with the height—*i.e.*, omitting other considerations, as stated in last paragraph but one, on page 187.

“The horizontal distance of the drops being constantly the same at whatever angle with the vertical the rain may fall” being called a

fact, as stated on page 203, amounts to begging the question, for it seems to me that the point in dispute hinges on the question whether the horizontal distance is the same at all heights, or whether it increases as the elevation increases : when either of these alternatives can once be proved satisfactorily, then, as it strikes me, *cadet questio* as to the influence of the angle.

As my line of argument on page 185 is thought by Dr. Burder, on page 211, to be fallacious, I beg first to say that, in doing so, I was following a mode sometimes used for simplicity of proof of some astronomical problems, as when the sun is supposed to revolve round the earth, instead of the reverse, which is the truth, so for the sake of employing only one figure, I showed the gauge in different positions, and supposed the figure to be turned round, instead of showing the different angles of falling rain, which would have complicated the figure, and consequently could not clearly have been shown in one figure, but it would have required a separate figure for each successive angle, by which means, however, the same proof could as easily have been given.

Instead of encroaching on your valuable space by giving a separate figure to each, I propose now to do the same thing by another mode of figure, showing the same gauge placed promiscuously at different heights, C H, C K, &c. (using the same nomenclature as before), of one and the same shower of rain, by which it is seen that the proportion lost, F H, F K, &c., of the total amount F C which would be caught if the rain were to fall vertically and perpendicular to the surface of the gauge increases, and the proportion caught, C H, C K, &c.,

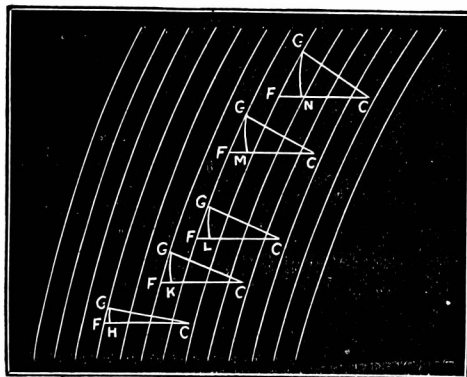


Fig. 1.

of such total amount decreases, with the elevation and with the increase of angle made by falling rain with the vertical (each of the lines C H, C K, &c., being equal to C G).

I trust you will soon pass your editorial judgment on the discussion, as was promised some few months ago, and set the question at rest.

C. O. F. CATOR.

P.S. There is another subject closely connected with this—viz., the advisability or otherwise of setting up gauges whose receiving surface shall be parallel to the general surface of the country in different lo-

DECREASE OF RAINFALL WITH ELEVATION.

To the Editor of the Meteorological Magazine.

SIR,—I think Mr. Stow and Mr. Cator, and some other of your correspondents, confuse themselves by looking at the rainfall in a small gauge, instead of in a large area. Let them take a whole county, and imagine two cords placed round it at the height of, say, 1 ft. and 10 ft. above the ground, to represent gauges at those elevations; it must then be evident that, however the winds may vary in force, or the rain-drops in inclination, the amount of rain that falls within the cord at 10 ft., but is blown into the next county before reaching the lower cord, must be extremely small in proportion to the whole rainfall; so also must the amount that is blown *into* the county between the two cords. With the exception of these very small quantities, we would naturally suppose that the same rain would fall within the 10 ft. cord as within the 1 ft. Now, our small gauges are supposed to show the true rainfall; yet they collect more rain at 1 ft. above the ground than at 10 ft. There can be only two ways of accounting for this: either (as has hitherto been believed) more rain *really* falls at a height of 1 ft. than at 10 ft., and therefore rain must be formed in the intervening space to a sufficient extent to make up the difference; or else (as Mr. Harrison and others suggest) the way in which rain has hitherto been measured is utterly wrong.

I would point out *one* way in which the former theory may be reconciled with the experiments on the inclination of rain. *If* the increase of the rain as it descends is due to its collecting particles of moisture, we may easily imagine that it will increase most in a strong wind, because then it will take so much longer to descend from 10 ft. to 1 ft.—Yours, &c.,

T. W. BACKHOUSE.

Nov. 28th, 1871.

To the Editor of the Meteorological Magazine.

SIR,—Mr. Stow misquotes my letter. I did not say anything about valleys, but drew a comparison between rain caught on a solitary hill and on a pole in a plain; the latter, of course, out of the range of the former's attraction. For the sake of brevity, I avoided explanations of points obvious by the context. He is also in error in speaking of "absorption of much of the rain by the drier strata of air below," for moisture decreases as we ascend, as a general rule. The rainfall of valleys is largely increased by the attraction of the surrounding hills, and this circumstance gives me an annual excess of 10 or 12 inches over Cardiff. If a hill-top is prolonged into a lofty slender peak—say over a mile in height, or perhaps much less—it would be above nimbus clouds, and get too little rain. The principle I advocate would operate at altitudes not high enough to diminish sensibly the attraction of gravitation plus the attractive force of the mountain mass. I thank Mr. Malet for his interesting notes, derived from Indian experience, in corroboration of my views; and for the tone of his expression of

opinion. With regard to Mr. Cator's diagrams, November number, page 184, I may remark that, if we apply the test of figures, the fallacy of his deduction will be at once apparent. Let A B D E and F C (see diagram) be taken as five inches, the diameter of an ordinary gauge, and it will be evident that D E and F C are receiving exactly the same amount of rain. If the gauge be tilted up to C G, it is quite clear that it will only receive rain on about three-fourths of its diameter, and that the whole surface would catch 25 per cent. too much. If this proves anything, it is, that a gauge inclined at right angles to oblique rain would receive much more than a horizontal gauge in vertical rain. This is proving too much, and it would not be a correct measure of the rain received on an equivalent area of the earth's surface. Trusting that this discussion by your correspondents will result in much good, I remain, yours faithfully,

FRANKLEN G. EVANS, M.R.C.S., F.M.S., &c.

Tynant, Radyr, Cardiff, Dec. 19, 1871.

To the Editor of the Meteorological Magazine.

SIR,—Let me again try to pick out the threads which may give a clue to the discovery now sought for. Taking Mr. Malet's Indian experience of the ascending scale of cloud-layers as disposed in rain, drizzle, and mist, may we not accept it as evidence of the cumulative process of rainfall? At the lowest level, rain, those drops which fall (*rainfall proper*), which our horizontal gauges duly measure; at the next level above, drizzle, driven rain (*rain-drift*), of which probably whatever is deflected by the wind beyond 75° from the vertical is carried on, unless intercepted by terrestrial objects, or caught in vertical gauges; and at the highest level, mist, vesicles of aqueous vapour (*cloud proper*), which are carried by ascending currents from the lower to float in the higher strata of air; such, probably, is the normal stratification of condensed aqueous vapour, although, perhaps, in windy weather the three forms of it may be found more or less intermixed near the earth's surface.

But the question still remains *why* rainfall increases as the earth is neared. Of the solutions offered the "electric polarization" of rain-drops near the ground, representing a force of precipitation increasing as the square of the decrease of distance from the ground, seems to me the only *adequate* one. Well then, omitting reference to the auxiliary forces mentioned in the course of this discussion, is there any other mechanical force of a like tendency? I believe there is. For each rain-drop, in displacing air as it falls, creates a vortex immediately behind it so as to suck in and attach to itself the particles of vapour lying nearest its path. Hence its increased size. Moreover, a moving body leaves on every side of its path an oblique train of waves or ripples of air which, as observed in the flight of wild-fowl, presents a *path of least resistance* to a following body; and hence there is a constant tendency to convergence of rainfall towards the part where the air is in this way most freely cleft. I can, on this point, confirm

METEOROLOGICAL NOTES ON DECEMBER.

ABBREVIATIONS.—Bar for Barometer; Ther. for Thermometer; Max. for Maximum; Min. for Minimum; T for Thunder; L for Lightning; TS for Thunderstorm; R for Rain; H for Hail, S for Snow.

ENGLAND.

CAMDEN TOWN.—First 12 days fine, but very cold; thence to the end more mild, with frequent showers.

LINTON PARK.—Sharp frosts from 2nd to 13th, the 8th and 9th being especially severe; but being mostly calm, and a little snow on the ground, its effects were less felt. Brisk wind on 18th and 28th, but the whole of the month after the 13th was mild, with frequent hazy rains, but no heavy rainfall. Dense fog all day on the 23rd, while the next day was bright and sunny. Winds mostly S. and N.W. Bar. generally high from 2nd to 18th, afterwards unsteady. Taken in conjunction with last two months, the three have been the driest I have on record for the like period for 17 years, only 3·82 in. of R having fallen, being less than one-third that fell in the like period in 1859.

SELBORNE.—First half of the month extremely cold, the average min. of the first 12 days being 24°·7. On the 8th the max. was only 28°. A sudden rise of bar. on 20th; at 5 p.m. it stood at 28·9; at 8 p.m. it had risen to 29·44—more than half an inch in three hours, the wind W., and very high. Prevailing winds first half of month, N., N.E. and N.W., afterwards about S.W. Not sufficient S to be measured, though some fell on several days. Very damp from 11th to 17th, dense fog on 17th. On 19th, min. higher than since October (46°). Thrush singing on 26th, and blackbird on 27th.

CULFORD.—First 10 days exceedingly severe, the min. of the year (8°) being on the night of the 8th. From the 11th to the end of the month remarkably mild for the season, the mercury never having gone below 32° since the night of the 10th. Mean temp. of the month 36°·5. Westerly winds during 21 days, and easterly on 10 days. The highest reading of bar. was 30·18 on the 13th, and the lowest 28·90 on the 29th.

BRIDPORT.—First part of the month fine, and very high bar. from 8th to 17th; latter part wet. S.W. gales on 19th, 24th, 28th, and on 31st of Dec. to 1st of Jan. Skating from the 5th to the 9th inclusive.

BODMIN.—Average temp. of month 40°·7, being 2°·1 below the average for December. A very heavy W. gale on the 20th, but of short duration.

SHIFNAL.—An unusually cold December, the first 12 days averaging 25°, and on 18 it was at or below 32°, and on the 8th sank to 16°; on one day only (the 19th) it reached 50°. Up to the 19th very dry, only ·24 of an inch having then fallen. From that date R fell almost every day, and on Christmas Day it rained incessantly. Westerly winds, with two exceptions (23rd and 29th), prevailed throughout. Heavy gale from S.W. on 18th, fog on 23rd and 24th. Vast quantity of hips and haws, and also yew and holly berries. Unusually few woodcocks.

ORLETON.—The dry weather which prevailed during the last month continued till the 18th, with a low temp. and very severe frosts, but no S. The rivers frozen across from the 9th till the 12th; the latter part of the month was warm and rainy, with rough winds. Average temp. of the month about 2°·5 below the mean.

GRIMSBY.—S.W. winds prevailed most of the month, often high. The max. temp. of the month lower than for several years past.

NORTH SHIELDS.—TS on 3rd, S on 3rd, 4th, 6th, and 7th, T on 7th, lunar halos on 18th and 23rd, fine on Christmas Day.

SEATHWAITE.—S on the mountains on 5th and 9th, T H and R on 21st. 3·88 in. of R fell on the 18th, and 3·59 on the 25th. H on the 27th and 28th.

WALES.

CEFNFAES, RHAYADER.—The month has been generally damp, cloudy, and unsettled. Frost at the beginning; the last half mild storms of wind from N.E. and S.E.

LLANDUDNO.—The month has been mild, with a good deal of R and damp. Little wind and no fog. Very fine on Christmas Day. TS, with H, at 6.40 p.m. on 30th. S on the hills from 2nd to 13th.

SCOTLAND.

DUMFRIES.—The first 10 days of the month were fine, but frosty by day. On the morning of the 5th, the protected ther. registered 17°. The remainder of the month was variable, with much R. S on 22nd and 31st.

HAWICK.—Snowstorms on the 1st, 3rd, 15th, and 22nd. Hurricanes on 17th, 18th, and 31st. Hard frost from 4th to the 10th; the rest of the month pretty open.

AUCHENDRANE.—Of the 62 observations this month, the Polar winds were present on four occasions, Calms on 16, Equatorial on 42. Between 1st and 11th occurred the lowest ther. of the month (17° on 4th), and highest bar. on 8th, with no R. Fine winter weather, and ice on 10 nights. Between the 11th and 31st occurred the highest ther. of the month, and lowest bar. on 28th, with incessant R; boisterous weather. Two very heavy Equatorial gales on 18th and 30th. River in high flood; ice on 23rd, 26th, and 29th; L on 20th. On the 14 occasions when the air was at saturation, six were between the 1st and 11th, the cold period of the month; and eight between the 12th and 31st, the warm period; and the air, though of a higher temp. than the December mean, was not so dry as the mean. The strength of the winds and of evaporation are both below the December means.

DEANSTON.—Frosty and fine till the 10th; a very little S on the 8th; gale on 18th from S.W.; frost again, and two inches of S on 22nd, but which disappeared on 25th. Heavy gale on night of 31st.

LOGIERAIT.—Hitherto a remarkably mild winter; chief characteristic, changeableness. This month severe frost, but of short duration, with a few spring-like days. On the closing of the month a considerable rainfall. The rainfall for the year 1871 is 3.43 in. below the average of the last seven years.

BALLATER.—Sharp snowstorms in the beginning of the month; some lay on the ground for 10 days; latter half of month open weather and quiet, with occasional intense frost.

ABERDEEN.—A month of rather dry weather, and somewhat cold, particularly during the first and second weeks. Wind pressure rather less than usual; no winds from N.E., E., or S.E.; S.W. average; W., N.W., and N. above the average.

PORTREE.—A very wet and stormy month; S and frost in first week; gales on 12th, 17th, 18th, 19th, and 31st; very heavy on 17th and 18th, and a perfect hurricane on 31st. All these gales came on from S., and ended from S.W. The old year went out like a lion, and the new one came in like a tiger.

LOCHBROOM.—Except the first few days, which were frosty, in continuance of last month, this month was very boisterous and rainy, with great storms and continued moisture; the only redeeming quality was that it was open for grazing and pasture. The amount of R precisely the same as in October.

SANDWICK.—From the 1st to the 10th December was cold and frosty, with N. winds. On the 10th, the wind changed to the S.W. and W., and of course we had thaw. Since then the weather has been mild and open, with several gales, that did not amount to storms. Auroræ on seven nights; large lunar halo on 22nd and 24th.

IRELAND.

MONKSTOWN.—A December unusually free from rain, but atmosphere very moist; frost only on mornings of 5th, 6th, 7th, and 31st.

WARINGSTOWN.—A fine month on the whole; hard frost from 4th to 10th; three days' good skating.

calities, instead of, as a matter of course, their being always placed horizontally; for the main object is to ascertain the quantity of rain received by the earth in different localities, and if, on an undulating or hilly surface a gauge is placed horizontally, it will not give a specimen of what the inclined surface of the ground would receive, but would catch a greater or less amount than would be received by an equal area of ground, according as the direction of the falling rain at the time of reaching the earth lies above or below the line which is at right angles to the surface of the ground.

For instance, supposing rain to fall vertically, the amount caught by a horizontal gauge at the position P in annexed sketch would anticipate all the rain that would otherwise have fallen on its projection A D, which is greater; or the amount caught by gauge A B would be

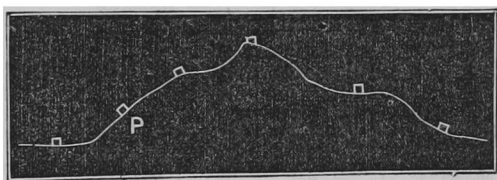


Fig. 2.

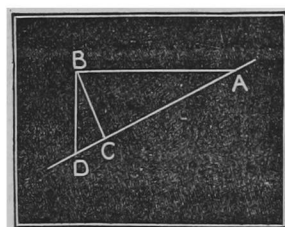


Fig. 3.

erroneously attributed to the area represented by the line A C (= A B), or the error = C D = A D - A C = A D - A B = A B sec. α - A B = gauge's area \times (sec. α - 1) where α = complement of the angle which the falling rain makes with the surface of the ground.

If the rain should meet the ground perpendicular to its surface, the amount caught by a horizontal gauge would be practically the same as would have fallen on an equal area of the ground, or by the formula, error = area of gauge (sec 90° - 90° - 1) = area (1 - 1) = 0.

C. O. F. C.

NOTE.—Two errata in November number: page 185, line 6, for "R C" read "B C"; page 187, line 7, after "sec. 90° " insert "—1."

To the Editor of the Meteorological Magazine.

SIR,—I shall feel obliged if you kindly draw the attention of your readers to two *errata* in my letter published in No. 71: in each of the figures 2 and 3, the letters A and B should be transposed. These errors do not occur in the original draft, but I much regret that I did not observe them when correcting the proof sheets.

I am, Sir, your obedient servant,

JOHN PARNELL.

Hadham House, Upper Clapton, Dec. 1871.